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[ ] 42 COLONIA 71 Z.P. [|] 72 73

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SISTEMAS MARITIMOS Y PORTUARIOS

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" 13	17 a 21 h	Transporte Marítimo	Lic. Enrique Rechy Zárate
" 14 y 15	17 a 21 h	Evaluación de Proyectos Marítimos	Ing. Daniel Ocampo Siguenza
" 16	17 a 21 h	Las Instalaciones y la Operación Portuaria	Ing. Julio Pindter Vega
" 19	17 a 21 h	Empresas de Maniobras en los Puertos	Ing. Enrique Cárdenas Trigos
" 20	17 a 21 h	Administración y Operación Portuaria	Ing. Jaime Jaramillo Vázquez
" 21	17 a 19 h	Instalaciones Turísticas	Ing. Roberto Bustamante Ahum
" 21	19 a 21 h	Instalaciones Pesqueras	Ing. Guillermo Romero Morale
" 22	17 a 21 h	Instalaciones Petroleras	Ing. Mario Rodríguez de la Gal
" 23	17 a 19 h	Puertos Industriales	Ing. Juan Valera Adam
" 23	19 a 21 h	Industria Naval	Ing. Humberto Martínez Nájera

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CENTRO DE EDUCACION CONTINUA

División de Estudios Superiores
Facultad de Ingeniería
U. N. A. M.

SISTEMAS MARITIMOS Y PORTUARIOS

(Curso del 12 al 23 de Marzo de 1979)

INTRODUCCION

En el mes de Febrero del año de 1972, se impartió por primera vez el curso denominado DISEÑO Y CONSTRUCCION DE OBRAS MARITIMAS; posteriormente del año de 1974 a 1978, se han ofrecido anualmente cursos similares con el título PROYECTO Y CONSTRUCCION DE OBRAS MARITIMAS Y PORTUARIAS.

Debido a la gran demanda y al éxito obtenido en dichos cursos, así como a los comentarios tanto de alumnos como de profesores en el sentido de que, era conveniente ampliar el tiempo de exposición de los diferentes temas, para poder comprenderlos y discutirlos en forma más razonable, se decidió que, en este año de 1979 se impartieran cuatro cursos en relación con la Ingeniería Marítima y Portuaria, con otra inovación adicional, consistente en otorgarles créditos académicos a los participantes que obtengan una evaluación satisfactoria en el examen que deben sustentar para ello, o bien, en forma opcional, llevar el curso como oyentes únicamente.

Los cuatro cursos mencionados son los siguientes:

I) SISTEMAS MARITIMOS Y PORTUARIOS, que es el primero de la serie, se inicia el 12 de marzo y se termina el día 23 del mismo mes, con el cual se persigue proporcionar al participante los elementos básicos para la planeación de las obras marítimas y portuarias, describiendo su justificación, administración y operación. Este curso se ha diseñado para proyectistas, supervisores y todas aquellas personas que de alguna manera, participan en la realización de obras marítimas y portuarias. El examen para poder acreditar, en forma opcional, este curso, se llevará a cabo durante la semana que se inicia el día 30 de marzo próximo.

II) ESTUDIOS MARITIMOS Y PORTUARIOS, del 4 al 15 de junio; puesto que, todo proyecto de Ingeniería requiere de estudios previos que, serán más extensos mientras mayor número de disciplinas intervengan, este curso mostrará la importancia de contar con bases de este tipo.

III) PROYECTOS MARITIMOS Y PORTUARIOS, del 13 al 24 de agosto. Tomando como base los dos aspectos anteriores, es posible el proyecto de una obra marítima portuaria, por lo que, en este curso se proporcionan los elementos básicos para ello.

IV) CONSTRUCCION MARITIMA Y PORTUARIA, del 8 al 19 de octubre. Como etapa lógica siguiente a un proyecto, se tiene la construcción, presentándose en este curso los procedimientos de construcción más comunes que existen en la Especialidad de las Obras Marítimas.

Los aspirantes a obtener créditos académicos en estos cursos, deberán presentar el examen o evaluación correspondiente a cada uno de ellos, que será llevado a cabo una semana después de terminado el curso.

En esta forma, dependiendo de los resultados obtenidos, será posible en un futuro próximo lograr la constitución de una Especialización en Ingeniería Marítima y Portuaria, para lo cual se tomarán en cuenta los créditos obtenidos en esta serie de cursos que ahora se presentan, complementados con varios más que a su tiempo serán programados.

Se espera seguir contando con el éxito acostumbrado en todos nuestros propósitos.

L. Herrejón

EVALUACION DE LA ENSEÑANZA

CURSO: SISTEMAS MARITIMOS Y PORTUARIOS

FECHAS: Del 12 al 23 DE MARZO DE 1979

	DOMINIO DEL TEMA	EFICIENCIA EN EL USO DE AYUDAS AUDIOVISUALES	MANT. DEL INTERES (AMENIDAD, FACILIDAD DE EXPRESION, COMUNICACION CON LOS ASISTENTES)	PUNTUALIDAD
Panorama marítimo nacional (Bustamante)				
Transporte marítimo (Rechy)				
Evaluación de Proyectos Marítimos (Ocampo)				
Administración y Operación Portuaria (Jaramillo)				
Empresas de Maniobras en los Puertos (Cárdenas)				
Las Instalaciones y la Operación Portuaria (Pindter)				
Instalaciones Turísticas (Bustamante)				
Instalaciones Pesqueras (Romero)				
Instalaciones Petroleras (Rodríguez)				
Puertos Industriales (Valera)				
ESCALA DE EVALUACION DEL 1 AL 10				

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Muy agradable ☐ Agradable ☐ Desagradable ☐

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5. ¿Recomendaría el curso a otras personas? Si ☐ No ☐

6. ¿Qué curso le gustaría que ofreciera el Centro de Educación Continua? ____________________

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SISTEMAS MARITIMOS Y PORTUARIOS

EVALUACION DE PROYECTOS MARITIMOS TEMARIO A DESARROLLAR

ING. DANIEL OCAMPO S.

MARZO. 1979.

Palacio de Minería Calle de Tacuba 5, primer piso. México 1, D. F.

EVALUACION DE PROYECTOS MARITIMOS

(Temario a Desarrollo)

PLANES, PROYECTOS Y PRIORIDADES (Ref.1.- pág. 13-25)

1. Introducción. Punto de partida. Directrices. Planeación General y parcial.
2. Importancia de la disponibilidad de proyectos.
3. Planes a largo plazo. Presupuestos. Prioridades

LAS DECISIONES SOBRE INVERSIONES. (Ref.2-pág. 11-30)

- El contexto del Desarrollo.
- Objetivos del Desarrollo. Papel del Transporte.
- Plan Integral
- Planificación de las Inversiones en Transportes

PLANIFICACION DEL SECTOR TRANSPORTE (Ref.2.-pág 121-144)

- Factores comunes en la planificación Sectorial. Política de beneficios y precios. Efectos Externos sobre el desarrollo. Los planes sectoriales y bienestar
- Rasgos distintivos de la planificación del transporte. Carácter Global de las inversiones en transportes. Problemas de tiempo y espacio. Problemas de distribución.
- PROBLEMAS Específicos de la planificación. Costos y especificaciones. Mantenimiento. Construcción nueva. Administración.
- Plan óptimo. Conclusión.

EVALUACION ECONOMICA DEL SECTOR TRANSPORTE (Ref. 2-pág 219-246)

- Pasos preliminares
- Problemas de la evaluación de proyectos.
- Medición de los costos económicos. Precios de sombra y otros ajustes.
- Medición de los beneficios económicos. Gastos operativos. Tráfico. Disminución de accidentes. Ahorro de tiempo. Estímulo al Desarrollo Económico.
- Comparación de Costos y Beneficios.

LA ADMINISTRACION DEL DESARROLLO PORTUARIO (Ref. 3-pág. 5-22)

- Plan Nacional de Puertos. Desarrollo Portuario. Planeamiento de largo plazo. La secuencia de las inversiones. Mantenimiento de la capacidad operativa. Planeamiento de plazo medio. El análisis necesario. Servicios. Desarrollo de la organización portuaria. Control de proyectos. Las propuestas para inversiones. El procedimiento de implementación de los proyectos portuarios. Concursos y contratación, supervisión.

PRINCIPIOS DEL PLANEAMIENTO (Ref. 3-pág. 23-35)

- Objetivos. Plan de Inversiones. Principios para el proyecto. La capacidad de atraque. Costos, Ocupación del frente de atraque. Relación entre los tiempos de espera y de servicio. Planeamiento en relación con las variaciones del tráfico. Planeamiento en relación con cambios inesperados. El óptimo económico de las inversiones. Tráfico programado. Variaciones estacionales. Especia lización. Flexibilidad y cambio tecnológico. Principios de la evaluación de inversiones. Evaluación financiera. Evaluación económica. Costos. Beneficios. Descuentos. Resumen sobre los métodos de evaluación. Decisiones sobre inversiones. Proyectos conjuntos. Incertidumbre

PREVISION DEL TRAFICO (Ref.3-pág.36-46)

- Principios. Descripción del ámbito. Estadísticas. La incertidumbre. El procedimiento de predicción del tráfico. Tráfico ro-on - roll off. El mercado. Tasa de crecimiento. Eventos. La política del puerto. Tendencias. Estacionalidad. Carga general y el producto nacional. Tráfico en containers. Heuterlaud Tráfico originado por agencias gubernamentales. Tráfico de transbordo. Cambios tecnológicos. Arribas al puerto y tamaño de embarques. Tamaño de las embarcaciones.

PREVISION DE LA PRODUCTIVIDAD (Ref.3 - pág. 47-51)

- Errores en la estimación de la productividad. Productividad efectiva. Eslabonamiento de operaciones. Condiciones locales. Incremento de la productividad. Productividad a largo plazo. Incremento de la productividad con los embarques mayores. Efectos que reducen la productividad. Metas de productividad.

PLAN MAESTRO Y ZONIFICACION (Ref.3 - pág.52-66)

Localización. Aproximación a un plan maestro. Clases de puertos.

Configuración del puerto. Puerto industrial. Rellenos. Uso de la tierra. Principios generales. Ingresos provenientes de expansiones del puerto.

- ALGUNOS ASPECTOS DE INGENIERIA
- TRANSPORTE INTERIOR
- MANTENIMIENTO Y EQUIPAMIENTO

(Ref. 3 Pág. 67-101)

EVALUACION DE PROYECTOS (Ref. 4 pág. 1-119)

- Evaluación Económica. Evaluación Financiera
- Costos económicos
- Beneficios económicos.
- Comparación de costos y beneficios.
- Otros aspectos.
- Discusión de ejemplos y casos.

EVALUACION DE PROYECTOS MARITIMOS

Referencias

Ref. 1 "Recursos Financieros y Reales para el Desarrollo"
John H. Adler
C.E.M.L.A - 1465

Ref. 2 "La Inversión en el Transporte y el Desarrollo Económico"
Gary Fromm. (The Brookinys Institution 1965)
Ediciones Troquel - 1974 (Traducción)

Ref. 3 "Port Development"
U N C T A D
United Nations - 1978

Ref. 4 "Evaluación de Inversiones Portuarias"
U N C T A D
Naciones Unidas - 1977

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SISTEMAS MARITIMOS Y PORTUARIOS

EVALUACION DE PROYECTOS MARITIMOS

"PORT DEVELOPMENT"

UNIT NATIONS

MARZO, 1979.

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References to dollars ($) are to United States dollars.

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In particular, the secretariat has been actively assisted in preparing the handbook by Mr. B. Nagorski and Mr. S. M. Maroof and by the consulting firms of Rendel, Palmer and Tritton, and Sir William Halcrow and Partners.

Valuable information has also been supplied by Bremerhaven Lagerhaus Gesellschaft, Manalytics Incorporated, the National Ports Council of the United Kingdom, the Overseas Coastal Area Development Institute of Japan, Peat, Marwick, Mitchell and Company, the Planning and Research Section of Los Angeles Harbour Department and Sea-Land Service Incorporated.

The UNCTAD secretariat would also like to express special thanks to the Governments of Denmark, Finland, the Netherlands, Norway and Sweden whose generosity in providing a grant made it possible to undertake this work.

The UNCTAD secretariat is pleased to state that Mr. A. J. Carmichael, Ports Adviser in the Transportation Department of the World Bank, and other Bank staff members working on international port development have welcomed the publication of this handbook and commended its use as a reference manual.

The valuable comments and suggestions made by the World Bank staff are most gratefully acknowledged. While the opinions expressed in the handbook are those of the UNCTAD secretariat, the individual members of the World Bank staff who have read the text have agreed with the secretariat's view that port development based on the methods recommended is likely to be economically and technically sound.

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ABBREVIATIONS USED IN THIS VOLUME

Names of bodies and organizations

API	American Petroleum Institute
FIDIC	Fédération internationale des ingénieurs-conseils (International Federation of Consulting Engineers)
IAPH	International Association of Ports and Harbours
ICHCA	International Cargo Handling Co-ordination Association
ISO	International Organization for Standardization
PIANC	Permanent International Association of Navigation Congresses
UNCTAD	United Nations Conference on Trade and Development

Other abbreviations

BACAT	Barge aboard catamaran
CFS	Container freight station
dwt	Dead weight tonnage
FCL	Full container load
FLASH	Feeder-LASH
f.o.b.	Free on board
GNP	Gross national product
grt	Gross registered tonnage
IRR	Internal rate of return
LASH	Lighter aboard ship
LCL	Less than full container load
LNG	Liquid natural gas
LPG	Liquefied petroleum gas
n.a.	Information not available
NPV	Net present value
PERT	Progress evaluation and review technique
ro/ro	Roll-on/roll-off (of cargo loading and unloading)
TEU	Twenty-foot equivalent unit
VLCC	Very large crude carrier

INTRODUCTION

(i) For many years the UNCTAD secretariat, through its Ports Section, has made consistent efforts to help developing countries in their task of extending and modernizing their seaports, which form a vital link in the chain of transport. The training of competent personnel, for both port management and port planning, has been one of the main goals. Port training courses, fellowships and a number of technical publications have been widely used by UNCTAD for this purpose.

(ii) It became apparent during the course of this work that there was a real need for a reference book in which the basic principles of modern port planning were summarized in an easily understood form. The present handbook is intended to meet this need.

(iii) The paramount importance of a far-sighted port development policy does not appear to have been fully appreciated in the past by many governments. As a result, ports have often been unable to keep up with the rate of expansion of a country's overseas and coastal trade.

(iv) The consequences of a failure to provide proper port capacity *before* the increased traffic arrives are clearly illustrated by the recent congestion in many ports of the world, in particular in developing countries. The enormous sums of money lost through congestion would often have been sufficient to build a lavish system of modern ports.

(v) Seaports can, moreover, play a major role in promoting international trade by generating commercial and industrial activities which directly assist the economic progress of the country. The history of many European ports—for example, Hamburg, Antwerp, Marseilles, the ports of Poland and, in particular, Rotterdam—shows how a bold policy of extending and modernizing ports can revitalize the economy of a region.

(vi) The immediate aim of the handbook is to offer daily guidance to port planners in their difficult task of formulating a national port development policy and preparing realistic programmes for the extension and improvement of individual ports. The long-range purpose is to contribute to the training in developing countries of competent port planners, able to co-operate on equal terms with international experts and foreign advisers.

(vii) The first part of the handbook deals with general principles of port planning and with procedures to be applied for establishing a practical and consistent programme of work, for forecasting traffic and productivity, and for studying various problems that have a direct impact on the development of ports.

(viii) The handbook suggests that the preparation of a port development programme should follow a definite sequence of steps, which are outlined, so as to ensure that the work of planners is more systematic and efficient and that nothing of importance is forgotten. However, since it is impossible to deal adequately in one volume with the myriad problems that affect the planning of a major port, it was felt necessary to concentrate, in the handbook, on those points that appear to be least familiar to planners in developing countries, and to refer only briefly to other subjects. It is recommended that port planners should endeavour to build up a reference library on the subject of port development, and to this end a list of publications by private specialists, international organizations and the secretariat of UNCTAD is appended to the handbook, in annex III.

(ix) In the second part of the handbook, methods of planning various kinds of port facilities are discussed. Procedures are described for the preparation of plans for general cargo berths and for specialized terminals where containers or bulk cargoes are to be handled. Sound and realistic decisions on port investments must be based on accurate numerical analyses of several alternatives and on correct procedures for selecting the most advantageous plans.

(x) The use of sophisticated methods has not been recommended. Instead, a set of straightforward methods has been developed by UNCTAD, mainly in the form of curves and diagrams based both on empirical data and on mathematical calculations. They offer a degree of numerical exactitude comparable to that of many of the advanced computer-based approaches and are more satisfactory for general use.

(xi) The decision to recommend simple manual methods was taken after several years of testing the computer-based approach of the UNCTAD secretariat's early work in the simulation of seaports. Although that early work made possible the development of the simplified methods recommended in the handbook, and served as a basis for the UNCTAD research programme on port development, it became clear to those engaged in the work that the use of computer-based methods by port planners in developing countries would be too costly, both in time and in scarce skills, to be justified in the majority of cases. This conclusion has been reinforced by the realization that, during the present period of rapid

technological change, the input information in those countries will continue for many more years to be uncertain and inexact.

(xii) Port planners ought, rather, to bear in mind that there is no substitute for experience and sound judgement. Diagrams and formulae are merely an auxiliary tool for their work, a means of relieving them of time-absorbing calculations and of freeing their minds for creative work. Port planning is a challenging and complex task but not an exceptionally difficult one. It requires a full understanding of the way in which an efficient port works, a sound knowledge of the general economic conditions of the country, a good deal of common sense and a certain talent for visualizing the future.

(xiii) It is hoped that this handbook will prove to be a useful contribution to the common international goal of establishing a world-wide system of efficient ports. It is unlikely that many of the decisions that may be taken with the aid of the handbook can be implemented before the early 1980s, by which time many technological changes may have occurred. It is of the utmost importance, therefore, that all port development plans should be as flexible as possible in order to ensure a prompt response to changing demand.

Part One

Chapter I

THE MANAGEMENT OF PORT DEVELOPMENT

A. The need for a national ports plan

1. Technological improvements in recent years have made it essential to plan the transportation system of a developing country as a whole, in order to achieve a balance between the capacities of the various parts. In maritime transport it is sometimes possible—particularly for bulk and unitized cargo movements—to include the shipping, port and inland transport facilities in one co-ordinated plan. In other cases the ship traffic is not under the control of the planner and it is only possible to co-ordinate the port facilities with those of inland transport and distribution. Planning a sea-port without considering the connecting road, rail and barge facilities may lead to serious faults in national communications. This is particularly true in the case of developing countries, in many of which the freight traffic is rapidly growing and changing. Co-ordinated planning is discussed further in part one, chapter V, on master planning and port zoning.

2. Within the ports sector, a balanced plan is needed for each class of maritime traffic. The number of ports, their specialization and their location have to be considered. Although some countries still permit free competition between their ports, this is no longer seen as acceptable where national resources are limited. For example, the trend towards handling bulk commodities at specialized, high-throughput terminals (the annual throughputs of which are measured in millions of tons) means that the whole national traffic flow of a particular product may be handled at one terminal irrespective of apparent geographical requirements. To allow this traffic to spread over a number of ports, as may happen without national planning, will mean either that each can only afford to install low-volume equipment, which will not allow the country to take advantage of the economies of scale obtainable throught the use of large bulk carriers, or that each port has to invest large sums in under-utilized terminals. Either alternative will lead to steep increases in unit costs which may often far outweigh the increased land transportation costs resulting from the development of a single, specialized, high-throughput terminal.

3. With regard to all classes of freight, there is a growing need to avoid the over-investment which can result from competition in a context of increasingly expensive cargo-handling technology. The example of European container berth investment during the 1960s, when the total capacity installed was several times greater than the demand, is one that developing countries can ill afford to follow.

4. Recent technological changes in transportation methods require such specialized cargo-handling facilities that there is a strong case for the regional co-ordination of investments in specialized terminals. The joint planning of port investment by countries sharing the same hinterland can clearly be economically advantageous, but in any case it is now virtually obligatory for each country to develop its own national ports plan.

5. The factors which should be taken into consideration in the preparation of a national ports plan are illustrated in figure 1. It would be advisable to use that figure as a check-list to determine which aspects require further study before any major port investment decision is taken. The amount of work involved would probably justify the maintenance of a small permanent nucleus of professional planners, to be augmented by an additional professional team when a full revision of the national plan is needed.

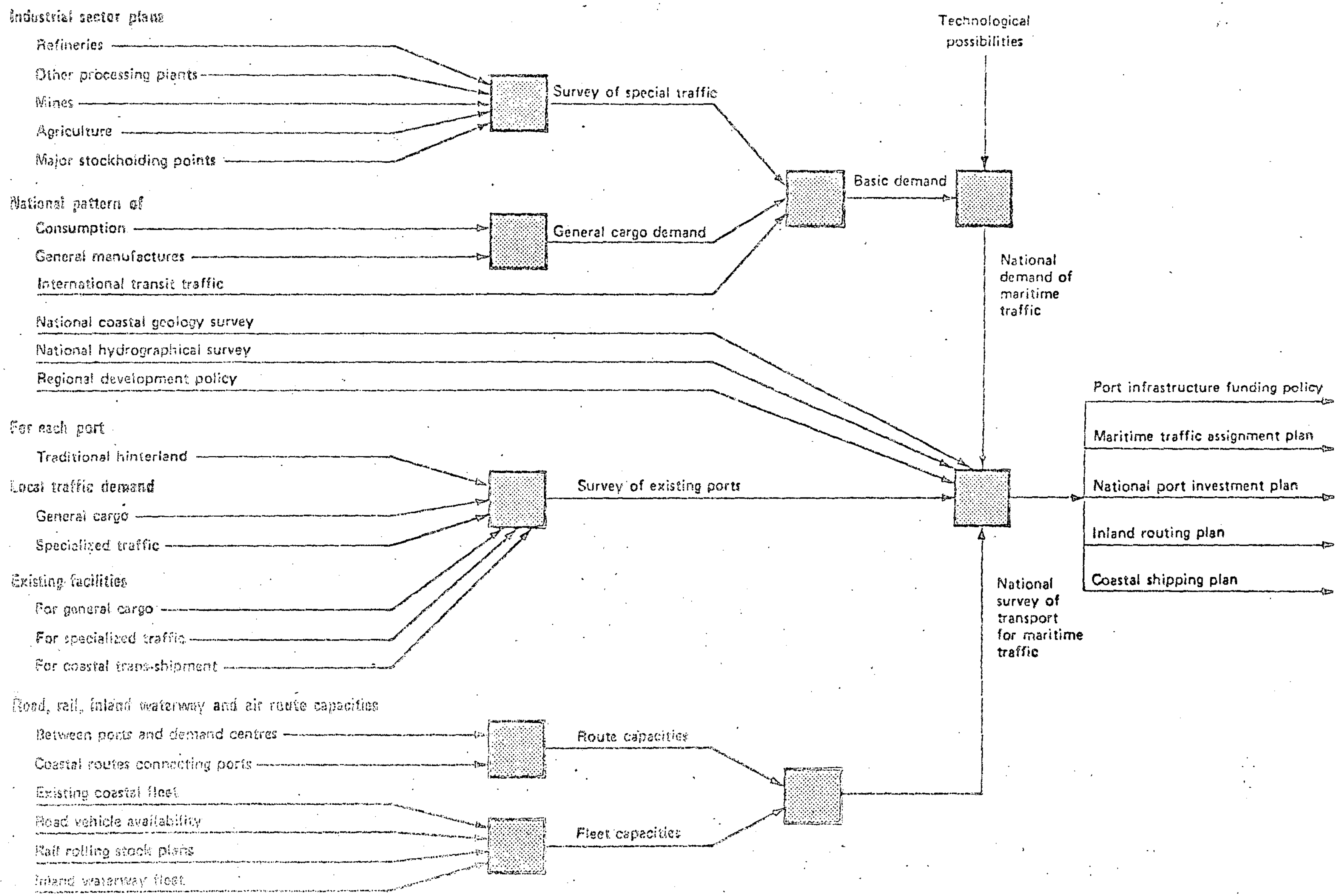
6. The main activities indicated in figure 1 are the forecasting of the national demand for maritime traffic transport, the surveying of existing ports and the national surveying of the means of transport available for maritime traffic. In addition, where major new terminals are under consideration, it would be advisable to make preliminary surveys of coastal geology and hydrography.

7. A number of related plans will result from this examination: a maritime traffic assignment plan; a national port investment plan; an inland routing plan and a coastal shipping plan. All of these will be conceived at a broad strategic level only, the planning of detailed facilities being left until each specific port development project is prepared.

B. The national ports authority

8. A further requirement at this point will be a decision on the policy as to which parts of the port infrastructure will be paid for by the central government and which by the individual port authority from its own revenue. There may be certain large capital expenditure items that would place too heavy a strain on port finances if they were to be supported from income while charges were maintained at a reasonable level. Some would argue that only the connecting road and rail systems should be excluded

FIGURE 1
National port planning



from financing by the port and others that major long-term structures such as breakwaters and work such as approach channel dredging should also be partly or wholly charged to the central or regional government. It is for each government to decide this policy according to the financial capacity of existing ports and the expected profitability of planned new ports.

9. In deciding to what extent the central government should retain the responsibility for setting port development priorities, it should be borne in mind that an individual port authority may be limited by its physical boundaries from finding what is economically the right location for a new terminal. In times of change, a port authority is likely to place emphasis on those alternatives which preserve or enlarge its level of activity. Modern technological developments make such tendencies undesirable from the point of view of the country as a whole, as the location of existing port facilities may be inappropriate for the use of the new technologies.

10. For such reasons there is a strong case for setting up a specialist government agency with the overall responsibility for co-ordinating port policies at a national level. To build up and maintain the capability needed, and to allow a free interchange of ideas with the many interests involved, it may be more appropriate for the agency to be separated from the central government ministry concerned and to take the form of a national ports authority with defined statutory powers, such as those listed below. There is a close parallel to the move in a number of countries towards national airport authorities, national oil authorities and so on. A small permanent secretariat would be appropriate.

11. For efficient management of port activity, the operational decisions should be taken locally; it would normally be wrong to give a national ports authority any operational responsibilities. Its main function should be one of co-ordination and regulation, the principal aim being to prevent the undesirable duplication of investments. The statutory powers which it may be appropriate to give to a national ports authority are as follows:

(*a*) Investment: power to approve proposals for port investments in amounts above a certain figure, for example, $5 million. The criterion for approval would be that the proposal was broadly in accordance with a national ports plan, which the authority would maintain.

(*b*) Financial policy: power to set common financial objectives for ports (for example, required return on investment defined on a common basis), with a common policy on what infrastructure will be funded centrally and what locally; advising the government on loan applications.

(*c*) Tariff policy: power to set a common tariff structure (local conditions will determine to what extent the authority should also regulate tariff levels).

(*d*) Labour policy: power to set common recruitment standards, a common wage structure and common qualifications for promotion; power to approve common labour union procedures.

(*e*) Licensing: where appropriate, power to establish principles for the licensing of port employers, agents, etc.

(*f*) Information and research: power to collect, collate, analyse and disseminate statistical information on port active for general use, and to sponsor research into port matters as required.

(*g*) Legal power to act as legal adviser to port authorities.

12. It would be advisable for such an authority to set up a method of obtaining advice from persons with wide experience in the matters of harbours, shipping and inland transport, in industrial, commercial, financial and economic matters, in applied science and in the organization of labour. An appropriate method would be to co-opt such persons onto the Board of the authority or onto its subsidiary committees. Liaison would also take place with national bodies representing shippers, shipowners, etc.

13. The risk involved in giving such an authority powers over port investments and tariff policy is that additional delays may be introduced. It would be essential, therefore, to institute in addition an emergency procedure to speed up or even by-pass the normal decision process when, for example, there were sudden changes in traffic or rapid increases in congestion.

C. Port development

14. Within the broad national strategy, the development of each individual port must be comprehensively planned. The development of a port consists of a combination of medium-term and long-term planning of new facilities plus in the case of an existing port—a programme of short-term action to improve the management, the present facilities and their use.

15. For each investment there must be, first, a planning phase, which ends in a recommendation on which course of action the port should follow, giving only a broad treatment of each technical aspect; secondly, a decision phase, which can be substantial and includes the securing of funds; thirdly, a design phase, which turns the chosen plan into detailed engineering designs, and lastly, the construction or implementation phase. This handbook is concerned mainly with the planning phase, and goes only into sufficient technical detail to supply the information necessary to produce preliminary cost estimates. Final cost estimates are predominantly dependent on the engineering difficulty and magnitude of the project. These estimates must be made, and the subsequent engineering design and construction work carried out, after the conduct of more detailed investigations by qualified civil and mechanical engineers, in consultation with the port authority. This handbook makes no attempt to provide a substitute for the use of such professional staff.

16. The long-term plan—the master plan as it is often called—consists of a view of the future situation as it will be after a series of individual developments have been carried out. However, it does not try to say whether and exactly when each of them will occur, since this will depend on traffic development. The master plan will be set within the framework of the national ports plan and in turn will provide a framework within which the medium-term plans for action can be drawn up and specific projects defined. This principle of going from a broad long-term plan to a detailed medium-term proposal should be a standard procedure.

17. The programme of immediate practical improvements for the use of existing facilities can, however, go ahead independently of the medium- and long-term plans. There will always be an urgent need for moderate technical and operational improvements, such as the extension of available storage space, the introduction of additional cargo-handling equipment or the purchase of pilot boats or lighters. Improvements of this kind are independent of future capital investments and should not be delayed until the main investment plan is finalized.

18. For example, the identification and removal of bottle-necks which impede the productive flow of goods may be studied by the methods indicated in UNCTAD's report on berth throughput.[1] This approach can be undertaken at any time independently of the planning project, but it would be advisable for sufficient analysis of throughput to be made by the middle of the planning phase to give reasonable practical estimates of future productivities. The establishment of these estimates is one of the most important and difficult tasks of the port planner.

D. Long-term planning

19. In order to prepare both the national ports plan and the master plans for individual ports, the planner needs to ascertain the development framework within which each port will be operating. To do this he should consider the following aspects:

(*a*) The role of the port, which may include some or all of the following tasks:

- (i) To serve the international trading needs of its hinterland as reflected by traffic forecasts, either in total for all needs or excluding specific commodities (e.g. bulk commodities which are to be handled at special terminals outside the port's responsibility);
- (ii) To assist in generating trade and regional industrial development;
- (iii) To capture an increased share of international traffic either by trans-shipment or by inland routing;
- (iv) To provide transit facilities for distant hinterlands not traditionally served or for neighbouring land-locked countries.

(*b*) The extent of the port's responsibility for infrastructure needs, as follows:

- (i) Marine responsibility, which may be total, from landfall to berthing, or may exclude estuarial, river or canal approaches or the financing of major marine works (e.g. main breakwaters, capital dredging);
- (ii) Landward responsibility, which may be total, including road/rail links between port and inland depots, etc., or may exclude either links shared with other users or local connecting roads/sidings.

(*c*) The land-use policy for the port, which may have freedom within fixed boundaries, or freedom to acquire or dispose of adjoining land either on the open market or with compulsory purchase, or freedom to acquire non-adjoining land for storage, for inland clearance depots, or for additional berths at new coastal locations.

(*d*) The financial policy as regards the port, which may be either fully commercial, self-supporting and with freedom to set tariffs as necessary, or subject to restrictions on tariff policy linked to a limitation on commercial accountability or subject to public control as an instrument of national development.

20. The long-term plan will place more emphasis on what is desirable than on what the trends seem to show to be likely. The planner needs to place himself in the future situation, even if this is 20 years hence, and try to draw a consistent picture of all that he will find at that time.

21. This picture will allow the planner to lay out a sensible future situation which is at least feasible and far-sighted, even if there can be no certainty that its details are correct predictions. The land-use aspect and that of the major water areas and channel developments are the most vital features of the long-term plan. These must be provided for in a manner consistent with the expected increase in traffic, which over a long period can be quite substantial (for example, a one-million ton level increasing by 10 per cent each year for 20 years becomes 6.7 million tons). Modern technological developments have made the need for ample land space still more imperative than was the case in the past. A container terminal or a major terminal for ores requires an area of tens of hectares. Clearly, failure to earmark substantial land areas may mean that residential and other forms of development may use them up first.

22. The industrial planning policies of government—central, regional or municipal—together with the national ports plan when available should give much of the framework necessary to set each port's objectives. But it would be unreasonable to expect those responsible for such policies to be very precise at the outset since their understanding of the possibilities of port development is likely to be incomplete. Therefore, after talking to the authorities concerned, and collecting what views exist, the port planner will almost certainly be left with some unanswered questions. He will then be forced to fill

[1] *Berth throughput: Systematic methods for improving general cargo operations* (United Nations publication, Sales No. E.74.II.D.1).

these gaps by making his own assumptions on the long-term role of the port. It is far more important to reach a reasonably comprehensive interpretation of this role, within perhaps one month of starting the project, than to attempt to get an accurate and formal official statement.

E. The sequence of investment

23. Strictly speaking, since the short- and long-term investment plans form part of the same sequence of financial investment and of economic benefits, the whole sequence should be considered as one programme, and the planner should look for the over-all economic optimum for the whole series of investments.

24. But this is an ideal which cannot yet be realized, since the methodology necessary to calculate such a complex economic optimum is not yet satisfactory.[2] The best that can be done at the present time is to try to set out a series of the main investment alternatives and to calculate at each main date of investment and of commissioning what will be the costs and the benefits. Planners may be assisted by research units or consulting firms in making a broad pre-investment study of the country. The basic aim will be to determine the general direction of expansion and to quantify the tonnage to be handled and how it will be shipped. By making calculations for a range of possible investment programmes for this traffic, the planner may succeed in devising a programme which is not too far from the optimum, although even this will entail a good deal of work. To simplify the process, only rough calculations need be made during the initial phase of filtering out options mentioned above. It may be helpful to point out that the long-term plan can be based on a definite sequence of investments, largely irrespective of the rate at which trends develop, so that, although the sequence itself may be fairly firm, the timing of them will be flexible.

25. The master plan should have a continuous existence as a formal port reference document. It should be modified periodically, either as a result of a definite decision to take a fresh look at the whole future situation at a given date (and in the present rapidly-changing technological stage in shipping a three- to five-year revision would be advisable) or as a result of events in the course of the current period which make a review desirable.

F. Maintaining capacity during engineering work

26. An existing port must continue to provide an undiminished service during the execution of an improvement or extension project. It is usually the expectation of more traffic than can be handled that is the justification for the project, and it will be self-defeating if the project work itself is allowed to cause congestion from which it may be difficult to recover.

27. An operational programme must be prepared, showing, for the whole duration of the work, how the growing traffic is to be handled in spite of any closures or obstructions. This may show that there will be a need to provide additional temporary facilities purely to maintain capacity during the execution of the project. Such facilities are a financial charge to the project and it may be that their cost will swing the balance over to the choice of a different engineering option. In any case, there will need to be a careful phasing of the engineering work and the commissioning of temporary facilities.

28. The difficulty of maintaining capacity may even cause the port development strategy to be modified. For example, the construction of a new group of berths in two stages may cause less interference in operations than closing a larger area of the port to build them all in one project. Conversely, the faster completion of the group in one project instead of in two consecutive partial projects may in certain cases be less disruptive.

G. Medium-term planning; the feasibility study

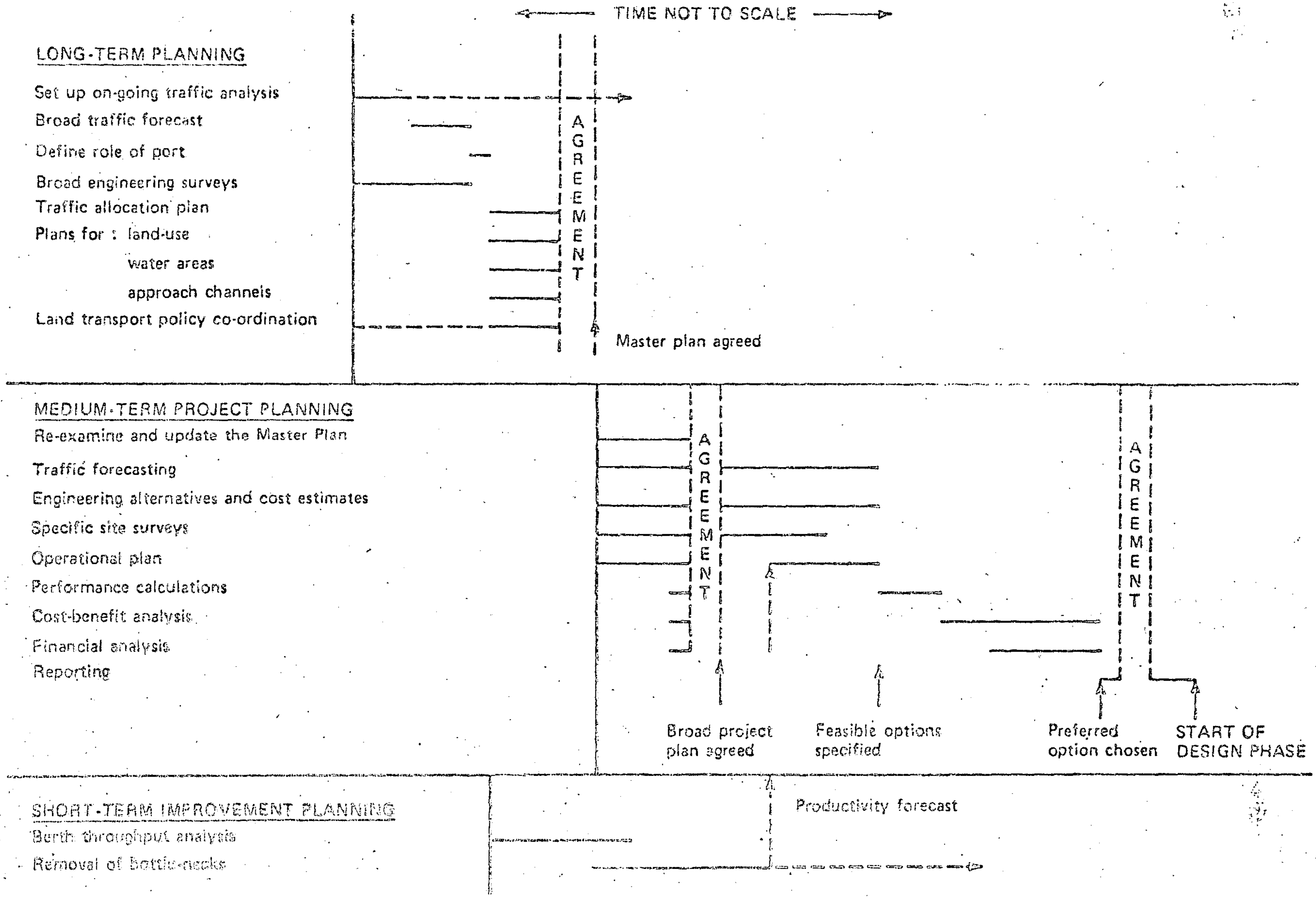
29. A medium-term plan is detailed, usually taking the form of a feasibility study of the best way to satisfy a particular requirement, and it is followed by the design phase. The medium-term plan must be consistent with the master plan and it must be seen as one step in its implementation. A feasibility study claiming to show the need to deviate from the master plan must produce strong evidence in support of this claim. If the deviation is accepted, the master plan will need to be revised to take account of the possible effects on other facilities. All these processes take time, and there may be instances where during the time-lag a clear case develops for a change of direction—for example, if there is a development in technology. It could then be fully appropriate to make the necessary changes even in mid-project, provided that the cost implications are clearly analysed and accepted.

30. Each feasibility study should preferably cover only one medium-term proposal. For example, the decision to build a container terminal should be studied as a separate issue from the decision to enlarge the storage capacity of the general cargo berths. Very often, however, both for reasons of administrative convenience and because of physical relationships within the port, several such projects are combined in one feasibility study and one report. Although this is acceptable, the numerical analyses for the various projects should be separate. It is not helpful to include in one economic or financial appraisal several different investment proposals. For example, a combined proposal for two additional break-bulk cargo

[2] The mathematics involved are not complex, but the interaction of costs and benefits of varying sequences of investment produces a heavy load both on analysts and computer time which, in view of the uncertainty in the forecasts of traffic, productivity and costs, is not justified.

FIGURE 2

The port development medium-term project plan



berths and a new bulk cargo terminal will confuse the decision if only one set of cost and revenue figures is given. It may be that the break-bulk cargo berths are economically justified but are financially loss-makers; the joint proposal will hide this fact and conceal a cross-subsidy from the profitable bulk cargo terminal. This subject is discussed further in part one, chapter II, on planning principles.

31. Inevitably there will be several areas where technological changes are taking place which might markedly affect the investment plan. Some of these will lie outside the port personnel's own experience, and the project leader of a port development project should seek external advice on these subjects. For example, it should not be his responsibility to carry out an extensive review of the trends in ship technology or cargo handling methods. Much work has already been done on these topics, and he should be able to refer to it. In the case of any difficulty, reference can be made to the UNCTAD secretariat, which will help wherever possible.

32. Similarly, in economic forecasting, it is not the job of the port planner to carry out an international or even a regional trade forecast, however important these are for him as a basis for calculation of the expected traffic. He should go to other sources for such economic forecasts—normally, the national economic planning agency. However, having pursued those sources as far as possible, he is likely to be left with incomplete information and to have to collect further data himself through various sources such as traders and banks.

33. The procedure of devising a medium-term plan involves finding the solution to a specific requirement and culminates in a justification for investment. It is normally carried out as a clear-cut project with a well-defined programme of work. It is advisable to prepare a summary bar-chart of the full range of project activities, in a form similar to that shown in figure 2. Diagrams of this kind show a sequence of activities, pointing out which ones have to be terminated before the next one starts and thus need to be given priority; they are useful in setting out the range of tasks and skills needed. But they should not, once published, be treated as sacred. In particular, it is not advisable to prevent a subject from being considered before its scheduled time on the chart. The central portion of the bar-chart in figure 2, dealing with the medium-term project plan, has three main stages indicated by the vertical arrows.

34. The first stage which, after a period set aside for agreement by the authorities, leads to a broad project definition, should take perhaps 10 per cent of the time available, although if little thought has been given to the needs of the future port before starting the project, 20 per cent might be more advisable. Furthermore, if no master plan exists, it may be necessary for a substantial amount of time to be allocated first to the collection of traffic data and the carrying out of preliminary geological and hydrographical surveys.

35. The work of the second stage includes the preparation of detailed traffic forecasts and broad engineering studies, and the specification of all the feasible alternatives, together with rough cost esti-

TABLE 1

Check-list of the steps involved in preparing a port development plan

1. *General development policy:* Identify the role of the port and its range of planning and financing responsibility (long-, medium- and short-term).
2. *Traffic forecasting:* Carry out a traffic forecast for the time period of the development in question.
3. *Technology policy:* For each class of traffic that is forecast, and bearing in mind the expected form of presentation of the cargo, examine the alternative port handling techniques and their impact on future productivity.
4. *Traffic assignment:* Group together traffic classes with similar or compatible characteristics and assign them to separately planned berth groups or terminals.
5. *Preliminary determination of dimensions:* For each berth group or terminal, use the planning charts to find the approximate level of additional facilities required, and make a rough estimate of their dimensions.
6. *Preliminary site selection:* For each alternative combination of berth groups and terminals, propose alternative water and land areas of appropriate size and in locations that will not cause interference with the traffic in adjoining zones.
7. *Engineering feasibility:* For each of the locations, carry out the engineering studies needed to show all the main categories of work involved. Adjust site locations where necessary to eliminate excessively costly proposals.
8. *Rough cost estimates:* Estimate the cost of constructing and equipping each of the facilities under consideration.
9. *Preliminary narrowing down of alternatives:* From all information available so far, and where necessary repeating the interrelated steps 4–8, eliminate the less attractive alternative solutions.
10. *Discuss conclusions with decision authority and obtain agreement on a short list of possibilities.*
11. *Operational planning:* For all alternatives retained, prepare a plan showing how the facilities are to be operated, what equipment is needed and what will be the productivity target.
12. *Final determination of dimensions:* Repeat step 5 at a detailed level, using the appropriate planning charts.
13. *Preliminary design:* For each alternative solution, design the layout of all facilities required in sufficient detail to show up any problems in the matter of access by water or by land and in the location of operating and storage areas.
14. *Detailed cost estimates:* Refine the cost estimates for all works and services in order to produce a basis for the economic and financial analyses.
15. *Cost-benefit analysis:* Analyse the economic case for each of the alternatives.
16. *Financial analysis:* Analyse the financial viability of each alternative and review the available methods of achieving financial health.
17. *Final selection:* Bring together all analyses and compare the over-all advantages and disadvantages of each alternative so as to produce a recommended solution.
18. *Discuss conclusions with decision authority and obtain agreement in principle on recommended solution.*
19. *Reporting:* Formalize agreed solution in a report with supporting analyses.
20. *Obtain authority to proceed with implementation and arrange for local and international funds.*

mates for each. It also includes the important task of considering, for each alternative, what operational plan and cargo-handling methods will be used. In order that the answers to these practical questions should be realistic, a productivity forecast should be made on the basis of progress recorded to date in consequence of the short-term improvements. This stage should take at least 30 per cent of the project time.

36. The third stage involves the carrying out of the analyses which will show which of the alternatives are the more attractive, and it culminates in a recommendation for a single solution. It is likely to be the longest stage, taking more than 30 per cent of the time. It includes, first, the carrying out of performance calculations to determine what level of service will be given by each combination of traffic and facilities, and then, on the basis of these performance figures, the filtering-out of alternatives, with the use of economic and financial analyses. A twenty-step list of the tasks involved in the preparation of a port development plan is given in table 1. The sequence of tasks illustrates the method of gradually narrowing down the alternatives.

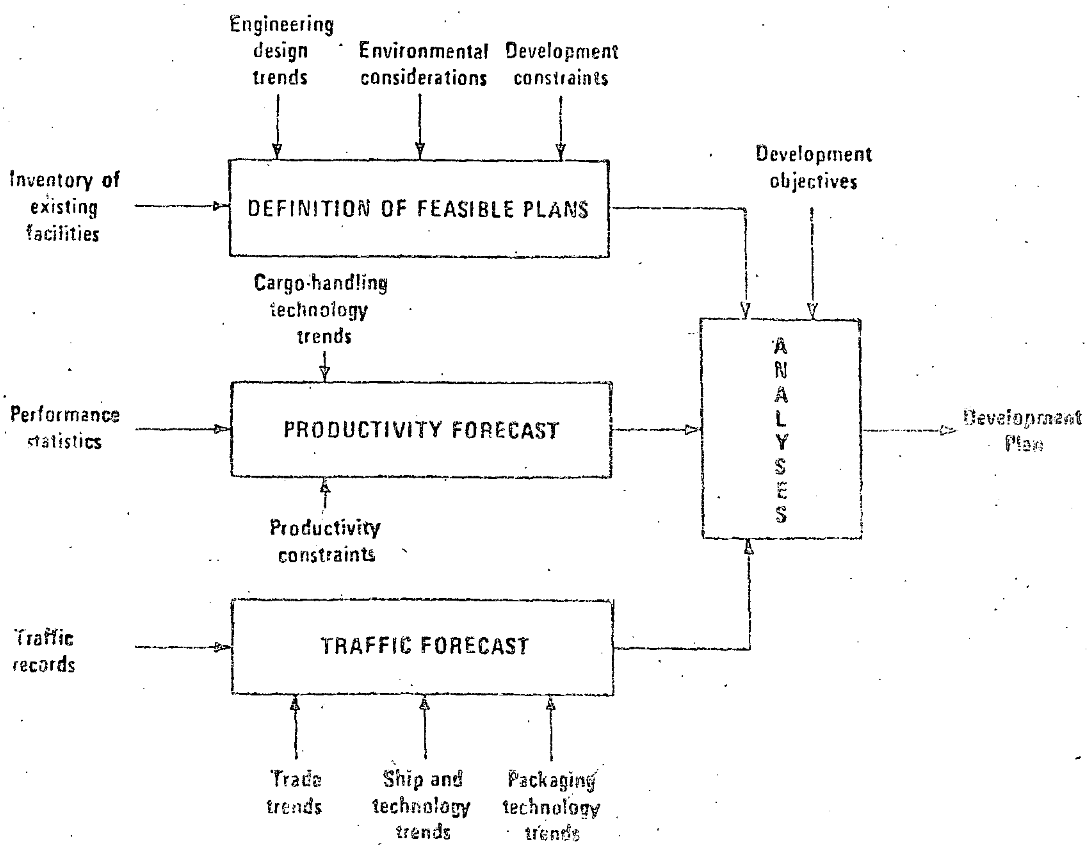
H. The analyses needed

37. In the third stage there is a danger that an inexperienced team will put the emphasis on the wrong task. The economic cost-benefit analysis and the financial analysis, which shows whether a facility will pay for itself, are by far the most important tools to be used in reaching the right investment decision. However, they entail rather laborious and routine calculations which are less interesting to make than the calculation, by novel methods, of the performance of each of the alternatives for the various forecast traffic levels. The appeal of such performance calculation techniques (for example, that of simulation with the use of a computer) can lead to an excessive amount of the valuable project time being spent on them. If a team has a suitable simulation model available, and is experienced in its use, then the work can be done quickly. If, however, the team is new to the method, it should on no account set out to learn the technique during a port investment appraisal. The gain in precision will certainly be at the expense of an excessive amount of time and effort.

38. However, the performance calculations are important and some of the simpler methods which have been used in the past are insufficiently accurate for present needs. For this reason the UNCTAD secretariat has carried out a research programme for the development of a new methodology which will offer a middle course between rules-of-thumb and computer simulation. This methodology is described in part two of this handbook. It consists of sets of general curves which, given a reasonably accurate set of practical input data, give a sufficiently accurate basis for the economic analysis. The performance curves pro-

FIGURE 3

Information needed for port development project



vided have been deliberately designed to have an accuracy matched to the accuracy of the relevant facts and figures known to a typical port planner.

39. To reach a single recommendation on investment, the calculations will need to be done for a number of cases, each concerned with the handling of future traffic by a set of future facilities working at a future productivity. The relationship of these information needs in port development planning is shown schematically in figure 3. Central to this information are the operational statistics necessary for productivity forecasting.

40. In summary, the port planning team will need to be provided with the skills and the time needed to carry out each of the following analyses:

(*a*) A performance analysis to determine the effect of different levels of port capacity on the level of service provided to the port's customers;

(*b*) Engineering studies to determine the feasibility and approximate cost of each design;

(*c*) Operational planning to determine how the proposed facilities will be used and what the productivity and the operating costs will be;

(*d*) An economic analysis to compare the desirability of each alternative in terms of the stream of costs and benefits it generates;

(*e*) A financial analysis to determine what the revenue will be at different traffic levels and tariffs and whether such revenue will support the costs of the facilities and the servicing of any loans. The effect of the project on existing costs and revenue, and the resulting financial viability of the whole port, must also be studied.

41. Certainly, the whole project involves a considerable amount of work, but in view of the importance to the national economy of finding the right decision, this work is fully justified. It is just possible to bring all these calculations together in one computer model which provides an "optimum" solution. However, this is a very expensive procedure and unsatisfactory as a basis for investment decisions. Planners should rather continue to carry out an individual analysis, with consistent data, for each of the alternatives they wish to study in detail. Where the team has access to computer facilities and skills, these should be applied first to the laborious but straightforward task of carrying out a cost-benefit analysis of a range of alternative proposals, and of their sensitivity to uncertainty in the input data. A well-documented computer programme for this work is available on request from the Central Projects Department of the World Bank.

I. Ancillary services

42. A complete port development plan must include provision for many facilities which are ancillary to the main port operations of trans-shipping and storing cargo. These range from fire-fighting and rescue services to document-handling and data-processing systems. Ancillary services are discussed individually in later chapters and a check-list is given in table 2. They will generally require financial provision, which in total can be a substantial addition to the total costs of the project. Even if certain ancillary facilities were to be financed separately, provisions should be made for any land required within the framework of the land acquisition plan.

TABLE 2

Check-list of ancillary port services

1. Pilotage;
2. Tugs;
3. Harbour craft;
4. Navigation aids;
5. Fire-fighting facilities;
6. Rescue service;
7. Medical service;
8. Port security and policing services;
9. Dangerous material area;
10. Equipment maintenance areas;
11. Canteens;
12. Rest-rooms and temporary living quarters;
13. Recreational facilities for ships' crews and port workers;
14. Fuel bunkering facilities;
15. Services (water, electricity, sewerage);
16. Ships' provisions and spare parts;
17. Minor repair facilities;
18. Quarantine facilities;
19. Lighting (for night work);
20. Communications (including ship to shore);
21. Pollution control (buffer zones; facilities for purification of contaminated waters);
22. Waste disposal (dumping areas; incinerators, crushers);
23. Environmental protection (beaches, green areas, open spaces, landscaping).

J. Development of the port organization

43. The selection of an appropriate form of port administration is a matter of port policy rather than part of the preparation of a specific port development plan. The basic system of port administration, whether it is to be an autonomous or a centrally directed administration, should be determined by the national ports authority. However, there are certain organizational elements of the administration which are the responsibility of the local port authority. A check-list of these elements is given in table 3.

44. In the case of a new port or of an independent port terminal, planners should take the opportunity to make suggestions for modifying and improving these organizational elements. The possibility of escaping from traditional bad practices can be a powerful argument for developing a new port rather than expanding an existing one. But even in the latter case, where the proposal is for further development of an existing port, the opportunity to introduce modern management techniques in the new facilities should be taken wherever possible. In particular, the introduction of new technologies can spur changes

TABLE 3

Check-list of organizational elements needed in a port administration

1. Organizational structure;
2. Administrative procedures;
3. Cost analysis and control;
4. Tariff structure;
5. Consignment documentation and customs procedures;
6. Electronic data processing and telecommunications systems;
7. Data collection, analysis and dissemination procedures;
8. Staffing and manning policies;
9. Staff selection procedures;
10. Training programmes;
11. Marketing and public relations (including the education of potential users of a proposed new facility).

which will improve the operations. For example, the development of a container terminal can be accompanied by the introduction of modern data-processing methods to improve the quality of the information necessary for managers to control the flow of containers.

45. In any case, whether or not major investments are being made, as the demands on the port change and as the modern business environment changes, there may be a need to adapt the organizational structure of the port and possibly to introduce new functions.

46. It is difficult to generalize as to the best organizational structure for a modern port, but a typical structure is given in figure 4. Attention is drawn to the planning section within the management services department, with responsibility for the following tasks:

(*a*) The analysis of trends in existing traffic and performance statistics;

(*b*) The analysis and forecasting of future traffic, in terms of shipping and cargo tonnage by types and routes;

(*c*) The evaluation of information on new technologies in ships and cargo handling as they affect the future port tasks;

(*d*) The analysis of requirements in water and land areas, equipment and storage;

(*e*) Liaison with all other planning authorities concerned;

(*f*) The preparation and maintenance of the port master plan;

(*g*) The preparation of specific project proposals.

For major new works, an implementation section may be formed within the engineering department which is given responsibility for the construction of the new works.

47. There may be local reasons why the structure should be substantially different. Further, it should be appreciated that such an organization is more particularly appropriate to a larger port which is to a great extent responsible for its own affairs. For smaller ports, or where it is more appropriate for control to be exercised over several ports together, a number of these responsibilities would naturally be assumed by the appropriate ministry or by the national ports authority. Nevertheless, it would be unwise to transfer any of the functions listed entirely to the central body. However small the port staff may be for the performance of a particular function, a substantial degree of authority and skill should be retained at each port. An exception to this may be the legal affairs function, for which it may be difficult to justify keeping professional staff in each port.

K. Project control

48. It is not necessary, for the supervision of a general port planning project, to use methods of monitoring and control as detailed as those of the engineers who will have to design or construct the facilities. The use of a PERT network is out of place here and critical path methods make little sense in this type of analytical project.

49. A simple method of control is to identify successive goals, or "milestones", along a bar-chart, and to check progress towards each of these goals at regular progress meetings. Satisfactory "milestones" can be simply the completion of the three stages described, each ending with an intermediate decision.

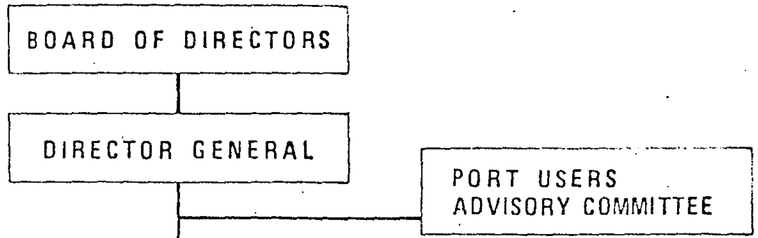
50. Monthly progress meetings would be appropriate in most cases. These meetings should be informal, technical and as extensive as the subjects demand. This will often require at least a half-day of discussion about the work, and this time should be considered well spent.

51. Formal progress reports to management or other authorities can be dispensed with in many such projects. Automatic monthly or three-monthly reports can do more harm than good. A better method is to prepare a report only when there is something of interest to report on, and to provide, on a regular basis, only very brief notes on the subjects discussed at the progress meetings and the actions agreed on. A time-table for producing drafts of reports should be agreed upon in advance.

52. It is inadvisable to delegate responsibility for the whole project to an analyst and let him work in a back room for six months. He must be drawn out of the back room very frequently for discussions with those who know the practical problems. This means that progress meetings should be regularly attended by senior managers responsible for traffic operations and by members of the engineering department. It is more useful to have their views as the work proceeds than to receive their comments after it is finished. However, the project leader must take the initiative in driving on to the end of the project, whatever doubts are expressed (on data accuracy, forecast accuracy, etc.), after he has listened to all comments. Doubts expressed at progress meetings and the need for discussions on technical points should not be al-

FIGURE 4

Typical port organizational structure



	MARINE	TRAFFIC	MANAGEMENT SERVICES	SECRETARIAT	FINANCE	ENGINEERING
	Assistant Director-General for Marine matters	Assistant Director-General for Traffic	Assistant Director-General for Planning	Assistant Director-General for Administration	Assistant Director-General for Finance	Assistant Director-General for Engineering
Personnel	Director of marine Harbour master Pilots Port craft operators Signal tower staff	Director fo traffic Wharf superintendent Wharf inspectors Shed foremen Pier superintendent Port labour	Economist Systems analyst Engineer Cargo-handling expert	Secretary Legal adviser Director of establishment Port police	Director of finance Chief cashier Statistics officer	Civil engineers Electrical engineers Marine engineers Mechanical engineers Draughtsmen
Functions	Channel maintenance Navigational aids Movement of vessels Use of port craft Control of pilots Control of marine staff Registration of vessels Survey of vessels Control of signal tower Marine statistics	Cargo handling Allocation of berths Commercial correspondence and claims Operation of sheds Submission of outturn report Supervision of vessels work Operational control of mobile equipment Operation of barges Control of gates and cargo deliveries Operational statistics	Management information system Planning Port promotion Market research Organization and methods study Preparation of quarterly reports for Director-General	General and despatch section Port security Staff cars Public correspondence Accidents Archives Preparation of agenda and minutes of meetings Liaison with heads of departments Keeping of confidential papers Preparation of annual reports Maintain files for leases, contracts and other legal matters	Collection of revenues Calling of tenders Control, supply and purchase of stores Control and preparation of budget Preparation of salary and bills Payments to staff Payments of public bills Preparation of monthly and annual financial statistics Electronic data processing	All civil engineering works Maintenance of mechanical, electrical, marine and civil engineering works Assistance in port planning Supervision of contractors' work Supervision of slipway and marine workshop

lowed to cause delays. The project leader should insist on steady progress on the basis of the best information he has available, with the objective of reaching the scheduled "milestones"

L. Use of consultants

53. In many cases the planning agency concerned with the port development will feel that it lacks certain of the skills needed to complete the work, and, whilst retaining over-all control, will wish to hire individual specialists in the missing skills. In other cases, it will be felt preferable to contract out the work in its entirety. Both alternatives are acceptable, but in the hiring of outside assistance certain points should be borne in mind:

(*a*) Past work, and previous planning studies, even if shelved and not acted upon, should be made available to the new team. Furthermore, even if there are points to criticize in such past work, it will often be more valuable to engage the same team again to carry out a revision or to study a new requirement, than to make a fresh start with a new team.

(*b*) It can cost more to ask for urgent early answers than to give the consultants more time to carry out the work at its natural pace.

(*c*) The outside team should be contracted to spend a substantial part of the study period at the port location. In return they should be provided with a high standard of office accommodation conducive to intensive work during this period.

(*d*) Consultancy contracts should name the individuals to be employed on the contract and care should be taken to check the capability of the individuals named. It cannot be assumed that a high-grade corporate capability will be reflected in high-grade individual performance if this is not done.

(*e*) A liaison officer should be named by the authority to provide a single point of contact with the team, and this officer should be given a satisfactory level of authority in technical and administrative decisions.

M. UNCTAD assistance

54. Assistance in any of the matters discussed in this handbook can be provided by UNCTAD. Informal requests for minor points of advice may be directed to the UNCTAD secretariat in Geneva. More substantial assistance can be the subject of a technical assistance project within the United Nations Development Programme, formulated in consultation with the Resident Representative in the country concerned.

N. Port development finance

55. The scale of port development can be very large, and in the case of an expanding economy the funds needed will usually require joint action by central government, local municipality and, where appropriate, with international financing organizations.

56. Development projects of as little as one million dollars may be of value, but the more usual port project is more likely to be measured in several tens of millions. At the upper end, it is interesting to examine the financing of a major, self-contained development nearing completion at the port of Kobe, Japan. This takes the form of an artificial port island of reclaimed land, as illustrated in figure 5.

57. The development of Port Island, Kobe, is part of the Osaka Bay Port Development Authority's master plan agreed on in 1968, and in fact reclamation has been in progress since 1966. The work, which is designed to provide 11 container berths and 18 general cargo liner berths, together with full operational and commercial facilities, will be completed in 1980—a total development period of 14 years. The first berth was brought into operation in 1969, three years after the start of work on the project.

58. The total budget for the Port Island development was $466 million. This figure includes the cost of transferring 80 million cubic metres of soil by belt conveyor from a nearby mountain site to the shore and then by barge to the reclamation site. The financing of the project was arranged as follows:

	Percentage
Grants from the central government	10
Grants from the municipality concerned	10
Long-term financial loans from the central government . . .	40
Long-term financial loans from the private sector (shipping companies and terminal operators with exclusive use of facilities)	40

The 80 per cent long-term loan funds are in the form of the issue of Port Development Authority bonds.

O. Contents of an investment proposal

59. The proposal for a major port investment prepared for submission to an investing authority should be set out in a manner similar to the following:

(*a*) Rationale for the proposal;

(*b*) Status of the proposal (will the project proposed compete for capital with other projects, or is it an alternative to another proposal?);

(*c*) Traffic forecast, giving background assumptions, expected future developments, and margin of uncertainty;

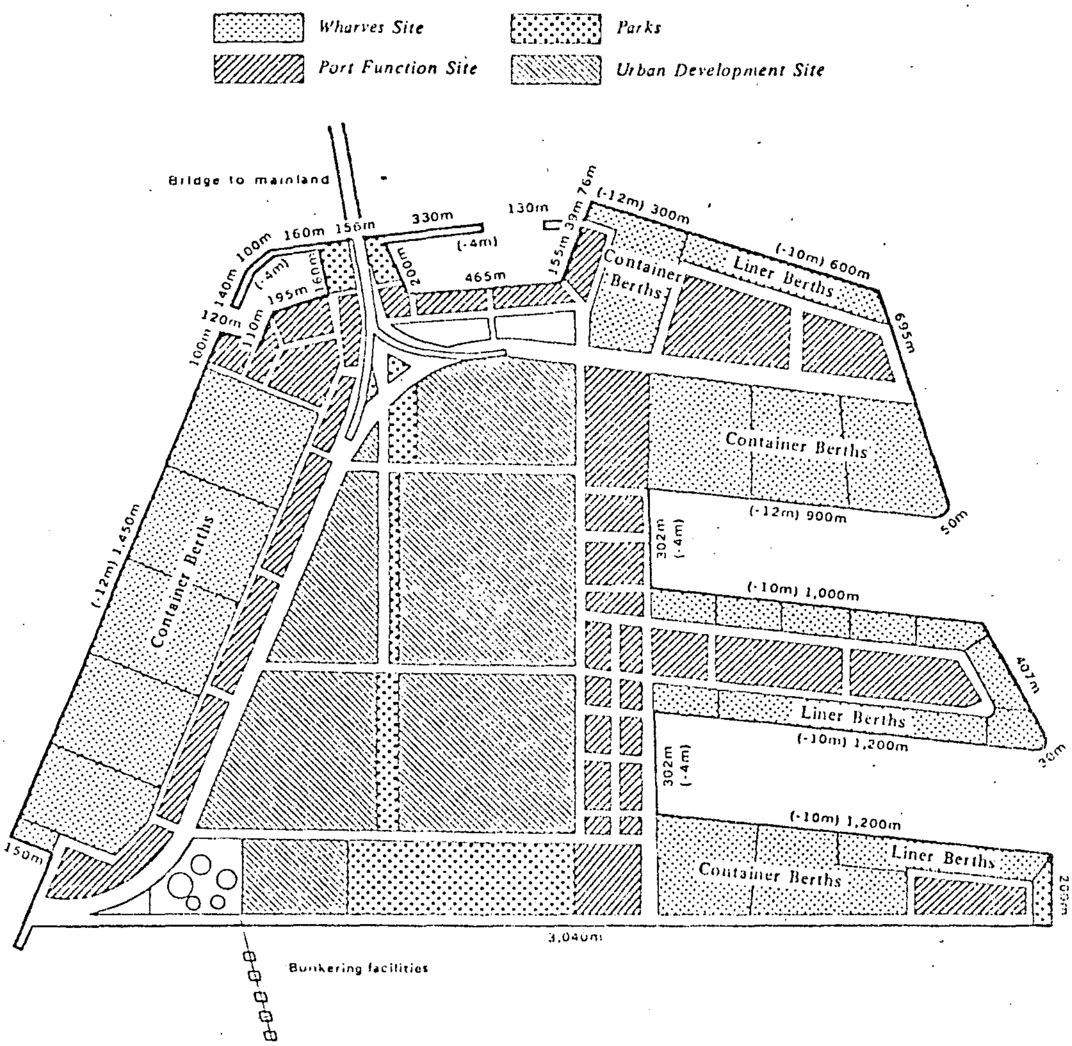
(*d*) Productivity forecast, giving reasons for any estimate which differs from the current productivity, and any training needs associated with this;

(*e*) Operating plan for the new facilities, including traffic allocation policy and contingency plan for periods of peak demand;

(*f*) Performance analysis, indicating expected turnround times and berth-day requirements for each class of traffic;

FIGURE 5

Port Island, Kobe, Japan



(*g*) Tariff proposal;

(*h*) Cost-benefit statement;

(*i*) Financial statement, including cash-flow forecast and statement of risks and uncertainties.

P. Procedure for implementation of port projects

1. THE IMPLEMENTATION SEQUENCE

60. The last phase of preparatory work for a port development project consists in making arrangements for construction. The best plans can be seriously harmed by unsatisfactory construction work or by neglect in selecting the correct building materials. The span of useful life of newly built facilities may be shortened and consequently the amortization of the invested capital made more difficult. Moreover, urgently needed works may be delayed unless the actual implementation of a major port project is carefully prepared.

61. The feasibility study shown in the central portion of figure 2 is followed by a design phase of the selected alternative and is normally carried out by consulting engineers. The field investigations discussed in the chapter on civil engineering aspects are carried out, and detailed layout and design of all facilities is completed, together with cost estimates. It may be necessary to carry part way through this design phase a choice of two major alternatives, postponing the final decision until sufficient engineering and cost implications of each allow a single design to be chosen.

62. The over-all procedure of planning, design and construction is illustrated in figure 6, where it can be seen that even with no delay for decision-making, and with the procurement of funds starting as early as possible in the design phase, the first works are unlikely to be complete in less than 4 years. Therefore as soon as the decision to proceed with the chosen project design has been taken, time can be saved by setting out a systematic programme of dates for the often protracted tendering sequence. Figure 7 shows a typical sequence in which 8 months elapse between the decision to proceed and the point at which the main contract can be signed. A fuller set

FIGURE 6

The over-all procedure for port development

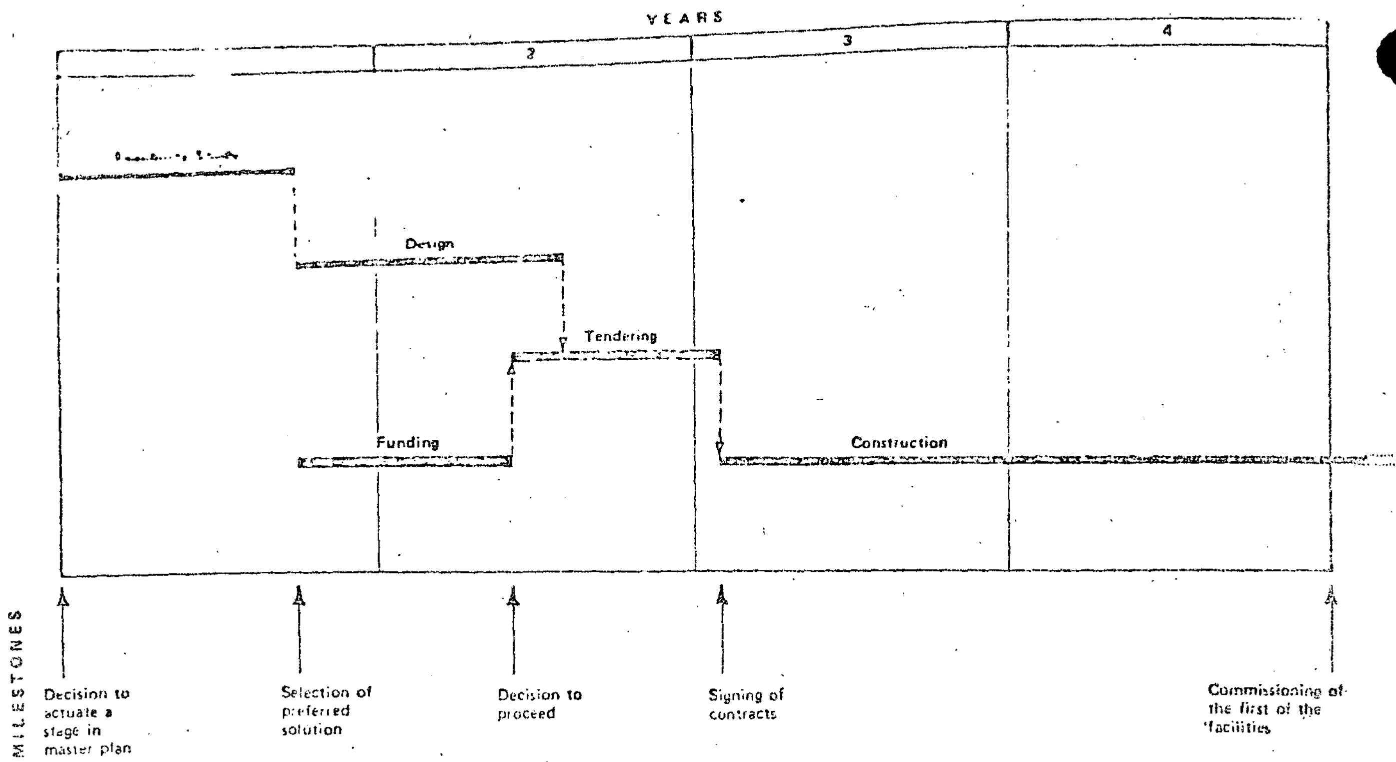
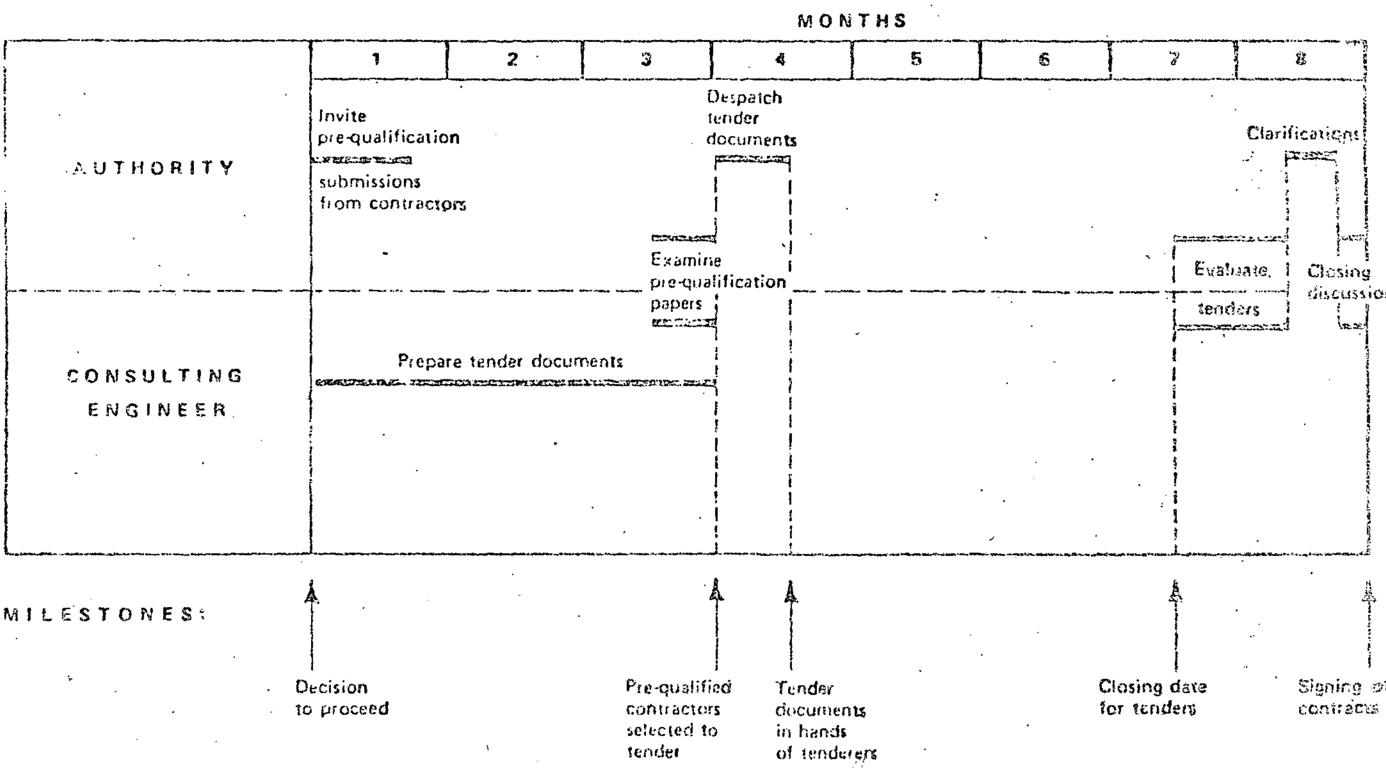


FIGURE 7

A typical tendering sequence



of guidelines for procurement is given in a brochure issued by the World Bank.[3]

2. Tendering policy

63. Particularly for major port projects, it is advisable to seek offers from several contractors in order to be able to select the most advantageous one. Care should be taken to deal only with firms of high professional standard and ample experience in marine construction work. Low-priced offers that may be submitted by less competent and experienced contractors can be very costly in the final analysis, as difficulties and delays may arise and claims may be made for additional compensation.

64. In general, it is desirable that one general contractor should be made responsible for all civil engineering works and for medium-sized specialized installations such as generating plants, lighting equipment and not overly complicated mechanical equipment. Confusion can arise at the site if two or three contractors are carrying out their respective tasks simultaneously, especially if the tasks are of a similar nature. Specialized installations, such as a grain silo or facilities for a major bulk cargo terminal, require contractors specialized in the fields in question. Such services could be provided by a subcontractor nominated in the prime contract. Civil engineering works connected with some special installations, such as foundations, may be left in the hands of the general contractor. For large dredging works, a separate tender is almost unavoidable. Civil engineering contractors cannot be expected to have the necessary costly and diversified equipment.

65. In some developing countries there are capable local contractors of international standing who would normally be pre-qualified. But it would be unwise to restrict tenders for large projects to local contractors, since the benefits of international competition and of an access to a wide range of technical expertise would be lost. The employment of local firms may be obtained by encouraging foreign contractors to subcontract as widely as possible to local organizations for less complicated works. Only for minor projects would it be appropriate to restrict tenders to local contractors. In many countries foreign bidders are required to enter into a partnership with a reliable local firm.

66. For the construction of large port complexes, even the basic civil engineering works can be divided into a small number of separate contracts. The breakwaters may well be built independently from works within the port area as there would be no danger of mutual interference, and since the construction of large breakwaters can be a difficult task requiring the full attention of a contractor. Separate tenders will also normally be arranged for dredging and reclamation, which are usually very extensive in such big schemes. Nevertheless, for the sake of administrative convenience and simplicity a main general contractor may be entrusted with all or most of the construction work with the understanding that, by agreement with the Government, he will enter into partnership with other firms or employ subcontractors.

67. At an early stage, well-known international contractors should be asked whether they are interested in the project and willing to submit offers at a fixed date. If so, they should send pre-qualification papers listing their relevant experience and achievements. Advertisements in professional publications or leading daily newspapers can supplement individual letters in order to reach a wider range of firms. The character and scope of the project need be only very briefly indicated in the letters and advertisements.

68. Upon receipt of pre-qualification papers a list can be prepared of firms qualified to submit tenders. At this point the temptation to pre-qualify too many contractors should be resisted. However, a proportion of those invited will normally not tender. The objective is to have sufficient tenders to obtain a broadly based comparison. Tender documents are then sent to the selected firms with a request to submit offers by a certain fixed date. The tender documents will be the basis of the future contract. It is generally preferable to inform each firm invited to tender of the names of the others. Little purpose is served by secrecy in these matters and there can often be a definite advantage in speeding up the possible process of the formation of partnerships or consortia.

3. Tender documents

69. A clear and full description of the project should be given, in addition to the technical, financial and legal conditions of contract. Only with sufficient understanding of the required port facilities, and reliable information on local natural and labour conditions, can a contractor submit a realistic offer. Three months should be allowed to all bidders for preparing and submitting their bids, and each bidder must be required to visit the site of the future work in order to become acquainted with local conditions.

70. Detailed conditions of tender, including conditions of contract, technical specifications of all works, bills of quantities etc., usually form a volume of some 200 pages. They must be prepared by a team of engineers well acquainted with the drafting of such documents. The International Federation of Consulting Engineers (FIDIC) and similar approved associations have standardized conditions of contract which will be of assistance in this task. This task is normally beyond the capacity of an average port administration, and it is appropriate to retain a firm of consulting engineers for the preparation of tender documents. This is a natural continuation of the previous task of consultants who have assisted in the planning of the proposed port facilities.

[3] *Guidelines for procurement under World Bank loans and IDA credits* (Washington, D.C., World Bank, 1977).

71. Typical tender documents consist of two parts: general information for the bidders, and detailed specifications of all works. The general information includes the following:

(a) Practical data about the submission of bids, the closing date, and so on;

(b) A full description of the project;

(c) Basic information about local conditions;

(d) A statement of the guarantees required (a small bid guarantee (2-3 per cent of the contract value) and a more substantial performance bond or bank guarantee by the successful bidder (10-15 per cent of the full price of works));

(e) The conditions of contract (standard form plus variations);

(f) A bill of quantities in which the bidder has to insert unit prices for each category of work;

(g) Questions concerning legal provisions, arbitration procedure, the problems of contractor's responsibility and modalities of payment are usually dealt with in the conditions of contract. Price escalation clauses noting adjustment provisions and ceilings should be clearly defined. It is very helpful to the bidder if a standard form of contract is used.

72. Arrangements may be included in the conditions of contract for advance payments of the contractor for his mobilization expenses, which can be substantial. Heavy cranes, pile-drivers, bulldozers, graders, trucks, trailers and passenger cars and possibly a dredger with auxiliary equipment, may have to be brought from abroad at a high cost. Housing, storage sheds for building materials and canteens have to be provided, which often require a special water supply and a small power plant; bidders should be asked for a separate quotation for such items. An alternative method, which is not recommended, particularly for a large project, consists in requiring the bidders to include prorated costs of initial expenses in their quotations of unit prices for the various works. The unit prices become artificially inflated by this procedure and excessive payments will have to be made if additional work not foreseen in original plans is to be performed, or if the quantity of work is at all higher than indicated in the bill of quantities.

73. The second part of tender documents includes:

(a) A list of the equipment that the contractor has to bring to the building site and of temporary facilities to be provided for his staff, the workmen and the supervising team.

(b) Specifications proper, that is, detailed descriptions of all things to be done by the contractor, the materials to be used, their storage, handling, sampling and measuring, and the way in which various construction activities should be organized. The written specifications are supplemented by a set of basic drawings as an integral part of contract conditions.

74. It is a good practice to authorize the bidders to make their own proposals for modifying some technical conditions of tenders and to submit an alternative offer with full design data, in addition to the mandatory offer in compliance with the tender documents. The more experienced contractors may be able to make useful suggestions for slight modifications of the designs or for the use of different materials that may result in lower prices without affecting the quality or character of the works.

75. Price quotations must be made by the bidders in unit prices. For each item listed in the bill of quantities, the bidder must enter two separate figures, one for the claimed unit price (per cubic metre, square metre, kilogram, tonne etc.) and another for the entire item in accordance with the quantity indicated. However, payment is made in accordance with the quantity of work actually performed as measured by the supervising engineer and not according to the quantity originally estimated, as shown in the bill of quantities. A different method of pricing is often used for items where the quantity of materials and the amount of work can be estimated accurately in advance, for instance, an office building. In this case a lump sum price for each of such items should be entered in the bid, so that no measurements will be necessary after completion of the work but only the usual control of quality of work and materials. A similar procedure is used for prime cost items, for example, equipment specified in the contract.

4. Bid evaluation and award of contract

76. Bid evaluation has the purpose of determining the value to the authority of each bid and the determination of the lowest evaluated bid (which may not be the bid offering the lowest price). In addition to the bid price, adjusted to correct arithmetical errors, other factors such as the time of completion of construction or the efficiency and compatibility of the equipment, the availability of services and spare parts and the reliability of the construction methods proposed, should be taken into consideration. To the extent practicable these factors should be expressed in monetary terms according to criteria specified in the bidding documents.

77. A report on the evaluation and comparison of bids setting forth the specific reasons on which the determination of the lowest evaluated bid is based should be prepared by the authority or by its consultant. The award of a contract should be made to the bidder whose bid has been determined to be the lowest evaluated bid and who at the same time meets the appropriate standards of capability and financial resources. After final clarifications and discussions the contract can be signed and unsuccessful contractors notified and bid guarantees returned.

5. Supervision of work

78. The work even of a qualified and reliable contractor must be properly supervised to satisfy the in-

terested government or port administration that everything is being done fully in accordance with the approved plans. The first duty of site supervisors is to verify the quality of materials and work. Building materials must be inspected before they are shipped from their place of origin. The method of transporting them, their storage at the building site, and the cleaning and other treatment of materials in preparation for use must be carefully watched. Methods of work and technical operations such as the mixing and placing of concrete should be supervised.

79. A second function of site supervisors is to measure the quantities of work performed and of materials used by the contractor in order to determine the amount of periodical part payments. Usually, such payments are made monthly on the basis of certificates signed by the supervising chief engineer. Payments are calculated on the basis of unit prices quoted in the contract with the application of the price adjustment coefficient and the quantities measured by the supervisors.

80. The supervisor also has a role in providing guidance and, where appropriate, direction to the contractor and in helping to resolve difficulties. He is required to explain the more complicated parts of designs, to supply additional drawings and to issue instructions in case of doubt. He ought also to appreciate that suggestions made by a contractor with wide experience may be of great value, even though they may be at variance with some provisions of the original specifications. In such cases, provided that the variation is carefully recorded and signed by both parties, noting the implications both as to time and as to cost, the variation may be accepted. Finally, the supervisor may have authority, under the arbitration procedure, to decide on matters in dispute under the contract.

81. To organize such supervision may be a simple task for a relatively minor project but for a large project a strong team of supervisors is needed, since all the above-mentioned tasks cannot be performed by a single person. Civil engineers, mechanical and electrical technicians, surveyors, accountants and office staff are needed for a large project, in addition to an experienced engineer as chief of the supervisory team. These persons must have at their disposal appropriate office facilities, living quarters and transport, all of which may have to be provided by the contractor under the conditions of contract. In addition, the team may have to call on specialized assistance from time to time.

82. It is therefore an appropriate practice to entrust the task of supervision to the firm of consulting engineers which prepared the detailed plans and specifications for the project. The firm's staff are best acquainted with the designs and are thus in a favourable position to offer guidance or direction to the contractor. Few port authorities are able to provide for such supervision from among their own staff, but it would be valuable to attach to the supervising team one or two qualified port staff.

6. Design and construct tenders (turnkey contracts)

83. A different procedure may be used for urgent port projects. Instead of providing prospective bidders with final designs and specifications, a small number of highly experienced firms is invited to propose particulars of construction, prepare specifications themselves and submit them together with price quotations. A general description of port facilities, their character, size and general lay-out are supplied to the bidders, and it is up to them to select the best structural design and most appropriate building materials. This kind of agreement is also known as a turnkey contract as the builder is expected to design and to construct a complex of facilities in full operational order.

84. Advantages of the turnkey contract are twofold. The first is a considerable saving of time, as price calculations are made simultaneously with the preparation of specifications in a single operation. Secondly, the interested port administration may receive a larger variety of ideas and designs from highly experienced sources at a relatively small cost.

85. A well qualified staff is needed by the port administration for the preparation of basic plans together with other conditions of contract, and later to evaluate the varying technical offers, particularly the different specifications proposed, and to supervise the works. Not many ports have a sufficiently competent staff for this, so that consulting engineers may still be needed. Although a potential saving of consulting engineer time exists, this is unlikely to be great.

86. To prepare such a design and construct offer is a difficult and costly task which can be successfully performed only by firms organized for both port planning and port construction. The number of firms invited to submit offers should be limited to not more than three, since otherwise the incentive for participation would be very small. The high costs of preparing the bid would not be justified by a small chance of obtaining the contract in the face of competition. It is therefore fully appropriate in a design and construct tender to offer a moderate compensation for the preparation of offers, irrespective of the final award of the contract.

87. The design and construct method is more often applied to work requiring very specialized technologies, such as oil refineries, petrochemical plants or even large grain silos. Nevertheless, it can also be used for more general port construction projects if particular circumstances so warrant.

7. Tenders for dredging and reclamation

88. Conditions of contract for a major dredging project are usually standard amendments to the FIDIC forms. It is not easy to determine in advance the quantity of material that is to be dredged or the exact nature of the soil. For purposes of payments, there-

fore, the formula for measuring the amount actually dredged must be carefully established. Conditions of tide and weather may seriously affect dredging operations and the kind of equipment to be used. Tender documents for a large dredging scheme should be prepared with particular care, and the data gathered during the field investigations discussed in part one, chapter VI, on the civil engineering aspects, should be made fully available to the bidders.

89. The target depth of water to be achieved can never be expected to be reached exactly by the contractor owing to the very nature of dredging. A fair tolerance must be allowed for in tender documents; and in any case the quantity of material moved can be determined only approximately. Descriptions of the kinds of soil which will be found should be as accurate as possible. The nature and the estimated quantity of each kind should be listed in tender documents, together with an indication of the degree of accuracy the estimate is believed to have. The classification of soils should preferably be made in accordance with the 1972 Report of the Permanent International Commission of PIANC;[4] a different nomenclature may be misunderstood by the bidders. The classification of rock materials is less standardized, so that a detailed description in the tender documents is essential.

[4] The Permanent International Association of Navigation Congresses, 155 rue de la Loi, Brussels, Belgium.

Q. Participation of project planners

90. Since most of the routine work of implementation is usually entrusted to consulting engineers, the local port planning team has the opportunity to concentrate its attention on the continuing substantive aspects. Team members should follow the progress of work to ensure that the conceptions and designs are transformed into reality as technical facilities each of which has a pre-determined function. Small errors and apparent imperfections can usually be corrected during the construction period.

91. When the newly-built facilities become operational it is highly advisable for the port planners, or at least a part of the original local team, to observe carefully current port operations in order to see how various particulars of the design and lay-out affect the efficiency of the daily work. Observations of that kind, carried out for a certain period of time, will serve as a most valuable guidance for planning future facilities and for possible improvement of those just completed.

Chapter II

PLANNING PRINCIPLES

A. Port planning objectives

92. Ideally, the facilities which a port provides should be designed jointly with the ships which will use them, the land transport and the port facilities at the other end of the route—that is, as part of an integrated transport system. Unfortunately, this ideal can rarely be achieved. It is possible only when the whole transport chain is under a unified management. For example, in the case of a specialized bulk chemical cargo terminal associated with a local chemical plant, where the managing authority also controls the shipping fleet and the land distribution system; or again, in the case of a door-to-door container operation, where the carrier manages the whole system.

93. In such cases, the planner should consider the port problem entirely in the context of the larger transport system of which the port is a part. The planner should not forget that strategic and social considerations play an important role in the location of a new port. Within these considerations he should, however, encourage and assist the industrial planners to search for the over-all economic optimum between, for example, ship size, rate of discharge, size of buffer stock and hinterland transport facilities. At this stage the planner should also examine the technical specifications of the ships proposed, to bring to light any technical problems which may arise in the port.

94. More often, such all-embracing plans will be very difficult to draw up and implement since they involve many different interests. Insisting on an integrated transport plan as a preliminary to port development may then cause serious delay. Moreover, in the case of a public berth to handle general cargo, there will be so many different users, each with their own physical distribution systems, that there would be little meaning to integrated transport planning. In that case the port development planning can safely go ahead with the following objective:

To provide port facilities and operating systems in the national interest at the lowest combined cost to the port and port users.

95. To plan for such an objective demands a good knowledge of the future customers and their probable cargoes, and is the traditional form of port planning. It aims to produce the best plan for whatever traffic demand is placed on it without trying directly to influence the form of that demand. Naturally, any promotion activity in favour of the port, and efforts to attract traffic and increase its volume, should be taken into consideration.

B. The investment plan

96. Ports in developing countries should normally plan on the basis of a continuing climate of growth for the next few decades. The continuing expansion of overseas trade in the majority of developing countries implies a continuing expansion of maritime trade, and in order to serve a fully developed hinterland the extent of port facilities required may be several times greater than those existing at present. Clearly, in spite of the offsetting effect of the introduction of the use of containers and of import substitution policies, there are grounds for believing that developing countries will in general see a strong continuing growth of demand for new or improved port facilities.

97. There will be technological and social developments that necessitate the use of new types of facilities or different locations, for example, sites nearer deeper water or at a newly planned industrial centre. There will thus be a break with the past and the need for a new development policy, independent of previous plans. But in many cases the build-up of demand will be continuous, and the adoption of the new technology will be gradual during a sequence of investments. For example, as described in part two, chapter IV, a multi-purpose general cargo terminal may be implemented in stages, each of which takes account of existing general cargo facilities. In such cases it is advisable, both from the engineering and from the economic points of view, to ensure that the investments are in fact treated as a sequence.

98. The master plan for each port should set the long-term development strategy and this in itself should indicate likely investment sequences. Before taking a decision on any one development project within the master plan, the investing authority should call for comparative economic analyses of several variations in the sequence of which it forms part. The major variations which should be studied should include:

(*a*) Delaying capital investments by investing instead in improved productivity (equipment, special installations and associated training programmes);

(*b*) Improving existing facilities instead of building new ones;

(c) Combining the first and second stages of a development programme into a single large project in order to economize in construction costs and to avoid the interference in port operations which would result from a second period of construction activity;

(d) The simple economic policy of investing in facilities one by one as the demand for them builds up.

The first two methods should be employed to the extent possible, before investment is made in the expansion of facilities.

99. The most appropriate plan will usually comprise a mixture of all four of these possibilities, and therefore mathematical methods of optimizing the development policy are not often likely to be of assistance. There is no satisfactory alternative to calculating the economic and financial results of each of the development sequences and comparing them in detail. This work of searching for the best sequence of developments through which the port should pass on its way towards a growth target, rather than merely finding the best configuration to handle a given traffic forecast can be readily carried out in the form of a discounted cost and revenue analysis.

100. A major advantage of having studied an alternative investment sequence is that at any time during the period after the initial investment has been committed, it will be relatively easy to change the plan as circumstances change, the requisite information being available. This adaptability is an important feature of the continuing development plan. This calls for the regular updating of systematic traffic forecasts and the ability to recognize and take quick account of sudden changes in shipping services or traffic demands. Traffic forecasting is discussed in chapter III below. The principle to be established is that the port management should maintain a permanent ability to recognize changes in demand and to re-assess the development programme. Steps which could be considered are:

(a) The setting up of small permanent planning and market research sections;

(b) The institution of periodical (e.g. quarterly or semi-annual) planning meetings at which any new developments are reported and possible action is discussed;

(c) The incorporation in each development project, whether supported by national resources or by external funds, of the possibility of modifying it, if necessary, at any suitable stage of its progress;

(d) Ensuring that the economic, operational and financial calculations of each of the alternative proposals are properly documented and stored for easy reference.

C. Terminal design principles

101. Part two of this handbook gives methods of calculating the required capacity of a terminal to handle a given traffic demand. For these calculations, different principles have been applied, depending on the nature of the different classes of ship traffic:

(a) For conventional break-bulk cargo, it is necessary first to ascertain the number of berthing-points needed in order to keep ship waiting-time down to an economic level;

(b) For container cargo, it is necessary first to determine the area needed to handle the annual throughput without impeding the operation;

(c) For specialized bulk cargo, it is necessary first to find the hourly rate of discharge or loading that is needed in order to handle the ships in an acceptable period of time.

102. Although the starting point for each calculation is different, the full method requires the joint study of productivity, the number and size of facilities needed and the level of service to be provided. The relationship between terminal capacity and level of service provided is a basic feature of all development plans, and is discussed in the following paragraphs.

D. The problem of planning berthing capacity

103. If ships arrived in port with complete regularity, and if the time taken to discharge and load ships were constant, it would be a simple matter to determine the berthing capacity that would guarantee both the full utilization of berths and the avoidance of "queueing" by ships. Unfortunately, such an ideal situation can never exist. Liners, and more particularly tramp vessels, arrive in port as if at random. In addition, the time taken to discharge and load ships varies considerably owing to variations in the quantities and types of cargo handled, the way cargo is stowed and the cargo handling rate.

104. This combination of a variable ship arrival rate and a variable ship working time means that a 100 per cent berth occupancy could be guaranteed only at the expense of a continuous queue of ships. Similarly, the guarantee that ships would never have to wait before being able to berth could be given only at the cost of extremely low average berth occupancies. Neither of these two alternatives is acceptable. What is required is a compromise between these two extremes.

E. Cost considerations

105. Port costs are made up of two parts:

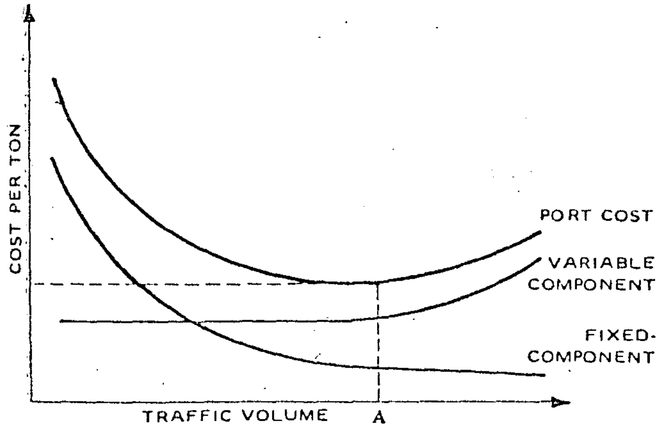
(a) A fixed component which is independent of the tonnage throughput (including the capital costs of quays, sheds, cranes, etc.);

(b) A variable component which depends on tonnage throughput (including labour and staff costs, fuel, maintenance costs, etc.).

As the tonnage handled at a berth increases, so the fixed component, when expressed as a cost per ton, decreases. The variable component, when expressed

FIGURE 8

Variation of port cost with increasing traffic



as a cost per ton, will probably remain fairly stable until the berth comes under pressure to achieve high tonnage throughputs, at which point the variable cost per ton will tend to rise owing to the need to use more costly methods of cargo-handling. Figure 8 illustrates the relationship between the port cost per ton and the throughput. It can be seen that the port cost curve (which is the sum of the fixed and the variable components) reaches a minimum value when the rate of reduction in the fixed cost per ton equals the rate of increase in the variable cost per ton (point A on the graph).

106. Then there is the cost of ship's time in port. This time also, is made up of two parts:

(*a*) The time the ship spends at the berth;

(*b*) The time the ship spends waiting for a berth to become vacant.

As traffic increases, the time ships spend waiting to get onto a berth increases. At high berth occupancies this increase in ship waiting time is quite dramatic, as is shown in figure 9.

FIGURE 9

Variation of the cost of ship's time in port with increasing traffic

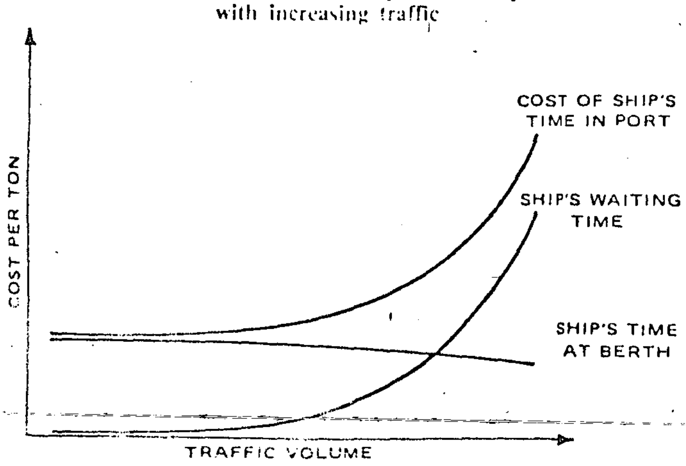
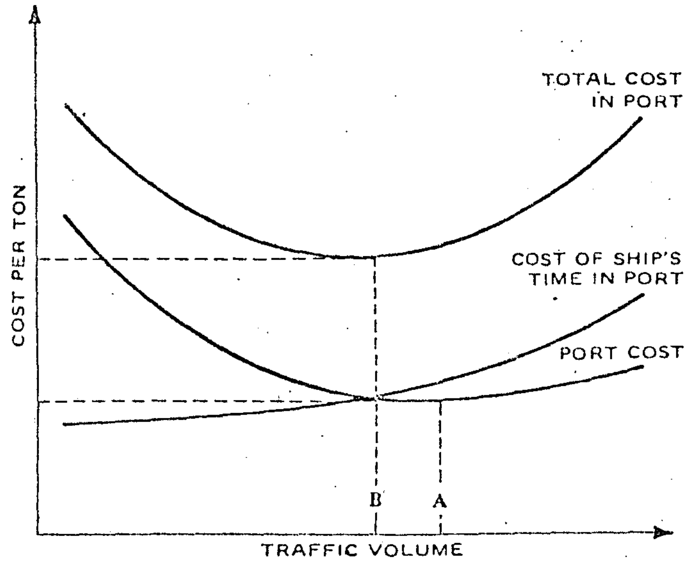


FIGURE 10

Variation of total cost in port with increasing traffic



107. The total costs incurred by ships in port is found by adding together actual port cost and the cost of ship's time in port, as illustrated in figure 10. The total cost per ton curve also has a minimum point (point B on the graph), but this minimum is achieved at a lower throughput than that at which the lowest port cost occurs (point A). Port planners need to be aware of this most important point. Planning to minimize port costs alone will generally result in an unsatisfactory level of service to shipowners which can lead to congestion surcharges and will not be economically acceptable.

108. The minimum total cost depends on the size of the various cost elements. The location of this minimum is dependent on the relative capital costs of ships and of berths. Thus, in respect of break-bulk general cargo ships higher berth occupancies are economically justified than is the case in respect of the much more expensive specialized vessels such as container ships, tankers and liquefied natural gas carriers. For this reason figures 8, 9 and 10 do not have quantified scales. Furthermore, the shape of the curves and hence the position of the minimum depends on the relationship between berth occupancy and ship waiting time, which is complex. Queueing theory, a mathematical technique, can be used, but there are dangers in using the published tables based on this theory without an understanding of the assumptions involved.

109. To assist the planner in choosing terminal capacity, part two of the handbook provides planning charts which bring into play all the important practical factors. They include a sufficiently accurate relationship between waiting-time and berth occupancy to enable planners to find the optimum economic capacity needed to meet a given traffic demand. The

relationships are based on a distribution of arrival and service times which corresponds most closely to typical conditions.

F. Berth occupancy

110. Care is needed in interpreting records on berth occupancy, if this is to be used as a yardstick for future plans, or for comparing the relationship between berth occupancy and throughput at different terminals. Berth occupancy is a mesure of facility utilization and should not be used as a measure of traffic demand unless the other main factors—resources used, productivity, berthing policy—remain constant, which is rarely the case.

111. For example, a certain container terminal was keeping monthly statistics both of berth occupancy and of the quantity of cargo handled. Examination of a nine-month period showed an apparently inverse relation between the two sets of statistics: as the figure for tonnage handled went down, the figure for berth occupancy went up. This seemed contrary to common sense, and on further examination it was found that the higher berth occupancy figure was the result of congestion at the terminal, which slowed down ship turn-round and so caused the berth to be occupied for longer periods, while tonnage throughput dropped. In this case urgent steps taken by the management to relieve the terminal congestion brought a reverse in the trend, with throughput rising again and berth occupancy falling.

112. Although recorded data on berth occupancy may be misleading, berth occupancy rules-of-thumb can be used in planning calculations where the productivity target is clearly defined. A better procedure is, as in the planning charts given in part two of the handbook, to obtain the figure for berth occupancy as an output statistic from calculations based on the other factors. Comparison with recorded figures can then be used as a check.

G. Waiting-time/service-time ratio

113. This ratio is widely used as a measure of the level of service provided by a terminal, as would seem logical, for ships that have less cargo to discharge cannot afford to wait as long as ships that have more. It is usually considered that waiting time should be not more than 10 to 50 per cent of working time. But this ratio also is misleading since it can improve (i.e. decline) as service-time deteriorates (i.e. increases). As with berth occupancy, the ratio should be used only when the other factors are constant. Better still, as shown in the planning charts in part two of the handbook, the ratio should be set aside and only the total turn-round time used as a measure of the port's performance. When the plan has been based on investing for the economic optimum, the waiting-time/service-time ratio is bound to be an acceptable figure, generally less than 30 per cent.

H. Planning for variations in traffic

114. It is not necessary to use complicated mathematics to demonstrate that a tardy port response to an increase in traffic will lead to congestion which can be serious and long-lasting. Supposing for example that a terminal can handle 60 ships a month, a 10 per cent increase in traffic, meaning a mere six additional ships a month, is likely to go unnoticed for some months if arrival rates are not carefully monitored. Unless action is taken to increase the rate of working there will be an extra 18 ships in the queue after three months. If the port management then responds to the situation by increasing the rate of handling ships at the port by 10 per cent, and maintains this increased rate continuously, it will merely stop congestion getting worse. There will still be a permanent queue of more than 18 ships, and long waiting times. In order to relieve congestion, much more must be done: if the rate of working were increased by 15 per cent over the original rate so that the port could handle 69 ships a month, it would still take a further six months to clear the congestion. Furthermore, under congested conditions improvements in handling rates are extremely difficult to introduce and maintain.

115. While emergency action can be taken in such circumstances, the possibility of emergency action is not an acceptable reason for restricting investment at the planning stage. There has been too little appreciation in the past that many ports have been working with far too small a margin of safety in their capacity.

116. Working with too small a margin of spare capacity can have serious consequences not only when traffic gradually increases, but also when there are short-term surges in traffic, particularly as a port has a tendency to be inefficient when it is congested. The port may thus reach a position from which it cannot recover without emergency action. For example, a group of chartered bulk cargo vessels arriving all together can prevent general cargo vessels from using the berths, and their cargo can congest the port land area. Consequently the facilities are unable to recover to handle the average traffic after the peak has subsided. When the increased demand congests a port, work slows down and throughput drops. This is a strong argument for bringing into play more capacity when the demand is high and less when it is low, i.e. having a reserve of port capacity which is used only during peaks. Is there therefore a case for investing in some spare capacity and keeping it for emergencies? To examine this problem the planner must ask what will be the form of a traffic increase when it comes, how the management will find out about it, and what control the port management will have over the port's reaction to it.

117. The traffic increase is most likely to take one of the following forms:

(*a*) The introduction of a new shipping service or of additional chartered vessels;

(b) A gradual trend towards larger shiploads in an existing service;

(c) More frequent calls by an existing service (through the placing of additional ships in the service—normally announced in advance);

(d) Exceptional calls, for example, ships diverted from a neighbouring congested port.

118. Another change which can have a major effect on the port without being recorded as a change in the level of traffic is a change in the manner of carrying the cargo. For example, a decision to transport grain in bulk can cause serious problems for a port accustomed to and proficient in discharging grain transported in bags.

119. The increase will be sudden when, for example, a new service forms a sizeable part of the total traffic of a port, when a major national planning decision is taken—for example, to increase a building programme, with the resulting arrival of a series of cement charter ships at a port, or when a large neighbouring port becomes congested and diverted traffic swamps a smaller port. Responding to a sudden increase only after it has happened will usually be too late, because of the time needed for adjustment. When the change is gradual (either because it is a matter of a progressive increase in the size of shiploads or because an additional ship placed in a service accounts for only a small proportion of the total arrivals), it may escape notice unless traffic figures are being very closely watched. Although accurate current statistics in fact reflect the changes that are taking place, since the traffic level fluctuates about its average value all the time, an important trend can be concealed by the normal traffic variation. Consultations with shippers can be of help in discovering these trends or even in predicting them.

120. There can be problems of short duration. For example, when the arrival of a priority passenger vessel prevents work on a ship-loader for one shift, the effect is not likely to be serious. The volume of export cargo piling up is not likely to occupy a large part of the storage space available. With situations of slightly longer duration, congestion problems may arise. For example, when importers take advantage of a low commodity price, a large number of containers may arrive together but several weeks will probably be required to arrange onward transport. The containers must stay in the port area for that period, and unless an overflow park is available, there will be congestion in the container park.

121. Longer-term traffic changes raise the question of the proper level of port investment. Here, choosing the amount of spare capacity which is available for use but which is kept in reserve is a very serious decision. The balance between, on the one hand, investing in reserve capacity and thus keeping expensive facilities idle and, on the other hand, the probability of facilities becoming congested, will need to be argued out on standard economic grounds. However, it must be recognized that the uncertainty in forecasting is such that merely finding the economic optimum solution in relation to the best forecast, and investing for that situation, does not in itself constitute a satisfactory port plan.

I. Co-ordinated contingency planning

122. In addition, an investment plan should make provision for flexibility in the port's response to abnormal increases in traffic demand. it is strongly recommended that each port should have at its disposal a contingency plan for bringing additional reserve capacity of various kinds into use in a systematic, coordinated fashion. The major facility needed to provide reserve capacity is additional berthing space. Investing in excess modern berths and then delaying their commissioning is one option, but it will normally be too expensive to tie up capital-intensive berths in this way. Arrangements for overflow traffic should be cheap and simple, for example, working to lighters and then to lighterage berths. This will result in higher cargo handling costs, but the total economic cost per ton of cargo will be less than if ships are made to wait for regular working.

123. The characteristics of such overflow arrangements—low capital cost and high operating cost—are precisely those of the older berths in the port, or of moorings. An effective policy can be to use regular new berths during normal conditions, keeping the old berths and moorings in reserve for peak periods. This is advantageous also from the productivity standpoint as concentrating the traffic as much as possible on the new berths will result in lower operating costs. It is true that the approach causes certain management problems in the commissioning and decommissioning of the overflow berths, since the switching of labour and facilities may not be easy, but the effort involved should be worthwhile.

124. There are several other forms of reserve capacity. Each of the factors that are involved in the measurement of capacity (as shown in the planning charts in part two of the handbook) could have some spare capacity in them. In the matter of ship working these factors are:

(a) The productivity in tons per gang-hour;

(b) The number of gangs allocated per ship;

(c) The number of days the berth is in commission;

(d) The number of hours worked per day.

125. In order to hold down unit costs, productivity should always be as high as possible. Since there is usually a labour pool which is a cost to the port even when idle, and cargo distribution in holds often limits the effectiveness of extra gangs, it will normally be wrong to keep any spare gangs in reserve. Days allocated to maintenance and dredging work should not be considered as a reserve since these activities are essential to the long-term capacity of the berth, although some flexibility in scheduling the work dur-

ing periods of peak traffic can be useful. Thus the main room for manoeuvre will be in the number of hours worked. A port which is congested should work the maximum possible number of hours within the limits of the available storage area and trained labour. The aim should be to revert to less than this maximum as soon as the congestion is cleared.

126. It is not a good policy for planners to base investment analyses on the assumption that new facilities can be brought into operation and more intensive working methods introduced at one and the same time. Continual planning on the basis of maximum working possibilities and minimum economic investment will leave the port vulnerable to normal variations in traffic. The provision of reserve capacity should be given the same systematic attention by port planners as is given both to the port development plan and to the programme of practical improvements in the use of existing facilities.

127. Preparation of the co-ordinated port contingency plan consists of three main actions:

(*a*) Providing equivalent reserve capacities in all parts of the port system;

(*b*) Obtaining prior approval for the use of these capacities when certain situations occur or are about to occur;

(*c*) Setting up an information system to report automatically when such situations arise or are about to arise.

The basis of any contingency action will be top management approval, although this approval will normally be given only when the agreed indicators of demand have passed the planned threshold.

128. In addition to the use of additional mooring berths, increased overtime working and working during normal holidays, typical contingency plans may include:

(*a*) Increasing handling facilities by hiring mobile cranes from outside the port;

(*b*) Increasing the average number of gangs per ship by hiring additional contract labour;

(*c*) Speeding up the repair of equipment by buying spare parts manufactured locally;

(*d*) Hiring additional lighters and working overside both at moorings and on the outer ship's side at berth;

(*e*) Opening up additional storage areas under customs bond either within or outside the port;

(*f*) Hiring additional trucks and trailers for transport to storage areas;

(*g*) Giving priority berthing to high throughput ship types or ships with perishable goods.

J. The economic optimum

129. The main economic benefit of port investment is the ability to reduce ship turn-round time. Consequently this is often the determining factor in setting the economic optimum. There are two aspects which managements should be aware of in making an investment decision on this basis.

130. First, the immediate benefit from port investment may accrue, not to the investing authority but to the users of the port, many of whom will be foreign. However, in the long run, the port and the country as a whole will derive considerable benefit from the extension and modernization of port facilities. It is also quite in order for the authority to invest in more capacity than the economic optimum when it has good reasons for doing so, for example, in order to provide a deliberately higher level of service to the user as a promotional policy to encourage the use of the port or to foster local industry as part of a regional development policy. There is not likely to be any good case for investing in less than the economic optimum except where the relevant analysis was made on too narrow a base or where the decision authorities know that in a wider context the growth of the port should be restricted (for example, when traffic is to be diverted to other ports or other transport modes).

131. The second aspect is the practical implications of the average ship waiting-time. This measure of service to ships is not as simple as it may appear. A typical cost-benefit calculation may show that the best compromise between the cost of keeping ships waiting and the cost of providing extra capacity is arrived at with a berth occupancy of 75 per cent for a group of five general cargo berths, and that this gives an average waiting-time of one day, compared with an average service-time of $3\frac{1}{2}$ days.

132. An average waiting-time of one day has a specific mathematical meaning, however. Taken over the long term, this one day average waiting-time for a five-berth group should mean that:

(*a*) Some 55 per cent of the ships arrived to find a vacant berth and did not have to wait at all;

(*b*) About 10 per cent had to wait more than 4 days;

(*c*) About 5 per cent had to wait more than 10 days;

(*d*) For about 2 per cent of the time, all berths were vacant.

133. Thus, for this economic optimum berth group, for the greater part of the time there is no queue of ships waiting for a vacant berth, and for about one week in the year all five berths may be vacant. But in spite of this there will be times when the queue builds up to cause ship waiting-times substantially longer than the service time.

134. There are three lessons to be learnt from this:

(*a*) A group of berths which rarely or never runs its queue of ships down to zero is loaded above the economic optimum.

(*b*) The normal situation at a group of berths should be that immediate berthing is possible for a majority of the vessels arriving, but the fact that this is the case at a given port does not mean that further investment cannot be justified.

(c) Shipowners are not entitled to use the excessive waiting-time of a few ships as an argument that the port is congested. Only the average of the waiting-times of a sufficiently large number of ships can be used in such discussions.

135. The planner should also be aware of the fact that, even with the same rate of working and the same long-term average traffic demand, there may be substantial deviations from the average waiting-time. There is always the chance of a higher than average level of traffic persisting for a month or more, with a slow upward drift of waiting-time and queue length which will be equally slow to clear. These upward drifts in waiting-time can be counteracted by means of an operational policy that reacts to pressure. For example, provision should be made for more intensive working when required. Planning on the basis of the long-term economic optimum without allowing for contingencies is bound to lead to short-term congestion.

K. Scheduled traffic

136. Where there are expensive facilities for handling expensive ships, ensuring that the ship will not be made to wait will result in a low berth occupancy which will not be acceptable to the port. The only way in which the berth occupancy can be increased without giving an unacceptably high probability that the ship will have to wait for a berth is to persuade ship operators to schedule their arrivals more regularly. Specific days can then be allocated to particular services, so that each ship can be guaranteed immediate berthing if it arrives on time. Such arrangements generally allow a certain amount of latitude as regards arrival times, but with an agreement that a vessel arriving outside these limits loses its priority.

137. If several services can be persuaded to enter into such agreements, berth occupancy can be quite high. In such cases service-time and waiting-time relationships cease to apply and the berth requirements can be calculated directly from the programme of scheduled arrivals. When some days are allocated to scheduled services and others to general traffic, the calculation of requirements for the general traffic must be made after subtracting from the total available berth commission days those taken up with scheduled arrivals. This calculation can be carried out directly with the planning charts given in part two of the handbook.

L. Seasonal variations

138. When traffic studies show that there is a large seasonal variation, the first action of the port planner should be to persuade shippers' organizations or industry sector planners to investigate the possibility of taking steps to even out the demand. Ordering and stockholding policies may be changed to smooth out the demand fluctuations. New industries such as the processing of agricultural products into non-perishable forms may be introduced in order to reduce the peak demand at harvest time. Another form of smoothing which can always be used is to seek complementary traffic for the terminal concerned during the off-peak season.

139. Such means of smoothing out demand may be less costly in economic terms than the provision of the requisite port infrastructure, the associated physical distribution facilities and a reserve of labour at a level sufficient to meet the peak demand but which remain under-utilized for much of the year. The economic penalty of this under-utilization will be partially offset by the low unit costs resulting from the efficient handling of large quantities during peak periods. In each case the advantages and disadvantages involved must be calculated.

140. Unavoidable seasonal variation is bound to cause a substantial economic penalty which will be related to the level of service the port gives to its customers during the peak period. At one extreme, the port can be designed for the average monthly traffic, which will result in long waits for ships and cargo during the peak periods. Alternatively, facilities capable of handling the peak demand can be provided, and their under-utilization during slack periods accepted. Neither of these courses will normally be acceptable.

141. The port management must first decide on an acceptable level of delays during the peak periods. Then steps can be taken to provide the necessary facilities. Care should be taken when calculating the costs and benefits in each season and then combining them not to overlook important operational considerations. In order to reduce investment, the provision of makeshift or secondary facilities for use during the peak periods can also be considered. Although these secondary facilities will be less efficient and will give rise to higher unit operating costs they will reduce capital costs. In the development of an existing port there is a case for using the modern facilities throughout the year and using the less efficient facilities only during peak times. Possibly such older facilities may be switched to coastal or river traffic when not required for peak working.

142. Seasonal fluctuations are often due to the occurrence of seasonal peaks with respect to a small group of bulk or semi-bulk commodities and it will be advantageous to use specialized handling equipment for these commodities. If the level of such seasonal commodities justifies the installation of fixed equipment which prevents the berth being used at other times, the specialized berth may have to be taken out of commission during the off-season. Normally, it will be preferable to find a type of specialized equipment which can be moved or dismantled during the off-season. This will ensure that the modern berths can be used throughout the year, while

the older berths are brought into action for handling general cargo only when the specialized handling installations for bulk cargoes are in use at the newer berths.

M. Capacity and traffic specialization

143. When determining the capacity needed to handle the demand forecast, it makes little sense to treat the port as a single entity, however small the total volume of traffic. Each class of traffic must be examined separately, and separate forecasts of annual tonnage, ship size, productivity and acceptable level of service must be made for each. The traffic must be assigned, either individually or in combinations of types, to the berth groups; then the appropriate capacity for each berth group must be designed. This principle of dealing separately with different types of traffic runs throughout the methods given in part two of the handbook, where separate planning curves are given for each main class of traffic.

144. Serious errors can be made by grouping into one traffic analysis cargoes or ships with widely different characteristics. For example, in a given port it may happen that a number of roll-on/roll-off ships are using a break-bulk group of berths for which the demand is fairly light. The over-all cargo-handling demand (measured in berth-days required) will fail to justify additional investment because the present average waiting-time is, say, only one-tenth of the average service time. However, these averages conceal the fact that the ro/ro ships, with a quicker service time, are receiving an unsatisfactory level of service, a situation which cannot be fully rectified by giving them priority berthing. There may be a good case for investing in a special purpose ro/ro berth, a matter which should be separately studied. The special berth may bring added advantages such as the possibility of scheduling the ro/ro services, introducing special tariffs, etc.

145. At the planning stage, it should be considered, on balance, that the handling of dissimilar traffic at the same berth group causes lower throughput than when they are kept separate. This question is complicated, for, on the one hand, specialization causes a loss of flexibility, as follows:

(*a*) A loss of berthing capacity through dividing the port and the traffic into two before allocating berths, i.e. a loss of berthing flexibility;

(*b*) A loss of the transit areas capacity achieved by mixing complementary traffic, for example, by alternating ships discharging shed cargo with ships discharging bulk cargo for direct delivery while the shed clears.

On the other hand, specialization gives the following gains in consistency:

(*a*) A gain in service capacity in each facility when the segregation of the different classes of traffic means also a separation of high and low average service-times and of long and short ships, i.e. there is a gain through greater consistency of demand;

(*b*) A gain in average productivity since specialized facilities can be made more efficient than general-purpose facilities;

(*c*) A gain through making fuller use of expensive water areas, dredging costs, for example, being less for berths allocated to smaller vessels.

146. The balance between these advantages and disadvantages of specialization will need separate judgement in each case, but there is one general rule. Wherever a specific traffic on its own would provide sufficient throughput for a separate specialized terminal, this should be the preferred basis for investment. The planner should thus concentrate on identifying and separating traffic which will justify developing specialized facilities. Where a certain traffic taken alone cannot justify a specialized berth, the planner must revert to a multi-purpose solution. Certain traffic combinations for which efficient multi-purpose terminals can be designed are discussed in part two, in chapter IV.

147. It is difficult to quantify generally the extent to which working mixed traffic reduces berthing capacity. The effect is greatest when the occasional large bulk ship is worked at a berth normally handling smaller general cargo ships. In that case the disturbance to a smooth berthing sequence will be substantial. The planning charts in part two of the handbook can be used by planners to compare the effect on ship time of building two separate specialized berths or a two-berth multi-purpose terminal.

N. Flexibility and technical change

148. The flexibility which the contingency plan gives in the handling of a fluctuating traffic demand should be matched by flexibility in accommodating technical change. The choice for a port strategy is clear in this respect. It is either to develop separate specialized facilities for each major handling technique, or to develop multi-purpose facilities capable of coping with any handling technique. Specialist facilities are the most efficient and economical when intensively used, but are uneconomical during the transitional build-up period. Multi-purpose facilities are more expensive to install and operate, but are likely to be fully used for the whole period and so may be cheaper over-all. Complete failure to plan for the new techniques will lead to the most expensive result—new traffic being handled inefficiently in old ways at very high cost.

149. A specialized terminal will normally be justified whenever a traffic forecast shows that there is sufficient demand, even if the remaining traffic leaves another facility less than fully utilized. This principle will apply to specialized terminals for cargoes such as containers, timber products, iron and steel and dry bulk commodities. For example, a port currently having 6 break-bulk berths each handling

150,000 tons per annum may be faced with a general cargo traffic forecast of 1,200,000 tons of which 50 per cent will be containerized. If one specialized container berth is built, its throughput of 600,000 tons will load it to a reasonable level and justify the terminal. However, this will leave only 600,000 tons to be spread over the 6 existing berths, which are currently able to handle 900,000. Nevertheless, the best policy would be to build the specialized berth and either to de-commission two break-bulk berths or, alternatively, to retain them as occasionally used overflow berths.

150. The alternative policy in this example would be to continue working mixed traffic at break-bulk berths and to build two more conventional berths. The cost of the two conventional berths might well be less than the cost of a specialized container terminal. However, this policy should be clearly ruled out on grounds of cost per ton and unsatisfactory service to the container operators.

151. A far more difficult policy decision faces the port where the traffic forecast for a specialized technology cannot justify investment in a separate terminal. In the above example, if the forecast containerized fraction were only 20 per cent (240,000 tons) then the total container demand would not normally justify investment in a specialized container terminal. Nevertheless, both container-handling facilities and additional break-bulk capacity are needed. The solution in this case could be to build one extra multi-purpose terminal equipped with a combination of handling facilities as recommended in part two of the handbook. The main advantage of this solution is that the multi-purpose terminal can be converted stage by stage from predominantly break-bulk cargo to predominantly unitized cargo of various kinds, to conform with the changing traffic.

152. Even where, owing to local circumstances, it is forecast that a port will continue to receive mainly conventional break-bulk traffic, the principle of flexibility in design is still advisable. Where possible, operating areas should be larger, depths of water greater, quay foundations stronger and quay superstructures less permanent than has been traditional. All these features will make it easier to adapt berths to accommodate ships exemplifying the newer technologies, when they eventually arrive.

O. Principles of investment appraisal

153. This section summarizes the main principles of investment appraisal as they affect ports. Both a financial and an economic evaluation are generally required before a loan for a port investment project is approved. The former is essentially a computation of commercial profitability and is not in itself sufficient; it is the economic evaluation—the comparison of the social costs and benefits to the country—which determines whether or not a loan is granted.

154. The two evaluations are identical in several respects:

(*a*) They require an evaluation of a succession of costs and benefits over the whole useful life of the project;

(*b*) They take into account the time-value of money—whereby, because this year's money can earn interest, it is of more value than next year's money, which must therefore be discounted back to its present-day value in order to bring both onto an equivalent basis;

(*c*) They use common criteria to evaluate investments, namely, one or more of the following:

(i) Average rate of return;
(ii) Pay-back period;
(iii) Net present value;
(iv) Internal rate of return;
(v) Benefit/cost ratio.

However, the two evaluations differ with respect to the costs and benefits included, since the port account is concerned with direct costs and benefits while the national government is concerned also with social costs and benefits deriving from trade promotion and similar effects.

P. Financial appraisal

155. The financial costs are straightforward; they are the actual disbursements which the port authority will be required to make in connexion with the investment. They include the cost of all preliminary studies and plan preparation, the cost of land, construction and the purchase of equipment, and the cost of operating the installation, including wages, fuel, spare parts, etc. The financial benefits are the additional revenue which will result from operating the extra facilities, as compared with the revenue which would have been received without them. The main sources of such additional revenue will be the port charges on ships and cargo.

156. Clearly, the results of the financial evaluation will be heavily dependent on the assumed throughput. Normally, therefore, evaluation should be done for a range of traffic growth forecasts. Moreover, the opportunity should also be taken, while computing the financial results, to calculate the consequences of different tariff levels. This will provide the necessary information for a soundly based discussion of what would be an appropriate scale of charges.

157. The financial criterion for justifying a project is that, with a realistic tariff, and after covering all costs, including that of annual depreciation, the net revenue earned in each year of operation will pay the interest on loan capital and the equivalent of the interest forgone on the port's own capital expenditure. The adoption of this financial criterion will thus lead to the accumulation of the reserves that would be necessary for building facilities of equivalent value upon expiration of the amortization period.

Q. Economic appraisal

158. The economic evaluation is generally known as the cost-benefit analysis, although strictly this term could also be applied to the financial evaluation. The economic evaluation is based on costs and benefits which differ from the financial transactions in a number of ways. A fundamental characteristic of these costs and benefits is that they accrue mainly to the other participants in the trade rather than to the port authority.

R. Costs

159. The main resources for a port project in a developing country are land, labour and foreign exchange. The economic cost of each of these resources is its "opportunity cost" or "shadow price". This cost is equivalent to the highest-valued benefit which is given up by using the resources for this project rather than for another project. In the case of land, a port may previously have purchased the land needed for expansion at a cost, for example, of $1 million. The value of the land may have appreciated and, if it were released for building offices, might be valued at, say, $5 million. Therefore, in the economic appraisal, $5 million would be entered as the cost of the land. The opportunity cost of labour is very low when there is no alternative useful employment. In areas of high unemployment, irrespective of the wages which will be paid, the labour costs used in the economic appraisal will be very small and may often be set at zero.

160. Foreign exchange rates in developing countries are often fixed at arbitrary levels and consequently the demand exceeds the supply. In that case, the economic cost of the foreign exchange component of the project will be higher than the quoted exchange rate. It is this higher rate, normally determined by a central bank or ministry of finance, which must be used in the economic appraisal to bring the foreign exchange component on to a common base with other costs. Customs duties and other taxes on elements of a port development are not included in the economic costs since they are purely a transfer payment from the port to the government.

S. Benefits

161. The major economic benefits of port investment are:

(*a*) The transport cost savings made possible by the use of ships which can carry the goods at lower cost per ton of cargo (e.g. larger or more modern ships);

(*b*) The reduced turn-round time of ships in port. This is often the largest single benefit and it is essential to estimate both the waiting-time and the time at berth. Irrespective of the fact that this benefit often accrues in the first place to foreign shipowners, it is now standard practice to include it in the appraisal on the understanding that in the long run this benefit will filter through to the national economy, for example, through lower freight rates;

(*c*) The reduced period goods spend in port and on ships. This will free capital tied up in goods and thus give indirect financial benefits to the country as a whole;

(*d*) The transport cost saving from the new routes for goods to and from inland locations. This may, for example, be due to the new port facility cutting out an overland transport leg;

(*e*) The benefit derived from stimulating or making possible increased national economic activity. This benefit is often difficult to measure and should only be included when the activity could not take place if the port project were not undertaken. The benefit must be offset against the opportunity cost of the resources used in the increased activity;

(*f*) The benefit from making possible an increase in exports through, for example, providing facilities for larger bulk carriers which will result in lower transportation costs and allow the overseas price of the export commodity to be more competitive. For instance, new facilities could permit an increase in exports of a given commodity from one million to two million tons per year, and at the same time reduce the price of transport. The savings on transport for the first million and the benefit from the sale of the additional million are both to be included.

T. Discounting

162. The first step involves the calculation, year by year, of the net monetary flow expected from the project over its life. The net monetary flow in any year is the difference between the benefits expressed in monetary terms and the costs also expressed in monetary terms. The net flow is then discounted to obtain the net present value. Discount tables such as those given in annex I can be reused. For example, with a discount rate of 10 per cent, a net flow of $100,000 in the fifth year of a project has a present value of $62,100 since the discount factor is 0.621. This is equivalent to saying that $62,100 would be worth $100,000 at the end of five years if invested at 10 per cent interest.

163. For commercial profitability, the correct discount rate is the market rate of interest. However, for national economic profitability the appropriate discount rate is more difficult to define because of social factors. The choice of the appropriate rate of discount is a matter of national policy, on which the port planner needs guidance.

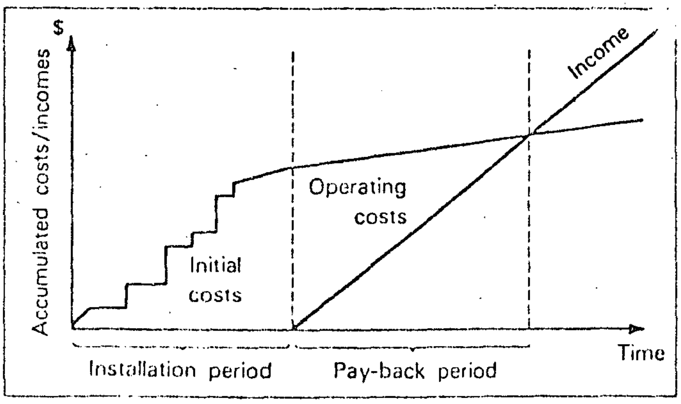
U. The congestion cost pitfall

164. There is a pitfall to avoid when appraising a port investment which is planned to relieve or prevent congestion. With such an investment, the first

additional facility will yield greater benefits than the second and subsequent additional facilities. This is due to the very large reduction in congestion costs which is brought about by the construction of the first facility and which subsequent capacity increases cannot possibly match. This should not be used as an argument that this first, limited, investment is the most economic, since in the long run this would amount to planning for a permanent and substantial level of congestion. To minimize the over-all costs of maritime transport, the correct level of investment is that which provides the maximum possible capacity while meeting the investment criterion which has been adopted.

FIGURE 11

The pay-back period approach



V. Summary methods of evaluation

165. There are several methods of evaluation which could be used depending on the nature and magnitude of the investment. A detailed discussion of these methods with worked examples is given in a document on port investments prepared by the UNCTAD secretariat.[5] The more common methods used are:

(*a*) Average rate of return;

(*b*) Pay-back period;

(*c*) Net present value;

(*d*) Internal rate of return;

(*e*) Benefit/cost ratio.

The port's evaluation of a project could take the form of any one of the above methods. For economic cost-benefit analyses, however, the more relevant techniques are the last three.

166. The average rate of return is an accounting device and represents the ratio of the average annual profits after taxes and depreciation to the average net investment in the project (the original investment divided by two) or, sometimes, the original investment itself. Since depreciation will gradually reduce the value of the investment during the life of the project to zero, the average investment is approximated by dividing the total investment by two.

167. The pay-back method literally means the number of years required to recover or "pay back" the initial cash investment. The basis of the pay-back calculation is shown in figure 11, which is self-explanatory.

168. The net present value or NPV method takes into account the time value of money. The discount rate specified must be used to discount all future cash flows to their present value. Summing these flows gives the net present value of the investment. The criterion used in the NPV method is to accept the project if the NPV is greater than zero and otherwise to reject it.

169. The internal rate of return or IRR method is another method which takes account of the time value of money. The IRR is the discount rate that gives a zero NPV, that is, the rate at which the present value of benefit equals the present value of costs. If the IRR of a project exceeds the required rate of return, or cut-off rate, the project is acceptable; otherwise it is not. The IRR method and the NPV method will give similar answers with respect to the acceptance and rejection of an investment proposal.

170. The benefit/cost rate uses the present value of benefits and the present value of costs and is obtained by dividing the benefits by the costs. A ratio greater than 1 implies that the project is acceptable, while a ratio less than 1 implies that the project is unacceptable.

W. The four investment decisions

171. There are four distinct questions that must be answered about a port investment proposal:

(*a*) Is the proposal in isolation economically and financially justified?

(*b*) Does it represent the best use of the available funds?

(*c*) Is the proposed level of investment in additional facilities the right level?

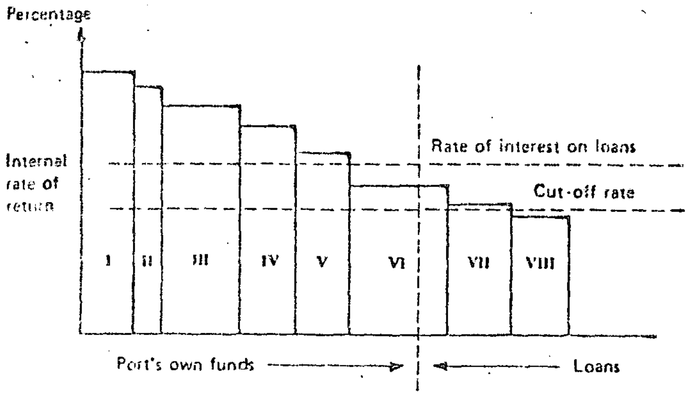
(*d*) What is the best point in time to make the investment?

172. To answer the first question, the method chosen depends upon whether agreement can be reached on what is the appropriate discount rate to be used. When all concerned are able to agree on a minimum acceptable return on capital, then the cash flows can be discounted at this rate and the justification for the project in isolation will best be on the basis of the benefit/cost ratio or net present value. When it is difficult to reach agreement on the proper discount rate, then it will be necessary to calculate the IRR. In some cases it may be advisable to decide to use the IRR method from the start simply to avoid introducing doubt and delay into the project appraisal work programme.

[5] "Appraisal of port investments" (TD/B/C.4/174).

FIGURE 12

Application of funds to a number of competing projects



173. In answering the second question, and in order to find how to apply a certain quantity of funds to several projects, the most straightforward approach is to rank the projects in order of their NPV, and to stop investing at the project that is only just above the investment criterion used or when funds are exhausted, whichever is the sooner. Unfortunately, there is a complication since there will usually be at least two different types of funds, port reserves and borrowings, and different criteria may apply to each. However, a single method can be used for both, as is shown in figure 12. Here, projects which are competing for the funds are ranked according to their IRR, and on the horizontal scale the point at which the port's own funds are exhausted and a loan will be required is also shown. In the case shown, the IRR of the first five projects is above the required rate of return on the port's own capital, or cut-off rate, while the IRR of the sixth is above this level but is not up to the higher level of interest required to be paid on loan capital, even though it would require a loan. An alternative would be to carry out project VII before project VI, which should either be deferred or, if this is technically acceptable, cut by one third. Ranking by IRR will not be the only criterion, however; whether a project is socially useful, generates employment, or causes direct rather than indirect benefits, will all be part of the decision.

174. The third question is to choose the right level of investment in facilities; for example, what is the right number of berths to invest in at any time? The correct level of investment is found by progressively increasing the number of berths until the NPV (or IRR) falls just above the required value.

175. Finally, to find out when to invest in additional facilities, after a decision has been taken on the form of the project, the first year rate of return method may be used. The first year rate of return method involves a comparison of the first full year benefit with the cost of the project discounted up to the year of completion of construction of the project, i.e., up to the year prior to the year in which benefits will begin to accrue. If the ratio so obtained is less than the discount rate, then the project should be delayed by a year.

X. Joint proposals

176. With two proposals, A and B, calculations will have to be made for three cases, A alone, B alone and A and B together. If there is no interaction between the two proposals (with respect, for example, to traffic sharing, space sharing, storage requirements and landward access), A and B together will simply be the sum of A and B alone. When they interact, the joint proposal will need analysis in its own right.

177. Thus, when two interacting proposals are included in an investment appraisal, it will be necessary to calculate costs and benefits both separately and together. Clearly, when three or four interacting proposals are combined in one appraisal, there will be a great deal of work and considerable complications for the decision-maker. However, this will generally be preferable to artificially separating projects which affect each other. For example, the decision to buy fork-lift trucks for old berths will affect the decision to build new berths since the fork-lift trucks are alternative ways of increasing capacity. If these two matters are treated as separate investment projects then not only will the calculation of the benefits of each be false, but the investment authority may not appreciate that there is a real and important choice to be made as to where to put its funds to the best advantage. The authority may then proceed with the new berths and decide that it cannot afford the fork-lift trucks, with the result that the chance of a valuable short-term improvement in capacity is lost.

178. On the other hand, it is equally wrong to present a single analysis for what are in fact two separate proposals. This can obscure the fact that one may be profitable and the other not. The economic justification and financial viability of each type of facility must be investigated separately. Cross-subsidies cannot always be avoided, but before accepting that solution it is important to examine methods of securing the financial reward of the economic benefit, normally by tariff adjustment.

Y. Examination of uncertainty

179. When the full cost-benefit analysis and financial analysis for the central forecast of each parameter have been completed, the effect of uncertainty can be studied by means of a simple sensitivity analysis. This is carried out by repeating the analysis for a variation in each main parameter, taken one at a time, by an amount estimated to be a comparable degree of risk. For each of these values, the economic and financial effects are recalculated. The ship's time costs can be derived simply from the planning charts given in part two of the handbook. For example, for a project which has an IRR of 12 per cent, the sensitivity analyses may show the following:

	Central estimate	Risk position	IRR at risk position (Percentage)
Cost of facilities	$ 10 million	$ 12 million	10
Productivity	500 tons per ship day	20 per cent less	8
Traffic growth rate	5 per cent per annum	2 per cent higher per annum	14
Economic life of facilities	20 years	15 years	10
Cost of ship's time	$ 2,000 per day	$ 2,500	15
Number of commission days per year of facilities	300	270	10

180. The percentage change produced in the IRR by each parameter change allows the investing authority to see the effects of changes in its estimates and to take all possibilities into account in its decision procedure. For example, it can be seen that a 20 per cent reduction in productivity gives twice the change in the IRR (−4 per cent) as a 20 per cent rise in the cost of the facilities (−2 per cent). A more rapid change in technology which would make the facilities uncompetitive in 15 rather than 20 years has a 2 per cent effect on the IRR.

181. A useful variation is to invert the calculation and show by how much each of the variables would have to change before the IRR fell to the minimum acceptable level, all other things being equal. For example, if construction costs would have to rise by 40 per cent before the IRR fell below the acceptable (cut-off) rate, then local management might judge this an acceptable risk.

182. The planning charts given in part two of the handbook have been designed with such sensitivity analysis in mind. Since no calculations are required, each alternative value can be tested very quickly so that it is possible to obtain ship's time costs for a sensitivity analysis without too much effort. Four of the six parameters listed above can be used as inputs for the planning tables in order to arrive at the total cost of ship's time. The other two (cost of facilities and economic life of facilities) can be directly inserted in the cost-benefit analysis.

Chapter III

TRAFFIC FORECASTING

A. Forecasting principles

183. The essence of port traffic forecasting is to find out:

(*a*) What kinds and tonnages of commodities will move through the port?

(*b*) How will these commodities be packaged and carried as maritime cargo?

(*c*) What ship calls will this result in?

Traffic forecasting requires a combination of commercial and economic knowledge; the mathematical techniques are of minor importance and can often be omitted entirely. Far more important is the need to bear constantly in mind the very high degree of uncertainty in any forecast, and to take steps to minimize the risk which this causes.

184. Any forecast of future trade will be uncertain, and ports are particularly vulnerable in view of their long planning time-scale and limited ability to influence demand. All forecasts should be linked with the over-all national development plans. Furthermore, maritime trade is going through a period of rapid change which critically affects the volumes and types of traffic likely to use any port. Errors in forecasting can be serious, and the consequences of over-estimating and under-estimating are not equal. To over-build may add only a few dollars, at most, per ton to freight costs, but to under-build may cause congestion leading to additional costs of $100 per ton.

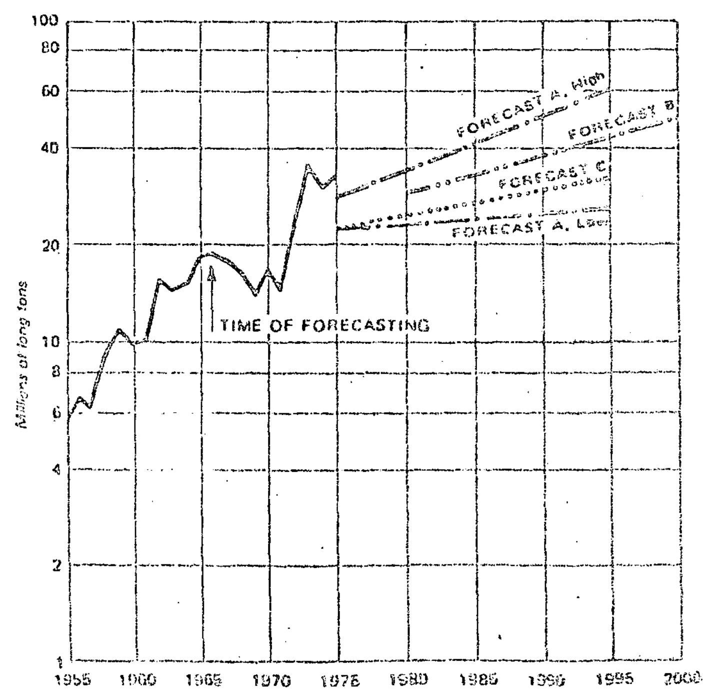
185. Even when all precautions have been taken to reach realistic and well-reasoned forecasts, the remaining uncertainty usually produces a wide variation of possible levels of traffic when projected several years in the future to the date of commissioning and beyond, and even greater uncertainty in the long-term master plan. All forecasts are thus to be treated with caution. It is hoped that the actual traffic level will be closer to the central forecast than to the upper or lower forecasts, but the risk that it will not be is normally too great a one for a port management to accept. This applies both to volume and to type of traffic. Thus the range of variation in the traffic forecast will usually be the first concern of an investment sensitivity analysis of the kind discussed in chapter II.

186. It is difficult to emphasize too strongly the inability of even the most penetrating analysis to forecast accurately more than a few years in advance. For example, figure 13 shows forecasts of exports of a major export commodity made in three independent studies by experienced economic consultants in 1967. Even though one of the consultants provided a wide range of possibility between a high and a low estimate of the trend, the actual figure in 1973 reached a level that even the highest forecast did not predict as occurring before 1982 and which the great weight of opinion did not expect until 1955. It may be noted that the tonnage is plotted on a logarithmic scale and that the errors involved are very large. This range of uncertainty is by no means unusual.

187. The planner can do a great deal to minimize this risk by searching for a design solution which is robust—one that is a good investment under a variety of possible future traffic. To do this he must be able to construct a number of different scenarios describing these alternatives. The port management can reduce the risk further by introducing an operational system which can respond to changes in traffic, together with an information system which gives a clear signal when the response is needed.

FIGURE 13

Forecasts of seaborne exports of feed grain



Sources: Port Development in the United States (Washington, National Academy of Sciences, 1976). *Highlights of US Import & Export Trade* (Washington, USA Bureau of Census), various issues.

B. Scenario writing

188. A traffic scenario is a consistent description of the whole of the future traffic likely to come to the port. It assumes that the port has done nothing to prevent the traffic arriving, but has encouraged it by providing reasonable facilities. For each cargo category the probable volumes under different circumstances, and the possible alternative types of technology that may be used in carriage and handling, are all considered. Several scenarios are then drawn up, each fully self-consistent, resolving any clashes between forecasts for different trades and permitting a reliable estimate to be made of the resources needed.

189. The scenario-writing team should include an operational manager. It is an appropriate task for the traffic manager of the port. The planner must consult the traffic department early in the project and participation of the traffic manager is a useful way of doing that. Representatives of shippers' and shipowners' interests should also be invited to participate, if possible as full members of the team. If the scenario-writing team is formed entirely of local staff who have not recently travelled outside the region, it would be advisable for a small group to visit modern ports at the far end of their main trade routes to become familiar with possible future developments.

190. It will not be possible for the scenario-writing to take place until after the routine analysis of traffic data, an examination of numerical trends and the making of simple projections. These are the data on which the scenario is based. But the team should be aware of the danger of reaching conclusions from extrapolation of past figures. For example, a team looking only at past traffic figures may ignore the potential export traffic of mineral products from undeveloped mines whose potential for production and export to overseas markets have been definitely established. The possible high volume of such exports will markedly affect port development.

C. Control statistics

191. It is the task of the traffic forecaster to provide both a central trend forecast and also a system of watching at given intervals to see when the actual traffic begins to deviate from this forecast. At, say, yearly intervals "signposts" will direct the management either to carry on as planned or to change direction, depending on the degree of deviation from the forecast. This approach can be simple and very powerful. It requires:

(*a*) The regular collection of a small number of essential traffic statistics to serve as a control;

(*b*) Giving a port manager (e.g. the head of the permanent planning unit, where this exists) the responsibility for re-activating the planning process when pre-determined deviations from forecast are reached.

192. Since any one port investment project may take up to five years to complete, it is possible that within this period the deviation from forecast will exceed the acceptable level. In that case the planning procedure should be repeated, starting from the state which had been reached in the project. Some form of re-adjustment will usually be possible even at a fairly advanced stage.

193. The most useful control statistics available from the ship and shift records which should be kept are, as appropriate to each terminal:

(*a*) The total tonnage handled;

(*b*) The average ship turn-round time;

(*c*) The average tonnage loaded and discharged per ship;

(*d*) The volume of special traffic handled at a multi-purpose terminal, i.e., the percentages of containers and ro/ro units, of bulk and bagged bulk shipments and of loads on pallets and pre-slung and pre-packaged loads;

(*e*) The percentage of ships with a specified type of equipment such as ship-board cranes or stern ramps;

(*f*) The average ship length;

(*g*) The maximum draught on arrival and maximum ship length.

With the exception of the last item, it is preferable to use the three-month moving average for the control statistics.

D. Combining the uncertainty in separate factors

194. Where a traffic forecast is being prepared from a detailed analysis of the factors involved, which are combined (either by addition or by multiplication) to produce the final figure, care has to be taken in dealing with optimistic and pessimistic estimates of each separate factor. Clearly, if there are three independent factors affecting the forecast, then the probability of it turning out that all three have a high value or all three a low value is very small. There are simple statistical methods of calculating this over-all probability. These methods are given in annex II, section C, of the handbook, and should be used where appropriate.

E. The forecasting procedure

195. The first step is to examine the existing traffic in detail, preferably on a year-by-year basis going back for at least three years. If possible, the analysis should be broken down in two ways: by country of loading or discharge, and by major cargo class. This will provide a tabulation such as is shown in table 4.

196. The grouping of country flows into regions should be by loading and discharge areas on specific trade routes. This is valuable because in general the

TABLE 4

Typical traffic forecast layout

	Origin													
	North-west Europe							South-east Asia						
Imports[a]	*Norway*	*Sweden*	*Netherlands*	*Federal Republic of Germany*	*United Kingdom*	*France*	*Total*	*Malaysia*	*Singapore*	*Indonesia*	*Philippines*	*Total*	*Japan*	*United States of America*
Liquid bulk cargoes:														
Crude oil														
Oil products														
Sulphur[b]														
Molasses/vegetable oils . . .														
Dry bulk cargoes:														
Coal														
Iron ore														
Sulphur[b]														
Cement[b]														
Cereals														
Other														
Containers and ro/ro loads.[c] . .														
On cellular ships														
On conventional ships														
On ro/ro ships														
Cargoes carried by intermediate methods:														
Packaged timber														
Iron and steel products . . .														
Other pre-slung and palletized cargoes														
Break-bulk cargoes:														
Wheat in bags														
Cement in bags[b]														
Fertilizer in bags														
Refrigerated fruit														
Vehicles														
Machinery														
General														

[a] The principal commodities shown are typical of those that may need separate forecasting at a single port; the list is not intended to be complete.

[b] Commodities should be sub-divided into different traffic classes according to the mode of carriage.

[c] ISO containers and ro/ro loads should be recorded both in tons and in twenty-foot equivalent units (TEUs).

same kind of cargo from the same loading area will be carried in a similar way. It is advisable, also, however, to make separate records of the individual country flows because this will make it easier to adjust forecasts to take account of political and other circumstances.

197. The grouping of traffic into classes should be done in such a way that it will be possible to estimate, first, the volumes of cargo and secondly, the numbers and types of ship that carry it. There is no very easy way to do this, and it is likely that the classes used will include a mixture of commodities and of ship technologies. One method of classification is as follows:

(*a*) All bulk traffic should be classified separately by commodity;

(*b*) Bulk traffic in the same commodity should be sub-divided according to mode of carriage and handling where this is significant (e.g. wheat carried and discharged in bulk; wheat carried in bulk and bagged in the hold before discharge);

(*c*) Non-bulk cargo should be sub-divided according to mode of carriage, i.e., type of vessel carrying it, as follows:

(i) Conventional liner;
(ii) Specialized pallet ship (sideloader, etc.);
(iii) Roll-on/roll-off ship;
(iv) Cellular container ship;
(v) Specialized semi-bulk carrier for packaged timber, iron and steel, etc.).

In addition, as an overriding principle, any commodity which is of particular importance locally—a principal commodity—should be recorded separately.

198. Typically, this approach for a port in a developing country will produce a list of, say, 10 export and 20 import traffic classes. Care must be taken with regard to the units used. It is unsatisfactory for development purposes to record movement in revenue tons (or freight tons or port tons) which are a mixture of weight and cubic measurement. All figures should be in tons of gross weight (it is preferable for metric tons of 1,000 kilograms to be used, but if this is not possible then the exact unit must be clearly stated). With regard to containers, both the tonnage of the freight contents and the number of boxes (in twenty-foot equivalent units, or TEUs, where a 40-foot unit counts as two TEUs) should be recorded.

199. A difficulty arises when vessels load a cargo belonging to a different traffic class from the cargo they discharged, and possibly intended for a different trade route. For example, a liner discharging manufactures from Western Europe could load cotton for the Far East; or, after completing a charter voyage to discharge fertilizer, a vessel might load bulk clinker for a near-sea destination. If these discharging and loading operations are carried out at different terminals, the ship moving from one berth to another, then the solution is simple. Separate terminals or groups of berths must be planned separately, as explained in chapter II above. Their traffic must be considered as independent demands. Hence a ship which discharges at one terminal and loads at a different terminal must be counted as two separate ship visits for planning purposes. This is a point where regular port statistics will not agree with the planners' data.

200. If the discharging and loading of cargo belonging to different traffic classes take place at the same berth, then the solution is not so clear-cut. It will normally be adequate to work with the average performance figures for the mixed traffic. There are two reasons for separating the traffic in the traffic statistics:

(*a*) To obtain a better estimate of the ship turn-round time and productivity;

(*b*) To enable separate forecasts of each kind of traffic to be made and to be revised in accordance with changing conditions.

201. The planning data needed for the actual design process given in part two of the handbook uses a single set of average figures for the traffic stream. The normal procedure will be to start with detailed commodity forecasts and obtain aggregated traffic figures.

F. Forecasting cargoes carried by ro/ro ships

202. The variety of cargo classes carried on ro/ro ships makes it particularly difficult to convert commodity tonnage forecasts into shiploads. The majority of ro/ro ships in fact carry a mixture of the following cargo classes:

(*a*) Rolled on and off:

(i) Containers on semi-trailers/chassis, with or without the prime-mover vehicle;

(ii) Container-like loads on road trailers or semi-trailers, with or without the prime-mover vehicle;

(iii) Wheeled cargo (trucks, cars, buses, etc., which are themselves the consignment).

(*b*) Carried on and off:

(iv) Containers carried on and put down by large fork-lift trucks or straddle-carriers;

(v) Other unit loads such as packaged timber;

(vi) General cargo carried on by fork-lift trucks and stowed in conventional holds, including a high proportion of pallets. (General cargo may also be rolled on board on trailers and then stacked.)

(*c*) Lifted on and off:

(vii) Normal container operations on deck or in special compartments.

203. For development purposes, it will be difficult to determine what type of ro/ro ship will carry the future cargo, and hence the proportions in which these seven classes are mixed will not be known. A simplification for statistical and forecasting purposes will be to group them under four headings only:

(*a*) Containers: classes (i), (ii), (iv) and (vii) (it may be noted that container-like loads can be measured in TEUs since a road trailer is roughly similar in load capacity to a container of the same length);

(*b*) Cargo carried by intermediate methods: class (v);

(*c*) Wheeled cargo: class (iii);

(*d*) General cargo: class (vi).

204. This grouping then allows the ro/ro cargo forecasting to be part of the over-all terminal forecast since all four categories will be forecast in total irrespective of the ship type that will carry them. Only after preparation of the cargo forecast will it be possible to consider, according to the sea route, roughly how much of each of the four categories may be carried on conventional ships, on cellular container ships or on ro/ro vessels.

205. The final calculation to determine the number of ro/ro shiploads and thence the probable number of ship calls cannot be accurate. After discussion with the ship operators concerned, a feasible and consistent solution will be to specify one or more "standard ro/ro ships" with a given part-load-capacity for each of the four categories. The first category will be defined in ship TEU capacity and the remainder in tons deadweight capacity.

G. The market forecast

206. An essential part of a realistic port plan is the identification of the potential users and the means of transport being used for the various commodities.

This should take the form of a market forecast. In many ports it will be advisable to appoint a commercial manager to carry out a continuous study of the market, and to make sure that this activity is closely co-ordinated with that of planning.

207. The aims of the market forecast should be to describe:

(*a*) The present users:
- (i) Who are they?
- (ii) What traffic are they offering?
- (iii) Who are the authorities making the decision whether or not to ship via the port?
- (iv) What influences their decision?
- (v) What berthing, cargo-handling or other services do they require?

(*b*) The potential users: a similar analysis.

(*c*) The ability of the port to influence the market:
- (i) What users and traffic are likely to be captured by port action?
- (ii) What additional facilities would this demand?
- (iii) What will be the effect of raising or lowering the port tariff?

208. These questions will be difficult to answer, and normal commercial practice will obscure the truth. Nevertheless, a continuous effort to discuss them with representatives of shipping lines and conferences, and with shippers and inland carriers, will normally pay substantial dividends and ensure that the port plan can be developed to meet the true future demand rather than passively follow past trends. In view of the particularly rapid pace of change in ship and cargo-handling technology, each stage in the analysis should ask specifically:

(*a*) What types of ship are being constructed for (or transferred to) services which may affect the port?

(*b*) What methods of cargo-handling will they require?

H. Rate of growth

209. In some service industries, such as telecommunications, the demand may be limited only by the facilities provided, so that any forecast may be self-fulfilling. There is an element of such investment influence in ports, as modern facilities often generate commercial and industrial activities related to maritime traffic, and these activities have a multiplier effect on the development of the port. However, such influence is generally considered to be small. A port whose investment lags behind the demand will certainly hold back economic development at least in the local region; but a port that invests ahead of the demand may only slightly encourage economic development. In a competitive situation early and substantial port investment can make a very large difference. However, it is not normally appropriate for ports in developing countries to engage in strong competition or in speculative investments.

210. The fact that a congested port can inhibit economic development has an important implication. It is not unknown for port planners to develop their own estimates of future rates of national and regional growth, tempering the central governement's growth ambitions with the cold water of past experience. This may be understandable from the narrow point of view of a port's financial interests, since port management normally has to make sure that the future port is financially viable, which it will not be if, for example, investment has taken place on the basis of a govemment target of 11 per cent annual growth in GNP when over the five years of a development project the actual growth has only been six per cent. The demand at the time of commissioning of the new facilities will in that case be only 79 per cent of the forecast demand, an error of over 20 per cent.

211. Nevertheless, this conservative approach by a port authority is not admissible. The past is not always a reliable guide to the future. In the case mentioned above it would still be possible for a change to take place that might accelerate growth to the target level. The port management must accept that there may be wider issues involved and that its span of responsibility does not include the revision of government targets. Instead, it must take two steps:

(*a*) Point out to central planners the implications of a high rate of economic growth for port investment at the time the national plan is being formulated, so that this factor can be taken into account;

(*b*) Introduce review-points into each project plan at which developments in volume and type of demand are taken account of; this will be part of the system of "signposts" mentioned earlier (see paragraph 191 above).

I. Events

212. Important events which may affect the level of a particular traffic should always be looked for, both to explain past changes and to indicate future changes. These may include political events, the bringing into operation of new factories and refineries, the construcion of new inland transport connections, changes in the market price of a principal commodity and hinterland agricultural developments.

213. The difficulty of predicting future events should not discourage the forecaster. Very often a re-examination of a forecast made earlier will show that a vital event was not foreseen. This does not destroy the value of forecasting or mean that it was a bad forecast. It is impossible to do more than prepare a forecast that is based on the best information available. Surprise events or circumstances can never be foreseen. The possibility that they will happen is a primary reason for the flexibility in planning recommended in chapter II above.

J. Effect of the port's own policies

214. The policies of the port will influence the future levels of traffic that use it. The users of a port are of two kinds:

(*a*) Captive users, i.e., the shipping lines, shippers and local industries which ship via the port because there is no economic alternative route;

(*b*) Non-captive users, i.e., those which, while obliged to move goods in and out of the region, can use another port within the region, or another mode of transport, and secondly, those which could cease trading activity with the region and so inhibit local economic development.

Both types of non-captive user will react to the decision taken by a port planner. Thus a port by its own policies can cause diversion of traffic to other ports or loss of regional traffic. Normally, such questions should be discussed at the regional planning level in terms of a set of objectives for the port.

215. One of the major ill effects which a port can have on the traffic using it is to prevent the introduction of more modern or more economic ship types. For example, the arrival of larger bulk carriers can be prevented by the failure to provide deeper water. It is generally such changes which are in question rather than a gradual falling off in demand as costs rise or the level of service falls.

216. Only rarely, for example when there are competing ports in the same country, will an attempt to evaluate the more sophisticated traffic relationships be justified. Such methods as demand elasticity estimation, analysis of effects of inter-port competition and analysis of traffic creation sensitivity are difficult to apply because knowledge of shipping lines' and shippers' commercial intentions will not be adequate. Moreover, the probability that unforeseen events will seriously affect the forecast is always present. Nevertheless, there may be occasions when the planner considers that the level of use of a certain facility will depend on the charges made for using it, and is at the same time faced with the difficulty that the charges needed to pay for the facility depend on the level of use. In that case it is best to forecast on the basis that charges and unit handling costs will be comparable with those applied at other installations of similar technology in the region and thus neither attract nor dissuade traffic. Accordingly, the market research which is needed before investment should be based on the assumption of a level of service and price roughly corresponding to those at other installations. If, however, the new port facilities are to be based on improved technology, for instance in handling dry bulk exports, costs may be considerably lower than those for older installations in the region and the above approach cannot be used. The forecaster is then obliged to estimate the relationship between charges and traffic.

K. Trend forecasting

217. The fact that over the last few years a particular class of traffic has been increasing does not in itself mean that the trend will continue. Trends can reverse themselves very quickly. Before projecting any past trend into the future, the planner should determine the reason for this trend, and the likelihood of its persisting. In most cases in developing countries the reasons will be one of the following:

(*a*) Traffic is directly dependent on the GNP;

(*b*) Traffic in a specific commodity or product has been deliberately developed or run down (e.g. national self-sufficiency in a major foodstuff; development of a new industry or of mines);

(*c*) A gradual shift in regional centres of production or consumption is occurring;

(*d*) A gradual shift in transport technology or routeing is occurring (from break-bulk shipment to containers; from maritime to overland transport, etc.).

218. If it is desired to find a traffic trend in a series of annual figures, simple methods are the best to use. Usually all that is necessary is to calculate an annual percentage growth rate, or to plot quarterly figures and draw in the trend by eye. When the trend is particularly important and likely to persist, additional accuracy can be obtained by carrying out a "least squares fit" procedure to ascertain the form of the trend. This is a standard method given in textbooks on statistics.

L. Seasonal variations

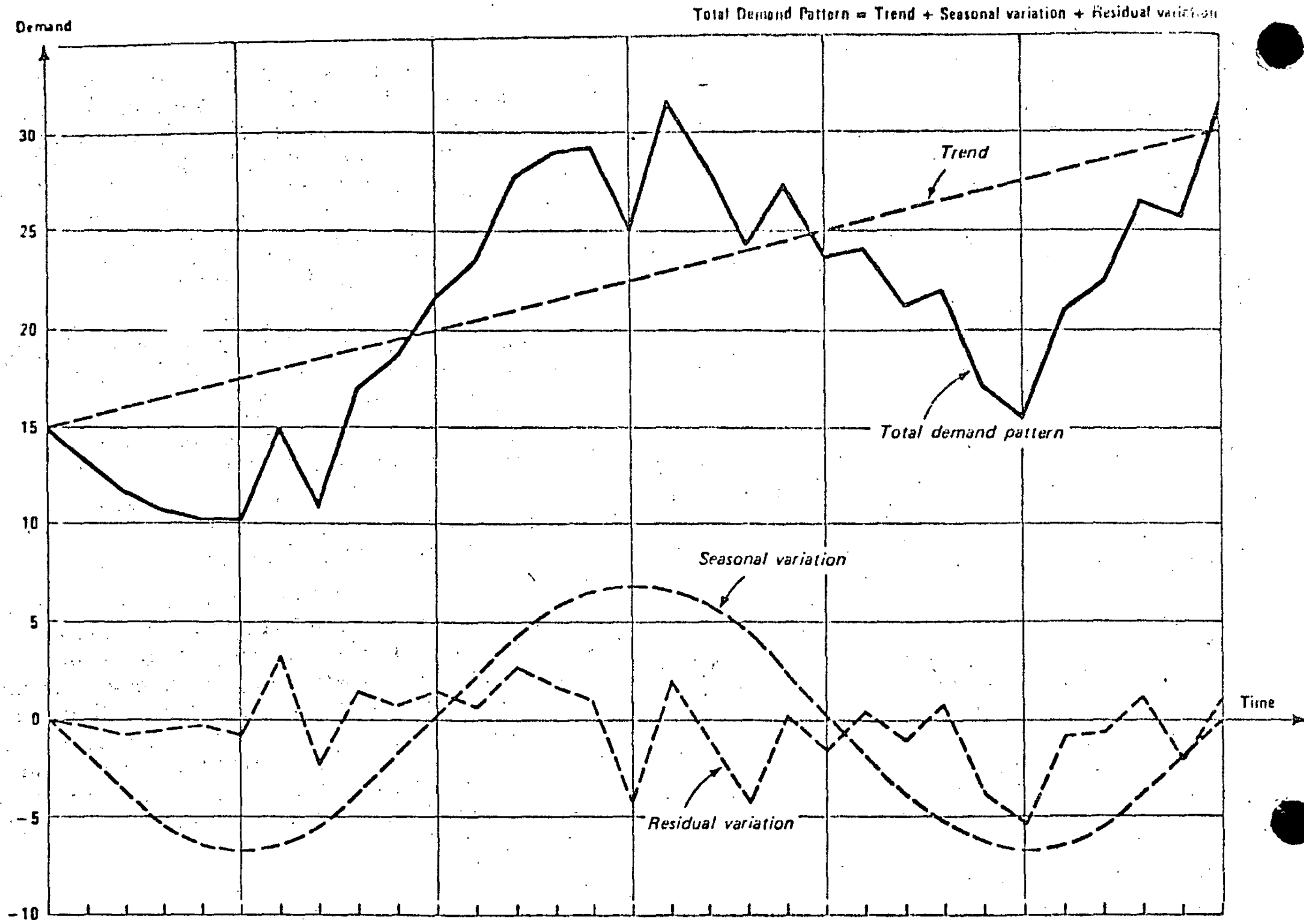
219. When a detailed traffic record—for example, monthly figures maintained for several years—is examined, a regular, cyclic pattern may be noticed. This normally results from a seasonal variation in demand for, or production of, certain commodities. The continuous trend line can be subtracted from the total to obtain the seasonal variation. There will still be superimposed on this seasonal variation a random residual variation, as shown in figure 14. Such analyses are likely to be very much simpler and more useful if the traffic is divided into principal commodities, seasonal commodities being kept separate.

M. General cargo traffic and GNP trends

220. Whereas specialized traffic is generally linked to the development of a specific industrial sector, or to individual events and policy decisions, general cargo—which in many developing countries consists predominantly of imports of consumer goods and general manufactures—is far more dependent on the trend in national wealth. An appropriate measure is the gross national product. The figures for the GNP trend and the government target should be taken directly from figures available at the national economic planning unit. Port planners should not normally en-

FIGURE 14

Separating a seasonal variation from a trend



gage in this form of forecasting. It is, however, necessary to adjust the GNP trend and to forecast for the hinterland deviation from the national trend.

221. For example, the hinterland trend may be below the national trend owing to a different rate of growth in various areas or regions of the country. The factors causing this may be expected to continue unless definite government measures are planned for the development period with a view to restoring the balance. Where regional GNP figures are available, useful comparisons can be made between regional growth and general cargo growth which will allow projections to be improved.

222. Apart from deliberate regional development policies, there will be occasions when pressures that build up produce trade shifts of their own accord. One recurring pressure is that caused when a central region or capital city area grows to the point at which land and labour costs become very high and industrial conditions become less attractive. When that situation occurs, a port located in an area of less pressure, with good connexions to the major internal markets, can expect a fairly rapid build-up of industry looking for alternative locations where conditions are more favourable.

N. Container traffic forecasts

223. Several principles should be observed when preparing the forecast for container traffic:

(*a*) The percentage of any trade which may become containerized must be determined on the specific commercial and economic grounds for each case;

(*b*) There are no fixed lists of commodities which are "containerizable" and commodities which are not, and a wider range of goods is being shipped in containers every year;

(*c*) Provision must always be made for a substantial proportion of containers moving empty;

(*d*) The average weight of cargo per 20-foot container can vary from 5 to 18 tons according to the nature of the commodity.

224. There will be a significant trade imbalance, with import containers predominating, during the early years of container operations in developing countries, since few of those countries will be able to provide sufficient containerized export cargo to fill the available import containers. The number of empty containers being loaded in developing countries will therefore be very high. Even so, however, a

small number of empty containers will be unloaded there, for example, refrigerated containers intended for perishable exports. Thus, to the number of loaded units exported from and imported to the port, an appropriate number of empties should be added. In the absence of other information, a figure of 60 per cent for export empties and five per cent for import empties would be reasonable estimates.

225. Although for rough planning, over-all averages of cargo tonnage per container can be used, it is inadvisable to use a single blanket figure, since a tonnage forecast of 500,000 tons, for example, could be carried in anything from 30,000 to 60,000 TEU containers. Wherever possible, the principal type of cargo to be carried (e.g. rice, general manufactures, refrigerated fruit) should be determined and with the appropriate stowage factor, the figure for the average number of tons per TEU can be used, as shown in table 5. In the absence of such information, it would be wise to plan on the basis of a maximum figure of 12 tons per TEU for imported general consumer goods in developing countries.

226. When the class of cargo is known, the procedure for planning more accurately is similar to that of calculating ship loadings. According to the stowage factors of the cargo, the maximum load can be limited either by the weight or by the space occupied. For planning purposes the internal volume of a 20-foot container can be taken as:

29 cubic metres
or 1,024 cubic feet

This volume will be filled at the maximum allowable cargo weight of 18 tons only when the cargo stowage factor is 57 cubic feet per ton (or 1.6 cubic metres per ton). Commodities of this density are, for example, flour, potatoes and palm kernels.

227 Cargoes with stowage factors greater than 60 cubic feet per ton will thus be limited by the physical size of the container, as shown in table 5.

TABLE 5

Maximum weight per TEU as a function of stowage factor

Stowage factor of cargo		*Cargo net weight per TEU (Tons)*
Cubic feet per ton	*Cubic metres per ton*	
60	1.7	17.1
70	2.0	14.5
80	2.3	12.6
90	2.5	11.6
100	2.8	10.4
110	3.1	9.4
120	3.4	8.5
130	3.7	7.8
140	4.0	7.3

Cargoes with lower stowage factors will be limited by the maximum allowable weight per container (18 tons), and will be packed to a height less than the standard 2.2 metres available in a container. They will all approximate to an 18-ton net weight. For cargoes with a lower stowage factor, the use of half-height containers may be warranted. However, it is not likely that this proportion can be forecast, so that attempts to estimate the effect of half-height containers on stacking and productivity are not likely to be justified.

O. Hinterland changes

228. The port's local and wider hinterland can be examined by studying the inland origins and destinations of a sample of consignments. The hinterland, and hence the port demand, can be affected by changes in the following factors:

(*a*) Population and GNP;

(*b*) Regional development plans;

(*c*) Land transport developments;

(*d*) Coastal shipping and inland waterway developments;

(*e*) Possible re-allocation of traffic to neighbouring ports.

The planner should examine these factors when preparing the traffic forecast.

P. Government traffic

229. It should be possible to obtain information on the traffic demands which central government departments or other authorities have already decided to place upon the port. The only forecasting task with respect to such traffic is to obtain a reasonable estimate of its rate of growth. This traffic will probably consist of large quantities of individual commodities. For example, there may be a central decision to import a predetermined quantity of fertilizer or cement. In this case every opportunity should be taken to convince central planners of the vital necessity of staggering the arrival dates of a series of bulk charters. Very serious congestion can result from failure to appreciate this fact, and the economic consequences of grouping the bulk vessels should be presented to the central planners.

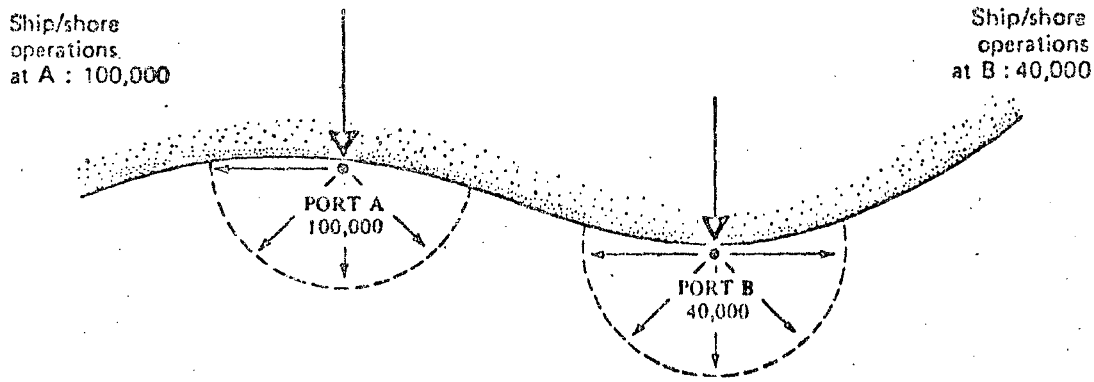
Q. Trans-shipment traffic

230. The trend towards more rational route planning, and the need to reduce the number of port calls made by large, fast and expensive ships on a trunk route, gives increased importance to the trans-shipment function of a port. Not only do such changes introduce a very different class of ship (feeder ships will be smaller and able to work in restricted draught conditions, and will have a high load factor) but there is also a variety of possible effects on the resulting traffic which is often overlooked.

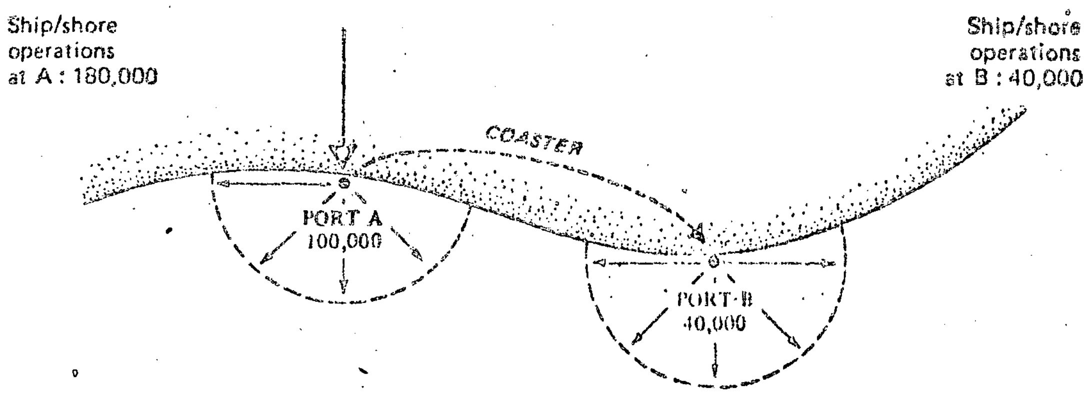
231. For example, figure 15 shows two ports, A and B, each with its own hinterland demand for traf-

Figure 15

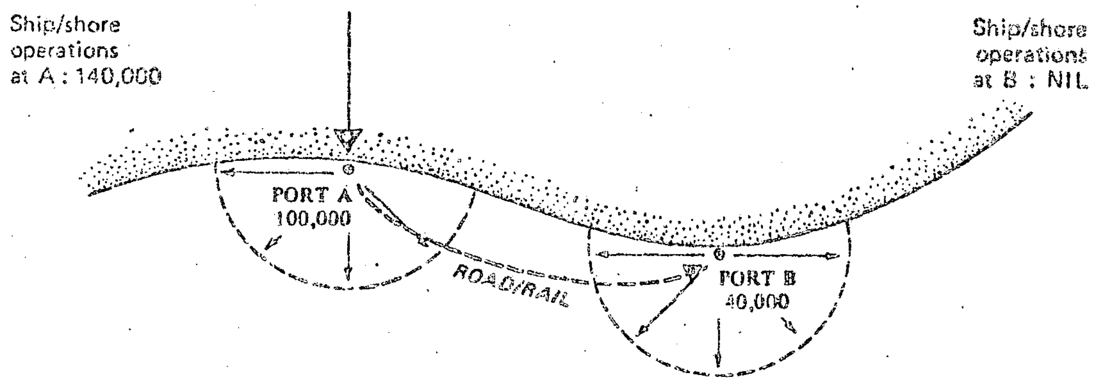
The effect of feeder services on quayside activity



(a) *Both ports on trunk route*



(b) *Port A main port; port B feeder port linked by coaster or barge*



(c) *Port A main port; port B feeder port linked by road/rail*

fic of 100,000 and 40,000 units per year respectively. When both ports are served by the trunk route ship (case (*a*)), each has only the standard level of quayside activity associated with its own hinterland traffic. In case (*b*), the trunk route ship stops calling at port B and its traffic is carried in a coastal feeder vessel. The level of quayside activity is now:

At port A: The port's own traffic plus double the trans-shipment traffic for port B (first discharging the trunk route ship, then loading the feeder ship).

At port B: The same level of activity, but with smaller ships.

In case (*c*) the feeder service to B is via land transport. The level of activity is now:

At port A: The port's own traffic plus the trans-shipment traffic for B.

At port B: Nil.

232. Clearly, the demand for port services varies substantially. After forecasting the traffic demand for the port's hinterland, the forecaster must then consider whether it will be a main port or a feeder port for that traffic, and what proportion of any feeder traffic is likely to go by sea or waterway, as opposed to road or rail. Handling facilities and storage require-

ments will both be affected. Road or rail feeder traffic will, of course, also place an additional load on the handling and access problems of the land transport vehicles.

R. Technological changes

233. For each class of traffic and principal commodity, the planner must consider the possibility of change in methods of packaging, handling and storage and in types of ship. These possibilities must be discussed with major shippers and shipping lines to determine:

(a) What decisions have already been taken;

(b) What long-term changes are likely

(i) Assuming that the port plays an active role in providing the necessary modern facilities;

(ii) Assuming that the port relies upon its existing facilities.

If possible, discussions should also be held with the managers of ports at the other end of major trade routes, since the technological situation at the far end will generally determine the change. This is one of the reasons for maintaining traffic statistics route by route.

234. The decision to introduce new technologies is normally taken by the ship operator. Unfortunately, the time of the port investment decision is usually well before a firm commitment can be expected from the shipping line to bring a specific class of ship to the port. This leads to great uncertainty as to the nature of the future traffic, and often the planner will be able only to suggest that the general trend in technology justifies a particular type of port facility. The port management's decision in such a case—for example, to invest in an expensive container crane—will inevitably carry an element of risk.

235. The technological changes in shipping which are taking place are discussed in detail in a series of reports on the subject prepared by the UNCTAD secretariat.[6] These changes take the form of a swing to traffic specialization and economies of scale, both on board ship and in the weight of the indivisible load unit that is lifted, rolled or floated off the ship. The planning implications of container and other unit loads, or roll-on/roll-off methods, and of barge-carrying vessels are examined in part two of the handbook.

S. Shiploads and number of ship calls

236. A forecast of the tonnages of each main cargo class on each major route, which is based on the probable trends in modes of carriage and cargo-handling technology, can be converted, by means of the average ship-load, into the number of ship calls.

237. The forecast of the number of calls (the ship-traffic forecast), and of the related size of ship is important in planning for the estimation of the following:

(a) Required depth of water;

(b) Required berth lengths;

(c) Future productivity;

(d) Turn-round time for individual ships;

(e) The frequency of ship calls;

(f) The back-up areas required to handle the peak shipload.

238. It will be useful to discuss the prospects for the consolidation of shipments with local shippers' organizations and with the shipping lines. Those bodies should be encouraged to consider what is the required and economic frequencey of shipment, the size of shipment and the storage demand, on the expectation that there will be a trend towards economies of transport and distribution.

239. Both the trend analysis and the discussions will produce a picture of the future which should be satisfactory for the purposes of ship traffic forecasting. The forecast of the number of ship calls should be made in the following two ways and if necessary a compromise forecast arrived at between the different results:

(a) By dividing the figure for total cargo by that for the average shipload;

(b) By ascertaining the number of calls directly from present records and the general trend.

240. It should not be assumed that there is a direct relationship between the tonnage loaded or discharged by a ship at a port and the ship's size. In liner services the size of the cargo load taken on or discharged at a given port is virtually independent of the ship's carrying capacity, except for home-ports or terminal ports, where loads tend to be a larger fraction of the capacity. For regular short-sea feeder services or ferries, on the other hand, it is reasonable to assume full shiploads (allowance having been made for a minimum of 10 per cent unused capacity in addition to the stowage factor limitation). For bulk carriers it is not normally likely that calls will be made for loads of less than 25 per cent of the ship's capacity, but it should not be assumed that bulk tramp ships will have a regularly high percentage utilization at a single port. Loads varying between 25 per cent and 75 per cent of the ship's capacity are to be expected, except with respect to major high-capacity terminals for the export, for example, of mineral ores, where the bulk carriers may be fully loaded.

241. The portion of the carrying capacity of a ship that is loaded at a particular port is determined by whichever is the smaller of the cargo available and the shipping space available. In addition, for a given amount of space, there will be a minimum load which will economically justify the call. This load will also depend on the pattern of calls made at

[6] "Technological change in shipping and its effects on ports" (TD/B/C.4/129 and Suppl.1-5).

neighbouring ports as part of a sharing of carrying capacity. In the case of container ships, port loadings have already settled down to typical figures on economic grounds. The average numbers of TEUs loaded or discharged per port of call are 400 to 500 on deep-sea routes and 100 to 150 on short-sea routes. These averages are relatively independent of ship size in both cases. The pattern of sharing out of carrying capacity is, of course, seriously changed on the introduction of feeder services.

T. Ship size

242. It is likely to be fruitless to try to find the future ship size on a route by looking for the relationship between size of ship and route length in existing services all over the world. Such relations exist, but they are so imprecise as to be of less value than a practical operator's opinion. For example, although there is a clear relationship between the grt of a given class of ro/ro vessels and service distance, as would be expected on economic grounds, there is a wide range of variation within this trend. On 1,500-mile short-sea services ships vary from 2,000 to 8,000 grt and on 4,000-mile services they vary from 7,000 to 14,000 grt. Planning cannot be based on such broad trends. The planner should study the existing port traffic and attempt to forecast future trends in order to determine this essential factor.

243. An element to be borne in mind in long-term planning for handling bulk cargoes is the tendency to use larger and larger ships for this purpose because of the economies-of-scale they afford. Consequently, sufficient water depth as well as width of turning basins and channels must be ensured for the long-term development of bulk-cargo terminals. The relations between dwt and the principal ship dimensions are reasonably systematic and thus can be used in planning. They may be found in the various chapters of part two of the handbook dealing with the different ship types.

Chapter IV

PRODUCTIVITY FORECASTING

A. Pitfalls in estimating productivity

244. Estimating the cargo-handling productivity which will be achieved is a vital part of the plan for a future port development. A mistake here can lead to serious investment errors. In considering the extension of existing facilities, the planner must find out:

(*a*) What is the real productivity at present? Recorded data are often inaccurate or misleading;

(*b*) How will this change with the new development? In theory, new methods should improve productivity, but in practice this is not necessarily the case.

245. There have been many cases of very poor estimates of future productivity, almost all being unduly high. This has probably been due mainly to two basic errors:

(*a*) Contrary to a widespread misconception, an increase in cargo-handling productivity will not automatically give higher berth throughput. For example, a change from conventional break-bulk cargo handling to the use of pallets should give, say, a 50 per cent increase in discharging rate, from 10 tons per gang-hour to 15 tons per gang-hour. But unless this is followed by a similar gearing-up of all subsequent activities (putting into storage, passing through customs, etc.), there will be no increase in berth throughput and probably very little increase in ship handling rate.

(*b*) Planners find it difficult to accept that productivity can go down as well as up. Yet it is a common experience in developing countries that at certain stages of development there is a transitional period during which productivity falls.

246. For example, a port in a humid tropical area accustomed to the use of contract labour drawn from the fittest young men from up-country villages is likely to suffer a steady deterioration in work output when it converts to the use of a permanent work force with workers assured jobs until the age of 60. It will then only be possible to maintain productivity—not to speak of increasing it—through the gradual introduction of mechanical handling equipment suitable for local conditions.

247. Again, a port which has perfected methods of manual handling over many decades is likely to see a drop in productivity for a considerable period after a change to less labour-intensive mechanical methods. For example, discharge of wheat in bags by a large, skilled work-force can achieve tonnages per shift which may be diffficult to match during the first year of operation of bulk discharge equipment.

248. With respect to a new terminal, where there are no local data to serve as a basis for estimating productivity, planners are forced to rely on performance figures taken from elsewhere. Great caution is needed before adopting these. Often the figures are taken from installations with quite different conditions. New methods have generally been first introduced in countries with a temperate climate, whereas the performance which can be achieved in a tropical climate may be far lower. This is due, not only to the human problem of keeping up continuous activity under difficult climatic conditions, but also to the direct effects of humidity and heat on equipment, which can seriously reduce both performance ratings and reliability.

249. These local effects are sometimes compounded by the optimistic sales information provided by manufacturers of cargo-handling equipment. There is a tendency to quote performance figures on a short-run basis and to imply that long-run performance is merely a question of multiplication. This is seldom true of any machinery, for:

(*a*) There may be other parts of the installation which cannot keep up with the main equipment;

(*b*) There will be faults and breakdowns;

(*c*) There will be periods when the equipment is out of commission for routine maintenance.

250. These questions are discussed further in later chapters where the main classes of equipment are reviewed and some guiding figures are given. Nevertheless, wherever possible, the planner should search for proven experience with the equipment in question from ports with similar conditions to his own. Assistance can also be given by the UNCTAD secretariat and by organizations such as ICHCA and IAPH.

B. Rated and effective productivity

251. There are three basic elements in cargo-handling performance. The first is the rated productivity, defined as the number of tons each gang, crane,

shiploader, pump, etc., handles when it works for one hour without interruption. The second element is the interruptions which tend to happen during any shift and the consequent idle time that reduces the shift output. As a result of this idle time, the average hourly performance is reduced to what may be termed the effective productivity. The third element is the manner in which gangs and appliances are used, for example, how many are used per hatch and per ship, how many shifts there are, how much overtime working there is. This last element is termed the working intensity. It determines how much total effort is used and this, combined with the effective productivity, produces the long-term performance.

252. A major preoccupation of the planner will be to make a realistic assessment of the effective productivity from all the optimistic and arbitrarily chosen productivity figures which will be given to him. For example, many container terminal operators quote productivities of 700 TEUs per day, but a rigorous UNCTAD analysis[7] showed that, of 21 major container terminals only one, working so-called second- and third-generation container ships, was able to maintain a productivity of this order (749 TEUs per day) over several months, whereas at the great majority of the terminals, working with two gantry-cranes, productivity fell within the range of 300-500 TEUs per day.

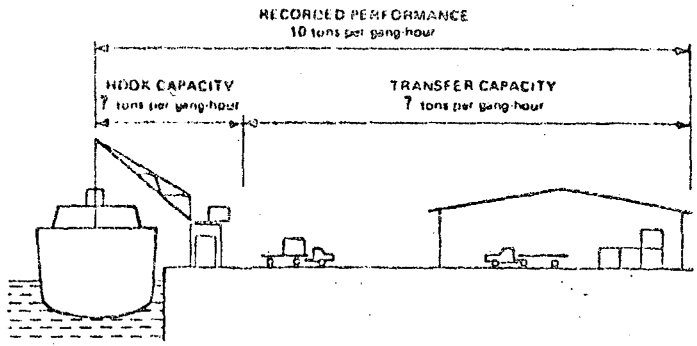
C. Matching of operations

253. Some parts of the berth system are linked in that every ton of cargo which passes through one of them has to pass through others. The most important links are between the ship cargo-handling system and storage, and later, between storage and onward transport. The first pair of linked operations, unloading from the ship and placing in storage, must be matched on an hourly basis; otherwise one operation will have to wait for the other, or goods will pile up in the operational area and cause congestion. To find out if they are matched, it is necessary to know the hourly capabilities of each operation separately. But here lies the problem: it is difficult to measure the one independently of the other, as any recorded performance will be that of the combined operation. For example, with regard to figure 16, where it is known that for a break-bulk operation the performance being achieved is 10 tons per gang-hour, it will be very difficult to find out whether this figure is limited by the gang in the hold which is feeding the hook, or by the tractor which is transferring cargo to the shed.

254. Retrieving cargo from storage for onward transport cannot be matched with the placing of cargo in storage either on an hourly basis or even on a daily basis so far as general cargo is concerned. Customs clearance and delivery formalities take time, and their duration may vary considerably. But the

FIGURE 16

Combined capacity of ship cargo-handling system and transfer system



capacity to despatch cargo from the transit storage areas must match the flow of cargo from quay to storage on, say, a weekly basis; otherwise, transit sheds and open storage areas will become over-filled, and serious congestion will result.

255. Such methods as those described in the UNCTAD report on berth throughput,[8] if applied with respect to break-bulk cargo early enough during the project planning period, can serve as the basis both for achieving improvements in current productivity at the port and for giving planners a better idea as to what the future productivity is likely to be. It is advisable to be very cautious—indeed, pessimistic—at the planning stage. Planning figures should be lower than the targets the operating staff set themselves and intend to achieve under a new set of operating methods or with new equipment.

256. The methods proposed in the berth throughput report can be used to check that the development proposal for a terminal gives a balanced throughput capability. In the operations of a port, the various sub-systems function together so that the effectiveness of one sub-system affects the operations of others. The various sub-systems can be thought of as a series of highway sections of different widths, as illustrated in figure 17. The maximum throughput through this traffic system is determined by the capacity of the narrowest section, B, which forms a bottleneck. It is obviously not possible to increase the over-all capacity by widening any other section before making improvements to section B. The only way to increase the over-all capacity is to increase the capacity of section B to that of the next largest capacity-section, D. Then, if justified, further improvements in the total capacity will require an equal increase in the capacities of both sections B and D.

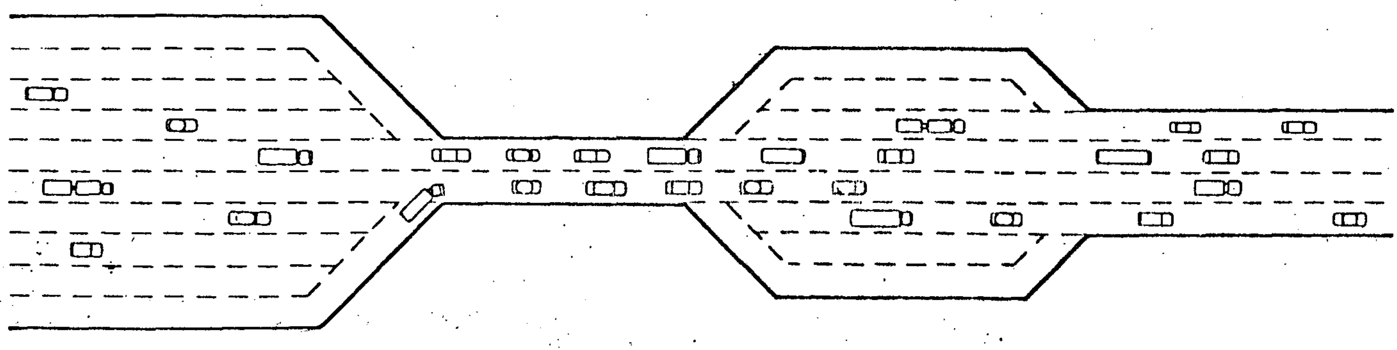
257. The two major capital costs in many terminals will be the berthing points, with their associated discharge equipment, on the one hand, and the storage areas on the other. Planning charts for both of these are given in part two of the handbook, but it is important to appreciate that the planning of these major

[7] See TD/B/C.4/129/Suppl.1, table 10.

[8] See foot-note 1 above.

FIGURE 17

Diagrammatic representation of a highway of varying widths



elements is based on the assumption that an equal level of capacity is provided also in the other stages of the operation, in order to allow full exploitation of the two major investments. For the import operation this will require particularly:

(*a*) A design for the capacity of the system for the transfer of cargo from discharge point to storage point;

(*b*) A design for the capacity of the system for the clearance of goods from storage;

(*c*) A check with sector planners as regards the capacity of the onward distribution system.

D. Local conditions

258. Some handling equipment demands an operator work-load and tempo which are excessive in a hot climate and for the local labour physique. This will hold the output down below what can be achieved in a temperate climate. In some cases the controls, for example foot pedals, are designed for persons of different physique, a fact which makes the tasks very difficult and lowers output further. This can apply to fork-lift trucks as well as to more advanced equipment.

259. It is thus vital not only to make sure that productivity targets are realistic for the local conditions, but also that the suppliers of equipment can refer to its successful introduction in similar port conditions elsewhere. Unless there is definite experience to go on, ports are advised to reject offers of untried equipment and go for proven equipment only.

E. Productivity increases

260. Although the emphasis throughout this chapter has been on the danger of planning on the basis of too optimistic a forecast of future productivity, it would be wrong to ignore the real increases in productivity which can gradually be achieved when specific changes are made. Measures for the improvement of productivity that can be incorporated into a proposed project can be divided into three main categories: those concerned with human relations (labour and personnel), those concerned with technical factors and those concerned with administrative and procedural matters.

261. The first category will include all means for improving the performance of each individual manager and labourer irrespective of existing technical conditions. Experience in many ports has shown that the productivity of labour and of clerical personnel depends not only on their professional skill but to a great extent on how far they are satisfied with the conditions of their work and whether they are really interested in that work. Specific measures may include:

(*a*) An adequate level of wages, commensurate with the arduousness of dockers' work, including premiums for performance above pre-determined norms;

(*b*) Possibilities for promotion to more skilled jobs;

(*c*) Accident prevention measures, first aid stations and well organized health care;

(*d*) Canteens and rest-rooms near working areas;

(*e*) Adequate housing and recreation facilities;

(*f*) Training in technical skills and general education, and greater delegation of responsibility resulting in greater opportunities for initiative.

262. In the category of technical improvements, the following steps can be taken:

(*a*) The introduction of preventive maintenance programmes, with properly equipped and staffed workshops and an adequate supply of spares;

(*b*) The purchase of a set of pallets to be used for general cargo;

(*c*) The purchase of additional tractor-trailer combines or fork-lift trucks for increasing capacity for the horizontal movement of cargo;

(*d*) Technical training programmes for superintendents, the labour force and union officials, including visits to ports in developed countries.

263. The third category of measures, those for the improvement of procedures and organization, includes some that are likely to bring about a considerable increase in throughput at a general cargo berth. Specific measures will include:

(*a*) Strict enforcement of the rule that individual consignments must be removed from transit sheds within a limited period, normally seven or ten days;

(*b*) Simplification of old regulations and cumbersome procedures which can delay the smooth transit of cargo through the port.

264. A forecast percentage increase in productivity should not be taken as meaning that there will be an equivalent percentage cut in service time. The two are not proportional, for

$$\text{Service time} = \frac{\text{Total number of tons worked}}{\text{Effective ship productivity}}$$

where the effective ship productivity is the number of tons worked per day at berth. At the maximum, a 100 per cent increase in productivity would result in only a 50 per cent decrease in berth time. The planning charts in part two of the handbook can be used to determine the effects of various changes in productivity.

F. Long-term performance

265. In the planning charts, care has been taken to call for data inputs at the detailed effective productivity level—number of gangs, tons per gang-hour, etc.—rather than at the over-all performance level, such as tons per day or tons per year. This is advisable in order that the forecast should be fully thought through in operational terms. When longer-term performance figures are needed, they can be taken from the appropriate output scales of the planning charts.

G. Increased productivity with large shiploads

266. For any given combination of cargo type and method of handling, there is clear evidence that larger quantities make higher productivity possible. This is a simple effect due, first, to a reduction in time lost in starting up operations and, secondly, to the building up of a higher work tempo on a long run. The effect is not sufficiently precise, however, to be used for planning calculations, and it is often swamped by other factors causing variations. It would be wise to plan on the basis of a single figure for the average shipload.

H. Offsetting effects

267. Productivity improvements are often associated with social and commercial factors which offset them. The gradual trend to shorter working hours, and the resistance to working at night or at week-ends in industry in general, may become important factors in ports of the future. Again, theoretical reductions in ship service time due to increased productivity may be offset by increased idle time as the ship operators may have a tendency to keep to a traditional fixed time in port.

I. Productivity targets

268. It can be misleading to give standard or even average figures for hourly or daily productivity. There are many valid local reasons why one port, or one berth group within a port, may be able to achieve a figure much higher than another, and inter-port comparisons of this sort are of no great value. Each port should compare its current performance with its performance of previous years and try to improve on that rather than attempting to achieve apparently higher figures derived from elsewhere, which may have been calculated on a different basis.

269. When the planning charts given in part two of the handbook are used, the figures entered for the tons per gang-hour, the fraction of time worked and the number of gangs employed should all be taken from figures actually recorded. Where these are not available, and particularly where a port has little experience of the type of operation proposed, it is strongly recommended that operational staff pay a visit to a port experienced in that operation, preferably in similar local conditions. The information they gather on such a visit, suitably adjusted to take account of local conditions, should be used as the basis for planning.

TABLE 6

Productivity check-list[a]

Cargo class	*Tons per ship-day*
Conventional general cargo:	
On deep-sea routes	700
On short-sea and coastal routes	500
Fully palletized general cargo	900
Packaged forest products	1 500
Bundled iron and steel products	2 000
Pre-slung cargoes	900
Ro/ro units	2 500
Containers:	
On deep-sea routes	450 TEUs[b]
On short-sea and feeder routes	275 TEUs[b]
Dry bulk:	
Loading	70 per cent of shiploader rated capacity[c]
Discharging	50 per cent of unloader rated capacity[c]
Liquid bulk	Ship's pumping capacity (approximately 5–10 per cent of dwt capacity per hour)

[a] Before these figures are used reference should be made to paras. 268-270.

[b] See para. 253.

[c] See definitions of capacity in part two, chapter VII, on dry bulk cargo terminals.

270. Nevertheless, in order that such productivity estimates remain realistic, the planner will want to check that the figure proposed is within the right range. Table 6 gives values which can be used for this purpose. The figures given are for a well-trained and motivated team working the average number of hatches for each class of ship, and for a shift pattern which gives a fraction of time worked (standard shift-hours per week divided by 168) of 0.6. The figures can thus be considered in the nature of long-term operational targets. Their main purpose, however, is to act as a check-list to prevent over-optimistic productivity estimates. Higher figures should not be used unless strong evidence exists to the contrary, and planners may prefer rather to adopt lower figures according to local circumstances.

Chapter V

MASTER PLANNING AND PORT ZONING

A. Port location

271. The early, traditional ports were generally located close to or were part of a coastal city. Their function was to serve that city and secondarily, inland areas and towns. The traffic they handled was predominantly general cargo. Even where there were principal export commodities, the quantities involved were small enough also to be handled in break-bulk fashion (for example, in bags). The commercial activities associated with the port, apart from warehousing, did not call for much land area, and there was little industrial activity. Thus the city centre waterfront was an acceptable location for the old general cargo piers.

272. In the last few decades, many factors have influenced the location of the port, changing the above picture almost completely:

(*a*) Commercial, warehousing and light manufacturing activities have been forced to move out of the main urban area, both because of their increasing scale and resulting land needs, and because other demands for city centre land have become too great;

(*b*) Industries have grown up which require extensive land area and easy access either to the port or to the inland distribution system, or both;

(*c*) The tonnage of principal commodities has increased to the point where the whole scale of the old operation has been outgrown;

(*d*) This increase has made possible the introduction of bulk transport, which utilizes larger ships needing deeper water and large transit storage areas, and also requires unencumbered landward traffic routes;

(*e*) The economies of scale have induced port planning authorities to concentrate development at a single port which services a considerably larger area than before;

(*f*) The old concept of mixing port activity with the normal life of a city population has been generally abandoned on environmental grounds.

273. As a result, the preferred location of a modern port is no longer on a city waterfront. Existing city ports may continue to operate, but they serve only a fraction of the total traffic, mainly the residual break-bulk cargo traffic for the local hinterland, together with coastal trade and lighterage operations. The principal traffic and the major proportion of the general cargo traffic, especially when unitized, must move to more suitable locations. In developing countries, where unitization is developing slowly, there may be the possibility of continuing for a certain time to handle all the general cargo in the old location, but if there is a considerable volume of general cargo traffic, even if it is not unitized it may need a new, more convenient location. In the great majority of cases the industrial port activities must be moved out of the urban area, even if only on environmental grounds. In fact the new port may function as a focal point for regional development and thus its location can be used to stimulate national economic growth.

274. A point to consider for ports contemplating the transfer of some activities to new areas is the possibility of offsetting the cost of new developments by selling or leasing the valuable city centre waterfront land.

B. The master planning approach

275. The search for suitable locations for new port developments and for extensions to existing ports will be governed by the need for the following:

(*a*) Deep safe water at berthing points, and satisfactory approach channels;

(*b*) Sufficient land area;

(*c*) A labour force;

(*d*) Good access to road, rail or waterway routes.

This chapter considers the way in which the first two requirements may be harmonized. The availability of a labour force to operate the port is a very important aspect, as the economic and social costs of re-settling workers is considerable. Engineering aspects of the water area requirements are discussed in chapter VI below. The inland transport connexions are discussed in chapter VII below.

276. These requirements form an early part of the work of master planning. The relationship between the master plan and other, shorter-term, port development projects, was described in chapter I, where it was pointed out that the master plan is concerned with preparation for the long-term future. The emphasis is on setting a rational development framework into which successive construction projects can be fitted as the traffic increases.

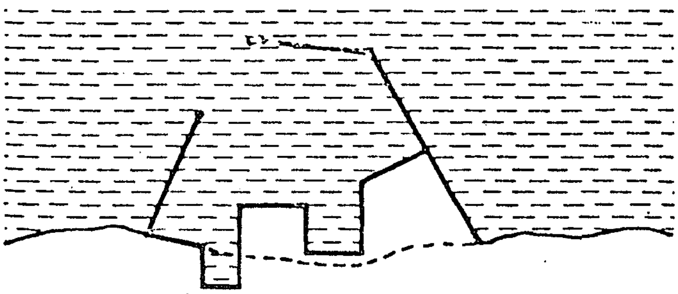
277. Master planners must look into the distant future and search for the most economic configurations, but the usual financial project appraisal techniques are not appropriate at this stage of planning. The major criteria are industrial, social and environmental, with enough practical engineering study to ensure that the long-term path chosen does not lead in a direction of excessive civil engineering cost. A principal consideration of the master plan will be to keep the port's options open as long as possible. For this purpose the planner should give his main attention to preparing an over-all programme of land use and preventing the authorization of the use of land for other purposes which would hamper the future development of the port.

C. Classes of port

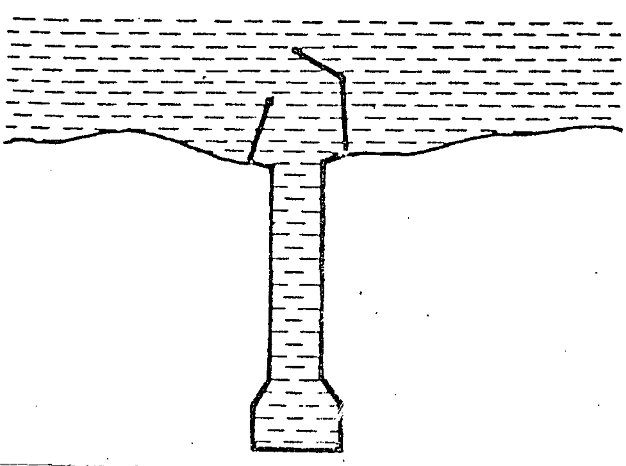
278. It is important to consider a wide range of alternatives before selecting one concept. A common mistake is to become preoccupied with one proposal too early in the work. Nowhere is this more important than at the broad master planning stage, since there are opportunities here for influencing the whole course of a country's regional development. The conceptual stage starts with the co-ordinated national port strategy, and here the options open for a country with a long coastline or many rivers are numerous.

FIGURE 18

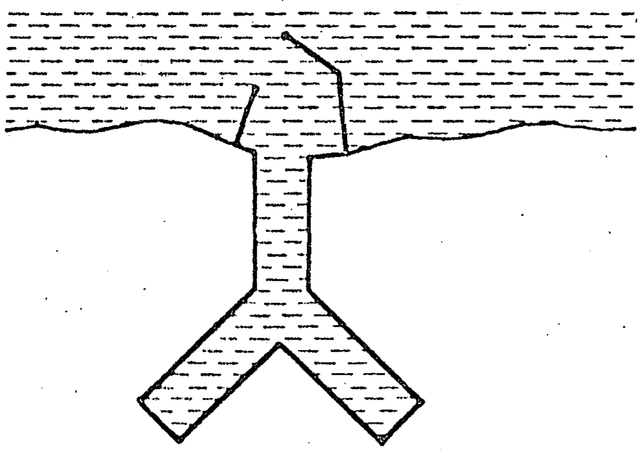
Artificial harbour configurations



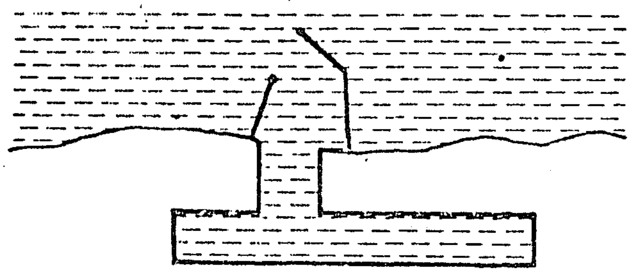
A. Projecting (dotted line shows original coastline)



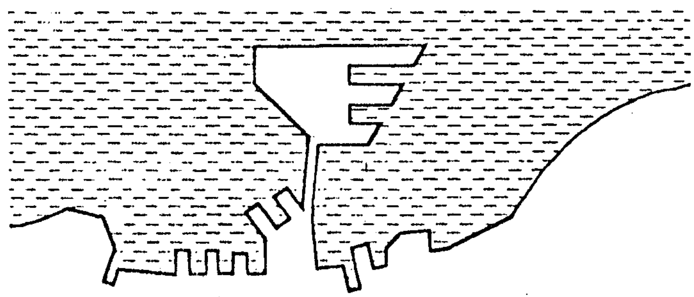
B. Cut channel and turning basin



C. Y-cut channel



D. Parallel cut channel



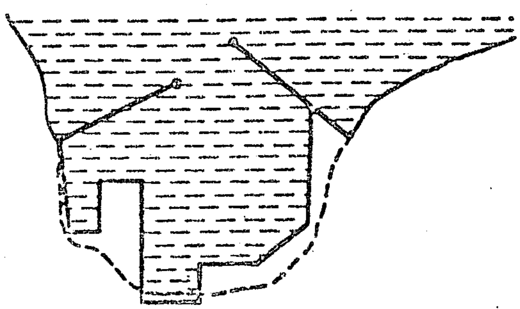
E. Addition of artificial port island to an existing port

279. The main classes of port which may be considered before deciding on a short list of site alternatives are shown in simplified form in figures 18 and 19. In every case the aim of the development is to provide sheltered water with access to substantial areas of land. In that respect the artificial harbour formed by cutting a channel in land is particularly useful, and the Y-cut version (figure 18, C) may be considered to give the possibility of an optimum land-use policy. Such a Y-cut can also be a useful elementary dock shape in more complex ports. In certain cases, however, such channels have been found to amplify the wave pattern and therefore careful model studies should be carried out. Where the facilities needed require more space than would be provided by any possible extension of the berthing length of a fully-developed port waterfront, and water conditions permit, the formation of an extensive artificial island linked by a bridge, as shown in figure 18, E, offers a solution.

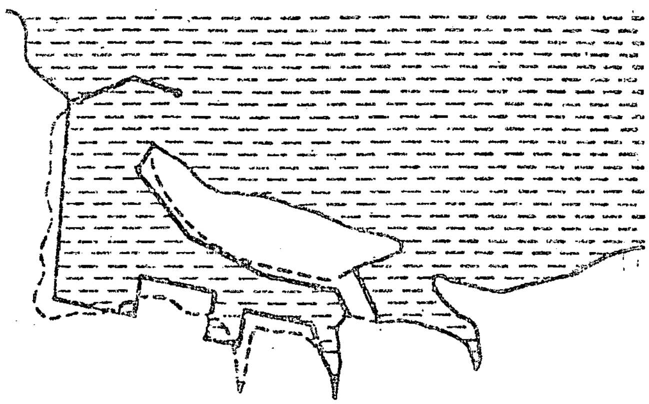
280. In the case of natural harbours, the estuarial port, such as that in figure 19, C, is likely to be the most productive of harbour facilities per unit of construction cost, provided that dredging costs are not too high. To avoid excessive maintenance dredging, this type of development requires particularly careful analysis of the hydraulic conditions, and the configuration chosen will normally be most satisfactory when it reinforces the natural regime rather than disturbing it.

FIGURE 19

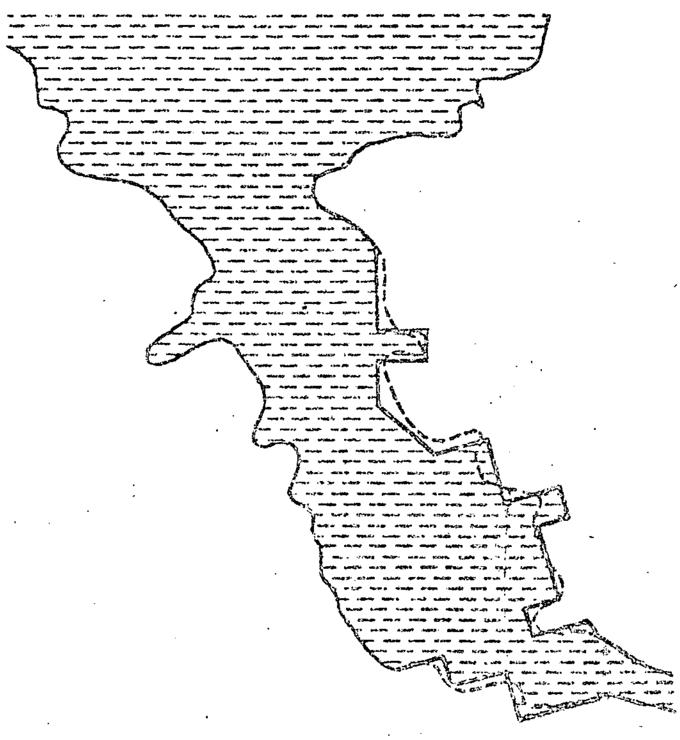
Natural harbour configurations



A. Development of a natural harbour



B. Development of a natural off-shore island



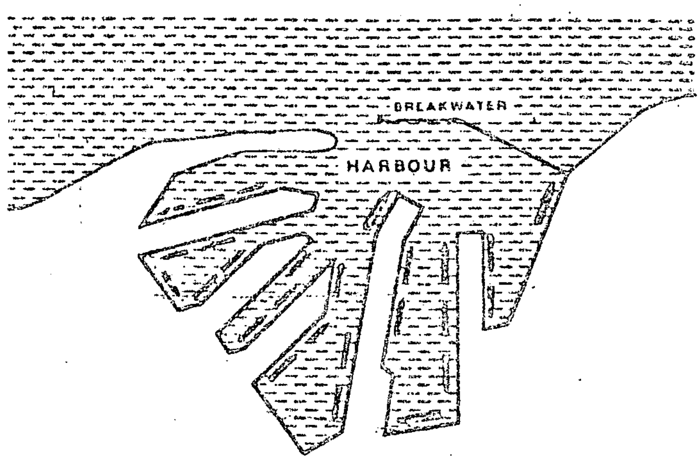
C. Development of a natural estuarial harbour

D. Harbour configuration

281. A useful indicator of area requirements in port layout design is the number of square metres of operational land needed per metre of quay. For a linear quay, this can be simplified to the depth of operational land needed behind the quay wall. In earlier days, with small ships and low handling rates, the figure was small—often around 50 (50 square metres per metre of quay), which included the areas required for the quay apron, sheds and rail track. This enabled long narrow piers to be built inside a harbour to maximize quay wall length, as in figure 20.

FIGURE 20

Port layout to maximize quay wall length

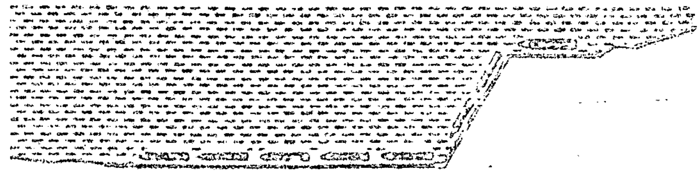


282. In this typical old harbour layout, maximum use was made of the sheltered water. When the cargo carried per ship increased and productivity went up, the indicator increased quickly to 100 and then 200, so that it was impossible to find enough operational land with such an internal layout. It has more recently been fashionable to try to eliminate piers and basins entirely and to use only deep corner areas and long linear quays as shown in figure 21.

283. Although the layout shown in figure 21 is excellent from an operational standpoint, it clearly uses

FIGURE 21

Port layout to maximize operational land area



far more natural coastline and far more sheltered water per berth than the layout shown in figure 20. Therefore this construction is only likely to be economically feasible in rivers and estuaries where ample coastline and sheltered water are available. It would be very costly to build the harbour illustrated in figure 21 on a coastline which needed artificial protection by breakwaters.

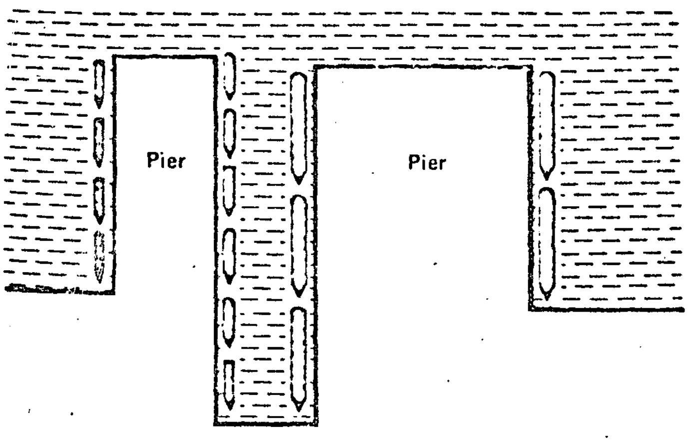
284. The best layout for providing the operational land needed without wasting coastline and sheltered water is one with a pier-type configuration but where the piers are far wider than is traditional. As a rule of thumb it may be taken that a pier for any form of general cargo should not be less in width than two ship-lengths, as shown in figure 22, A, that is, about 320 metres wide for an average operational cargo pier. For operational reasons it is advisable, where possible, to use the end of the pier only for minor harbour-craft and not as a berth. Prevailing currents and winds plus other navigational considerations will often make it preferable to use a slanted or herring-bone pier as in figure 22, B.

E. The industrial port

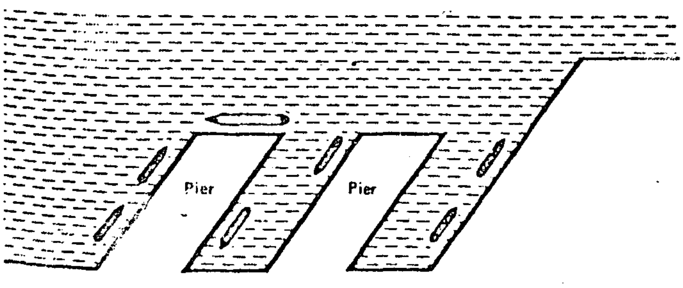
285. Whether the port is to fulfil only its primary function of transferring cargo between land and sea transport or to play a wider and more active role in national development is a primary question for the government. On economic grounds alone, a clear case can often be made for siting certain industries at the point at which different modes of transport meet, since any other intermediate location between the source of raw material and the destination of the product will introduce an extra handling and buffer storage stage.

FIGURE 22

Modern pier layouts



A. Straight piers



B. Slanted or herring-bone piers

286. But the question is deeper than this. Port activity constitutes a substantial industry in its own right. The port employs large numbers of workers and trains them in a variety of skills which are transferable to other industries. It is therefore a focal point for a complete community and exerts a natural attraction for other industrial activity. Environmentally, it is also likely, prevailing winds permitting, that atmospheric pollution can be minimized when plants are located on the coast. Thus, to plan a port without considering an industrial zone is to lose a valuable opportunity of stimulating regional development. The development of a new port that does not include some industrial activity can normally only be justified when:

(*a*) Urban pressure and/or environmental aspects are a deterrent to further development;

(*b*) Geographical or climatic factors limit coastline activity to the bare minimum.

287. Strictly speaking, major industrial developments which, for reasons of economy, are to be sited near a waterfront, should be considered purely as generators of traffic and supplied with port services in the normal way. However, there will be arguments advanced for such industrial areas to have their own port facilities. This gives rise to the concept of a specialized industrial port which is dedicated to that group of industries and separated from the commercial port. Relatively isolated industrial complexes—for example, a mine and an ore-processing plant near a stretch of undeveloped coastline—may justify the building of a special terminal close at hand to reduce land transport costs. Large oil terminals are also often sited away from built-up areas for environmental and safety reasons. However, in both cases, the accessible water depth is likely to be the governing factor, but the possibility of long jetties or off-shore terminals gives considerable freedom in siting.

288. Such freedom to operate independently from an established port can be very attractive to industry planners who may prefer to keep control over all stages of their operation. Two notes of warning must be sounded, however. First, it should be recognized that, in the long term, industrial complexes of any type tend to gather around them associated industries and commerce, with a gradual build-up of local population and all the resulting land-use needs. It would be wise to foresee such developments before deciding on the location of the specialized terminal. Secondly, even though it appears that the terminal will be sited on an undeveloped stretch of coastline, and it may not be possible to imagine any alternative use, the long-term prospects may be very different.

Coastline, which is a national resource, should not be given up to a user without a reasonable revenue being collected. In such cases legislation may have to be passed to re-define the boundaries of an existing port area to include the new terminal, so that the port authority can collect revenue as well as providing any miscellaneous services (maintenance of navigation aids, ship repair, tug assistance, fire-fighting) which it would be uneconomical to duplicate.

289. Major industrial development areas, as opposed to isolated industries should, if sited adjacent to a port, be provided with normal common-use port facilities and the temptation to give up coastline exclusively to special industry needs should be resisted. General cargo needs should be routed through the normal port facilities, and only when specific industrial concentrations require specialized bulk terminals should they be given a separate terminal within the enlarged port area. The cargo-handling needs of the development area will thus be brought fully under the planning and control of the port authority, one of whose main concerns in master planning will be to exclude users of port land who do not need to be located in the port area. Analyses have shown that the proportion of users who do need to be located in the port area is sometimes surprisingly small. Such considerations can lead to a realignment of the proposed development area inland, rather than parallel to the coast, thus reserving the maritime community's future freedom of action.

290. Since the secondary and tertiary industries add the most value and aid regional development most, while the primary industries tend to contribute most to port revenue, a conflict of interests may arise in the allocation of land by the port authority to the various industries. Where the economic advantage of a particular port land-use overrides the port's financial objective, a land-use subsidy by the government may be appropriate to compensate the port for its loss of revenue.

F. Reclamation

291. Parcels of operational land are often gained by pumping or carrying dredged material from the waterside of a quay wall to where land is needed. This engineering activity can significantly change the master plan possibilities.

292. By this means, an island, a sandbank, marshland or a tongue of land which would otherwise not be usable can be improved and given a berthing face and an operational surface. Small offshore islands can play an important role in a modern port, particularly in the development of bulk handling facilities for commodities which can be transferred to land via pipelines or conveyors without the need for an expensive causeway. A costly alternative, using advanced technology, is to create a complete floating off-shore port. This, however, is not likely to be a feasible solution for a developing country.

293. Reclamation on a wider scale, for example to provide substantial industrial development areas, is another possibility. Such an area will usually need to be large enough for several industries, and its development as part of a regional policy will normally be undertaken by a public authority which, for a port industrial zone, means the port authority. Various sites would then be leased on a long-term basis by the authority to industry. Unfortunately there can be little guarantee of successful leasing at the time of planning, since tenants will not start enquiries until the area looks less like mere sandbanks or marshland and more like a real industrial site. It will be necessary—if land reclamation for industry has been chosen as a policy—to go ahead without any clear assurance that it will be possible to lease the land so reclaimed. But once the site is complete, industrial demand is capable of building up very fast and as a general rule such reclamation must be beneficial to regional development.

294. Expensive infrastructure projects of this kind take so long to complete that they have to be started not merely well in advance of any project to build the superstructure which is to use them, but often before the need for the superstructure has even arisen. This is a vital aspect of port development and was probably first appreciated in the Netherlands where action of this kind was a major factor in the success of Rotterdam.

295. When forecasts show that the growth in trade will eventually necessitate very substantial new port facilities, large-scale reclamation schemes deserve serious study as a long-term solution. The reclaimed land can reach out to deep water and so reduce dredging costs. The whole complex can be planned to minimize adverse social and environmental effects. The complex can become a combined residential, commercial and industrial development with properly planned communications, including a commercial airport. Such integrated schemes are likely to become more necessary as development gathers pace.

296. The principle mentioned earlier of selecting a quay configuration in harmony with the existing conformation applies even more strongly to schemes for the recovery of large areas of tidal flats or marshes. In such cases not only can the major change in land/water interface cause environmental effects which may only partly be foreseen by model studies, but the approach channels and berth faces may be subject to siltation and other adverse effects which can normally be minimized by co-operating with the natural system.

G. Rationalizing port land-use

297. In parallel with the type of development discussed above, where the extra land needed for the modern port is provided by reclamation, extension or developing additional harbours, there is the need to examine the port's existing use of land and its gen-

eral waterfront configuration. This examination is an essential part of the master plan, since the rationalization of the configuration and of the zoning of land-use can release land for the increased operational port areas needed in a modern port.

298. In a port which has grown up haphazard into a complex pattern of piers, basins and railway marshalling areas, a major rationalization needed is the simplification of the layout by closing berths made redundant by modern cargo-handling methods, filling in basins and docks, removing rail tracks and re-surfacing. This can transform the port from a configuration which may look rather like that of figure 20 to that of figure 19, A. The process is a gradual one but such a long-term direction of modernization should be set at the master planning stage.

299. A second possibility is the transfer of non-essential activities out of the port area. Strictly speaking, the only essential port activity is the loading and discharge of ships and all else could be done some distance away, either inland or on a less valuable part of the coast. A port of this type is an impractical commercial concept, but the principle of removing activities inland when port land runs out is a valid alternative in master planning. Long-term storage or warehousing with the associated sorting and commercial activities may be strong candidates for removal. The three necessary technical conditions for movement to an inland depot are: first, that the transport operation can be organized economically; secondly, that the consignments are through-consigned on the shipping documents; and thirdly, that customs formalities are transferred to the inland depot. But in addition there can be serious organizational problems, which means that only countries with a strong management base may find this solution feasible.

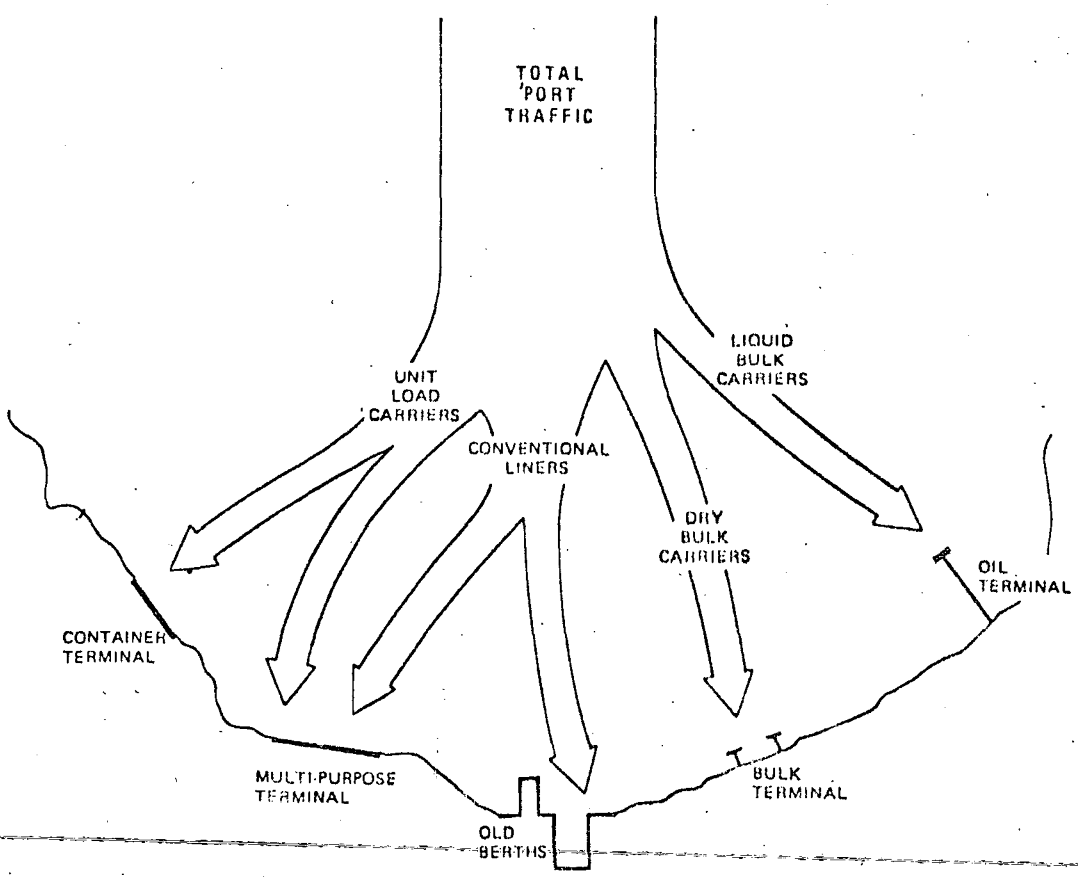
H. General layout principles

300. The way in which the different areas are fitted together will be a major factor in preventing future congestion. The most serious mistake to avoid is to allow long-term commitments to be made with respect to a piece of land which may later prevent the expansion of other areas and/or the access to them. A similar mistake is to allow land to be used—even when there is no long-term investment—for purposes which it will later be too difficult to change for social and political reasons; for example, waterfront recreational areas.

301. All except the smallest or most specialist ports consist of several separate terminals or groups of berths, each handling one kind of traffic. The need to divide the port area into specialized zones has resulted from the demand for increased productivity at each terminal. Where the volume of traffic is too

FIGURE 23

Allocation of traffic to port zones



small to justify a separate terminal for each kind, or where uncertainty as to the form of future traffic does not justify a specialized terminal, the answer can be a multi-purpose terminal. In general terms the port will consist of the separate zones shown in figure 23.

302. At an early stage in the preparation of the master plan, these zones should be clearly identified. Subsequently, the port authority should recognize the separate nature of these zones and should both delegate specific responsibilities for their control to designated managers and institute separate information systems to collect traffic and performance statistics for each zone.

303. The point at which it becomes economical to provide a specialist terminal for a particular class of traffic depends mainly on the annual throughput of that traffic. The planner must determine the ships' turn-round times for the two alternatives. Then, with the cost estimates of the various terminals, the best development strategy can be selected.

304. The relative siting of the zones in the port will depend on the following factors:

(*a*) Water depth requirements for each terminal: the traditional break-bulk depth of 7.5 to 10 metres will not be adequate for deep-sea container vessels or dry-bulk and oil-carrier vessels;

(*b*) Land area requirements for each terminal: for example, the back-up area for a container berth will be greater than that for a break-bulk berth;

(*c*) The influence of prevailing winds: the siting of the zones should be such that dust and odours from bulk cargoes are not carried towards general cargo berths, passenger facilites or inhabited areas;

(*d*) Safety considerations: terminals for oil products, which must often be sited within the main port area, should preferably be located near the port entrance at a reasonable distance from general cargo zones. Other dangerous cargoes will need similar special zones;

(*e*) Inland transport access: terminals for dry bulk commodities should be sited in such a way that an easy access to the highway or railway network can be arranged, without the necessity of crossing densely inhabited areas;

(*f*) Compatibility of adjoining zones: apart from the consideration of prevailing winds, care should be taken to avoid placing zones together whose cargoes may have adverse influences on each other. For example, a zone for grain and flour can safely be located next to timber or steel terminals, but not in the vicinity of fertilizer facilities;

(*g*) The traffic flow system: a zoning plan should not be adopted before making sure that the routes for vehicles, rail-track, conveyors and pipe-lines fit harmoniously together. A plan which produces a large number of route crossings, bridges and fly-overs must be suspect.

305. In considering whether or not to site individual traffic separately, the possibility of finding compensating import/export traffic should be checked. Examination of origins and destinations of traffic shown in the forecast may suggest a combination of compatible flows which will help fill ships on their return voyages. Such possibilities should be discussed with the shipping authorities. If the different kinds of traffic concerned are sited together, ship movements within the port will be minimized and operational areas may be used more intensively.

I. Increasing revenue from large port expansions

306. The development cost of creating either large areas of sheltered water or large areas of reclaimed land will be very high. It will be essential to exploit the potential thus created fully so that the costs can be carried over a wide range of uses. For example, the best place for the breakwaters forming an artificial harbour may be one enclosing a water area that is larger than that needed for mooring and access to berths. It would then be advisable to look for ways, such as the construction of berth extensions or jetties, or the development of a fishing port or a recreational park, which will permit the sheltered water to be used more fully and allow the costs and benefits of the breakwaters to be shared by a larger number of users. Similarly, on tidal flats it may be necessary to site the port facilities adjacent to a low water line that may be several kilometres from dry land. The sea defence work necessary to create the port may be more viable if they enclose a large land area rather than merely a narrow access strip. The costs of the works can then be partially supported by revenue from the dry land created by reclamation.

ANNEX

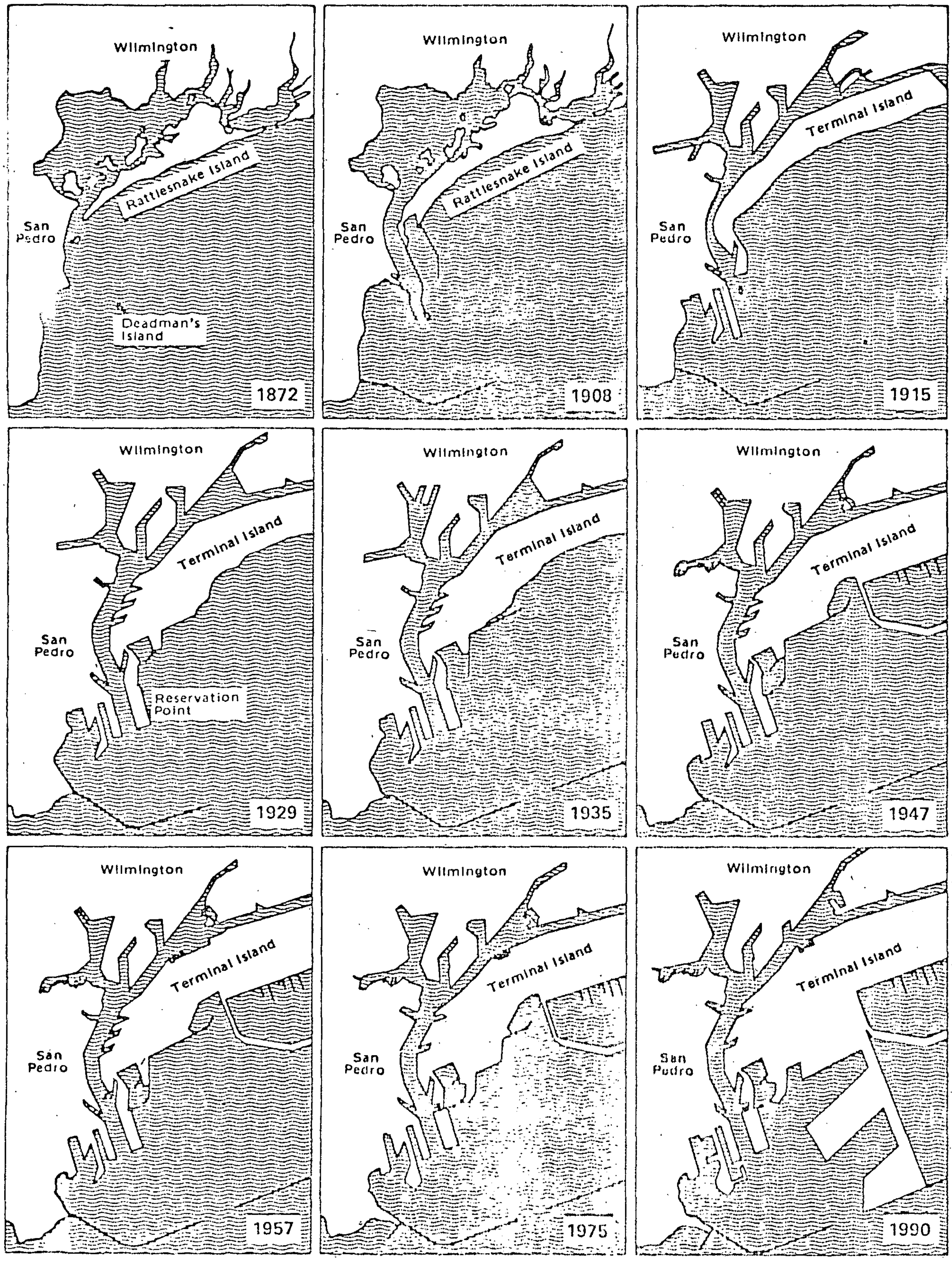
MASTER PLAN CASE STUDY: LOS ANGELES

A. Historical development of the port

1. Figure A.1 shows the stages of development of the port from 1872 to the time of preparing a new master plan in 1975. The stages through which the port has passed give an interesting example of the way in which a bay with some off-shore islands may be developed into a large harbour with substantial waterfront and land areas. It will be seen, however, that although the areas developed up to 1975 were very substantial, the master plan for 1990 requires a net increase of 1,000 acres of land to serve the port's needs.

Figure A.1

Past and future development of the port of Los Angeles, 1872-1990



Source. This figure and subsequent figures in the annex have been taken from the "Port of Los Angeles Comprehensive Master Plan 1990" prepared for the Port by Voorhees, Trindle and Nelson Consolidated, Inc., in 1975.

2. In the first diagram, relating to 1872, the port was handling 50,000 tons of cargo per year at small jetties, mainly in the San Pedro area, the approach channel being to the left of Dead Man's Island. This channel had been recently dredged to a depth of 10 feet at low tide from its previous depth of 18 inches.

3. Between 1872 and 1908 a good deal of development took place, with a breakwater off the southern point and two short breakwaters defining the entrance channel to the inner harbour which was beginning to be used, this channel now being dredged to 15 feet. By 1908 the breakwaters formed an outer harbour in which projecting jetties were built. Railways were constructed both to the wharves on Rattlesnake Island and to the jetties in the outer harbour. The build-up of cargo was very rapid, reaching 500,000 tons in 1888 and a million tons by 1908. Successive dredging projects produced a depth of 18 feet at low tide throughout the whole of the main channel.

4. Between 1908 and 1915 Rattlesnake Island was gradually built out to a new harbour line, producing substantial warehousing and market areas, plus wharfage. The southern end of the island, now renamed Terminal Island, was developing as a substantial fish harbour. The eastern breakwater was removed to widen the channel, but Dead Man's Island still remained as an obstruction.

5. By 1929, substantial new infilling broadened Terminal Island even further, Dead Man's Island was removed and Reservation Point was reclaimed for federal use (to this day, and even in the 1990 master plan, Reservation Point has been retained for federal purposes which in fact are not connected with the real objectives of the port). The required berthing spaces were achieved in typical fashion for the needs of vessels of that period by cutting slips and piers along the main channel waterfront. During this period, access roads were built through to the waterfront and bridges and viaducts were constructed. A very substantial build-up of traffic followed the commercial opening of the Panama Canal, and the traffic doubled, re-doubled and doubled again during the ten years from 1920 to 1930, reaching a peak of 26 million tons of which 21 million tons consisted of petroleum imports. The west basin on the land side of the harbour was developed, including substantial dredging, with all channels in the harbour deepened to 35 feet.

6. In 1935, the middle breakwater was built across the bay to provide calm water and warehouses, ferry services and many other facilities were steadily developed.

7. The pattern of development from 1947 was mainly a specific response to the need for specialized facilities for individual shipping lines, including, for example, a bulk grain terminal, special oil terminals and a scrap metal terminal, together with new storage areas and new customs building. The development plan in 1960 proposed 15 new berths to be added during the next five years and an early container facility. During this period the final dredging of various sand bars from the interior of the west basin was completed. Private boating began to develop with a boat marina, and yacht and small boat anchorages.

8. The main developments between 1967 and 1975 were a number of container berths and the improvement of access roads. Ro/ro facilities were installed in 1974 and planning began for provision for liquid natural gas tankers.

9. The resulting port zoning which was reached in 1975 is shown in figure A.2.

B. Future requirements

10. At this point, in 1975, a major master planning study was carried out to assess the long-term needs of the port and give a set of guidelines for the zoning and major port development which could, in the immediate future, be translated into detailed developments.

11. The study found that for the port to remain competitive it must be able to accommodate ships of greater size and draught. Vessels with draught greater than the existing range of 30 ft. in the inner harbour and 45 ft. in the outer harbour and channel have been visiting the port in increasing numbers. A large number of these have been unable to enter the port at fully loaded draughts and have had to be lightened in deep water outside the breakwater before entry. It was anticipated that by the year 1990 the average size of tanker would be 250,000 dwt (draught 70-75 ft.) and bulk carriers of 100,000 dwt (draughts at least 45 ft.). Moreover, examination of the world container fleet showed that the port would not be able to accommodate container ships larger than those of the so-called second generation. Finally, liquid natural gas (LNG) cryogenic carriers are expected, and these also have greater draughts than can be accommodated. Many tenants of inner harbour areas indicated that they would need 45 ft. depth in order to remain. Thus there is a definite need for deeper water to accommodate increasing ship sizes.

12. Secondly, the study found that there was a need for additional land. Land use analyses and cargo forecasts indicated a requirement for a net additional 1,000 acres of land to serve the port's needs by 1990. The need existed to increase the length of straight berths and the area behind them for the space needs of tenants. Sites with these characteristics are not available at the port.

13. Since deepening would naturally require a substantial dredging programme, there was a unique and exceptional opportunity to solve the port's need for deeper water and additional land in an economically, technically and environmentally sound manner. This was to combine the current dredging programme with a landfill programme. This possibility led to the proposal for a large landfill area extending south east from Terminal Island.

14. The estimate of the requisite port capacity from the cargo-handling point of view was concerned rather with area requirements than with the number of berthing points needed. The port planners had found that any reasonable quay wall layouts such as those given earlier in this chapter (see figures 18 and 19 above), must provide sufficient berthing points when the area behind them provided the space needed for typical annual throughputs.

15. The individual zones of the port were examined in detail but the preliminary cargo flow projection looked at the demand on the port considered as a whole. Figure A.3 and table A.1 show the broad long-term forecast to the year 2000 broken down by the major cargo groups. These forecasts were developed using standard techniques as described in chapter III above. Figure A.4 illustrates the magnitude of the increase between the 1973 actual figures and the 1990 projections. The next stage was to convert the commodity flow forecasts into land area requirements; straightforward land use coefficients were used, relating the tons per year throughput figure to the number of acres needed as is done for the existing situation in table A.2. There was great uncertainty regarding the intensity of land use in the long-term and two alternative assumptions were used in the calculations. Alternative A was based on the assumption that all tenants would continue to operate at their present intensity of tons per acre. This gave very large requirements, as shown in table A.3. Alternative B assumed that with the advance of technology the land utilization would intensify and a figure of 30 per cent higher intensity was used. The reduced requirements given by this alternative assumption are also shown in table A.3 and in fact this was the assumption adopted for the master plan.

16. The forecast was checked against a survey of user opinion and the two results are shown in figure A.4 B. It is interesting to note that port users forecast much lower area requirements than the planning team and it can be expected that the views of users will often be too low because of their conventional approach to long-term planning which is likely to be less imaginative.

FIGURE A.2

Port of Los Angeles, land use 1975

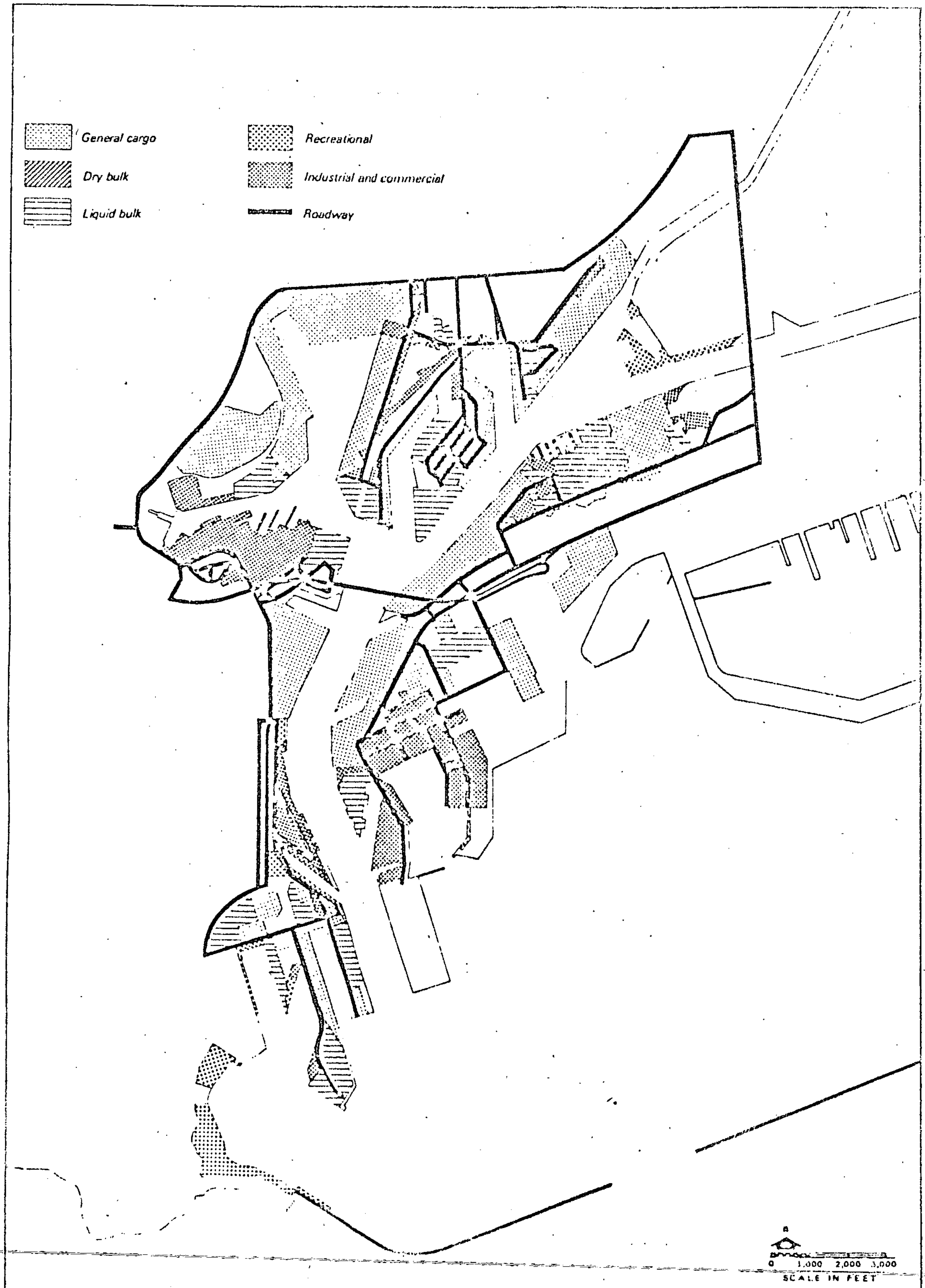


TABLE A.1

Total cargo commodity flow projections, 1980-2000
(In thousands of short-tons)

Commodity group	Year 1973	1980	1990	2000
General cargo				
Special general cargo:				
Lumber	355	483	483	483
Automobiles	235	301	421	538
Iron and steel	410	658	795	960
Bananas	102	102	124	150
Special general cargo sub-total	1 102	1 544	1 823	2 131
Containers	3 224	4 848	7 315	9 363
Break-bulk cargo	1 025	1 025	1 384	1 747
General cargo total	5 351	7 417	10 522	13 231
Liquid bulk cargo[a]				
Crude petroleum	7 528	26 974	47 402	68 828
Other liquid bulk cargoes	9 040	9 040	9 222	9 408
Liquid bulk cargo total	16 568	36 014	56 624	78 236
Dry bulk cargo	2 397	2 397	3 009	3 814
Total	24 316	45 828	70 155	95 281

Source: This table and subsequent tables in the annex have been taken from the "Port of Los Angeles Comprehensive Master Plan 1990" prepared for the Port by Voorhees, Trindle and Nelson Consolidated, Inc., in 1975.

[a] Excluding LNG, imports of which have been estimated by the Western LNG Terminal as rising to approximately 6 million tons by the year 1990 and to as much as 12 million tons by the year 2000.

FIGURE A.3

Tonnage projections for port of Los Angeles

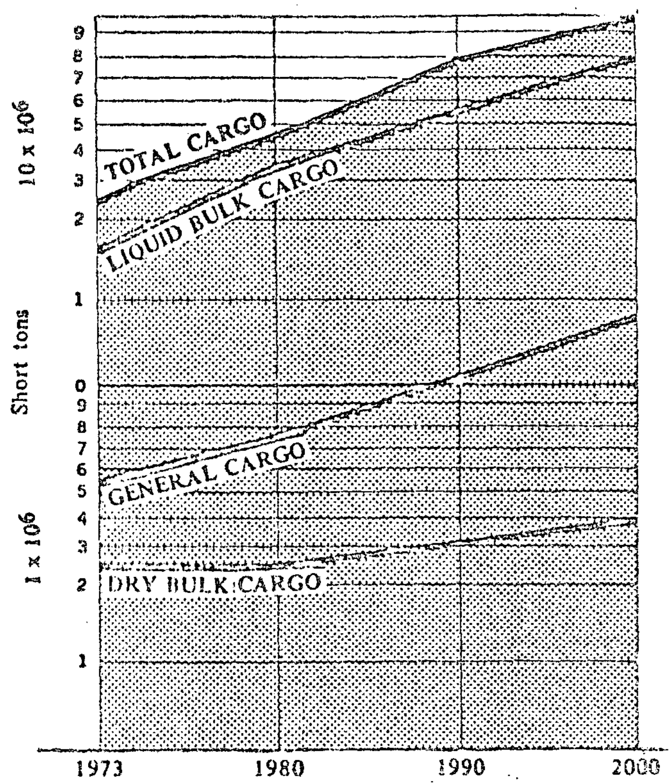
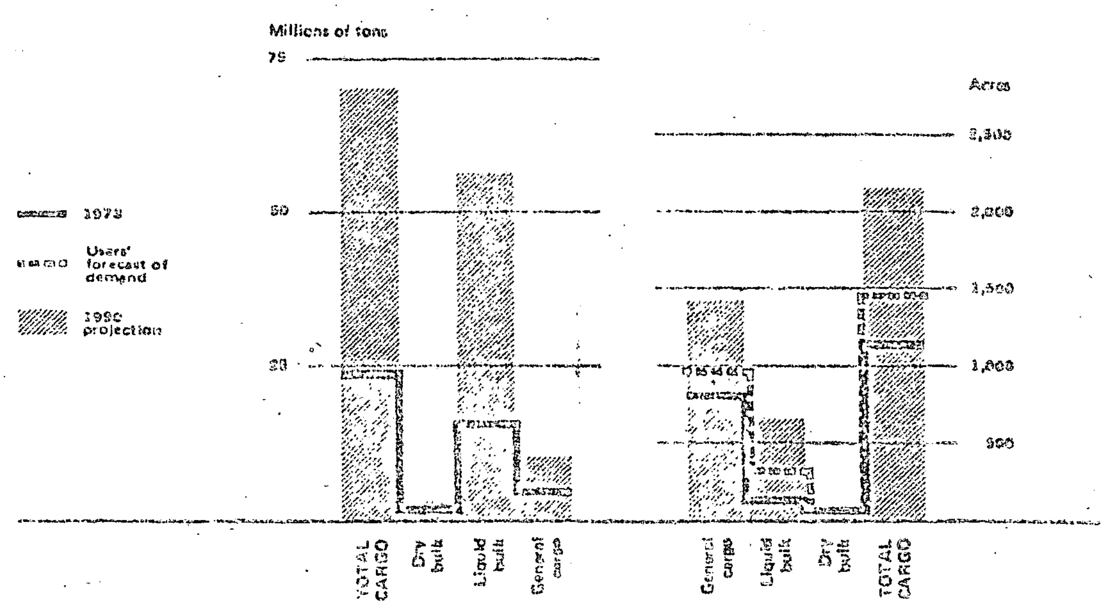


FIGURE A.4

Comparison of commodity flow projections and land acreage needs



17. The cargo-handling requirements form only part of the land utilization of the port, and similar forecasts of land requirements were carried out for industrial, commercial, recreational, institutional and miscellaneous uses. These are shown in table A-4, where the uses are broken down by planning areas—i.e., port zones. Again substantial increases, particularly in industrial use, are forecast and land has to be provided for these.

C. Master plan decisions

18. As suggested above, the major decision was to carry out substantial dredging, linked to the landfill of a new port area of 1,034 acres. This landfill is expected to be carried out in co-ordination with the over-all dredging programme and the demand for deeper channels. It was also decided that hydraulic analyses would be required and that a hydraulic model would be used. The main alternative which had been discarded in reaching this decision was that of using off-shore buoys to provide the deep water facilities. This decision was based mainly on the fact that the San Pedro Bay area is susceptible to earthquakes and underwater pipelines would be liable to rupture, with serious effects. Moreover, operating experience with single buoy moorings had indicated, in the view of the port planners, a high maintenance cost on floating hoses. Expensive dredging for a pipeline trench, buoy maintenance, and ship collision possibilities, together with possible ecological effects on marine life, were all contributory reasons for deciding to provide deep water inside the harbour rather than utilizing the deep water outside it.

19. The landfill decision was less difficult since, as shown in figure A.5, the three possible solutions within the port boundaries were based on the same area of landfill but with varying quay wall configurations, all of them adopting a major pier approach as described earlier in this chapter (see figure 22 above). The alternative selected had the simplest shape and the broadest piers and connecting arm.

20. Once the main lines of development were decided in this way, the allocation of land use between the seven different zones of the port was considered from a fresh point of view given the combination of future possibilities and existing use. In many cases users were invited to move to more suitable locations. It was decided to eliminate minor irregularities of quay wall in order to provide better berthings, and to demolish out-of-date superstructures such as warehouses in order to provide larger service areas. The resulting land use changes planned for each of the zones is summarized in table A.5, from which it can be seen that there is no

TABLE A.2

Intensity of land utilization for cargo handling and storage, 1973

Commodity group	*Gross acres*	*Total tonnage (thousands of short tons)*	*Tons per year per acre (thousands of short tons)*
General cargo			
Special general cargo:			
Lumber	70	355	5.07
Automobiles	197	440	2.23
Iron and steel	[a]	[b]	[b]
Bananas	9	102	11.33
Special general cargo sub-total	276	897	N.A.
Containers	187	3 224	17.24
Break-bulk cargo	314	1 230	3.91
General cargo total	777	5 351	N.A.
Liquid bulk cargo	215	16 568	80.42
Dry bulk cargo	97	2 397	24.71
Total	1 089	24 316	N.A.

[a] Land use for iron and steel cargoes is included in acreages for automobile and break-bulk facilities.

[b] Iron and steel tonnage (410 000 short tons (see table A.1)) has been divided equally between automobiles and break-bulk cargo.

TABLE A.3

Projected land needs, 1980-2000

(In acres)

Commodity group	*1973*	*Alternative A 1980*	*Alternative A 1990*	*Alternative A 2000*	*Alternative B 1980*	*Alternative B 1990*	*Alternative B 2000*
General cargo							
Special general cargo:							
Lumber	70	95	95	95	73	73	73
Automobiles	197	282	366	455	216	282	350
Iron and steel[a]							
Bananas	9	9	11	13	7	8	10
Special general cargo sub-total	276	386	472	563	296	363	433
Containers	187	281	424	543	216	326	418
Break-bulk cargo	314	346	455	567	266	350	436
General cargo total	777	1 013	1 351	1 673	778	1 039	1 287
Liquid bulk cargo[b]	215	448	704	973	344	542	748
Dry bulk cargo	97	97	122	154	75	94	118
Total	1 089	1 558	2 177	2 800	1 197	1 675	2 153

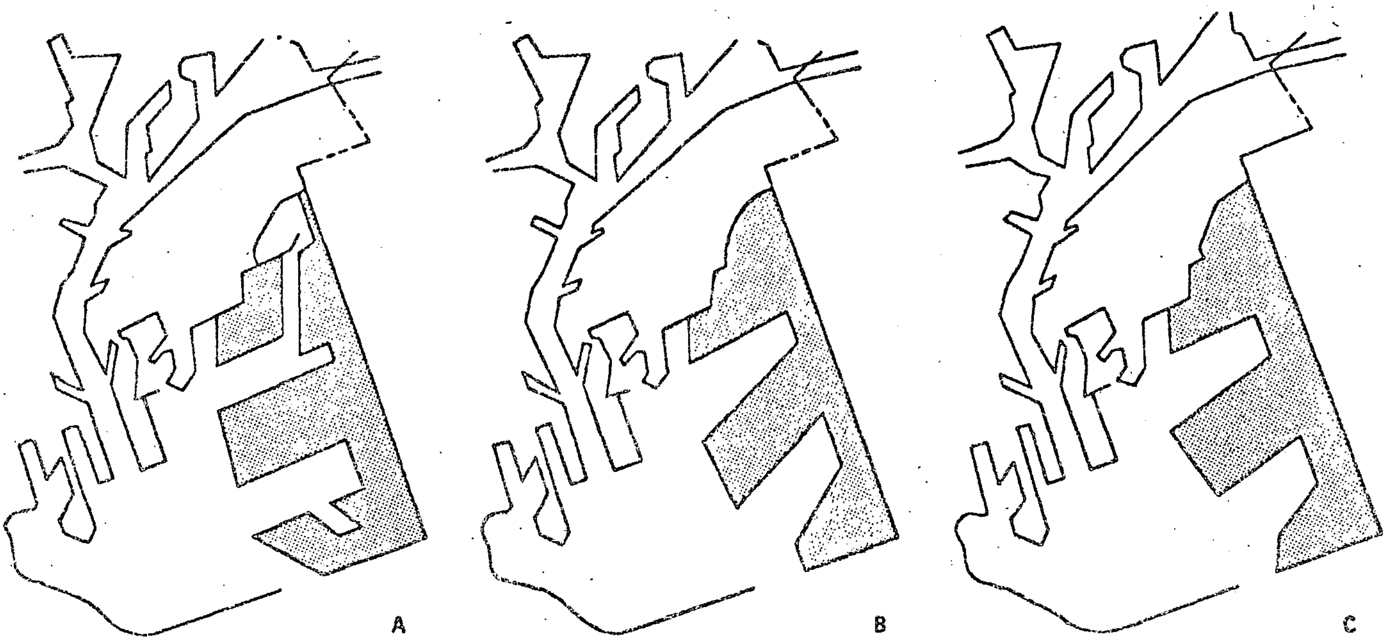
[a] Iron and steel land needs are included in acreages for automobile and break-bulk facilities.

[b] Excluding land requirements estimated for LNG.

FIGURE A.5

Alternative landfill proposals

(Alternative C was selected)



general policy of specializing or of distributing cargoes between zones. Area 7, the new landfill, is allocated a range of cargo types.

21. A communication plan was built up, consisting of a new layout for rail connexions and road connexions with a major new road link down the connecting arm of the proposed south east landfill area and several simplifications of trunk access to other port areas. Figure A.6 illustrates the land use and communication network as provided for in the 1990 master plan.

22. Before the plan was finalized, a series of impact analyses were carried out to ensure that the master plan proposed did not produce problems. These consisted of:

(*a*) An air resource impact analysis: this concerned mainly air pollution industrial activities in the port;

(*b*) A biological resource impact analysis: this examined possible effects on marine organisms and displacement of fish and plankton;

(*c*) A geological resource impact analysis: This consisted of analysing the effect on the geologic environment of the major channel and landfill activities;

(*d*) A water resource impact analysis: this studied water supply problems and waste water treatment questions together with navigational safety;

(*e*) A cultural resource impact analysis: this was a check on archaeological and historic sites;

(*f*) A socio-economic impact analysis: this major study consisted of reviewing energy requirements, questions of health and safety, employment and aesthetic questions, in close co-operation with the local planning authorities.

TABLE A.4

Summary of land utilization for purposes other than cargo handling and storage, by planning area, 1973

(In acres)

Use	*Planning area*[a]							*Port*[b]
	1	*2*	*3*	*4*	*5*	*6*	*8*	
Industrial	5	14	78	13	68	221	4	403
Commercial	1	42	18	0	0	5	0	66
Recreational	70	2	0	0	19	4	0	95
Institutional	37	0	0	0	23	285	0	345
Other[c]	22	60	51	85	374	285	270	1 147
Total	135	118	147	98	484	800	274	2 056

[a] Area 7 is the proposed Terminal Island landfill that is non-existent today.

[b] Includes land within the port study areas not controlled by the Los Angeles Harbor Department.

[c] Other includes vacant land, land in litigation, the Knoll Hill residential area (area 3), right-of-way of roads, rail and utilities. Since 1973, 32 acres in area 8 have been leased for liquid bulk use.

FIGURE A.6
Port of Los Angeles, master plan 1990

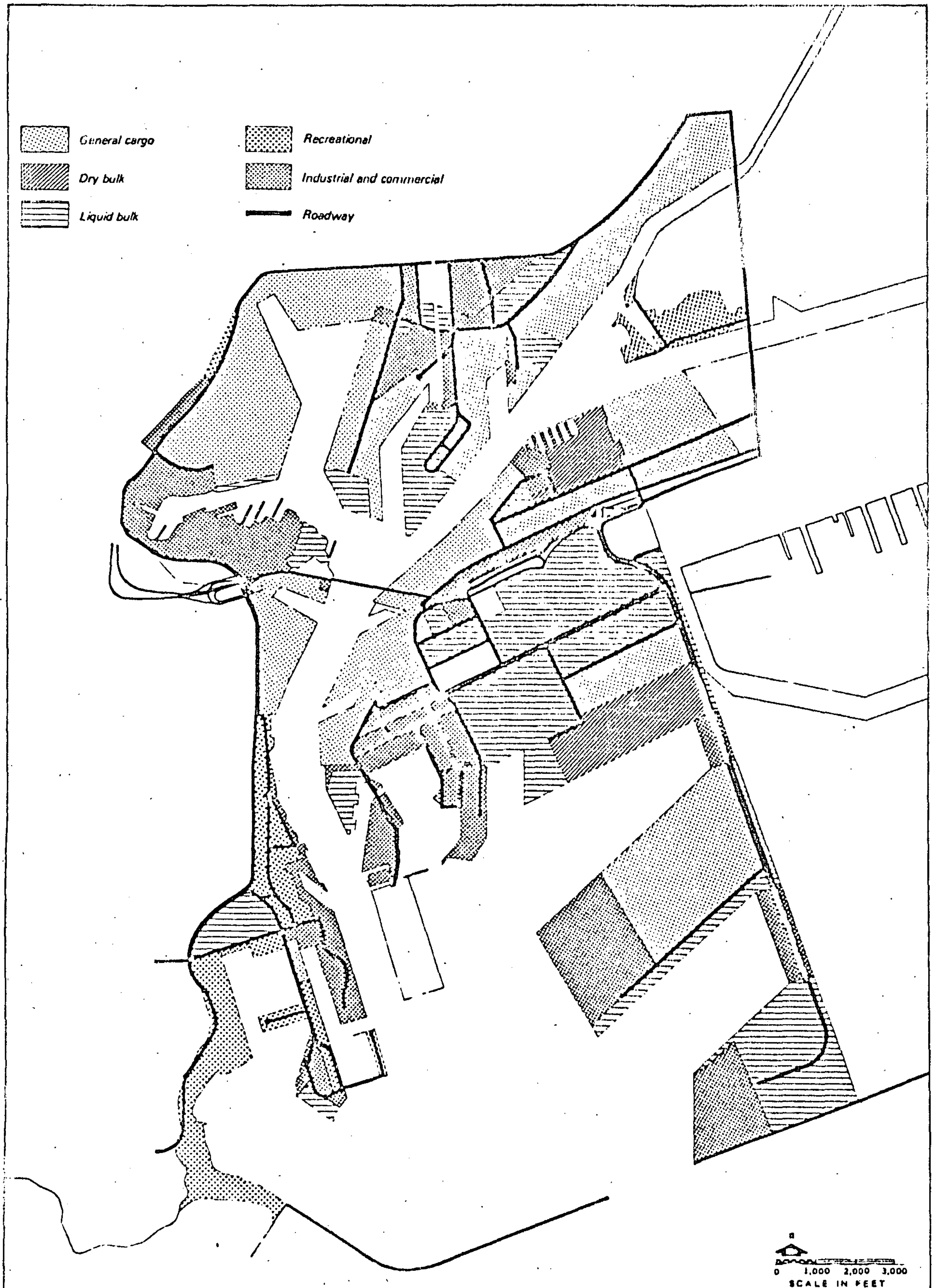


TABLE A.5

Planned changes in areas for handling different types of cargo
(*In acres*)

Type of cargo	Planning area							
	1	2	3	4	5	6	7	8
Containers								
1975	—	—	57	33	11	86	—	—
1990	—	—	63	175	—	155	100	—
Break-bulk cargo								
1975	14	33	—	—	195	42	—	30
1990	—	11	—	—	250	52	100	—
Special cargo								
1975	—	—	—	89	57	100	—	30
1990	—	—	—	—	136	60	65	30
Dry bulk cargo								
1975	—	21	—	—	6	70	—	—
1990	—	—	—	—	10	70	100	—
Liquid bulk cargo[a]								
1975	—	—	—	—	5	—	—	—
1990	—	—	—	—	5	—	—	—

[a] Not including liquid bulk cargoes for energy production.

Chapter VI

CIVIL ENGINEERING ASPECTS

A. Introduction

307. The work of engineers in a port development project extends over a long period. Starting with initial studies of the development potential of alternative sites, the costs of engineering proposals which meet the water and land area needs are broadly estimated to give the basis for the investment appraisal and the project decision. Detailed drawings and specifications are then prepared; contracts are awarded; the construction work is supervised, and, finally, the new facilities are handed over to the operating authority.

308. In this chapter, attention is directed to the part played by the engineer in the studies leading to an investment programme. Technical judgement is important to enable proper estimates of development alternatives to be prepared, but close attention to detail is not necessary at this stage.

309. A most important feature of the engineers' work in the project team is that estimates should be realistic. The starting points for this are a sound knowledge of the physical features of the site and a full appreciation of the requirements of the various types of shipping and port traffic.

B. Field investigations

1. General

310. Careful investigation of the site is essential to the success of the project. Field investigation means the study of all physical features of the area:

(*a*) Hydrography and topography;

(*b*) Meteorological and oceanographic influences;

(*c*) Coastal hydraulics, which comprise the local influence of the sea on the shoreline processes;

(*d*) Exploration of the sub-soils both on land and under the sea.

Field studies may be supplemented by the use of special hydraulic modelling techniques to forecast changes due to port construction works.

2. Hydrographic and topographic surveys

311. Reliable information on the bathymetry (the depths of water in the sea or river) is essential. The depths of water are represented on charts by figures for individual soundings or by submarine contours.

312. For a new project, the hydrographic charts available may provide sufficient information for preliminary engineering purposes. It may also be possible to obtain copies of the working charts of the hydrographic surveyors who did the original work for the hydrographic charts, and these may show soundings at closer intervals than those given on the published charts.

313. When the detailed bathymetric survey for the project is being planned, the area selected for the survey should be large enough to allow for alternative sea approaches and alternative locations for the port installations.

314. Most bathymetric surveys are now carried out by means of a high-resolution echo sounder, which can be mounted in a suitable vessel obtained locally. The older method of taking soundings by lead line is still used, however, particularly in awkward places and near structures.

315. Some topographical surveying is required in conjunction with hydrographic surveying to establish shore points. In addition, a survey of the land areas associated with the port works is required.

316. For a new port site, after a first examination of all available plans, an area should be defined for an outline survey, and permanent survey-points established. As the project crystallizes, the extent of survey work required is more closely defined and the degree of detail correspondingly increased.

317. For the production of contract drawings, fully detailed survey plans of the port area, with particular attention to road and rail access, should be prepared. A suitable scale for these plans would be 1:1,000.

3. Meteorological survey

318. Most inhabited regions of the world have weather records, although in some cases they may be insufficient for statistical trends to be fully assessed. Nevertheless, it may be reasonably expected that, for any port site, wind and rainfall records will be available from some adjacent location, which will serve at least for a preliminary study. Once the site has been selected, an anemometer, a rain gauge and a barograph should be set up to record the weather

throughout the construction stage and eventually to become part of the operational activity of the port.

319. Knowledge of the frequency and severity of storms is important in designing maritime engineering works. With the continuously recording anemometer, wind speeds and directions and duration of gusts will be obtained.

4. Oceanographic survey

320. Oceanography is the study of the behaviour of the sea, and covers a wide range of natural phenomena. For a port project, the particular factors of concern are waves, currents and tides.

321. The length, height and period of waves arriving offshore may be estimated from wind records. Waves depend on the wind's speed, duration and fetch (the distance over which the wind has acted on the water), and empirical relationships exist between these factors and the waves generated. Records of ships give further wave information, but direct measurement of waves is the most reliable method. This is usually done by means of a wave recorder.

322. The major ocean currents are well known, but they are of much less significance for the designing of a new port than the local currents, which should be measured.

323. Tide records are usually fairly reliable, but care is often needed to ensure the correct datum of tides related to land survey and soundings. A datum can be obtained by recording the tide over a period of at least one month and establishing the mean water level. Tide gauges can then be fixed in relation to this datum and tide readings continued during the project period.

5. Coastal hydraulic survey

(a) *Waves*

324. It is preferable to measure the waves occurring at the port site directly. Many types of wave recorders are suitable and in the selection of an appropriate type, the most important factor is its suitability for local operation and maintenance. The statistical extrapolation of records taken over a period of time permits computation of the likely frequency of recurrence of a given height of wave, alternatively, of the wave heights associated with storms of a certain frequency of recurrence such as once in one year, in ten years, in fifty years or in a hundred years.

325. The interaction of the wave with the sea bed as the wave travels towards the shore modifies the direction and height of the wave. The effects of shoaling and refraction are complex, but simplified approaches and computation are usually adopted for port planning purposes.

(b) *Currents*

326. Currents must be studied in the vicinity of the port in order to establish their speed and directions at the various stages of the tidal range. Seasonal and lunar variations in the currents and the effects of fresh water flow, in the case of an estuary, must also be taken into account.

327. Coastal currents are measured by the use of floats, which are released at predetermined positions and their subsequent tracks plotted, or by use of current meters which record the variations of strength and direction at a fixed point.

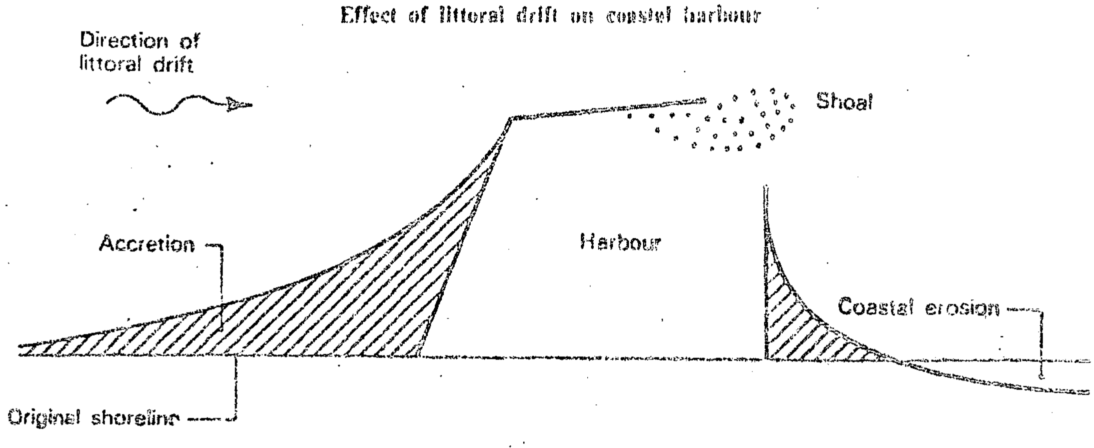
(c) *Littoral drift*

328. When there is a current close to the coast, the combination of wave action on the shore, which loosens material, and the current, which transports beach material, can alter the coastline. This mechanism of sediment transport is called littoral drift. Over a period, littoral drift may occur in one direction and then in the reverse direction, but generally there will be one direction which predominates.

329. Where the beach is interrupted by a feature such as a tidal inlet or an estuary, a spit tends to

Figure 24

Effect of littoral drift on coastal harbour



form in the direction of the predominant movement of material. Similarly, if an obstruction such as a breakwater is placed across the beach, material will build up on one side of the obstruction and erosion will occur on the other side. Figure 24 illustrates the effects of littoral drift. It is therefore important in planning a harbour on a coast to estimate the amount of littoral drift and to investigate its likely effects.

6. Geotechnical survey

330. Geotechnical site investigation is an important preliminary to maritime construction. Exploratory offshore drilling either from floating craft or from a temporary platform is expensive, but the cost of the investigation is normally small relative to the value of the works constructed.

331. The following are the main methods used for investigating the sub-soil:

(*a*) *Boreholes* formed by excavating within a lining tube. Also termed shell and auger drilling, this method uses a cylindrical cutter, with chisels for rock or other obstructions. Operation is by a wire rope connected to a winch. Undisturbed core samples are obtained for close examination.

(*b*) *Boreholes* formed by rotary drilling. A hardened drill is used to recover cores of rock. This method is slow and costly and therefore used only when the precise engineering properties of the hard strata need to be determined for the purposes of the foundations of engineering works.

(*c*) *Penetrometer tests.* To investigate soft sub-soils, a cone is forced down into the soil by steady pressure. The side friction and end resistance give the required data. It is usual to supplement the penetration tests by conventional shell and auger boreholes.

(*d*) *Wash probes.* Certain limited information about the general nature of certain soil strata may be achieved by use of a high pressure water jet probe.

(*e*) *Vane tests.* For shearing strength measurements of sub-soils it is important to avoid structural disturbance of the samples. Thus, a borehole is sunk to the required depth, a four-bladed vane is inserted into the undisturbed sub-soil at the bottom of the borehole and rotated until the sub-soil has failed, providing a measure of its strength.

(*f*) *Geophysical exploration.* Seismic soundings provide information on the boundaries between different sub-soil strata. They must be supplemented by one or more of the direct exploratory methods described above.

332. The exact form of the geotechnical investigation will be different for each site and project. International standards agreed upon for the classification of soils should be used. The aim should be to improve the quality of soils knowledge as the project develops, but since in many parts of the world the costs of the mobilization of personnel and equipment (particularly for offshore boreholes) are high, full value must be obtained from any programme of work: returning later to gather supplementary information can be very expensive.

7. Hydraulic model studies

333. The techniques of hydraulic modelling, both physical and mathematical, are advancing rapidly. In many projects the need for model studies will not arise, but in various special situations the use of models is important for the prediction of changes due to the proposed development works and for the achievement of economies in construction and maintenance costs.

334. Model investigations for port planning and design are normally undertaken in conjunction with a major hydraulic research institute, and the engineer would normally discuss the requirements of the project with one of these organizations before formulating an applied research programme.

335. Three physical features of the port environment are normally studied through models: the movement of water and its effect on ships; the movement of soil and its effect on navigation areas and the effects of the marine environment on the stability and safety of structures.

336. A physical hydraulic model of a proposed port layout enables wave action to be measured for various breakwater configurations and quay locations, and an optimum solution selected. The simple models compare wave heights by direct measurement, but more sophisticated techniques are available to study the movement of model ships.

337. In a river or estuarial port, the construction of new facilities can alter tidal heights and velocities, which in turn can affect the movement of bed material and the siltation and erosion of navigation channels. Mathematical models and physical models are available for the prediction of such changes and they provide the engineer with a valuable means of judging the best form of development. This work is specialized, and considerable experience is needed; very careful on-the-spot measurements and considerable experimentation are often needed to ensure the most useful results.

338. Coastal movements caused by a new development may be conveniently studied by means of mathematical models, and similar techniques can, for example, determine the alteration in wave action caused by dredging a channel or by depositing dredged material offshore. In addition to the normal three-dimensional models, two-dimensional physical models are frequently used in designing breakwaters in order to study the stability of the construction and the possible erosion of the sea bed.

339. It is often the case that, although there may be considerable scope for model investigation during a project, the time required to carry out a full model

test programme is not available during the period of a feasibility study, particularly when a lengthy programme in the field and in the laboratory is needed. In such a case it may be possible to formulate the initial investment programme in such a way that technically difficult decisions are left until later stages, thus permitting a careful investigation during the earlier years of project implementation.

C. Water area requirements

1. Ship draught rule of thumb

340. For water depth planning, the curves showing full-load draught, together with length and beam, for typical modern ships of each type, given in part two of the handbook, may be used.

341. A useful rule-of-thumb for planners who do not have permanent access to the curves is as follows:

Full-load draught in metres equals
square root of dwt, in thousands, plus 5

For example, a 100,000 ton bulk-carrier draws roughly ($\sqrt{100}+5$) metres, i.e. 15 metres.

342. This formula will give the draught to within one metre over the range 10,000 to 500,000 tons deadweight, for dry and liquid bulk carriers. It also gives a valid figure for general cargo ships down to about 5,000 dwt. For vessels below 5,000 dwt it gives an overestimate of the draught, and for second- and third-generation container ships it gives an underestimate of the draught of about one metre.

2. Approach channels

(a) *Introduction*

343. In the immediate approaches to a harbour, shipping is usually obliged to sail within a prescribed approach channel. This corridor may be purely for the sake of navigational discipline, or it may be necessary in order to direct ships along a course where there is sufficient depth of water. Most major ports, particularly as ships increase in size, are likely to be approached by way of either an artificial channel or a natural channel which may require maintenance dredging.

(b) *Site investigation data*

344. The determination of the feasibility of constructing an access channel requires a knowledge of the direction and strength of the currents and the predominant direction of the waves since, under current and wave action, considerable movement of bed material can take place. This is most likely to happen where the channel nears a natural shoreline and the water becomes shallow. There have been cases of rapid infilling of channels caused by the action of waves and currents.

345. If the harbour is situated in the vicinity of a river, the amount of suspended sediment in the river flow must also be studied, preferably for at least one year. Insight into likely problems can be gained from a study of historical records of the site.

(c) *Conceptual design of channel*

346. The basic aim in approach channel design is the safe passage of all vessels requiring to call at the port from the sea to the berthing area.

347. If, for reasons of economy, it is decided to restrict the depth of the channel, the depth must nevertheless be sufficient to allow vessels with the deepest draught to pass through the shallowest reach of the channel at some stage in each tidal cycle. The design method includes the construction of time-related diagrams indicating the inter-relation of vessel passage times, tide level and water depth.

348. The requirements with regard to speeds of vessels in the channel are to some extent conflicting. In a long channel the transit time, and hence speed, of a deep-draught vessel may be critical if the vessel is to pass through a shallow area at a given time, whereas increased speed results in increased "squat" of the vessel, thus reducing its under-keel clearance.

349. The channel dimensions, together with the depths of water to be provided at berths and moorings, will have a profound effect on the levels of service which the port can offer to the increasing number of larger ships. Normally, a joint economic and engineering study must be conducted to determine what policy should be adopted. In projects where the water area questions are important, the calculation of advantages and disadvantages for the range of options open can be difficult, but it must be carried out on the basis of the best information available, and it may be advisable to carry out a traffic simulation linking the time-and-tide-related vessel passage diagram to the traffic arrival rates and service-times. This can be done by hand, with the aid of the planning chart given in part two of the handbook, but that might be laborious, and it would be useful if a computer-based simulation model could be used for this purpose.

(d) *Width of channel*

350. A major consideration will be whether the channel should be wide enough to allow ships to pass in opposite directions. Unless there are severe economic restraints, a two-way channel should be made in order to offer unrestricted access to the port. A secondary consideration is that if there is an accident in one lane of the channel, access to the port will still be possible and so there will be less disruption of traffic to and from the port.

351. Channel widths depend on the size of ship to be catered for and the physical conditions of the site. As a typical example, illustrated in figure 25, in a well-marked channel, the total width of full-depth channel required for two-lane traffic may be taken to comprise, on straight reaches, manoeuvring lanes of about twice the vessel beam for each direction, plus about 30 metres between vessels and up to one-and-a-half times the beam for bank clearance each side. For a typical 20,000 dwt cargo vessel, a total width of about 190 metres would be appropriate.

352. At bends in the channel, greater widths are required than on straight stretches because of the tendency of ships to drift on turning. An additional width, depending upon the radius of curvature of the bend but approximately equal to the beam of each vessel, will be required in order to allow for the projected width of vessels negotiating the bend. This feature of projected width will also occur on straight reaches of channel subject to the action of cross-winds and currents, which will also cause vessels to drift.

(e) *Depth of channel*

353. Consideration of the depth of water to be provided in a channel is complex and inevitably a compromise has to be reached between, on the one hand, allowing unimpeded access permitting the largest ship expected to use the channel at all stages of the tide, and on the other hand, excluding large vessels, imposing load-factor limitations on them or giving them access only at high tide. The cost of dredging to provide and maintain a deep channel for an occasional caller can be very high.

354. Where the nature of the traffic is such that the largest ships carry full loads in only one direction, i.e. either export or import, a deeper channel can be provided in the appropriate direction if a clear separation is possible.

355. Factors to be considered in deliberations of this kind are as follows:

(*a*) The transit times of vessels along the channel, both with and against the tidal stream, and the relationship of these times to the tidal cycle;

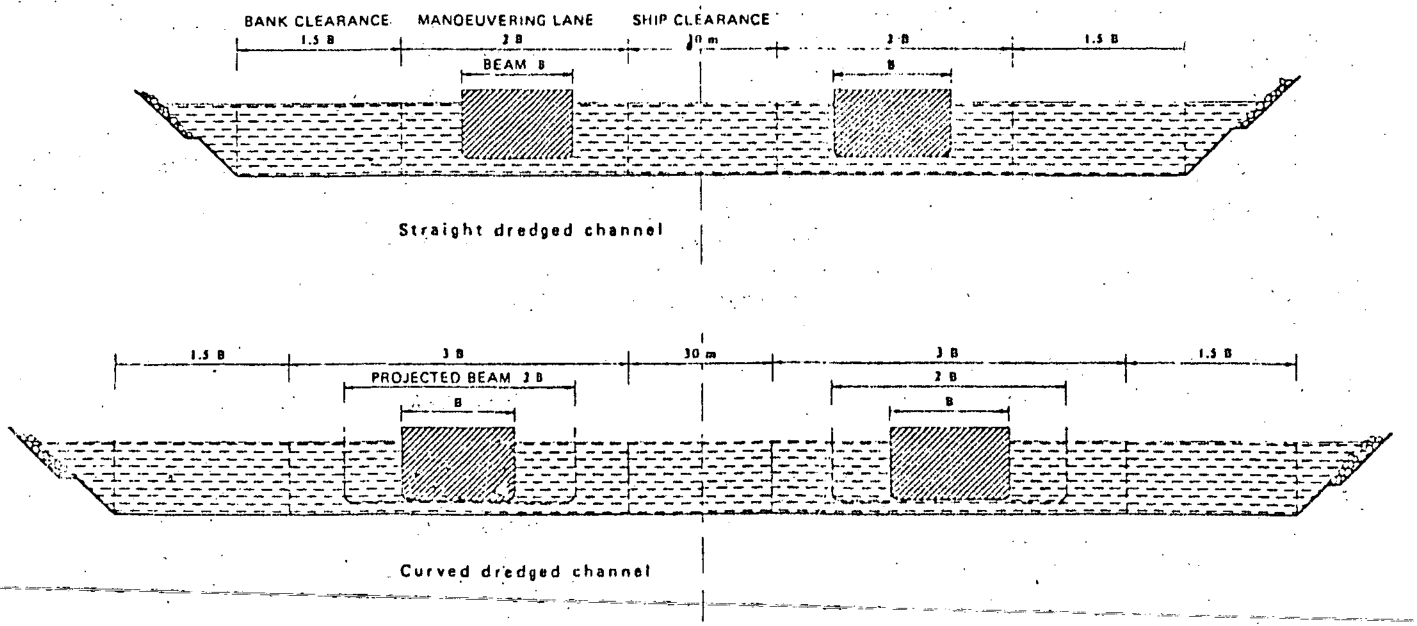
(*b*) The nature of the sea or river bed which, if of soft silt, for instance, might lead to a decision to reduce the designed under-keel clearance for vessels using the channel;

(*c*) The ship draught: upon entering an approach channel, the load-line draught of the vessel is modified by such factors as water density changes, which may occur along the length of the channel, the effect of squat and the effect of wave action causing pitch and roll of the ship.

356. Each case and location must be studied to finalize channel depth design, but a preliminary assessment of the order of magnitude is usually possible and sufficient for initial studies. A general cargo ship with a draught of 9 metres at sea would squat about half a metre in a narrow channel; pitching would require about half the wave height in additional draught, and rolling somewhat less. Moving into fresh water would add about a quarter of a metre to the draught but would usually occur only in sheltered water, where pitching and rolling do not occur. Thus, allowing half a metre for bed clearance if the channel bed is soft, it might be assumed, for preliminary planning purposes, that a vessel drawing 9 metres might require some $10\frac{1}{2}$ metres of dredged

FIGURE 25

Typical width dimensions of channel



depth in an approach channel. A greater depth would be necessary where the channel bed was hard. At certain ports having deposits of very soft mud a zero or even a negative under-keel clearance may be acceptable, but such cases require very special consideration.

357. It should be appreciated that channels are not always of uniform depth, especially if they lie along an improved natural feature such as a river or tidal inlet. For example, a relatively long channel may be limited in depth only over a small proportion of its length. Regular dredging of this localized area may provide the depth required to allow vessels to traverse the entire length of the channel unrestricted by considerations of tide and thus greatly facilitate accessibility to the port.

358. A ship that is to travel along an approach channel should have a draught no greater than that which will allow a specified safe clearance over the channel bed in the shallowest reaches of the channel. As suggested above, a minimum clearance of one metre to one and a half metres might be taken as appropriate for most vessels. The specified clearance usually allows for squat, so that the actual under-keel clearance will be less than that specified. Where the under-keel clearance of a vessel is expected to be critical, the transit time of the vessel along the channel, the time of the vessel's arrival at the shallow reaches and the state of the tide at that time must be carefully calculated, contingency provisions being made for vessels failing to traverse the shallow reach at the required time.

(f) *Channel alignment*

359. The manoeuvrability of a vessel moving in a confined waterway of limited depth is impaired two ways, (*a*) because the ship takes longer to respond to the helm, owing to the effects of shallow water and (*b*) because the proximity of the side of the channel have a tendency to cause the vessel to be drawn towards them. This attraction or suction experienced by the ship towards the sides of the channel also applies between two vessels when passing.

360. Where there are changes of direction in the alignment of a channel, these limitations on ships' manoeuvrability must therefore be taken into account. The radii of bends must be as large as is practicable, and required ship movements must be kept as simple as possible.

361. The desirable geometry of bends in navigational channels for deep-sea general cargo ships may be taken as:

Angle of deflection not more than 30 degrees;
Radius of curvature not less than 1,500 metres.

362. A channel in the open sea should, if practicable, be aligned with the predominant storm direction and the principal current directions. Where these differ, and where other conflicting constraints arise, model studies are called for. Where a channel is situated within a large estuary or river, model studies will also be advisable, except in the simplest of cases.

3. Lay-bys and turning areas

363. Lay-bys are anchorages or berths where ships may be held for quarantine or other inspection, while awaiting change in weather conditions, or when queueing for service at the port. Special anchorages available for ships carrying explosives or dangerous cargo are separately provided and such areas should be so designated on charts. The anchorages are usually located away from the marine terminal and adjacent to main channels so that they are near deep water, but clear of other ship movement. Allowance must be made, in allocating lay-by areas, for the distance of swing out, during the tidal cycle, of a ship at anchor or moored at a buoy.

364. Lay-by areas may, in common with the harbour area, be protected either by natural features or by artificial structures such as breakwaters, but at many port vessels wait for berths by anchoring offshore.

365. In the immediate approaches to berths, vessels usually have to make more complicated manoeuvres than are necessary in the approach channel. Consequently, appropriately generous water areas must be provided and in most cases the assistance of a tug will be required.

366. The most basic of these manoeuvres is turning the vessel and it may be taken as a general indication of the space required to turn a vessel that a circle with a diameter four times the ship's length is required where there is no assistance from tugs. Where assistance from tugs is available, a circle half this size is adequate. These are average figures and the actual area needed will depend, in addition on wind, wave and current conditions in any particular case. Shipping lines should be consulted during this stage of the planning.

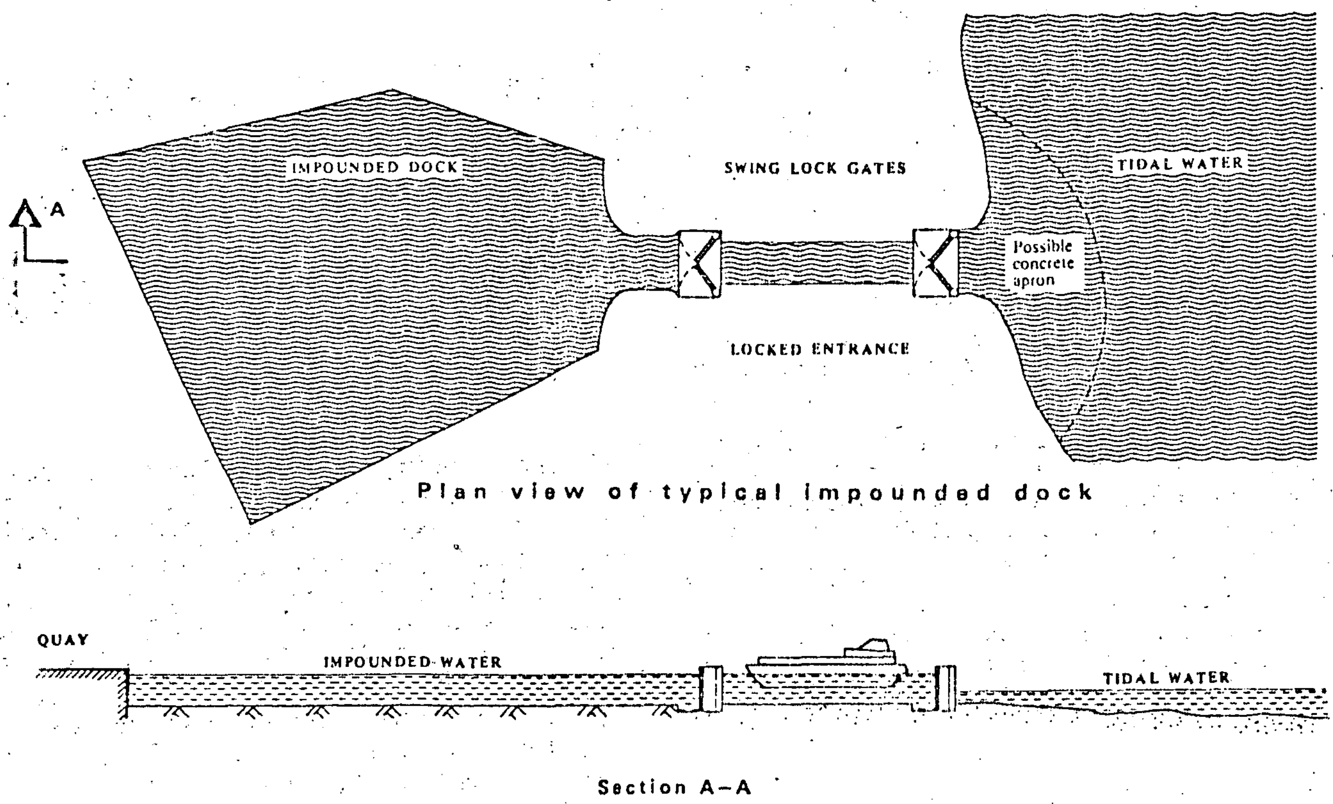
367. Where space is limited, the ship may be turned by warping around the end of a pier or a dolphin. Some modern vessels are equipped with bow thrusters which considerably enhance their manoeuvrability and for such vessels restricted sea room is possible. However, for the majority of ports there will still be many vessels requiring the larger areas referred to above.

4. Tidal harbours and locked basins

368. An important decision in the conceptual design of the port is whether berths in the harbour should be open to tidal influences or whether a locked basin may be justified. A locked basin—sometimes referred to as a wet dock—is one in which an area of water is maintained at a fixed level, usually equal to the high water level of the tidal water out-

FIGURE 26

Example of a locked basin



side the dock. Access to the dock is achieved by means of a ship lock. This arrangement is illustrated in figure 26.

369. Where the tidal range is so wide that an exceptionally deep harbour, and so high quay walls, would be required in order to allow ships to remain afloat at low water, there would be a strong argument in favour of having a locked entrance to the dock. Tidal fluctuations may also cause problems with regard to the loading and unloading of ships at quays. Some vessels, such as bulk carriers and oil tankers, can more easily accommodate tidal variations while loading and unloading than others, such as ro/ro ships. The type of traffic must therefore be taken into account when considering the possible need for a locked basin.

370. The disadvantages of the locked basin are:

(*a*) The high cost involved in providing the sealing dam and the ship lock itself, which is a complicated civil engineering construction, although the larger the number of berths over which the cost of the impounding dam and ship lock can be spread, the more viable the proposition becomes;

(*b*) The delays to shipping resulting from the locking operation.

371. To take a specific example, at a port with a substantial number of berths and where the tidal range was about three metres, facilities for larger vessels were provided economically by impounding the whole basin at high water level. The cost of the new lock was less than it would have cost to deepen the harbour. A crucial factor in this case was the fact that it was possible to continue using the harbour during construction of the lock. The decision between the options of extending or improving a port is often governed by considerations as to the possibility of uninterrupted use of existing facilities.

372. The choice made is thus a matter of economic, operational and engineering analysis in each case, but the modern trend seems to be away from locked basins where possible. The advantage of the operational flexibility afforded by free access to the open sea is generally considered to outweigh the disadvantage of the increased capital cost involved.

5. NAVIGATIONAL AIDS

373. The alignments of the straight reaches of a channel are often delineated by at least two masts on shore ahead of the approaching vessel, clearly visible by day and provided with lights at night.

374. The boundaries of the navigable channel are marked by fixed markers or floating buoys. The latter are more common in deep offshore channels but in a river system the former are frequently more economical. Buoys must be able to withstand wave action and must remain visible at all times.

375. Systems of buoyage vary around the world and it is therefore important to establish which sys-

tem is appropriate at a particular port. Essential advice is available from the national lighthouse authority, coastguards or navy departments in most countries.

376. The principal considerations leading to the choice of spacing of the visual aids for ships approaching and leaving a port are:

(*a*) The configuration of the channel;

(*b*) The incidence of low visibility;

(*c*) The usual sea condition in the channel;

(*d*) The presence of cross currents and winds.

Closer spacing of buoys will be required at bends and lit buoys are required if the port is to be approached by ships at night.

377. A new port will frequently require a main location beacon or lighthouse, and consideration should also be given in the general planning to radar reflectors, which ships can locate, port radar to monitor and control ship movements and radio communication between ship and shore.

378. Advice on these specialist navigational questions can be obtained from the Inter-Governmental Maritime Consultative Organization which has it headquarters in London.

6. Economic factors

379. The capital cost of marine structures can vary with the cube of the depth while, in the case of dredged channels and basins, the greater the depth the greater also the maintenance burden, perhaps proportional to the square of the depth. Decisions concerning the depth and width of channels and basins and the number of berths should therefore usually be made only after thorough economic studies of each situation.

D. Dredging

1. Introduction

380. The removal of soil from the sea bed or river bed to provide greater depth of water in the approaches to ports and adjacent to quays has a long history. As the size of ships has increased, the dredging of existing ports has become increasingly important.

381. Great advances in dredging technology have been made in recent years, and various types of dredger currently used are described in section 3 below.

382. Dredging itself is essentially an excavating operation, but the selection of the correct equipment is vital in achieving economy. All dredging activity calls for special consideration of the nature of the ground to be dredged, the best means of removing soils and the optimum work programme. Both capital and maintenance dredging must be considered.

2. Site investigation data

383. The site investigations particularly required for dredging work should provide data on tides and bathymetry, on wind, waves and currents and on the nature of the materials to be dredged, their *in situ* strengths, particle size distribution, degree of compaction and, in the case of silts, settling characteristics once disturbed. In all cases, standard classifications of material to be dredged should be used.

384. Section B above describes the carrying out of general investigations, of which those for dredging work form a part.

3. Types of dredger

385. The following types of dredger are usually available for contract dredging work, and the mechanics of their operation are illustrated in figure 27.

(a) *The bucket dredger.* The modern bucket dredger comprises a continuous chain of buckets mounted on a ladder adjustable for depth. Each bucket discharges its load at the top of the ladder, into chutes which direct the material into a hopper barge.

Bucket dredgers are best confined to work in sheltered locations and are useful for fairly accurate trimming of the bed. They can deal with some hard material but large pieces in the bucket can cause serious delays.

(b) *The grab dredger.* The grab dredger is usually a self-propelled vessel with a hopper and a grab crane. A simpler version which requires attendant barges is simply a crane on a pontoon.

(c) *The dipper dredger.* Excavation is achieved by means of a forward or rearward-facing shovel mounted on an arm suspended in front of the pontoon body, which operates by digging into the underwater material.

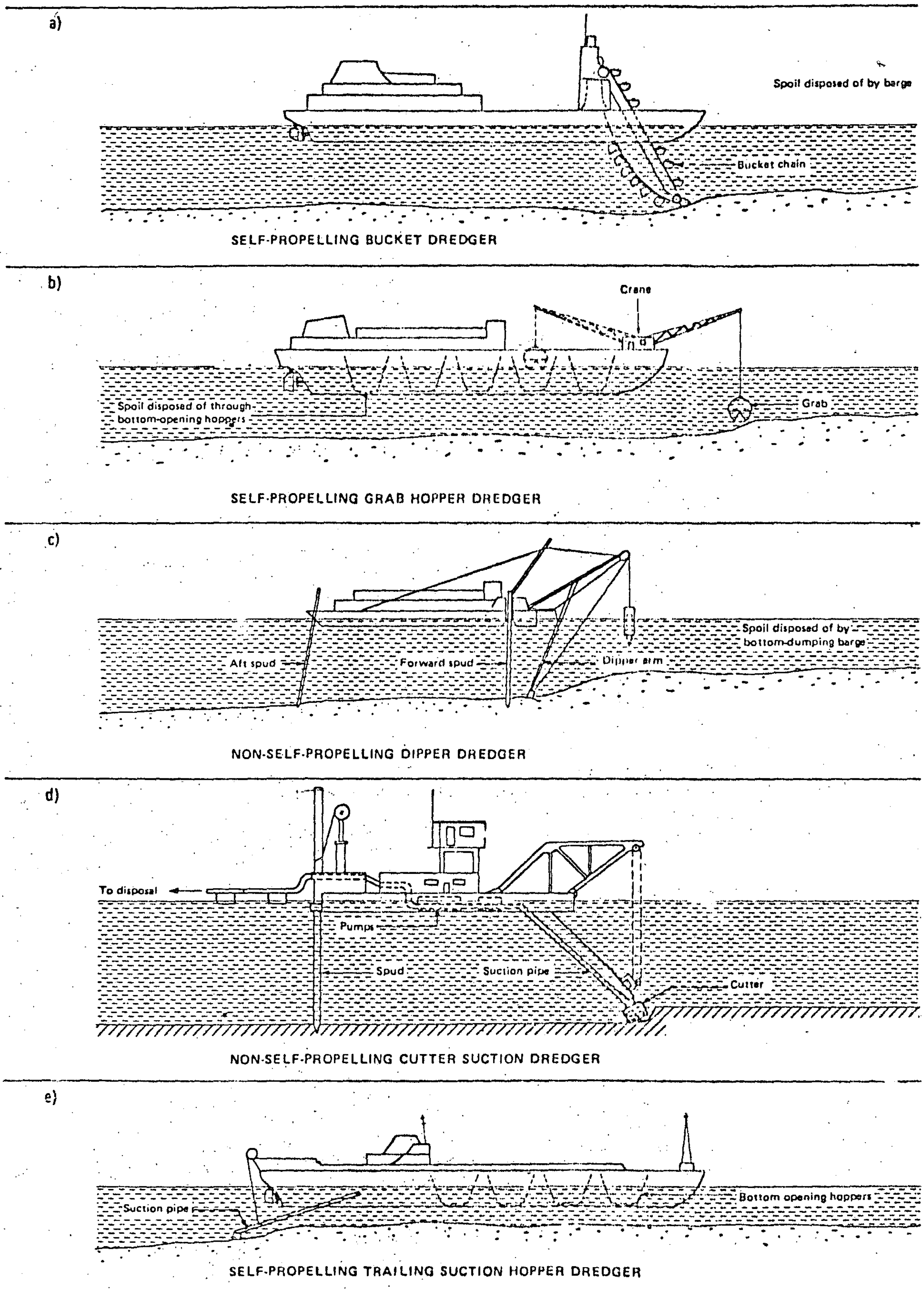
(d) *The suction dredger.* The basic components of this type of dredger are a pontoon hull which houses the pumps and engines, a suction pipe suspended from the vessel to the sea-bed and a delivery pipe from the pumps to a dumping area or, in some instances, to barges.

Only small granular material can be dredged by suction and it is common for this type of dredger to be equipped with a rotating cutter on the end of the suction pipe. Cutters can be designed to suit the particular material to be dredged and cutter suction dredgers can remove sand and gravels, medium stiff clays and, with the addition of special cutting teeth, stiff clays and soft or broken rock. Output, however, varies considerably according to material type and conditions. Nevertheless, this cutter suction dredger is now the most usual dredging equipment for capital work and is particularly suited for reclaiming purposes.

(e) *The trailing suction hopper dredger.* The trailing suction hopper dredger is a self-propelled vessel with suction pipes suspended from one side or from both

Figure 27

Five types of dredger in common use



sides. The dredged material is delivered through the suction pipes to the hopper. When the hopper is full, the vessel proceeds to the dumping ground.

This type of dredger is widely used in the maintenance of channels, where its ability to manoeuvre as a ship is a distinct advantage. A further advantage of this type of vessel, when compared with the other types discussed, is its ability to remain effective in rough water and offshore locations. It is, however, suitable only for relatively loose materials as would be found in maintenance dredging.

4. Dredger operation

386. The selection of the most suitable dredger depends upon the material to be dredged, the depth of dredging, the quantity and disposition of the material, the location of the dumping ground, the rate of production required and also on whether the dredger may have complete or partial possession of the waterway.

387. The programme and sequence of the dredging operations required careful consideration. If possible, dredging should commence in a location which would be least liable to siltation from later dredging. Timing of the dredging activity relative to the construction of other parts of the project, some of which, such as breakwaters or groynes, may give shelter or affect siltation, must be considered in the over-all planning of the project. Timing may also depend on local seasonal variations of tidal currents and winds, which can render dredging activities much easier in one season than in another, especially in estuaries. A further factor which must be borne in mind is the date of the start of operations at a new port, which may be in advance of the completion of the whole project so that the construction requirements of, or the need for access to, particular berths will influence the sequence of dredging.

388. The removal of solid rock constitutes a specialized dredging activity in that some means must be found to fragment the rock before it can be lifted from the sea bed by one of the conventional dredging methods described above. Usually a bucket or grab dredger is used to remove rock debris, but suction dredgers have also been employed to remove sufficiently fragmented rock.

389. The most commonly employed method of rock breaking under water is that of drilling and blasting, although jointed rock with thin bedding layers may also be fragmented by a heavy chisel or a pneumatic hammer on the rock surface.

390. Drilling and blasting under water is a specialized, slow and expensive operation and many trials may be needed to obtain the right results for the dredgers to be used. The dredging of coral or cemented sand causes frequent problems. These can sometimes be easily fragmented and dredged by a powerful cutter suction dredger. However, only careful investigation will show whether this is likely, and massive formations may need to be treated as rock before dredging.

5. Reclamation

391. It is of considerable advantage if the dredged material from a port project can be used for reclamation projects, but only certain granular soils are suitable for this purpose. Silts and clays are generally much more difficult to use.

392. The settlement behaviour of the fill material should be carefully analysed and monitored before construction is permitted. Pre-loading through the construction of embankments may be needed to achieve settlement within a reasonable period before buildings are erected. Geotechnical analysis will generally provide the correct solutions.

393. An important aspect in project planning is the balance of dredging and reclamation and this must be assessed in each case with a view to economy.

6. Economic factors

394. In assessing dredging costs it is important to remember that in many places large equipment must be brought from far afield to do the work, with a consequent heavy mobilization cost. The quantity of dredging required for any particular scheme therefore has a pronounced effect on the over-all unit rate. For a modest amount of work it may be found economical to employ simple equipment such as excavators on barges. Even though their working costs and productivity are less favourable, the saving in mobilizing the less sophisticated equipment can more than offset the less efficient performance in the field.

395. Such judgements are difficult to make and are often best resolved when tenders for the work are invited, but during a project study the various factors must be considered so as to permit a realistic estimate of dredging costs to be prepared.

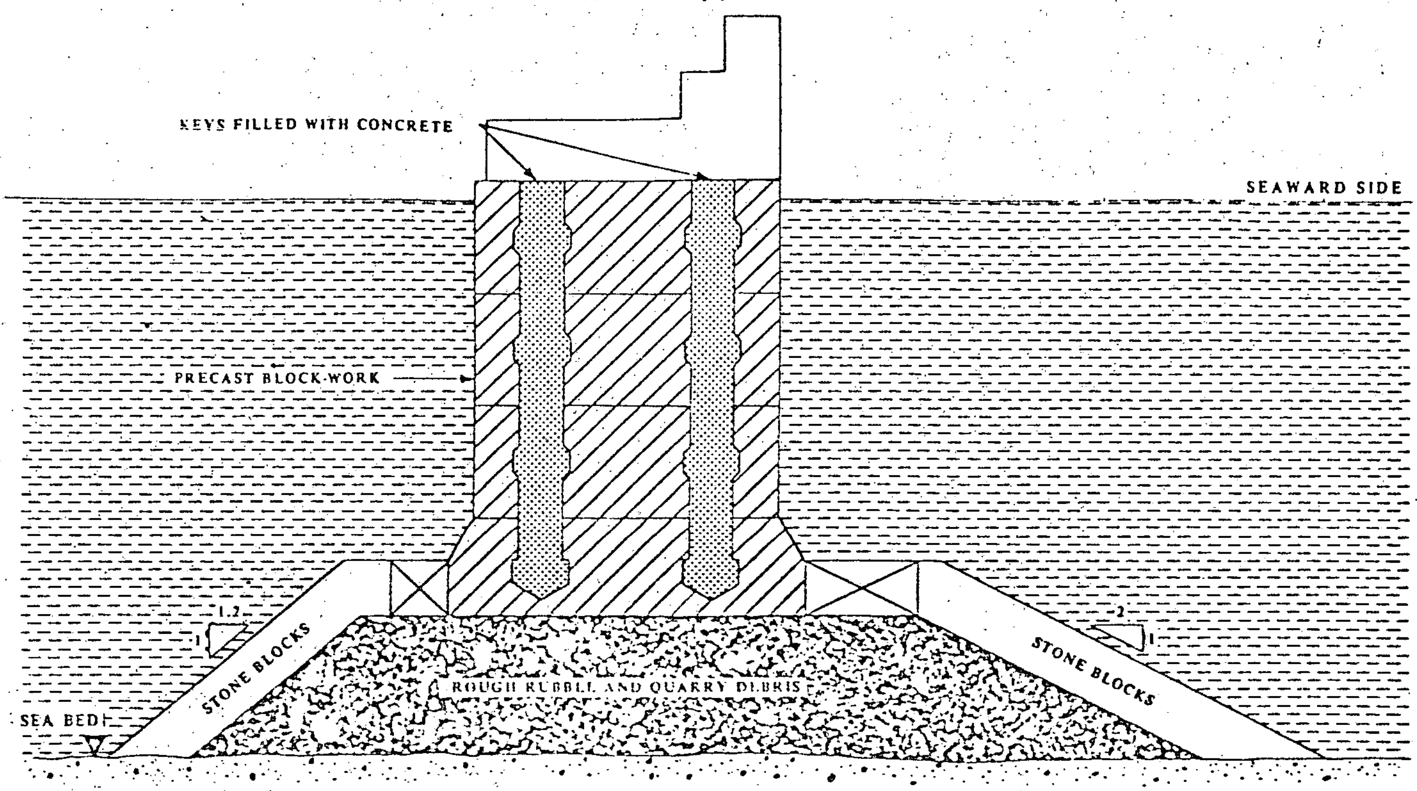
E. Breakwaters

1. Design data required

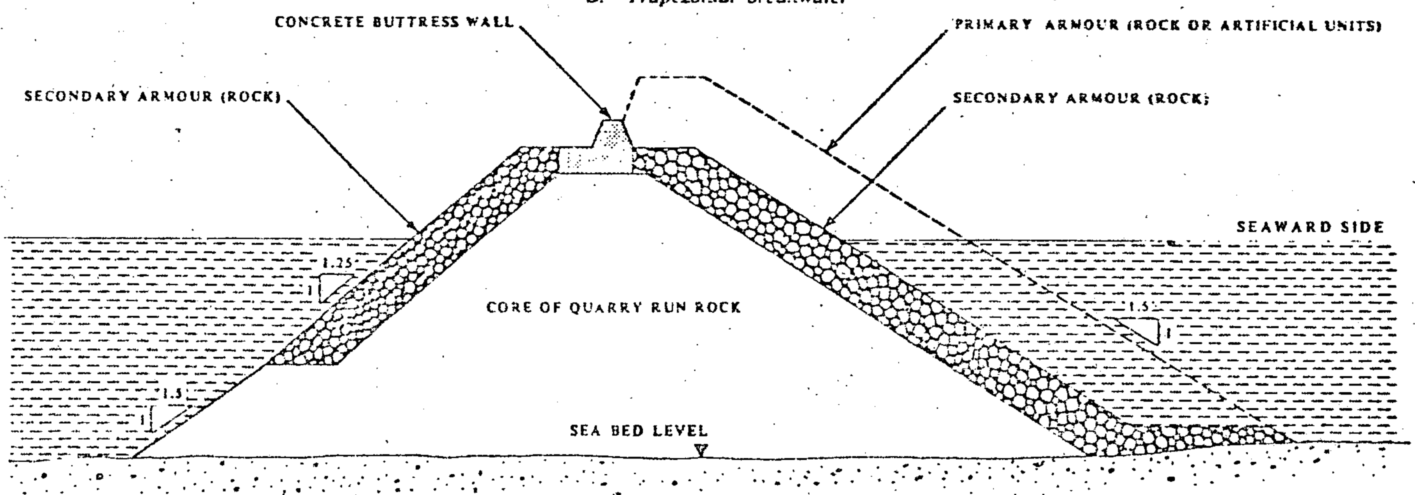
396. Where there is insufficient natural protection, breakwaters are needed in order to form an artificial harbour. Breakwaters deflect, reflect or absorb the energy of swell and storm waves which would otherwise enter the harbour area, and thus provide an area of relatively calm water.

397. The chief information needed for the design of breakwaters is the height and period of the storm waves likely to occur. The normal practice is to choose a design wave which represents the maximum wave measured during a storm which statistically will occur once in so many years, for example, once in 100 years. The likelihood of waves breaking

A. *Vertically faced breakwater*



B. *Trapezoidal breakwater*



against the structure is also a factor of importance in design. Data about the probable daily maximum wave must also be collected in areas of continuous swell, since this may have a significant effect upon the cross-sectional design of the breakwater.

398. The determination of the design wave requires the study of available oceanographic and meteorological data. It is preferable that direct recording of wave heights and periods should be made at the port site, but this is not always possible within the time available.

399. As waves are generated by winds, an estimate of wave activity can be made from wind records. Local reports of storm occurrence also assist in building up a statistical picture of the waves which can be expected. Tide and storm surge water levels should also be recorded or estimated, as waves are affected by water depth near port entrances.

400. The foundations of breakwaters warrant careful geotechnical investigation. Boreholes must be made and soil and rock samples taken over an area sufficiently large to allow variations in the position of the breakwater to be considered, and the possibility of scour of the sea-bed for some distance in front of the breakwater to be investigated. The strength and settlement properties of soils under a proposed breakwater require study to depth at least equal to the width of the breakwater base, since weak soils at depth may be overstressed by a large structure. Weak soils at the surface may have their bearing capacity enhanced by the placing of a blanket of sand or gravel on the surface prior to construction of the breakwater.

2. Alternative types of breakwater

401. Breakwaters may be in the form either of an offshore island or of an arm projecting from the shore. The breakwater may present a vertical or near vertical wall or a sloping surface composed of variously sized blocks. The two types are illustrated in figure 28. The structure may be submerged below sea level at some or all tide levels.

402. In the past, vertical- or near vertical-face breakwaters often comprised two walls of masonry blocks laid in horizontal, well-bonded courses with rock rubble fill placed between the walls. In later years concrete blocks replaced expensive masonry and more recently reinforced concrete caissons have been used. The caisson is constructed in a dock and then ususally floated to its final position and sunk onto a prepared sea-bed or blanket of rock rubble. Some form of interlocking between the individual caissons is usually required. Another approach is to precast the caissons on land, then to transport them along the already completed length of breakwater and to lower them into position by means of a large cantilevered gantry crane.

403. Rubble mound breakwaters vary in the type of primary armouring used. These breakwaters are of basic trapezoidal shape in cross-section, with a mound of smaller-sized rock called the core. Graded stone armouring is placed on the slopes and on top of this core. On the outside face of the breakwater, which dissipates the energy of the storm waves, the largest primary armour is placed. Many breakwaters of this type with natural rock primary armouring have been built and much published data is available.

404. In cases where it would be uneconomical to provide rock of adequate size, artificial concrete armour units are employed. Considerable research has enabled many specialized shapes to be evolved with high efficiency in resisting wave attack. In its simplest form (a concrete cube), artificial armour is a substitute for rockfill, but many of the special units have been designed to improve interlocking between units, while providing the maximum voids in the armour layer to dissipate wave energy. Examples of artificial armour are shown in figure 29.

405. While designing the cross-section of a rubble mound breakwater the source of rockfill should be investigated for quality and output. An assessment should be made of the likely proportions of rock which can be obtained from the quarry so that these proportions can be matched in the finished structure and waste of certain sizes minimized.

3. Design procedure

406. A preliminary assessment of breakwater requirements can be made by drawing possible breakwater layouts on a chart and estimating their effectiveness in intercepting anticipated wave attack. The effectiveness of the proposed breakwater layouts in reducing wave heights within the harbour can then be varified by model testing.

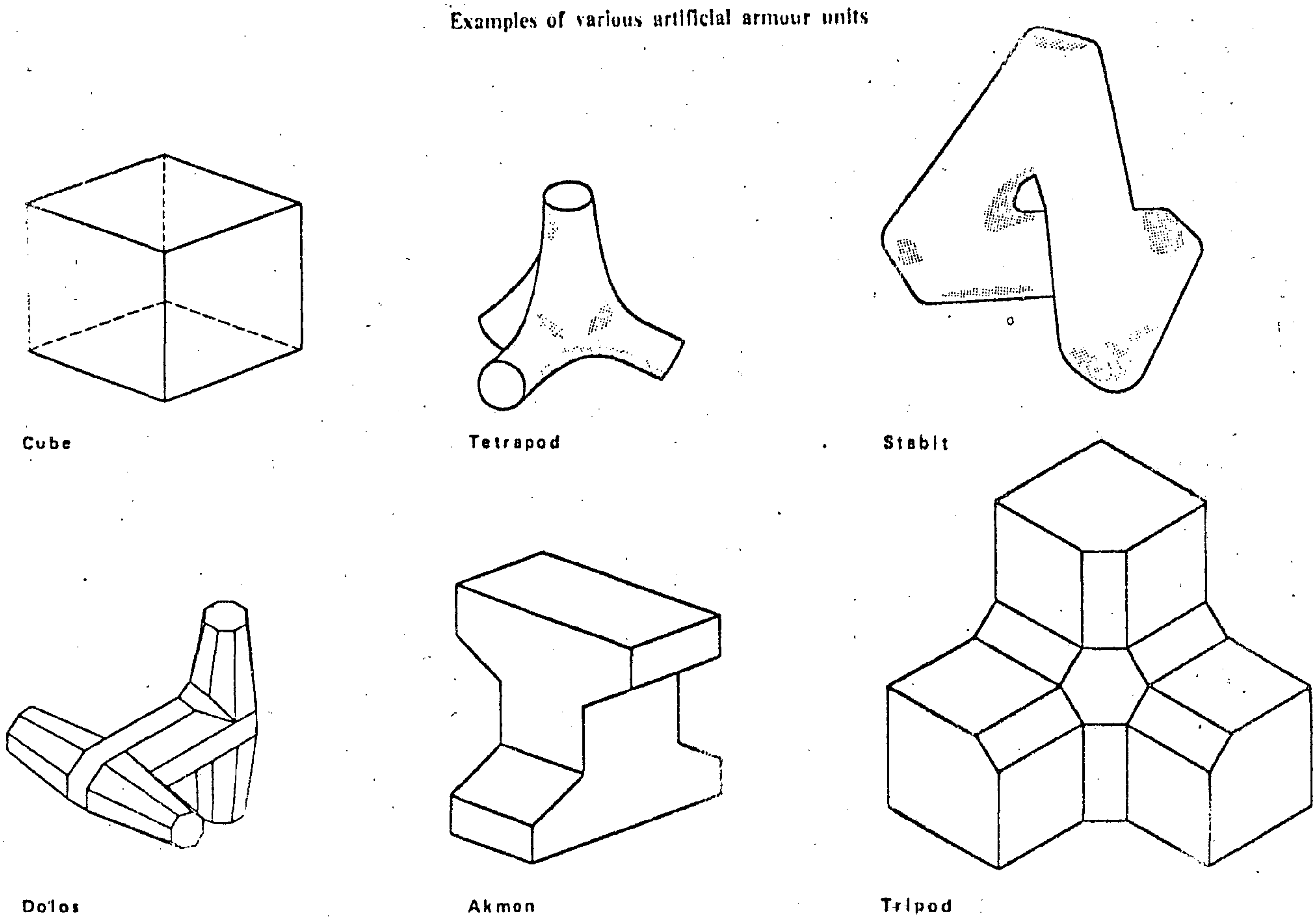
407. An element of compromise is usually found necessary between the most effective hydraulic solution to exclude wave energy from the harbour, and the ease of access and berthing of ships. The types of ships and methods of cargo handling need to be known so that residual wave activity in the port can be matched to the shipping requirements.

408. The design of the breakwater mass against the possibility of overturning is fairly straightforward, but the possibility of sliding on the foundation is frequently less easy to provide against. Measures to ensure an adequate factor of safety against the latter type of failure may take the form of providing a sheet pile curtain or an additional build-up of material against the inside wall of the caisson.

409. A disadvantage of vertical-faced breakwaters lies in the scouring action on the foundation which may be set up by the refraction of waves from the face of the wall. This aspect should be carefully examined. Nevertheless, an approximate guide is that if the erodible bed material is situated at a depth of less than twice the wave height below the lowest water level, scour needs to be carefully guarded against.

FIGURE 29

Examples of various artificial armour units



4. CONSTRUCTION

410. The two major types of breakwater discussed in the preceding sections require totally different construction methods and plant.

411. The core of a rubble mound type of breakwater is commonly constructed by end-tipping progressively from the shore, but careful checks are needed against segregation of the rocks which may occur during loading and tipping. A large crane can then travel along the top of the core mound to place the upper core rock to finish the profile and then to place the outer armour layers of rock and/or artificial armour. A floating crane can be used but is economical only in areas where severe sea conditions are rare. Similarly, the lower part of the core can be placed in position from barges.

412. The caisson type of breakwater involves construction processes which usually take place off site. The caissons, which are made of concrete and have closed bottoms, are usually constructed in a dry dock or on a launching area on shore until the walls have attained sufficient height to allow the caisson to float. When the walls have been completed to the required height, the caissons are towed to the breakwater location where they are sunk onto a prepared sea-bed. A time of minimum current and wave activity should be selected for this operation. The caissons should be filled with material, usually sand, as soon as possible after sinking to give the earliest full weight against wave action.

5. ECONOMIC FACTORS

413. The selection of a particular type of breakwater also depends on such factors as the availability of materials, plant and labour. A vertical wall breakwater will place different demands on these factors than a trapezoidal rubble mound breakwater.

414. The rubble mound breakwater will require more material because of its shape. Thus in an area which has an ample supply of rock strata capable of providing large primary rock armouring, this type of breakwater would be preferred. A major expense is the large crane required for rock handling, which is normally written off against the cost of the project. For short breakwaters this results in a high unit cost. This form of breakwater does not require a large pool of skilled labour.

415. The vertical wall breakwater in the form of caissons requires less material. Reinforced concrete

provides the armouring and sand or gravel can be used as the fill material. More modest equipment is required but facilities are necessary to tow the caissons into position for placing. Such facilities, for example tugs, normally have a use in the port. To prepare the necessary forms to construct the caissons a more skilled pool of labour is required.

F. Quays and jetties

1. Introduction

416. A distinction must be made between heavy structures on which cranes and large vehicles can operate, and light structures which can only support pipelines, conveyors and light vehicles. The heavy structures—interchangeably called quays and wharves—can be either marginal (i.e. parallel to the shoreline) or in the form of piers which project from the shore. The light structures, which also project out to deeper water, are called jetties.

417. A jetty is economical where the depth of water available for the ships calling is available only some distance offshore. It is suitable for bulk cargoes—dry or liquid—where the jetty head in deep water accommodates the specialized loading or unloading equipment and the cargo is conveyed ashore by pipeline or moving belt along the jetty approach. A jetty is unsuitable for general cargo, where storage area near the ship is important, unless a high tidal range makes it the only economical solution.

418. In any project there will be a variety of engineering possibilities which may call for either the improvement of outdated facilities or the construction of new facilities in accordance with modern standards. In the case of new structures, known engineering approaches can be utilized, but for the improvement of old facilities there are usually factors which impose considerable restraints on technical options and each case has to be considered as a special problem.

2. Quay walls

419. Several forms of construction are available, each suitable for certain conditions. They include the block-work retaining wall, the anchored bulkhead wall and open-pile marginal quays, as described below.

(a) *Block-work retaining wall*

420. This type of wall, shown in figure 30 A, requires a firm, non-erodible foundation, preferably rock or a stiff clay, but a rock blanket over loose ground can be used to prevent scour.

421. Such a wall can be built up from individual blocks, usually placed under water. Among the possible variations are solid block-work, in which the block are laid in horizontal courses, slice-work, in which the blocks are laid on sloping courses which allow the quay to accommodate settlements, and hollow block-work, which reduces the weight of unit to be handled. If dry construction can be used for the wall, then mass concrete *in situ* construction is very suitable.

422. Concrete caissons can be used for quay walls, either by floating pre-formed boxes into place and sinking them, or by constructing a box in the final position and excavating inside it until it sinks to the desired level.

423. The suitability of each of these gravity walls depends greatly on ground conditions. Blockwork and floating caissons would normally be used only where the quay is built in water which has a depth close to the final dredged depth. A caisson can be built in its final position where the wharf is at present dry land and where the ground above dredged level is soft.

(b) *Anchored bulkhead wall*

424. Anchored steel sheet pile retaining walls, as shown in figure 30 B, have been widely used for quay walls and are to be recommended particularly where the quay height required is not unduly great and where the soil is a medium dense sand.

425. Higher sheet pile quay walls can be obtained by using special composite sheet and H-pile sections which are now available. Other measures which may be used to reduce the bending moment in the wall are to employ a double bank of tie bars or to form a relieving platform above the sheet piling. Concrete piles can be used in this type of wall and in many countries where the cost of steel piling is high, since it has to be imported, concrete may give considerable economies.

426. However, concrete piles are heavier, more difficult to drive and there are problems of ensuring a satisfactory seal against soil escaping between them. The purchase cost of steel piling may therefore still be justified. Table 7 compares factors which should be considered in each case.

(c) *Open-pile marginal quays*

427. One of the most widely used forms of marginal quay construction is the open-piled suspended slab as shown in figure 30 C and D. This form of quay may include, in addition to normal vertical piles, raking (inclined) piles and/or tie rods connected to anchor blocks placed some distance behind the quay. This type of quay is built over a rock-revetted slope (a slope faced with harder rock) or over a rock embankment or dyke which serves to retain the finer soils—usually reclaimed material—behind the quay.

428. In order to reduce the width of the apron slab, a low bulkhead wall is sometimes introduced at the rear of the quay to retain the upper fill material.

FIGURE 30

Examples of quay wall construction

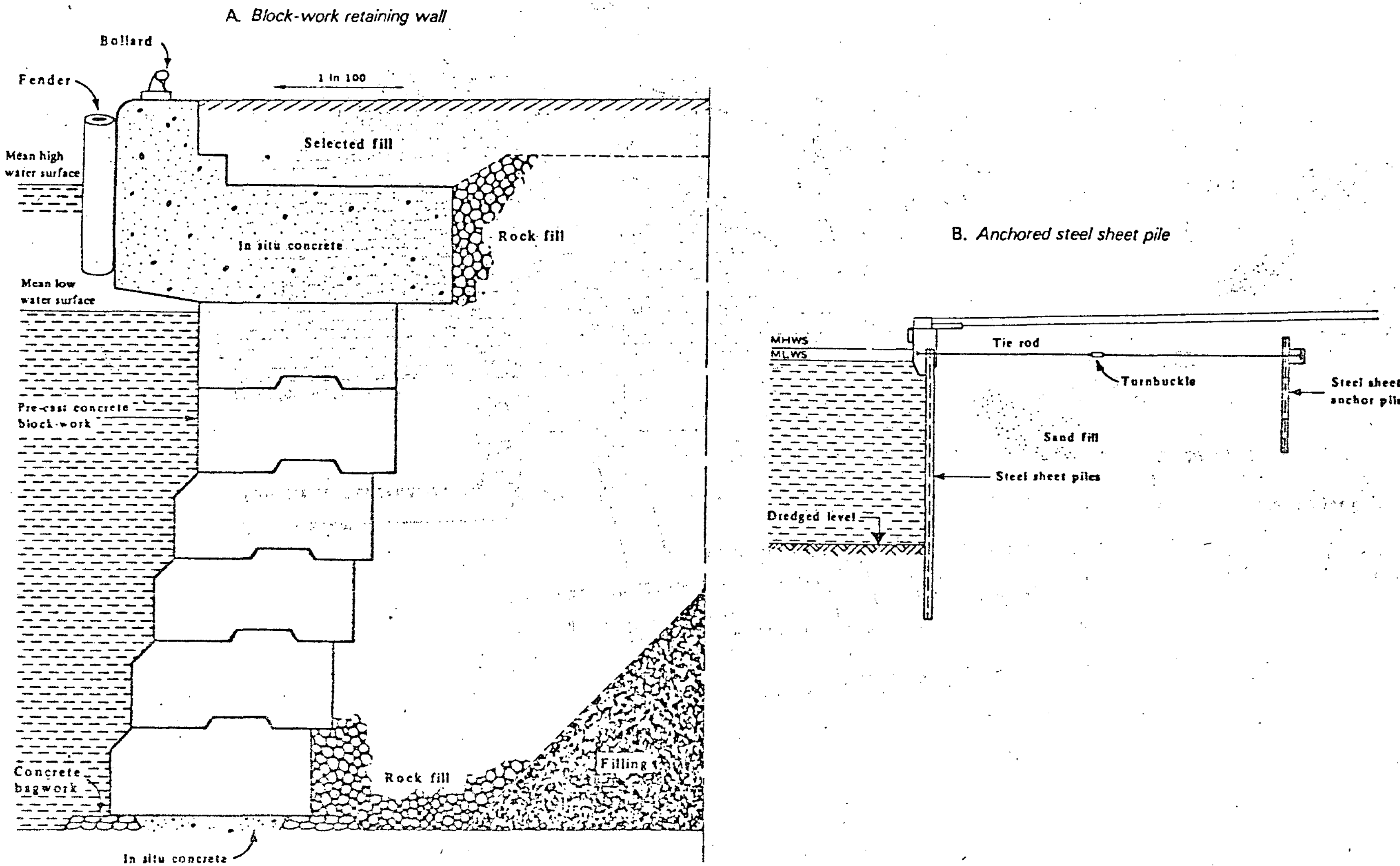


FIGURE 30 *(continued)*

C. *Open-piled quay with raking piles, typical cross section*

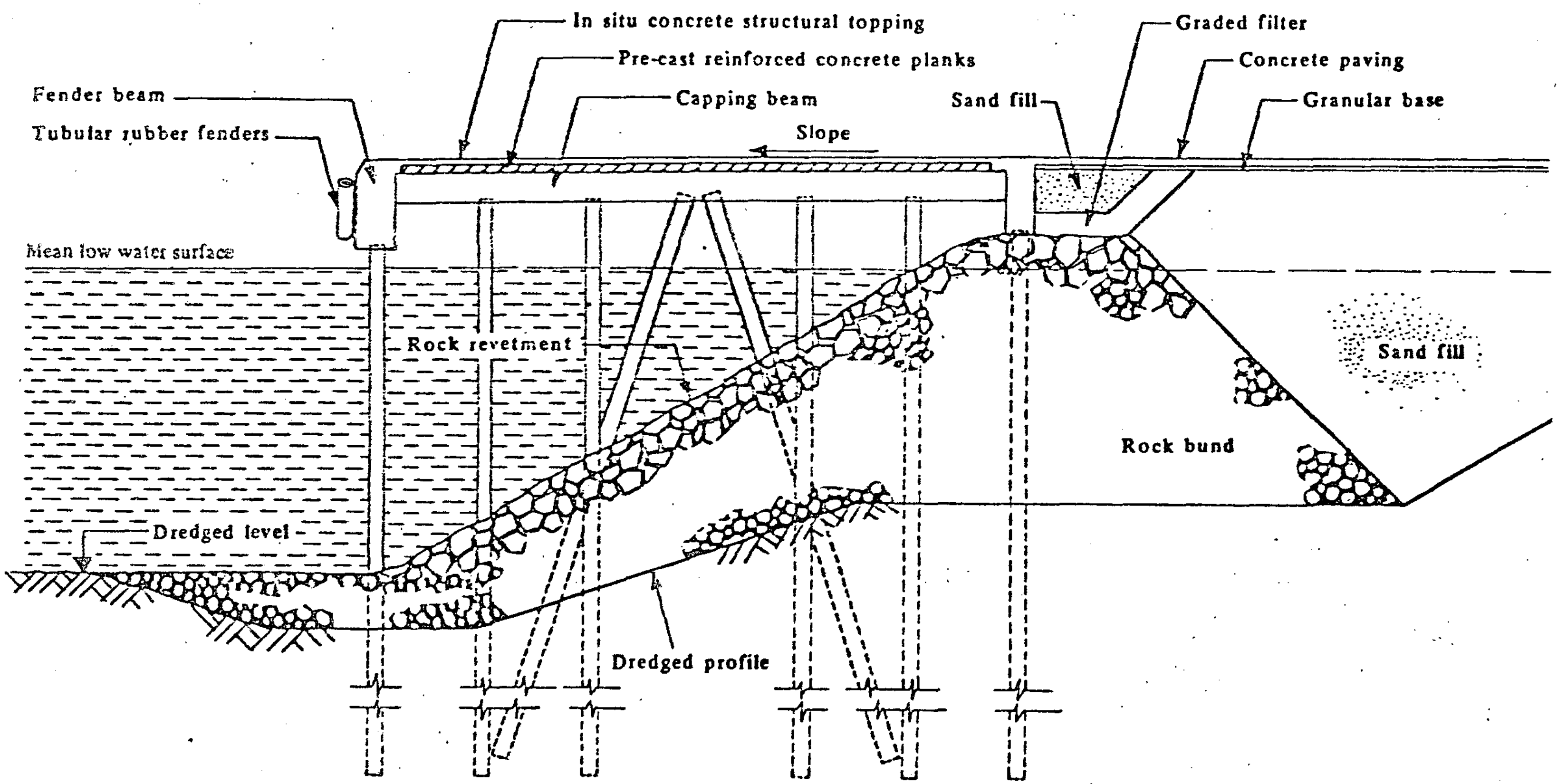


FIGURE 30 (*concluded*)

D. *Open-piled quay with anchors, typical cross section*

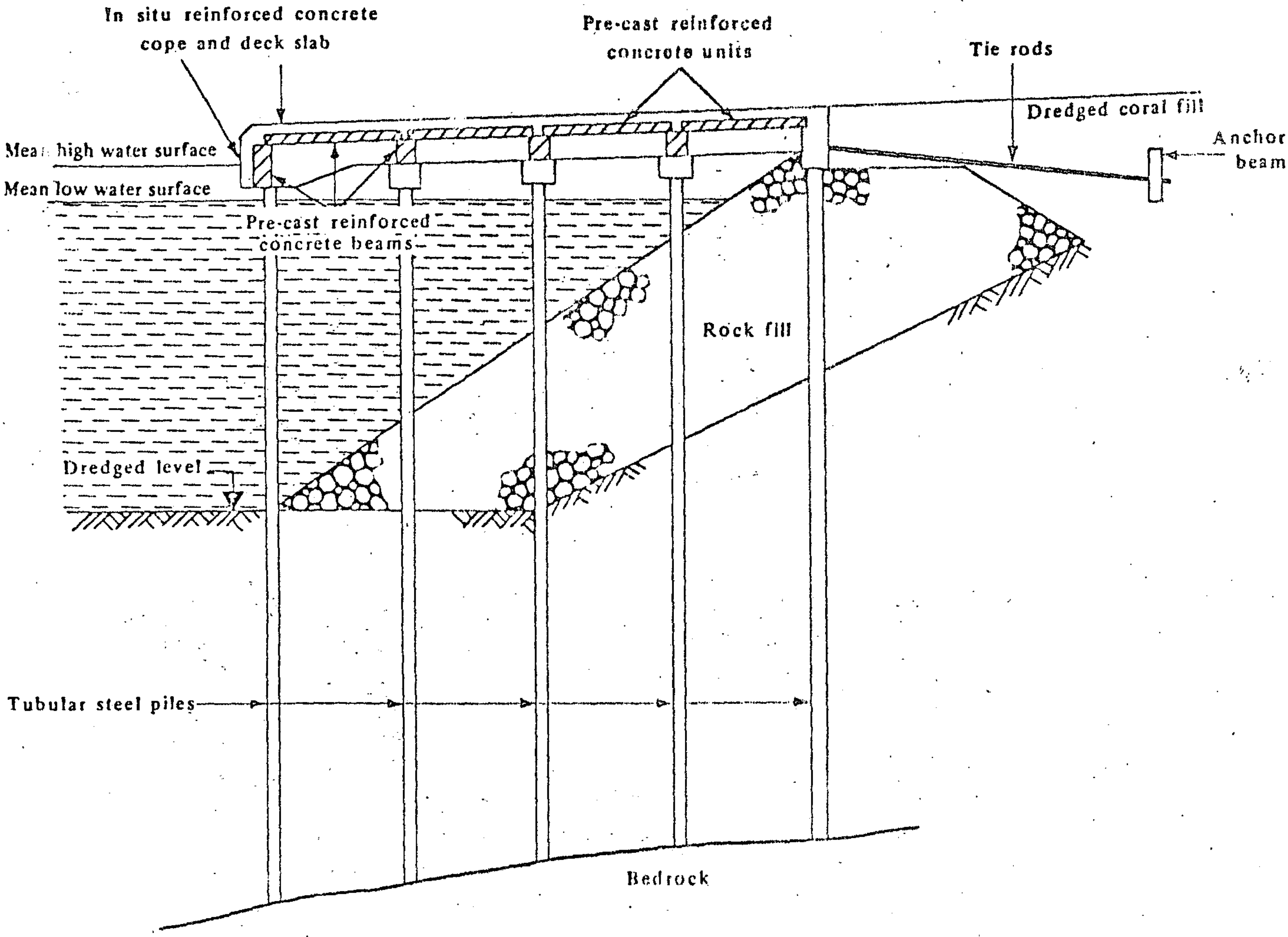


TABLE 7

Comparison of steel and concrete piles

Aspect	*Steel piles*	*Concrete piles*
Material	High cost	Low cost
Transport	Usually have to be imported	Can be made on site
Inspection and treatment	Require simple inspection and works quality certificates; cleaning and possibly sandblasting on the site	Require careful site checking of materials and workmanship
Handling	Comparatively light to handle and robust	Heavy and careful handling needed
Driving	Can withstand hard driving	Careful driving needed and risks of cracking
Extension	Readily extended by welding	Extension is time-consuming or needs sophisticated connexions
Maintenance	Liable to corrosion and require painting, extra wall thickness or cathodic protection	Require little maintenance if well made and undamaged

A variety of construction techniques is available in steel, concrete or even, in modest structures, timber. The most economical deck width and the pile spacing have to be established by examining different solutions in each case.

429. Where there is heavy vertical loading, such as from container or bulk-handling cranes, large-diameter concrete cylinder piles may prove an appropriate solution for the quay structure. In addition, the spacing of crane rails can influence pile spacing and should be taken into account when planning the quay dimensions.

3. Jetties and dolphins

430. A jetty provides a berth some distance from the shore. A trestle structure or causeway joins the jetty to the shore and may carry a roadway, pipelines or conveyors. In certain special cases the approach structure can be dispensed with by using, for example, submarine pipelines for oil, or cableways for bulk ore. A jetty may be built in sheltered harbour waters to provide a relatively cheap berth for specialized cargo vessels and in such cases a short approach structure is all that is usually needed.

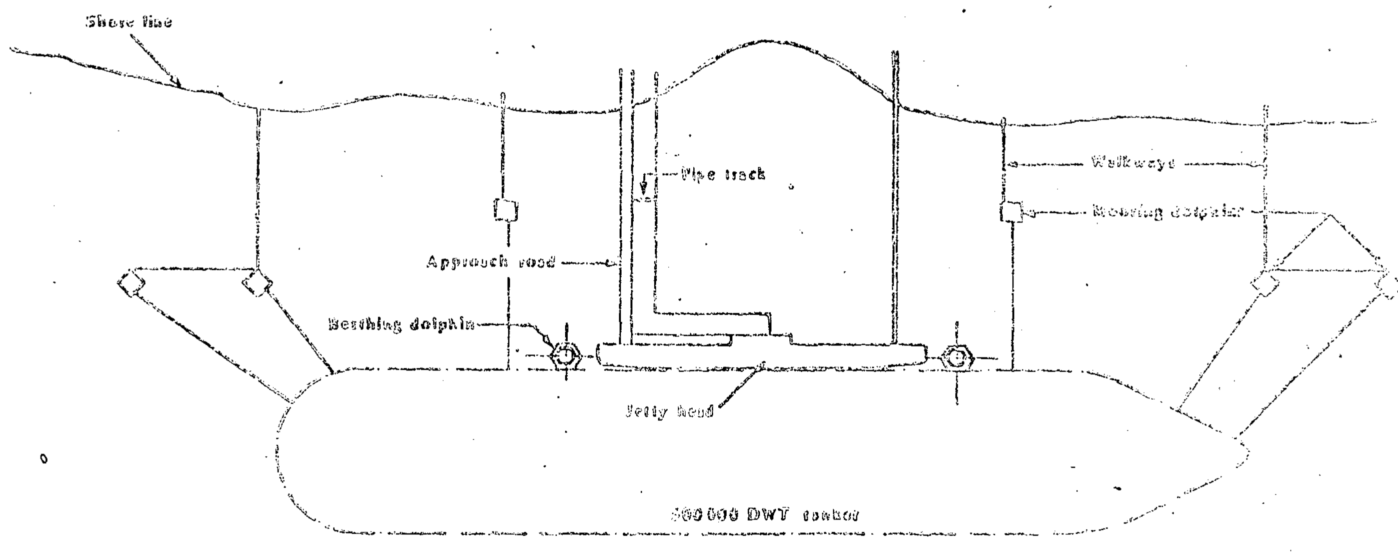
431. Alternatively, a jetty may be built offshore in the open sea, with a long approach structure to reach adequate water depths. For tankers and bulk carriers a jetty can be an economical means of providing a facility, but the hostile construction environment and the periods when the berth is unusable because of weather conditions must be taken into consideration before this solution is adopted.

432. While a normal quay wall structure performs the two functions of providing a berthing position for the ship and a working platform for ship-working activities, in the case of a jetty it is usually economical to separate these two functions structurally. Therefore, a working platform (or jetty head) carries bulk cargo handling equipment, pipe handling gear, etc., while separate berthing and mooring dolphins are provided to hold and control the ship (see figure 31). The platform for cargo-handling gear is then not required to accept the horizontal impact from the ship berthing or the loading while it is berthed, as the ship makes contact only with the berthing dolphins.

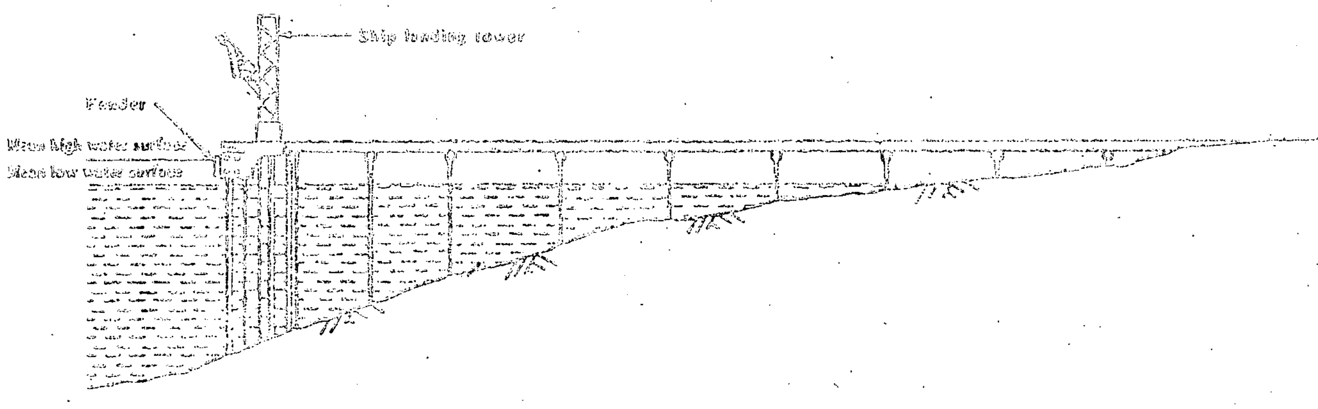
Figure 31

Typical jetty for large oil tankers

A. *Plan view*



B. *Longitudinal elevation*



433. Where the sizes of ships do not vary greatly, as at an oil or ore berth, berthing or breasting dolphins are usually placed on either side of the jetty platform at a spacing of about 0.4 times the length of the ship.

434. A group of raking piles with their tops held in a concrete pile-cap may form the dolphin, with rubber fenders on the berthing face to provide the necessary resilience. Alternatively, a berthing dolphin can be formed by using a group of large-diameter tubes of high tensile steel driven into or fixed in the sea bed. The energy absorption of such flexible steel tube dolphins can be computed to suit the anticipated berthing energy of an approaching ship, and it is frequently economical to vary the section of the tubes over their vertical length. The degree of fixity of the pile in the ground is important for such calculations and the soil properties must therefore first be determined by a thorough ground investigation.

435. Mooring dolphins are provided at a jetty to support bollards for ships' mooring ropes. A group of piles or some other such structure which will take bollard pulls, depending on ship size, of up to 100 and sometimes 200 tons, is used for this purpose. In this case the piles are set some way back from the berthage line of the ship. Where the jetty is close to shore with a very short approach, the mooring dolphins can be constructed on the shoreline. Access for small boats carrying ropes should be provided at mooring dolphins.

436. The jetty head is usually a simple piled structure with fendering for those small vessels or barges which may use the berth. Steel piles with a reinforced concrete deck are often used for this type of structure.

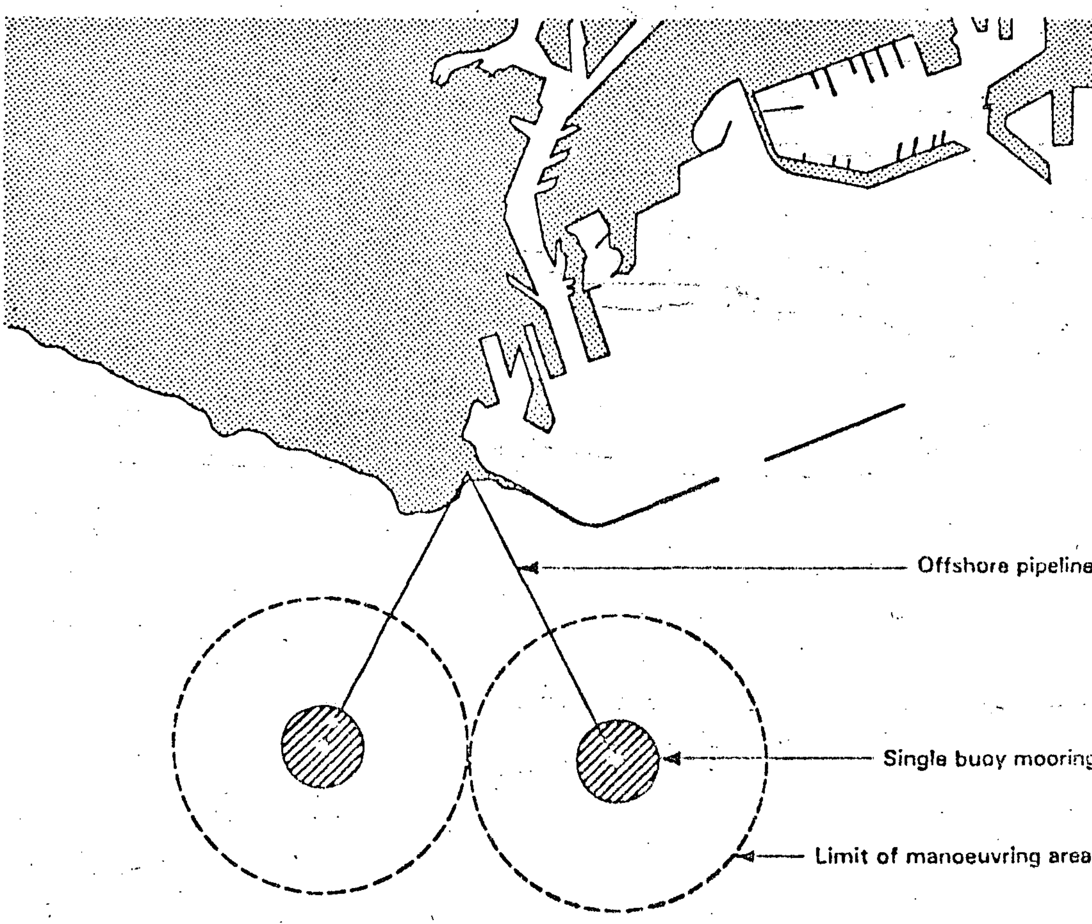
4. Special types of berth

437. In addition to the quays and jetties normal in any port, a number of unusual berth types have been developed for special shipping services. These are unlikely to fall within the scope of planning and designing common-use port facilities, as they are usually associated with a particular industrial development.

438. Bulk ores and petroleum are now transported in very large vessels and it is difficult to extend existing ports to include berths for such ships. More-

Figure 32

Water area requirements for single buoy mooring



Source: "Port of Los Angeles Comprehensive Master Plan 1990".

over new sources of crude petroleum and ore are frequently in areas where no ports exist and so completely new facilities have to be set up.

439. While jetties may be extended a considerable distance offshore, natural or artificial islands created in favourable water conditions offshore can prove more economical. Cableways (for dry materials like ores) or submarine pipelines (for liquid products) replace the approach causeway. Sometimes such islands have the additional advantages of providing storage and facilitating subsequent trans-shipment.

440. A further development in recent years for petroleum discharge has been the single point mooring for large tankers, as illustrated in figure 32. The use of ordinary mooring buoys and submarine pipelines for tankers has long been known but, more recently, single large buoys or fixed structures have been developed which hold the ship. There are a number of types, some of which include the hose connexion within the mooring, others which separate the two functions, but the main feature of all such systems is that the vessel can take up the most favourable position with regard to sea currents and winds by rotating around the buoy.

441. The major advantages of such systems are that down-time due to weather is less than would be the case at a fixed berth in the same location; capital outlay and commissioning time are generally less; berthing is easier, and the system is relatively easy to remove to a new location. These advantages may be offset by cost, maintenance problems and safety questions.

5. Berth fittings

442. The fitting required on a berth comprise fendering to absorb the energy of impact of the vessel, mooring devices to secure the vessel during its stay at the berth, access ladders or landing steps for small vessels and boats and services supplying the various needs of vessels in port. Fendering is discussed in more detail in section 6 below and the other features are briefly described in the paragraphs that follow.

(a) *Mooring devices*

443. Mooring devices vary progressively in size from those required for small boats to those for large bulk carriers, and include bollards, mooring rings, cleats and quick release hooks.

444. The most important and most commonly used device is the bollard, which should be a low cast-iron post, shaped with lobes such that ship's ropes may be securely held. Although bollards are classified according to the loads at which they will fail, the design should be such that failure takes place first in the holding-down bolts at a pre-determined failure load, the structure itself thus being safeguarded.

445. Bollard capacities and spacings appropriate to certain sizes of vessel are given in manufacturers' literature. For example, for 20 000 dwt cargo vessels, 50-tonne bollards at 25-metre intervals would be suitable. Quick release hooks are usually employed on large vessel berths and proprietary designs are available to suit the requirements of the ship operators.

(b) *Ladders or landing steps*

446. Ladders or landing steps should be provided along the face of the quay at about 40-metre intervals. They serve not only to allow access to vessels of low freeboard and to small boats, but also as a safety measure for anyone who falls in the water. Ladders or landing steps are also necessary on isolated mooring dolphins in order to allow access from the launch during rope-handling operations.

(c) *Services*

447. The port can offer a number of different services at a berth. The most common facility is the provision of fresh water. The water supply may be arranged at metered hydrant pits spaced at 50-100-metre intervals along the length of the quay edge, fed by ring mains usually as an extension of the local water supply system. Any limitation on the fresh water supply per ship should be specified in port documents.

448. Water must also be available for fire-fighting purposes. The use of fresh water, although it does least damage to cargo, may be expensive, and sea water can be used. Special salt-water mains can be laid which are left empty, to be charged with salt water in an emergency, by either a fixed or mobile pump installation. For a more effective system, pressure-charged mains and automatic pumps for instant use may be provided. This shore-based fire emergency system augments the usual provision of firefighting equipment on tugs.

(d) *Fuel bunkering*

449. At some ports there is a demand for the provision of ships with fuel. The alternative to using a fuelling barge or setting aside a special fuel berth is to provide a fuel supply at the cargo berth, so that the ship can be fuelled during its time at berth. According to the classes of traffic expected, fuel oil, marine gas oil, marine diesel oil and intermediates may be required. Not every berth needs to be so provided, but fuel hydrants served by buried pipelines should be provided at convenient locations. Blending valves may be needed and maximum and minimum supplying rates in tons per hour should be specified.

(e) *Electrical power*

450. It is not usual for the port authority to provide electrical power to vessels, but depending upon the normal usage of the ships calling at the port, this may be required. In this case, electrical plug boxes would be provided on the apron at each berth. Lighting of the aprons is needed for night operation and to avoid there being lamp posts which might obstruct cargo handling lights are usually fixed on the transit shed. For an open berth, high light-towers away from the ship's side are preferable.

(f) *Ship-to-shore telephone*

451. Telephone communication direct from the ship is an increasingly important service. Ship-to-shore points are usually provided at each berth, preferably near either end to be conveniently placed for the ship's superstructure. Ducts are placed in the apron with draw wires through which telephone cables can be drawn when they are needed.

6. Fendering of berths

452. The impact between a berthing vessel and a quay structure could cause damage both to the vessel and to the quay wall unless a fendering system, examples of which are illustrated in figure 33, is provided to absorb the impact.

453. In the case of a solid quay, such as one of concrete blockwork construction, the maximum allowable force would be determined by the ship's ability to resist permanent deformation, the wall being able to sustain much higher forces than the vessel. In the case of open pile designs the strength of the structure tends to be the determining factor in fender design. In both cases fenders must be placed so as to reduce the forces which are transmitted to a given part of the structure.

454. Fender systems vary from quite complicated arrangements to virtually no fendering at all for some berths servicing smaller vessels. The most usual form of modern fendering is rubber in various shapes which can be easily attached to the structure and designed to suit the particular conditions. Timber fenders are also widely used particular for general cargo berths, although the maintenance required is often considerable.

455. The allowable berthing speed of a vessel is dependent on the size of the vessel, the navigational skill of the mariner or tug master and weather and harbour conditions. A higher than normal velocity should be selected as a design figure to enable the fenders and structures to cover all circumstances of berthing, but it is usually quite out of the question to design for an accidental collision. Manufacturers of proprietary fenders produce specifications of their fenders' energy absorption data and tables which enable a selection to be made.

456. Other types of fender would normally be designed as a mechanical/structural system to suit the particular application. For specialized berths the ship operators would normally have opinions on the suitable types of fender for their vessels and should be consulted where possible. The following types of fender, illustrated in figure 33, cover the range of choice normally available.

457. Fender pile systems employ piles driven into the sea bed along the quay face. Impact energy is absorbed mainly by bending of the pile. For high berthing loads the capacity is usually enhanced by the inclusion of a rubber block between the head of the pile and the quay structure and by connecting the piles with longitudinal members to spread the load.

458. Hollow cylindrical rubber fenders are very convenient and economical, but generally because of their limited capacity for energy absorption are used on structures that can absorb high impact forces. They are easy to install, suspended by chains or steel cable and are easy to replace. To cope with both horizontal and vertical movements of ships they are normally installed diagonally. In ports with high tidal ranges, several rows may be needed. In some cases rubber fenders are placed between a timber or steel rubbing strip and the quay wall. As the coefficient of friction of the ship's side against wood or steel is less than it is against rubber, the longitudinal forces are greatly reduced. Various other types of rubber fender have been designed to act in shear, in torsion or in bending and in some fenders rubber and steel are bonded together to act as a unit in absorbing energy.

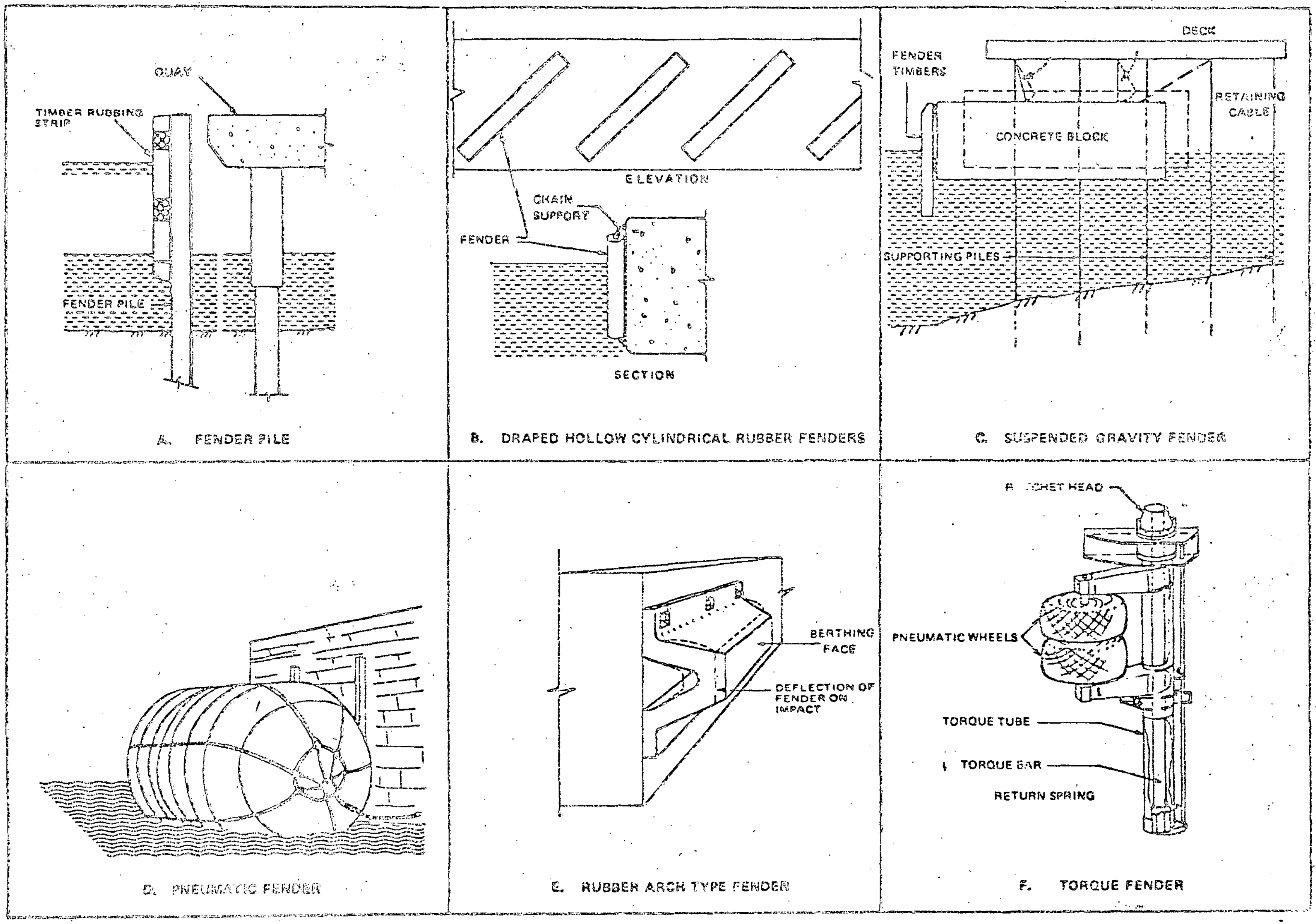
459. Gravity type fenders are designed to transform the kinetic energy of the moving ship into potential energy by raising a weight. Three general types have been developed which act by a system of cables, by a pendulum or by trunnions. A typical example, of the many which have been used, is that in which a large concrete block is suspended below the quay deck by two pairs of cables. The front face of the block, suitably faced with a timber rubbing strip, acts as the berthing face. The impact of the ship forces the concrete block to swing backwards and upwards until the ship has come to rest.

460. Pneumatic fender systems are pressurized air-tight devices designed to absorb impact energy by compression of air inside a rubber envelope. One type floats freely but is tethered by ropes between the quay and the ship. Another type is the fixed air block fender, which has high energy absorption and consists of an enclosed rubber cylinder into which air is pumped. The assembly is bolted to the quay wall face.

461. Torque fender systems are designed to absorb the berthing energy by plastic deformation of metals in torsion. A mild steel torsion bar is used in such a manner that it is twisted by the motion of the ship against the fender.

FIGURE 33

Examples of fendering systems



7. Engineering cost estimates

462. During the earlier stages of a port development project the engineering studies aim at identifying possible solutions and providing sensible estimates for their capital and maintenance costs. As a project develops, the degree of confidence in the estimates will increase as further knowledge becomes available and more detailed design work is carried out. Contingency allowances should be made at each stage, decreasing as confidence increases. Only when the work is completed will the final cost be accurately known. A pretence of great accuracy in the early stages should be avoided, and usually a tolerance of ± 20 per cent is perfectly satisfactory for the economic evaluations, bearing in mind that traffic and shipping forecasts cannot be any more precise.

463. The engineer should, however, seek to make estimates for alternative schemes easily comparable. It is often necessary to provide the economic appraisal team with estimates for alternatives which may not have been foreseen at the outset when planning field investigations. An example of this is when the option of expanding an alternative port arises. In such cases the engineer may need to do a rapid investigation of another site, without time to carry out a full field survey and design appraisal. The engineer should not place a restriction on the number of alternative concepts and designs which the team generates, but should avoid embarking on too detailed an investigation before the list of options has begun to be narrowed.

464. The basis for estimating engineering costs must be defined by the project team, and it is frequently decided that present-day costs and benefits will be used throughout. Nevertheless, the engineer may need to assess inflation rates in construction costs, for use in the joint appraisal as appropriate.

465. The division of the cost estimates into proportions of local and foreign currency and taxation elements is often needed, and the engineer may obtain guidance from the economists. Nevertheless, these elements can be seriously influenced by whether a locally based or foreign contractor is chosen. The engineer must therefore at an early stage acquire a sound knowledge of the national construcion industry and consider whether the project would be within its competence, or whether an international contractor would be needed, with a larger foreign exchange requirement.

466. It is important to consider the effect on cost estimates of different construction phasings. For example, an expanding port may require further break-bulk berths in future years. To build, say, one berth every two years might appear a theoretically attractive solution, but in practice a proper study of the relationship between costs and phasing may indicate that these berths should be built at the outset, with a further phase of berth-building commenced about five years later. A significant feature here is that mobilization costs would be much the same irrespective of the number of berths to be built under any one contract. Estimates for project alternatives are therefore best produced in two parts: the direct cost for each element of a package, and the mobilization cost for whichever package is being considered added separately at the end. This facilitates the manipulation of a variety of alternative estimates in the economic comparisons.

Chapter VII

INLAND TRANSPORT

A. The system as a whole

467. The importance of the port planner's looking beyond the port boundaries to the next transport leg has been emphasized in other chapters. He will often have little authority in planning that leg, but should always consider how goods are to be moved to and from the port and should try to influence the inland transport plan accordingly.

468. The starting-point is to consider what the modal split of the traffic in question will be, i.e., what proportions will come and go by road, by rail and by waterway. This will often require a sample of existing consignments to be examined. In judging whether the modal split is likely to change, the main factor will be the extent to which waterway frontage, trunk road access and internal rail sidings are available at the shippers' premises (factories, warehouses or mines). These facilities change very slowly in view of the large investments involved.

469. For each main traffic class (e.g. break-bulk cargo, containers, ro/ro cargo and each of the principal bulk commodities) it is next necessary to forecast its own modal split and to link this with the future distribution system. In each case the possibility of bottle-necks in the system is a primary concern. The system can be considered as a series of connected tanks with taps which have to be shut off when any one tank becomes full, as illustrated in figure 34.

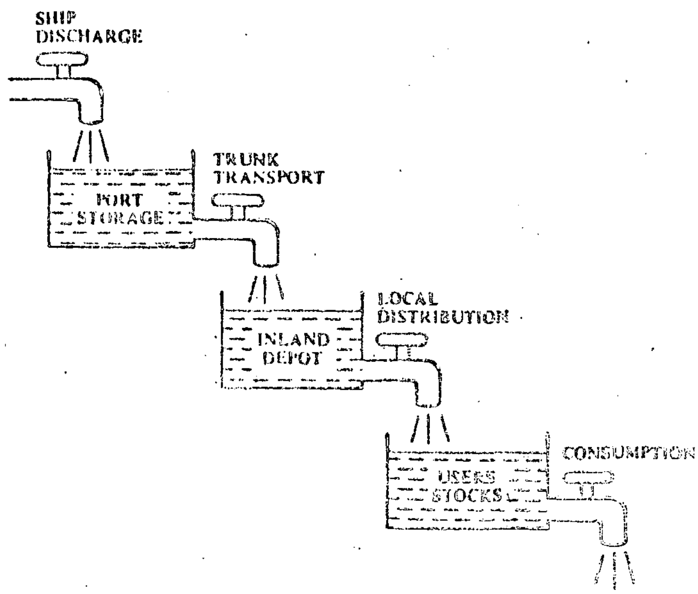
470. In accordance with this figure, if any one of the stores (port storage, inland depot or users' stocks) becomes full, then in the short term the normal solution is to stop the flow into it. This soon causes the preceding store to fill up. As regards the port import storage, port management has difficulty in turning off the ship discharge "tap" when there is a hold-up in the system, and consequently the port feels the overload. In the longer term, the solution may be to increase the size of the inland depots, but there is not often the possibility of increasing the outflow from any store since this would need to be passed down the line and can only end with increased consumption, which is not a transport solution.

471. Such diagrams illustrate the chain reaction principle involved, but in reality there will normally be a branching network of depots and transport connexions, all of which taken together act to clear the port storage, as shown in figure 35. The total tonnage capacity of all these must be made sufficient to handle the total ship discharge rate.

472. In the case of barge transport, there may be the option—particularly if the barges can be manufactured, locally and cheaply—of allowing the barges themselves to act as temporary storage. For export cargoes awaiting ships this can be an economical solution compared with the cost of double handling through export warehouses. This approach is not likely to be possible with road or rail vehicles, where the cost in foreign currency terms is much higher per ton carried.

FIGURE 34

The import flow



B. Trading practices

473. The second "tap" shown in figure 34, which controls the flow of goods out of the port storage, is to some extent under the control of the port management. Import consignments are normally cleared from the port only when:

(*a*) All duties and charges have been paid;

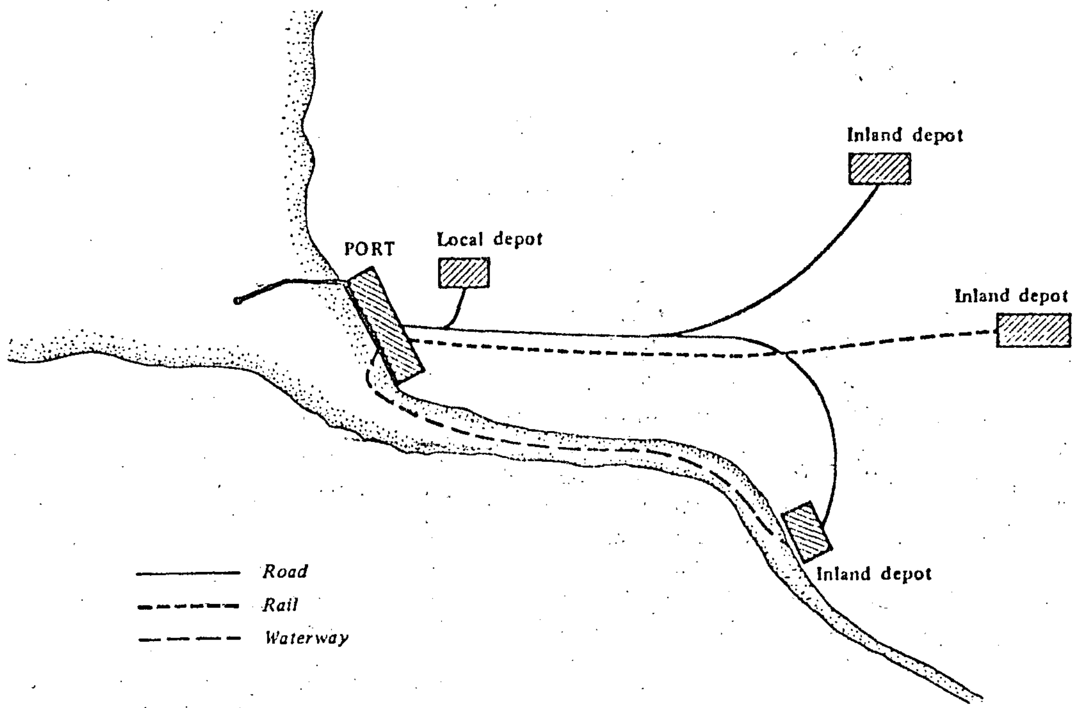
(*b*) Documentary formalities have been completed;

(*c*) Customs clearance has been given;

(*d*) The consignee wants the goods.

FIGURE 35

Inland transportation network



The port development plan should include as one objective the encouragement of better practice in all these matters.

474. Ideally, the physical flow of goods should never be slowed down by delays with respect to finance or paper work. It will be a long time before this ideal can be achieved, but there are several actions that the port and the customs authority can take jointly:

(*a*) Agents can be required to provide a financial guarantee which permits consignments to be cleared before dues are paid. A single monthly invoice can then be sent for payment. The introduction of such guarantees or deposits can also help by limiting the number of such authorized agents and so concentrating the clearance operation in fewer and more efficient hands.

(*b*) A routine organizational study of the flow of documents will often show up possibilities of substantial simplification. Fears of reductions in clerical staff can be to some extent offset by the need to transfer staff to the more useful control function mentioned below.

(*c*) Customs working hours and staffing levels are very often too limited to handle the work smoothly. Steps may be possible either to increase the customs effort or to reduce the workload of customs staff by limiting the sample of goods inspected or opened.

(*d*) Strict enforcement of the regulations concerning the transfer of goods to long-term warehousing after a limited period, with reasonable storage charges in the warehouse, can encourage consignees to clear their goods more quickly from port storage.

475. It is unfortunate that this area of the operation is sometimes subject to malpractices, for example, in the form of illegal payments to ensure priority of completion of the formalities. Managements may need to be vigilant in this respect, and it may be advisable to introduce systematic methods of recording the progress of the consignment documents, either manually or with electronic data processing, purely to avoid such practices. This control function can be an important responsibility of a special department with adequate clerical staffing.

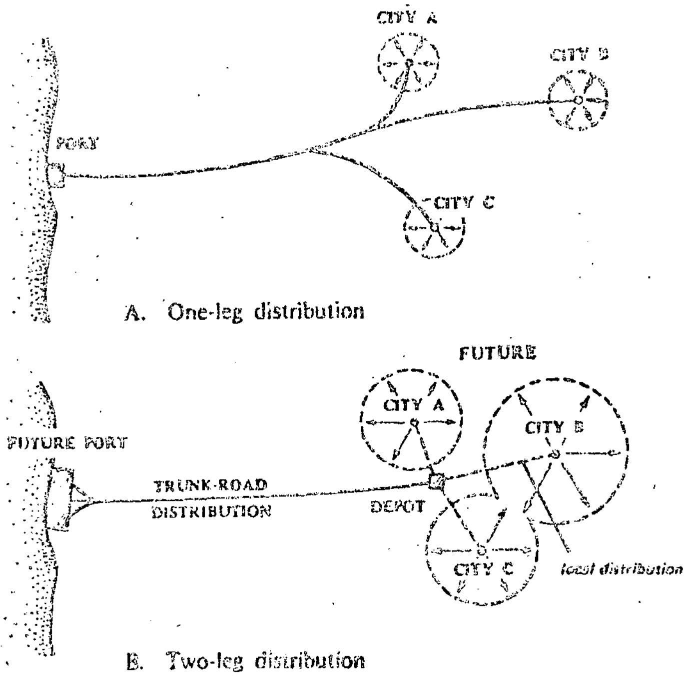
C. Land transport capacity

476. When checking that proper provision is being made for the land transport capacity needed to match the forecast port throughput, the port planner should look both at the vehicle fleet and at the route capacity required. Both of these are heavily dependent on the inland distribution pattern.

477. It is not sufficient to calculate the number and type of vehicles which will be needed per day to bring or take away the daily loading and discharge tonnages. This figure will show what the handling, marshalling and administrative needs are, and are thus a first step in planning the layout. But they give little indication of the transport problem because they leave out the vehicle journey time. For example, to clear 1,000 tons a day to the adjacent city area may call for about 42 local delivery vehicles of eight-ton capacity fitting in an average of three round trips a day, whilst to clear the same 1,000 tons to an inland depot 600 kilometres from the port may call for about

FIGURE 36

The effect of introducing intermediate depots



200 vehicles of 20-ton capacity taking four days to make each round trip. The distribution pattern and the route capacity determine not only the number of vehicles needed but also the type of vehicle and the port handling facilities. The number and type of vehicles should be roughly calculated, and the regional transport planner asked to confirm that provision of the vehicle fleet is included in the regional plan. The daily road, rail and barge traffic forecast for the port and the design surface loadings can also be discussed.

478. When looking several years ahead it should be remembered that the growth in traffic volume combined with the spread of industrial and urban areas are very likely to cause basic changes in the pattern of inland distribution. One of the major effects, which has strong repercussions on the port, is the need to introduce intermediate depots to separate trunk-road transport from local distribution.

479. This effect is illustrated in figure 36. When there is a change from the one-leg pattern to the two-leg pattern the type of vehicle serving the port is likely to increase in size and cost and will therefore demand faster servicing in port to match its shorter journey time in order to reduce unit costs. This is a similar trend to that in shipping.

480. Long routes tend to justify rail transport and in this case an option open to the transport planner is to introduce a third leg which enables the port to load cargo onto road trailers, which are then taken to a rail-head and carried by means of a "piggy-back" or "kangaroo" system using rail flat-cars to the inland depot. In addition, this method removes pressure from the road network. This can be an economical system combining the best characteristics of short-haul road transport and long-haul rail transport. The port sees only the smaller, short-haul trailers, as shown in figure 37.

D. Vehicle access

481. Traditionally, general cargo berths worked a mixture of indirect cargo (via the transit shed) and direct cargo (loaded or discharged direct to or from rail wagon or road vehicle at the ship's side). This suffered from certain drawbacks:

(*a*) The rail and road vehicle movements on the quay interfered with each other and with other operations;

(*b*) The rail track when not recessed caused apron circulation problems which slowed the movement of other vehicles and operating equipment;

(*c*) The rigid planning of vehicle availability at the right time was difficult to maintain so that direct working generally slowed down the ship operation.

482. These problems have led to an approach which, although at first sight it appears restrictive, is

FIGURE 37

Combined road-rail hinterland distribution network

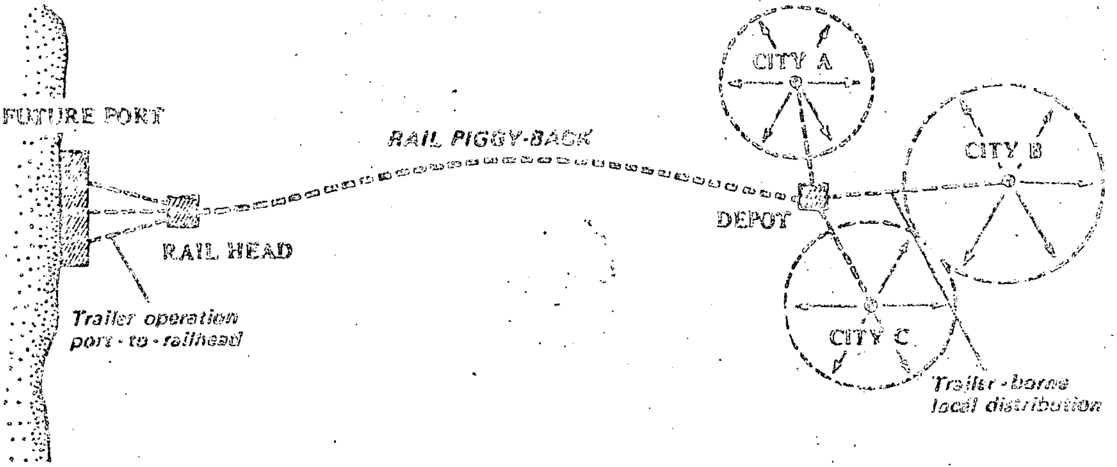
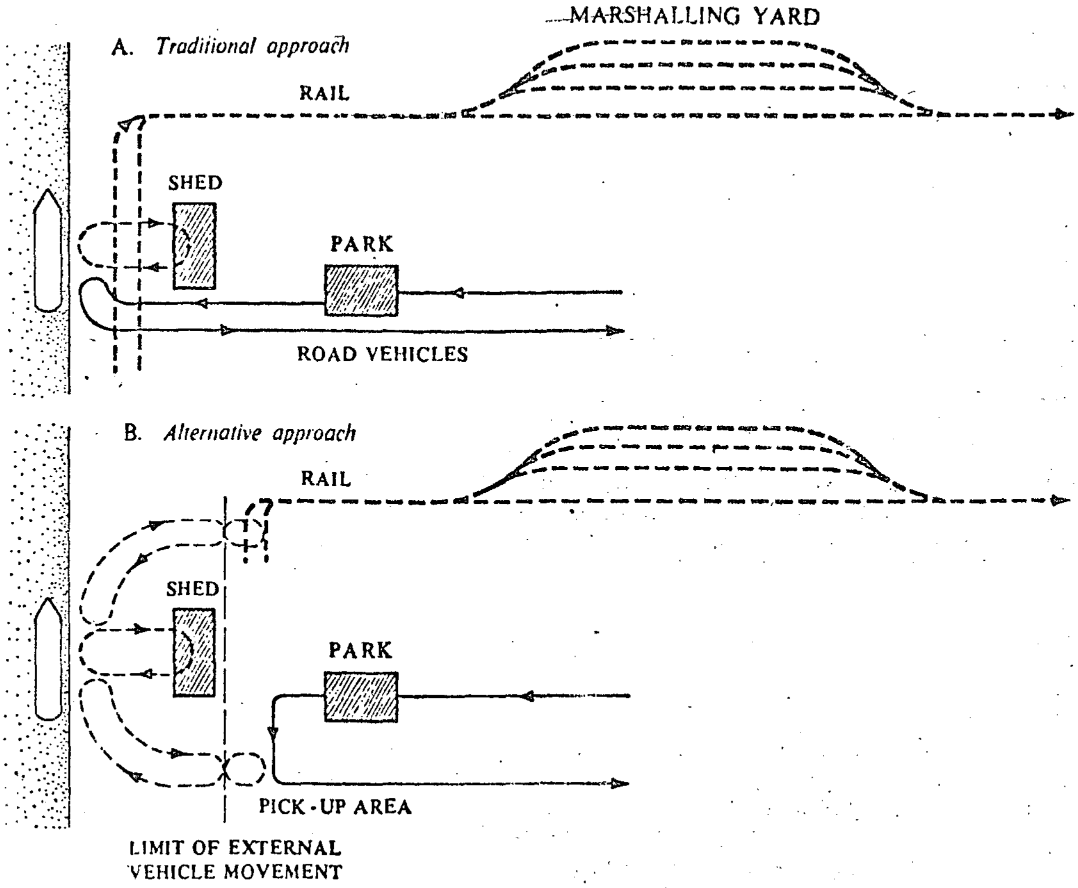


FIGURE 38

Limitation on vehicle access to quay



more flexible and smoother in operation. This is to prevent any external vehicles access to the apron for direct delivery. Through the introduction of a transfer system using, for example, tractors and trailers, to a temporary buffer area at the rail or road pick-up point, direct deliveries are still accommodated. The increased cost for transfer equipment is balanced by the improved working surface of the quay and the reduction in delays to ship working caused by the late arrival of vehicles. For berths dealing with large numbers of heavy loads to be lifted onto or from rail wagons, tracks flush with the apron surface can be utilized. Figure 38 illustrates the two approaches in which the alternative approach has a boundary beyond which external vehicles are not allowed to pass.

483. Another approach is to eliminate direct delivery by working all cargo through enlarged transit storage areas. While this alternative removes the problem caused by delays in the supply of direct delivery vehicles, the area requirements can be significantly increased as the transit time of goods will increase. However, this approach smooths the demand on hinterland transport and thus reduces the size of the vehicle fleet required to service the port.

484. The approaches eliminating direct delivery on the quay introduce double handling, but this cost is generally more than offset by the faster ship turnround and the elimination of rail track, particularly in countries where labour costs are modest. They also introduce the need for additional tractor/trailer units, but these can be of a standard type and they will add flexibility to the operations.

485. In terms of labour requirements, the double handling introduced tends to involve a transfer of men from the quay apron to the transit area, rather than an over-all increase in numbers. Furthermore, the transit area operation can make much better use of the labour since the operation can be closely planned instead of being dependent on improvisation owing to the unpredictable arrival times of vehicles and cargo as in the traditional method.

486. This question of more systematic planning is fundamental to modern operations. Because the ship operation, which involves the need for intense working for short periods is separated from the cargo arrival and delivery operation, the latter can go ahead more steadily, regardless of the peaks of ship demand. This has the important effect of reducing the size of the vehicle fleet required to service the port. In this more stable system, planned operations are possible without undue demands being placed on middle management.

487. There is a residual fraction of cargo on a break-bulk berth which, taken in isolation, would

merit direct delivery either to rail wagon or to truck. Often this requirement can be overcome by resorting to overside operations to lighters. The cargo can then be taken to an older berth with the possibility of direct delivery. When this is not possible, the decision to accept the penalty of not working this cargo directly may be more reasonable than to make a change of system which would place a penalty on all the rest.

E. Through-transport systems

488. The principle of separating the ship operation from the onward transport operation applies with even greater force to container and ro/ro operations. Although it would be attractive to the consignee, the transport vehicle should not be allowed onto the apron to pick up a load. Whether the unit load is for genuine through transport (pallets or a full container load (FCL)) or is a less-than-full container load (LCL) for discharging and re-routing in a container freight station, the transfer to and from the apron must be carried out under full port control using port vehicles—normally chassis, semi-trailers or straddle carriers.

489. In a new development there will be the opportunity to take this principle further and remove the container freight station from the port area to a point better situated for distribution to the urban area, thus freeing valuable port land, as illustrated in figure 39. This applies particularly when the development is for a traditional city port. When the proposal concerns the establishment of a new port it is likely that the port will in any case be located away from urban development so that the container freight station can again be located in the port area.

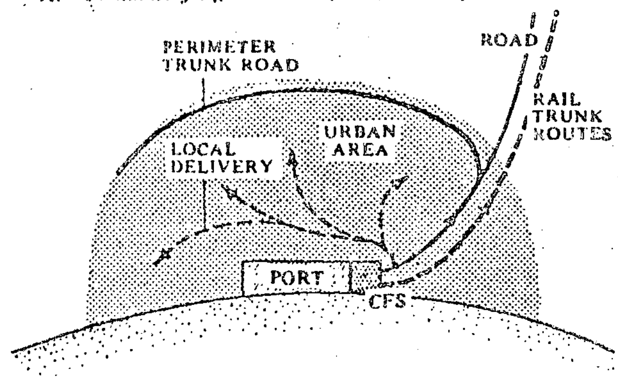
490. In the ideal through-transport arrangement, the port has no role as a storage or sorting point and is concerned only with the transfer of unit loads from one vehicle to another. All formalities can then be completed away from the port area, at a clearance depot inland, as close as possible to the final consignees. In practice this ideal is rarely attainable in developing countries, since the proportion of FCL's is low, and traditional commercial practices often demand re-consignment at the port, even for on-going FCL's. Even when an inland clearance depot is set up, it may be difficult to persuade agents to transfer their offices from the port, and it will also be necessary to solve the labour problems which arise from conversion of stevedores into inland clearance depot staff.

491. One specific type of development can readily use the inland clearance depot concept. This is where the coastal region is not a centre of production or consumption, so that the port's role is purely that of a staging-point en route to an inland region. In that case there will be many advantages in transferring as much of the operation to the inland point as possible, particularly when the coastal climate is adverse.

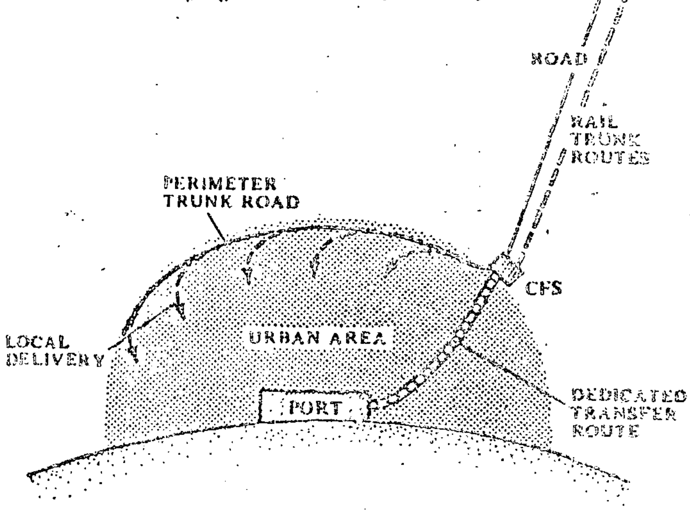
FIGURE 39

Comparison of locating container freight station within port area or outside it

A. *Container freight station (CFS) within port area*



B. *Container freight station (CFS) outside port area*



F. Technical specifications

492. The warnings on the danger of accepting manufacturers' claims without careful study of local technical requirements, which are given in other chapters, apply equally to land transport vehicles. There have been serious problems caused by purchases of vehicles unsuitable for the local climate, terrain and road surfacing. For example, roads in many developing countries necessitate stronger suspension if trucks are to operate without excessive breakdowns. In any case, the shortage of maintenance facilities on a long route can justify the setting up of a series of special roadside maintenance depots and a co-ordinating organization to control them.

493. In the case of rail, the future freight train is likely to be heavier and faster. Existing rolling-stock may need replacement, track may need upgrading and locomotives will need to be substantially more powerful. The port planner should ascertain whether appropriate specialist advice has been obtained in order to ensure that the design port loadings are accurate.

G. Information systems

494. The co-ordination of inland transport movements with consignment movements within the port area and with ship operations can be a difficult task. To keep down the cost of tying up expensive vehicles, to speed the movement of cargo, and to make good use of port storage, it is advisable to give special attention to the method of transferring information about cargo bookings, transport loading and ship itineraries. The establishment of a vehicle movement information centre at the port can be a valuable means of improving the road/sea co-ordination.

495. Where the road vehicles are in short supply, or where there is limited parking space, useful gains can be made by setting up a vehicle booking centre. This can be an office with sufficient telephone facilities to permit operation of an appointments system whereby hauliers collect specific consignments during specific time-slots, so that waiting is minimized. Priority in entering the berth area is then given to trucks arriving within the appointed time-slot (e.g. a half-hour period).

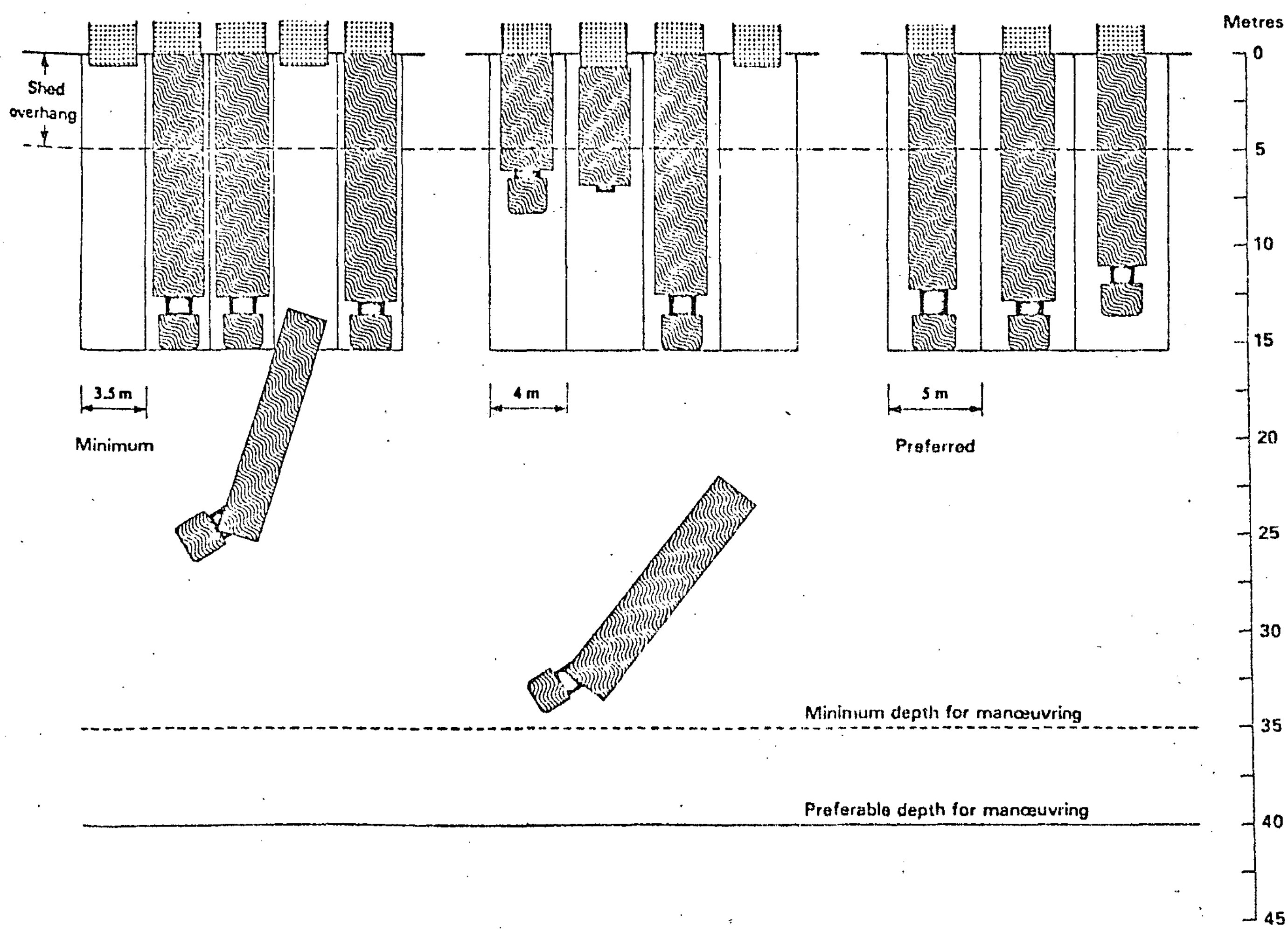
H. Port access gates

496. It will normally be fully justified, to help in reducing the cost of pilferage and major thefts, to provide a substantial security fence plus a patrolling security service under port authority control. The number of access gates should be reduced to the minimum and a rigorous gate pass system should be imposed. Staffing of the gate-house should be adequate to provide several parallel check-out points, sufficient to keep vehicles moving without too much interruption while exit permits are checked. In case of justified suspicion or improper loading, the vehicle should be removed from the exit into a special bay foreseen for this purpose next to the gate. Here the vehicle may be closely inspected or reloaded without impeding the movements of other trucks. A separate gate may be provided for the entry and exit of empty vehicles and private cars.

I. Loading bays

497. Loading bays provide a covered transfer area where goods requiring covered storage are loaded on-

FIGURE 40
Loading bay configuration for road transport



to or unloaded from road vehicles. A sufficient number of loading bays should be provided to handle peak traffic flows, and loading bays should be adaptable to future conditions. The covered storage should have an overhang of about 5 metres to allow work to proceed during bad weather. The bays require a separate approach road within the site area, a marshalling area where trucks assemble before moving into the loading bay position, and a truck parking area or a secondary manoeuvring area for trucks to wait prior to being directed to specific loading bays. The parking areas should be supervised by a traffic office and be used for trucks waiting for document processing.

498. Raised platforms are very useful and should be used in conjunction with a platform levelling device, as truck bed heights vary from type to type and between unloaded and laden conditions. Figure 40 illustrates typical raised loading bay layouts for 15-metre articulated vehicles. The additional 5 metres recommended in the depth of the marshalling area permits accelerated manoeuvring by allowing articulated vehicles to pass each other.

J. Platform levellers

499. The correct choice and application of a platform levelling device is necessary for efficient operation. The proper choice will increase the numbers of vehicles handled and the pallet and fork-lift truck battery life, and reduce operating equipment tyre bills. The length of the platform leveller plate depends on the height differential between the vehicle and the platform. The gradient should never exceed 1 in 10. The leveller should be 1.8 to 2.1 m. wide and have a non-skid surface. There is a large variety of platform levellers on the market, and expert advice should be obtained when making a selection.

K. Industrial doors

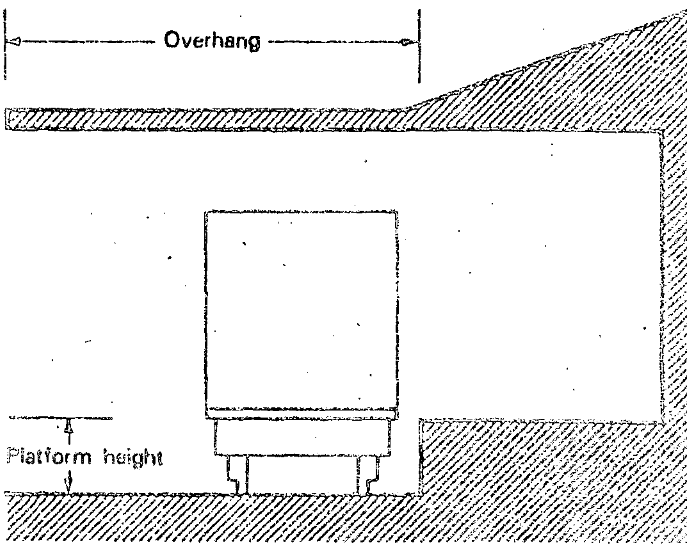
500. In addition to providing access to storage buildings, doors have to provide security and weather protection. They can be sliding, sliding-folding or vertical rolling and are normally made of steel, aluminium or timber. For power-operated doors, manual provision for operation should be provided in case of power cuts.

L. Rail loading bays

501. Where possible, loading bays should be constructed so that either road or rail vehicles can be used, for example by recessing the rail tracks to create a flush surface and allowing sufficient clearance for rail wagons beneath the shed overhang. If this approach is not possible, part of the transit shed loading bays will have to be dedicated to rail traffic. The local rail authorities should be requested to supply the information necessary for the designing of the platform. An overhang should also be provided to minimize delays due to inclement weather. Levelling devices should be used to adjust for variation between wagon platform heights. A typical rail loading platform is shown in figure 41.

FIGURE 41

Typical rail loading platform



Chapter VIII

MAINTENANCE AND EQUIPMENT POLICY

A. General considerations

502. The standard of maintenance in ports must keep pace with the demands of modern plant and equipment. There are few ports in developing countries which have managed to avoid accumulating a permanent pool of equipment awaiting repair. In some cases the reactivation of such equipment would give the biggest single gain in performance that management could achieve.

503. Good maintenance is not cheap, and needs to be considered at the planning stage. Substantial sums need to be provided for workshops, for spare parts, and for on-going maintenance. This is an extra expense but a necessary investment if the port is to function properly.

504. The care of civil engineering structures as well as of buildings and equipment, both fixed and mobile, must be considered. The various kinds of modern handling equipment used in ports, and particularly the larger items, are naturally expensive, and the desire to minimize capital outlay often results in insufficient consideration being given to maintenance costs and to the advantages of the standardization of equipment. Thus, designers are being pressed to design equipment for the lowest first cost, with insufficient emphasis on the costs of maintenance, and port engineers are under pressure to select the equipment with the lowest purchase price. Only by considering all the costs over the life of the equipment can the most economic selection be made.

505. Some of the mobile equipment used in ports is designed for use in the construction industry. The manufacturer tends to design for that industry's needs, producing equipment which can be used reliably and intensively (provided it is regularly maintained) for a short life before being jettisoned. Similarly, in the freight transport industry, trucks are frequently written off after as little as three years' intensive use. It is too optimistic to expect that, in ports in developing countries often far distant from the manufacturer's supporting services, and often in a more testing tropical environment, items of mobile equipment can be kept going for ten years or more. In the absence of experience to the contrary, ten years can be taken as the maximum useful life of much of the port's plant, while for more sensitive mobile equipment, such as fork-lift trucks, the maximum useful life is about five years only. For example, as regards fork-lift trucks, one port operator in a developing country experienced some 45 per cent down-time and in some areas of the port found it necessary to keep a complete second set of vehicles as spares. The average life of a unit was only two years. In this particular instance the fork-lift trucks spent a considerable proportion of their time travelling with their loads to and from the storage area.

506. There are two alternative policies for equipment selection: either ports must, as suggested above, accept short-life equipment and make regular provision of its replacement, or they must demand more robust and long-lived equipment for their own special needs. It is noteworthy that certain major European ports insist on the special strengthening and redesign of equipment to suit their own needs, and do not normally accept standard models. Ports that need only a limited amount of equipment or do not possess the necessary expertise are strongly advised to call in a specialist mechanical engineer who has spent many years in the maintenance of port equipment.

507. Among the factors to be taken into account in selecting equipment are the following:

(*a*) The demands that will be placed on the equipment in terms of utilization;

(*b*) The standard of driver training;

(*c*) The possibility of buying robustness by using equipment of a higher rating than the job would otherwise demand;

(*d*) The general ease of maintenance;

(*e*) The choice of a design appropriate to low labour cost and high cost of foreign exchange, whenever possible; for example, traditional bearings fitted with a grease nipple may be preferable to sealed prepackaged bearings which, although they need no regular greasing, have to be renewed every year.

508. On large items of specialist equipment such as shiploaders and unloaders, together with their associated extensive conveyor systems, provision must be made for preventive maintenance to be carried out on an inspection basis. For example, once it is decided what needs to be inspected and at what frequency, a definite sequence for the inspections must be established. Any corrective attention needed should be given by the inspector concerned during the shutdown period, or, where there is duplicate equipment, when the standby equipment is running. Any equip-

ment needing major repair should be removed to the workshops and a complete spare unit should be available for fitting into position. Another form of preventive maintenance which has been used is a replacement policy. A decision is taken from previous records on the length of economic life of all parts subject to wear, and they are replaced when they reach that age, irrespective of apparent condition. For example, it may be considered more economical to replace all the lighting lamps at once rather than having an electrician on constant patrol to replace faulty lamps. It may similarly be considered better to replace all fuses after a certain period of time has elapsed.

509. On mobile equipment, preventive maintenance takes the form of a regular servicing schedule. Spare units have to be provided in order that a complete unit can be taken out of service while it is still working and inspected under ideal conditions in a properly equipped workshop. Broadly speaking, the maintenance of mobile equipment falls under the following three headings:

(*a*) Lubrication and cleaning, to prevent wear and corrosion;

(*b*) Adjustment, to keep the equipment in the condition for which it was designed;

(*c*) Checking, to replace worn components before they fail.

B. The central workshop

510. As major repairs and overhauls will have to be made to a wide variety of equipment, the central port workshop will require layout planning in order that work can be completed and equipment returned to service with the minimum delay. A few salient points should be noted. For example, the workshop should be divided into mechanical and electrical sections and, when sophisticated equipment is beginning to be used, a small specialist electronics section. The mechanical section should include some provision for the fabrication of light structural steelwork, pipework and plating. The main bay should have several entrances and be serviced by an overhead travelling crane of a capacity to suit the largest piece of machinery to be handled. An adequate area for benchwork should be provided, with easy access to the main bay but not covered by the overhead crane. In addition, the following will be needed:

(*a*) Sets of special tools for each range of equipment to be serviced;

(*b*) A separate machine-shop with adequate lifting appliances, with at least one lathe being able to turn the largest component;

(*c*) A separate section to deal with mobile equipment, with inspection pits and hydraulic lifts;

(*d*) An area with the appropriate equipment for the testing and certification of ropes, wires, slings, etc.;

(*e*) An outside bay for the cleaning-down of pieces of equipment before they enter the shops;

(*f*) An adequate central store for all sections, controlled by a trained stores supervisor familiar with the principles of stock control and replenishment;

(*g*) Separate sections, with air conditioning, for the maintenance of fuel injection equipment for the diesel engines, and a battery room for the maintenance of batteries for fork-lift trucks;

(*h*) Administration offices with provision for the control of plant maintenance by means of modern wall charts and a card index.

511. The over-all cost of equipping such a central workshop (excluding the cost of buildings) is likely to be in the range of $2-5 million. Sufficient funds should be provided for during the funding phase of the development project.

C. Guidelines for estimating maintenance costs for mobile equipment

512. Table 8 sets out approximate annual maintenance costs as a percentage of the equipment purchase price for a range of equipment based on European experience. Half of these costs in Europe represent the cost of highly-trained labour. Ports in developing countries will need to alter the labour cost element as appropriate, from the base used, namely $7 per hour (1973) for skilled electricians and mechanics, and to increase the amount budgeted for spare parts to include freight costs and to take account of the possibility of more rapid replacement in the local environment.

TABLE 8

Maintenance cost for mobile equipment: values adopted for estimating purposes

Type of equipment	*Annual maintenance cost (1973) as a percentage of purchase price*
Container crane	5
3/5-ton quay crane (rail-mounted)	5
Mobile crane (10 tons at 20 m)	8
Mobile crane (25 tons at 25 m)	10
Straddle carrier	12
Fork-lift truck (20-ton)	8
Fork-lift truck (5-ton)	14
Road tractor	10
Trailer	3

Source: Paper on "Problèmes de manutention portuaire" presented by CERLIC (Compagnie d'Etudes et de Recherches de Logistique Industrielle et Commerciale) to the second UNCTAD/SIDA Port Training Course held at Algiers in 1973.

D. Spare parts provision

513. The provision of an adequate store of spare parts is an essential part of a port investment proposal and must on no account be the place for budget economies. The initial problem is to decide what

spare parts are needed bearing in mind that delivery delays and difficulties in securing foreign exchange at a later date might jeopardize port efficiency. Manufacturers' lists can be very misleading and, if possible, guidance from other ports using the equipment in similar conditions should be sought. Generally the user decides, from the lists provided and from previous experience, for how much of the equipment he should provide spare parts. The consumption rate under local conditions may be substantially higher than that foreseen by the manufacturer, but there will rarely be adequate local records to prove this. Where possible, the standardization of components will reduce the multiplicity of spare parts required for different machines. For example, the use of a standard range of electric motors, gear-boxes or fluid couplings will reduce considerably the number of different spare parts to be carried.

514. The type of component used can have a marked effect on the ratio of labour costs and spare parts costs, since the use of alternative designs for the same component can lead either to a throw-away policy, with consequent heavy foreign exchange costs, or to a virtually indefinite life, local labour stripping and overhauling, with simple local manufacture of parts.

E. Maintenance manuals

515. In a number of cases, the maintenance manual provided by the manufacturer will be insufficiently detailed. This is a result of the pressure to keep prices to a minimum, since such manuals can be very expensive to prepare. It would be wrong to demand too detailed information if the cost of this is going to be added to the purchase price. Nevertheless the following information should be provided, whether or not it is published formally in a manual:

(*a*) Operating instructions;

(*b*) Servicing schedules and required repair standards;

(*c*) Spare parts lists, with identifying illustrations;

(*d*) Sets of drawings, especially of parts subject to wear that may be manufactured on site, for example, renewable liner plates for shiploader chutes;

(*e*) Specifications for any special tools and jigs required for maintenance purposes.

F. Training

516. It is common practice to stipulate in the contract for the purchase of equipment a period of operator training by the suppliers' staff. However, the question of the training of maintenance personnel in the suppliers' workshops using the special tools to be provided is often overlooked. This provision should be written into the contract where appropriate. Training throughout the guarantee period (one to two years) is useful in order to form a sound base of skilled staff. Trainees should be bound to a contract for a period of time in order to retain their services in the port.

G. Defect reporting

517. It is advisable to set up a simple clerical system for recording each fault that occurs, to be used for estimating maintenance costs and future spare parts provision, and for judging the comparative performance of equipment of different makes and design. The report should come both from operators and from workshops, and should be regularly reviewed to determine areas of design weakness which may require action by management and may be considered in future development.

H. Maintenance of structures

518. While breakdowns in mechanical equipment or electricity supply and the deterioration of roads and buildings will be evident, the need for maintenance of the basic breakwater, wharf and jetty structures is less noticeable but no less important. Although there are many years' experience in many ports, there is a surprising shortage of reliable cost data on port structure maintenance. Yet a realistic estimate of maintenance costs is essential to complete the economic and financial appraisals of a proposed port project.

519. As part of the design studies the engineer should consider the manner and cost of any necessary structural maintenance in future years. Although a large civil engineering project can accept a high level of technology in its capital investment phase, this is not the case during its later life when maintenance and repair have to be done with local facilities.

520. Similarly, a structure of a certain design may involve less capital cost but require more maintenance with a resulting increased over-all operating cost. In theory, alternatives can be evaluated on an economic basis. In practice, however, such calculations are bound to be imprecise. Therefore, the selection of the appropriate design and provision for future maintenance is a question of judgement, in which both engineer and port management must co-operate.

521. As a guide, table 9 gives suggested percentages of capital cost which should be allowed in estimates for yearly maintenance during the whole economic life of the facilities. These are very general figures and should be used only in the absence of local information.

522. The arrangements for the maintenance of port structures would normally be under the direction of the engineering department of the port authority. In some places it is found convenient to include such work in the general responsibilities of a local

engineering or public works department which is responsible for other civil engineering maintenance in the area. The precise arrangement is a matter for local decision but in any case an adequate maintenance fund is needed and table 9 indicates the order of magnitude of finance which should be made available.

TABLE 9

Maintenance costs for structural elements: values adopted for estimating purposes

Class of structure and type	*Annual average maintenance costs as a percentage of current new cost or replacement value*
Quay structures	
Steel sheet piling	0.30
Steel piling with reinforced concrete deck	1.00
Reinforced concrete piles and deck	0.75
Rubber fendering	1.00
Embankments	
Rockfill	0.75
Surfacing	
Concrete aprons or roads	1.00
Asphalt	1.50
Other surfaces (gravel, etc.)	7.50
Breakwater	2.00

523. A most important feature of maintenance is regular inspection and reporting, upon which a routine maintenance system can be built up, so that structures are kept in good repair rather than allowed to deteriorate for a long period. Accidents should be dealt with immediately and here prompt reporting is essential, to allow dangerous conditions to be removed and clearly to establish financial responsibility.

524. Most reinforced concrete structures will not need maintenance until deterioration may be observed in the form of slight cracking. Cracks, other than hair-line cracks, should be sealed immediately to prevent the ingress of moisture and rusting of reinforcement.

525. Steel structures, on the other hand, normally require regular maintenance, particularly in the moist, salt-laden air prevalent at most ports. A steel structure exposed to a marine environment is subjected to corrosion which can seriously affect its structural integrity. Paint systems are used in many places, and recent research has resulted in many proprietory products with excellent protective properties. Nevertheless, paint systems deteriorate and suffer damage and are very difficult to maintain in first-class condition, particularly under water.

526. An alternative is to design the structure taking into account a rate of corrosion based on previous experience. If an additional steel thickness is provided at the outset, sufficient metal remains after some years of corrosion (say a 40-year design life) to carry working loads without excess stress. As steel corrosion in a marine environment is an electrochemical process, special steels with copper additives have also been used, in order to reduce corrosion. An alternative method is cathodic protection, whereby a sacrificial anode, normally zinc, is positioned on or near the structure so that the iron in the structure becomes cathodic and does not corrode. A second approach is to use a continuous electric current to maintain a potential difference between the structure and a separate anode.

527. The general quay fittings such as fenders, ladders and mooring rings, and the service facilities at the berth, require regular inspection; fenders, particularly, need to be replaced as soon as any damage or serious wear has occurred. Spare fittings are normally kept in the port authority's store, ready for immediate use when required.

I. Equipment replacement

528. Equipment replacement may be needed on two accounts: gradual deterioration or obsolescence, and sudden failure. Generally, port equipment falls in the first class and the problem consists of balancing the cost of new equipment against the rising cost of maintaining efficiency on the old. There is an age at

TABLE 10

Average length of economic life for port facilities and equipment

Facilities and equipment	*Average economic life (Years)*
Breakwaters	50
Wharfs:	
Concrete	40
Steel	25
Rubber fenders	10
Tugs	20
Pilot launches	20
Warehouses and sheds	25
Cranes:	
Grabbing	20
Quay	20
Gantry	15
Mobile	8
Mobile tower	15
Floating	20
Ship-loaders	25
Stackers and reclaimers	25
Belt conveyors	20
Belts	3[a]
Idlers	7
Mobile mechanical shovels	6
Straddle-carriers	6
Tractors and trailers	8
Ro/ro ramps	15
Fork-lift trucks	8
Dump trucks	6

Source: Based on data collected by the UNCTAD secretariat.

[a] Normally replaced in sections on a regular schedule.

which the replacement of old equipment is more economical than continuation at the increased operating cost. The problem for management is to determine a replacement policy such that the saving in operating costs resulting from the use of new equipment more than compensates for the initial cost of that equipment. There is no general solution to this problem but, given satisfactory cost information, techniques have been developed to assist management in choosing the appropriate point in time at which to replace equipment. The procedure consists of determining the economic life for each type of equipment. The minimum cost solution is a starting-point, but it will be necessary to depart from this when the march of technology makes equipment obsolete for reasons other than the cost of maintaining it. Moreover, before placing an order for new equipment, it is wise to check:

(*a*) Whether improved equipment is available;

(*b*) Whether the opportunity can be taken to reduce the variety of types of equipment operating in the port.

529. For the purpose of comparing alternative replacement policies, the discounted value of all future costs associated with each policy should ideally be known, if such costs change with the age of the machine or, in the case of selecting between two machines, if they differ between machines. Future costs include labour, power, maintenance, and down-time costs. Care must be taken, however, to exclude from each year's maintenance costs the cost of repairs due to accidental damage since these are largely independent of age and are not relevant for economic life calculations.

530. A satisfactory replacement policy based on historical cost records is one that replaces the equipment if the cost of replacing every $n+1$ years is greater than the cost of replacing every n years. The mathematical basis for this policy and a numerical example are given in annex II, section F.

J. Guidelines for economic life

531. Setting aside the question of genuine technical obsolescence mentioned above, guidelines can be given on the appropriate economic life, for use when data on maintenance cost trends are not available. Table 10 gives a set of figures for a range of equipment. These figures are basically derived from European experience, but they are broadly applicable to developing countries since the longer life justified by the lower labour cost is offset by the generally more intensive use under more arduous climatic conditions.

Part Two

Chapter I

TERMINAL PLANNING CONSIDERATIONS

A. The changing pattern

1. Before setting out to plan the future terminals and groups of berths, the port planner must have a clear view of the stages of development which a port normally goes through, and of the particular stage which his own port has reached. Five phases of development are shown in figure 1 but other patterns of development may also exist. In very rough terms, the blocks in these diagrams represent, in width, the number of facilities or length of quay wall and, in height, the annual throughput of each.

(a) *Phase 1:* Traditional

A group of general-purpose berths handling a mixture of break-bulk general cargo plus bulk shipments of commodities in packaged form (e.g. part-loads of wheat in bags, or of oil in drums) or in loose form that are packaged in the hold.

(b) *Phase 2:* Bulking of dry cargo

When quantities of the bulk shipments grow to an economical level, they are carried loose in bulk carriers, for which the port has to provide a separate dry bulk terminal. At the same time the break-bulk facilities have to be expanded to handle increased general cargo traffic.

(c) *Phase 3:* Advent of unit loads

When unit loads such as pallets, containers or packaged timber begin to arrive at a port they are in small numbers and are carried on conventional ships. At the same time, the volume of break-bulk cargo begins to decline, and the volume of dry bulk cargoes reaches the point where separate terminals are needed for different classes of material.

(d) *Phase 4:* Transitional multi-purpose terminal

With increasing volumes of unit loads, including the arrival of the first cellular container ships, special unit load facilities are needed. But since the way in which the traffic will develop is still uncertain, a flexible and adaptable multi-purpose terminal is needed which replaces part of the old break-bulk berths. Meanwhile dry bulk continues to grow and diversify even though several different classes of material can be handled on a multi-purpose bulk terminal.

(e) *Phase 5:* Specialized

Although in the case of a developing country it may take a long time, the specialization of forms of carriage is an inevitable process and eventually the volumes in each of several specialized forms of unit load traffic such as containers, packaged timber and ro/ro, will grow to the point where they need separate terminals. A phase-4 multi-purpose terminal can easily be converted into a specialized terminal through the provision of additional and slightly different equipment. By the time this phase is reached, the residual break-bulk volume will have shrunk considerably and older facilities for this type of traffic will have been closed down.

2. It is important to note that experience in recent years has shown that attempting to go direct from phase 3 to phase 5 can give serious financial problems unless transition to specialized traffic is quite definite and proceeding at a rapid pace. Investment in a special-purpose terminal before the pattern of traffic has developed sufficiently means not only under-utilization but also a high risk of built-in obsolescence. Another form of obsolescence which mistaken investment can produce is the continued building of conventional break-bulk berths after a port has moved into phase 3.

B. Study of existing port facilities

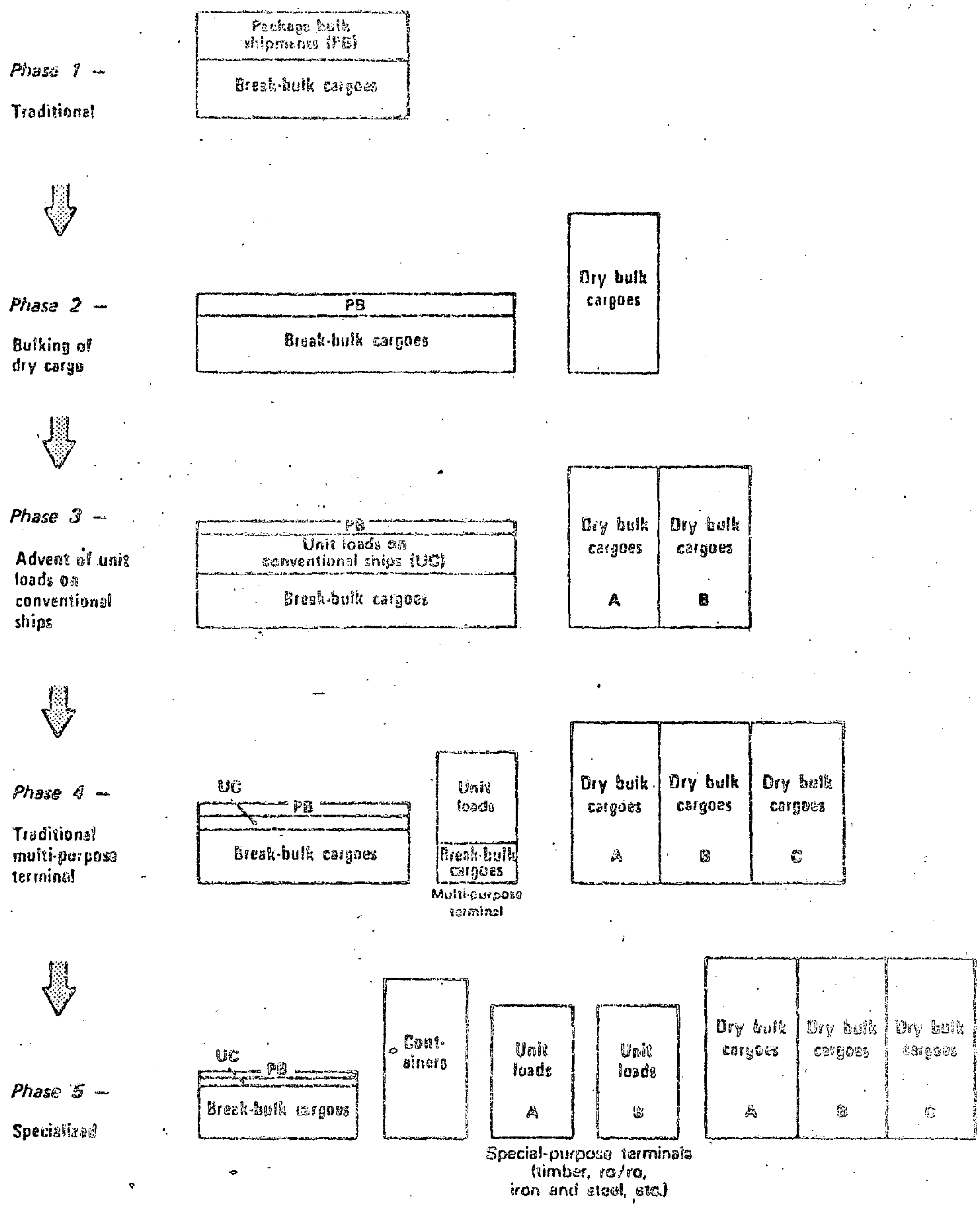
3. Port development projects can be roughly divided into two categories: the building of an entirely new port or of a major specialized terminal in a new location, or—a much more frequent case—a major extension of an existing port. In both cases, a necessary step is to study the port facilities that already exist in order to determine their real capacity and to find out possible deficiences in their design and use.

4. The first aim of the study is to see whether a part of the expected increase in demand could be met simply by a better organization of the existing port facilities and minor technical changes or additions. The second aim is to gather information on probable conditions under which the new berth groups or terminals will have to be operated and to bring to light mistakes in previous design to be avoided.

5. However, the findings of the investigating team need to be treated with caution. The future traffic mix and technological conditions may be very different, and a theoretical possibility of increasing the capacity of older installations may prove difficult to

FIGURE 1

Phases of transition of a growing port



achieve in practice. It might be safer to consider the potential and unused capacity of an existing facility as a kind of safety valve to be used for coping with peaks of traffic or sudden increases in demand. These principles are discussed in part one, chapter II.

6. The critical analysis of the performance at existing port facilities must be made separately for each group of berths or specialized terminals. The zone for general cargo is the obvious candidate for the start of the analysis.

C. General cargo berth group

7. The work of the investigating team must beg with an examination of port statistics in order to d termine how much cargo has been handled on t berths under study and what was the mix of the ca go, whether predominantly general cargo in brea bulk form, or a sizable proportion of bagged goo (sugar, rice, flour, etc.), or increasing quantities unitized consignments (packaged timber and ste and containers which may require special faciliti

8. A review of the statistics will allow the team to determine what phase of traffic development the general cargo zone has reached, and whether port extension plans should provide for the construction of additional conventional general cargo berths, or a multipurpose terminal, or whether traffic increases and technological changes have been so rapid that the time is ripe for the construction of specialized terminals for containers and dry bulk cargoes.

9. Statistical figures will also give a first approximation as to whether the actual throughput has amounted to a reasonable proportion of the estimated capacity of the berth group. Approximate figures rather than accurate calculations of berth capacity are needed at this stage. In most developing countries a throughput of about 100,000 tons a year at a berth with a predominant proportion of break-bulk cargo can be obtained without unacceptable waiting times for vessels. When bagged cargoes and some unitized cargoes account for 30 or 40 per cent of the total, higher throughputs of up to 150,000 tons can be reached.

10. If the actual performance at the berth group has been drastically below the approximate figures and yet there have been periods during the year when ships have had to wait for a berth, this would indicate that serious deficiencies must exist, either in the way the general cargo zone is managed, operated and equipped, or in the design and layout of facilities. The duty of the team will be to scrutinize carefully all sources of delay and to find the reasons.

11. The findings of the investigating team should be examined with a view to determining the best way of co-ordinating the planned new facilities with the existing group of berths. The possibility of activating any unused olders installations in full or in part should be assessed. A preliminary decision should be taken as to whether the prevailing trend towards a gradual increase in unit loads and containers would justify the construction of conventional berths or of multi-purpose terminals or even of a specialized container terminal. All conclusions will have a tentative character at this stage but they may help to put the port extension problem in a proper perspective and to indicate points which should be analysed with particular care during the main phase of port planning.

D. Bulk cargo terminals

12. The procedure for the examination of existing bulk cargo terminals is very different from that for the examination of general cargo berths, but the aims are basically the same: to find out whether there is a substantial unused capacity and to detect mistakes in planning and operating the terminal.

13. Terminals for the export of mineral ores most frequently require a considerable increase in the yearly capacity owing to the rapid development of mining and to the discovery of new deposits. The first important question facing port planners will be whether to build a new terminal or whether the existing one can be expanded sufficiently without a long-lasting interruption of traffic. This question and the experience gained so far in operating the terminal should be the subject of thorough examination as a first step towards actual planning. Attention should be focused on the following points:

(*a*) Was the existing terminal planned in advance for considerable extension in case of need, and if so, was the procedure for extension properly documented?

(*b*) Are all phases of operations at the terminal sufficiently co-ordinated? If not, where are the points of bottle-necks and what exactly is their cause?

(*c*) Is the size of the stock of cargo for loading in proper proportion to the volume of traffic? Has it happened that no cargo was available for loading upon the arrival of a vessel?

(*d*) Have the means of inland transport been adequate for the present traffic and suitable for a radical increase of capacity within the same system of transport, by road or rail?

(*e*) Have the dust-collecting and anti-pollution measures worked in a satisfactory way?

14. Such a thorough examination of existing port facilities is an indispensable preliminary step to planning a major port extension. Time spent on this task can save much time during the main planning phase and reduce the number of alternatives to be closely studied to a manageable level.

Chapter II

THE BREAK-BULK BERTH GROUP

A. Need *for* break-bulk berths

15. Some ports in developing countries, particularly the smaller ports, may still be in the initial phase of development. For these countries it is possible that conventional break-bulk traffic will continue to grow for 10 years or more, thus justifying the building of additional traditional berths. In any case, there will be a substantial residue of break-bulk cargo passing through ports in developing countries for several decades at least, and old facilities will need improving or renewing. For all these reasons, port planners will still be faced with the planning and design of the break-bulk berth group. Ports which conclude that there is no longer such a need should refer to the chapters on the multi-purpose terminal and the container terminal. In many rapidly developing ports there might be a need for both specialized terminals and conventional break-bulk berths. The latter should be planned for easy conversion to special uses.

B. The berth group

16. The term "berth group" has been used deliberately for break-bulk facilities, for the following reason. The planning of port capacity must always be on the basis of the set of berthing-points which share the same stream of traffic. When several different berthing areas can all deal with the same kinds of traffic, then—provided ships can be equally serviced in each area—there is a disadvantage in restricting a group of ships to one area. This is because splitting a stream of traffic into several separate streams (say, according to region of origin) destroys the smoothing effect of the possibility of allocating ships to berths over the whole berth group in a co-ordinated way, and leads to longer waiting-times. The way in which ports have grown has often led to there being several distinct wharves or basins which together form the facilities available for break-bulk cargo operations. It is the totality of these facilities which forms the break-bulk berth group for which the planning procedure is given in this chapter.

17. Where the operational staff send some of the ships in the break-bulk traffic stream to one berthing area and the rest to another, without considering the status of the two areas, then this should be treated as two traffic streams and two separate berth groups. Separate traffic statistics, forecasts and capacity calculations should be made. This happens when there are two berthing areas of substantially different depth and as a matter of routine deep-draught and shallow-draught ships are berthed accordingly. The management information system should distinguish between these two traffic classes. Another example may be where a particular berthing area is dedicated to ships on a given trade-route or conference. For operational purposes it must be accepted that such berthing policies are seldom rigid and the segregation policy will sometimes be broken according to the daily berthing situation. However, in spite of this, it is better to plan the facilities separately.

18. A particular berth group may have a mixture of facilities with markedly different productivities serving a single traffic stream. The best policy will be to use the more productive facilities in preference to the less productive ones. This policy will then make the average productivity per ship dependent on berth utilization. Thus, with low berth utilization, i.e. only the more productive berths in use, the average daily production per ship will be higher than when all the berths are occupied and less productive facilities also are being used. It is not likely to be worthwhile to try to estimate the over-all productivity by weighting according to the probability of use of individual facilities. The simple average productivity of the mixed group, although slightly pessimistic, is fully appropriate for planning purposes.

C. Economy of scale and berth occupancy

19. The combining of the berthing plans for small, physically distinct groups of berths into one berthing plan for the stream of traffic results in a reduction in ship waiting time. The greater risk of queueing when groups of berths are treated independently arises as a result of the possibility of a ship having to queue for a berth in one group at a time when there is actually a vacant berth in another group. A numerical example will show the significant advantage of a joint berthing plan, although the operations on each berth or small groups of berths may best be managed separately.

20. Let us consider two independent break-bulk general cargo five-berth groups each with an average ship service time of three and a half days and a ship arrival rate of one ship a day. Each group has an av-

erage berth occupancy given by dividing the arrival rate by the product of the number of berths and the service rate which, for this example, is 0.7. This would give an average queueing time of 19 per cent of the discharging/loading time which is close to the limit for which a port should be designed (see annex II, section D, table VII).

21. If the traffic were combined and handled as a single stream over the 10 berths, the berth group would now receive two ships a day, but the berth occupancy would remain unchanged at 0.7. However, this same berth occupancy on 10 berths gives an average queueing time of only six per cent of the service time, an important increase in the quality of service and an insurance against serious congestion during peaks.

22. As a quick guide, berth occupancies for conventional general cargo operations should be set so as not to exceed the figures given in the table below, which are based on a ratio of ship cost to berth cost of 4 to 1:

Number of berths in the group	*Recommended maximum berth occupancy (Percentage)*
1	40
2	50
3	55
4	60
5	65
6–10	70

Since port administrations of small ports would be reluctant to accept a 40 to 50 per cent berth occupancy and the resulting under-utilization of port facilities and labour, the retaining of an efficient lighterage service would be an economical way to allow the utilization of facilities to be increased without running the risk of excessive waiting-time. The lighterage service would then act as a safety valve for the handling of ships that could not be berthed alongside during periods of peak demand. Investment decisions cannot normally be based on these limits alone, however, and require the more detailed procedure described later in this chapter (see section G below).

D. Quays or moorings for general cargo

23. Over the years there has been discussion as to whether a modern port should dispense entirely with working general cargo ships at moorings. One view is that working to lighters introduces double handling costs and increases the risk of damaging cargo, which makes the operation less economical than working at berths. The contrary view has also been held, namely, that moorings are a cheap and useful facility for supplementing, during periods of peak demand, the limited number of berths that many ports are restricted to by space or funds.

24. There will in fact be circumstances when each view is economically justified. The decision should be based on the following factors:

(*a*) The importance to the shipowner of alongside berthing, there being other reasons for preferring berthing than merely ease of cargo handling, for example, the need for bunkering and other port services;

(*b*) The relative price of land and of labour, which can bring the economic advantage either to berthing or a combination of berthing and working at moorings;

(*c*) Existing labour practices in the port, for example, the existence or lack of a large and well-organized lighterage fleet;

(*d*) The local destination or origin of the cargo: for example, cargo going to private shallow-draught wharves or destined for onward transport via barge, would be best discharged to lighters at a mooring;

(*e*) The weather pattern at the port: it will generally be possible to work at berths for more days in the year than at moorings.

25. The rate of working to and from lighters, for conventional general cargo or bagged bulk commodities, cannot be clearly said to be higher than the rate of working at berth, using ship's gear or shore cranes. There has been conflicting evidence on this, and it can be concluded that in general the difference is not significant for certain cargoes while for other cargoes berth working is clearly superior. In addition, working at berth provides the opportunity to introduce a variety of modern handling techniques which cannot be used when working to lighters. This factor, together with the assurance of easier and more accurate tallying and reduced damage, may determine the decision to dispense with working to moorings in a new development.

26. The strongest case for working at moorings is to provide a major port contingency capacity, when the standard method is to work at berths. It is relatively easy to reintroduce working in the stream when traffic builds up above the immediate berthing capacity, provided that a reserve fleet of lighters and some lighter-handling facilities are available.

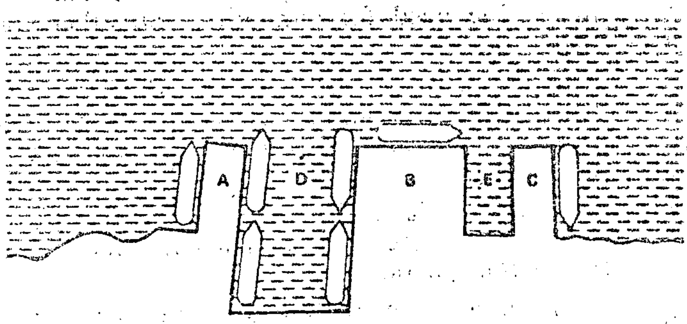
E. How many berths are there now?

27. Port extension proposals are generally justified by comparing the level of service which is given by the existing facilities with that which would be given by providing additional berths. To do this it is necessary to describe the existing facilities in terms of the number of berths that they represent. Often this is not obvious, where there are complicated waterfront layouts. It is not permissible to add up the separate lengths of quay in a berth group and from this work out the number of effective berths this total length represents. This will overestimate the capacity, since the capacity of a linear quay is usually greater than that of an irregular quay.

28. The correct approach is to use a map of the actual waterfront layout to determine how many ships of the average length for that traffic stream can be

FIGURE 2

Estimating the existing number of berths



simultaneously berthed at the berth group. The port marine superintendent or harbour-master should be consulted. This number of ships can then be taken as the number of berths for planning purposes. Where there are lengths of quay too short to handle average length ships, then these can be excluded and may be allocated to another traffic stream.

29. The illustration in figure 2 depicts a case of old facilities where a planner could be misled into believing that there are 11 berths, whereas there are in fact only seven for the forecast average size of ship. In this example there is a total quay wall of 2 km. The length of quay wall excluding the end faces of piers A and C and the inner face of slip E is 1.77 km. The theoretical berthing capacity with the forecast average ship length of 160 m is 11 ships. However, the actual berthing capacity, as shown, is seven ships, since it is not safe to berth more than four ships of average length in basin D, and berthing is so difficult in slip E that is only used for lighters and barges. The reason for the large discrepancy here is the unsuitability of the old slip E for ships of this average size.

30. This example also shows how unreliable are operational performance measures based on over-all quay wall length. For example, if the whole 1.77 km berthing lenth of this berth group were achieving an annual throughput of 1.05 million tons of general cargo, this would give 590 tons per linear metre of quay, which would generally be considered low. In terms of throughput per berth for the seven berths this would be better stated as 150,000 tons per berth, which is generally considered good.

31. The number of effective berths used in capacity calculations will often be different from the formal berth numbering system. For administrative pur-

FIGURE 3

Break-bulk general cargo terminal, planning chart I.A: berth requirements (2-10 berths)

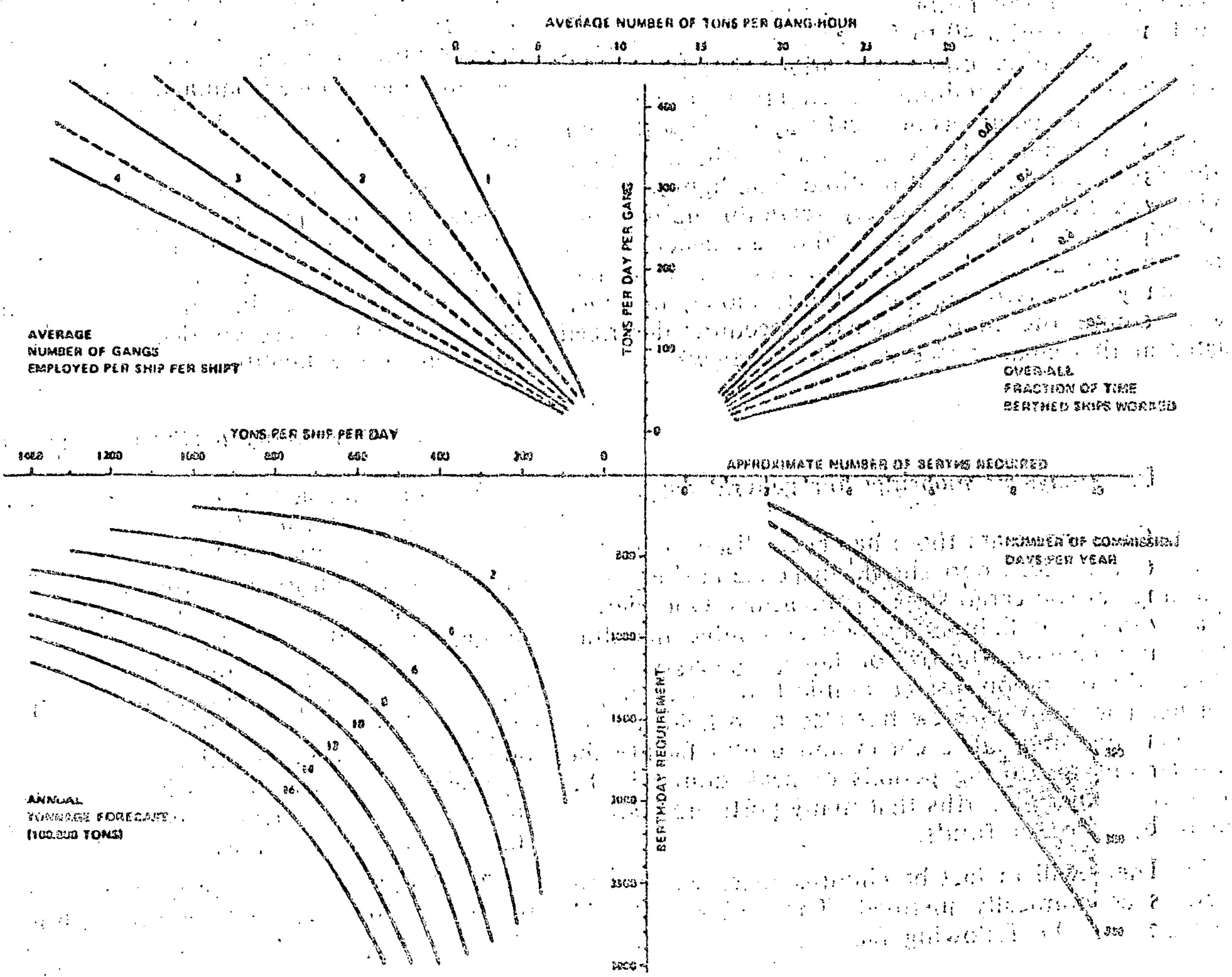
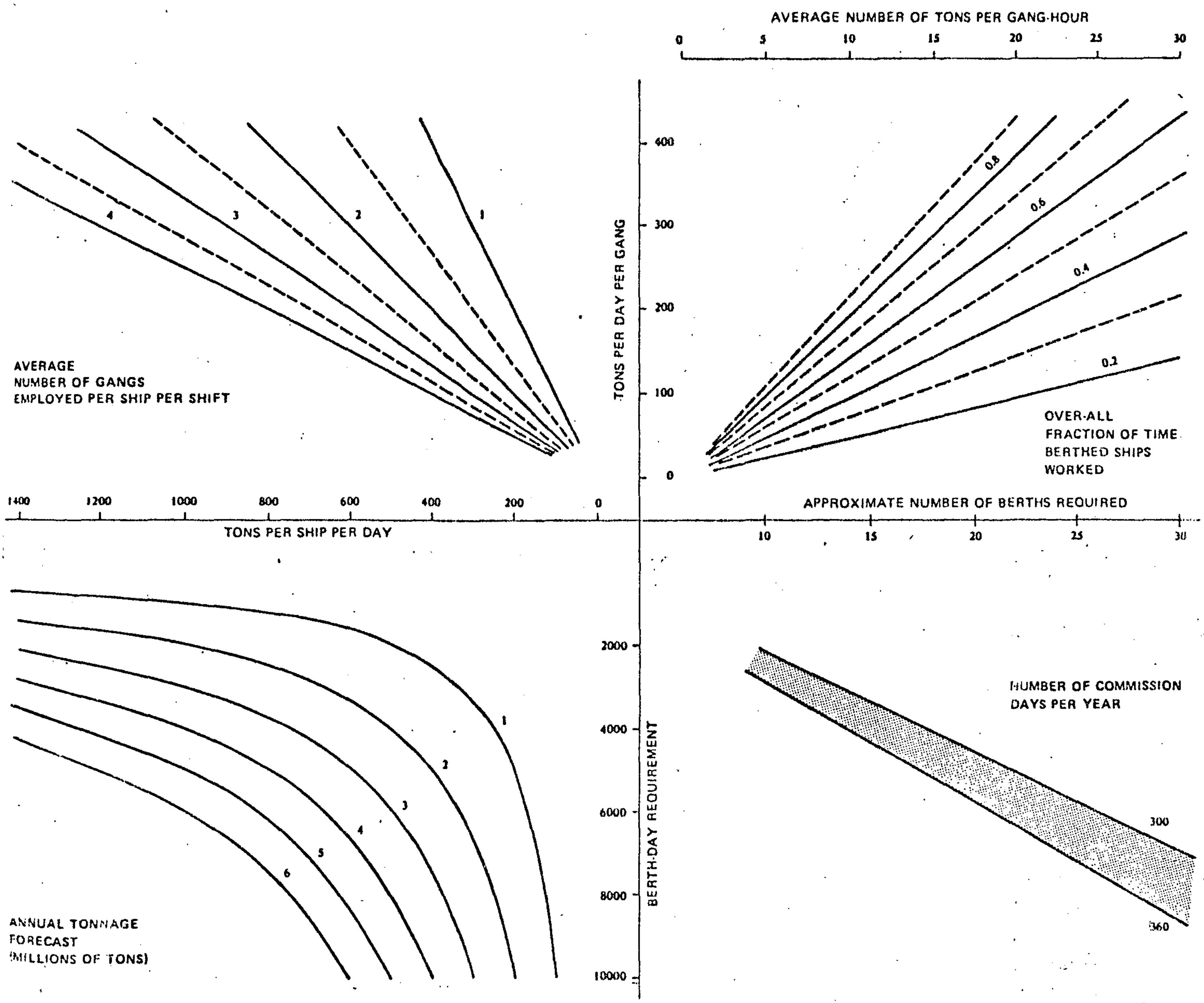


FIGURE 4

Break-bulk general cargo terminal, planning chart I.B: berth requirements (10-30 berths)



poses, it will often be advisable to maintain distinct berth identities, laid out, numbered, staffed and monitored separately, even when ships overlap berth limits. This should not affect the planner's capacity calculations.

F. Berth capacity calculations

32. The two major quantitative decisions for the planner are:

(*a*) How many berths there should be in the future berth group;

(*b*) How much storage space should be provided for each new berth and whether any additional storage space is needed at existing berths.

Procedures for each of the decisions are set out below. Separate planning charts are given for terminals of two to ten berths and terminals of ten to thirty berths, but before large numbers of berths are treated as one group, it should be carefully considered whether the traffic stream is truly uniform or if some part of the traffic would not be better handled separately.

33. Supplementary planning decisions are, of course, needed with respect to each of the following:

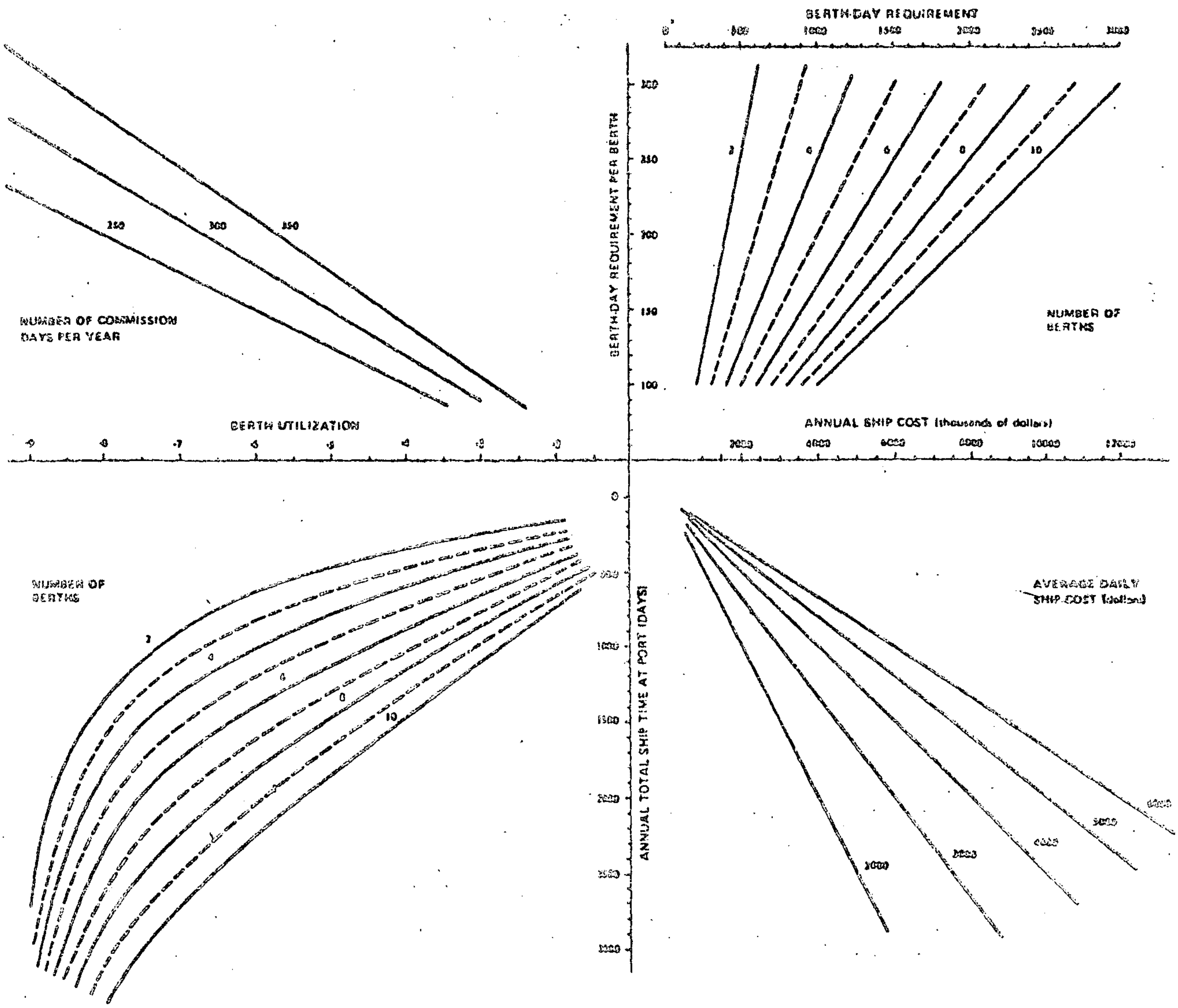
(*a*) The appropriate depth of water at quays or moorings;

(*b*) The appropriate quay layout for the operational plan proposed;

(*c*) The berth equipment needed;

FIGURE 5

Break-bulk general cargo terminal, planning chart II.A: ship cost (2-10 berths)



(*d*) The appropriate level of manpower;

(*e*) The cargo delivery and receiving system.

G. Number of berths required

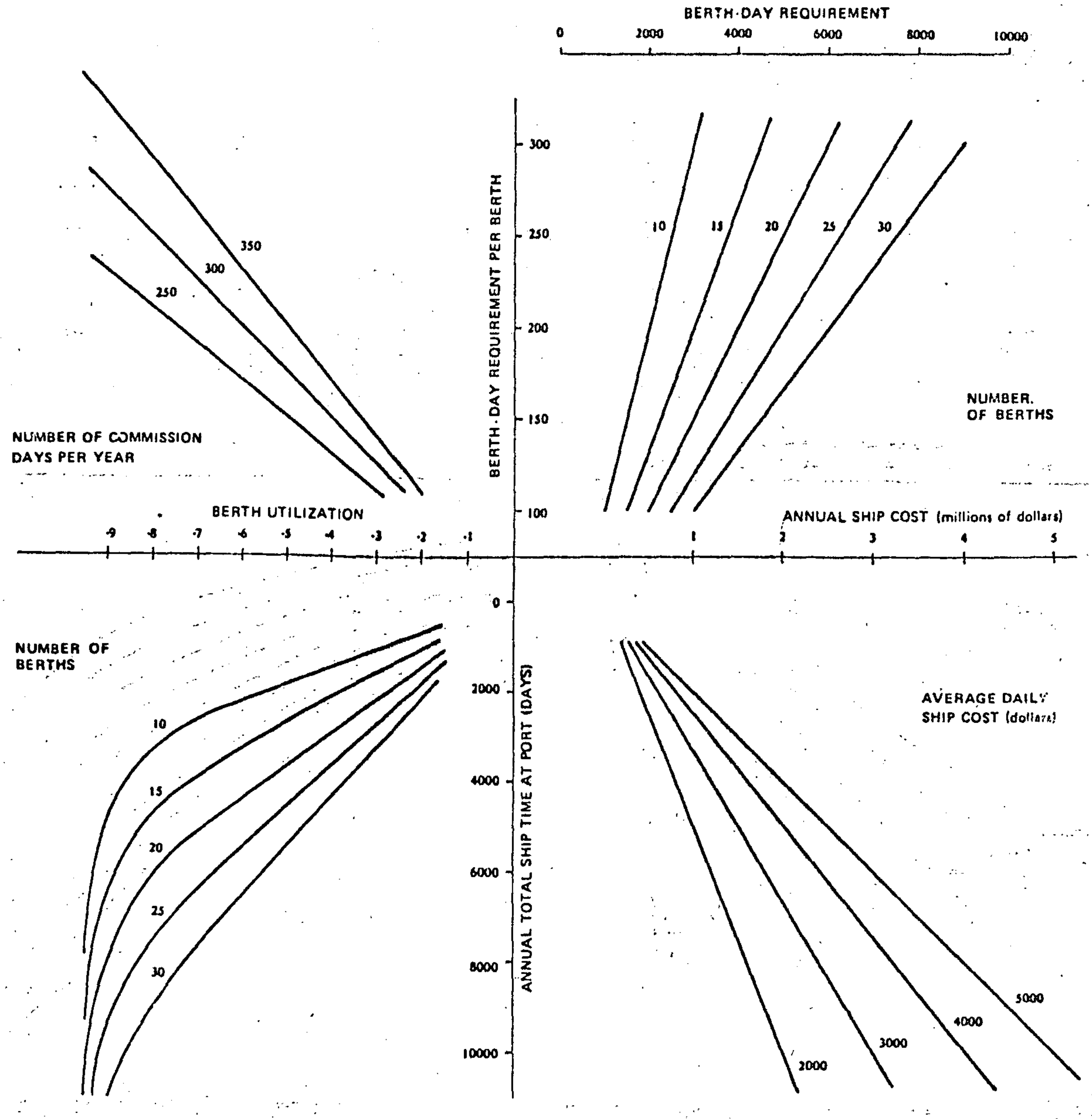
34. For the break-bulk cargo terminal, planning charts I.A and B and II.A and B should be used for deciding the appropriate number of berths. The first chart (see figures 3 and 4) allows the planner to determine the berth-day requirement (the number of days ships are at berthing points) and the approximate number of berths required. These values are used as a starting point for the second chart (see figures 5 and 6) which gives the expected ship time at port and can be used as the basis for a cost-benefit analysis. The relationships used to prepare these charts are given in annex II, section E.

35. With regard to planning chart I, the figure for the average gang productivity (number of tons loaded or unloaded per gang-hour) for the break-bulk berth group is entered on the chart. This figure should be taken from actual performance data obtained at the port, or, in the case of a new port, from observations and information deriving from other ports in the region. The planner then descends vertically to the "turning-point" where this vertical line meets the line indicating the fraction of time that berthed ships are worked. For a terminal working two eight-hour shifts six days per week, this fraction would be 16/24 × 6/7, i.e., .572. This factor thus takes into account the non-working days at the berth. Altering this factor to correspond to changes in working hours enables the planner to evaluate the effect on the berth-day requirement of different shift systems.

36. The planner then moves horizontally to the left to the next turning point, defined by this horizontal and the appropriate line for the average number of gangs employed per ship per shift. Unlike the fraction of time worked, which is under the control

FIGURE 6

Break-bulk general cargo terminal, planning chart II.B: ship cost (10-30 berths)



of port management, the average number of gangs per ship is dependent on the size of ship and the cargo distribution through the ship. This value should therefore be considered constant for a particular trade and not something to be modified by the planner. However, if the size and cargo distribution of ships calling is likely to change, the effect on the average number of gangs employed per ship should be estimated.

37. The planner then descends again to the annual tonnage forecast, moves horizontally to the right to the number of commission days per year (number of days per year that a berth is available for ships) and finally rises to the approximate number of berths required. On the way round the chart, the scales on the axes give the planner the following additional information: tons per day per gang, tons per ship per day and berth-day requirement.

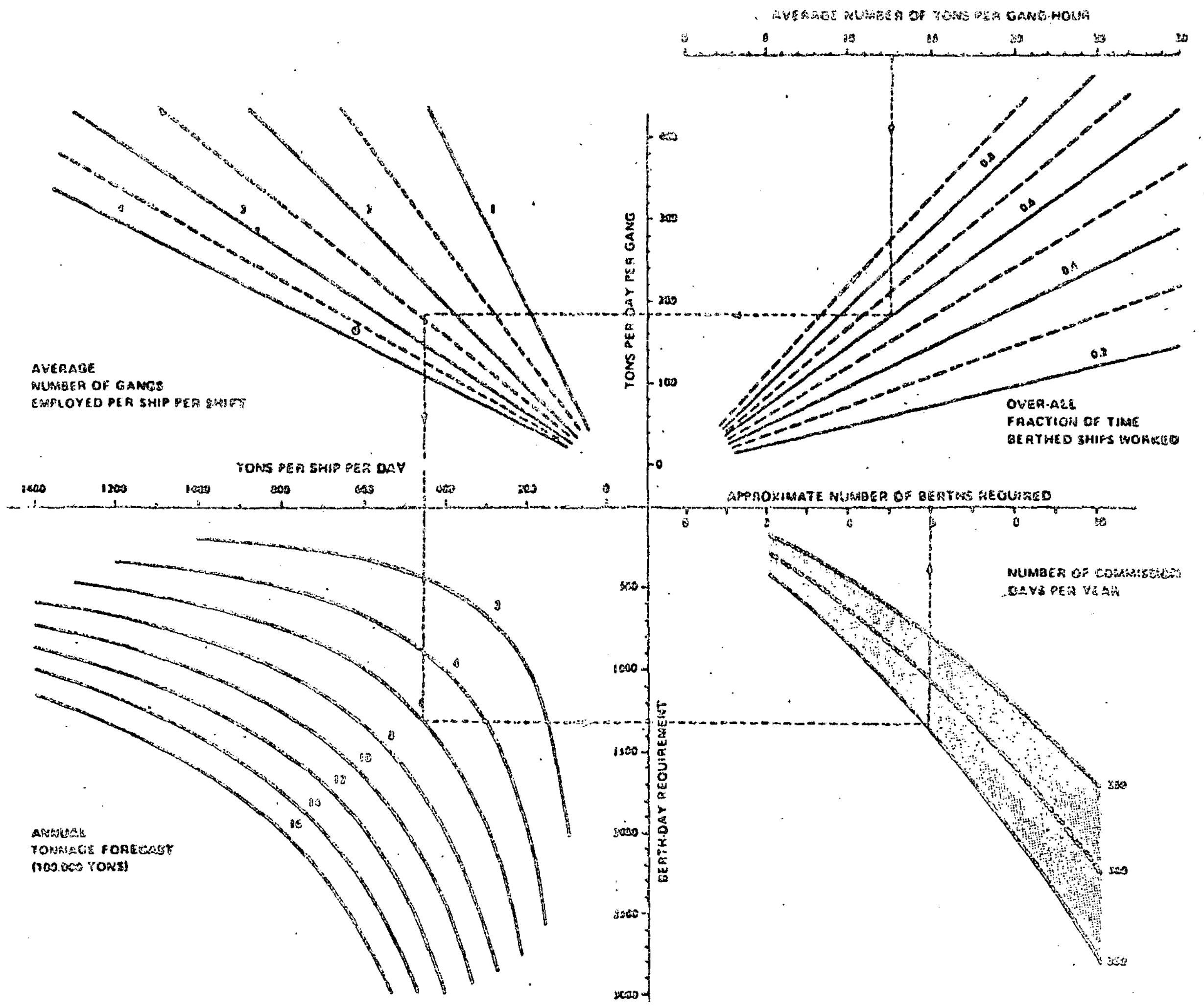
38. The example of the use of planning chart I A given in figure 7 has the following input data:

Number of tons per gang-hour	12.5
Fraction of time berthed ships worked	0.6
Number of gangs employed per ship	2.5
Tonnage forecast	600,000
Number of commission days per year	350

39. These inputs will give a mean ship productivity of 450 tons per day, and a berth-day requirement of 1,330 days per year which requires approximately six berths. But this is only a rough indication and has not taken into consideration the cost of ship time in port. To obtain this cost, the berth-day require-

FIGURE 7

Example of use of planning chart I.A



ment obtained from planning chart I is entered on planning chart II (see figures 5 and 6). A similar method as for the first chart is then used with, as turning points, the number of berths, the number of commission days per year, the number of berths again and the average ship cost at port per day. This ship cost would normally include both operating and capital costs. Different paths are traced to evaluate the effect of adding or subtracting berths. Each path gives the annual total ship time at port, which includes the expected ship waiting-time, and the total annual ship cost.

40. The example of the use of planning chart II A, given in figure 8, has the following input data:

Berth-day requirement	1,330
Number of berths	Either 5, 6 or 7
Number of commission days per year	350
Ship cost per day	$3,500

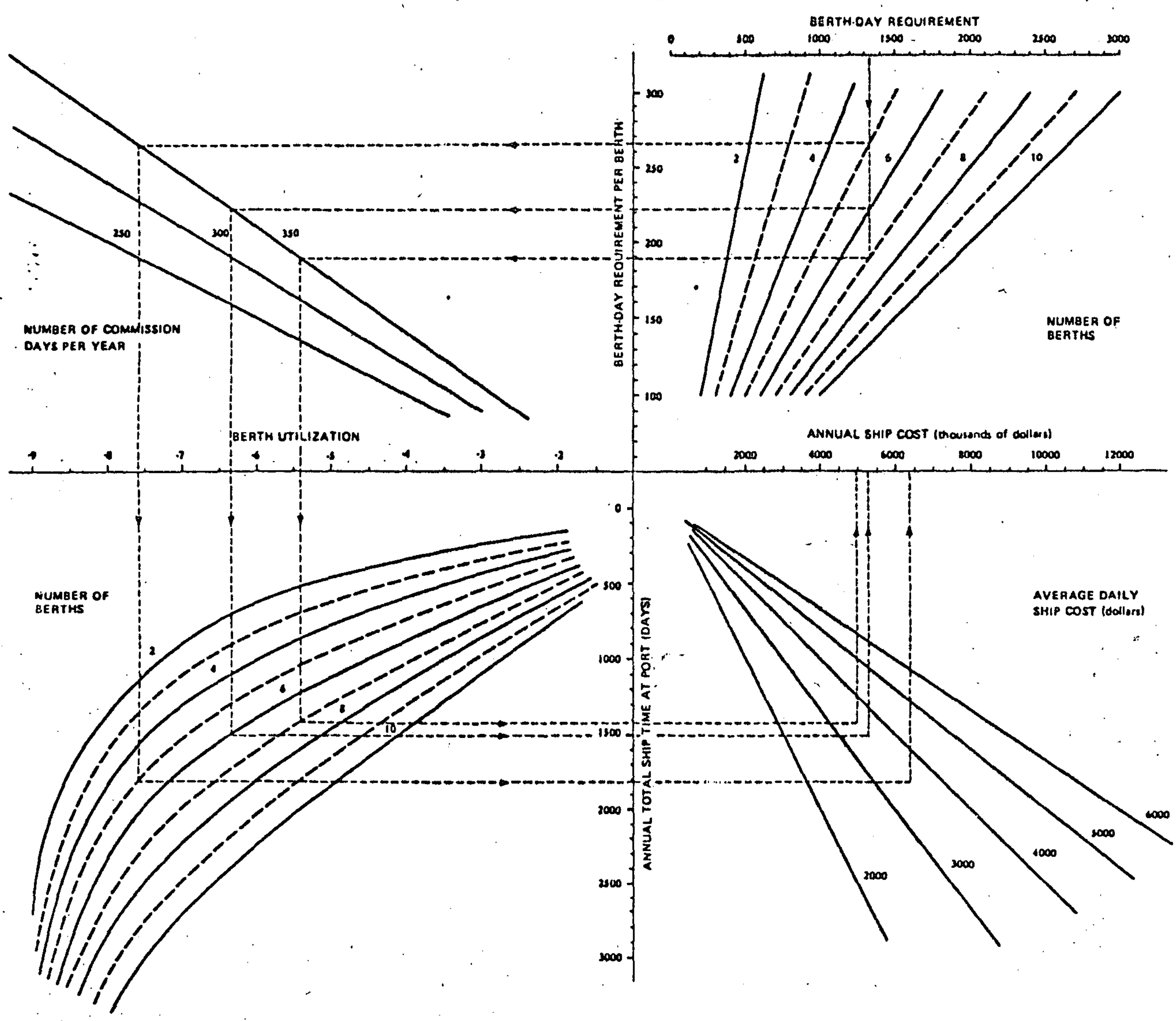
For the five-berth case the total time at port is 1,800 days, while for the six-berth case the total time at port is reduced to 1,500 days. There is a further 75-day reduction in ship time for the seven-berth case. Bearing in mind that losses due to scarcity of port facilities in the event of an unpredicted turn for the better in a country's economic development could be many times the cost of an additional berth, these alternatives need to be evaluated. The planner would have to ascertain whether the saving in ship time between the five-berth and the six-berth alternatives justified the investment in the additional berth and if so, then if the seven-berth alternative were justified. This would normally be done in a cost-benefit analysis as described in part one, chapter II.

H. Berth length

41. Once the number of berths required has been determined, the length of new berths must be set to enable cost estimates to be made. A wasteful tradition in port planning has been to use the currently fashionable berth length for a class of traffic irrespective of the local requirement. It is argued that it does not matter if the length used is not the economic optimum since on a linear quay there is less meaning to the individual berth. This, however, introduces yet another error into the analyses of economic advan-

FIGURE 8

Example of use of planning chart II.A



tages and disadvantages. Each port should consider for each of its zones what is the most appropriate berth length, and for this it needs a broad analysis of the ship lengths in the traffic stream in question.

42. The governing factor is the average ship length for that particular stream of traffic. Experiments made by the UNCTAD secretariat using different typical length distributions show that there is a general relationship between the amount by which the average berth length exceeds the average ship length and the amount of ship waiting time involved. This relationship is given in figure 9 in the form of a correction factor to be applied to the total ship time at port given by planning chart II. With a safety margin of 10 per cent, there is no correction to be made. In this way the effect of providing a greater or lesser berth length can be tested in the cost-benefit analyses.

43. The correction factor indicated in figure 9 applies to all berth group sizes except for the single berth, where the berth length must of course be that of the maximum ship length. The correction factor is not particularly dependent on the number of berths since the economies of scale achieved by shifting vessels daily to make the best use of gaps, on a linear quay, rarely apply to more than a three-berth length.

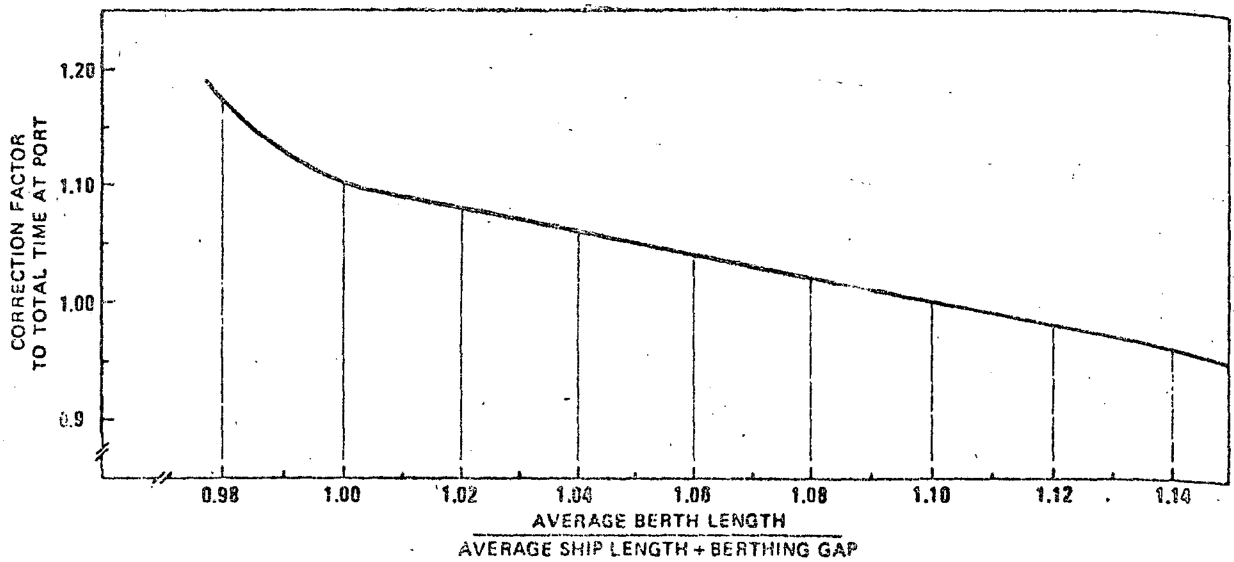
I. Sensitivity studies

44. Each of the figures used in the input data should have a sound basis. For example, the productivity used must be based on a practical operating plan for the berth, the fraction of time worked must be based on an agreed labour policy, and the number of commission days must be based on weather constraints and a berth maintenance and dredging plan.

45. There will often be alternative values for these figures, depending on other management policies and

FIGURE 9

Berth length-correction factor for break-bulk general cargo terminal planning



sometimes on other port investments. Planners should evaluate the costs or savings resulting from varying the values. Where there is a real choice involving related investment—for example, where the extension of a breakwater will increase the number of commission days per year—the various output values given by planning chart II should be used to carry out an economic sensitivity study.

46. Where the alternative value demands management action, such as a change to a new shift system, it should be remembered that such a change may involve costs either in extra staff, in upgrading existing staff, in hiring an external adviser or in higher pay for shift-working. These costs should be set out in the economic sensitivity study in such a way that if this alternative is chosen the necessary funds will be provided.

J. Dimensioning of storage areas

47. The break-bulk general cargo storage area requirements are dependent on many factors. For each type of area, for example, transit sheds, open areas and warehouses, a systematic procedure can be used by the planner. This procedure is summarized in figure 10 (planning chart III), and the relationships used to prepare this chart are given in annex II, section E. The various factors influencing the area requirements are discussed below.

48. Of the annual tonnage worked over a berth, part will be for direct delivery and part for storage, either in transit sheds or open areas. The proportion likely to follow each course, and thus the proportion likely to pass through the storage areas, must be estimated. This figure is the starting point for planning chart III. Next, the average transit time for the cargo must be estimated. Unless a great deal of emphasis is to be placed on cargo clearance, the present transit delay should be assumed. Normally steps should be taken to reduce the average transit delay if it exceeds ten days. From these two factors the required holding capacity is determined.

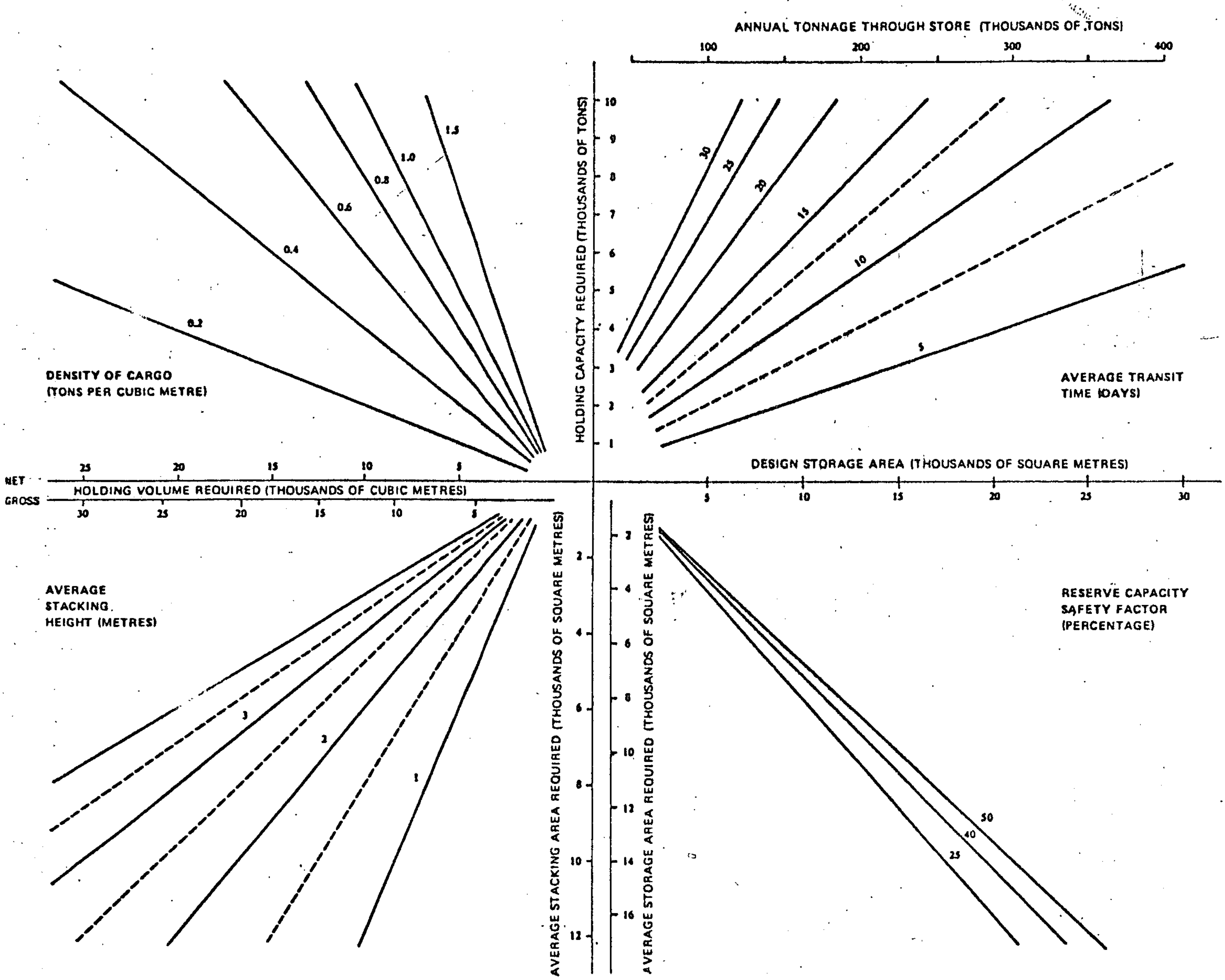
49. The average weight/measurement ratio or density of the cargo mix making up the traffic using the storage must now be estimated. Although the density of a cargo is often significantly different from the stowage factor of that cargo, owing to the lost spaces in the hold of the ship that carries it, it is usually satisfactory to use the latter, bearing in mind the levels of accuracy of tonnage forecasts and the similar need to allow for lost space in the store. Typical ratios are given in annex I, table I. For the estimated density, the net holding volume required can be calculated. To this volume must be added an allowance for broken stowage, that is, for the extra space needed when consignments are taken apart and the various items placed separately. A typical figure would be a 20 per cent allowance, which has been incorporated in the planning chart. The planner now has the gross holding volume required, which must be converted to the stacking area required.

50. For the cargo mix concerned, the average stacking height must be estimated. For planning purposes this height is the average of the stacking heights of the various cargoes that make up the mix, in a full store. The stacking height is a function of cargo type and packaging type, and these should be the determining factors. In the case of break-bulk cargo, different commodities may be stacked to a height of from one to three metres, the average figure being two metres. From this height the stacking area required can be determined.

51. There may also be a choice to be made between the cost of providing facilities for higher stack-

FIGURE 10

Break-bulk general cargo terminal, planning chart III: storage area requirements



ing and the cost of the larger area requirements caused by lower stacking. In this connexion there are several considerations to be taken into account:

(*a*) The cost of providing stacking equipment which can work to the full height chosen;

(*b*) The cost of building a store of sufficient height;

(*c*) The limitations imposed by lateral forces from the stack acting on the walls of the store;

(*d*) The limitations imposed by floor weight restrictions.

Floor weight restrictions are not generally critical at modern terminals, where the berth surfacing is more often governed by wheel loadings of mobile equipment and where shed location is flexible, but a check must always be made that the storage area design loading is consistent with the floor slab design specification. The floor loading, in tons per square metre, is obtained by multiplying the maximum stacking height by the cargo density in tons per cubic metre.

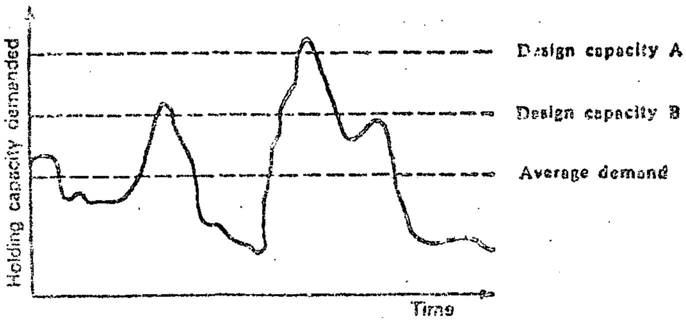
52. The average stacking area required must be increased by an allowance for all space not used for stacking, for example alley-ways, offices within the storage area, customs checking-points and social amenities. At the early planning stage when detailed layouts have not yet been prepared, an average figure must be used. For a break-bulk transit shed a typical allowance would be 40 per cent. This figure has been used in the planning chart to give the average storage area required.

53. A reserve of storage capacity must be provided over and above the average holding capacity, to handle the variation in demand. It will rarely be economical to provide a design capacity to cope with the very highest peaks of demand, but the capacity

chosen should be sufficient for handling the majority of peaks or surges. For example, with respect to figure 11, which shows a varying demand on a store, it is clear that to design for the average demand would be quite unsatisfactory. Whether the design capacity should be set at level A or at level B, for example, depends on the relative cost of providing and maintaining the extra capacity which is idle for a large part of the time, as against the cost of running out of capacity and having to take emergency action to prevent or cure the resulting congestion.

FIGURE 11

Variation in storage demand



54. Where the form of the variation is known—for example, where the size and frequency of the shiploads which give rise to it are known, as well as the hinterland transport movements—the cost calculation can be reasonably accurate, and a design capacity can be found which is an economic minimum. Such calculations will sometimes show that the cost of congestion will be so much higher than the cost of idle storage that the best decision is to provide for the maximum likely demand.

55. However, when there is little knowledge of the expected shape of the demand variation—for example, in a common-user terminal—there is little scope for finding the minimum economic design. Here it is more appropriate to rely on experience. The UNCTAD secretariat has examined a number of different cases and found that as a general rule it is desirable to provide an additional 40 per cent as reserve capacity over and above the basic capacity. This substantial margin, which is applied in addition to the extra spaces needed for access, broken stowage and administrative areas, is a safe figure. To provide less than a 25 per cent reserve would be unwise under any circumstances.

56. With the reserve capacity safety factor, the planner can complete his circuit of the planning chart and determine the design storage area. On the basis of this area, the necessary dimensions can be selected. The length of the shed or open-storage area will generally be governed by the berth length, although ample provision must be made for access to the part of the berth that is behind the shed. The width of the shed will generally be governed by the operational distances over which it is acceptable to handle the cargo. As a rough rule of thumb, the width of a modern break-bulk berth transit shed should be half its length, but not less than 50 metres.

K. Transit areas

57. The purpose of transit areas within the port is primarily to provide a buffer zone to harmonize the faster ship-shore flow with the slower shore-inland movement. In addition, these areas provide a safe place for checking the condition of all consignments and their correspondence with the manifest and bills of lading, and for accomplishing the necessary customs and delivery formalities. In no event should transit sheds be used for long-term storage, which should be a function of warehousing areas not adjacent to the waterfront.

58. A rough preliminary estimate of the requisite size of transit sheds can be made on the basis of experience of existing berths or in neighbouring ports. While the length of the sheds is usually limited to about 110 to 120 metres by the average length of the berth (about 160 to 180 metres) and the necessity of leaving wide access space between two neighbouring sheds, there is more freedom in selecting the width of the shed. Experience in many developing countries has shown that sheds should preferably be not less than 60 metres wide, with 50 metres as an absolute minimum when there is a shortage of available space on land.

59. In most countries ample storage should be provided in the open, especially when the rainy seasons are short. Vehicles and agricultural and road-building equipment do not require covered storage, nor do construction steel, oil in drums and many other goods. As much storage in the open should be provided as local land conditions permit, within, of course, some reasonable limits. Open storage yards should be well marked and clearly separated from roads and parking and loading areas. They should be levelled and properly paved, with adequate provisions for the drainage of rainwater.

L. Transit shed design

60. In the selection of a design for the transit sheds, the following errors of design should be avoided:

(*a*) Insufficient width of shed, below the absolute minimum of 50 metres, with a resultant shortage of storage space;

(*b*) An excessive number of interior columns supporting the roof, which will impede the free movement of mechanical equipment in addition to reducing slightly the usable space on the floor;

(*c*) Inadequate ventilation and lighting, making cargo-handling and reading the signs slower and more difficult;

(*d*) Poor quality of the floor, not smooth and resistant enough;

(*e*) An insufficient number of doors, and poor suspension of doors so that opening or closing them is difficult and slow;

(*f*) Waste of space on offices within the shed which could be located on an upper level;

(*g*) Too solid and monumental a construction, unsuitable for alterations or dismantling of the shed and its erection on another site.

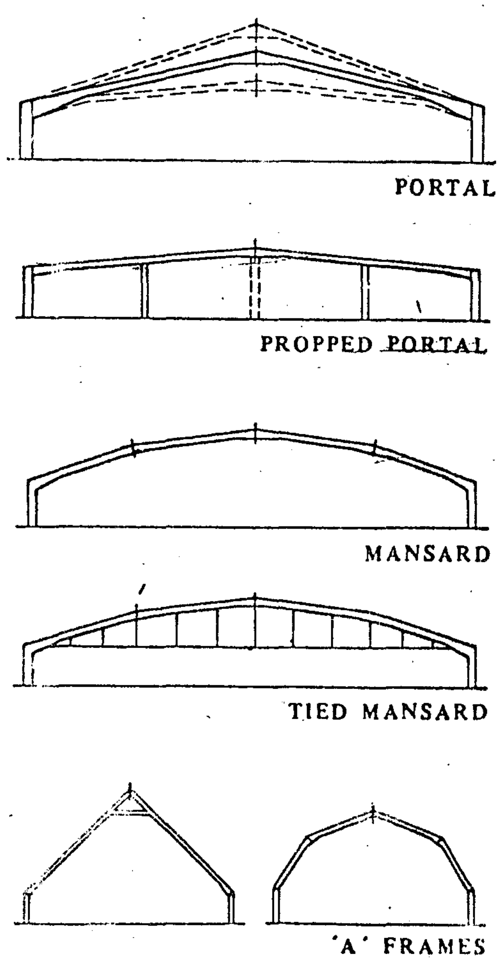
With the sole exception of the last point, all the deficiencies listed above may have an unfavourable effect on the efficiency of operations within transit sheds.

61. Multi-storey sheds are not normally appropriate either for transit sheds or for port warehouses. Single-storey sheds greatly simplify cargo-handling and obviate the need for expensive foundations and cargo lifts. Various types of shed are shown in figure 12 which create an interior unencumbered by internal support structures. However, the complete absence of interior columns will result in a more expensive structure than a shed with a limited number of columns, which can be placed in such a way as not to obstruct operations.

62. To achieve the goal of flexibility in the face of changing terminal requirements, it is an advantage to be able to dismantle a transit shed and re-erect it in a different location. This may be a factor in choosing the form of construction. A certain amount of material is damaged in dismantling and re-erection, but normally none of the main members is affected. If the work is done carefully, with professional supervision, the only loss may be the holding-down bolts and a few roofing sheets.

FIGURE 12

Types of transit shed construction



63. A further design point which affects the flexibility of future operations is the design for loading platforms at the rear of the transit shed. For berths which are expected to continue to be used for break-bulk cargoes for some considerable time, the rear loading platform running the whole length of the shed is advantageous, as trucks may be loaded or discharged without the use of fork-lift trucks.

64. A sloping floor design which gives a level entrance at the quay side and a raised platform at the delivery side is useful if the slope can be kept very slight; a slope of 1 in 50 is often needed for drainage purposes, but a slope of more than about 1 in 40 can make stacking by fork-lift truck difficult. Thus, for the average truck tail-board height, it will only be possible to keep the slope acceptable in shed widths of 40 metres and upwards.

65. If the shed-long loading platform is considered unacceptable, then it may be preferable to keep the surface at one level and to use mobile loading ramps. This point must be studied at the time of design, and the cost of a sufficient number of mobile ramps must be added to the list of berth equipment included in the project costs. For this form of shed, the shed floor can be sloped on both sides with a slightly raised rib in the centre. This arrangmeent can help in saving cargo lying on the other side of the rib from water damage in the event of fire-fighting or washing of the shed.

M. Warehousing

66. Warehouse storage is needed:

(*a*) When the maximum cargo flow exceeds the storage capacity of a reasonably-sized transit shed;

(*b*) Where the port wishes to engage in the commercial business of long-term storage of cargo, for example, for cargo that must be aged, or cargo which is to be sorted, packaged and sold from the warehouse.

67. In deciding what is a reasonable size of warehouse it should be recognized that the transit shed and the warehouse in the rear are complementary: it is their total which makes up the storage capacity. In deciding how to divide the total storage capacity between them, the following factors must be considered:

(*a*) In many developing countries the cost of the labour needed to transfer goods to the warehouse is low and the cost of quayside land is high;

(*b*) There is both a minimum space needed for satisfactory operations and a maximum shed dimension before internal travel distances become too great;

(*c*) The financial incentive to consignees of avoiding the cost of transferring goods to the warehouse can be a useful means of preventing excessive clearance delays.

N. Layout for deep-sea berths

68. The modern break-bulk berth, especially in developed countries, will be required to accept an increasing amount of palletized or equivalent (e.g. pre-slung or bundled) cargo. Very few pure pallet berths are likely to be needed, but the changes in break-bulk berths made necessary by the increasing size of ships entail the gradual incorporation of many of the operational characteristics of the pallet berth concept. These include increased berth length and the provision of a large total terminal area including a wide, well-lighted quay apron with a width of not less than 20 metres and preferably one of 25 or 30 metres. The need for better protection of most break-bulk general cargo results in the increase of the total shed area.

69. A typical berth layout for a modern break-bulk berth group handling conventional deep-sea liner traffic is given in figure 13. This diagram illustrates several points:

(*a*) The concept of a self-contained zone where the operations are planned and co-ordinated by a single management team;

(*b*) The substantial areas needed for operations, delivery zones and vehicle parks and movement;

(*c*) The provision of offices for agents of all kinds in the immediate vicinity of the operating area, to speed up the documentation and clearance of consignments;

(*d*) The provision of substantial parking areas for trucks and for private cars;

(*e*) The clearly laid one-way road circuit;

(*f*) The central road and rail delivery zone.

70. Each shed, with an area of over 9,000 square metres, will typically hold a maximum of 5,400 tons of mixed cargo. For berths handling 100,000 tons per year through the shed, this size of store would allow goods to have an average transit time of 14 days on the assumption of one ton of goods per square metre of stacking area. The warehouse could be located further away without serious disadvantage, or it could be replaced by an open storage zone if there were a high proportion of open storage cargo. If a large number of 15-metre-long trucks were used for delivery, the road/rail delivery zone would have to be widened. In all cases the rail tracks should be set flush with the concrete surface to allow easy passage of road vehicles and wheeled port equipment.

71. In addition, space must be available in the area of the rear of the berth for some auxiliary facilities such as a small shelter for mobile equipment, sanitary facilities, changing rooms, a first-aid station and a canteen to serve the group of berths. A separate shelter for explosives or inflammable goods may also be needed, and its location will depend on local port regulations. Altogether, a 200-metre-wide strip is the minimum usually needed to provide adequate space for all essential facilities—cargo handling facilities, transit storage, delivery and receiving areas and ancillary services. The offices in the vicinity of the operating area should be used only for the personnel needed for daily routine operations.

O. Layout for coastal or island berth

72. A layout suggested by the UNCTAD secretariat for a small berth for coastal trade or as the general cargo facility for a small island is shown in figure 14. The features to be noted here are the ro/ro ramp and the clear road access to it. Substantial covered storage area is often needed at such berths since they may also be required to assume a limited warehousing role in view of the absence of users' depots in the local area.

P. Manpower planning

73. The principles governing the organization and planning of the use of labour are discussed in the ILO publication mentioned in the reference list given in annex III. That publication places the emphasis on the social aspects of changing methods of cargo handling, since these are the constraints which usually limit the port management's freedom of action.

74. Purely from a quantitative point of view, there is the requirement for the planner to specify the size of the cargo-handling labour force needed to operate a port. It is necessary, as with berthing-points and storage, to plan the size of the labour force separately for each berth group or zone, since there are not likely to be significant economies of scale extending beyond the boundaries of a port zone and furthermore productivity and labour motivation should be improved through a reasonable degree of specialization.

75. The composition or strenth of a gang will be the subject of negotiation between the parties and the outcome will be arrived at by agreement. It is difficult to lay down what the minimum size of a gang should be for different types of cargo, and there is room for marked differences of opinion. There is, therefore, a great deal to be said in favour of not fixing gang strengths too rigidly in advance, but allowing them to be adapted to meet real needs. The first step is to decide the approximate labour requirements for the berth group and to plan in terms of number of gangs rather than in terms of manpower. The appropriate gang-pool size for each shift for the berth group may be calculated approximately as follows:

Gang-pool size per shift = Average number of gangs per ship per shift times the number of berths in the zone

FIGURE 13

Typical modern three-berth break-bulk zone
(480 × 250 metres)

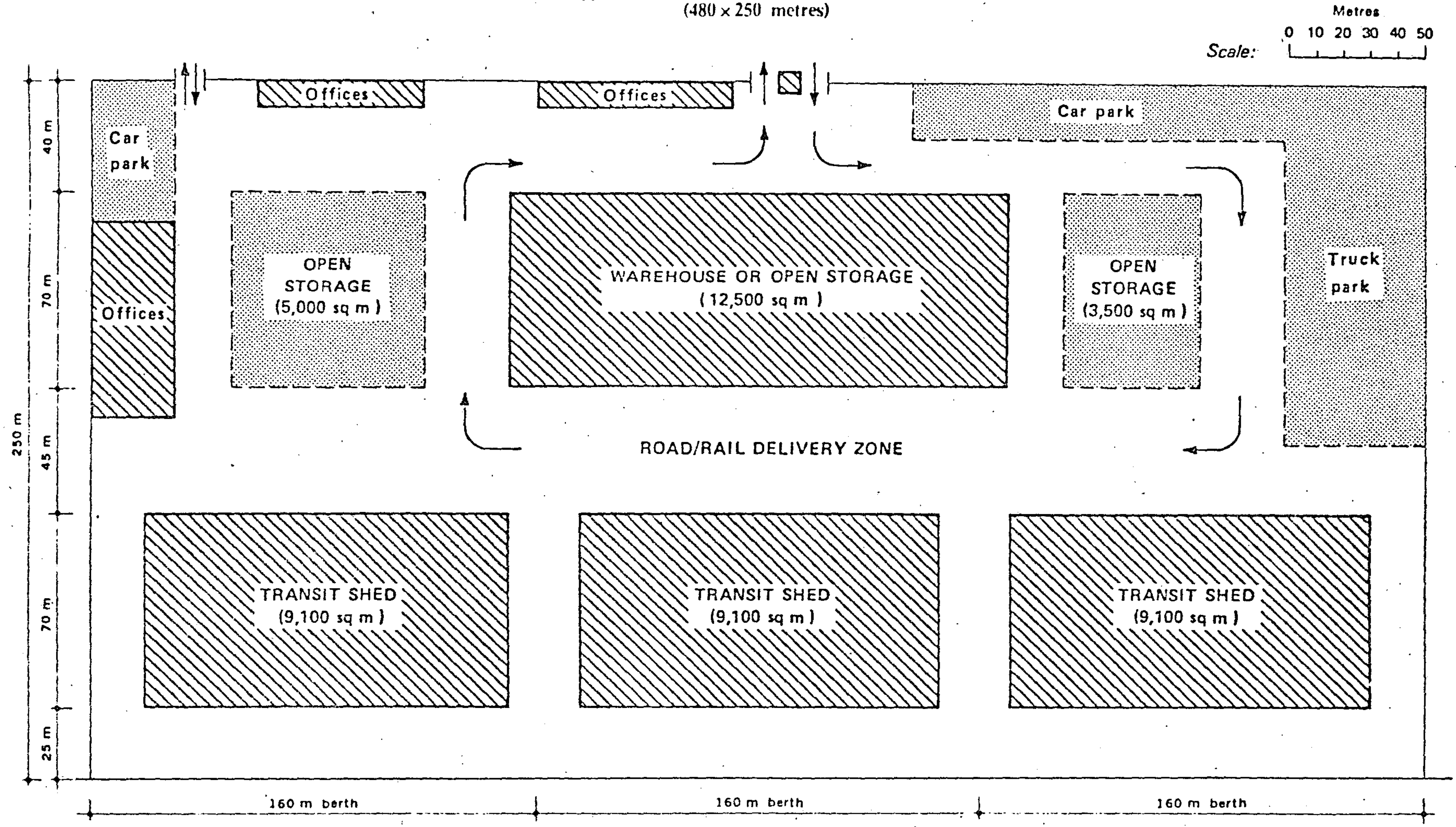
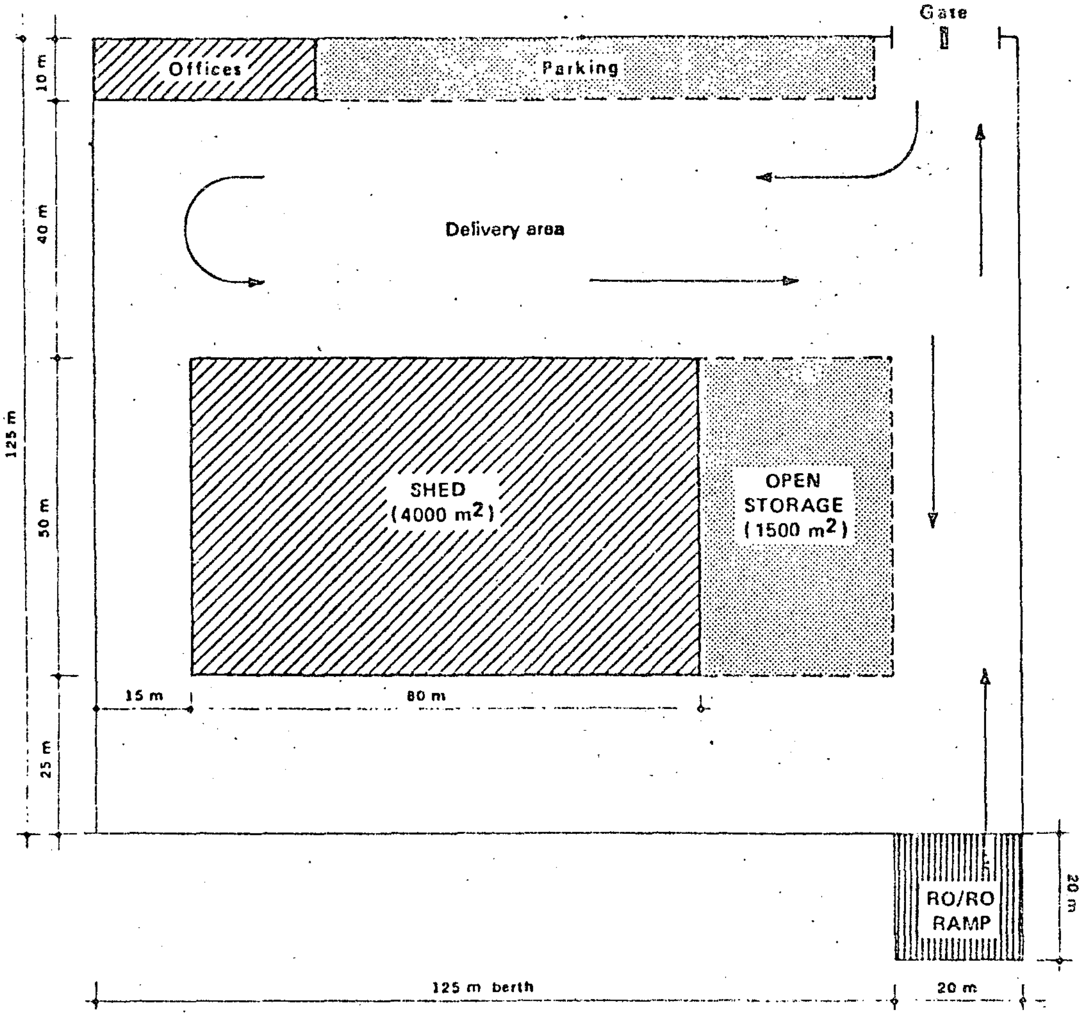


FIGURE 14

Small modern coastal or island berth



Thus the total gang-pool size for the zone will be the gang-pool size per shift times the number of shifts per day.

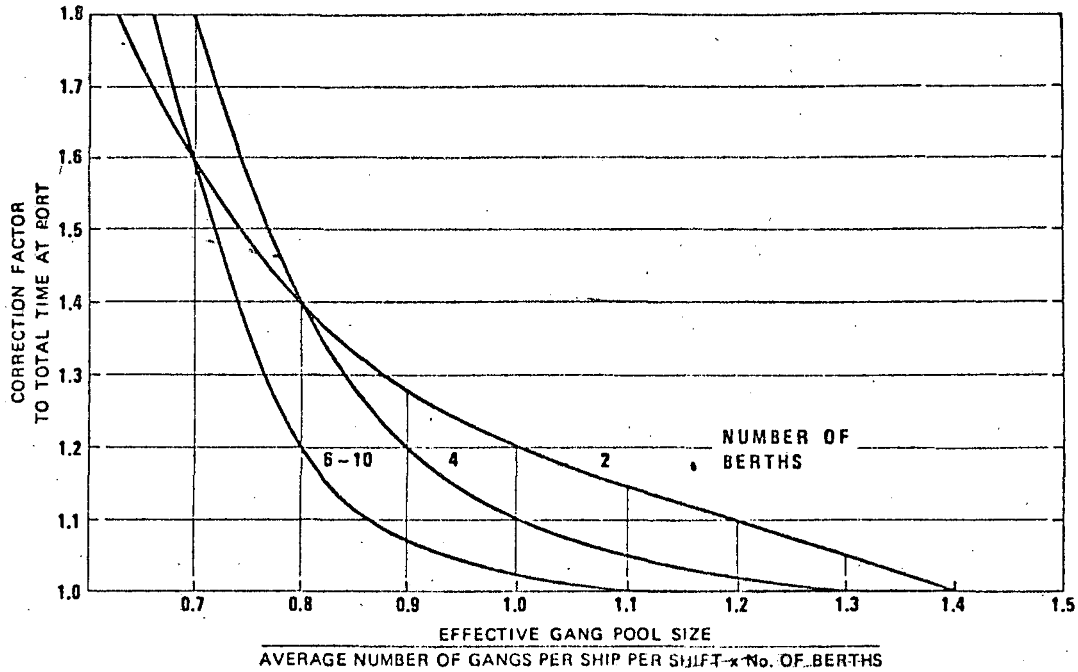
76. However, this rough rule takes no account of the need, when all berths are occupied, to provide extra labour for peaks of demand caused by the simultaneous starting of work on a group of ships or the need for urgent working on a number of vessels. Where there are more than six berths in a group sharing the same labour pool, no significant allowance need be made, but for smaller numbers of berths a reserve capacity of extra gangs above the number given by the approximate calculation may be needed. A shortage of gangs during periods of peak demand has a direct effect on ship turn-round time. For typical traffic streams and berth occupancies, a simulation technique has been used to quantify this relationship.

77. Figure 15 shows, for two, four or six berths in the group, the increase in waiting-time caused by various levels of gang-pool size expressed as the ratio of the number of gangs available to the gang-pool size given by the approximate calculation mentioned above. The effective gang-pool size is defined as the average number of gangs that are available to work at the terminal during a shift. Thus the number of gangs in the pool for one shift must be increased by a factor to take account of holidays and illness. A typical factor is 1.3. The average number of gangs per ship per shift is one of the elements used in planning chart I. As figure 15 shows, as the number of berths increases, the demand is smoothed, and the benefits of a ratio greater than 1.0 are reduced.

78. For example, a two-berth port, with an effective gang-pool size of four gangs and utilizing an average of two gangs per ship per shift, would have a ratio of 1.0. Therefore the ship time at port for this case, determined from planning chart II, would have to be increased by a factor of 1.2 which is obtained from figure 15. This increase in time is caused by shortages of gangs during peak periods. The waiting-time correction factor can be used in cost-benefit analyses to assist management in deciding how large the gang pool should be. In the above example, increasing the effective gang-pool size to five gangs would give a ratio of 1.2 and reduce the correction factor to 1.1. The 10 per cent reduction in ship turn-

FIGURE 15

Gang pool size correction factor for break-bulk general cargo terminal planning



round time would have to be compared with the cost of increasing the gang-pool size. This analysis would assist management to determine the best gang-pool size.

Q. Quayside rail track

79. Although the volume of cargo for direct discharging to and loading from rail will be the governing factor, there is a strong case in general against quayside direct delivery to rail for break-bulk operations. Quayside wagon shunting operations are very difficult to organize in such a way that high productivity can be achieved at the hatch being worked without interference with gangs working other hatches or other ships. Where possible, the loading to rail for onward transport in the case of imports, and the sorting of consignments from up-country for export, should be carried out in a rail yard away from the quay, with transfer from and to the quay being carried out on port mobile equipment, normally trailers. This move away from direct delivery to and from rail transport is due to the declining volumes of packaged bulk shipments being carried on general cargo liners. Only where a continuing and large volume of cargo in the form of heavy machinery, iron or steel and large bundles is foreseen, would the provision of quayside rail track be justified.

R. Quay cranes

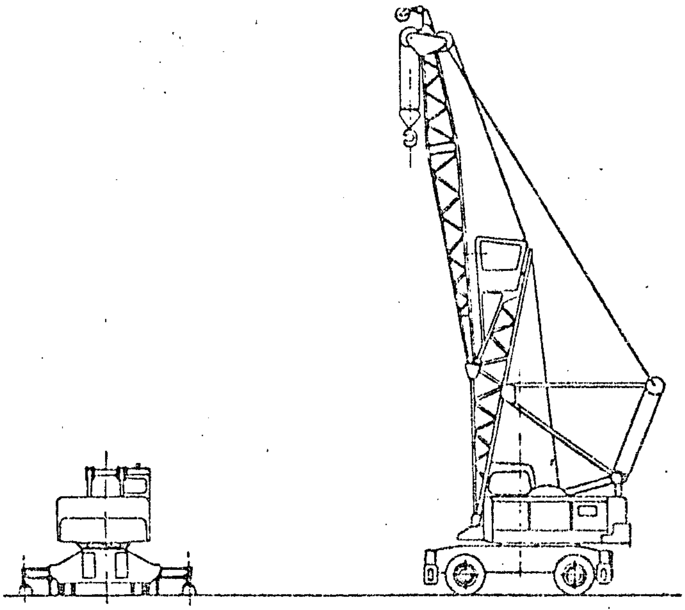
80. With the exception of those ports where there is a large tidal range, the use of quay cranes usually offers little handling advantage over the use of ship's gear while entailing heavy capital expenditure and additional maintenance problems. The difference in productivity between quay cranes and ship's derricks has generally been due to the difficulty of working derricks direct to rail wagons without frequent shunting. If there is no question of direct working to rail wagons, the difference in productivity becomes insignificant. The advent of shipboard electric cranes further sways the argument. The strengthening of the quay edge necessary for quay cranes, and the installation of the requisite crane track and electrical equipment involve further heavy expenses which should be avoided where possible.

81. It may be necessary for port management to accept the idea that the traditional forest of crane masts is no longer the right picture of a break-bulk berth group. A clear, well-surfaced apron for speedy transfer operations is a more appropriate picture. Only in the case where a continuing and large volume of heavy lifts is forecast are rail-mounted quay cranes justified.

82. If conventional rail-mounted quay cranes are not to be provided, a small number of mobile cranes on pneumatic tyres will be needed to lift the heavy items, including containers carried on deck, that will inevitably arrive. Normally, these special cranes will be needed for only a fraction of the ship working time and the number required is small, normally one per berth or one for two berths. When not required, they can supplement the mobile cranes working in open storage areas. These heavy mobile cranes with high towers for ship working are at least as expensive as conventional quay cranes, but they are much more flexible. A typical crane is shown in figure 16.

FIGURE 16

Mobile dockside tower crane



S. Provision of mobile equipment

83. When traditional handling methods are used in conventional break-bulk operations, the equipment allocated for the transfer of cargo to and from the quayside is often insufficient to permit the transfer operation to keep up with the hoisting of loads in or out of the ship's hold. This is demonstrated by the frequent sight of a stationary crane or derrick waiting for a load to be hooked on or off. Careful equipping and planning of the transfer operation will thus often be the most effective single method of raising ship-handling productivity.

84. It is difficult to give clear economic justification for any specific level of equipment for the quayside operation as can be done for the provision of berths and sheds; the estimate of equipment needs must be based on experience of the type of operation proposed. When the equipment needs have been estimated they must be included, together with the estimates for reserve equipment, spare parts and maintenance services, as an integral part of the investment proposal. No attempt should be made to economize in this area, since without proper equipment the economic and financial success of the whole investment will be jeopardized.

85. In recent years the quantity of mechanical handling equipment needed per berth has increased owing to the greater variety of cargo classes, including a higher proportion of palletized cargoes, and increasing numbers of containers and heavy loads carried on virtually every route, together with a continuation of the traditional break-bulk cargo. Moreover, higher equipment requirements than seem appropriate at first sight must be provided to allow for the time equipment is out of service because of scheduled maintenance, breakdowns and repairs.

86. As described in part one, chapter I, the project plan for a new development should include an operational plan. This plan should describe how ships are to be discharged and loaded, how goods are to be transferred to and from the ship's side, and how they are to be stacked in the sheds and open storage areas. The equipping and layout of the facilities should be based on this operational plan.

87. Nevertheless, it is often difficult at the time of planning a break-bulk berth to estimate precisely what the proportions of the different traffic will be. In this case a standard equipping policy can be adopted, along the lines set forth below.

88. The types of equipment needed for each part of the operation are as follows:

(*a*) Discharging and loading:
Where ship's gear is appropriate: nil
For containers and heavy lifts: mobile tower crane at ship's side

(*b*) Transfer between quay and storage areas:
Fork-lift truck
or
Tractor/trailer combination

The tractor/trailer combinations can be used in many ways, according to the transfer distance and how long the tractor would be immobilized either at the ship's side or at the stack if it remained coupled to the trailer. In principle, as suggested in the UNCTAD publication, on berth throughput,[1] the tractor should be uncoupled at both ends of the journey, working with three sets of trailers (one being loaded, one being unloaded and one being towed). This is often difficult to do, and moreover, since the optimum method of transfer may be to tow either a single trailer or a train of two or three trailers, exact planning is difficult. An over-all average for working methods would be in the region of two tractors and eight trailers per gang.

(*c*) Stacking and sorting in shed or open areas, and delivery from these areas:
Fork-lift truck
or
Mobile yard crane

89. It is unlikely that equipping decisions will be needed for a single berth in isolation, since to provide for all possibilities will then be very costly. It is preferable to plan the equipping of groups of berths—say, three at a time—with a daily allocation of the three-berth pool of equipment as required. For the three-berth group shown in figure 13, the following would be a suitable scale of equipment for allocation among the 10 gangs:

(*a*) For 4 gangs working ship's derricks to fork-lift trucks:
12 fork-lift trucks

[1] See *Berth throughput: Systematic methods for improving general cargo operations* (United Nations publication, Sales No. E.74.II.D.1) chap. IV.

(*b*) For 4 gangs working ship's derricks to tractor/trailers:

8 tractors
32 trailers

(*c*) For 2 gangs working mobile cranes to tractor/trailers:

2 mobile tower cranes
4 tractors
16 trailers

(*d*) For transit shed and open storage area operation:

8 fork-lift trucks
4 mobile yard cranes

90. The three-berth equipment should then be boosted by a reserve for breakdowns and preventive maintenance, as follows:

Mobile cranes	20 per cent (but it will often be necessary to provide one spare crane in any case)
Fork-lift trucks	25 per cent
Tractors	20 per cent
Trailers	5 per cent

This gives a total three-berth equipment of:

20-ton mobile tower cranes	3
10-ton mobile yard cranes	5
Fork-lift trucks	25
Tractors	15
Trailers	50

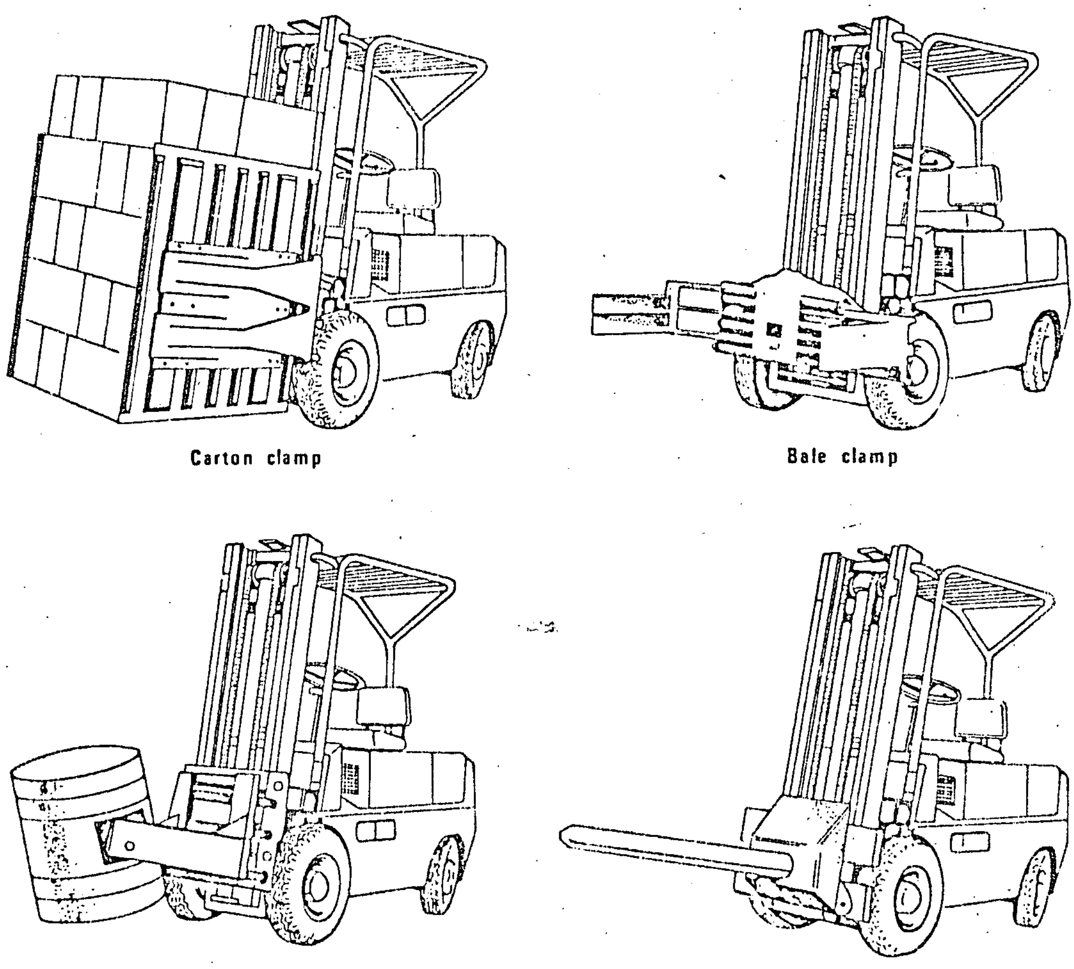
91. This level of equipping can be scaled up or down according to the number of gangs in the operation plan for the port zone. In the absence of local operational statistics, the following number of gangs may be assumed for planning purposes:

Deep-sea ships	3 gangs, occasionally 4 (average: 3⅓)
Smaller coastal and short-sea ships	1 or 2 gangs (average: 1½)

T. Cargo-handling attachments

92. The correct range of minor cargo-handling attachments cannot be exactly specified until the detailed composition of the traffic is known. In order to make funds available for their purchase, during and after commissioning of the new facilities, a definite

FIGURE 17
Examples of fork-lift truck attachments



Carton clamp — Bale clamp — Drum clamp — Post attachment provision should be made in the project budget. If this is not done there can be delays in obtaining authorization for minor purchases that can seriously endanger the operation of the new facilities.

93. A few of the attachments which may be required for fork-lift operations are illustrated in figure 17. Mobile cranes will also need a range of hook gear, including container spreaders as well as standard stevedore's gear. A suitable provision to include in the project budget is a figure related to the number of cranes and fork-lift trucks provided in the following manner:

Equipment	*Budget cost of attachments as a percentage of total purchase price*
Mobile tower crane	10
Heavy fork-lift truck	15
Light fork-lift truck	25

U. Elevators and conveyors

94. There are certain limited roles for elevators and conveyors in break-bulk operations. Pocket elevators can be used to work in and out of ships' holds for large consignments. They consist essentially of two continuous strands of chain which carry a continuous canvas band arranged in loop pockets. Although theoretically such elevators working continuously can produce substantial outputs, in practice there are frequent interruptions and in general terms it is unlikely that a pocket elevator can reach the speed of a well-planned conventional lift-off operation.

95. Various types of conveyor, such as slat, roller, belt and plate conveyors, can be used wherever the physical dimensions of the ship and quay permit, for example in the side ports of side-loading ships. They may also be used in transport sheds and warehouses. All conveyors, however, form a barrier to other movements and therefore conveyors made up of portable sections are to be preferred to fixed ones when used on the quay apron. Although conveyors are ideal for horizontal transport, they are not cheap, and the scale, speed and flexibility of the operation should be carefully assessed before installing a large conveyor system.

Chapter III

CONTAINER TERMINALS

A. Container ship development

96. Container ships are generally classified into "generations", that is, as having characteristics typical of certain stages in container development and container ship building. The main characteristics of each "generation" are shown in table 1. The term TEU is a useful standard term for defining the carrying capacity of a container vessel. One TEU is a twenty-foot equivalent unit and therefore a forty-foot container counts as two TEUs.

TABLE 1

Physical characteristics of container ships

	Container capacity (TEUs)	*Dwt*	*Over-all length (metres)*	*Over-all width (metres)*	*Draught (metres)*
"First-generation" container ships ...	750	14 000	180	25	9.0
"Second-generation" container ships ...	1 500	30 000	225	29	11.5
"Third-generation" container ships ...	2 500–3 000	40 000	275	32	12.5

97. To keep operating costs to a minimum, the maximum utilization of these large modern vessels must be achieved. Thus there has been a move to reduce the number of ports of call of the mother ships and to introduce feeder vessel services to the ports with smaller volumes of trade. The feeder ships have the task of relieving the long-haul container ships from making the extra calls which greatly increase the total time they spend in ports. Feeder ships vary in size from capacities of 50 to 75 TEUs up to 300 TEUs.

98. The rapid spread of container operations has been very fully documented. A detailed discussion of containerization and its impact on ports in developing countries is given in the UNCTAD publication on the subject[2] and in a series of reports, preparing by the UNCTAD secretariat on the subject of technological change in shipping and its effects on ports.[3] Soon the last major trade routes between highly industrialized countries will have been containerized. At the same time, there is already an increasing trend towards containerization of certain specific services linking developing and developed countries.

99. Examples of this trend are services between Europe and the Carribbean, between Europe and the Middle East, between Europe and West Africa and between North America and Central America. Generally the vessels involved are of the "first generation" kind or, on the shorter runs, feeder vessels. The basic problems with these services are the imbalance of trade and the labour problems caused by the reduced demand for manpower.

100. At present these and similar container services carry only a small fraction of the general cargo liner traffic between developed and developing countries, but in developed countries' ports container services already handle between 20 and 60 per cent of the cargo. Therefore port authorities in developing countries cannot afford not to consider the probable development towards containerization of their countries' trade, and the profound changes in port planning, management and operations which such development brings with it.

101. Both the break-bulk berth group and the multi-purpose terminal must be capable of handling containers—even if, in the former case, only a small number of units are carried (mainly on deck) in a liner operation. This chapter is concerned with the specialized container terminal needed to handle the cellular container ships.

102. These large ships will not normally call at a port without a specialized container terminal offering a specified level of service. By investing in a specialized terminal a port can make calls by container ships possible, but such an investment cannot be financially justified until a satisfactory level of use is guaranteed. The container throughput must be expected to build up to between 30,000 and 50,000 TEUs in the first three years of operation if the investment is to be justified. Below this level, the port should either provide limited facilities for container feeder ships or adopt the transitional multi-purpose terminal described in the next chapter.

B. Planning and organization

103. It is wrong to imagine that the planning, organization and running of a container terminal is a

[2] *Unitization of cargo* (United Nations publication, Sales No. E.71.II.D.2).

[3] Documents TD/B/C.4/129 and Supp.1-5.

straightforward task. Figure 18 gives an indication of the main factors which have to be taken into consideration in planning a container terminal and can be used as a checklist in order to ensure that none of the most important issues have been overlooked. The complexity of this type of terminal coupled with its newness necessitates a comprehensive training programme of the senior operating staff, often in a well-organized and efficient container terminal.

C. Productivity

104. There has been considerable inaccuracy in predicting container terminal productivity. In the course of its investigations into technological change in shipping and its effects on ports, the UNCTAD secretariat found that the average throughput for a sample of 21 ports was 442 containers per 24 hours in port,[4] a figure significantly below the figures used in theoretical calculations by consultants, theoreticians and potential operators.

105. The average productivity per hour per vessel, even averaged over a long period, varies considerably from one terminal to another, from about 10 to 50 containers per hour. This figure refers to single units either loaded or discharged and includes any idle time within a working period. The early ideal or operating objective of a one container off/one container on combined cycle is now rarely achieved or even attempted for any significant period.

106. The gross productivity per hour can be converted to a daily figure by using the ratio of working time to berth time. The working time includes any idle time within a working period, such as that due to equipment breakdown and therefore for ports operating around the clock the ratio could be 100 per cent. A number of reasons prevent ports from achieving this 24-hour per day operation, however, and the ratios usually vary between a peak of 95 per cent and a low of 40 per cent. Clearly this variation in the intensity of working can have a significant effect on the annual throughput of the terminal.

107. The figures for throughput per 24 hours in the sample referred to (see para. 104 above) are the most significant. The difference between the maximum and the minimum value for the 21 terminals taken together was quite large (a high of approximately 750 containers versus a low of approximately 225 containers per 24 hours in port). The average throughput for these terminals was nearly 450 containers per 24 hours in port. How satisfactory is this performance? Given that at most terminals 24-hour operation seven days a week is standard practice, the typical throughput used in past feasibility studies as a basis for cost-benefit analysis of container ship and container terminal operators alike was calculated as follows:

Average output per gantry crane	25 units per hour
Loss of output for opening and closing hatches	10 per cent of basic output rate
Average number of gantry cranes allocated to each vessel	2
Working time/berth time ratio	0.80

Thus, according to this earlier method,

Average throughput per 24 hours = 24 (average output per crane) × (average number of cranes allocated) × (coefficient for loss of output for opening/closing) × (working time/berth time ratio)

= 24 (25 × 2) (0.90) (0.80)

= circa 860 containers

108. The actual average throughput of the sample is slightly more than 50 per cent of this theoretical figure. Clearly the figures used in this procedure are too optimistic for planning purposes and more realistic figures should be used when calculating ship turn-round time for the economic analysis.

109. There is little doubt among container terminal experts that the present performance of container facilities throughout the world is far from optimum. No doubt part of the difficulty stems from the fact that there is excess capacity at the present time of economic slump and that fewer goods are being moved by this form of transport. However, there are major operating inefficiencies which are due to inappropriate planning decisions, operating procedures, equipment, or manpower policies. The main reason for inefficiency lies in the imbalance between the capacities of the various system parts at a terminal and inadequacies in the inland transport system.

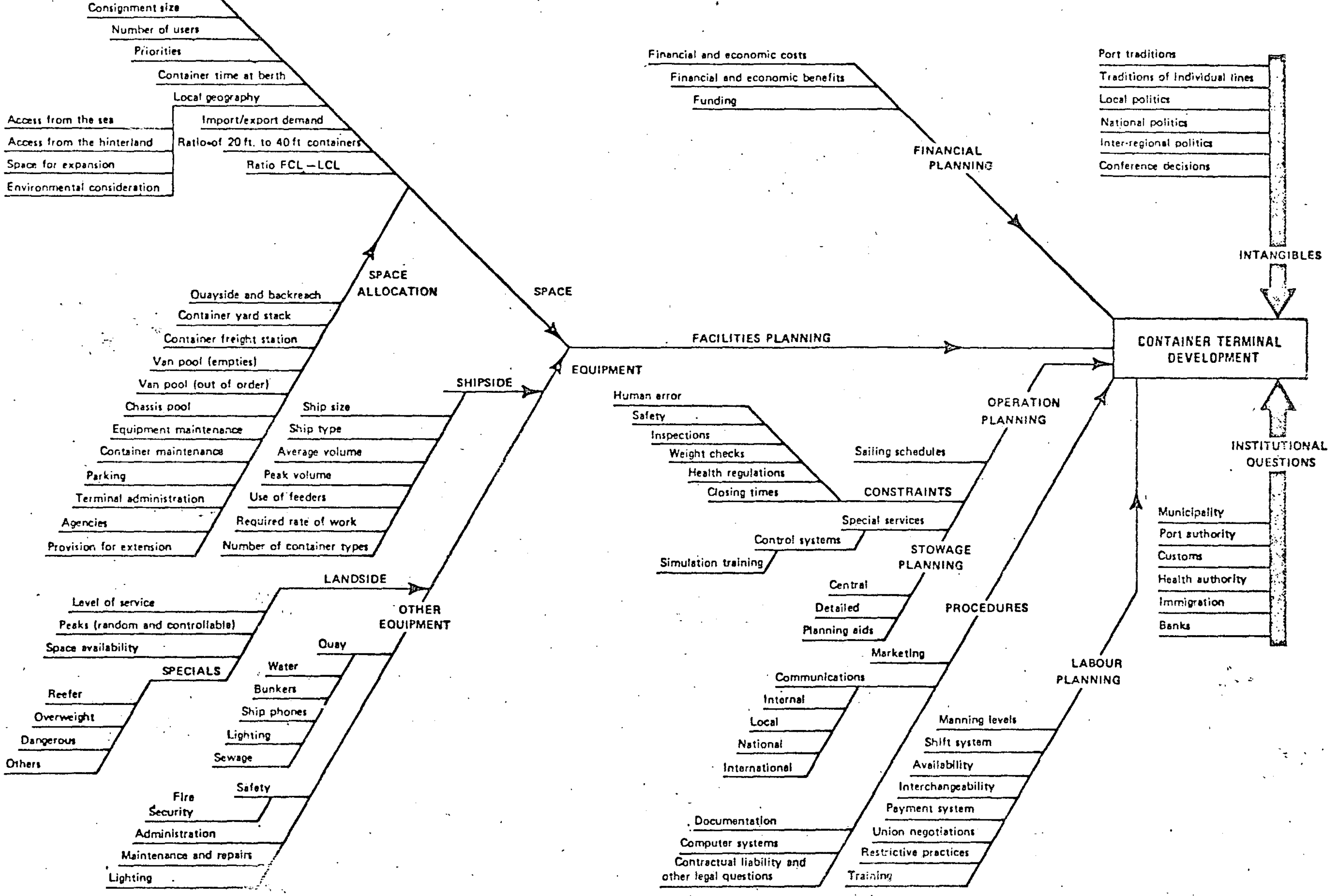
110. In general, the capacity which has been provided for the loading and unloading of containers exceeds the terminal's transfer, stacking, storage and delivery capacity. This has been due primarily to an under-estimation of the transfer distances that would have to be covered and of the proportion of time that equipment would be out of service for maintenance purposes. A survey carried out in four ports in the United Kingdom showed that the proportion of time during which straddle carriers were out of service for maintenance averaged almost 30 per cent.[5] The figure was even higher than this in ports with a high work-load. This fact supports the UNCTAD secretariat's view that, for developing countries, tractors and trailers are likely to be the most economic system for the transfer operation and that straddle-carriers should be considered as merely one possibility for the stacking operation.

[4] See TD/B/C.4/129/Supp.1, para. 90.

[5] H. K. Dally, "Straddle carrier and container crane evaluation" in *National Ports Council Bulletin* (London), No. 3, 1972.

FIGURE 18

Dependency tree for container terminal planning



D. Container handling systems

111. The three most commonly used container handling methods in operation today are the trailer storage system, the straddle-carrier system, and the gantry-cranes system, the gantry-cranes being either rail-mounted or rubber-tyred. There can also be various combinations of these types of equipment at individual terminals. The essential features of each of the main systems are given in the following paragraphs.

1. Trailer storage system

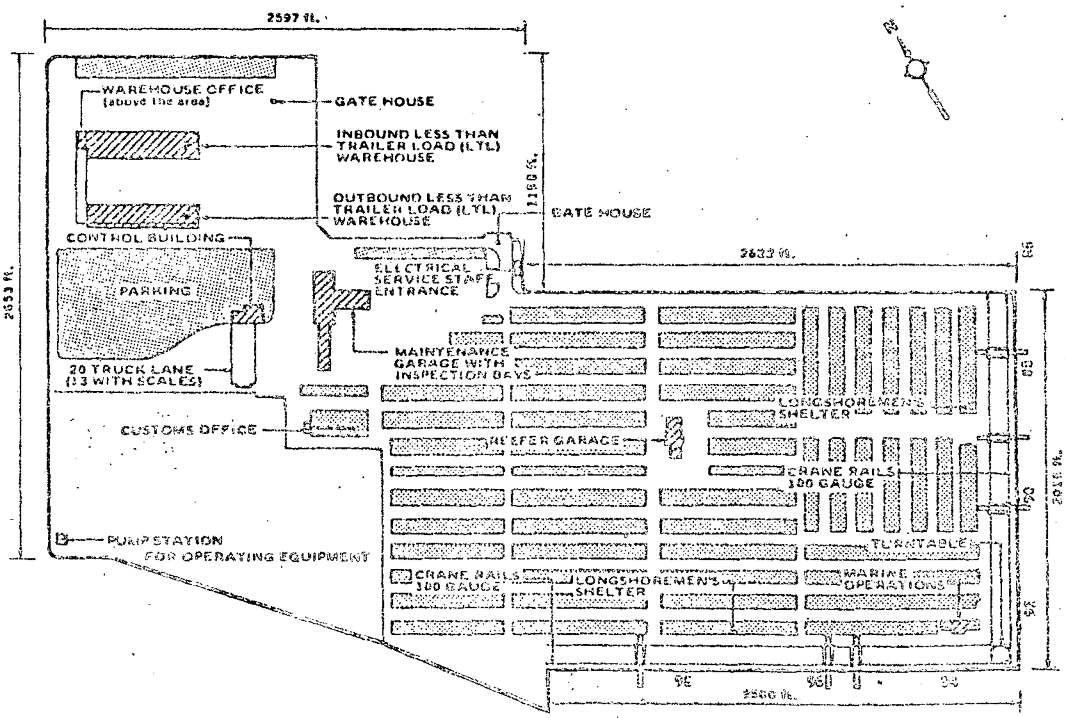
112. The import containers discharged from a ship by crane are placed on a road trailer, which is towed to an assigned position in the storage area where it remains until collected by a road tractor. Trailer carrying containers for export are placed in the storage area by the road tractors and towed to the ship by port equipment. The containers are thus of necessity stored one-high, and the system requires a very large transit storage area (see figure 19). This is a very efficient system because every container is immediately available for removal by a tractor unit, but in addition to requiring a large area it also requires thousands of trailers, entailing considerable expense. This method is therefore normally used only when a shipping company provides the trailers and either operates at a leased or reserved berth or has access to a special trailer compound. This makes trailer storage generally unsuited for use by multi-user terminals.

2. Straddle-carrier system

113. At the present time the straddle carrier system is the predominant one. Straddle carriers can stack containers two or three high, move them between quay crane and storage area, and load or unload them to or from road transport (see figure 20). In the past, however, these machines have had a poor reliability record, poor visibility, high maintenance costs and a short life. Leaks from joints in the hydraulic system and oil spillage from damaged pipework cause highly slippery surfaces, break up asphalt paving and necessitate continual renewal of the white lines and numbers essential in stacking areas. Safe operation demands that straddle-carriers should operate within a restricted area, and that workers on foot should be kept out of the working area. The fact that despite these drawbacks the straddle-carrier is so widely used is a testimony to its flexibility and its ability to meet peak requirements. Furthermore, major improvements have been made in the design of straddle-carriers, and most of their poor maintenance record resulted from a lack of preventive maintenance and the excessive use of the equipment for transfer operations. A variant of this system is the use of tractor-trailer units for the transfers between quayside and storage area, and the use of straddle-carriers only within the storage area for stacking and selecting containers.

FIGURE 19

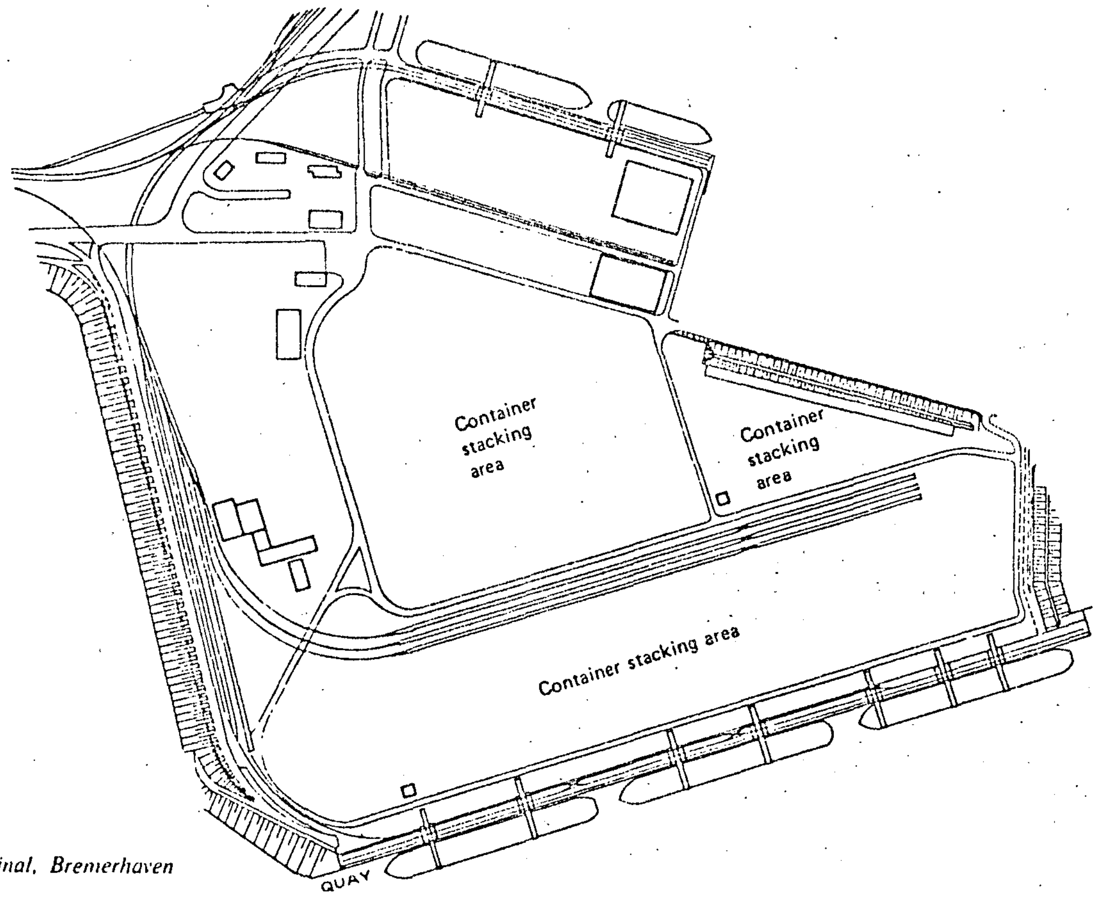
Example of trailer storage container terminal layout



General plan of new sea-land terminal at Elizabeth, New Jersey. (Parking space 3,757 35 ft containers and 2,498 40 ft containers.)

FIGURE 20

Example of straddle-carrier container terminal layout



Container terminal, Bremerhaven

3. Gantry-cranes system

114. In this system, containers in the storage area are stacked by rail-mounted or rubber-tyred gantry-cranes (see figure 21). Rail cranes can stack containers up to five high (although normally containers are stacked no more than four high). Rubber-tyred gantry-cranes can normally stack containers two to three high. Tractor-trailer units make the transfers between quayside and storage area. This system is economical in land because of the high stacking, and is suitable for varying degrees of automation. Gantry-cranes have a good safety record, are reliable and have low maintenance costs and a long life in comparison with straddle-carriers. Finally, they are considered environmentally superior. They are far less flexible than straddle-carriers, but to offset this, gantry-cranes (particularly the rail-mounted type) are better suited for automation. In the longer term, the need to economize in land is likely to be very important, and this favours the gantry-cranes system. This system is especially useful where exports are an important fraction of the total traffic, but perhaps less than optimum where import cargoes constitute the major portion of the traffic.

4. Mixed systems

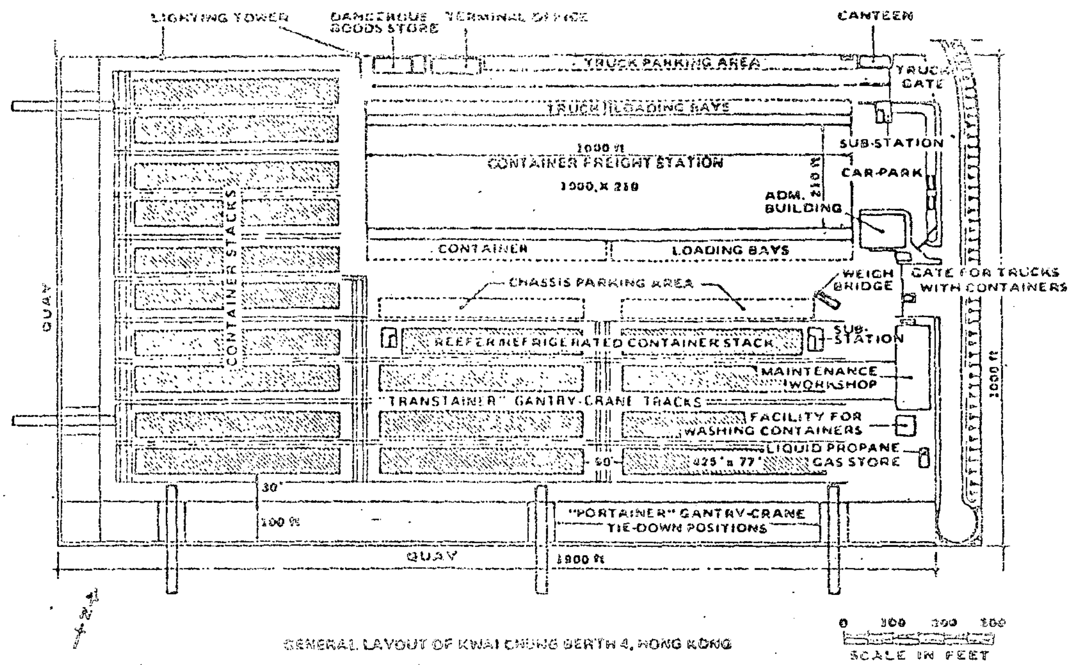
115. Mixed systems employ the best equipment for the particular operation. However, for such systems to be successful, a comprehensive information system and rigid operating policies are required, together with excellent management. For example, straddle-carriers are used for extracting individual import containers and delivering them to road vehicles, but gantry-cranes are used in the container park for feeding exports to the ship where it is possible to work straight off an export stack. Figure 22 (see folding insert) shows a mixed system where straddle-carriers and gantry-cranes are used.

E. Area requirements

116. The choice of operating methods and equipment and thus the area of land needed for a container terminal depends to a high degree on the availability of local land and on soil conditions. If the terminal is located far from urban agglomerations and land is plentiful and inexpensive, a system of storing containers only one high may be the most

FIGURE 21

Example of gantry-crane container terminal layout



economical. For this layout, no costly equipment is needed for stacking containers but transfer distances may become long, resulting in additional transfer equipment being needed. Also, on reclaimed land with relatively soft soil, this one-high method is particularly advantageous since the carrying capacity of the soil does not need to be reinforced as it would for heavy stacking equipment. On the other hand, if land is scarce and expensive, the stacking of containers as high as physical conditions and commercial requirements allow becomes a necessity.

117. Lack of container storage space has been another serious constraint on operations. It is true that, since the introduction of containerization on the major trade routes, there is a trend towards larger storage areas for container terminals, but in many planned developments the space requirements are still under-estimated.

118. The most frequent error has been to assume that the maximum stacking height can always be attained. In practice the average stacking height is much lower, depending on the amount of shifting of containers necessary in the storage area, and the need for containers to be segregated by destination, weight class, direction of travel (inward or outward), sometimes by type and often by shipping line or service. The need for storage of empty units and of unserviceable containers has also often been overlooked.

119. A further serious mistake is the belief that containers have a shorter terminal transit time than break-bulk cargo. In fact, the same constraints which cause break-bulk cargo to stay in the port will often have a similar effect on container cargo. In practice it is not unusual to find that the transit times for both are very similar. The following are typical delay times for containers at container terminals, taken from a number of terminals:

	Days
Containers carrying import cargo	7
Containers carrying export cargo	5
Empty containers	20

120. Container terminal planning chart I (see figure 23) is used to determine the most important dimension of a container terminal, the container park area. The figure for the number of twenty-foot-equivalent container units to be handled across the quay per year is entered on the planning chart. The planner descends vertically to the "turning point" where the vertical line meets the line representing the average time the container spends in transit at the terminal. He then moves horizontally to the left to the next turning point defined by this horizontal and the appropriate line for the area requirement per TEU.

121. The area requirement per TEU depends on the type of container handling equipment used and the consequent access requirements and maximum stacking height. Typical area requirements are as follows:

	Stacking height (number of containers)	*Square metres per TEU*
Chassis	1	65
Straddle-carrier	1	30
	2	15
	3	10
Gantry-crane	2	15
	3	10
	4	7.5

Figure 22

Example of mixed container terminal layout

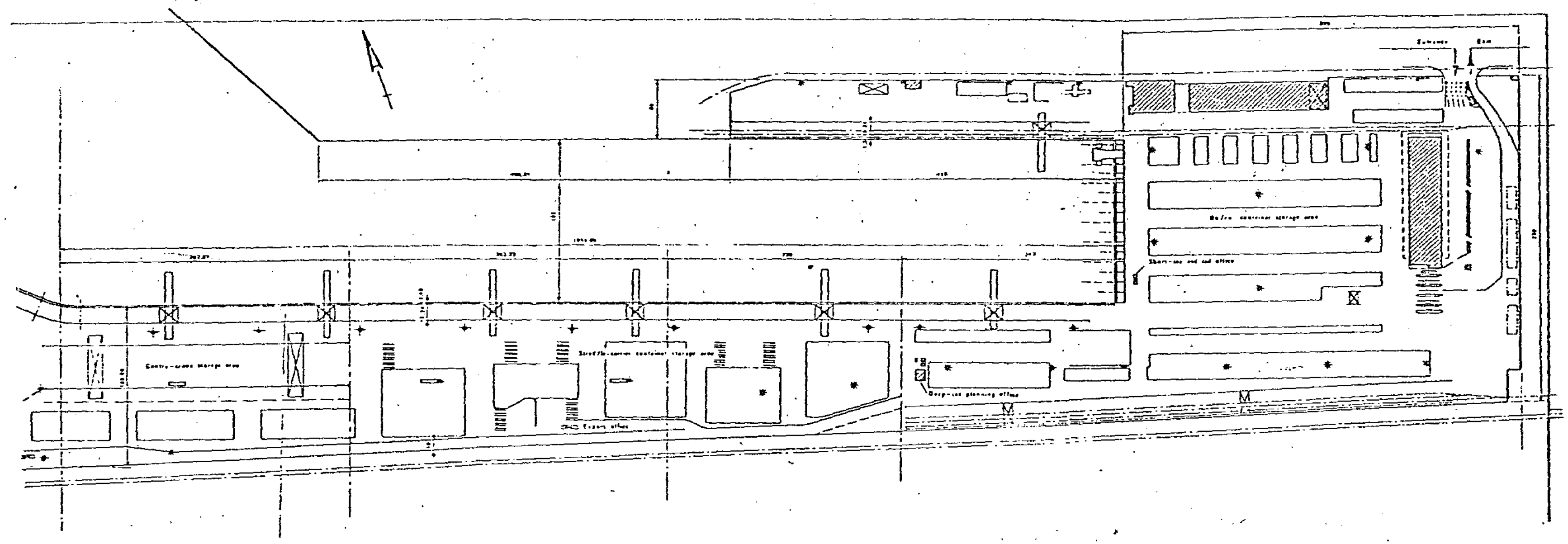
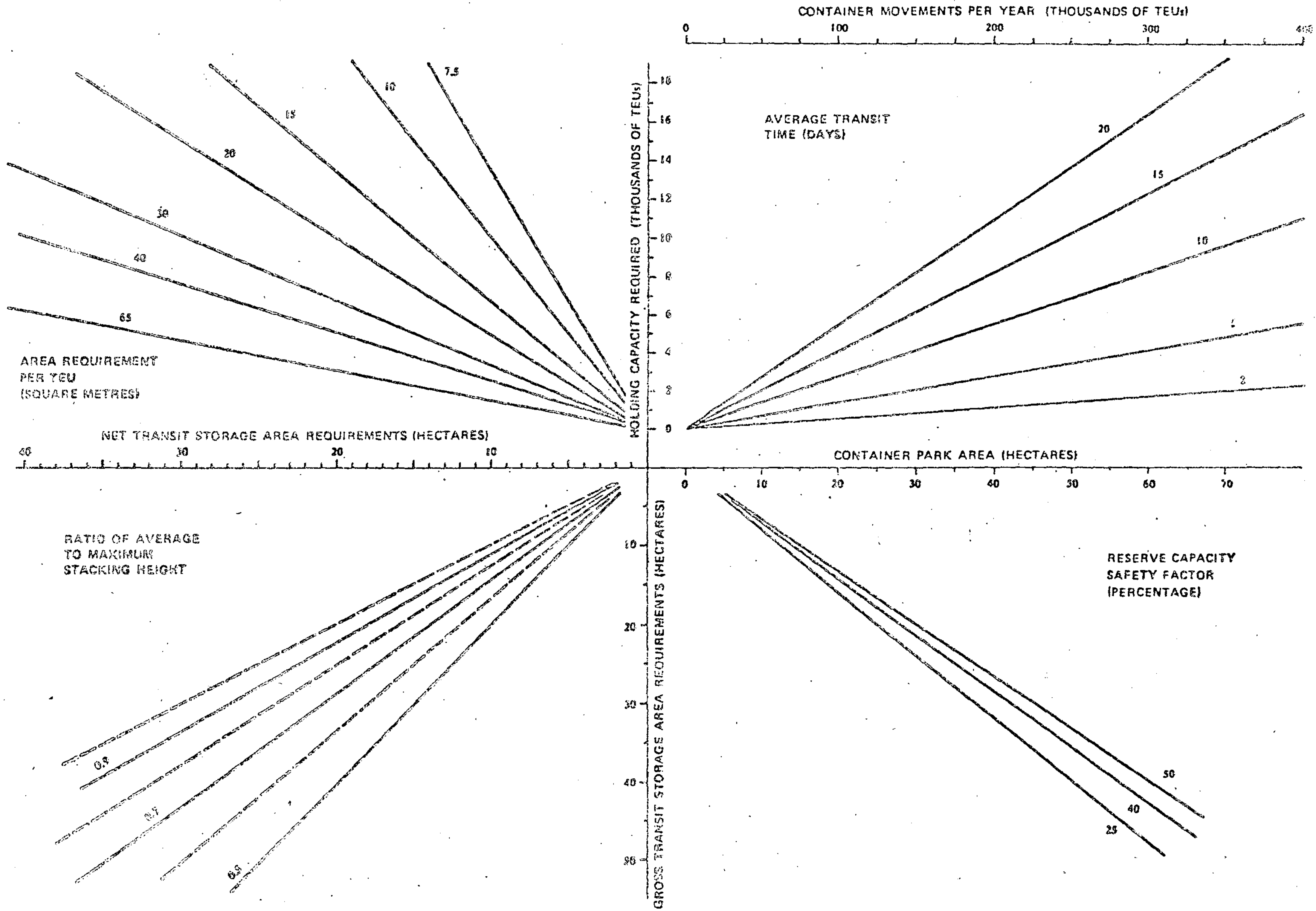


FIGURE 23

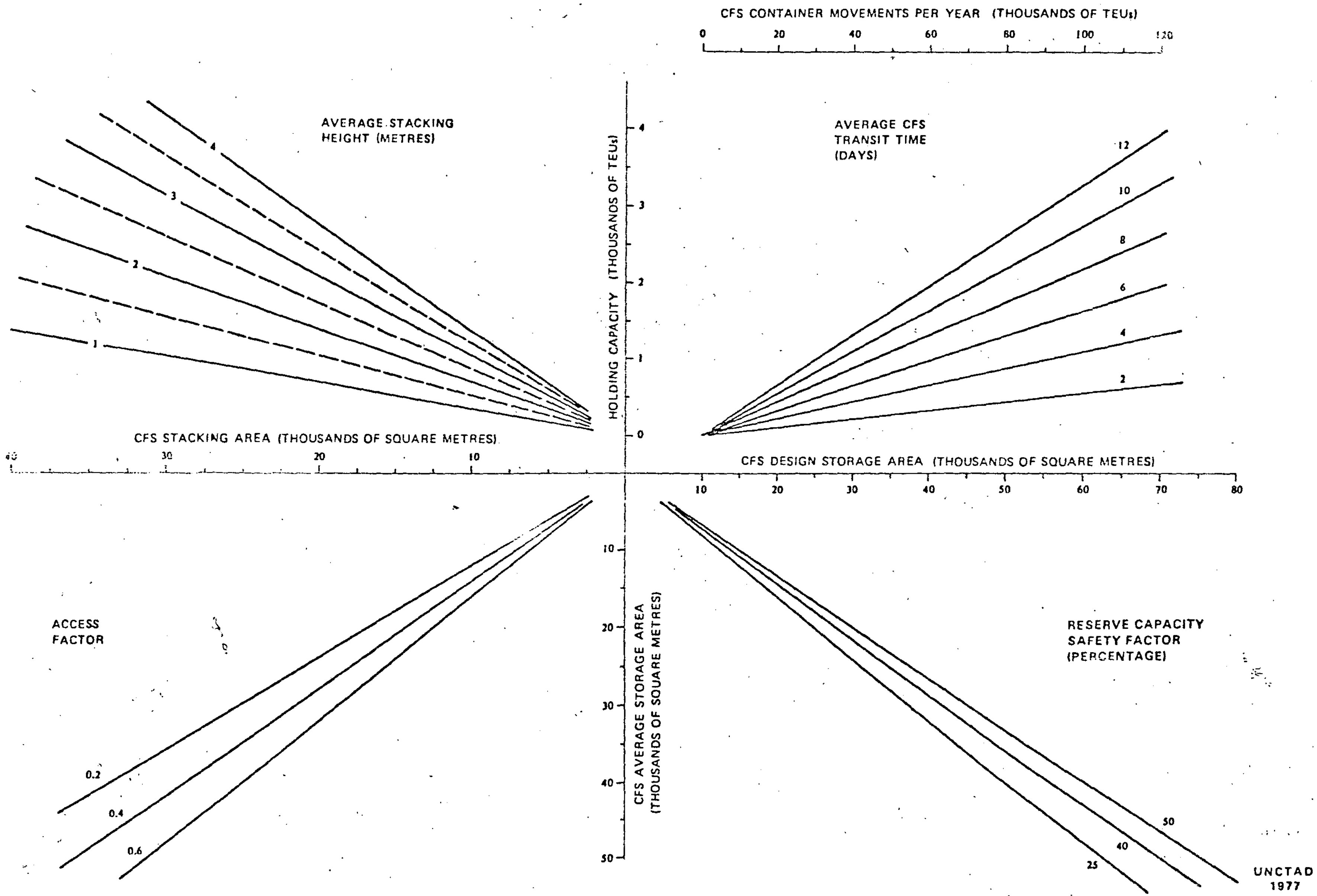
Container terminal, planning chart I: container park area



Note: 1 hectare = 10,000 sq metres.

FIGURE 24

Container terminal, planning chart II: container freight station area



122. The planner then descends again to the ratio of the average to the maximum stacking height of containers. The average height is the level at which operationally the container park area is considered full. For example, although a straddle-carrier can stack containers three high, it would not be practical for the operator to stack the entire park three high as it would then be impossible to remove individual containers. An adjustment factor must therefore be applied to allow for this fact. The planner now moves horizontally to the right to the reserve capacity safety factor—the factor which allows the park to handle peaks in demand.

123. Finally he moves upwards to the container park area required. The intersections of the trajectory and the axes give the planner the following information: holding capacity required, in TEUs, net transit storage area requirements, gross transit storage area requirements, and container park area. The chart may be used repeatedly to determine the effect on area requirements of different handling equipment in order to find the most economical solution for local conditions.

124. The planner must now estimate the area requirements for the container freight station (CFS), the structure used for "stuffing" and "stripping" containers and for consolidating and sorting consignments in the port area. Assuming that each TEU container handled via the CFS requires 29 cubic metres of space, the CFS storage area can be determined by using planning chart II (see figure 24). The following turning points are used: average transit time of consignment; average stacking height in CFS; access factor to allow for circulation and operational areas in the CFS; and reserve capacity safety factor for periods of peak demand. For example, a terminal at which 20,000 TEUs per year pass through the port CFS, with a mean transit time of 10 days, a stacking height of 2 metres, an access factor of 0.4 and a safety factor of 25 per cent, would require a CFS storage area of 14,500 square metres.[6] The structure should also have a large roof overhang to allow protection of the container loading bays from the weather (see figure 25).

125. In addition to the container park and CFS areas, the terminal requires space for marshalling areas, vehicle parking, rail and road access, customs, damaged containers, reefer cargoes, staff, administration, maintenance and dangerous goods storage facilities. Typical additional requirements per berth could be from 20,000 to 30,000 square metres.

F. Berth occupancy at specialized unit terminals

126. Specialized berths such as container terminals can achieve cargo handling rates five or even ten times higher than conventional berths. In addition, unitization results in a considerable reduction in the number of calls through the pooling of services, with larger consignments per vessel, which further increases the productivity per call. Thus, in unitized form, a given quantity of cargo can be handled at fewer berths, and it will be rare that a container terminal investment decision will involve more than two berths in the initial phase. Therefore the berth occupancies which will be appropriate in order to keep waiting time to an acceptable level will be low. The fact that container ships are much more expensive than general cargo vessels reinforces this need to minimize waiting time. In the planning procedure given below, the basic economic effect of waiting time will be a main factor in the investment decision, but there will in addition be the need to consider other criteria.

127. In the case of any special-purpose or advanced type of installation the following three criteria should normally be considered:

(*a*) Whether the resulting berth occupancy will give the right balance between ships waiting for a berth and berths waiting for a ship;

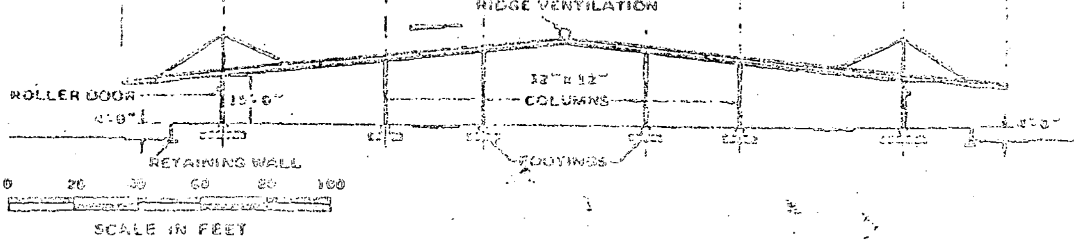
(*b*) Whether the average ship turn-round time will satisfy the normal user, irrespective of what this implies with regard to berth utilization;

(*c*) Whether there is sufficient peak capacity to give a satisfactory individual service to the exceptional, more demanding, user and to insure generally against congestion during periods of exceptional traffic.

[6] This figure can be compared with other CFS areas at the following container terminals: Guam: 2 berths, CFS 3066 m²; Keelung: 5 berths, CFS 2700 m²; Port Kelang: 2 berths, CFS 6771 m²; Singapore, East Lagoon: 3 berths, CFS 21000 m²; Kwai Chung berth 4: 3 berths, CFS 23 241 m².

FIGURE 25

Cross-section of container freight station



128. Performance calculations should be carried out to demonstrate that all three of these criteria are satisfied. There will often be a difference in the capacities which will satisfy the different criteria, and it will be necessary to reach a compromise. In reaching this compromise the port management will often need to take an entrepreneurial decision: there may be no clear-cut single solution with an economic justification which at the same time gives a level of service that will satisfy customers. It will be for the decision authority to consider these investment risks, and in order that it may do this the planning team should present separate proposals, according to each of the three criteria, for purposes of comparison. These will be more useful to the decision authority than a single proposal that attempts to meet all three criteria.

129. The container terminal planning chart III (see figure 26) is utilized to determine the berth-day requirement. The method used is similar to that used for chart I, starting with the standard working hours per day and with the following turning points: average number of TEUs per hour per crane, which should include an allowance for equipment downtime; berth and crane configuration (gantry-crane effectiveness factor per crane = 1 crane: 1.0; 2 cranes: 0.9; 3 cranes: 0.8); shipload (TEUs), and number of ships per year. This path gives the average number of units per day per crane, the average number of units per day per berth, the average berth time per ship (which includes a one-hour period for berthing and deberthing the ship) and the annual berth-day requirement.

130. Starting with the berth-day requirement, the following turning points should be used in planning chart IV (figure 27): number of berths; commission days per year; number of berths and average daily ship cost. The path traced gives the total time at port and the annual ship cost. In addition the chart gives the probability of a ship having to wait more than one average service-time for a berth.

131. The relationship between berth utilization and total time at port is based on queueing theory. The assumption has been used that the service time and the inter-arrival time follow an Erlang 2 distribution. A more detailed discussion is given in annex II, section D. For a terminal servicing a near-sea route for one or two operators, the arrivals would be more regular and the berth waiting time for a given berth utilization would be less. However, these curves can be used with a high degree of confidence for most container terminals.

G. Information systems

132. Many terminal operators have decided to utilize an electronic data processing system to assist in the collection and processing of the required information. It is generally accepted that for terminals handling 100,000 or more containers a year, a manual system, which may have proved very satisfactory up to that point, becomes far less practicable. A computer system can be introduced to handle the large quantity of information. There are, however, cases where efficient manual systems have been successfully used for much larger throughputs.

133. At present, many container terminals have both a manual and a computerized system, but each has a specific function. The manual system serves mainly to assist the terminal operator in the control of all terminal operations (including the location of the containers at the terminal). The computer-assisted system, on the other hand, is used to process invoices, gather statistical data and to present the container operators with detailed information, for example, on the type and number of units at the terminal, the availability of empty units and productivity rates on the ship. The project proposal for a container terminal should include any such data processing equipment as a terminal equipment cost item.

H. Schedule-day agreements

134. The need to achieve a reasonable level of berth occupancy without increasing the probability of ships having to wait has raised the question of the scheduling of arrivals. If vessel arrivals can be scheduled, a much higher berth utilization is possible without significant waiting. It is possible for agreement to be concluded between container terminal operators and shipping lines for specified schedule-days, particularly with short-sea services. Ships that arrive in the scheduled slot are then guaranteed immediate berthing. This procedure can give substantial gains.

135. Unfortunately, the risk that vessels will be slowed down on deep-sea routes, for example by weather, means that large safety-margins normally have to be provided. These destroy much of the advantage of the scheduling, and experience has shown that the ships from several lines arriving at a deep-sea container terminal are very little more systematic in their arrival patterns than the traditional liners they replace. The arrival pattern at a terminal is also affected by the hours of work at other ports. For example, if other terminals in the area do not work at the week-end, one that does is likely to find a group of vessels arriving at the end of the week.

136. Faced with this situation, the best that a large container terminal operator may be able to do is to give the fastest turn-round service possible on a first-come first-served basis. The use of a buffer stack of cargo to speed up service is a possibility. There could, for example, be a "post-stack" for import cargoes and a "pre-stack" for export cargoes, the stacks being placed directly on the quay near the vessel.

FIGURE 26

Container terminal, planning chart III: berth-day requirement

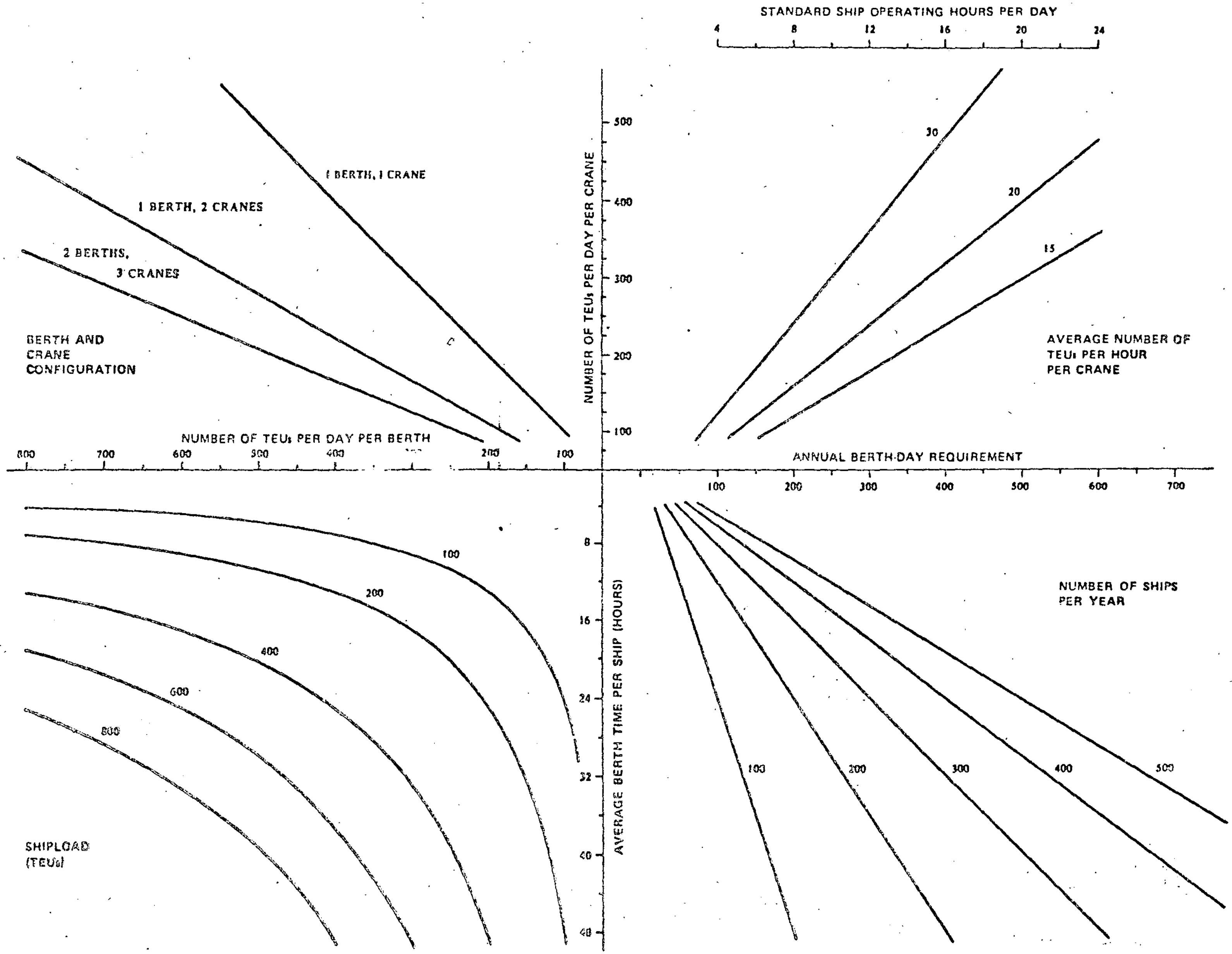
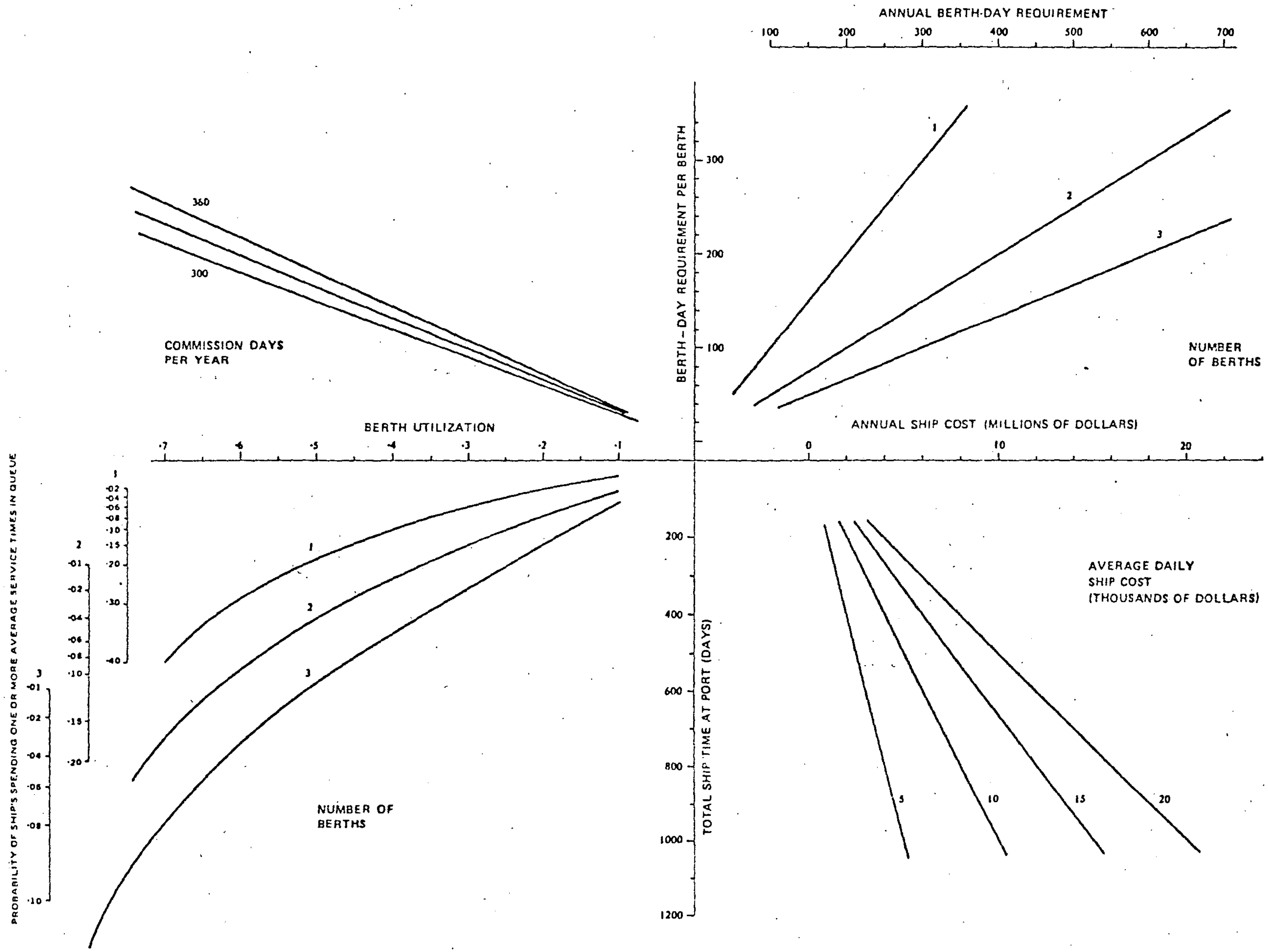


FIGURE 27

Container terminal, planning chart IV: ship cost



I. Container feeder services

137. The trend towards concentrating traffic at a small number of pivot or gateway ports is particularly pronounced on the long-distance container routes. The specialized container vessels have become larger and more sophisticated, while the cost of building a modern container terminal is very high. The economics are more and more in favour of unloading and loading all containers at one well-equipped port, and distributing them by coastal feeder vessels to other ports in the region.

138. It is difficult to forecast such developments, and close discussion is needed between the planner and the shipping lines concerned. The attitude of shipping lines is liable to change, and while they may initially wish the mother ships to call at every port, at a later date they may wish to introduce feeder services.

139. Feeder ships are normally designed for a specific service, with the characteristics of the port in mind. They are relatively small (usually having between 10 and 20 per cent of the capacity of the trunk route vessel), and are often built without ship's gear in order to increase their carrying capacity, to improve their stability and to reduce costs. The majority are probably ro/ro ships, but there are also pure cellular feeder ships and combination ro/ro and lift off vessels.

140. The load factor of feeder vessels is normally very high, approaching unity. At the ports serviced only by the feeder vessels, however, handling rates—although much higher than with the traditional break-bulk operation—will be lower than at the pivot or gateway specialized terminal because only one gantry-crane can work the feeder vessel. A typical figure of 15 units per hour may be achieved with a 100 TEU-capacity feeder ship. Table 2 gives the principal characteristics of several ships in this class.

J. Types of container handling equipment

141. The large size of ISO containers necessitates large equipment for handling. The choice of a particular handling method is related to the type of traffic (for example, ship to shore, train to truck or truck to ground), the number of containers to be handled per hour and the distance of travel, which depends on the size and shape of the site and the number of containers to be stored.

142. Gantry-cranes are specially designed for container traffic. They are capable of substantial cantilever lifting, with spreaders mounted on rotating tables so that containers can be aligned straight into a stack, or onto a vehicle (figure 28). These are expensive pieces of plant, a 35-ton-capacity crane for ship to shore operation costing approximately $2 million, excluding the rail track. The planner must design circulation routes such that any stoppage will not interfere with crane movement.

143. A mobile gantry-crane is basically a gantry-crane on rubber tyres, which combines the mobility of straddle-carriers, although it is slower, with the wide spans and height of a gantry-crane. One advantage of mobile gantry-cranes is their ability to move quickly to another task at a different part of the site.

144. Straddle-carriers are efficient for linear stacking operations up to a height of three containers. While these carriers are fast and manœuvrable, they are expensive to buy and operate, with a typical purchase price of $ 250,000 for a carrier capable of stacking containers three high. Among the reasons for the high operating costs are maintenance costs and down-time. Modifications are improving the reliability of this type of equipment.

145. Fork-lift trucks can be used for container handling, but not all containers have fork tunnels. Most operators therefore equip their fork-lift trucks with high level spreader beams as well. The use of this attachment for all container movements by fork-lift truck removes the risk of damage by forks. Normal fork-lift trucks can be used for the handling and stacking of empty containers, while a special heavy-duty truck is required for full units. For empty container handling, the slewing-mast fork-lift truck is useful, for it can load like a normal fork-lift truck, place the container at 90 degrees to the direction of travel and travel in aisles like a side-loading truck. A 3-ton-capacity fork-lift truck would cost approximately $ 25,000 and a 10-ton-capacity truck $ 50,000.

TABLE 2

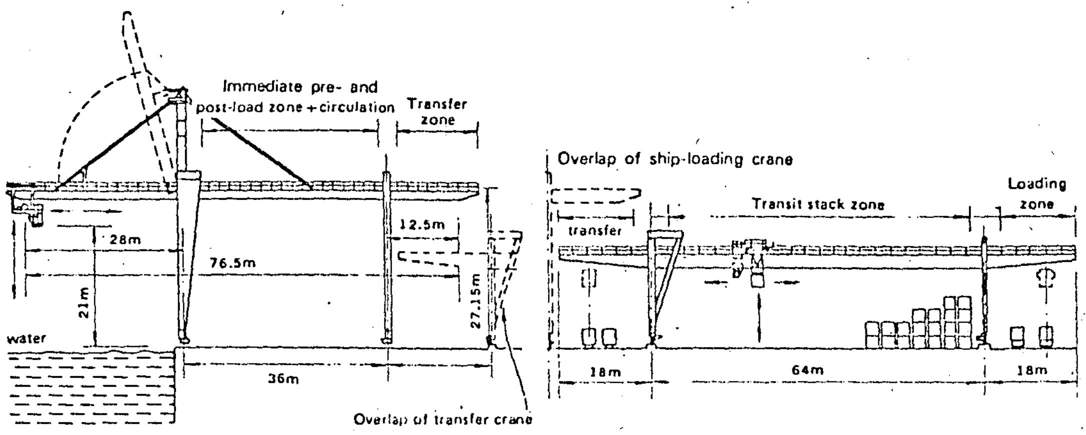
Typical container feeder-ships

Type	*Dwt*	*Container capacity (TEUs)*	*Over-all length (metres)*	*Over-all width (metres)*	*Draught (metres)*	*Special features*
Roll-on/roll-off	4 580	176	130	17	6.25	Catamaran design
Lift-on/lift-off	1 260	106	77	13	3.70	Gearless
Roll-on/roll-off ...... Lift-on/lift-off	6 500	330	115	19	7.40	Equipped with angled stern ramp and one 38-ton gantry crane.
Roll-on/roll-off ...... Lift-on/lift-off	2 080	111	87	14	4.70	Equipped with stern ramp and one 30-ton gantry crane.

146. Side-loading trucks designed for container handling lift a container from the ground or from a truck or stack, move it horizontally, and place it on the wide platform for stability. They are capable of travel in aisles no wider than themselves and are available with small turning circles.

FIGURE 28

Typical gantry-cranes



A. *Ship-loading gantry container crane*

B. *Gantry-crane for stacking and sorting containers and feeding ship-loading crane*

Chapter IV

THE MULTI-PURPOSE GENERAL CARGO TERMINAL

A. Economics

147. The sequence of changes in the kind of traffic arriving at ports, as a result of growth and transport economics, was discussed in part two, chapter I, on terminal planning considerations. The need for a multi-purpose terminal to handle both break-bulk cargo and a variety of unit loads during the transitional phase (denoted as phase 4 in part two, figure 1) was pointed out.

148. The role of the multi-purpose terminal is to provide efficient handling facilities for the period—which may last many years—when general cargo ships calling at the port may carry a variety of cargoes transported in modern ways: containers, flats, pre-slung cargoes, large units of iron and steel, large units of packaged timber, as well as cars and heavy machinery, together, of course, with a basic load of break-bulk cargo, increasingly palletized. These modern methods of transporting cargoes were introduced in order to reduce the cost of handling cargoes at ports in developed countries, and the cost of carriage by sea. Moreover, they can actually cause a decrease in cargo-handling productivity and disrupt operations at a port not equipped to handle them efficiently.

149. In order to be able to handle all these cargoes efficiently, the terminal needs to have a greater variety of mechanical equipment than is required for a conventional break-bulk terminal, and a different range of equipment than is normal for a specialized container terminal. The terminal needs a different layout, and modern management. These requirements are summarized below, and are given in more detail in the UNCTAD reports on technological change in shipping and its effects on ports already referred to.[7] Although the initial cost of the terminal is high, a high throughput can be achieved in view of the terminal's flexibility, and furthermore it can be fully utilized soon after commissioning in view of its suitability to handle whatever traffic may come. The resulting cost per ton of cargo handled and the total investment can therefore be significantly lower than the alternative of continuing to build extra conventional berths.

150. For example, a two-berth multi-purpose terminal working two shifts per day and 200 days per year should achieve a throughput of some 650,000 tons per year, assuming a productivity of 800 tons per ship-shift for a typical mix of cargoes with a different productivity for each type of cargo, as follows:

	Tons per shift
Conventional general cargo	400
Packaged forest products	900
Bundled iron and steel products	1 100
Palletized cargo	500
Ro/ro units	1 500
Containers	1 500
Pre-slung cargoes	500

151. The UNCTAD secretariat found that such a terminal would cost in the region of $16 million and give a handling cost of $12 per ton (including the cost of ship's time in port).[8] If the same cargo were handled over conventional berths the throughput would probably be no higher than about 175,000 tons per year, and would thus require four conventional berths costing approximately $20 million and giving an effective handling cost per ton of about $20. The figures given for a multi-purpose terminal, which imply very significant savings, are based on typical costs and interest rates in developing countries.

152. In view of the added long-term advantage that a multi-purpose terminal can more easily be converted later to a specialized unit load terminal, there is a strong argument for ports in developing countries to think of general cargo development mainly in terms of multi-purpose facilities.

B. Layout

153. Figure 29 shows a proposed layout for such a two-berth terminal. The following features should be noted: the placing of unit load transit and consolidation sheds at the rear of the quay, so that trucks can be served alongside the sheds without interfering with the transfer operations; the substantial open storage areas closer to the quay for any form of unit load, including containers, or for open storage general cargo; the large quay apron operational areas; the areas for road and rail transport through the terminal; provision of a ro/ro ramp.

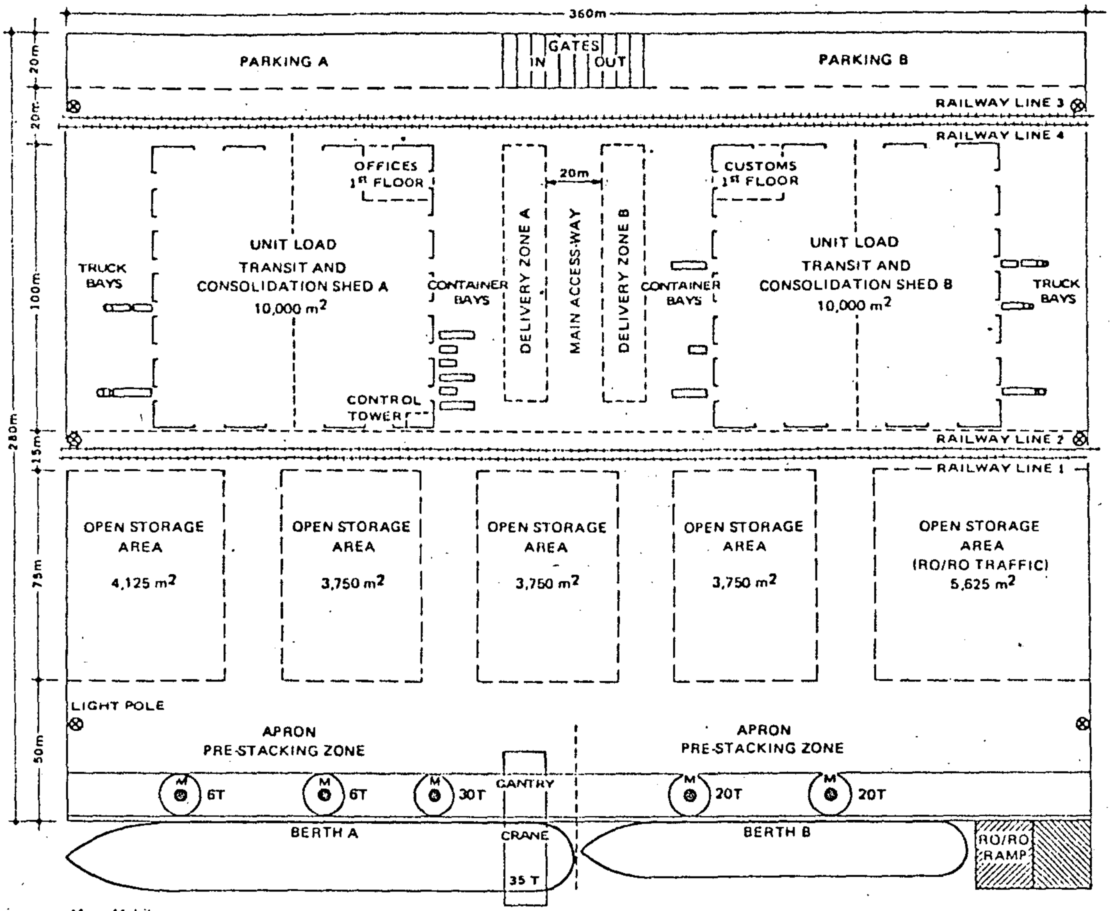
154. Since such a terminal is designed to serve a transitional phase, it might be advisable—depending on the traffic forecast—to proceed in two stages. Figure 30 shows a layout for a single-berth first phase,

[7] Documents TD/B/C.4/129 and Supp. 1-5.

[8] See document TD/B/C.4/129/Supp.1, paras. 201-202.

FIGURE 29

Proposed layout for a two-berth multi-purpose general cargo terminal



M = Mobile crane

in which a single berth can handle the traffic and when the traffic mix demands a higher proportion of open rather than shed storage. Figure 31 shows a layout that is more suitable where there is a higher proportion of shed cargo, where two berths are justified, and where the second phase development areas have been clearly allocated and partly surfaced. In this version, the transit and consolidation shed must be of a type which can be dismantled and re-used with additional material for the erection of two sheds further back during the second phase.

C. Equipment

155. The main method of ship handling is either by ship's gear or by mobile tower crane. No rail-mounted portal cranes are normally provided and only one gantry-crane in the first instance. A 30-ton mobile tower crane may, however, be on the same rails as the gantry crane. The standard method of transfer for virtually all classes of cargo is by tractor/trailer combinations, using trailers of a size generally associated with container operations but without corner fixings, of a low profile design, and equipped for easy coupling and uncoupling. While the cost of equipment listed in table 3 is substantial, it can be readily justified. This cost is included in the total terminal cost estimate given above (para. 151). The list given is for the initial equipping of the terminals illustrated. Perhaps the main reason for difficulties in the operation of unitized cargo terminals has been the failure fully to recognize the need for transfer equipment, and for this reason the quantity of transfer equipment suggested should not be reduced. As a particular traffic develops the terminal may start to take on a more specialized role and further equipment (such as additional container gantry-cranes and straddle-carriers) may be justified.

D. Management

156. To take full advantage of the multi-purpose terminal, a modern port management approach is needed. At the planning stage, special consideration should be given to the new status of the dock worker, and to the need for integrated planning of the operation. One of the most sensitive areas in a changing port environment is the status of the dock worker. Early action on the part of management can help to pave the way for a gradual change towards an improved labour management policy. The management effort in this respect should include:

(*a*) Training of specialized personnel (drivers of mechanical equipment, mechanical and civil engineers, traffic controllers);

(*b*) Advance planning of the requirements for manual and office workers, with a regular revision of the quotas required;

(*c*) Gradual improvement of the status of the dockworkers by conversion from a casual to a permanent working force, at least for a substantial proportion of the work force;

(*d*) Development of a time-based payment system, incorporating adequate social security provisions.

157. The port management must fully involve the unions in these developments and be willing to accept proposals from both manual workers and office workers. Changes will always occur more smoothly if there has been extensive consultation.

158. Another area of preliminary action concerns the operational organization of the terminal. Often, the activities on the ship, on the quay apron and in the shed have been considered as separate activities. The net result, even in the case of break-bulk general

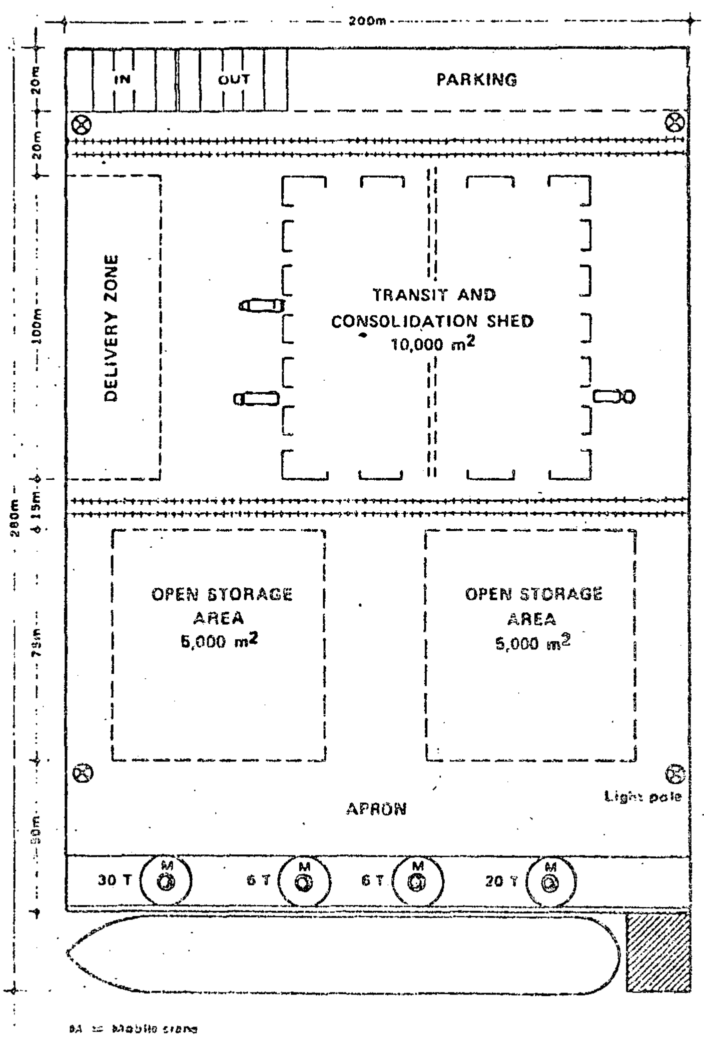
TABLE 3

Handling equipment required for multi-purpose general cargo terminals

	Single berth, first phase, alternative 1 (predominantly open storage)	*Two-berth, first phase, alternative 2 (predominantly shed storage)*	*Two-berth terminal, second phase*
35-ton gantry	—	—	1
30-ton heavy lift crane	1	1	1
20-ton mobile tower crane (for ship working)	1	2	2
6-ton mobile tower cranes (for ship working)	2	2	2
20-ton mobile cranes (for yard working)	1	—	1
5-ton mobile cranes (for yard working)	1	2	2
Straddle-carriers	2	—	3
3-ton fork-lift trucks	8	15	15
10-ton fork-lift trucks	2	3	5
Tractors (tugmasters)	3	6	6
Trailers/chassis	9	18	18
Ro/ro ramp	1	1	1

FIGURE 30

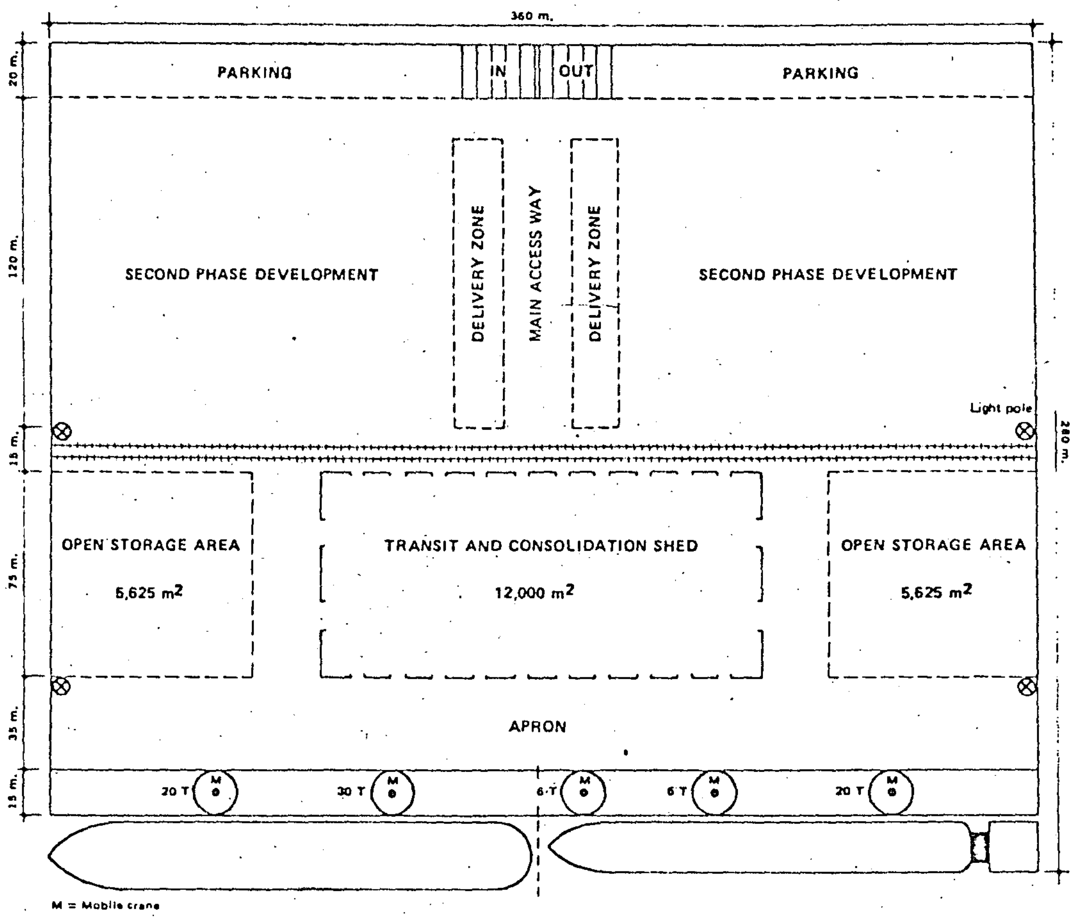
First phase of the multi-purpose terminal, alternative 1



M = Mobile crane

FIGURE 3.

First phase of the multi-purpose terminal, alternative 2



cargo handling, has been a considerable loss in operating capacity. At a specialized terminal, such separation is completely unacceptable, as a unified responsibility for the over-all operation and unity of control of the specialized terminal becomes an increasingly important requirement for its efficiency. On the other hand, it is desirable that the specialized terminal should be operationally independent of the conventional break-bulk berths.

159. Management methods should concentrate on control and continuous monitoring, of the type associated with specialized container operations, for all traffic handled. This will require provision to be made at the planning stage for the following:

(*a*) Management training;

(*b*) A supporting administrative organization with planned information flow;

(*c*) The planned preventive maintenance of equipment based on good repair facilities;

(*d*) The collection and use by management of statistical performance indicators, as suggested in the UNCTAD publication on the subject.[9]

(*e*) Close collaboration with shipping agents, forwarding agents and railways, which should have representatives at the terminal.

[9] *Port performance indicators* (United Nations publication, Sales No. E.76.II.D.7).

Chapter V

TERMINAL REQUIREMENTS FOR ROLL-ON/ROLL-OFF TRAFFIC

A. The role of ro/ro services

160. The spread of ro/ro services to the deep-sea trades is a development which will be of increasing importance to developing countries in view of the great flexibility of the operation. At present, there are more than 500 ports in 40 countries which have scheduled ro/ro services. The current (1975/1976) world ro/ro cargo fleet numbers some 404 vessels with a total grt of 1,702,898, and 93 vessels (651,126 grt) are on order, representing a growth of 38.2 per cent (assuming no scrapping or replacement). Before 1967, only four vessels were built with a grt in excess of 4,000. Since then, 80 such vessels have been delivered, 39 of then with a grt of over 10,000. This trend towards increasing vessel size can be expected to continue in the long term as ro/ro operations extend to more long-haul trades and those high-throughput trades where larger vessels will be used for larger loading per sailing.

161. As listed in part one, chapter III, on traffic forecasting, the variety of cargo types which can be carried on ro/ro vessels—in various combinations—include vehicles, loaded road trailers or semi-trailers and containers on chassis, as well as any general cargo on pallets or flats which can be carried on and off the ship by fork-lift trucks. In addition, ro/ro vessels are often used to carry passengers. Moreover, the majority of ro/ro ships are equipped for a percentage of lift-off operations for containers and heavy lifts, and in some cases also for bulk cargo. Because of the priority berthing which is often given to this type of service, it can bypass port congestion ship delays. Furthermore, where quays have a suitable load-bearing capacity, large, long, heavy or awkward loads can be worked without special heavy lift cranes, and in certain cases with less berth length.

162. Several types of vessel of varying sizes are in operation. Vessel design differs with respect to the ramp facility, which may be placed at the stern, in the bow or on the side. The ship itself may dock either alongside a quay or at right angles, for access through the bow or the stern. Cargo is carried on several decks, and access is often provided between these decks by ramps or elevators within the vessel. In some cases, connexions can be made to the shore at each separate deck level.

163. In general, for liner deep-sea trades, three main types of ship can be identified:

(*a*) Type 1: roll-on/roll-off ships with multiple decks and/or holds with side-ports requiring a quay ramp;

(*b*) Type 2: roll-on/roll-off ships with a ship-based angled stern ramp;

(*c*) Type 3: mixed roll-on/roll-off, lift-on/lift-off ships requiring a quay ramp.

164. Ships of the second type, with a ship-based angled stern ramp and multiple decks connected by ramps, are of particular promise for developing countries. The need for sophisticated and relatively expensive port-based link spans is avoided, while a large variety of cargoes can be handled. Moreover, these ships often employ their own fleet of straddle-carriers, fork-lift trucks and other mechanical handling equipment. Hence the investment cost for the port is considerably reduced.

165. An examination of the development of cellular container services and ro/ro services shows that, because of local conditions and differences of approach, the two modes of carriage are in competition on a number of trade routes. However, the true economics of the situation are likely to show that there is room for both on the major routes where there is at present competition. The economics of container services are such that they will usually capture all substantial containerizable cargoes, leaving non-containerizable general cargo to be carried by conventional means. As traffic grows, a point is reached where this residue becomes sufficiently substantial, or cargo-handling cost and ship waiting-time cost sufficiently great, for this merchandize to be divided into the "cream" cargo, cargo of higher value needing rapid handling, and the remainder. The "cream" cargo will tend to be carried on ro/ro service vessels.

166. Often, the more important factors are flexibility and the cutting-down of port investment, particularly where there are smaller traffic volumes, as in many ports in developing countries. Here, there is no competition between cellular container services and ro/ro services, and the ro/ro ships will therefore be equipped to carry whatever container traffic there may be.

167. It is also interesting to note that operators choose the roll-on/roll-off vessel for a specific commodity and not for the more diversified cargo-mix of the traditional liner trade. For example, automobiles may be carried on the outward voyage and forest products on the return voyage; or, say, steel products may be transported by ro/ro vessel between ports of

the same country. In such cases, cargo flexibility is a less critical factor than cargo-handling productivity and the ease with which changes can be made in ports of call.

B. Ro/ro demand forecasting

168. In any attempt to forecast the extent to which ro/ro services will penetrate a given route, the following two principal characteristics of the ro/ro service as opposed to the container service should be borne in mind:

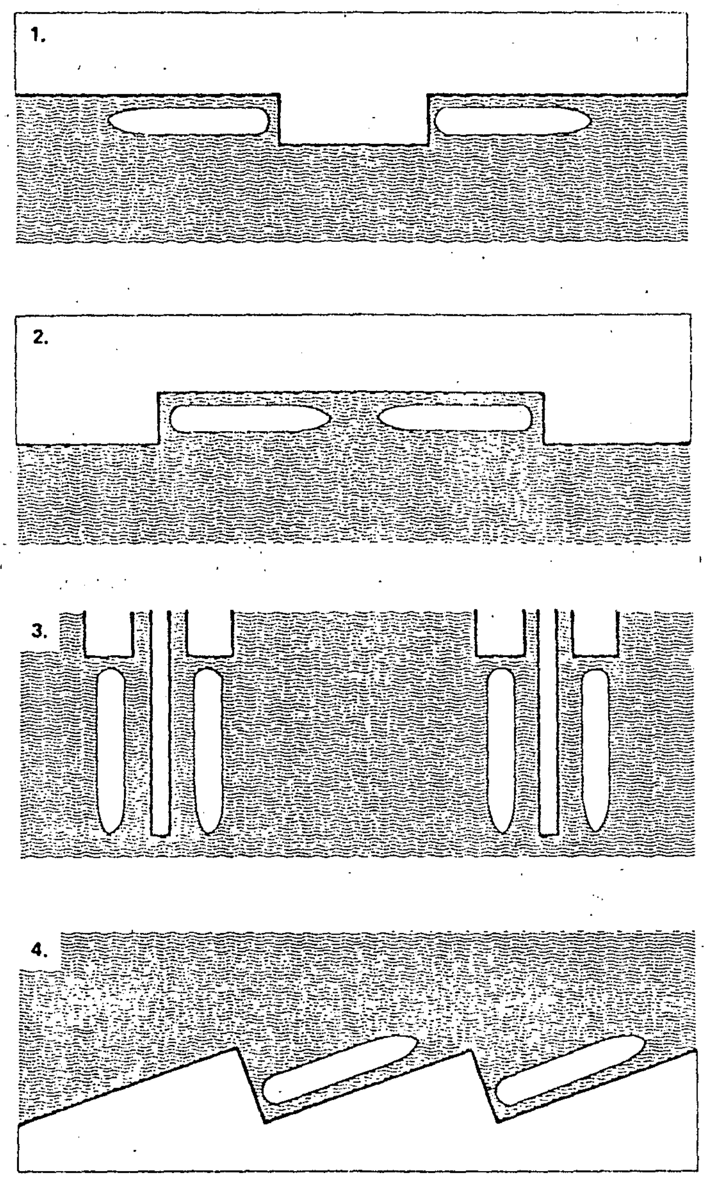
(*a*) The ability of a ro/ro service to attain high cargo-handling speeds in a highly developed port at one end of the route and satisfactory speeds in a conventional port at the other end;

(*b*) The ability of a ro/ro service to switch its ports of call easily in an area of changing trading patterns because it requires the minimum in the way of special port equipment.

169. At the same time, when a route capacity builds up to the point where a cellular container service is introduced, a ro/ro service will in general be phased out. This will happen because the carrying capacity of a specialized container vessel can be more fully used than that of a ro/ro ship. In broad terms, the nature of ro/ro cargo is that it is the high-value portion of the miscellaneous cargoes left over after containerization.

FIGURE 32

Alternative layouts for a ro/ro quay



C. Berth requirements

170. Thus, apart from the need for good access and suitable storage areas, ro/ro operations place little demand on ports for specialized facilities and can be fully self-supporting in smaller ports. However, this very flexibility means that it is difficult to forecast which class of ro/ro ship, carrying what cargo mix, will use any particular port.

171. Since a ro/ro berth can be prepared and equipped more quickly than most other kinds of berth and since, in many cases, the ship design will be known, the shore facilities should be designed to meet the ship's needs. But it is important to recognize that a berth will outlast most ships and that ships may be moved to other routes if traffic patterns make it desirable to do so. Therefore berth planning should be as flexible as possible, even though only one vessel type is expected at the outset.

172. Four alternative layouts are shown in figure 32. Alternative 1 offers a high degree of flexibility for the future, since it is easily converted to the handling of other types of ship, but a portion of the quay length is lost, usually about 60 metres. The total quay length necessary is important, and represents a costly investment.

173. Alternative 2 is feasible only if the length of the vessels calling at the port remains unchanged during the lifetime of the facility (30 to 40 years). In general, this cannot be guaranteed, and, given the trend towards larger ships, few ports may be prepared to take the risk of building a quay which might become inadequate within a time span of five to ten years. However, its advantage is that it separates traffic flows on the quay.

174. Alternative 3, although the least expensive in cost terms, is not generally appropriate since it can be used only for ro/ro vessels with stern or bow cargo-handling arrangements. This eliminates a large number of ships and any lift-off operation.

175. Alternative 4 has a number of advantages. It combines the flexibility required to handle different types of ships with the possibility of receiving vessels of increasing length. This staggered layout for two berths is a natural development of the single ro/ro corner berth, which is the preferred layout when only

one ro/ro ship at a time is to be handled. The typical layout of the single corner berth is shown in figure 33.

176. A ro/ro berth needs to be in a calm location in a port. Although some down-time can be accepted at any berth in a port, ro/ro traffic is, more than any other, dependent for its over-all transport economy on rapid turn-round times and it can be more seriously affected by swell and by tides than a lift-off operation.

177. In a location where there is no tide, ro/ro facilities can dispense with adjustable ramps and are very cheap to construct. The simplest form of ro/ro berth comprises a surface onto which the stern or bow ramp of a ship is lowered during loading/unloading. Figure 34 illustrates the typical design for a slewing ramp, which gives the ship a greater flexibility in berthing choice. In high tidal ranges, the necessary adjustable bridge ramp and supports add considerably to the cost of the basic facility. With a tidal range of five metres, a bridge ramp from 25 to 50 metres long[10] would be needed, capable of carrying the heaviest trucks and trailers. Under such conditions, the economic and operational possibility of an enclosed dock should be examined, as discussed in part one, chapter VI, on civil engineering aspects.

178. In more sophisticated systems, an adjustable bridge ramp forms a suspended roadway hinged at the inshore end and supported near the outer end to provide a connexion between the shore approach and the ship. The outer end may have a telescopic or hinged connexion. There is, therefore, a much greater interaction between ship design and berth design than for many other maritime facilities.

[10] The exact length depends on the maximum difference in elevation between the ship's exit and the quay surface.

FIGURE 33

Preferred layout of a single ro/ro corner berth

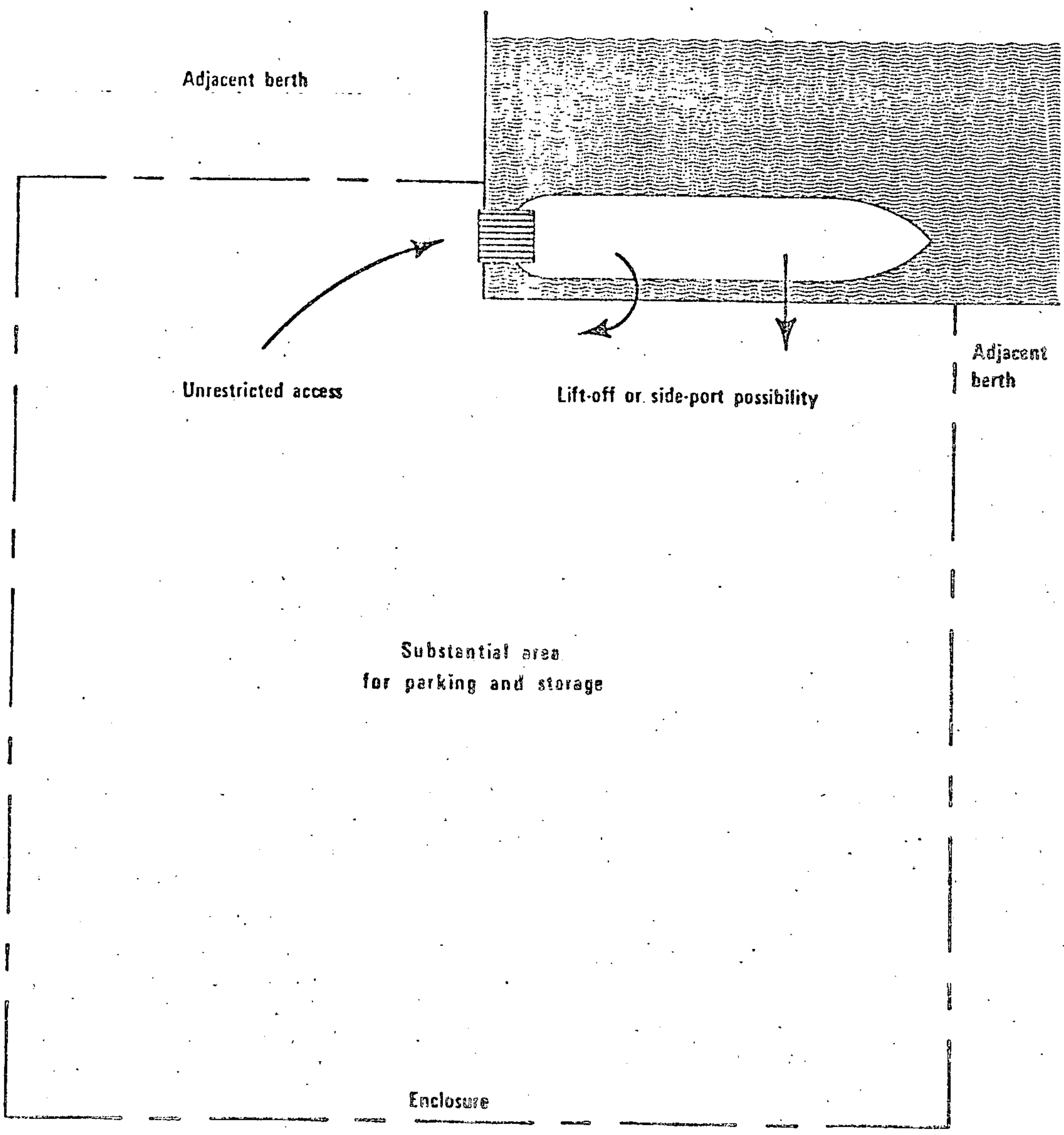
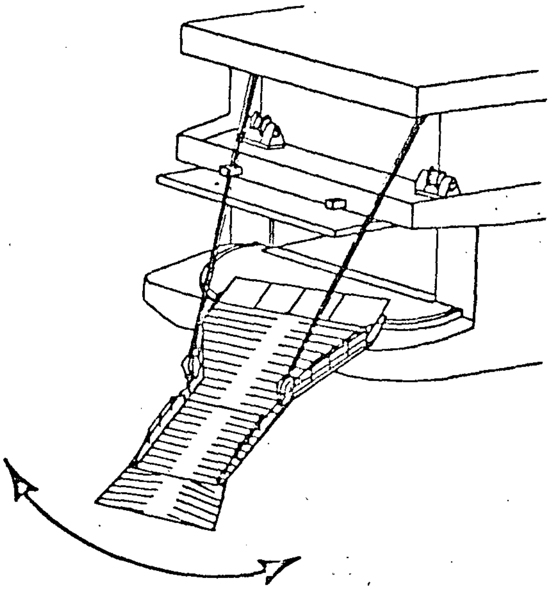


FIGURE 34

Example of slewing ramp for ro/ro service



179. Several basic design have been put forward for the bridge ramp, which differ essentially in the method adopted for the adjustment of the ship end of the bridge ramp to accommodate changes in level due to loading and discharging and tidal fluctuations. Two alternatives are normally considered. The first consists of a floating pontoon or bridge ramp which automatically rises and falls with the change of tide. Figure 35 illustrates one form of this bridge ramp. The second possibility is for the ship end of the bridge ramp to be connected to a fixed gantry structure either by cables or by hydraulic means, which provide the necessary adjustment.

180. An important feature of a floating bridge ramp is its capability of being moved from one part of the quay wall to another. This is desirable in many cases, to increase berthing flexibility. It is usually possible to tow pontoons to other locations fairly quickly.

D. Terminal area requirements

181. One characteristic of the ro/ro terminal is the need for adequately fenced, protected and surfaced storage areas with a wide, well-paved access way. The transit storage area needed for a ro/ro terminal may be even larger than that needed for a container terminal, which is normally 10 hectares per berth. To determine the storage area requirements, the ro/ro cargo forecasts should be grouped under the following four headings:[11]

[11] See part one, chapter III, section F, on forecasting cargoes carried by ro/ro ship.

FIGURE 35

Example of adjustable bridge ramp for ro/ro service

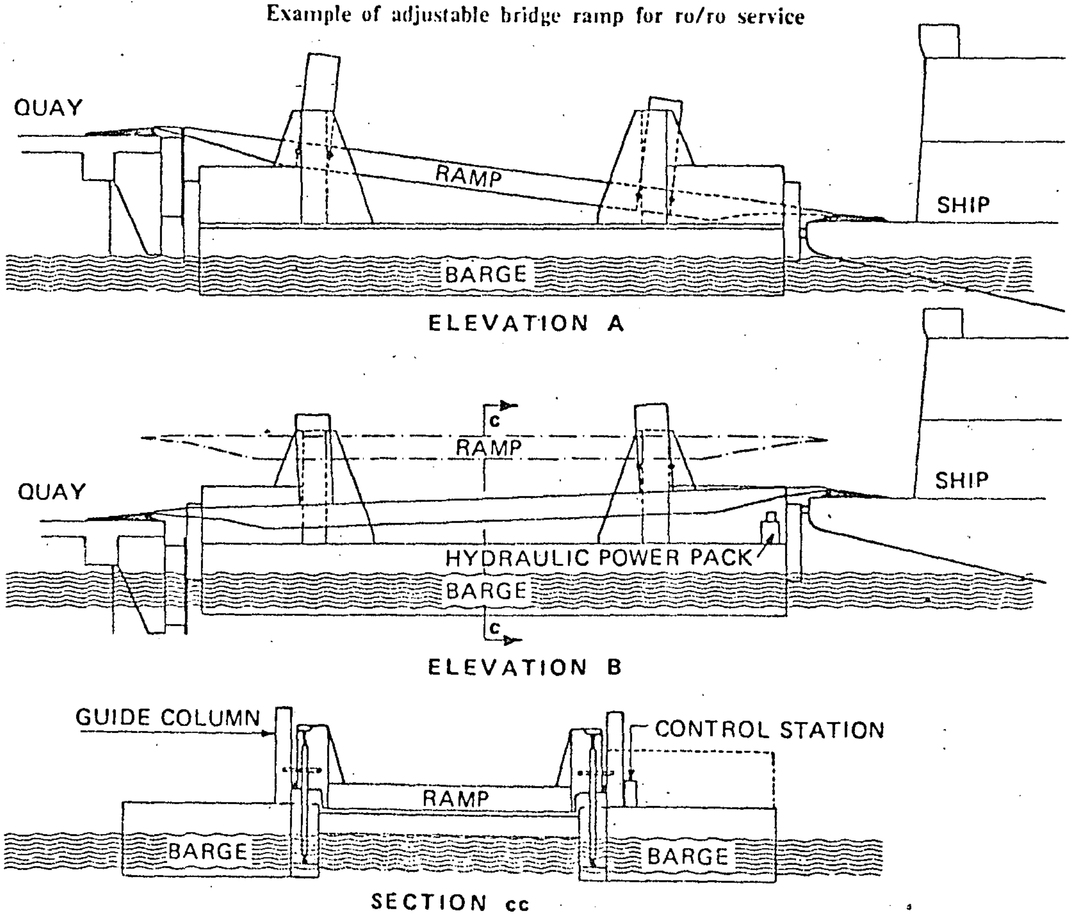
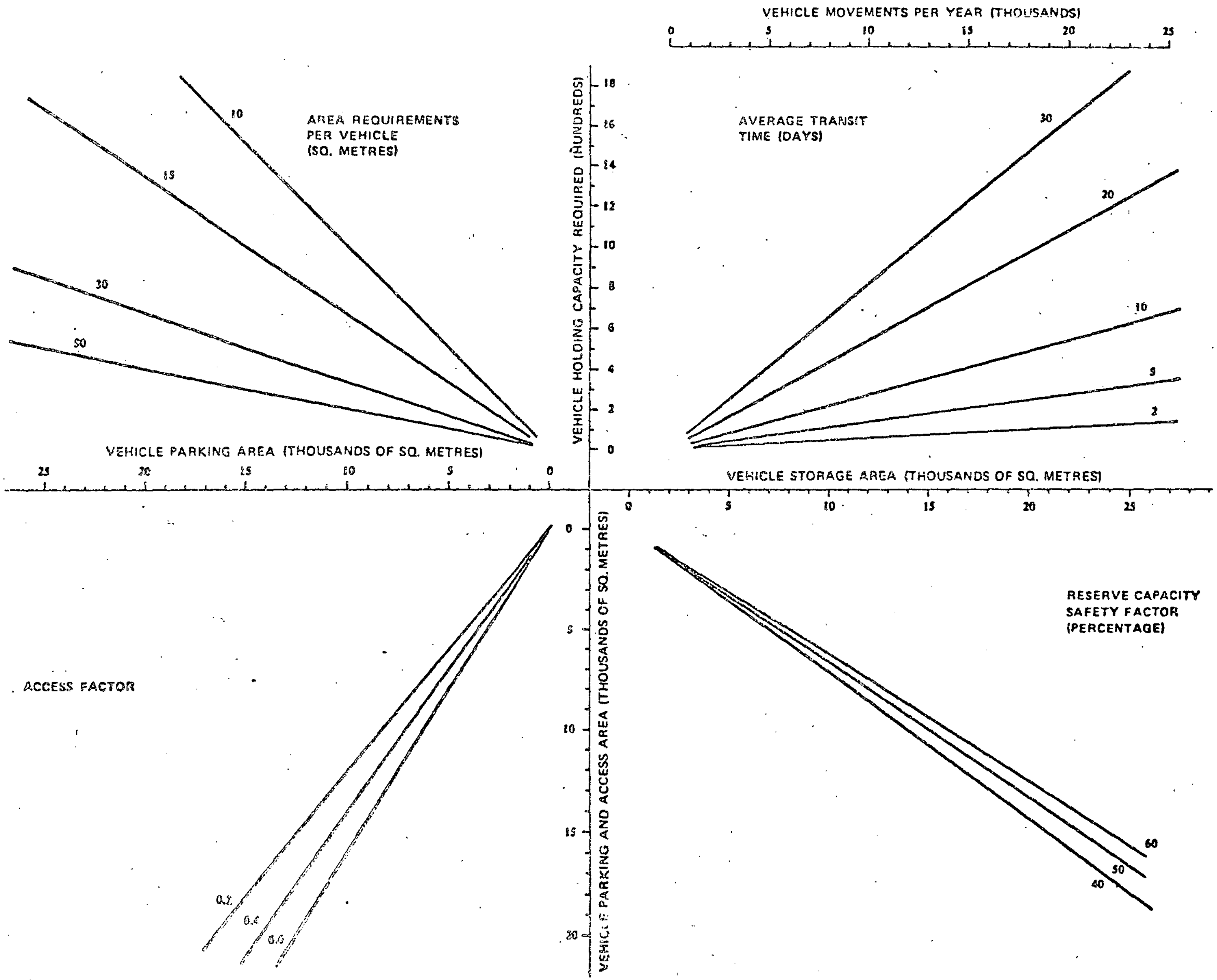


FIGURE 36

Ro/ro terminal planning chart: vehicle storage area



(*a*) Containers;

(*b*) Cargo carried by intermediate methods;

(*c*) General cargo;

(*d*) Wheeled cargo.

182. The container forecast is in TEU units and therefore the container terminal planning chart I, for the container park area (see figure 23 above) can be used. The appropriate area requirement per TEU factor, together with other factors such as transit time, will allow the planner to calculate the corresponding area requirements for ro/ro terminal.

183. The storage area requirements for the second and third categories of ro/ro cargo can be determined by using the break-bulk terminal planning chart III for storage area requirements (see figure 10 above). The appropriate stowage factor, stacking height and transit time must be used for each category.

184. The area requirement for ro/ro wheeled cargo can be determined from the ro/ro terminal planning chart for vehicle storage area, illustrated in figure 36. Typical area requirements for various road transport vehicles are as follows:

	Square metres
Articulated truck, 15-metre	46.5
Rigid truck, 16-ton	26.5
Automobile	
large	11.0
small	7.0

A sufficiently large area should be allocated to this category of cargo to accommodate the largest shipment of vehicles envisaged. For example, a shipment of 500 small automobiles would require a minimum area of approximately 4,500 square metres, assuming a 25 per cent allowance for access.

E. Ro/ro fork-lift truck operation

185. For working in the ship's hold via side ports, an electric fork-lift truck is preferable to a diesel-driven vehicle. Where possible, ports should resist demands on them to provide in-hold fork-lift trucks. These can reasonably be expected to be carried by the ship. Slopes and cambers can reduce fork-lift performance seriously. The gradient should never exceed 1 in 10. For example, where there is a slope both to the ship's deck and to the shed or stack, battery-driven fork-lift trucks may need recharging three times in one shift, and diesel lift trucks are more appropriate.

Chapter VI

TERMINAL REQUIREMENTS FOR BARGE-CARRYING VESSELS

A. Barge-carrier systems

186. The impact of barge-carrying vessels on port operations in developing countries is discussed in more detail in the UNCTAD reports on technological change in shipping and its effects on ports already referred to.[12] Two main types of barge-carriers are in service, LASH and SEABEE, the LASH (lighter aboard ship) system having been chosen by all lines except one. The principal dimensions of the LASH ships and the barges they carry are given in tables 4 and 5.

187. The barge-carrying system at present serves a considerable number of developing countries in the Mediterranean, the Far East, the Red Sea, the Persian Gulf, the Indian sub-continent and Latin America, with other services under consideration. Given the predominance of break-bulk cargo on these routes, the considerable waiting times ships periodically face, and the number of ports of call, the choice of the barge-carrier on these routes seems logical. Nevertheless it must be noted that there are apparently no firm intentions at present to expand the LASH fleet listed in table 4, while, on the contrary, the Pacific Far East Line is finding it necessary to convert all of its LASH-container ships to use for container operations only. However, another trend is that of eliminating the container space on board as, for example, Prudential Lines are doing.

188. As table 4 shows, barge-carriers may be equipped to carry containers or may be pure barge-carriers. The former vessels are provided either with cellular holds or special frames for the carriage on containers on deck, and they have a ship-based gantry crane for handling the containers.

189. Recent emphasis has been on the development of feeder vessels. Two alternatives are being tried: BACAT (barge aboard catamaran), and FLASH units (feeder LASH). BACAT I can carry 3 LASH barges plus 10 special smaller barges, while BACAT II can carry only LASH barges. FLASH is nothing more than a shallow-draft vessel, somewhat like a sea-going dry dock, capable of carrying 8 or 15 LASH barges at a time to and from ports which cannot accommodate large ocean-going vessels. This vessel is partially submerged, like a dry dock, during loading and unloading operations. The unit is actually a barge itself and is towed by sea-going tugs at a service speed of about eight knots. The 8-unit FLASH vessel has a length of 81.7 metres, a beam of 24.4 metres and a draft of 3.45 metres. This system was tried out in Burma, 42 barges being discharged from a mother ship in the sheltered deep-water anchorage of Kyaupkyu, and then being ferried 8 at a time to Chittagong (Bangladesh), 210 miles north. The system is now being used to serve a range of ports in South East Asia.

B. Ship-handling requirements

190. The initial idea of LASH was that the barges should be loaded and discharged from the mother ship while the latter was at anchor outside the port, and that the cargo carried by the barges should be loaded and discharged at any shallow-draught berth, tugs being used for towing the barges to the berth. The port facilities required would thus be minimal.

191. In practice, more sheltered water has been found desirable for the purpose of loading and unloading the barges, and the mother-ship operation normally takes place inside the port area—at moorings, alongside container or break-bulk berths, or even at a special T-shaped jetty. In either case, a deep entrance channel is required; in addition to the operating draught of the vessel, a minimum of 1 metre must be allowed for trim changes during the operation. The water areas required for the manoeuvring of such large vessels are also substantial, as is the area needed around the mother vessel for manoeuvring the barges.

192. Furthermore, LASH ships carrying a cellular container complement must call at a terminal with facilities for handling containers.

C. Barge-handling requirements

193. Handling the barges within the port requires "barge park areas" which are large water surfaces, well separated from the other water-based traffic in the port, where laden export barges await shipment, laden import barges stay until such time as they are sent inland or can be discharged, and empty barges are kept in stock. The area needs careful attention from the point of view of port security.

194. The requisite size of a park area can be considerable, since the inland penetration of the barges

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[12] TD/B/C.4/129 and Supp.1-5.

TABLE 4

Principal barge-carrying-ship dimensions

Operator and vessel	*Dwt*	*Over-all length (metres)*	*Over-all width (metres)*	*Full-load draught (metres)*	*Barge-carrying capacity*	*Container capacity (without barges) (TEUs)*	*Ro/ro deck space (without barges)*
LASH FLEET:							
Central Gulf Lines							
Acadia Forest; Atlantic Forest	48 306	261.4	32.6	12.1	73	—	—
Green Harbour; Green Valley; Green Island	46 890	272.3	30.5	12.4	89	—	—
Combi Line							
Bilderdyk; Munchen	44 799	261.4	32.3	11.3	83	—	—
Delta Steamship Lines							
Delta Mar; Delta Norte; Delta Sud	41 048	272.3	30.6	11.6	89	1 740	—
Pacific Far East Line (all to be converted to container vessels)							
Australia Bear; New Zealand Bear; Golden Bear; Japan Bear; Pacific Bear; Thomas E. Cuffe	30 298	249.9	30.5	10.7	74	1 200	—
Prudential Lines							
Lash Atlantico; Lash Espana; Lash Italia; Lash Pacifico; Lash Turkiye	30 293	249.9	30.5	10.7	74	1 200	—
Waterman Steamship Corp.							
Robert E. Lee; Sam Houston; Stonewall Jackson	41 578	272.3	30.6	11.6	89	—	—
SEABEE FLEET							
Lykes Lines							
Almeria Lykes; Doctor Lykes; Tillie Lykes	39 026	267.0	32.4	11.9	38	1 800	13 570 m²
USSR							
Two on order	36 600	210.0	35.0	10.0	26	n.a.	n.a.

Source: The scope for barge-carrying systems (London, H. P. Drewry (Shipping Consultants), 1976).

TABLE 5

Barge dimensions

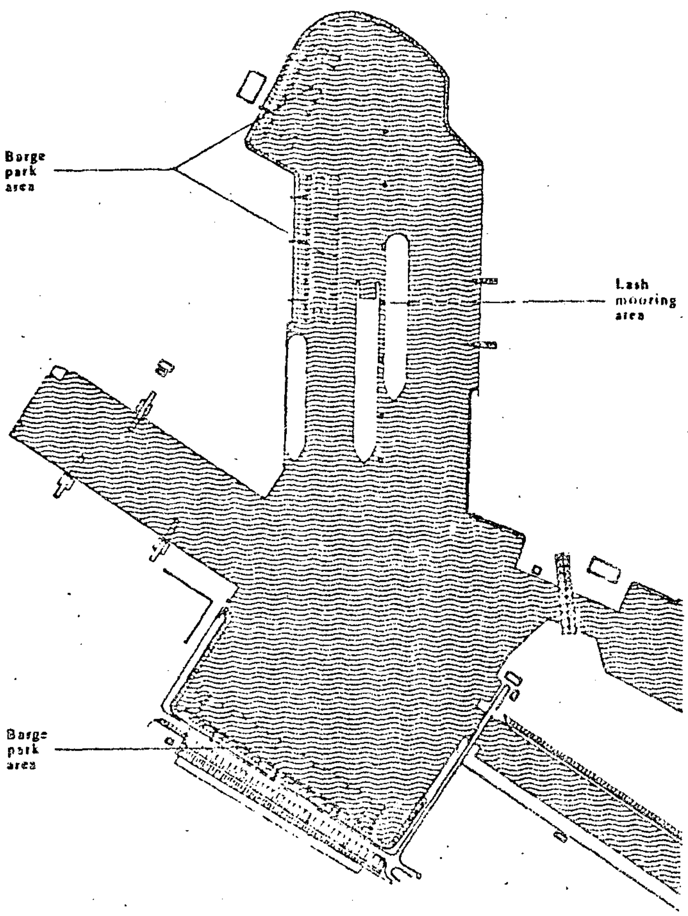
Type	*Length (metres)*	*Breadth (metres)*	*Full-load draft (metres)*	*Carrying capacity (tons)*	*Bale capacity (m³)*	*Grain capacity (m³)*	*Weight of hatch-cover (tons)*
BACAT	16.82	4.65	2.5	140	164	169	1.3
LASH	18.76	9.50	2.7	370	554	569	2.5
SEABEE	29.72	10.67	3.2	844	1 108	1 138	2.6
USSR	38.25	11.40	3.3	1 070	1 300	1 335	n.a.

is at present low, and thus the great majority are destined for port loading and discharge. Although large water areas may be available in river ports, in breakwater ports the lack of water area proves a major impediment to the smooth functioning of the barge-carrier service. As a rule of thumb, a minimum barge park area of 10,000 square metres should be provided, this area allowing for an average discharge of 8 barges per call and a peak of 25 barges.

195. In ports where the necessary areas have been provided, significant investment cost have been involved. At Bremerhaven, 31 pontoons have been constructed, offering mooring space for 140 barges. The total length of the pontoons exceeds 650 metres, and the total cost of the project was almost $4 million. The basin and barge park areas are illustrated in figure 37.

FIGURE 37

LASH facilities at Bremerhaven



196. Barges can be handled at existing break-bulk and lighterage berths, even of old-fashioned design. However, it might be advisable to provide special handling facilities for the barges where:

(*a*) Existing facilities are inadequate because they do not provide weather protection or sufficient space for assembling cargo and loading it onto barges;

(*b*) Existing facilities are fully utilized and the handling of additional barges would lead to congestion;

(*c*) The distance between the barge park area and the existing break-bulk berths is excessive;

(*d*) A combined terminal for handling containers and barges is preferred from a cost-effectiveness and operational point of view.

197. The higher the cost of labour in a port, the greater will be the need to build well-equipped and suitable barge-handling facilities. Only then can the operations be expected to achieve the considerable increase in productivity which is an essential requirement in ports with high labour costs if port cargo-handling charges are not to become prohibitive. Similar reasoning provides an incentive for the increased use of pallets, bundled units and pre-slung units in a barge-carrier operation.

198. In Singapore, a large warehousing complex (providing 200,000 square metres of covered storage space) at Pasir Panjang, which was built independently from the barge-carrier development, has now been partly set aside for the receipt of cargo from barge-carriers. This development has made it necessary for the Port of Singapore Authority to install in the Pasir Panjang area six mooring buoys, which will permit the safe anchorage of 120 barges. The buoys are approximately 700 metres apart and are all in line, thus stretching out over 3500 metres.

199. Although there is thus a variety of alternatives in providing facilities for barge-carrying vessels, combined with or independent of break-bulk or unitized berths, indicative planning figures for an annual throughput of 250,000 tons made up of 1,000 barge units with an average cargo load of 250 tons per barge would be as follows:

Number of mooring areas	1
Number of mooring buoys	4
Required barge park area (assuming a peak of 50 barges at one time)	20,000 m²
Number of tugs required to tow barges between the mother-vessel and the barge park area (depending on the distance between them)	3
Number of pontoons (assuming an inland penetration of less than 10 per cent)	20
Length of quay and area required to load and discharge the cargo of the barges in port	As for two break-bulk berths

Chapter VII

DRY BULK CARGO TERMINALS

A. Introduction

200. This chapter is concerned with dry bulk cargoes, but it is necessary first to note that the word "bulk" can be used in two different senses. Traditionally, the expression has been used to indicate that a commodity was loaded or discharged in loose or fluid form, for example, grain or petroleum. More recently, however, there has been a tendency to talk about "bulk shipments" in the sense of shipments by the full shipload or substantial part-load, whether or not the commodity in question is handled by bulk cargo methods in the traditional sense. Thus it is now common to speak of "bulk shipments" of steel plates or bundled timber. The term "semi-bulk" is also used, for example, with reference to large shipments of bagged cargo. This chapter considers dry bulk cargoes, using the term "bulk" in both senses.

201. Dry bulk cargo is customarily divided into two groups, the "major bulk" cargoes and the "minor bulk" cargoes. The major bulk cargoes consist of a group of five commodities which almost invariably move by non-liner methods in full shiploads. They are as follows:

	1975 movements (millions of tons)	*Percentage of total dry cargo*
Iron ore	292	18
Grain	137	9
Coal	127	8
Bauxite	41	3
Phosphate	38	2
TOTAL		40

The majority of shipments of these commodities are made by specialized bulk carriers and combined carriers, but general cargo vessels are also used to a certain extent. When a traditional 'tween-deck vessel is used, however, a severe reduction in handling speed results. Separate descriptions of a typical coal import terminal and a typical phosphate rock export terminal are given later in this chapter (paras. 355-360 and 364-370 respectively).

B. Main characteristics of a major bulk cargo terminal

202. A radical difference exists between the character of a major bulk cargo terminal, especially one for the export of mineral ores, and the average all-purpose commercial port. The requirements with respect to location, depth of water, type of infrastructure, layout equipment, storage facilities and auxiliary services are basically different from those in a typical general cargo port. Also, the administrative, operating and labour problems must be approached in a different way.

203. Unlike a general cargo port, a terminal for the export of mineral ores does not need to be located close to the main centres of commercial and industrial activities of the country. The nearest possible distance from the mining area, with good land communication, is the most desirable place, subject, of course, to there being favourable natural conditions at that sector of the coast. Depth of water requirements are more stringent, as the trend is towards the transport of most ores in the largest possible vessels with a draft often in excess of 15 metres.

204. Vessels of this size require huge stocks of ore at the terminal and therefore extensive storage facilities. In order to minimize expensive ship time at port, it is necessary to ensure a relatively low berth occupancy so as to avoid the risk of ships having to wait for a berth, and a very high rate of loading while they are at berth. To achieve the required speeds of loading, a network of belt conveyors is needed, linking powerful reclaimers to ship-loaders. The mechanization of cargo-handling has eliminated the need for a large labour force, and the uniformity and simplicity of the material handled at a dry bulk cargo terminal means that the many commercial services needed at a general cargo berth are not required at the former.

205. The handling techniques used allow vessels to be berthed up to a kilometre or more away from shore, if necessary, the ores being carried to the ship by belt conveyors placed on a light structure. A typical ore berth consists of at least two berthing dolphins, two mooring dolphins and some buoys. Inshore of the berthing dolphins, an independent structure supports the loading equipment, composed of a ship-loader connected to land by belt conveyors. The storage area on land requires the proper equipment for unloading vehicles from the mines, for stacking the ores on the stockpiles and for reclaiming ore for delivery by belt conveyor to the ship-loader. In addition, facilities for direct transport from unloading hoppers to the ship-loader should be provided.

206. Although the basic elements will remain approximately the same from one terminal to another,

the particulars of the design will vary considerably, according to local conditions, the nature of the material and the scope of the operation. Normally each installation will have to be designed and built to suit the particular circumstances.

C. Bulk carriers

207. Wherever possible, bulk cargo installations should be designed for specific ships known to be calling. Detailed discussions with the shipowners and shippers should therefore be held to agree on the requirements for shiploaders and unloaders. However, other ships will call and the specifications will need to take account of both maximum and minimum ship sizes.

208. The phenomenal growth of the bulk cargo fleet in recent years is comparable to the growth, in both numbers and size, of oil tankers. In the mid-60s there began a trend towards combination carriers able to transport two or more different types of commodities. Most of the larger vessels are capable of transporting both dry and liquid bulk commodities. Bulk carriers are classified into six types, designated as follows: B (bulk), O (ore), B/O (bulk/ore), O/O (ore/oil), OBO (ore/bulk/oil), and OSO (ore/slurry/oil).

209. Figure 38 gives curves showing the relationship between the length over-all, beam and full load draught, and the dwt, for the majority of dry bulk carriers. Where information on specific vessels to be employed is not available, these curves are sufficiently accurate for preliminary planning purposes.

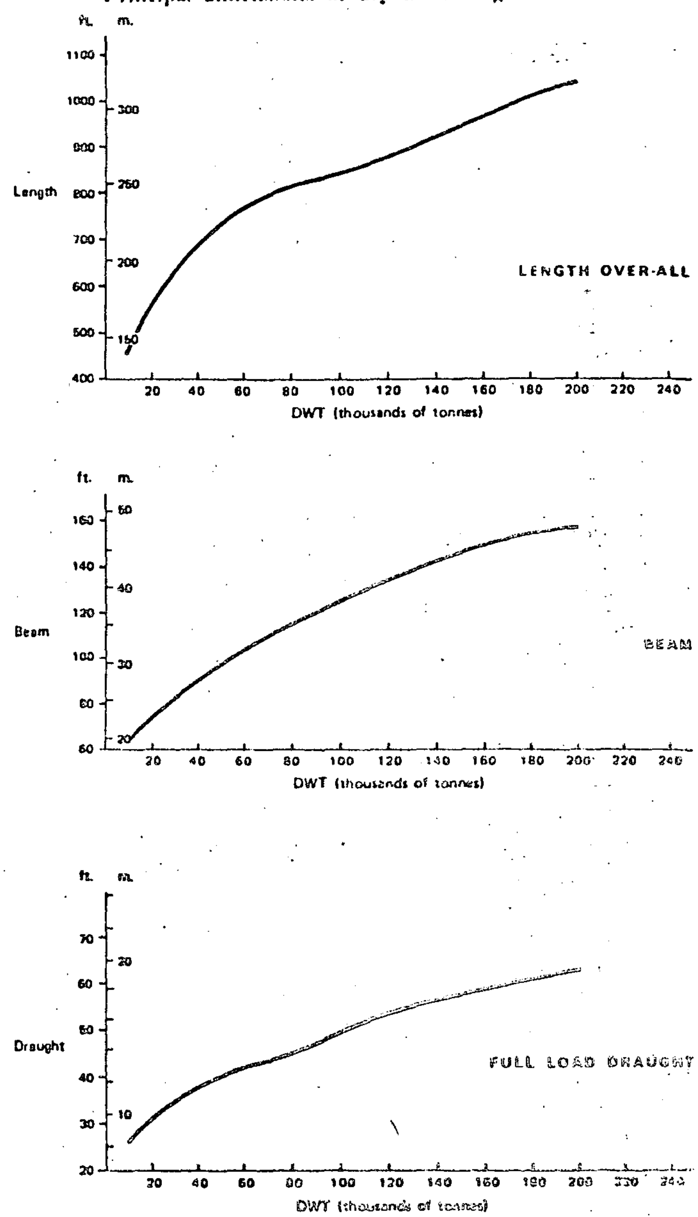
210. Ideally, all water areas which ships may have to pass through or lie in should be designed for their maximum (fully-loaded) draught, even though the occasions when ships will enter or leave port at this draught will be few in number. However, substantial economies can sometimes be made by providing less depth than this when there is certainty as to the loadings to be expected. A rough general relationship between load factor and draught for dry bulk carriers is given in figure 39.

211. It is possible for there to be certainty as to the dry bulk cargo loadings to be expected when there is an integrated transport service, for example, bulk carriers chartered by a chemical works. In such a case, the maximum load factor and hence the draught can be determined from the known stowage factor of the commodity in question and the specification of the ships to be chartered. Planning for a limited draught may also be justified when the draught of ships arriving or departing is linked to and limited by draught restrictions elsewhere.

212. The planner should also be aware that facilities designed for a fully loaded 100,000 dwt carrier may also have to handle a partially loaded 200,000 dwt carrier. While the draught limitation of the entrance channel is overcome by the reduced load factor of the vessel, the beam and length may prevent the vessel working at the terminal. This factor should be borne in mind when specifying mechanical handling equipment.

FIGURE 38

Principal dimensions of dry bulk cargo carriers



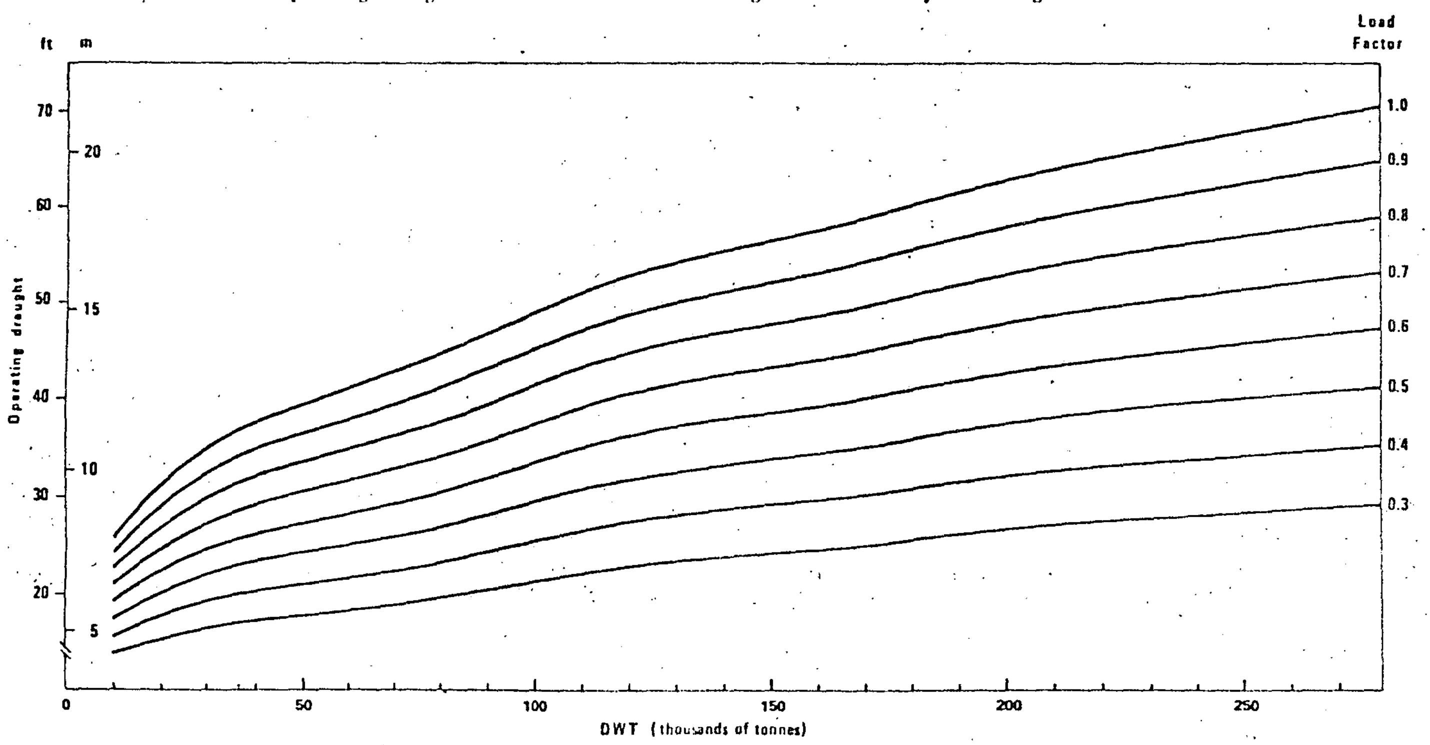
Source: University of Liverpool, Marine Transport Centre, *The Principal Dimensions and Operating Draughts of Bulk Carriers.*

D. Bulk handling equipment performance specifications

213. The exact meaning of the manufacturer's performance specification for a piece of bulk handling equipment must be understood by the planner of a terminal. In fact, the various items of equipment for bulk cargo handling are subject to wide variations in performance. This applies particularly to ship unloaders and reclaimers.

FIGURE 39

Operating draughts for different load factors against dwt for dry bulk cargo carriers



Source: University of Liverpool, Marine Transport Centre, *The Principal Dimensions and Operating Draughts of Bulk Carriers.*

214. In the case of a grab unloader, for example, the discharge rate depends on all of the following factors:

(*a*) Volumetric capacity of the grab;

(*b*) Density and nature of the material;

(*c*) Grab hoisting speed and acceleration;

(*d*) Trolley travelling speed, acceleration and braking;

(*e*) Skill of unloader operator;

(*f*) Shape of hold and hatch opening;

(*g*) Method of trimming in the hold;

(*h*) Ship's beam and unloader outreach;

(*i*) Depth of hold and tidal height;

(*j*) Travel distance from ship's rail to hopper.

215. Thus there is little meaning to a capacity figure for an unloader taken in isolation from the ship and the layout of the installation. The following three capacities should be defined in proposals, tender requests and design specifications: (*a*) peak capacity; (*b*) rated capacity; (*c*) effective capacity.

216. The peak capacity is defined as the maximum hourly unloading rate which can be achieved by the unloader for some relatively short interval of time when the cross traverse and hoisting distances in the unloading cycle are the absolute minimum, for example, when a full ship at the highest tide is discharging to a full hopper, and when the operator can exploit the maximum capacity of the hoisting and traverse speeds with a full grab. This rate is the capacity to which the connecting belt conveyors and weighers should be designed in the absence of other overriding economic factors.

217. The rated capacity differs from the peak capacity in two respects. It is the unloading rate which can be sustained for some specific length of time during unloading from a specific point in a vessel. This point is generally located, horizontally, at the centre of the vessel to be unloaded, and vertically, at mean low water level for the port. The payload of the bucket divided by the time taken to perform one cycle from the digging point to the receiving hopper on the quay and back gives the rated capacity. This figure is a useful definition for the comparison of equipment proposals and the classification of alternative solutions to a specific requirement.

218. The effective capacity is the average hourly rate of tonnage discharged during the unloading of the entire cargo of one ship, taking into account the time lost in trimming, cleaning up, moving between holds and the requisite breaks during the working periods, but excluding scheduled non-working periods, for example night-time and weekends. The effective rate is the figure used for port planning. The ratio of the effective capacity to the rated capacity gives the through-ship efficiency factor which for grabs is usually about 50 per cent. The effective rate and the factor for the fraction of time berthed ships are worked per day are used to determine the daily throughput and then the average ship service time.

219. The "peak capacity" and "rated capacity" are also known as the "cream digging rate" and the "free digging rate" respectively. In a typical case,

where the peak capacity is 2,500 tons per hour, the rated capacity may be 2,000 tons per hour and the effective capacity not more than 1,000 tons per hour. The effective unloading capacity can be even lower than 40 per cent of the peak capacity if the ship has unsuitable holds, narrow hatches and bad conditions for trimming.

E. Ship-loading

220. Ship-loading systems are simple in comparison with ship discharging systems. They normally require only a feed elevator or conveyor, a loading chute and the force of gravity. With such technically simple systems, phenomenal rates can be achieved. Other loaders are fitted with flight conveyors or spiral chutes to reduce the degradation of friable materials, or with telescopic tubes fitted with chutes or centrifugal slinger belts for distributing the material in the hold. Ship-loaders can normally be positioned adjacent to the hatch to be loaded, and they receive the material from high-capacity belt conveyors. The loading boom can be hoisted or lowered to suit the height of the vessel being loaded. In addition to continuous loading with a ship-loader, grabs can also be used for loading bulk cargoes.

221. Ship-loader capacities are usually limited by the other parts of the installation such as the conveyors or reclaimers, but normal capacity ranges are between 1,000 and 7,000 tons an hour. In special cases 16,000 tons per hour ship-loaders are possible for very large bulk vessels. At the higher loading speeds the limit may be imposed by the rate at which the ship can be de-ballasted.

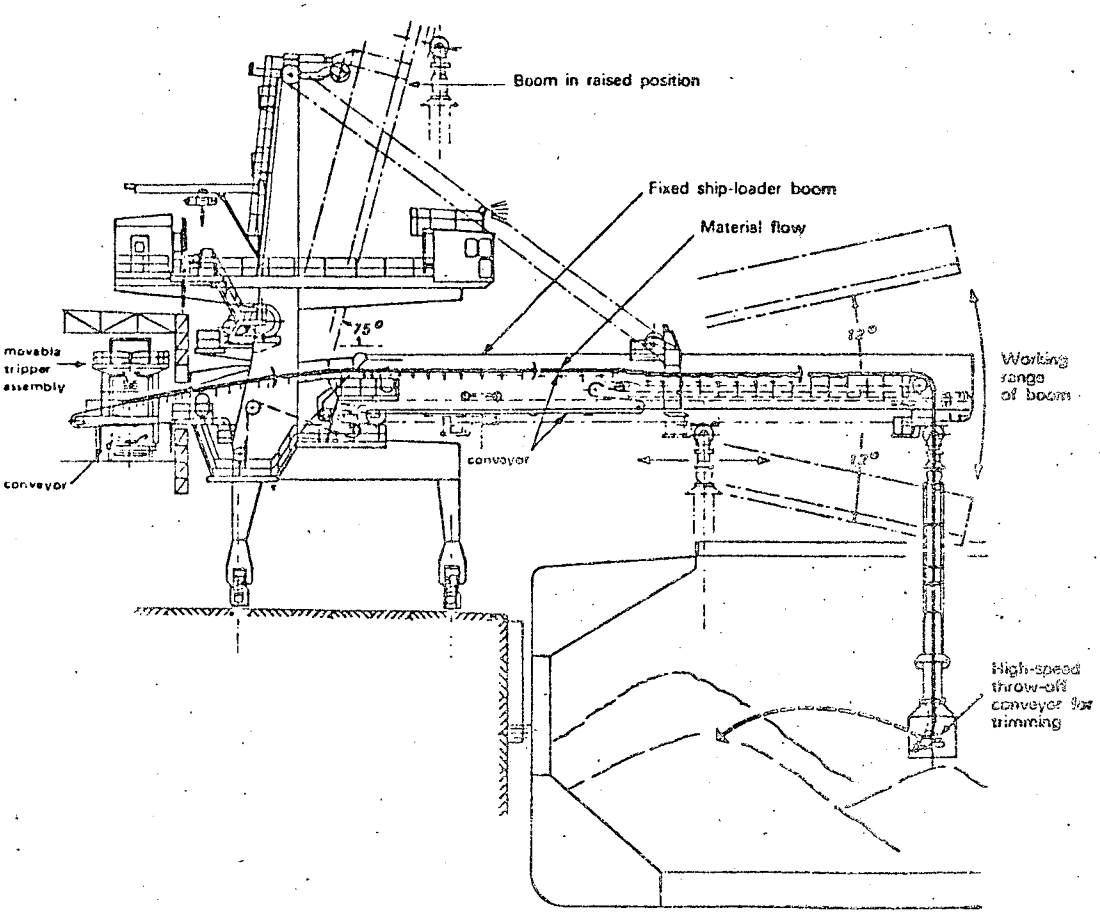
222. Ship-loaders are designed to permit the holds to be loaded in a definite sequence to avoid putting structural stresses on the vessel. Telescoping spouts at the end of the boom are frequently provided to direct the discharge into specific parts of the vessel. The boom can be raised to pass clear of a vessel's superstructure when changing from hatch to hatch, but this may require the conveying system to be stopped in order to prevent spillage of material. To avoid this the material can be conveyed into a surge hopper at a point before the loader and returned to the normal flow when loading is resumed. The loader belts must then run faster than the supporting conveyors to handle the additional flow.

F. Types of ship-loaders

223. The travelling loader (see figure 40) is on a gantry running parallel to the quay. The ship-loader is usually fed by a conveyor with a movable tripper. The tripper feeds the material from the conveyor to the ship-loader boom conveyor. The ship-loader con-

Figure 40

Example of travelling ship-loader with material from high-level conveyor

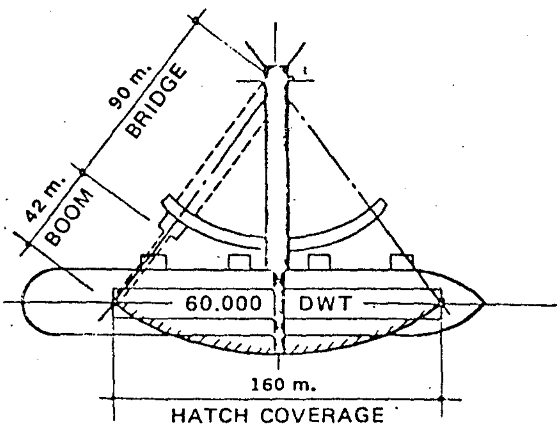


sists of a mast superstructure from which a hinged boom is suspended. The boom is raised or lowered to suit the vessel and to clear the vessel's superstructure when moving from hatch to hatch. The vessel end of the boom can be constructed to telescope or a shuttle section can be arranged to travel inside the fixed boom. A take-up system must compensate for variations in belt length due to the boom movements. A design feature of this type of loader is that there is only a slight shift of the centre of gravity within the structure in the course of all the jib and boom movements, and the loader can therefore be placed on somewhat narrower rails than other types.

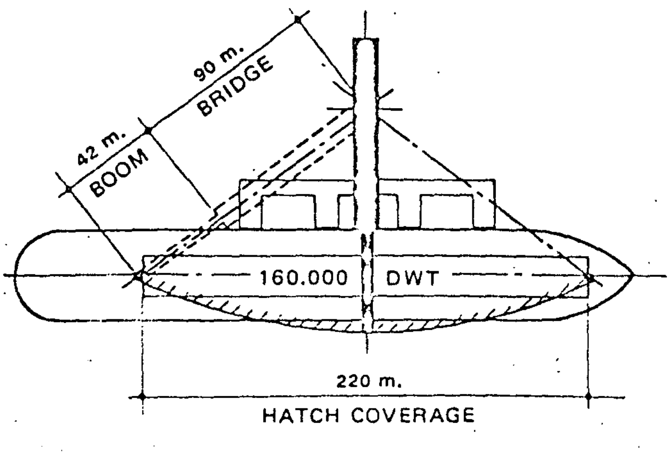
224. The radial loader was developed for use as an offshore unit and consists of a pivoted boom which can rotate or slew through an angle of approximately 90 degrees about one end, whilst the other end is carried on a curved track supported on suitable piles. The boom supports a conveyor which extends over the vessel. This section, in addition to travelling backwards and forwards, can also be made to luff. Material is discharged from the approach arm conveyor at the pivoted end of the boom conveyor, where, if required, a surge hopper can be located.

FIGURE 41

Radial and linear loader comparison



Radial loader



Linear loader

225. The main advantage of slewing bridge loaders as compared with the travelling loaders is the lower capital cost of the total installation, that is, of the loader and related conveyors, together with the marine structures. Another favourable feature is that it is easier to enclose the conveyor belts and transfers and to install dust control systems. A disadvantage is that this type of loader can completely fill, without final trimming, only a modern bulk carrier with no intermediate masts and derricks. This prevents carriers which are so equipped from using the terminal.

226. The linear loader achieves the same purpose by a combination of translation and rotation (the two methods are shown in figure 41; when the front turntable travels on a linear runway parallel to the ship, the turntable pivot is allowed to slide as well as rotate. Construction is usually simpler and less expensive with a straight runway rather than a curved one, and ship coverage is increased.

227. The travelling and slewing type of loader is a combination of a radial and travelling unit. It is particularly suited for use on both sides of a "finger" jetty, i.e. one extending out to sea with berthing facilities on either side. A travelling gantry with a rotating superstructure has a luffing boom conveyor which is fed from a jetty conveyor centrally located between the travelling gantry rails. By means of a tripper, the material is transferred from the jetty conveyor to a receiving hopper located over the pivoted end of the boom. Although only one vessel can be loaded at a time, the fact that vessels can be berthed on both sides of the jetty can eliminate delays in operating due to berthing and de-berthing. This may be important under conditions of high berth occupancy and tight scheduling.

228. The fixed ship-loader is generally used for smaller installations. As the vessel size is usually small, the output rarely exceeds 500 tons per hour. The movement of the loading boom between hatches is either non-existent or restricted, and it is therefore necessary to move the vessel. This may not present any problems with the smaller type of vessel having two or three holds only, and has been used extensively for the export of raw sugar.

229. The approach conveyor from the land is carried to the berth on a series of trestles and terminates with a tower structure. The conveyor is either extended in a short sliding section terminating with a telescopic shute or is carried in a luffing boom fitted with a telescopic chute. In some cases a limited amount of radial movement is provided to enable the whole area of the hatch opening to be covered and so reduce the amount of final trimming.

G. Ship unloading

230. There are four basic systems available to the terminal operator for the discharge of dry bulk material: grabs, pneumatic systems, vertical conveyors and bucket elevators. For a throughput per unit of

between 50 and 1000 tons per hour, pneumatic or vertical conveyor systems are adequate. For throughputs from 1,000 up to 5,000 tons per hour, grabs or bucket elevators are the only alternative. Grabs are the most widely used methods of loading and discharging bulk cargoes.

1. Grabs

231. The main principle of unloading bulk commodities by grab has not undergone any change in the past 50 years. However, the grab is now normally used only for picking material up from the vessel hold and discharging it into a hopper located at the quay edge feeding onto a belt conveyor, as illustrated in figure 42. In previous practice the grab trolley travelled further, discharging to the stockpile.

232. The attainable handling rate for each grab is determined by the number of handling cycles per hour and the average grab payload. The time of a handling cycle is a function of the hoisting speed and acceleration of the grab bucket, the travelling speed and acceleration of the trolley, the horizontal and vertical distances and the closing time of the grab. Further factors affecting it are the skill of the operator, the properties of the material being handled, the shape of the hatches and cargo holds and the degree of cleaning required at the end of each hold-emptying. Operator fatigue in any case places a limit of about 60 cycles per hour.

233. For a given lift capacity, the main method of increasing productivity is increasing the payload/deadweight ratio of the grab bucket. The normal ratio is 1:1, but newer high-capacity designs are approaching 2:1. A bulk cargo terminal handling a range of commodities will require a set of two or three grab buckets for each crane (one on the hook, one on standby and/or one in repair), plus a set of grabs for each commodity which has significantly different physical characteristics. The number of available designs is very large, ranging from the light grabs for handling products such as animal feedstuffs and grain, to the massive 50-ton-lift ore handlers. Specialist advice should therefore be sought to allow the choice of the correct unit for a specific material and crane type and for specific working conditions.

234. To achieve the desired rate of unloading, it is often necessary for a single vessel to be served by two unloaders. This has an important advantage in providing operating capacity during the failure of one of the units.

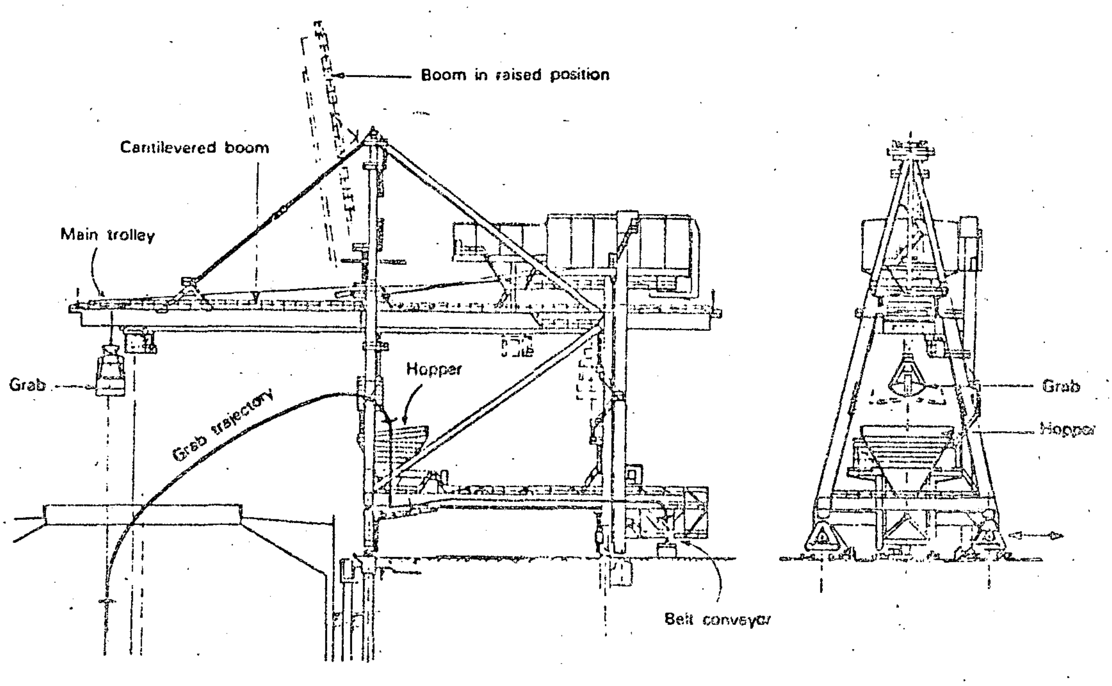
235. The principal materials for which the grabbing bulk unloader is used are the main bulk products, namely, iron ore, coal, bauxite, alumina and phosphate rock. Other commodities handled by smaller mobile grabbing cranes include raw sugar, bulk fertilizers, petroleum coke and various varieties of bean and nut kernels.

236. There are three main forms of grabbing crane. The travelling overhead trolley unloader has a cantilevered boom which projects over the hatch. The trolley transfers the bucket from the hold to the hopper on the quay. The structure travels parallel to the quay to allow working the full length of the ship. Typical free digging rates for these units range from 500 to 2,000 tons per hour.

237. The revolving grabbing crane, as shown in figure 43, is generally of the level luffing type and is

FIGURE 42

Travelling overhead trolley unloader grabbing crane



probably the most commonly used type for unloading. The crane grabs and lifts the material and discharges it into a hopper, generally at the front to eliminate slewing during operation. The hopper feeds a jetty conveyor in the usual way or it can discharge directly to trucks or rail wagons. These cranes can attain a free digging rate of between 500 and 700 tons per hour. When a normal general cargo crane is being used for grab unloading, the hopper must be located on the same track as the crane. The 90-degree slewing movement for each grab cycle limits the free digging rate to 250 tons per hour, a good average rate being about 180 tons per hour.

238. The third form of grabbing crane is the mobile port tower crane which is useful in smaller ports handling a wide range of mixed cargoes to and from smaller vessels. This unit comprises a standard

FIGURE 43

Revolving grabbing crane

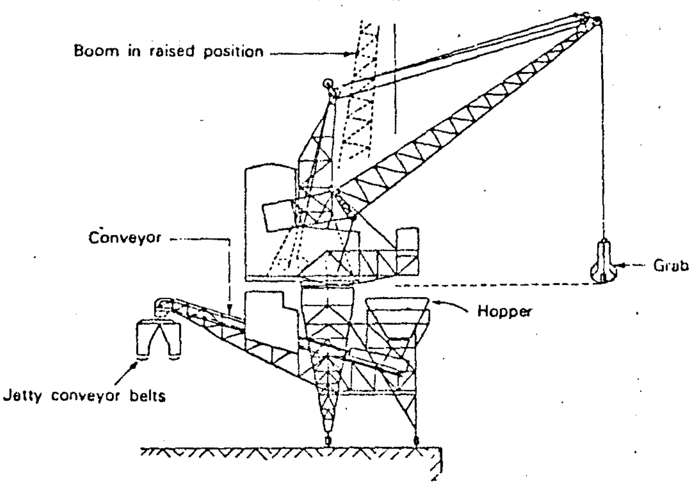
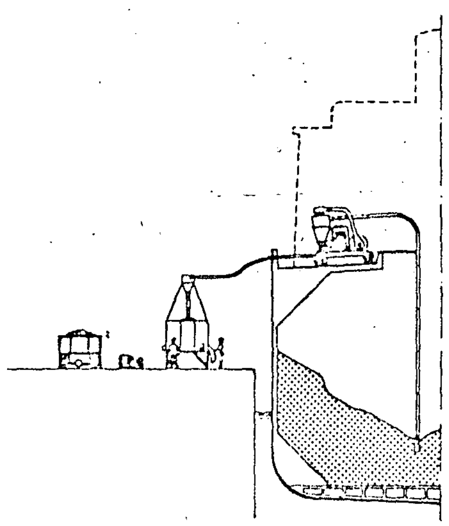
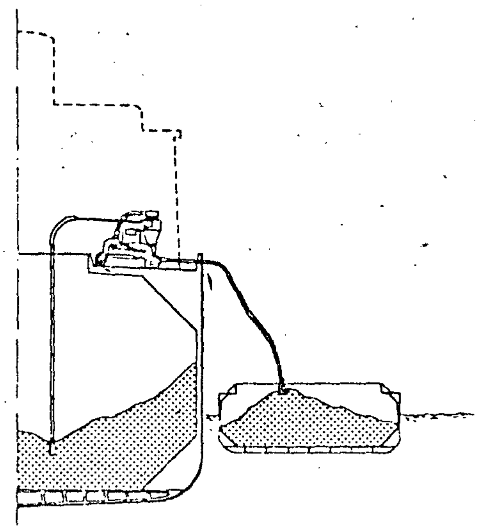


FIGURE 44

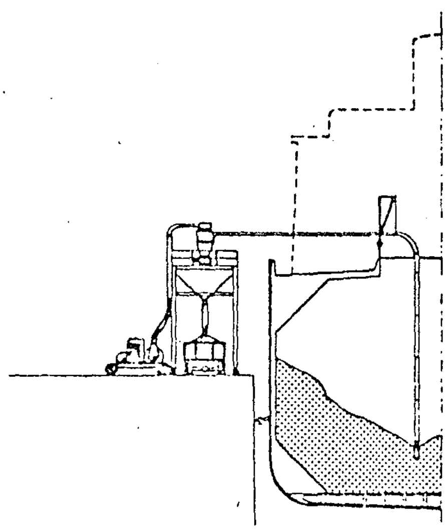
Portable pneumatic handling equipment



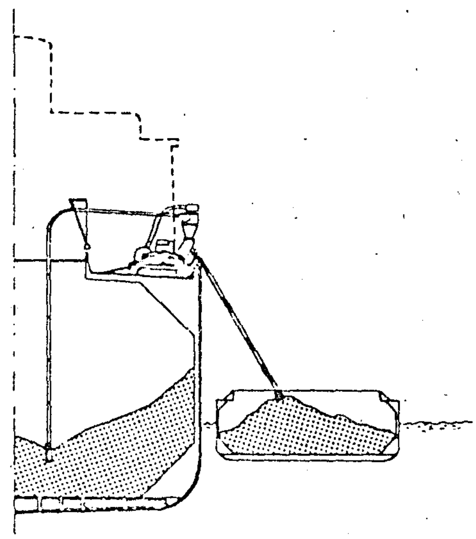
1. *Combination vacuum/pressure system; conveying grain from ship into bagging hopper*



2. *Combination vacuum/pressure system; conveying from ship to barge*



3. *Vacuum-only system: transferring grain from ship into truck or railwagon-loading hopper*



4. *Vacuuming grain from ship; loading grain by gravity into barge*

mobile crane with an additional tower structure fitted with an elevated cab to allow the operator to look down into the ship's hold. Productivities are similar to those achieved with the revolving grabbing crane.

2. Pneumatic systems

239. Pneumatic systems are suitable for handling bulk cargo of comparatively low specific gravity and viscosity such as grains, cement and powdered coal. Pneumatic equipment is classified into vacuum, or suction types and pressure, or blowing types. The former are suitable for collecting materials from several places to one spot while the latter are suitable for delivering cargo from one spot to several places. However, the blow type tends to create dust problems. A combination of the two systems is also used, but it is generally restricted to portable equipment. Typical uses of this equipment are shown in figure 44.

240. Vacuum pneumatic conveyors are simple in construction and materials are not lost through spillage during transportation. However, the power consumption is high compared with other transporting media. Before a decision is taken whether to adopt a pneumatic handling system or a conventional mechanical handling system, not only the capital, maintenance and operating costs must be considered, but also health, cleanliness and other factors which cannot be directly evaluated.

241. Certain materials are potentially dangerous and should be handled carefully to ensure the health of the operators. Some hazards to health can be overcome by the wearing of face masks and protective clothing. The adoption of a fully enclosed pneumatic handling system, although initially more expensive, often improves working conditions and reduces material loss as well. Cleaner conditions improve morale, facilitate plant maintenance and reduce health hazards.

242. The travelling pneumatic elevator consists of a rail-mounted gantry with a total enclosed superstructure for housing the major items of equipment. Generally, two units are housed in one gantry, and the usual limit of unloading rates is about 200 tons per hour per unit. The unloading arms terminate in flexible intake tubes which allow very efficient clean-up of the hold. Material sucked through the nozzle is collected by cyclone-type separators and discharged onto the onward conveying system, very often a belt conveyor.

243. There exist also waterborne versions of the travelling pneumatic elevator. They are self-contained and self-propelled machines, with a throughput similar to that of the rail-mounted kind. They can be used for discharging directly to shore storage or, in the case of onward transport, to barges. They can also be arranged to operate in reverse, from barge to vessel for export.

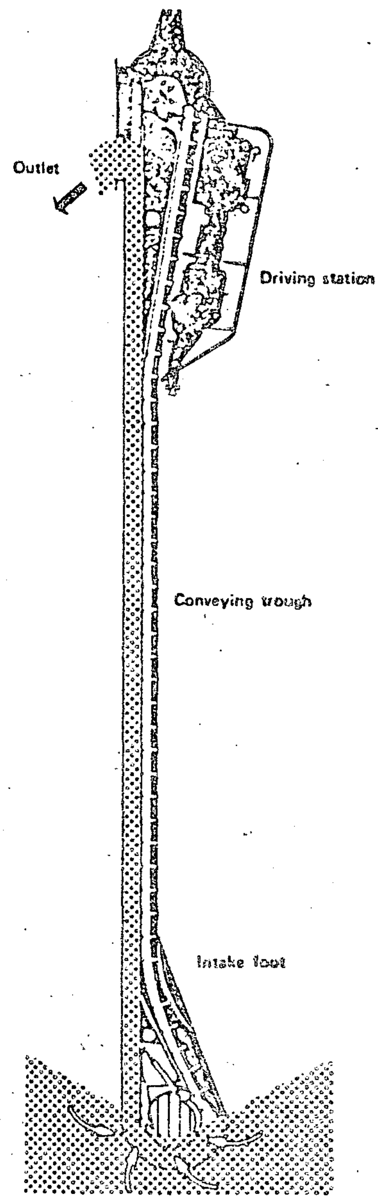
244. In addition, there are portable pneumatic units on wheeled trailers which can be positioned on the quay or aboard the vessel, as shown in figure 44. The handling rates of this light portable equipment are low, usually about 50 tons per hour.

3. Vertical conveyors

245. The chain conveyor unloader (see figure 45) is a self-contained unit working on the *en masse* principle. The free digging rate is generally limited to 150 tons per hour. The conveying chain is carried inside a rectangular casing and its motion carries material from the hold. A second unit can be used as a connexion to hinterland transport as the unit can be adapted for inclined and horizontal conveying. The units are restricted to dry, friable materials that

FIGURE 45

Chain conveyor unloader



are compatible with direct contact with moving parts. For intermittent use, it may be more economical to employ this type of unit rather than the grab ship unloader, in spite of its high maintenance cost.

246. The vertical screw conveyor is a full blade screw contained in a tubular casing. The unit can be used at any angle from the horizontal to the vertical. Screw conveyors can efficiently deal with all fine powdered and granular materials, lumpy material (provided the lumps do not exceed a specified size in relation to the screw diameter), semi-liquid materials and fibrous material. Free digging rates of up to 600 tons per hour have been achieved. The throughput is restricted to the rate at which material can freely flow into the feed aperture. A proprietary type of screw auger has an independently driven spiral around the feed intake to combat this feed problem.

4. Bucket elevators

247. Bucket elevators are another alternative for handling rates in the 1,000 to 5,000 tons per hour range. At present these continuous unloaders appear less efficient in terms of cost per ton unloaded than grabs, taking account of total capital expenditure and operating costs. However, the free digging rates for these units will approach 5,000 tons per hour, while grabs have a maximum rate of 2,500 tons per hour. Developments in this matter should be watched in view of the high theoretical handling rates.

248. One concept involves a continuously rotating bucket wheel suspended from the luffing boom of the travelling unloader. This bucket wheel digs up the material and feeds a continuous bucket elevator. The weight of the structure plus the dynamic digging forces require a heavier and more expensive quay than for the usual grab cranes.

249. An alternative approach uses a bucket chain elevator with the buckets acting as digging scoops. As in the case of the wheel and elevator, the bucket elevator is suspended from the luffing boom. A heavy foundation is again required to absorb the digging forces, and maintenance costs may be considerable. At smaller installations, for example, those for the unloading of coal and phosphate from barges, purpose-built facilities utilizing the bucket chain elevator can be very useful.

5. Slurry system

250. Certain materials, such as iron ore, salt, bauxite, heavy mineral sands and certain coals may be suitable for transportation via the slurry method. This method basically consists of making a 70-per-cent-ore-base slurry-water mixture at a mine site and then pumping it aboard specially equipped mineral tankers. Excess water is decanted prior to ship departure, leaving a concentrate with over 90 per cent solids. At the discharge port, rotating water jets in the bottom of the holds undercut and liquefy the ore concentrate so that it can be pumped ashore. This system eliminates loading and discharge cranes, elaborate docking arrangements and other facilities.

251. The slurry process is a clean one which minimizes material loss that occurs with other, dust-inducing ore-handling procedures. Decanted liquid during the loading process may have to be returned to a settling pond to avoid pollution and to recover ultra-fine particles. The slurry form of the cargo makes it economic to locate the storage area some distance from the port area. The rate of discharge will be dependent upon the size of ship and the installed pumps, but for large vessels it will normally be 6,000 to 8,000 dry tons per hour. Material can be loaded dry by conventional systems and unloaded using the slurry process.

6. Self-discharging vessels

252. At the beginning of 1976, approximately half of the bulk carriers were equipped with gear for self-discharge, while only 16 per cent of the ore carriers were so equipped. The average size of vessels so equipped was markedly smaller than that of vessels without gear. The gear usually consists of bucket cranes or derricks with a safe working load varying from 3 to 30 tons.

253. A limited number of carriers have been built which utilize gravity reclaiming onto a belt, chain or screw conveyor in the bottom of the holds to feed an elevator system within the ship. These vessels require only a hopper and conveyor arrangement at the discharging terminal to transfer material from the ship's system to the storage area.

H. Horizontal transport

254. Conveyors are the most extensively used piece of equipment in dry bulk handling and reappear in a variety of forms in elevators, ship-loaders, packers and reclaimers, as well as purely for horizontal transport. For horizontal transport, unlimited distances can theoretically be covered by conveyor, although transport economics will usually limit conveyor systems to a few kilometres before rail or road transport becomes more appropriate.

255. The conveyor system layout has a major effect on the whole terminal area requirements, and on its flexibility. The routes taken, and the choice between raised, ground-level or underground systems should be given a similar degree of attention to the layout of a road system in a built-up area. On long runs, design for ease of maintenance is paramount.

256. The general adoption of the belt conveyor as a mechanical carrier for bulk materials has been due to its inherent merits:

(*a*) Simplicity of construction;

(*b*) Dependability and economy of upkeep;

(c) Efficiency, with small driving power requirements;

(d) Complete discharge of the material handled;

(e) Adaptability.

The material is received directly onto the belt and is carried with a minimum of friction and noise to its destination. There are no joints or other projections to break or wear, and abrasion or friction between the material and the belt exists only at transfer points.

257. The limited vertical angle at which belt conveyors can carry materials necessitates a considerable amount of space to enable the material to be lifted to the required height. The supporting structure for long conveyors also requires routine maintenance work such as painting. These disadvantages have to be considered.

258. Belt conveyors are either flat or troughed with the former used for packaged material. Two flat belt conveyors with their carrying surfaces located in a vertical plane at an appropriate distance apart can form a "pinch" belt elevator suitable for the unloading and loading of bagged material. Peak rates of 4,000 bags per hour have been achieved.

259. Developments have made possible the production of stronger and wider rubber belts with canvas plies. In addition to these belts with canvas plies, belts with steel wire to increase tensile strength have been produced. In combination with improvements in the associated belt idlers, belt conveyors are capable of transferring several thousands of tons per hour.

260. The chain conveyor has a flighted chain which moves around inside a totally enclosed casing with a dividing partition. Material can be introduced at any point in the top of the casing; it falls through an opening in the partition plate to the bottom of the casing, and is then conveyed by the chain until it reaches a discharge opening. The conveyor can be used up to an angle limited by the characteristics of the material.

261. Any free-flowing material can be handled by this means, and the process is dust-free. Grain is the most common material handled, and rates up to 500 tons per hour are possible. For small port installations, in combination with chain type unloaders, this type of equipment is very useful.

262. The *en masse* conveyor is similar to the chain conveyor but is different in operating principle and has a casing of smaller cross-section. The unit works on the principle that the friction between the material and the specially designed chain is greater than the friction between the material and the casing. The material shifts as one body, *en masse*. This method permits vertical as well as horizontal conveying, and multiple inlets and outlets can be used. The construction can be made dust-tight. One disadvantage is that a certain amount of product degradation occurs.

263. Screw conveyors are a very compact form of handling with a totally enclosed casing, either U-shaped or tubular. The selection of the correct type of screw and trough cross section for the material to be handled is essential if maximum efficiency is to be obtained. Generally, capacities do not exceed 500 tons per hour. The power required is much higher than for other conveyors. Provision has to be made to accommodate end thrust due to the reaction of material along the casing. These conveyors can be inclined from the horizontal.

264. The powder pump can be used for the onward transport of dry pulverized free-flowing materials. Capacities of up to 200 tons per hour at distances up to 1,200 metres have been obtained. A high-speed screw feeds material through a non-return valve into a chamber fed with compressed air which conveys the material to the receiving vessel. Powders composed of fragile aggregates are unsuitable for this technique.

265. The fluidizing gravity conveyor can be used for horizontal transport, particularly for powders. The principle of the conveyor is that when air is passed upward through the material, the mass expands and behaves as a fluid. The conveyor consists of a sloping trough with a porous medium extending across its width. Powder fed into the conveyor flows freely down it.

266. The mono-cableway is the simplest form of aerial ropeway and is the cheapest to install and maintain. A single endless rope serves both to support and transport the load, which is carried in buckets. A single section rarely exceeds eight kilometres in length but multiple sections can be used. Buckets are disengaged from the rope at transfer stations and are pushed or run automatically onto the next section. At the terminals the loading and unloading can be either manual or automatic. The maximum capacity is generally taken at 150 tons per hour with a typical bucket capacity of 0.5 tons.

267. The bi-cable system separates the supporting and hauling functions of the ropes. Two parallel carrying ropes are provided on each side of the ropeway centreline. Each rope is anchored at one end and is provided with a tensioning device at the other. An endless hauling rope is used to move the buckets supported on the carrying ropes. The relatively heavy single loads which can be supported permit handling rates of up to 500 tons per hour.

I. Weighing and sampling

268. Material must often be weighed immediately prior to loading or after unloading for payment purposes, or for checking against shipping documents. A simple method is to weigh the material continuously while it is being conveyed, and according to the type of equipment used varying degrees of accuracy are obtainable. Essentially, the loaded side of the belt is carried over an independently supported section of conveyor structure. The weight of material on this

section of the belt is instantaneously recorded and in conjunction with the speed of the belt the quantity conveyed at any flow rate can be calculated automatically. Various forms of obtaining weights give different degrees of accuracy, and range from simple mechanical/electrical devices to electronic strain gauge units. Two standard levels of accuracy may be provided: an accuracy to within one to two per cent of the actual weight, and an accuracy to within two to four per cent. The degree of accuracy attained is dependent on the placing of the weigher, which is a skilled task.

269. Batch weighing methods are also employed, normally through the use of a weighing bin in conjunction with a surge hopper. Material is temporarily diverted to the hopper while the full bin is automatically weighed and dumped. Weighing towers are often incorporated into the conveyor network, an inclined conveyor being used to feed the top of the tower.

270. Sampling is sometimes a requirement in a transfer of material, generally to satisfy the purchaser that the material is in accordance with specifications. Any attempt to take a sample by hand could result in incorrect representation of a particular batch. It is therefore essential to take a series of samples automatically at timed intervals. In order to obtain a representative sample from the whole series of primary samples, they can be mixed together and a further sample taken. This procedure can be repeated until a very representative sample of the batch is obtained.

271. Several methods of obtaining samples are available according to the characteristics of the material and the accuracy required. A usual type of sampler consists of a scoop which is quickly swung through the material either on the belt or through the falling stream of material, and deposits its contents either into a sample box or into a mixing hopper for further sampling. The decision as to the best method of sampling and type of sampler to use should be left to the specialist.

J. Stackers and reclaimers

272. The stacker is a specialized machine designed for the continuous stacking up of various kinds of bulk materials in storage areas, and comprises a tripper (see figure 46) and a stacking-out conveyor. Material is discharged by means of a tripper which allows the stacker to be positioned anywhere along the whole length of the belt conveyor in the storage area. The material is then fed onto the stacking-out conveyor carried in a boom which is capable of being slewed and/or derricked, or may be fixed. Figure 47 shows a typical stacker arrangement. Sometimes, material can be discharged direct from the tripper to allow the area adjacent to the tripper to be used for storage. The capacities of stackers are constantly being increased, and outputs up to 6,000 tons per hour or more are possible, the limiting factor normally being the rate of feed from the unloading equipment. Blending is achieved by the right mode of stacking.

273. The modern reclaimer is a machine that can continuously reclaim and discharge the stored material from the storage area, and consists of the reclaiming mechanism and the intermediate belt conveyor. The reclaiming mechanism may be a revolving wheel on which buckets or gathering arms are attached. Reclaimers are high in efficiency provided that care is taken in stockpile planning. Typical rated capacities of individual units vary from 1,000 to 3,000 tons per hour. Peak capacities must be used for designing conveyor systems. There is a limitation on the order in which piles of different grades of material can be reclaimed according to their accessibility. It may also be necessary to use a bulldozer to push the farthest parts of the pile into positions accessible to the reclaimer arm. Large capacity machines are very heavy and require substantial track foundations, so that the existing ground conditions could be the limiting factor.

274. Stacker-reclaimers, as illustrated in figure 48, have the two functions of stacking and reclaiming in

FIGURE 46

Principle of belt loop or tripper

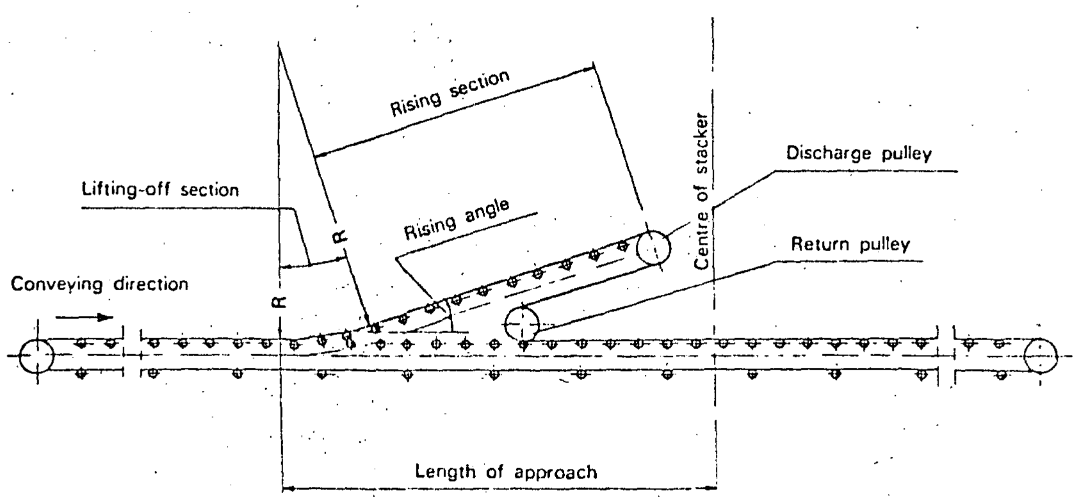


FIGURE 47

Arrangement of stacker for feeding stockpiles

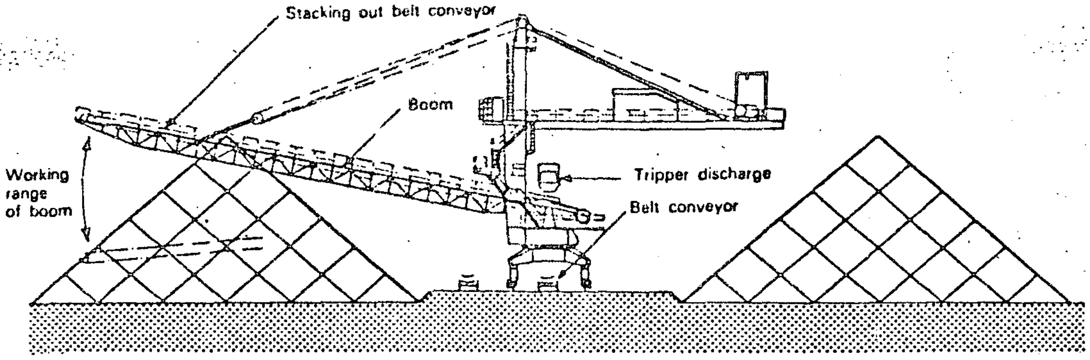
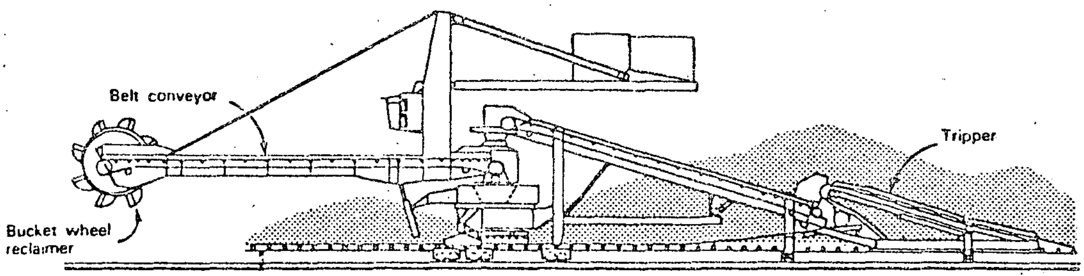


FIGURE 48

Typical stacker/reclaimer



a single unit. The belt conveyor on the boom travels in the discharge direction with the reclaim wheel stationary when discharging, and in the reverse direction with the reclaim wheel in operation when reclaiming.

275. When the storage area is small, stacker-reclaimers have proved to be extremely useful. In a small area, the installation of a separate stacker and a reclaimer will sometimes limit the working area of each machine and cause areas of inaccessible material. If the need for stacking and reclaiming at the same time does not arise, for example, when for a single material the arriving flow can be routed direct to the ship-loader in addition to the reclaimed flow, then it is recommended that a stacker/reclaimer should be used, with reduced initial investment. On the other hand, if both operations are required simultaneously, then separate function machines are required.

276. An alternative to the bucket wheel stacker/reclaimer is a scraper/reclaimer, also known as a "backstacker" reclaimer. Here the boom conveyor consists of two heavy-duty chains with flights of substantial proportions at regular intervals. For stacking, the boom conveyor flights scrape the material into the stack from the hopper feed, and for reclaiming, the chain conveyor is reversed and the material is scraped down the pile into a trough to a normal conveyor. This system is lower in maintenance costs and raises less dust. The method has been successfully used at a phosphate rock terminal.

277. A further alternative stacker/reclaimer arrangement, which in the past was used extensively, is the overhead travelling transporter. Here a travelling gantry spans the storage area and contains a belt conveyor at high level with travelling tripper. Also mounted in the gantry are usually two travelling bucket elevators which can discharge onto the belt conveyor.

278. In the stacking operation, material from the store yard conveyor is elevated to the gantry belt conveyor for discharge direct to store by the travelling tripper. For reclaim, the elevators, of open frame construction, are lowered into the material which is reclaimed in the buckets and discharged onto the reversed gantry conveyor. This discharges into the store yard conveyor which is also reversed. The reclaim rate of the elevators is limited to about 500 tons per hour and considering the extensive steelwork required to carry this equipment, with the subsequent high maintenance costs, this type of unit has generally been superseded by the other forms of reclaiming.

279. There is another scraper/reclaimer type of machine which is usually installed in a storage building, although it can be used outside for materials that do not require weather protection. Capacities of up to 1,000 tons per hour are available. In this unit the material pile is reclaimed by a scraper chain conveyor suspended from a portal frame and pivoted at its lower end. The frame is mounted on travelling

bogies running on rails throughout the whole length of the building. A belt conveyor in the terminal receives material from the pivoted end of the chain conveyor, whilst an additional chain scraper is sometimes suspended from the other leg of the portal frame to push the material into the path of the main chain conveyor.

280. This approach has several advantages:

(*a*) Fully automatic operation of the machine is possible, although it is usually operator-controlled;

(*b*) Reclaiming is continuous;

(*c*) Reclaiming output is independent of the skill of the operator.

A disadvantage is that the substantial space required for the plant causes loss of storage space inside the building.

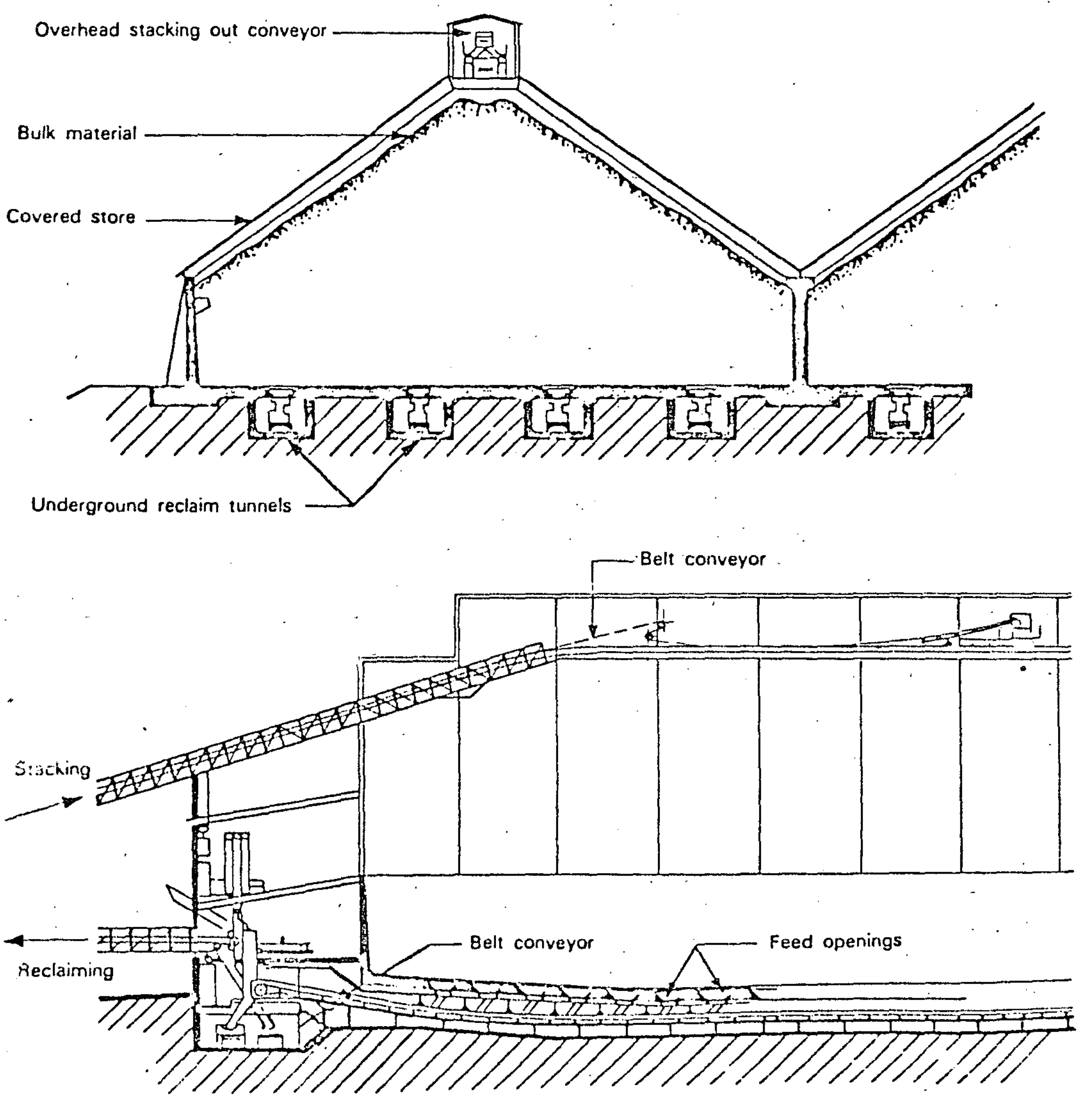
281. The underground reclaim system can be used for either covered or open storage, and it is probably one of the most common, although it has certain disadvantages. It normally consists of one or more underground conveyors running the whole length of the storage and enclosed in tunnels, as shown in figure 49. The system relies on gravity for the discharging of the material onto the underground conveyors. The shape of the tunnels is dictated by the method used for controlling the rate of discharge.

282. In one example of the system, there is a series of feed openings in the floor of the store, each fitted with a chute and an adjustable cut-off gate. The flow of material through an opening can reach a speed of up to 1,000 tons per hour, and the total reclaim rate will be dictated by the number of openings which it is feasible to control. Normally, three or four openings can be discharging at any one time onto each conveyor.

283. The main advantage of this system is that the capital costs are relatively low, but these may be outweighed by the operating costs and the inefficiency of the reclaim. Each feed opening will be able to

FIGURE 49

Underground reclaim with gravity feed to belt conveyor



reclaim only a limited amount of material, depending on its angle of repose. Moreover, the rate of flow through each feed opening will decrease throughout the discharge, requiring constant attention from an operator to ensure that the total reclaim rate is maintained. As it is usually necessary to have more than one outlet in operation at any one time, the extract rate will be dependent upon the skill of the operator and some loss in output is inevitable. Another disadvantage is that it will not be possible to empty the store completely without resort to the use of bulldozers, and this may not be acceptable when handling dusty or dangerous materials. It can also be difficult to avoid severe dust levels underground and arduous working conditions for the feed operators. Another important consideration to be borne in mind in the designing of underground reclaiming systems is that of drainage.

284. A form of extraction which overcomes the operational disadvantages is the provision of a paddle wheel extractor to feed onto the belt conveyor. Here a specially formed base to the store is required, having hopper sides and a continuous slot running the whole length of the store. The paddle wheel extractor, which has slowly revolving arms moving in a horizontal plane, is mounted in a travelling carriage which travels backwards and forwards along the slot. Material is therefore continuously taken equally from the whole store, and the whole operation can be carried out automatically by an operator from an isolated control room, which could be advantageous when dusty material is handled. The main disadvantage of this system is in the cost of construction of the special slot opening, which can be high.

285. The dragline scraper has been used quite successfully in the past, but has been superseded to a large extent by the mobile bulldozer and large capacity front-end loading shovel. It is, however, still useful where very dusty materials are handled and the use of mobile equipment in an enclosed store would be undesirable.

286. The equipment consists of a winch house, generally situated in a tower superstructure, which has a reception hopper at its base, and a pair of hauling ropes which extend from the tower to a travelling frame. This frame is power driven and moves around in an arc on the outside of the stockpile. A travelling scoop, attached to the ropes, can be moved backwards and forwards across the stockpile. During its forward motion, it moves material into the receiving hopper, whence it passes onto the conveying system.

287. For very small installations having an appropriately sized storage area adjacent to the quayside or to a reclaim conveyor system, it may be convenient to use a front-end loader and a mobile belt conveyor having a suitably sized feed hopper. In some installations, a small feeder conveyor below the surface must be used with a wide ground-level hopper having an open side through which material may be directly pushed. With a front-end loader, capacities up to 100 tons per hour are within the capabilities of each driver. The mobile belt conveyors can also be used for direct loading into barges and lighters from tipping trucks. The rate of loading is determined by the vehicle tipping speeds.

288. A scraper is standard equipment used in civil engineering for site preparation, and for the open pit working of certain minerals. It has been used very successfully for emergency stock reclamation, when a machine with a capacity of up to 20 cubic metres can be used. When the bowl is full, the clam-shell gate is closed and the bowl raised clear of the ground; the machine then travels to the discharge point. It is only possible to discharge into a suitably sized ground hopper, which will add to the civil engineering capital costs. This type of reclaim can be used only when degradation of the material, due to the heavy machine travelling over the storage area, is acceptable.

K. Storage

289. The availability of land for the stockpile is limited either by the natural conditions or by the cost of acquisition. The stockpile must therefore be planned so that a maximum amount of material can be stored in a minimum area. The volume of material which can be stored in a given area will depend, not only on the bearing capacity of the ground and the characteristics of the material but also on the outreach and height of stackers and reclaimers. The function of the stockpile is to enable transportation facilities with different times and rates of working to function independently of each other, so as to avoid delays caused by one facility having to wait for another.

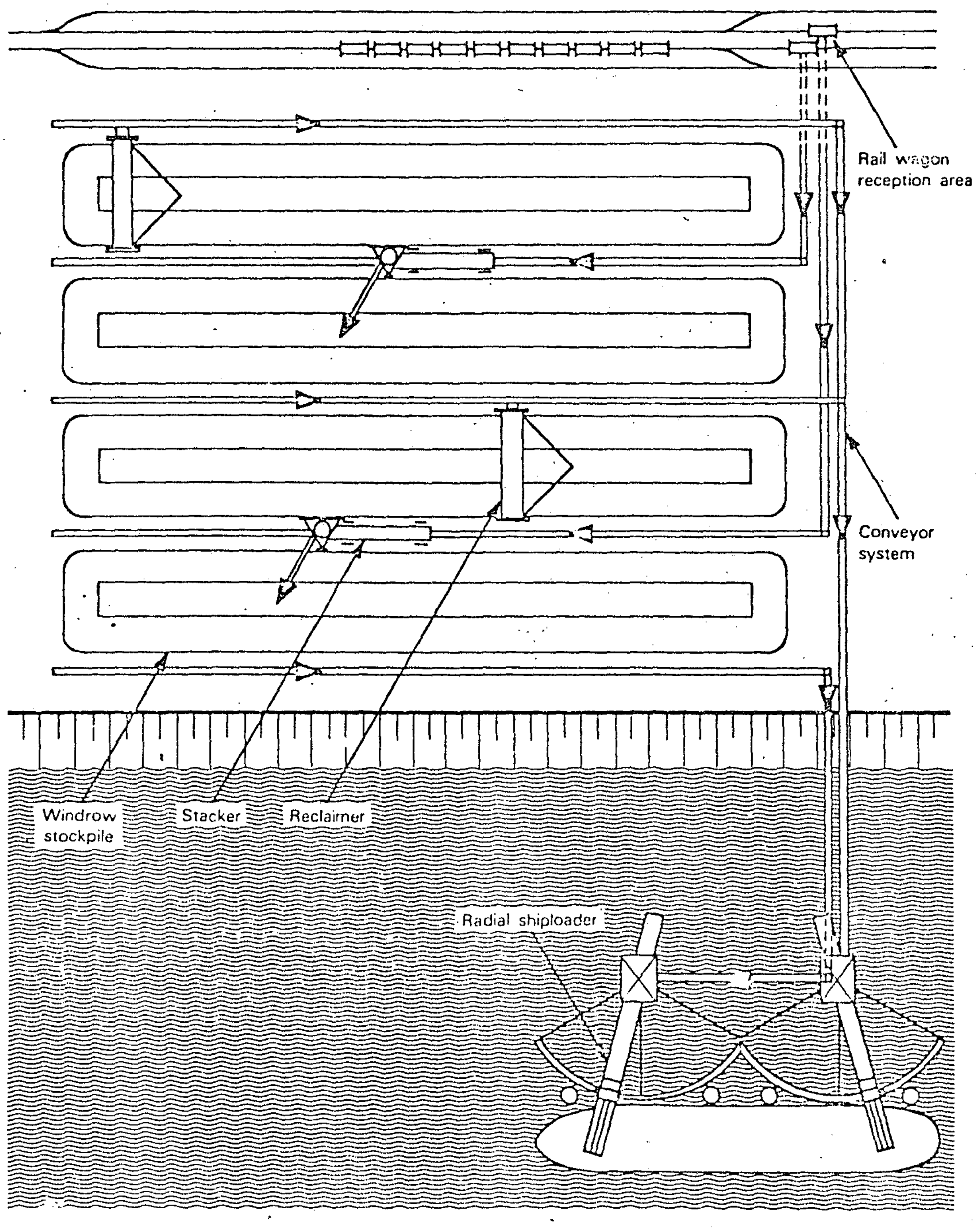
290. The most common form of bulk storage is the wind-row arrangement (see figure 50), where material is arranged in an elongated pile, the width of which is determined by the height of discharge and the angle of repose of the material. On smaller sites, a circular pile may be arranged, with stacking out and reclaim from a central rotating stacker/reclaimer. The storage area may be open to the elements or completely covered, according to the material and the prevailing weather.

291. For material affected by weather, a covered store, normally a portal-framed structure spanning the width of the pile and extending for the whole length, is used. Feed-in is generally from a high belt conveyor situated along the apex of the building and reclaim is by means either of a scraper/reclaimer or of an underground conveyor. When dusty materials are being handled it may not be possible to reclaim with a scraper/reclaimer at the same time that material is being fed into the store. The two options are then either to erect a second storage building, or to use an underground reclaim system.

292. When unloading a vessel it may be necessary to use road vehicles or rail trucks for onward trans-

FIGURE 50

Export port showing arrangement of wind-row stockpiles



port. In this case it may be convenient to use a storage bunker or truck silo in conjunction with the open storage. The bunker takes the form of an elevated store of limited quantity that can be fed at the same time as the main flow to the stockpile. The onward loading of transport vehicles is carried out from bottom-opening doors. Control is usually effected from raised plaftorms giving an unobstructed view of the loading operation and of the traffic movements. Bunkers may be constructed from reinforced concrete or structural steel and plating, and arranged to be fed from overhead conveyor systems or pneumatically.

293. When storage bunkers are empty, material entering could have a considerable distance of free fall, which would result in segregation and in degradation of friable materials. One device to prevent this degradation is a specially designed chute in the form of a spiral which arrests the fall of material by friction in the chute sides. Segregation occurs when particles of a well-mixed material, being delivered from a single point, fall onto the cone of material. Fine particles tend to lodge in gaps, while large particles tend to roll down the surface of the cone and collect near the walls. Where segregation is to be avoided,

care must be taken to ensure that material is withdrawn evenly from the whole cross-sectional area of the bunker. This can be achieved through careful design by specialists.

294. A silo may be a single unit or a multiple unit in which various grades of material may be stored. Silos are generally used for the storage of grain and animal feeds where provision must be made for sealing against the ingress of moisture and vermin. Construction materials used can be reinforced concrete or steel, in which case the steel wall plates should preferably be coated with vitreous enamel to provide a surface which is virtually impervious to corrosion. This protection is important, as a silo unit in close proximity to the sea would be adversely affected by salt sea spray. Internally, any corrosion would adversely affect the quality of grain. The silo is fed from an overhead system and discharged through bottom doors.

295. The tote bin system has been developed in recent years for the handling of minor bulk cargoes, especially where a sealed container is required. The bin is both a shipping container and an intermediate storage unit which becomes a discharge hopper when mounted on special tipping equipment. Thus the material remains in a single container throughout the process of transportation.

296. The usual material used for the bin construction is aluminium, which is light in weight, resistant to corrosion and capable of being stacked. Unfortunately, as in the case of all bulk bins, the return journey of the empty bin adds considerably to the cost of transportation, and this becomes a serious constraint for long journeys and for export materials. If the bin can be reduced in volume for the return journey this disadvantage is minimized. Alternatively, a cheap throwaway container can be used.

297. A surge hopper is often necessary to act as a temporary storage during a certain phase of a conveying operation. For example, during a loading operation a ship-loader will need to be moved from hatch to hatch. While it moves, the material flow from the ship-loader must be stopped to prevent spillage on the deck of the vessel. The conveyor system from the stockpile can be kept in motion if the material flow to the jetty conveyor is bypassed into a surge hopper.

298. When the ship-loader is in position again, the ship-loader and jetty conveyor are restarted, taking material from the approach conveyor plus the material temporarily stored in the surge hopper. The ship-loader and the jetty conveyor are sized to suit this increased flow of material.

299. This method can give considerable improvements in throughput, but for smaller throughputs the installation of a surge hopper may not be justified. The size of the hopper depends on the rate at which material flows along the approach conveyor and the time taken for the ship-loader to travel between the hatches furthest apart.

L. Vehicle reception

300. There are four main ways of discharging bulk cargo from rail wagons:

(*a*) Bottom discharge;

(*b*) Rotary tipping;

(*c*) End tipping;

(*d*) Pneumatic discharge.

In the first three methods, the material is discharged into a hopper which is emptied via a transfer conveyor. Bottom discharge wagons are fitted with bottom doors which open to empty the vehicle. For the rotary and end tipping facilities the rail car is physically rotated or tipped to discharge the wagon. With the rotary tipper, the rail wagons do not have to be uncoupled if they are fitted with rotating couples.

301. For powdery free-flowing materials a combination of compressed air and gravity can be used to discharge the wagon. The wagon consists of a pressure vessel and is discharged via hoses to the receiving store.

302. Road trucks have the same method of discharge as rail, but can often be self-tipping. High-capacity tippers have a gross weight of over 32 tons, while smaller tippers have gross weights of 24 and 16 tons. Trucks with pressure vessels for pneumatic discharge can be fitted with a diesel-engined blower unit to make deliveries independent of an external air supply. Self-tipper trucks can discharge directly to stockpiles via a mobile belt conveyor.

M. Stand-by facilities

303. The high cost of the vessel's time makes it essential that equipment should be available at all times while the vessel is alongside the jetty. A plant breakdown during unloading/loading operations can result in high demurrage payments. Preventive maintenance will go a long way to reduce this down-time, but stoppages through plant breakdown will still occur. In addition to a skilled maintenance force to repair the fault quickly, provision must be made for the duplication of certain conveyors and for the necessary re-routing of material flows. The provision of other stand-by equipment for unloading/loading should also be considered. This could take several forms; for example, either two reclaimers can be arranged to cover one stockpile, or the use of high-capacity mobile front-end loaders can be resorted to. Stand-by mobile front-end loaders can also supplement the normal rate of reclaim during seasonal peaks, using emergency reclaim hoppers which are mounted on tracks alongside the reclaim conveyors.

304. The grab bucket has high reliability, with only few components subject to wear, and any necessary repairs to the digging lips, shells and bearings can easily be effected at low cost in a workshop. Several sets of grab buckets for a single bulk unloader are normally purchased so that the correct type is available

for each of the different bulk commodities and vessels and reserve buckets are available for each commodity. Where two unloaders are in operation, one machine can continue operating during the short period needed to change the bucket on the other. Adequate provision for storage and for transportation of grabs to the workshops for repair should be provided in the jetty design.

N. Environmental considerations

305. Pollution prevention is a major cost item and at the outset of any scheme it will be necessary first to establish an environmental policy. It will be necessary for the appropriate authority to specify the importance it attaches to the local environment, and how much extra it is prepared to pay to maintain it. In order to take a decision, the planner will need to prepare a statement on the probable effects of the installation on the local environment in the absence of any special precautions. In additon, a study of working conditions within the terminal will have to be made. At this stage, experts should be called in and proper specifications agreed upon satisfying the policy laid down.

306. The characteristics of the material handled may be that it is very dusty, or dangerous to health, or even liable to form explosive mixtures with air or moisture. Several problems arise with respect to dust suppression or extraction. First, the degree of pollution tolerated must be clearly specified, the minimum requirements being stated quantitatively, for example, that the area within a specified distance from the installation should not contain more than a specific number of grams of material per cubic metre. Imprecise statements such as "nearly dustless" or "to the satisfaction of the engineer" should be avoided. A large amount of dust will emanate from a poorly maintained plant; thus simplicity of design and easy maintenance should be sought when a choice of equipment is being made.

307. A study should be made of equipment actually in use for the handling of similar material in order to determine the environmental effects. For example, many attempts have been made to seal the receiving hopper of a grab unloader effectively when material is being discharged from the grab into the hopper. The use of an air curtain will prevent dust spreading on discharge, but it should be remembered that the grab has to pass through this curtain to its discharge position and that a certain amount of material will be blown off the top of the material in the process. A more effective method may be to put the hopper into a chamber sealed with rubber curtains.

308. Often the prevailing wind will assist in preventing dust pollution by blowing the dust out to sea—a condition that may be acceptable. However, a port installation sited upwind of a community could find itself in serious trouble at times of high wind when a dusty product is being handled without effective dust control. Operations might have to cease at such times, with resultant high costs for ship delay. For certain cargoes, a water spray system may be used to prevent dust, or an enclosed storage area may be used to contain it.

309. Attention must be paid to the risk of corrosion and all structures should be adequately treated to protect them from the effects of the moist salt-laden atmosphere and of the materials being handled. Specialist advice should be obtained as that experience can be drawn on from existing installations. Should protective sheeting be fitted to structures, this should receive the same consideration. High daytime temperatures in hot climates produce extensive condensation during the hours of darkness. This is especially apparent on the insides of silos.

310. Wind can also blow dusty material off a belt if it is not protected by wind boards, a simple housing, or a totally enclosed gantry. In addition, wind forces can cause the belt to track very badly and, under extreme conditions, to lift off the idlers completely, especially when unloaded.

311. In the case of ship-loaders and unloaders, full account must be taken of needs for operating under wind conditions. The power applied to each operation must be adopted accordingly, especially when loaders or unloaders are being moved along the quay. Due allowance must be made for the opposing wind forces when the equipment is travelling into wind and, likewise, when it is travelling with the wind, due allowance must be made for the wind in determining the braking force required to arrest travel within the specified distance. Under storm wind conditions, special anchoring positions must be provided where the equipment can be positively secured.

O. Planning tasks

312. The argument is sometimes advanced that the planning of a bulk cargo port terminal should be done entirely by the industry planners for the bulk commodity concerned, as part of the total physical distribution system from, say, up-country mine to overseas customer. A coherent over-all plan, based on through-transport economic principles, should certainly be drawn up by the industry planners at the appropriate time. There are often large gains to be made by co-ordinating the production rate, land transport, port stockpiling and handling, and maritime transport. However, the work done by the industry sector planner does not relieve the port management of the need to plan and control the main design parameters of all dry bulk cargo installations within the port area.

313. The port planner will need to know at an early stage of the planning the general implications for land and water areas of long-term developments in the sphere of dry bulk cargo transport. Also, during the stage of the preparation of detailed designs by the industry sector planner, there is a need for close con-

sultation with the port planner to ensure that the main design parameters of the terminal are correct.

314. In addition, there are often common users of a dry bulk cargo terminal, and as far as they are concerned the design responsibility is clearly that of the port authority. There will be common parts of an installation that are used by several different bulk cargo carriers, for commodities that are to a varying extent compatible. It will be necessary for compromises to be reached between the demands of a number of different users.

315. For these reasons the port planner should carry out his own calculations for each of the following points, procedures for which are given in this handbook:

(*a*) The effective hourly capacity of each handling installation and the combined capacities of all the handling installations;

(*b*) The number of berths and the number of ship-loaders at each berth;

(*c*) The capacity and location of surge storage installations, stores and stockpiles;

(*d*) The capacity of the inland transport vehicle fleet.

316. Ideally, the industry sector planner should be able to give the port the specifications of the service the port should provide, and a target port cost per ton, based, in the case of exports, on the acceptable f.o.b. export selling price. Where the service specifications and a target cost are not provided, the planner may have to make broad estimates of the acceptable levels of cost and ship service.

317. From the point of view of port interests, one high-capacity dry bulk cargo terminal is preferable to two or more terminals with moderate yearly capacity. When growth in exports seems possible but uncertain, it may be advisable to start with modest and not too expensive facilities. Allowance should, however, be made for the possibility of installing additional shiploaders and higher capacity conveyors and increasing the stockpile area, if necessary, at a later stage, without any serious interruption of operations. With careful planning, expansion in this way should prove more economical than the construction of a second terminal for the same kind of material.

318. The ship handling capacity of the terminal is determined by a joint analysis of the number of berths and the number and handling rates of the ship-loaders or discharging installations at each berth. The handling rates of ship-loaders are governed largely by the reclaiming rate. Planning charts I and II, illustrated in figures 51 and 52, should be used for this analysis. Where seasonal effects are important, special attention must be given to the investment advantages and disadvantages involved, as discussed in part one, chapter II, on planning principles.

319. The planning charts for the dry bulk cargo terminal have been developed to assist the port planner in his economic analysis of the effects of various handling rates on ship turn-round time. In addition to the economics, the planner is also interested in the service times that various sizes of shipment will entail. These charts can be used for either an import or an export dry bulk cargo terminal.

320. As has already been made clear, the productivity of each ship-loader or unloader varies according to the characteristics of the ship and the cargo, and the position of the cargo in the ship. Manufacturers often publish rated capacities for a particular commodity which are based on near-optimum operating conditions. Thus a certain productivity ratio, which is usually about 0.5 for unloaders and reclaimers, must be applied to obtain the effective hourly capacity when working.

321. The law of diminishing returns applies as regards the number of ship-loaders or unloaders which can work one ship. That is to say, doubling the number of facilities at a berth will not necessarily double the throughput of the berth. For the purposes of the planning chart, the following throughput factors have been assumed for two, three, four and five ship-loaders/unloaders per berth respectively: 1.75; 2.25; 2.60 and 2.85.

322. Dry bulk cargo terminal planning charts I and II are used in the same way as break-bulk cargo terminal planning charts I and II. The planner needs the following basic information in order to be able to utilize these charts: ship-loader/unloader rated capacities, average shipment size, number of ships per year, average ship cost per day and number of berth commission days per year.

323. The planner enters the rated capacity on planning chart I and then descends to the turning point where the vertical line meets the through-ship efficiency factor. He moves horizontally to the left to the next turning point defined by this horizontal line and the appropriate line for the number of ship-loaders/unloaders employed per berth. He descends again to the standard number of ship operating hours per day, and then moves horizontally to the right to the average shipment size and finally rises to the average berth time for individual ships. A typical two-hour delay for berthing and deberthing ships has been added to this average time. When the actual delay differs from this, the average berth time can be adjusted accordingly.

324. The crossing-points on the axes give the planner the following information: the effective capacity of each ship-loader or unloader; the through ship gross loading or unloading rate; the through ship net loading or unloading rate, which is equivalent to the gross rate if the berth is worked 24 hours per day, and the average berth time for individual ships.

325. For planning chart II, the planner starts with the average ship berth time. A similar method is used as for planning chart I, with the following turning-points: number of ships per year, number of terminal commission days per year, number of berths

FIGURE 51

Dry bulk cargo terminal, planning chart I: berth time

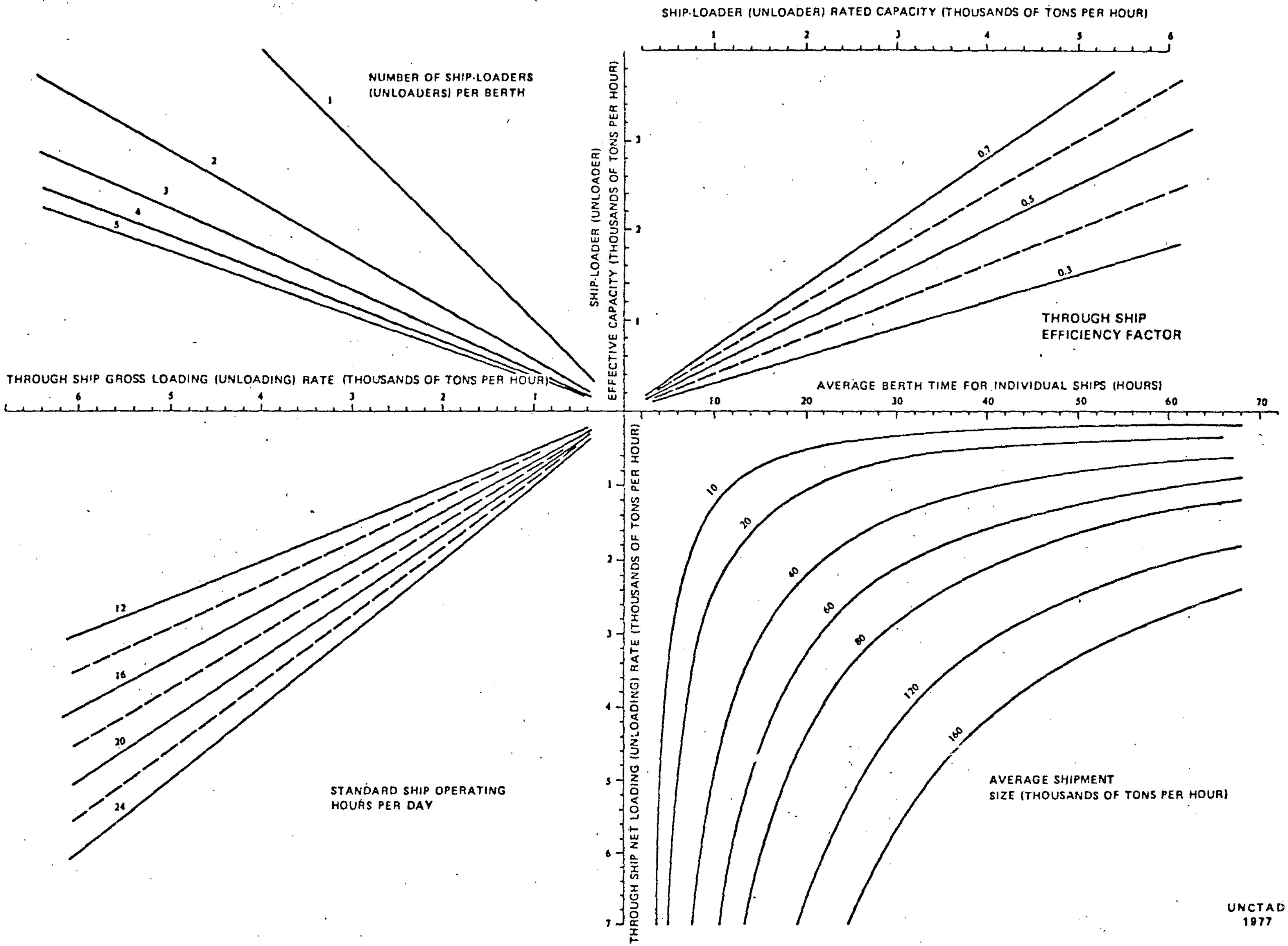
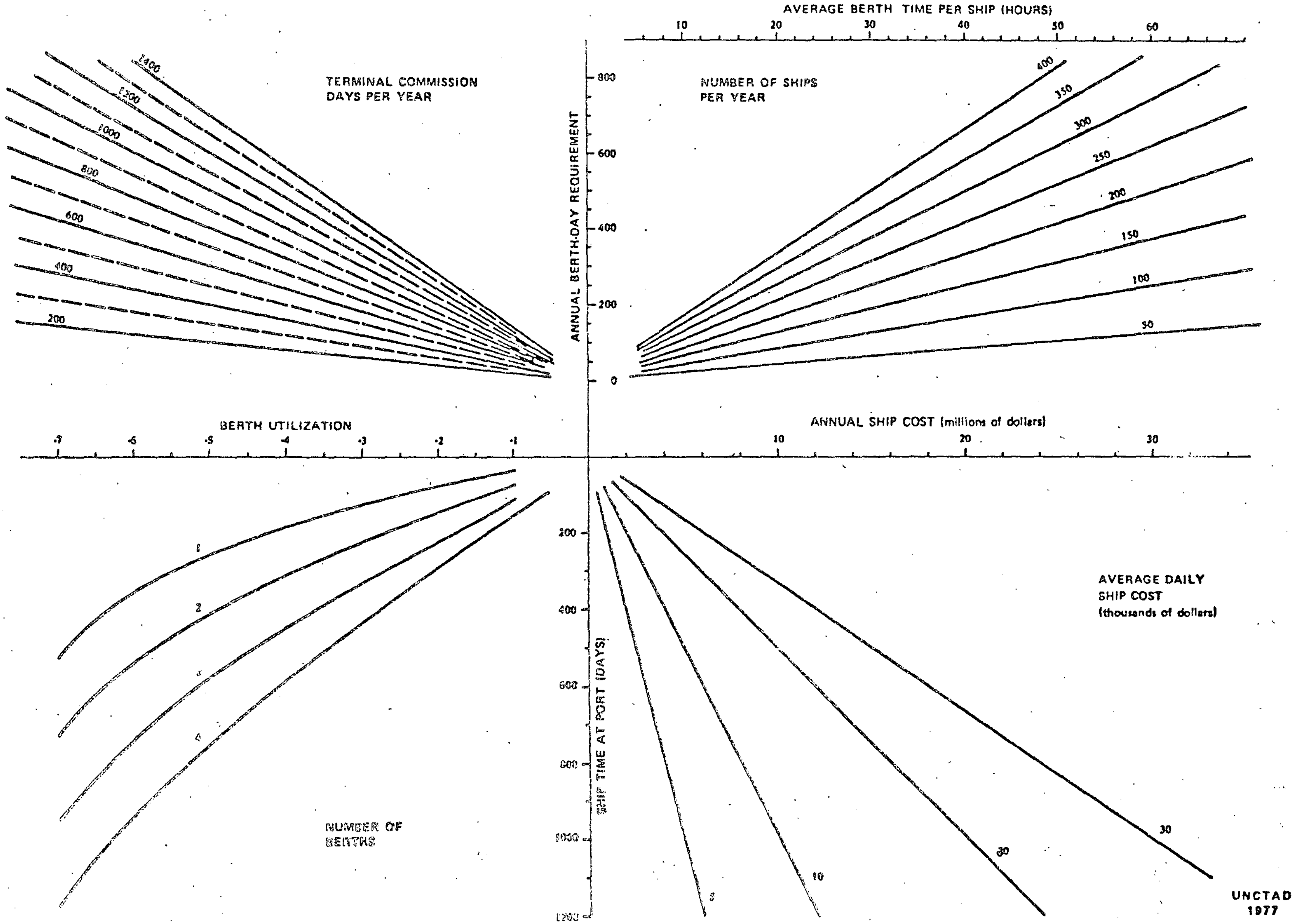


FIGURE 52

Dry bulk cargo terminal, planning chart II: ship cost



and the average daily ship cost while at port. The number of terminal commission days per year is the sum of the number of commission days for each berth. For each set of turning-points, the intersections of the trajectory and the axes give the planner the following information: annual berth-day requirement; berth utilization; ship time at port, and annual ship cost while at port.

326. The relationship between berth occupancy and ship time at port is based on queueing theory. The Erlang 2 distribution was used for both the service time distribution and the inter-arrival time distribution. Unlike break-bulk cargo terminals, there is a tendency, in the case of dry bulk cargo terminals, towards some scheduling of arrivals, and for this reason the slightly smoothed Erlang 2 arrival distribution has been assumed rather than the Erlang 1 (i.e. negative exponential) distribution. These distributions are discussed in annex II, section D.

327. The first chart can also be used by the planner to determine the best combination of rated capacity, number of facilities and daily operating period necessary for a specified berth time for a particular shipment size. When a suitable combination has been found, the planner can then use the second chart to select the number of berths necessary for the forecast annual throughput. The approximate number of ships per year is calculated by dividing the annual throughput forecast by the average shipment size. In order to determine the optimum number of berths, estimates must be made of total ship times at port with different numbers of berths. The optimum number of berths will be the number at which the total of berth costs and ship costs is lowest.

328. The export stockpile is needed as a buffer between the delivery system to the terminal and the ship-loading system. The delivery system's arrival distribution is dependent on the production rate and the inland transport system. Generally, the rate of arrival is much slower than the shiploading rate, and the economics are such that the ship should not be kept waiting. Therefore, when a ship arrives, the quantity for shipment should be in port storage.

329. With regard to the import stockpile, the converse is true, the hinterland transport system operating at a much slower rate than the ship unloading rate. The stockpile should never be so large that a ship is prevented from unloading, nor so small that inland distribution is disrupted and the industries using the bulk commodities are affected.

330. The planner is faced with the problem of selecting an inventory level and storage capacity which will minimize costs by acting as a buffer between the variable demand and supply. If the level falls too low, the situation will occur where either the ship or the industrial zone is kept waiting for cargo. If the storage capacity is insufficient, the system supplying cargo to the stockpile—either the hinterland transport or the ship—will have to wait. As against these waiting costs, there are the capital and operating expenditures involved in creating and maintaining the stockpile.

331. The area required for the stockpiles is dependent on the following factors: shipload size, ship arrival distribution, hinterland transport distribution and ship-loading and unloading rates. For export cargo, the hinterland transport requirement depends on production rates. The above factors are stochastic and thus there is no deterministic solution to the question of the appropriate inventory level and storage capacity. Figure 53 shows a typical variation in inventory level over a period of time.

332. Simulation or Monte Carlo methods, as described in annex II, can be used to evaluate the economics of various stockpile policies. However, information regarding the above-mentioned variables will often be limited. Certain assumptions have therefore been made (see the annex to this chapter). The curves, based on these assumptions, which are given in figure 54, show the average and maximum stockpile levels which reduce the probability of the disruption of operations for ships, production areas or industrial zones to less than one per cent. The cost of holding such an inventory level and developing the necessary capacity may be greater than the cost of the disruptions.

333. The charts should be used with some caution owing to the simplicity of the model, but they should give a good first approximation to the stockpile requirements. Thus, for a terminal handling one million tons per year with ships carrying an average of 20,000 tons, the maximum capacity of the stockpile should be 140,000 tons and the average amount of cargo held should be 75,000 tons. These figures must be increased by the amount of the dead stock, which is the residual material not loaded onto the ship in order to prevent ship delays arising from the slow process of clearing up the stockpile. The process of clearing up which is done during idle periods must be completed within a given time-limit in order to avoid deterioration of the commodity.

334. Bulk commodities must often be segregated according to their properties. For example, with regard to imports, each stockpile area must be of sufficient size to accommodate at least a full shipload from each source. One iron-ore importing terminal has made each stockpile area 50 per cent larger than the capacity of the largest ship used. This allows the accommodation of a subsequent shipload of similar ore before the earlier shipload has been fully used up. The need for segregation is thus a factor to be taken into consideration in the planning of bulk cargo stockpiles.

335. If a storage facility at the terminal is planned to overcome seasonal or market fluctuations by providing for a continuous supply in spite of a non-continuous consumption, or vice versa, large areas must be set aside. Obviously a high degree of mechanization of the whole storage area in this case is uneconomical, and an appropriate design must be selected.

FIGURE 53

Typical variation in dry bulk cargo terminal inventory level

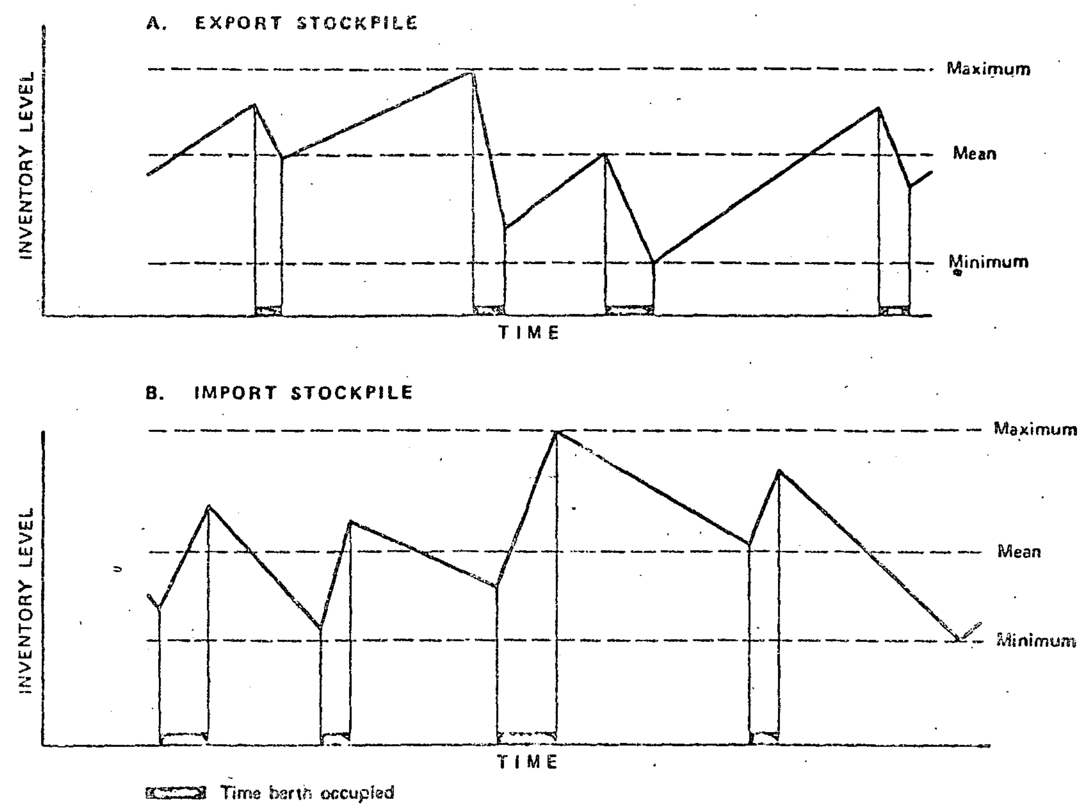
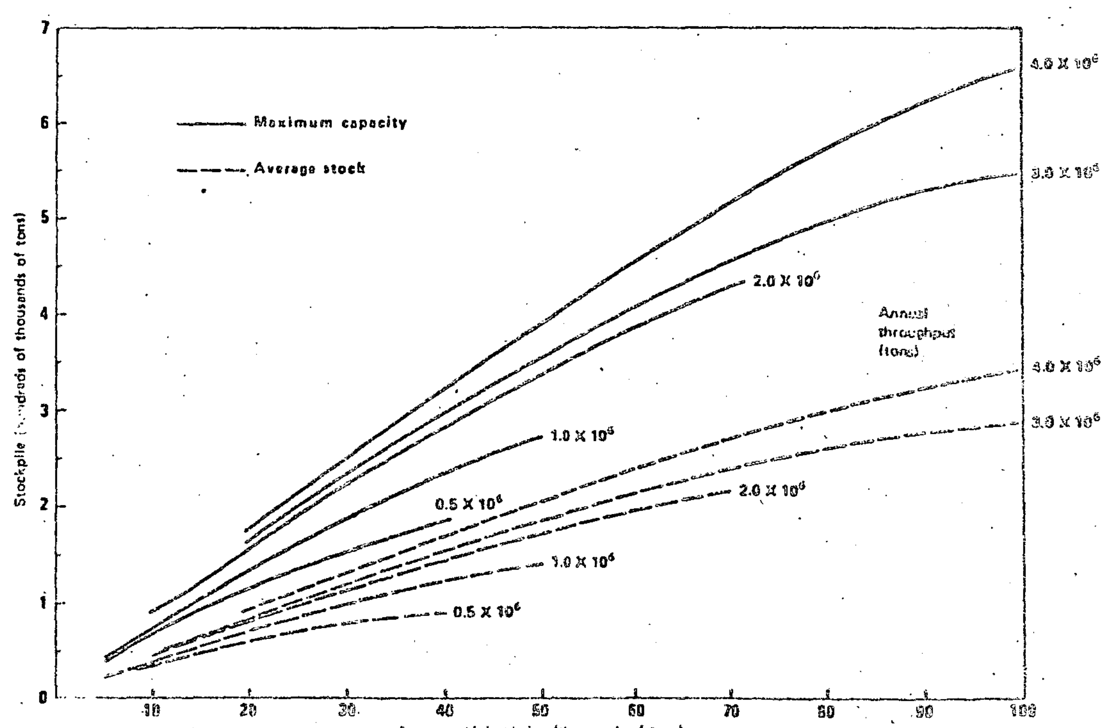


FIGURE 54

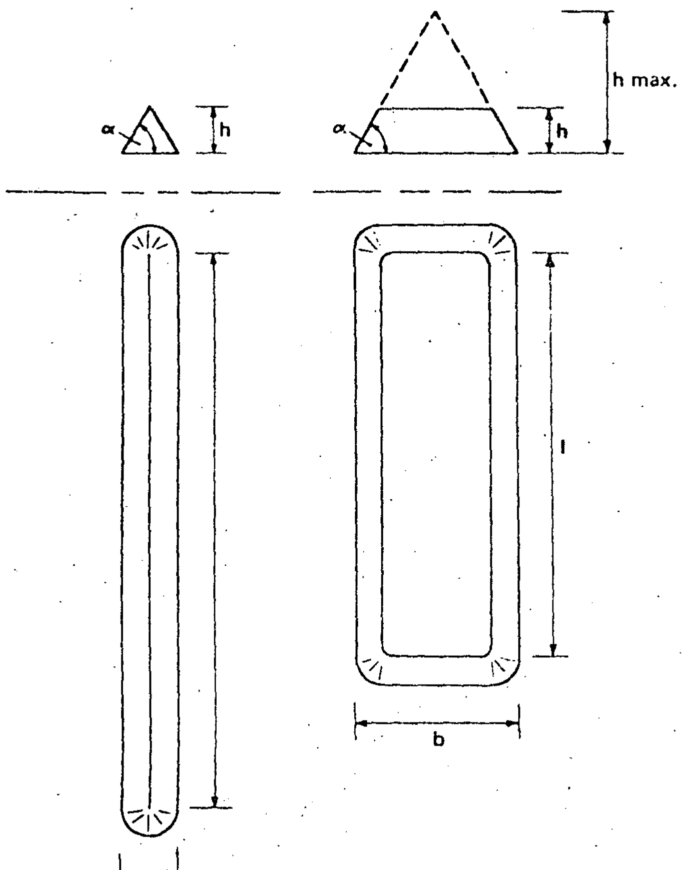
Guidelines for export stockpile dimensioning as a function of annual throughput and average shipload



336. Upon determining the stockpile requirements in tonnes, the planner must then determine the layout and the area required to store this tonnage. Possible layouts are shown in figure 55 where: α=angle of repose, h=height, l=length and b=base. The height and base dimensions of the stockpile are determined by the characteristics of the material, the bearing capacity of the ground and the reach of the stacker/reclaimer. With these dimensions the planner may use the stockpile dimensioning dry bulk cargo terminal planning chart III shown in figure 56.

FIGURE 55

Stockpile layouts



337. The figure for the base of width of the stockpile is the starting point for the use of the chart. The planner descends to the angle of repose of the commodity, which is the angle between a horizontal surface and the cone slope obtained when bulk cargo is emptied onto this surface. Angles of repose for various commodities are given in annex I. He moves to the right to determine the maximum height to which the material can be piled, and to the left to determine the maximum cross-sectional area. The ratio of actual height to maximum height determines the next turning-point. The planner descends from this point to the line indicating the length of the stockpile. The cross-sectional area of the stockpile is given by the intersection of this path with the axes. From the appropriate line he moves to the right to the stowage factor, and then rises to the horizontal indicating the capacity of the stockpile. For a given base and height, the length can be varied to give different stockpile capacities.

338. The task of planning the land transport fleet is simple, but it should never be omitted in forward planning lest the often daunting size of the transport fleet needed is overlooked. Three elements regarding which mistakes in planning are likely to occur are the following:

(*a*) The number of transport working days per year;

(*b*) The average number of trips per day;

(*c*) The number of road vehicles out of action for maintenance and repair.

339. With these cautions in mind, the method of calculation for a single commodity is straightforward and a numerical example is shown in table 6. Here, the implications of carrying the whole output either by road or by rail are given first, followed by a suggestion for a sharing of the load. Reserve capacity is needed, not only for maintenance purposes, but also to make it possible to augment the vehicle fleet temporarily to cope with peak demands.

340. A complication occurs when several different commodities have to be transported by the same facilities. For example, an aluminium smelter may re-

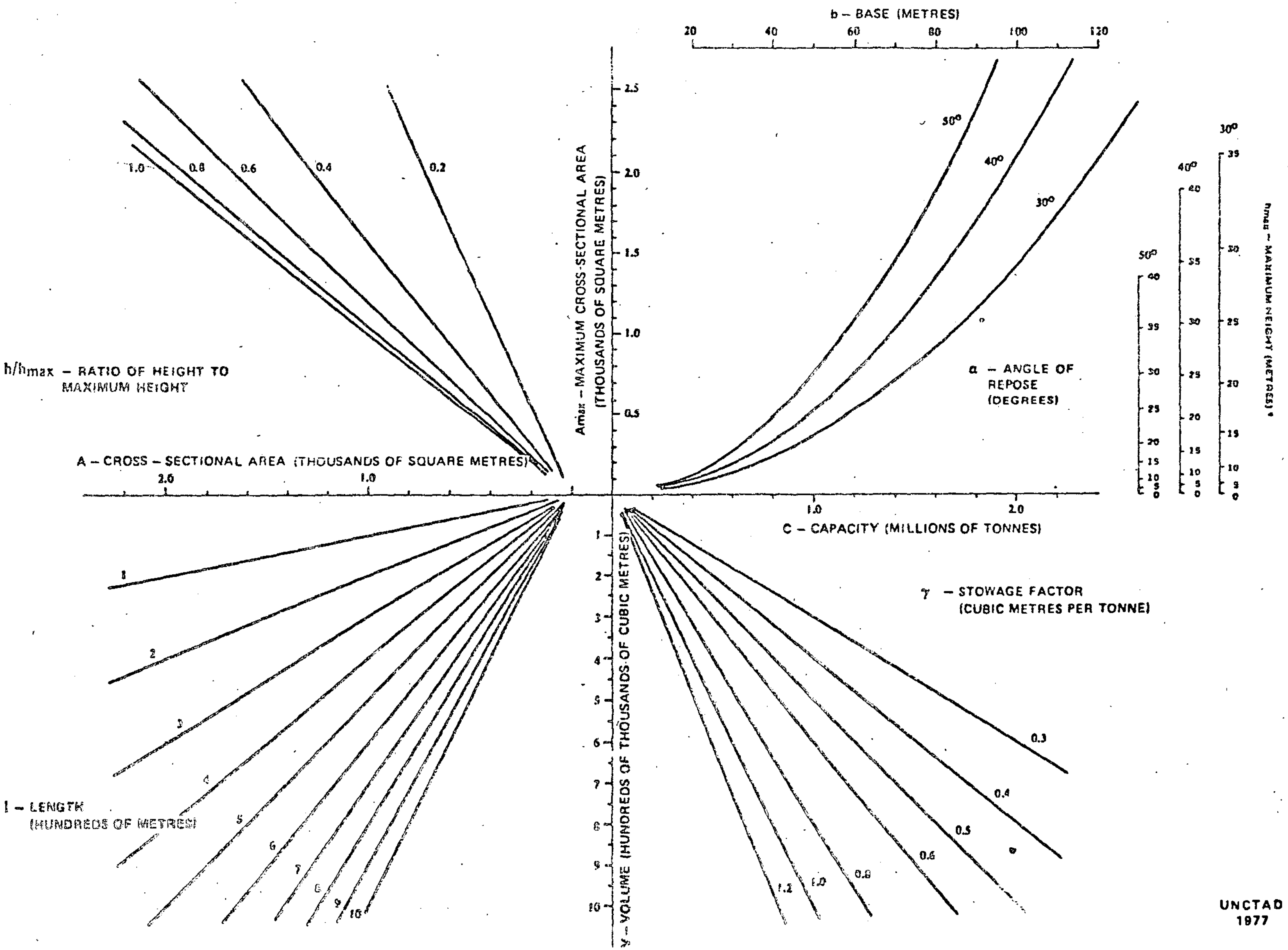
TABLE 6

Transport fleet planning for a single commodity

Annual terminal throughput (tonnes)	*Number of transport working days per year*	*Daily transport demand (tonnes)*	*Average vehicle capacity (tonnes)*	*Daily vehicle demand*	*Average number of trips per day*	*Vehicle fleet size*
All by road:						
2 000 000	278	7 200	24	300	3	100, plus maintenance reserve = 110 trucks
All by rail:						
2 000 000	330	6 060	20	303	1	303, in 5 trains of approximately 60 wagons each
Suggested combination:						
20 per cent by road						
400 000	278	1 440	24	60	3	20 plus reserve = 24 trucks
80 per cent by rail						
1 600 000	330	4 850	20	242	1	242, in 4 trains of approximately 60 wagons each

FIGURE 56

Dry bulk cargo terminal, planning chart III: stockpile dimensioning



quire the import of 1,500 tons of petroleum coke for each 5,000 tons of alumina imported, and it may then export via the same route 2,500 tons of aluminium metal. In such a case it would be normal to plan the transport of these three commodities jointly. In a rail operation it might be possible to introduce a closed-loop train system. In a road operation it might be possible to co-ordinate the haulage of different commodities using a common vehicle fleet. In the aluminium smelter example, since there is no prospect of balancing the import and export flows, and since, further, the type of vehicle suitable for alumina and coke is quite unsuitable for aluminium bars and ingots, it would be appropriate to introduce two separate transport systems and tolerate the poor return-load operation.

341. Table 7 gives a numerical example for this solution. An additional feature as compared with table 6 is that the common alumina and coke fleet needs to be scheduled, with say, four days of hauling alumina and then one day of hauling coke. Such a schedule will be dictated by, and will in turn dictate, the buffer stock capacity both at the port and at the smelter, and will be influenced by the economies involved in cleaning vehicles and changing common reception/delivery installations from one commodity to the other.

P. Major bulk commodities

1. Iron ore

342. Iron ore is the most important dry bulk commodity in international seaborne trade, representing almost 20 per cent of total dry cargo shipment in tonnes. Iron ore includes ores such as magnetite, hematite, limonite, siderite and roasted iron pyrites. Iron ore is seldom sold in the form in which it is extracted from the ground, normally being processed to improve its characteristics or to increase its iron content. Washing, grinding, screening, agglomerating processes (pelletizing, sintering, briquetting) and various methods of concentration are used for this purpose. Traditionally, the separation of waste from the ore has taken place at the consumer end. However, this is changing, and the trend is towards taking steps at the producing end to increase the iron content of the ore.

343. The ore shipped has a stowage factor which varies between 0.3 and 0.8 cubic metres per metric ton. Iron ore is always tranported in bulk and in full shiploads. Over the past decade, iron ore trade have been the subject of considerable competition between alternative suppliers, characterized by increasing distance between sources and markets and the employment of the largest possible carriers. With the increased distances, the quick turn-round of specialized ore carriers in ports no longer compensated for the loss of time involved in lengthy ballast voyages. Thus, combined carriers offering greater versatility in the employment of vessels have been replacing the specialized ore carriers. In 1975, 92 per cent of total iron ore shipments were carried by bulk carriers and combined carriers of over 18,000 dwt and 63 per cent in vessels of over 60,000 dwt.

344. While there are no major discharging terminals for iron ore in the developing countries, there are several loading terminals. For loading terminals, figure 57 illustrates the distribution of berths relative to vessel size, and its evolution with time. Generally, iron ore ports serve as transfer terminals linking two modes of transportation, and hence some stockpiling capacity is almost always necessary to provide a surge capability between the more or less continuous overland movement and the intermittent ocean shipments. Figure 58 shows a typical iron ore export terminal.

345. Ore varies both in the nature of its constituents other than iron and in the percentage of its iron content. Iron ores are generally dusty and, although there is a variation in dust pollution between the various qualities and particle sizes, it is normally necessary to provide dust extraction equipment and to consider terminal siting carefully. Because of the importance of producing steel of a suitable grade for a particular purpose, control is necessary over the

TABLE 7

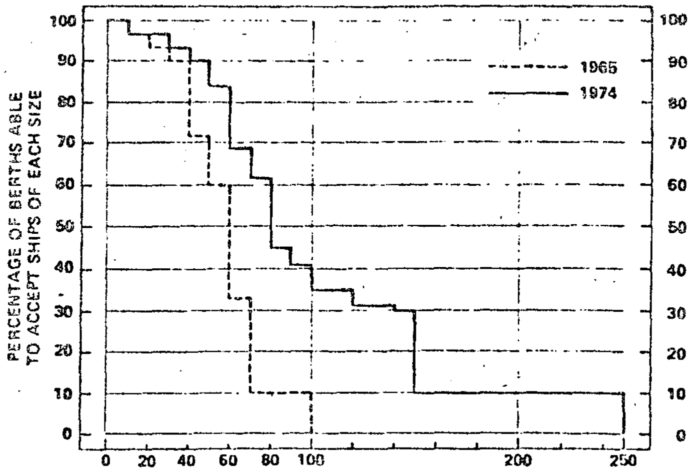
Transport fleet planning for multiple commodities

Annual smelter throughput:
Output: 120 000 tonnes aluminium metal;
240 000 tonnes alumina;
72 000 tonnes petroleum coke.

Weekly requirement (tonnes)		*Number of days per week scheduled*	*Tonnes per day*	*Average vehicle capacity (tonnes)*	*Daily vehicle demand*	*Average trips per day*	*Fleet size*
Alumina	4 615	4	1 154	20	58	6	10
Coke	1 385	1	1 385	20	69	6	12
Proposal: 12 vehicles plus 3 reserve = 15 trucks.							
Aluminium metal	2 310	5	462	22	21	4	5+
Proposal: 7 tractor/trailer units, including reserve.							

FIGURE 57

Iron-ore loading berths: maximum acceptable ship sizes



Source: M. Latham, "Developments in handling dry bulk cargo", in ICHCA, *Progress in cargo handling*, vol. 6, *Changing user requirements* (London, Gower Press, 1976).

blending of ores for blast furnaces. This necessitates the segregation of ores according to their properties. The density of iron ore limits the stacking height because of the limits of the load-bearing capacity of the ground. The angle of repose is normally less than 40 degrees.

2. GRAIN

346. In 1975 the seaborne trade in grain was 137 million tonnes and formed 9 per cent of total dry cargo shipments. These shipments were composed of wheat (60.2 million tonnes), maize (44.6), soybeans (15.9), barley/oats/rye (10.6) and sorghum (9.5). In addition, some 5 million tons of rice were shipped in the short sea trade. These grains have different densities, which means different stowage and handling requirements. Furthermore, grain is a perishable commodity which requires proper ventilation and protection from the weather and pests during shipment and storage.

347. Seaborne grain shipments come under two headings, commercial shipments and international aid shipments. Commercial shipments take place, in order of importance, to Western Europe, Japan, the USSR and Eastern Europe from the main exporters, the United States, Canada and Australia.

348. In the grain trade, variations in climatic conditions result in large variations in supply and demand, with consequent fluctuations in transportation requirements. Without the incentive of a sustained level of import demand within each country, and considering the high capital cost of facilities, port development for vessels carrying grain is often not feasible. One solution is the use of mobile pneumatic equipment. Also, the trend to standardization of vessel type and size has been less pronounced than in the other bulk cargo trades. Many types of vessel are employed, ranging from small traditional 'tween deckers through various bulk carrier types and sizes, into the smaller ranges of combined carriers and even some small tankers. While the size of the average carrier has increased over the years, with the transfer to the trade of combined carriers of approximately 150,000 dwt,[13] the ships most commonly used are those of up to 40,000 dwt, the majority being in the 20,000 to 30,000 dwt range. Ships in this range built during the period 1971-1975 were, on the average, 172 metres in length, 23.8 metres in maximum breadth and 10.1 metres in summer draught. The trend towards the use of larger vessels is shown in figure 59.

349. An example of a grain terminal is the one owned and operated by the Port Authority of Marseilles for common users, which is primarily used for discharging cereals from vessels. A plan of the terminal is shown in figure 60. Cereals or other materials suitable for pneumatic discharge may be stored in the bulk warehouse.

350. At the terminal, two berths having a total length of 297 metres are used for discharging or loading vessels with a draft of up to 9.8 metres. There are four pneumatic extractors on rails with four intake tubes for discharging vessels, each with a rated

[13] These large vessels were transferred to the grain trade following the slump in the oil trade which took place from 1974 onwards.

FIGURE 58

Material flow in ore export port at Nouadhibou, Mauritania

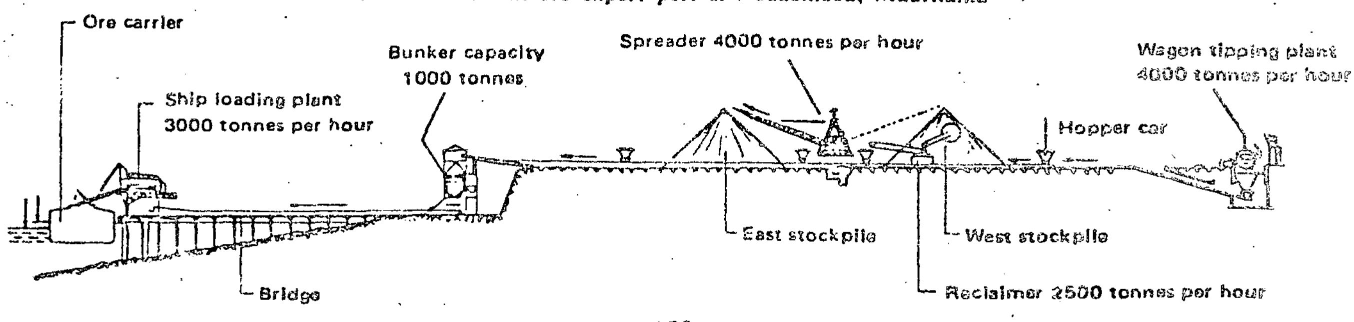
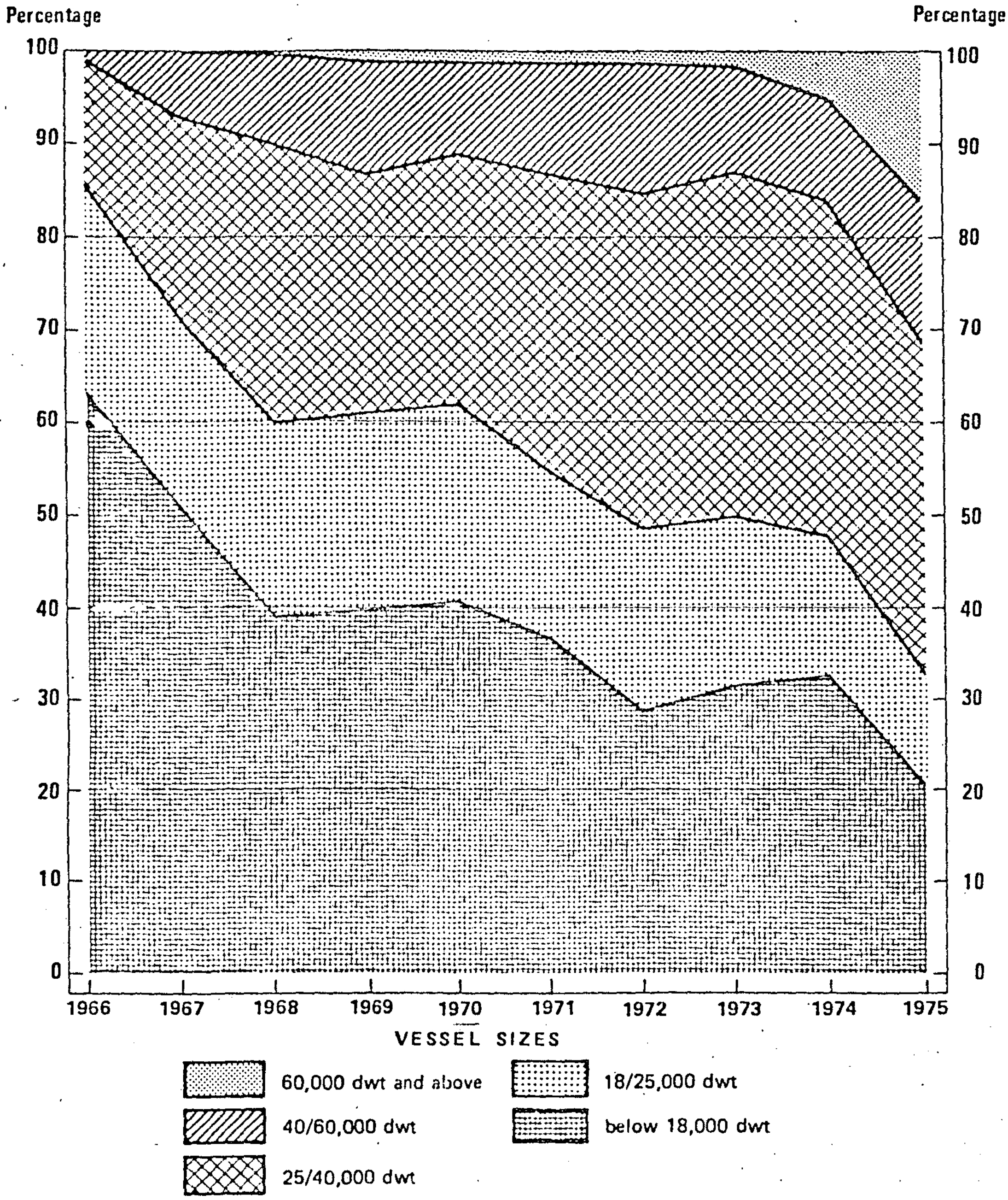


FIGURE 59

Breakdown of vessel sizes employed in the grain trade



capacity of 250 tonnes per hour and an effective capacity of 200 tonnes per hour. Two of the extractors, each with two separate discharge tubes, can also be used for loading but have an actual performance of only 100 tonnes per hour.

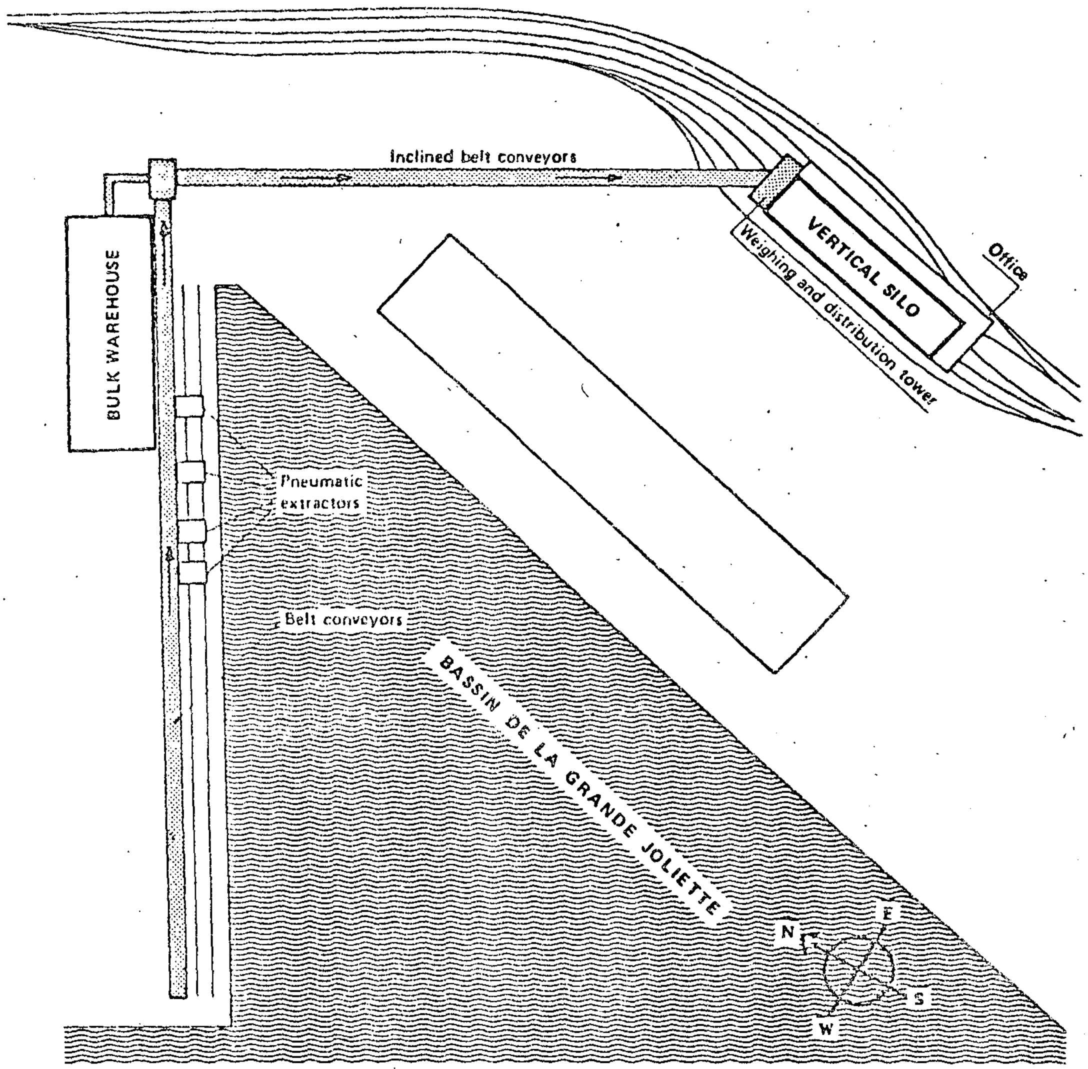
351. There are four conveyor belts, two of which are reversible for loading ships, each with a rated capacity of 250 tonnes per hour. The four belts lead to the vertical silo where the cereal is lifted to the top of the weighing and distribution tower. There are four weighing bins each with a capacity of three tonnes which allows the recording of cereal movement before storage. The vertical silo is made of 57 cells of 420 cubic metres each and 40 cells of 110 cubic metres each, permitting the storage of about 20,000 tons of cereals. The silo can discharge to trucks or rail wagons. The manning requirements vary from 14 to 41 depending on the number of pneumatic extractors in use.

3. COAL

352. The seaborne coal trade has grown substantially since the 1960s, and in 1975 reached a volume of 127 million tons, about eight per cent of all dry cargo shipments in tonnes. The major importing

FIGURE 60

Plan of typical grain terminal



Port of Marseilles

areas in order of importance are Japan, Western Europe, Eastern Europe and South America, while the major exporting areas are North America, Australia and Eastern Europe. In 1975 Japan accounted for nearly 65 per cent of shipping demand. The majority of the coal transported is coking coal for use in steel-making.

353. With the exception of the near-sea trades, there has been a continual increase in the average size of ship employed to transport coal. In near-sea trade, a wide variety of sizes and types of ship, including barges, are employed, with the majority of the shipments handled by ships of under 15,000 dwt. Coal shipments by bulk and combined carriers of over 18,000 dwt represented 77 per cent of the total trade in tons in this commodity in 1975. The bulk of this long-haul trade is handled by full shipments on conventional bulk carriers and combined carriers of 70,000 dwt and under. Coals make up 15 per cent of the total dry bulk shipments by bulk vessels and only five per cent of the shipments of combined carriers.

354. Coal has a stowage factor which varies between 1.2 and 1.4 cubic metres per metric ton. All types of coal, even anthracite, are subject to spontaneous combustion caused by heating of the coal as it absorbs oxygen from the air. This characteristic must be borne in mind when planning the working of the coal stockpile, so as to prevent portions of the stock from lying dormant for long periods of time. Generally high-ash, low-volatile coals, as used for power stations, can be safely stacked, although some loss from oxidation will be inevitable. On the other hand, high-volatile, strongly caking coals used for coke production in the iron and steel industry will require constant monitoring for the indicative temperature rise in the store, whilst some coals such as steaming coals cannot be stored at all. Generally the dust nuisance is minimal and the use of water sprays at transfer points and discharge positions in extreme

cases will reduce any nuisance from this aspect. A description of a typical coal import terminal follows.

355. Coal is unloaded by means of two trolley-type grabbing unloaders, the rail-mounted legs of which straddle one or more lines of ground conveyors. Also mounted on the rail tracks is a travelling hopper which receives coal discharged by the unloader grab. By means of a feeder unit fitted to the base of the hooper, coal is discharged onto the jetty ground conveyor. The travelling hopper can be coupled to the unloader so that they travel along the jetty in tandem, or it can be uncoupled and stored out of the way during occasional general cargo operations.

356. The jetty conveyor transfers material via a further system of belt conveyors to the stacking area, where it is received by stacking belt conveyors running the whole length of the storage area. Mounted on rail tracks on each side of the stacking conveyor is a travelling boom stacker. This is a specialized machine consisting of a tripper which discharges onto a boom conveyor capable of being slewed through 270° and derricked from below horizontal to a maximum incline of 15°. The stacker travels under its own power, under the control of an operator, and places the coal in wind-rows.

357. Reclaiming is carried out by a bucket-wheel reclaimer consisting of a revolving wheel carrying buckets with digging teeth. This wheel is attached to a boom, which also carries a belt conveyor onto which the buckets discharge. This conveyor in turn discharges onto a reclaim belt conveyor which runs parallel to the stacking conveyor. The reclaimer, which is capable of being derricked and slewed, is designed to reach to practically the extremities of the coal piles, and is always under the control of an operator. To recover any material normally out of the reclaimer's reach, a bulldozer is used to push the coal within the range of the reclaimer.

358. From the reclaim conveyor, coal is transferred by a further system of conveyors to a tripper located over loading bunkers. These elevated bunkers have surge capacities to act as buffers between the discharge rate to onward transport and the reclaim rate at the coal stack. The tripper is usually under the control of an operator whose duty is to maintain the level of material in the bunkers, although this operation may be performed automatically by the introduction of sophisticated equipment.

359. Below the loading bunkers are situated weigh hoppers which receive a pre-determined quantity of coal from the bunkers, after which all further flow from the bunker is automatically cut off. Empty rail wagons are located beneath the discharge outlets from the weigh hoppers. They are positioned accurately by an automatic wagon positioner under the control of an operator. The same operator controls the opening of the weigh hopper doors, permitting rapid discharge of the material into the wagons.

360. The entire unloading system from the ship to the storage area could be under the control of the ship unloader operator himself in the case of a small terminal, whereas for a larger terminal it would be necessary to install a central control room communicating with all sections and with the operators in the unloading section. Similarly, the loading into onward transport and the associated stack reclaim could be controlled by the operator of the tripper conveyor maintaining the material levels in the loading hoppers. With a larger installation and an extension of automatic controls, the wagon loading operator could be in control. An important feature of such an installation is an automatic interlock system which prevents any section from being operated before the next section has been run up to the right speed. The total manning requirements of such a terminal per shift would be in the region of 28, made up of four supervisors, 14 operators and 10 shift maintenance staff and conveyor attendants. This figure excludes the main workshop repair staff.

4. Phosphates

361. Phosphate rock (minerals containing the fertilizer nutrient phosphorus) is the main raw material for the fertilizer industry and the most important commodity for seaborne trade within the fertilizer group. This class of minerals accounts for 3 per cent of total dry cargo shipments. The 38 million tonnes shipped in 1975 were exported from North-West Africa, the Red Sea area, the United States of America and Nauru, Ocean Island and Christmas Island. An interesting development is the production of the phosphate intermediate, phosphoric acid. This step significantly increases the P_2O_5 content, a measure of the value of the commodity to the fertilizer industry. The forecast trade of phosphoric acid is 6 million tonnes in 1980. The terminal facilities are completely different as the acid is a liquid and carried in specialized tankers.

362. The size distribution of vessels employed in the phosphate rock trade shows that 46 per cent of the seaborne trade was covered by vessels of less than 18,000 dwt, 21 per cent by vessels of 18,000 to 25,000 dwt, 23 per cent by vessel of 25,000 to 40,000 dwt and 10 per cent by vessels of over 40,000 dwt. The majority of phosphate rock loading ports cannot accommodate vessels of more than 40,000 dwt.

363. Phosphate rock is very dusty and absorbs moisture very readily, which can create problems for unloading. It has an average stowage factor of 0.92 to 0.9 cubic metres per tonne. Practically all shipments are in bulk as a powdery concentrate. A large proportion of the crushed rock is very fine and a great deal of dust is given off whenever a transfer of material takes place. It is therefore necessary to ensure that, for example, when material is discharged from a wagon or road vehicle into a ground hopper, provision is made for the dispersal of the heavily dust-laden air. The material itself is non-toxic, but it can be a nui-

sance to the operator in constant close contact with it at a discharge point.

364. For a typical phosphate rock export terminal the phosphate can enter the port area by two routes. The first is via a railway direct from the mines in specially designed, totally enclosed hopper wagons with roof feed openings and bottom discharge. The wagons are positioned over a series of under-rail discharge hoppers, and the phosphate is discharged by the manual operation of the discharge doors from operating platforms running each side of the wagons. The whole operation takes place under cover with appropriate provision for dust extraction. The second route is by road vehicle. Since special tipper trucks are not available, the trucks are discharged with the aid of tipping platforms, again into hoppers.

365. Phosphate is extracted from the hoppers via controllable sliding valve doors onto a belt conveyor a section of which automatically records the weight of the phosphate passing over it. The phosphate then travels via conveyors to one of two closed stores, depending on quality, where it is distributed by means of an overhead tripper. The storage shed has an "A"-frame design with the slope of the roof equal to the angle of repose of the material.

366. Phosphate for shipping is extracted through the floor of the store by means of underground belt conveyors, the flow through each discharge point being controllable by means of rack-and-pinion-operated clam-shell doors. The angle of repose of the material is such that a sizable residual quantity is left to form a contingency stock. To recover this material it is necessary to use small bulldozers or remote-controlled drag scrapers.

367. The store's underground extraction conveyors discharge onto a main conveyor and, via an approach arm belt conveyor and a transfer tower, onto two jetty conveyors situated in a high-level structure running the whole length of the jetty. Each of these conveyors is fitted with a tripper which feeds a shiploader.

368. The shiploaders can traverse the full length of the quay and have a fixed boom with a telescopic extension. Attached at the end of each telescopic section is an extending chute capable of loading ships at all states of the tide. The end of the extending chute is provided with a flexible dust hood for the control of dust emission, together with a deflector plate to help distribute the cargo in the hold of the ship. It is thus possible by means of the long travel motion along the jetty, together with the telescoping of the conveyor boom, which has in addition a luffing operation, to reach any part of the ship being loaded. At the same time the boom can be retracted to permit clearance of deck superstructure and fittings when the shiploader is moved from one hatch to another.

369. The whole operation is under the control of the operator of each shiploader, the preceding conveyor systems being interlocked with its operation. Owing to the relative closeness of the store to the shiploader, the conveyor system will be allowed to clear itself before the shiploader is moved between hatches, so no surge storage is required.

370. A typical manning per shift for an installation of this size would be 37, made up of 3 supervisors, 20 operators and weighmen, 6 shift maintenance engineers and 8 plant labourers and conveyor attendants. Because of the dust generated, several of the jobs can be arduous and dirty, thus requiring a substantial level of relief manning as well as adequate shower facilities.

5. Bauxite/alumina

371. Bauxite ore when processed into alumina is the basic raw material for the production of primary aluminium. Some 5.2 tonnes of bauxite produce two tonnes of alumina which produce one tonne of aluminium. Shipments of bauxite ore and the intermediate product, alumina, represented about 3 per cent of total dry cargo shipments, or 41.2 million tonnes, in 1975. The two raw materials differ greatly in bulk, in density (bauxite typically stows at 0.878 cubic metres per tonne and alumina at 0.585) and also in handling characteristics. The trend is towards the conversion of bauxite to alumina at source, which more than halves transportation requirements and therefore limits the growth of bulk shipping and terminal requirements. The participation of bulk vessel in total seaborne trade was 65 per cent in 1975, the size of vessel employed depending on the route.

372. The major exporters of bauxite/alumina are Australia, Jamaica, West Africa and Central and South America. In the short-sea trade between the Caribbean/South America and United States ports in the Gulf of Mexico, increased use has been made of medium-sized bulk carriers to reduce transport costs, but a proportion of the shipments are still handled by small ore carriers and multiple-deck ships owned or chartered by the aluminium companies. The Australian bauxite shipments to Europe are more suitable for large bulk carriers, with the long haul and growing volume of trade pointing to an optimum size of around 100,000 dwt. This trade is mainly serviced by 40,000 to 70,000 ton carriers which have also been employed for alumina. For the trade between Australia and Japan/North America medium-sized carriers of up to 40,000 dwt are the preferred size.

373. The integrated structure of the world's aluminium industry results in many terminals being owned and operated by the industry. These commodities, particularly alumina, are dusty and require precautions against plant and area pollution. A conveyor system feeding a closed system shiploader, with the loading chute in close proximity to the loaded material, will minimize material loss due to dust. Generally, pneumatic or closed screw conveyor systems are used to discharge the vessel.

Q. Multi-purpose bulk cargo terminals

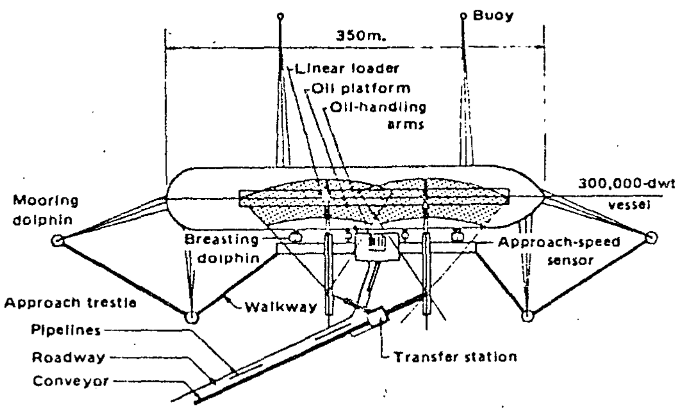
374. If within a reasonable period a separate berth will be justified to cater for a single trade, the installation can be planned on that basis, permitting the most economical use of plant and avoiding problems of contamination between materials.

375. If more than one bulk cargo trade is forecast but throughput for each trade is insufficient to justify separate berths, it may be feasible to establish a bulk cargo handling terminal for more than one material. Commodities such as coal and sugar, petroleum, coke and alumina, as well as ore and coal, can be handled with dual-purpose facilities. In some cases the same equipment may be used for different materials, but separate storage will be necessary for each commodity, and particular care must be taken to ensure that the commodities handled are compatible and that all systems can be thoroughly cleaned after use. Care must be taken in handling and storage to ensure that wind-blown dust does not contaminate other products. In other cases, only the berthing point can be shared and separate equipment must be used for each material. Figure 61 illustrates a multi-purpose terminal designed for importing oil and exporting iron ore and other dry bulk materials.

376. Equipment will have to be sized to give the best compromise between the requirements of the various materials handled, considering such factors as bulk cargo density, size and type of ships and size of individual cargoes. Imports and exports can be handled at the same berth provided that there is sufficient capacity to permit this and that there is no conflict in scheduled ship arrivals and departures. Sufficient length must be available on the berth to store idle equipment in a position which permits the full length of ships' hatches to be worked by the other equipment. It is simpler to install separate conveyor systems for imports and exports, and the size chosen is usually more economical than is the case when one set of reversible conveyors is used.

FIGURE 61

Example of multi-purpose oil-bulk-ore pier



377. Combining bulk cargoes and general cargo on a berth is not desirable unless annual bulk tonnages are clearly too low to warrant a separate berth. In that case it is advisable to check on two features:

(*a*) Loaders and unloaders should be mobile or, if they are rail-mounted, the layout of the berth should be such as to provide sufficient quay length for parking loaders of unloaders clear of the general cargo operational area.

(*b*) Conveyor systems should be either elevated on gantries at the rear of the berth or placed in tunnels so that the working area for general cargo is not obstructed.

ANNEX

Bulk stockpile planning

1. The following assumptions on the statistical distributions of the variables affecting the size of the stockpile in conjunction with a simple model have been used to estimate the stockpile requirements as a function of shipload and annual throughput. The interval between ship arrivals follows an Erlang 2 distribution. The shipload size follows a uniform distribution with a range of ±10 per cent. The arrival or delivery distribution of the commodity to or from the terminal also follows a normal distribution with a percentage coefficient of variation of 10. The loading or unloading rate has been set to give a berth utilization of 0.4 and the loading/unloading follows a normal distribution with a percentage coefficient of variation of 5.

2. The model records the flow of bulk commodity in and out of the terminal over a period of time and calculates the maximum and the average amounts of the commodity present. Through repeated use of the model, an estimate of the maximum stockpile requirements and the average amount of commodity stored can be determined.

Chapter VIII

LIQUID BULK CARGO TERMINALS

A. Introduction

378. It is difficult to indicate in general terms a liquid bulk cargo terminal, since the equipment required and the number of berths needed is not directly related to the total quantity of bulk liquid to be handled. This is mainly because of the need to segregate the invariably large number of grades of the same liquid commodity. Thus the numbers of storage tanks and other equipment needed depend on the number of different grades of the same commodity expected to arrive at the terminal rather than on the total quantity. Generally, the rate of discharging liquid cargo is governed by the capacity of the ship's pumps rather than by that of the port handling equipment. The planning of installations for liquid bulk cargoes is therefore a special task which is normally carried out by the industry concerned in close co-operation with the port administration.

379. The general design and location of each terminal are of considerably greater interest to port managements than the technical details. For mineral oils, safety measures and the prevention of spills are an important concern. The technical design will depend on the actual characteristics of the individual ships which will use the terminal. The following points should be closely checked to ensure compatibility between the vessel and the terminal:

(*a*) Number, length and diameter of loading arms or hoses;

(*b*) Maximum height of ship's manifold;

(*c*) Manifold connexion specifications;

(*d*) Number, diameter and maximum pressure of pier pipelines.

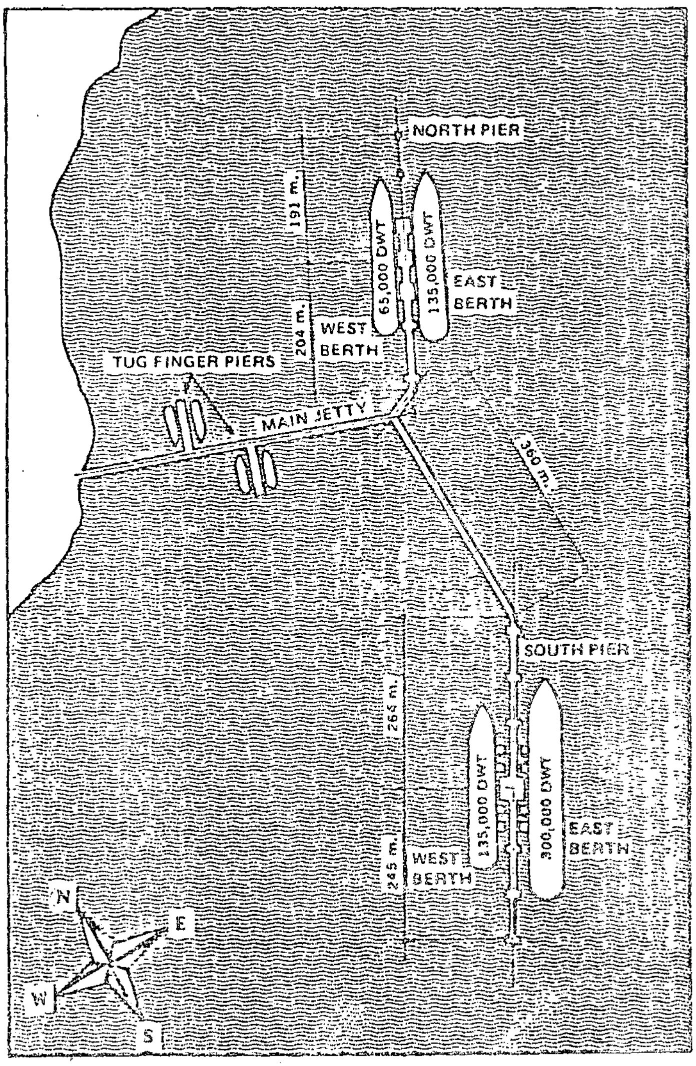
B. Crude oil and oil products

380. World seaborne trade in crude oil in 1975 was 1,259 million tonnes, as compared with the 1974 figure of 1,360 million tonnes. Tankers and combined carriers of over 60,000 dwt accounted for 78 per cent of crude oil movements in tonnes, while tankers of over 200,000 dwt accounted for 39 per cent of movements. Oil product movements, excluding short-sea and coastal trade, amounted to 233 million tonnes in 1975 and almost all of that amount was transported in vessels of less than 60,000 dwt.

381. Large crude oil loading and discharging ports are located in quite separate and isolated points, normally far from densely inhabited regions. Easy access from the sea to suitable areas with calm and very deep water is the most important requirement. The draught requirements often lead to off-shore terminals with strong fendering systems to absorb the berthing impact of large tankers. For the import of oil products or small amounts of crude oil for local ref-

FIGURE 62

Typical jetty arrangement for tanker terminal



ineries, the zoning of an oil sector inside the commercial port is necessary. Methods for preventing oil spills from spreading is also an important consideration for the planner. The berthing arrangements for a typical oil terminal are shown in figure 62.

382. Crude oil and oil products have very different properties and may be divided into two main groups:

(*a*) Black oils, which include crude oil, furnace oils and heavy diesel oils;

(*b*) White oils, which include motor spirits, aviation spirits, kerosene and gas oil.

The carriage of crude oils has given rise to the greatest pressure for transport economy, leading to the super-tanker concept. Figure 63 gives the length, beam and draught requirements of such very large crude carriers (VLCC).

383. Separate sets of handling equipment are required for each group of oils. Under certain circumstances, separate sets of equipment may be necessary for each product, or sub-group of products within a group, to avoid contamination. A strict pumping sequence must be followed in the case of a common set of equipment for a group of products.

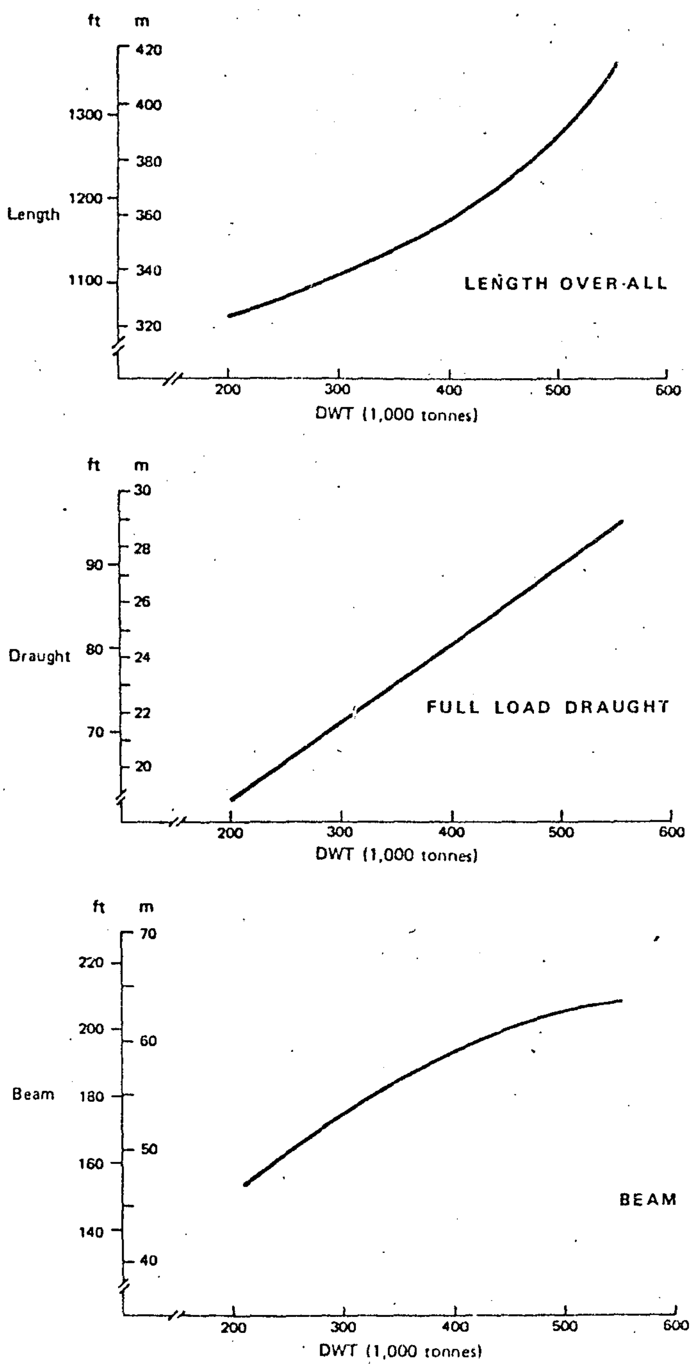
384. Crude oils and oil products are hazardous to handle and hence entirely separate berths, jetties or single buoy moorings, completely isolated from other berths and port facilities, are invariably provided for handling such oils exclusively. All items of equipment are specially designed for handling these oils and are suitable for operation in a hazardous atmosphere. To prevent the build-up of static electricity, electrical earthing cables need to be built into the quay or pier.

385. It is recommended that loading and unloading arms should be of fabricated mild steel and operated either manually or hydraulically. Suitable hoses may be used in some cases where quantities to be handled are small, for example with tankers of 18,000-tonne capacity, and where operating pressures and tidal variations are low. Depending on the design discharge or loading rate, the arms may be from 200 mm to 500 mm in diameter. The rate of pumping from shore to ship will vary widely according to the size of the ship to be loaded, the limitations of its equipment for receipt of oils, and the turn-round time planned. As ships' capacities vary from 500 tonnes to 500,000 tonnes, the range of variation is great. The rate of pumping from ship to shore is governed by the capacity of the ship's pumps. Normally, four cargo pumps are installed, with a typical combined discharging rate of 6,500 cubic metres per hour for a 60,000 dwt tanker and a 15,000 cubic metres per hour for a 200,000 dwt tanker.

386. Mild steel pipelines are invariably used, with a diameter normally between 150 mm and 900 mm. Even larger diameters are possible, depending on the quantities to be handled. Pipelines for furnace oils and other heavy black oils may require trace-heating or lagging (covering with insulating material) in temperate climates. Centrifugal pumps are normally used, except for heavy black oils for which positive displacement pumps or rotary pumps may be necessary. Some heavy black oils require heating, even in sub-tropical climates.

FIGURE 63

Principal dimensions of very large crude carriers



387. If products are being pumped through pipelines for a distance of over three kilometres, pipeline pigging equipment may be necessary to flush the lines in order to avoid excessive contamination when changing products, or to clean the lines to increase flow. Pig launching and recovery equipment allows

the insertion of a hard rubber sphere, or pig, into the pipeline. The pig is forced along the pipe by the oil pressure to the pig trap, where it is recovered. Because of the hazardous nature of these oils, good effective communication between various points along the pipeline is of vital importance. A special telephone system or radio communication system designed for use in such a hazardous atmosphere is required.

388. Spillage collection and disposal equipment is required for pollution control areas where spillage is likely to occur—for example, at points where hoses are connected and disconnected and where pigs are lauched or recovered. The equipment consists mainly of an underground or low-level mild steel tank of adequate size and a small pump for the disposal of the collecting tank's contents back to the appropriate pipeline or tank. In addition, facilities to contain and clean up accidental spillage into the sea, such as oil booms and specialized skimming craft, should be provided.

389. In the case of exporting countries, it is required that ballast water from ships should be discharged ashore before loading. The oil contaminating the water must be separated out before disposal of the water. Suitable equipment, including tanks, oil-water separators and pumping equipment are therefore required.

390. An elaborate system of fire-fighting equipment is required at all hazardous points. The first requirement for this purpose is an adequate supply of extinguishing liquid: water for a non-petroleum fire, and foam for an oil fire. The main items of equipment required are high-pressure pumps, pipelines, hydrants, foam storage tanks and distribution pipelines, monitoring towers and suitable mobile equipment. Provision will need to be made for the storage of an adequate quantity of water if the supply of water is not reliable. Sea water can be used for fire-fighting purposes with suitable equipment designed for the handling of salt water.

391. Welded mild steel tanks are required for the storage or petroleum products. Two distinct groups of storage tanks should be erected, one group for black oils and one group for white oils, each group being surrounded by bonded walls of adequate height. Two types of tanks are available, one type with a floating roof and the other with a fixed cone-roof. The former type reduces evaporation losses while the oils are in storage. All tanks normally have sumps for draining. The capacities of tanks are usually between 500 and 20,000 cubic metres, but can be even larger, depending on requirements. The weight of tanks, and thus also their height, are restricted by the soil conditions in the area. The heating and lagging of tanks may be necessary for heavy black oils in temperate climates. The measurement of quantities in tanks is carried out by dipping or by means of specially installed gauges. Special laboratory equipment, also, is necessary for the quality control of products.

C. Liquefied natural gas

392. Cryogenics is the branch of physics that relates to the production and effects of very low temperatures. Liquefied natural gas, commonly known as LNG, is transported at approximately atmospheric pressure with a temperature of −161°C. The expansion coefficient for LNG to a gaseous form is 630 times the original volume. Liquefied petroleum gas (LPG) is produced in conjunction with petroleum refining and oil field production. LPG must be transported under pressure, as contrasted to LNG, which can be transported at atmospheric pressure but under extremely low temperatures.

393. The hazardous nature and the very low temperatures of LNG necessitate special facilities entirely isolated from the rest of the port. Surfaces in contact with LNG must be manufactured from alloys to withstand very low temperatures, as ordinary steel would become as brittle as glass.

324. A wide variety of complex equipment is required for liquefaction, storage, refrigeration, loading, unloading and regasification of LNG. Depending upon the distance from the gas production area and other factors, not all of these processes may be carried out at the terminal. However, insulated pipelines and insulated storage tanks with refrigeration plant are required for storing LNG in the terminal. Typical export storage tanks have a capacity of 300,000 barrels, or 47,750 cubic metres.

D. Vegetable oils

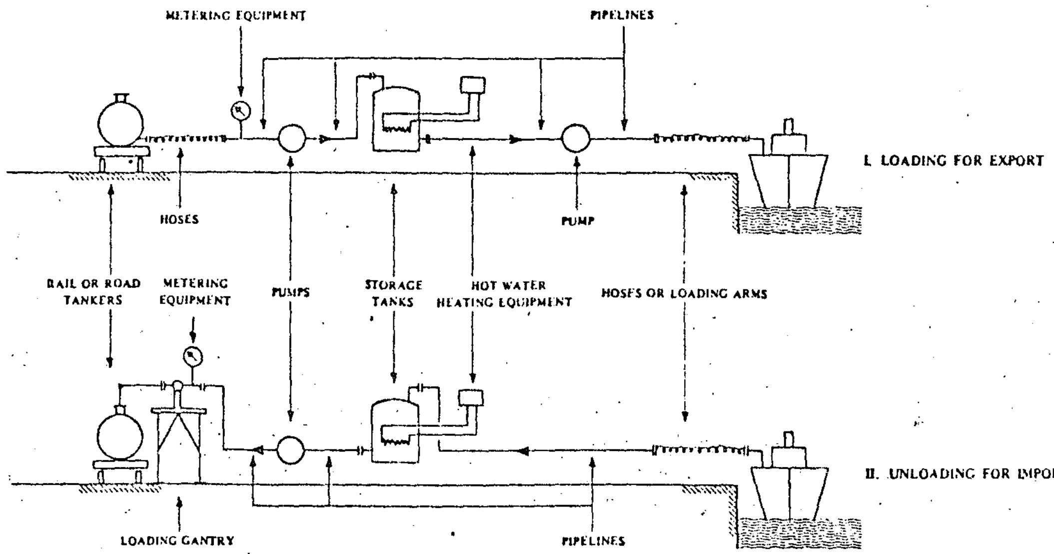
395. This heading covers a variety of oils—for example, palm kernel oil, cotton-seed oil and coconut oil—each having different properties and specific gravities. Some of them are in a solid state at ambient temperatures and require heating. The handling equipment required will, therefore, vary, but a typical installation is as shown in figure 64.

396. Handling temperatures range from 15°C to 65°C. When heating is necessary, the maximum teperature change over 24 hours should not exceed 5°C. Oils should not be repeatedly heated and cooled as this results in a deterioration of their quality. The specific gravity varies between 0.8 and 0.95, depending on the type of oil and also on its temperature.

397. For loading onto the vessel, special rubber hoses suitable for handling vegetable oils are preferred. However, mild steel loading or unloading arms with special internal linings may be used. Hoses or loading arms sizes normally vary from 150 mm to 200 mm in diameter. Smaller hoses are required for the unloading of rail or road tankers. Suitably designed cast iron pumps should be used. Centrifugal pumps are normally used for this application, but rotary-type or mono-type pumps are also suitable. The normal pumping rate for shore to ship pumping is 100 to 150 tonnes per hour.

FIGURE 64

Typical vegetable oil installation



398. For pipelines, unlined stainless steel pipes of 150 mm to 200 mm are recommended. The heating and insulation of pipelines may also be necessary in temperate climates. The main valves in tanks and pumps should be of cast steeel. All other valves may be cast iron. The washing down of pipelines is carried out with the use of suitable detergents. Pipelines are flushed by means of spherical pigs. Pigging equipment for pig-launching and pig-recovery is therefore installed at suitable locations.

399. Vegetable oils are stored in welded mild steel tanks with a suitable internal lining. As quantities of bulk vegetable oils handled are relatively small, a tank capacity is normally about 1,000 tonnes or less. All storage tanks should be filled from the top. For certain fatty oils, draw-off points should be provided at various levels along the side of the tank. Storage tanks may be sited outside the port area if necessary, due regard being given to the limitations of the pumping equipment. Quantities in tanks are normally measured by dipping. Tank cleaning and washing equipment, also, is required, particularly when a different type of vegetable oil is to be stored in the tank.

400. Covered loading gantries with retractable pipes with swivel joints, or suitable rubber hoses, should be provided for loading road or rail tankers. Special meters are also provided on the gantries to measure the quantity received or delivered. Purpose-built road or rail tankers, possibly with heating equipment, are required. Off-loading pumps may need to be provided if the vehicles are not so equipped.

E. Molasses

401. Molasses is a viscous, dark-brown syrup drained from sugar during refining. Temperature control is important both in handling and storage since below 32°C the product solidifies and above 38°C it caramelizes, i.e., becomes sticky like toffee. The specific gravity is 1.34. The handling of molasses differs from that for vegetable oils.

402. Hoses for loading or unloading of ships should be 250 mm diameter or greater and are normally handled by ships' derricks, and mobile cranes may be required for handling hoses out of reach of ships' derricks. Hoses for the loading or unloading of road or rail tankers should not be of lesser diameter than 150 mm. Only positive displacement type pumps or rotary pumps, with positive suction head and double by-pass to assist start-up, should be used. Normal ship-to-shore pumping rate is 150 tonnes per hour.

403. Pipelines can be of mild steel or cast iron, but pipe diameters should be of 500 mm to 600 mm. Cast steel gate valves should be used throughout. Pipelines and hoses should be cleared by compressed air and washed down with fresh water after use.

404. The high specific gravity of the liquid requires specially designed welded mild steel tanks with fixed roofs. No internal tank lining is necessary. The average capacity of storage tanks is 14,000 tonnes. Hydrostatic gauges should be provided for the measurement of the tank contents.

405. Road or rail tankers should be purpose-built and should be lagged and provided with heating facilities and off-loading pumps with 150 mm diameter outlets. The average capacity of such tankers is 30 tonnes. It may also be necessary to provide weigh bridges to measure quantities loaded into road or rail tankers.

F. Rubber latex

406. Liquid latex is a milky viscous sap exuded from rubber trees when tapped. Approximately 36 to 38 tonnes of rubber are obtained from 100 tonnes of latex. The fluid is miscible with water, and forms rubber by coagulation. The coagulation of latex can be prevented by the addition of ammonia or formaldehyde. Temperature control is important and the temperature should not be allowed to fall below 5°C or rise above 32.5°C. The normal tank storage temperature is about 29°C. The specific gravity of liquid latex is 0.94.

407. Special rubber hoses, normally of 150 mm or 200 mm diameter, are used. Screw displacement type pumps or mono-pumps with a neoprene stator are recommended for this purpose. Centrifugal pumps may also be used. The normal pumping rate for loading ships is 150 to 200 tonnes per hour.

408. Pipeline and storage tank requirements for rubber latex are similar to those for vegetable oils, but in the case of rubber latex it is generally recommended that stainless steel ball valves should be used. Diaphragm valves may also be used. The capacities of storage tanks vary between 200 tonnes and 2,500 tonnes, and an internal coating of microparaffin wax is sometimes applied to the walls of the tank to prevent the formation of deposits of rubber.

Chapter IX

MISCELLANEOUS TRAFFIC

A. Service craft

409. Port planning requires the provision of adequate accommodation for service craft. These craft include tugs, barges, fire-boats, water taxis, trash boats, pilot boats and floating construction and maintenance equipment such as pile drivers, salvage and dredging equipment, cranes and floating oil-spill equipment.

410. The principal service craft are likely to be the fleet of tugboats, barges and pilot boats. Tugboats are used for towing, docking, undocking and shifting vessels. Tugs also provide the needed towing capacity for moving barges and other types of floating equipment. Barges can be used for delivering bunkers and drinking water to vessels at berth or anchorage. Pilot boats are required for placing pilots on vessels as they enter port and taking pilots off as vessels leave. The pilotage area should therefore be placed in a position near the entrance to the port.

411. Service craft, with their limited draught requirements, present little problem to the port planner in terms of providing adequate water depths. However, sufficient calm water berthing space and suitable docking facilities must be made available for these essential activities.

B. Passenger terminals

412. The planning of passenger terminals is outside the scope of this handbook and is therefore only briefly mentioned. A fuller discussion of the subject may be found in Nagorski's book on port problems in developing countries.[14] The trend for some years in passenger vessels has been towards cruise-type ships which are actually tending to become smaller rather than larger. The average size of cruise ship is at present about 20,000 gross tonnes but it will probably fall to the 10,000 to 12,000-ton mark. Most orders being placed are for combined passenger and car-ferry vessels.

413. Passenger ships can use general cargo berths when certain specialized facilities are provided. For example, a second storey on a transit shed may serve as the passenger terminal building with facilities for customs, immigration and health. However, the allocation of passenger ships to general cargo berths can cause problems in view of the priority which normally has to be given to cruise vessels and other passenger liners, and the disruption of cargo operations which this can cause. The passenger ship traffic must be taken into account when calculating the number of commission days available for the general cargo traffic using the terminal. Where passenger or cruise traffic is substantial, it is advisable either to allocate a separate berth or to provide a well-sheltered mooring and a fleet of launches. This latter alternative is not possible when a combined passenger and ro/ro type service uses a port.

C. Fishing ports

414. A fishing port is no longer a point of transfer of goods from one mode of transport to another. Rather it is an industrial zone for unloading, processing and marketing fish as well as for maintaining and servicing the fishing fleet. In consequence, a fishing port is an integral part of the national fishing industry rather than part of the country's transportation system. A modern fishing port is an important element in promoting the fishing industry of a country. Only a brief description of the main facilities in a fishing port are included, and more detailed information can be found in the book by Nagorski referred to above (para. 412).

415. Facilities for handling a fishing fleet can be in the form of a wharf or jetty in shallow water, normally at an extremity of the normal cargo handling areas, or in a special basin. Where fishing is a more important activity, a quite separate, well-selected location is needed. If the number of fishing boats to be accommodated is considerable, a large area of sheltered water is required, while the numerous facilities will necessitate the provision of substantial space on land. In addition, it is desirable to isolate fishing smells from commercial port operations.

416. Local fishing boats can be expected to have draughts of two metres, while larger motor trawlers and fish carriers may draw three metres. High-sea fishing with large trawlers requires a four-metre draught. The length of the unloading wharf should normally be sufficient to complete the unloading of all boats active in the local fleet during the peak period. The boats are normally berthed herring-bone

[14] See list of publications in annex III below.

fashion or double banked. A quay apron width of six metres is sufficient, and the apron should have a slope towards the waterfront, normally of 1 in 20, to facilitate washing-down.

417. A covered hall, extending the length of the wharf, is needed for washing, sorting and weighing. The hall should consist of two sections separated by a wide alleyway. The waterside section, mainly used for washing fish, should slope to the waterside and may be eight metres in width; the landward side, used for sorting and packing, should be of similar width and have a rear loading platform for trucks. The total width of the hall should thus be approximately 25 metres.

418. Open areas for drying nets and for repairing boats, slipways and a workshop are also needed. The remaining facilities needed may be:

(*a*) A cold storage plant;

(*b*) An ice-making plant;

(*c*) Provision stores;

(*d*) Gear sheds;

(*e*) Fuel tanks;

(*f*) Electric lighting;

(*g*) A fresh water distribution system;

(*h*) Fire-fighting equipment;

(*i*) Offices, rest-rooms and a canteen;

(*j*) Fish-processing plants;

(*k*) Fish-meal factories.

D. New types of marine transport vessel

419. Research and development in the field of marine transport technology has produced several new types of vessels, vehicles and methods of propulsion. Two of these types are the hovercraft and the hydrofoil. None of these new types of craft are expected to be of a substantial size and it is likely that they will remain limited to ferry services carrying passengers and vehicles.

420. Hovercraft can be propelled by underwater propellers and are therefore not all amphibious vehicles. Speed, manœuvrability and lack of wash and wake are the main advantages of hovercraft. The amphibious flexible skirt hovercraft requires a wide shallow concrete ramp with a maximum slope of 1 in 20, rather than a berth. Old lighterage berths could be readily converted to this use. All cargo-type hovercraft are still in the early stages of development.

421. The use of hydrofoils has been confined to high-speed passenger ferry services and military vessels. Hydrofoil craft at present do not require more than three metres of draft and therefore passenger berths can be used with a special gangway.

422. The port authority should be ready at the appropriate time to provide facilities for these new types of craft. As it is difficult to estimate the future need in terms of land area and water frontage for these craft, the master plan should allow the necessary flexibility to accommodate these developments.

Annex I

GENERAL INFORMATION

A. Conversion factors

1. Length

1 centimetre (cm) = 10 millimetres (mm) = 0.3937 in.
1 metre (m) = 100 cm = 3.2808 ft
1 kilometre (km = 1000 m = 0.6214 mi

1 inch = 2.5400 cm
1 foot = 12 inches = 0.3048 m
1 yard = 3 feet = 0.9144 m
1 fathom = 6 feet = 1.8288 m
1 mile = 5,280 feet = 1.6093 km
1 nautical mile = 6,080 feet = 1.8531 km

2. Area

1 sq metre (m^2) = 10,000 sq cm (cm^2) = 10.7638 sq ft
1 hectare (ha) = 10,000 m^2 = 2.4711 acres
1 sq km (km^2) = 100 ha = 0.3861 sq mi

1 sq yd = 9 sq ft = 0.8361 m^2
1 acre = 4,840 sq yd = 4046.9 m^2

3. Volume

1 cu m (m^3) = 1,000 litres (l) = 1.3080 cu yd
= 35.3147 cu ft

1 cu ft = 0.02832 m^3
1 cu yd = 27 cu ft = 0.7646 m^3

4. Capacity

1 litre (l) = 1000 cu cm (cm^3) = 0.035315 cu ft
= 0.2200 Imperial gallon
= 0.2642 US gallon
1 hectolitre = 100 l = 22.00 Imperial gallons
= 26.42 US gallons
1 pint = 0.5683 litres
1 US gallon = 3.7854 litres
= 0.8327 Imperial gallon
1 Imperial gallon = 4.5461 litres
= 1.2009 US gallons
1 Imperial bushel = 1.2844 cu ft = 0.03637 m^3
= 8 Imp. gallons = 1.0321 American bushels
1 American bushel = 1.2445 cu ft = 0.03524 m^3
= 0.9689 Imp. bushel
1 US barrel = 5.6146 cu ft = 158.99 litres
= .15899 cubic metres
= 42 US gallons
= 34.9726 Imperial gallon
1 gross register ton = 100 cu ft = 2.83 m^3 of permanently enclosed space
1 net register ton = 100 cu ft = 2.83 m^3 of permanently enclosed space for cargo and passengers
1 shipping ton = 40 cu ft = 1.13 m^3 of permanently enclosed cargo space

5. Weight[a]

1 gram (g) = 0.002205 pound
1 kilogram (kg) = 1,000 g = 2.2046 lb
1 tonne = 1,000 kg = 2204.6 lb
= 0.98421 long ton
= 1.10231 short tons
1 pound (lb) = 0.4536 kg
1 hundredweight (cwt) = 112 lb = 50.802 kg
1 long ton = 2240 lb = 1.0165 tonne
= 35 cu ft of salt water = 1.12 short tons
1 short ton = 2000 lb = 0.90719 tonne
0.89286 long ton

6. Unitization

(a) *ISO pallets*

Dimensions: Centimetres	Inches
80 × 100	32 × 40
80 × 120	32 × 48
100 × 120	40 × 48
120 × 160	48 × 64
120 × 180	48 × 72

(b) *ISO containers*

Type	External dimensions: Metres	External dimensions: Feet	Gross weight (long tons)	Capacity (cubic metres)
1A	12.190 × 2.435 × 2.435	40 × 8 × 8	30	60.5
1B	9.125 × 2.435 × 2.435	30 × 8 × 8	25	45.0
1C	6.055 × 2.435 × 2.435	20 × 8 × 8	20	29.0
1D	2.990 × 2.435 × 2.435	10 × 8 × 8	10	14.1
1E	1.965 × 2.435 × 2.435	6.67 × 8 × 8	7	9.0
1F	1.460 × 2.435 × 2.435	5 × 8 × 8	5	6.4

[a] The deadweight tonnage is the weight a vessel can carry when fully laden, which may be expressed in tonnes, long tons or short tons.

7. GRAINS (STANDARD)

Type	Pounds/Imperial bushel	Imperial bushels/long ton
Wheat	60	37.3
Maize	56	40.0
Soy beans	63	35.6
Barley	48	46.7
Oats	32	70.0
Rye	56	40.0
Sorghum	59	38.0

8. OILS

Gravity		Barrels		Tonnes
Degrees API	Specific gravity[b]	Per tonne	Per long ton	per 100 m^3
10	1.000	6.30	6.40	99.8
12	.986	6.39	6.50	98.4
14	.973	6.48	6.58	97.1
16	.959	6.57	6.68	95.7
18	.947	6.66	6.76	94.5
20	.934	6.75	6.86	93.2
22	.922	6.84	6.95	92.0
24	.910	6.93	7.04	90.8
26	.898	7.02	7.13	89.6
28	.887	7.10	7.22	88.5
30	.876	7.19	7.31	87.4
32	.865	7.28	7.41	86.3
34	.855	7.37	7.49	85.3
36	.845	7.46	7.58	84.3
38	.835	7.55	7.67	83.3
40	.825	7.64	7.76	82.3
42	.816	7.73	7.85	81.4
44	.806	7.82	7.95	80.4
46	.797	7.91	8.03	79.5
48	.788	8.00	8.13	78.6
50	.780	8.08	8.21	77.8
55	.759	8.30	8.44	75.7
60	.739	8.53	8.67	73.7
70	.702	8.98	9.12	70.1

B. Commodity characteristics

1. Table I is intended to help port planners in several tasks:

(*a*) The conversion of traffic forecast figures given in tons into shiploads, according to ship size, for the planning of probable ship calls;

(*b*) The conversion of tonnages of a cargo mix into the volume of future port storage capacity required;

(*c*) The grouping of commodity forecasts into totals to be allocated to each class of port terminal and of port storage.

2. The list of commodities included is not exhaustive but should cover the overriding majority of traffics offered to a port. In the case of general cargo it is not possible to be comprehensive but sufficient data is given to permit the conversion of a preliminary general cargo mix tonnage to a volume requirement.

3. The stowage factors given have been mainly derived from a standard work.[c] The stowage factor of any commodity is the figure which expresses the number of cubic feet or cubic metres which a ton of 2,240 lbs. will occupy in stowage and includes a proper allowance for broken stowage and dunnage. These stowage factors are not absolute and should serve merely as a useful guide in the absence of local figures. In most cases only a central value in each range is given, since it will not normally be feasible to deal with a range of values during the planning task. This approximation is sometimes very rough, but it will generally be at least as accurate as the traffic forecast itself. The table is intended for use in the estimation of storage requirements and not for the purpose of accurate operational planning for specific ship cargoes.

4. Similarly, the degree of accuracy called for is not so great as to warrant differentiating between the stowage factor of a ship, the stowage factor in a port store, and the weight/measurement ratio given in the consignment documents. The figures given can, within the limit of forecasting accuracy, be used interchangeably for each of these cargo characteristics for port development studies.

C. Discount factors

5. Table II provides factors to allow discounted cash flow analyses to be made. For example, when the rate of interest or time value of money is 12 per cent, the present value of a sum of money that will be received after five years is 0.56743 times the sum of money.

6. The discount factor is calculated by the formula:

$$d.f. = \frac{1}{(1+r)^n}$$

where

$d.f.$ = discount factor;
r = annual rate of interest as a fraction;
n = number of years before sum received.

D. Amortization factors

7. Table III provides factors to allow the calculation of capital charges based on the life of the asset and the rate of interest. For example, an item of equipment costing $100,000 with a life of 10 years and a rate of interest of 10 per cent would have an annual amoritization charge of $ 100,000 times 0.16275, or $16,275.

8. The amortization factor is calculated by the formula:

$$a.f. = \frac{r}{1-(1+r)^{-n}}$$

where

$a.f.$ = amortization factor;
r = annual rate of interest as a fraction;
n = life of the asset.

E. Random number table

9. Table IV, a table of random numbers, is provided to allow the use of such techniques as the Monte Carlo simulation. To select a random sample the user must decide upon an arbitrary method of choosing entries from the table. He must then decide upon some arbitrary method of selecting the required number of positional digits from each entry. For example, the first and the last digit of each entry may be used to give a two-digit number. The procedure is repeated until a sufficient number of samples is obtained.

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[b] Specific gravity = $\frac{141.5}{\text{Degrees API} + 131.5}$

[c] R. E. Thomas, *Stowage; the properties and stowage of cargoes*, rev. by O. O. Thomas, 6th ed. (Glasgow, Brown, Son and Ferguson, 1968).

TABLE I

Commodity characteristics for port planning

Commodity	*Physical characteristics* — Bulk commodities, angle of repose where relevant (degrees)	*Stowage factor (cubic metres/ton (cu.ft./ton))* — Bulk	Bags	Other	*Handling characteristics* — Method of handling	Class of storage	Special requirements
LIQUID CARGOES							
Crude oil		1.2 (42)			Pipeline	Tank	
Oil products		1.2 (43)			Pipeline	Tank	
Latex		1.0 (37)		Drums 1.5 (52)	Pipeline	Tank	
Vegetable oils		1.1 (39)		Barrels, drums 1.8 (64)	Pipeline	Tank	
Molasses		0.8 (27)		Baskets, casks 1.4 (50)	Pipeline	Tank	
Wines				Casks, tanks 1.8 (63)			
DRY CARGOES							
Ores, minerals and chemicals:							
Alumina	35	0.6 (21)			Loader/conveyor	Convered	Cleaning of conveyors and storage area necessary when alumina handled after bauxite at common facilities
Bauxite	28 (dry)-49 (wet)	0.8 (28)	1.1 (39)				Dust filter
Cement	40*	0.7 (23) 0.9–1.5	1.0 (34)	Drums, casks 1.1 (40)	Conveyor screw and pneumatic	Totally enclosed	Exclusion of moisture, dust filter
Chrome ore	35	0.4 (14)		Cases 0.4 (15)			
Coal	30-45	1.4 (48)			Unloader/Belt conveyor	Open	For certain grades, fire precautions
Coke	37	2.4 (85)			Unloader/Belt conveyor	Open	
Gypsum		1.1 (38)	1.2 (44)		Unloader/Belt conveyor	Covered	
Ilmenite sand	40	0.4 (13)			Unloader/Belt conveyor	Open	
Iron ore	30–50	0.4 (14)			Unloader/Belt conveyor	Open	Dust filter for certain grades
Iron pyrites	40	0.7 (25)			Unloader/Belt conveyor	Open	
Kaolin (China clay) .	30–35	1.1 (39)	1.3 (46)		Unloader/Belt conveyor	Covered	
Lead ore	40	0.4 (13)	0.5 (17)		Conveyor Package	Covered	
Magnesite	35	0.7 (25)			Conveyor	Covered	
Manganese ore		0.5 (17)	0.7 (23)		Conveyor	Covered	

* The angle of repose of cement is difficult to define as it depends upon the amount of air in the cement. With a constant supply of air, the angle of repose can be as low as 7° but when the cement is consolidated and has little or no air in it, the angle of repose approaches 90°.

TABLE I (*continued*)

	Physical characteristics				Handling characteristics		
	Bulk commodities, angle of repose where relevant	Stowage factor (cubic metres/ton (cu.ft./ton))					
Commodity	(degrees)	Bulk	Bags	Other	Method of handling	Class of storage	Special requirements
Nickel ore			0.6 (20)				
				Barrels			
				0.7 (25)	Package	Covered	
Petrocoke	30–40	1.5 (52)			Unloader/conveyor	Open	
Phosphate (rock)	30–34	1.0 (34)			Unloader/conveyor	Open or closed	Dust filter
Potash	32-35	0.9 (33)			Unloader/conveyor	Closed	Dust filter
			1.0 (36)				
Salt	45	1.0 (37)			Conveyor	Covered	Humidity
			1.1. (37)		Package	Covered	Controlled
				Barrels			
				1.4 (41)	Package	Covered	
Sand	30–40	0.5 (19)			Conveyor	Open	
				Cases			
				1.7 (60)	Package	Open	
Sulphur	35-40	0.9 (31)					Precautions against
				Barrels			health and fire risks
			1.0 (36)	1.3 (47)	Conveyor	Covered	
Superphosphates	35		1.1 (39)		Package	Covered	
Foodstuffs and vegetable products:							
Animal meals			1.5 (53)		Package	Covered	
Bananas				Cartons			
				3.9 (138)	Pocket conveyor	Closed	Refrigeration
Barley	16–28	1.5 (54)			Conveyor	Covered	
			1.7 (60)		Package	Covered	
Citrus fruits				Cases, cartons,			
				etc.			
				2.5 (88)	Package	Covered	Cool store
Cocoa			1.9 (67)				
				Cases			
				2.5 (87)	Package	Covered	Protection
							from weevils
Coffee			1.8 (65)		Package	Covered	
Copra		2.1 (73)			Conveyor	Covered	
			2.9 (103)				
Cotton				Bales			
				2.7 (94)	Package		
Deciduous fruits				Cases, cartons,			
				etc.			
				2.7 (97)	Package	Covered	Cool store
Esparto grass				Bales			
				4.2 (150)	Package	Covered	
Flour			1.3 (45)				
				Sacks, barrels			
				1.6 (55)	Package	Covered	
Grapes				Cases, barrels			
				3.9 (140)	Package	Covered	
Maize	30–40	1.4 (44)			Conveyor		Protection from
			1.5 (54)		(pneumatic)		vermin and weevils
Oats	32	2.1 (75)			Bags	Enclosed	
			2.3 (80)		Package		
Oil seeds		1.8 (63)					
			2.1 (74)				
				Cases, kegs			
				2.0 (70)	Package	Covered	
Other vegetables			2.0 (71)				
				Cases, barrels,			
				bales			
				1.61 (57)	Package	Covered	

TABLE I *(continued)*

	Physical characteristics				Handling characteristics		
	Bulk commodities, angle of repose where relevant	Stowage factor (cubic metres/ton (cu.ft./ton))					
Commodity	(degrees)	Bulk	Bags	Other	Method of handling	Class of storage	Special requirements
Potatoes		1.6 (57)					
			1.7 (60)				
				Cartons, baskets, barrels			
				2.7 (95)	Package	Covered	
Rice			1.5 (54)				Protection from vermin and weevils
				Kegs			
				1.9 (69)	Package	Covered	
Rye	30	1.4 (50)					Protection from
			1.6 (55)		Conveyor	Covered	vermin and weevils
Semolina			1.7 (61)		Package	Covered	Protection from vermin and weevils
Soya beans	29	1.2 (44)			Conveyor	Covered	Protection from
			1.4 (50)				vermin and weevils
Sugar	32	1.3 (46)			Conveyor	Covered	Protection from
			1.3 (46)				vermin and weevils
Sugar, green				Baskets			
				1.5 (52)	Package	Covered	
Sugarbeet			3.8 (135)		Package	Open	
Tapioca			1.5 (53)		Package	Covered	
Wheat	25–28	1.3 (47)			Conveyor	Enclosed	Protection from
			1.5 (52)				vermin and weevils
Animal products:							
Bacon				Cases			
				1.7 (59)	Package	Covered	Refrigeration in hot climates
Butter				Cases, cartons, kegs			
				1.7 (60)	Package	Covered	Refrigeration in hot climates
Bones		2.4 (84)			Conveyor	Open	
Bones, calcined		2.8 (100)			Conveyor	Covered	
			1.8 (65)				
Canned meats				Cases			
				1.7 (60)	Package	Covered	Cool store
Cheese				Cases, cartons			
				1.4 (50)	Covered		Cool store or refrigeration
Frozen:							
Beef		2.6 (92)			Pocket conveyor	Enclosed	Refrigeration
Lamb		3.2 (115)			Pocket conveyor	Enclosed	Refrigeration
Whalemeat			2.3 (80)		Pocket conveyor	Enclosed	Refrigeration
				Cartons			
				2.1 (75)	Pocket conveyor	Enclosed	Refrigeration
Hides, wet				Cartons, bales bundles			
				1.8 (65)	Package	Covered or open	Good ventilation
Milk, dry or powdered			1.9 (68)				
				Cases, cartons			
				2.0 (72)	Package	Covered	
Milk, condensed ...				Cases, cartons, kegs			
				1.7 (60)	Package	Covered	
				Loose			

Commodity	Physical characteristics: Bulk commodities, angle of repose where relevant (degrees)	Stowage factor (cubic metres/ton (cu.ft./ton)): Bulk	Stowage factor: Bags	Stowage factor: Other	Handling characteristics: Method of handling	Handling characteristics: Class of storage	Handling characteristics: Special requirements
Skins, dry hides ...				5.2 (185)	Package	Covered	
				Bales 4.2 (150)	Package	Covered	
				Pressed bales 2.5 (87)	Package	Covered	
Wool				Pressed bales 1.4–2.5 (50–90)	Package	Covered	
				Pressed bales (greasy) 4.2 (150)	Package	Covered	
				Pressed bales (dumped) 0.5 (18)	Package	Covered	
Fish products:							
Canned fish				Cases 1.7 (60)	Package	Covered	
Fishmeal			1.8 (63)		Package	Covered	
Fish oils		1.1 (40)			Pipeline	Tank	
				Barrels, cases 1.6 (56)	Package	Enclosed	
Frozen fish				Boxes 2.1 (75)	Package	Enclosed	Refrigeration
Forest products:							
Cork				4.2 (150)	Crane	Open	
Hardwood				0.9–1.4 (30-50)	Crane	Open	
Paper				Rolls 2.5 (90)	Crane	Covered	
				Bales 1.4–2.8 (50-100)	Crane	Covered	
Pit props and plywood				2.2–3.4 (80-120)	Crane	Open	
Plywood, chipboard .				2.3 (80)	Crane	Covered	
Rubber				Sheet 1.7 (60)	Crane	Covered	
				Bales, bags 1.9 (66)	Crane	Covered	
				Crepe, cases 2.0 (70)	Crane	Covered	
Sleepers				1.3 (45)	Crane	Open	
Softwood				1.4–2.0 (50-70)	Crane	Open	
Woodpulp				Pressed bales 1.7 (60)	Crane	Open	
Metal products:							
Copper				Ingots 0.3 (11)	Crane	Covered	
				Coils 0.9 (30)	Crane	Covered	
Copper concentrates	45	0.5 (16)					
			0.7 (25)				
				Slabs 0.3 (12)	Crane	Covered	

Commodity	*Physical characteristics* — Bulk commodities, angle of repose where relevant (degrees)	*Stowage factor (cubic metres/ton (cu.ft./ton))* Bulk	Bags	Other	*Handling characteristics* — Method of handling	Class of storage	Special requirements
Iron and Steel				Pig-iron 0.3 (10)	Crane	Open for short periods	Provision for drainage
				Billets 0.3 (12)			
				Bars 0.4 (15)	Crane	Covered for long-term storage	
				Steel plates 0.3 (12)			
Scrap iron and steel		1.0 (35)			Crane	Open	
Tin				Ingots 0.3 (9)	Crane	Open	
Tin plate				0.3 (12)	Crane	Covered	
Zinc				Ingots 0.4 (15)	Crane	Covered	
Zinc concentrates ..	40	0.6 (21)			Crane	Covered	
Vehicles:							
Motor vehicles, unpacked				4.0–8.0 (150-300)	Crane	Open	
Motor vehicles, knocked down ...				Crates 1.0 (35)	Crane	Open	

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TABLE II

Discount factors

Number of years	*Annual rate of interest (percentage)* 10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	20.0	25.0	30.0
1	0.90910	0.90091	0.89286	0.88496	0.87720	0.86957	0.86207	0.85471	0.84746	0.83334	0.80000	0.76924
2	0.82645	0.81163	0.79720	0.78315	0.76947	0.75615	0.74317	0.73052	0.71819	0.69445	0.64000	0.59172
3	0.75132	0.73120	0.71179	0.69306	0.67498	0.65752	0.64066	0.62438	0.60864	0.57871	0.51200	0.45517
4	0.68302	0.65874	0.63552	0.61332	0.59209	0.57176	0.55230	0. 53366	0.51579	0.48226	0.40960	0.35013
5	0.62093	0.59346	0.56743	0.54276	0.51937	0.49718	0.47612	0.45612	0.43711	0.40188	0.32768	0.26933
6	0.56448	0.53465	0.50664	0.48032	0.45559	0.43233	0.41045	0.38984	0.37044	0.33490	0.26215	0.20718
7	0.51316	0.48166	0.45235	0.42507	0.39964	0.37594	0.35383	0.33320	0.31393	0.27909	0.20972	0.15937
8	0.46651	0.43393	0.40389	0.37616	0.35056	0.32691	0.30503	0.28479	0.26604	0.23257	0.16778	0.12259
9	0.42410	0.39093	0.36062	0.33289	0.30751	0.28427	0.26296	0.24341	0.22546	0.19381	0.13422	0.09430
10	0.38555	0.35219	0.32198	0.29459	0.26975	0.24719	0.22669	0.20804	0.19107	0.16151	0.10738	0.07254
11	0.35050	0.31729	0.28748	0.26070	0.23662	0.21495	0.19542	0.17781	0.16192	0.13459	0.08590	0.05580
12	0.31864	0.28585	0.25668	0.23071	0.20756	0.18691	0.16847	0.15198	0.13722	0.11216	0.06872	0.04293
13	0.28967	0.25752	0.22918	0.20417	0.18207	0.16253	0.14523	0.12990	0.11629	0.09347	0.05498	0.03302
14	0.26334	0.23200	0.20462	0.18068	0.15971	0.14133	0.12520	0.11102	0.09855	0.07789	0.04399	0.02540
15	0.23940	0.20901	0.18270	0.15990	0.14010	0.12290	0.10793	0.09489	0.08352	0.06491	0.03519	0.01954
16	0.21763	0.18830	0.16313	0.14150	0.12290	0.10687	0.09305	0.08111	0.07078	0.05409	0.02815	0.01503
17	0.19785	0.16964	0.14565	0.12522	0.10780	0.09293	0.08021	0.06932	0.05998	0.04508	0.02252	0.01157
18	0.17986	0.15283	0.13004	0.11082	0.09457	0.08081	0.06915	0.05925	0.05084	0.03757	0.01802	0.00890
19	0.16351	0.13768	0.11611	0.09807	0.08295	0.07027	0.05961	0.05064	0.04308	0.03131	0.01442	0.00685
20	0.14865	0.12404	0.10367	0.08679	0.07277	0.06111	0.05139	0.04328	0.03651	0.02609	0.01153	0.00527
21	0.13514	0.11175	0.09256	0.07680	0.06383	0.05314	0.04430	0.03700	0.03094	0.02174	0.00923	0.00405
22	0.12285	0.10067	0.08265	0.06797	0.05599	0.04621	0.03819	0.03162	0.02622	0.01812	0.00738	0.00312
23	0.11168	0.09070	0.07379	0.06015	0.04912	0.04018	0.03293	0.02703	0.02222	0.01510	0.00591	0.00240
24	0.10153	0.08171	0.06589	0.05323	0.04309	0.03494	0.02838	0.02310	0.01883	0.01258	0.00473	0.00185
25	0.09230	0.07361	0.05883	0.04711	0.03780	0.03038	0.02447	0.01975	0.01596	0.01049	0.00378	0.00142

Source: Calculated by the UNCTAD secretariat.

Table III

Amortization factors

Number of years	Annual rate of interest (percentage)											
	10.0	*11.0*	*12.0*	*13.0*	*14.0*	*15.0*	*16.0*	*17.0*	*18.0*	*20.0*	*25.0*	*30.0*
1	1.10000	1.11000	1.12000	1.13000	1.14000	1.15000	1.16000	1.17000	1.18000	1.20000	1.25000	1.30000
2	0.57620	0.58394	0.59170	0.59949	0.60729	0.61512	0.62297	0.63083	0.63872	0.65455	0.69445	0.73479
3	0.40212	0.40922	0.41635	0.42353	0.43074	0.43798	0.44526	0.45258	0.45993	0.47473	0.51230	0.55063
4	0.31548	0.32233	0.32924	0.33620	0.34321	0.35027	0.35738	0.36454	0.37174	0.38629	0.42345	0.46163
5	0.26380	0.27058	0.27741	0.28432	0.29129	0.29832	0.30541	0.31257	0.31978	0.33438	0.37185	0.41059
6	0.22961	0.23638	0.24323	0.25016	0.25716	0.26424	0.27139	0.27862	0.28592	0.30071	0.33882	0.37840
7	0.20541	0.21222	0.21912	0.22612	0.23320	0.24037	0.24762	0.25495	0.26237	0.27743	0.31635	0.35688
8	0.18745	0.19433	0.20131	0.20839	0.21558	0.22286	0.23023	0.23769	0.24525	0.26061	0.30040	0.34192
9	0.17365	0.18061	0.18768	0.19487	0.20217	0.20958	0.21709	0.22470	0.23240	0.24808	0.28876	0.33124
10	0.16275	0.16981	0.17699	0.18429	0.19172	0.19926	0.20691	0.21466	0.22252	0.23853	0.28008	0.32347
11	0.15397	0.16113	0.16842	0.17585	0.18340	0.19107	0.19887	0.20677	0.21478	0.23111	0.27350	0.31773
12	0.14677	0.15403	0.16144	0.16899	0.17667	0.18449	0.19242	0.20047	0.20863	0.22527	0.26845	0.31346
13	0.14078	0.14816	0.15568	0.16336	0.17117	0.17912	0.18719	0.19538	0.20369	0.22063	0.26455	0.31025
14	0.13575	0.14323	0.15088	0.15867	0.16661	0.17469	0.18290	0.19124	0.19968	0.21690	0.26151	0.30782
15	0.13148	0.13907	0.14683	0.15475	0.16281	0.17102	0.17936	0.18783	0.19641	0.21389	0.25912	0.30598
16	0.12782	0.13552	0.14340	0.15143	0.15962	0.16795	0.17642	0.18501	0.19372	0.21144	0.25725	0.30458
17	0.12467	0.13248	0.14046	0.14861	0.15692	0.16537	0.17396	0.18267	0.19149	0.20945	0.25576	0.30351
18	0.12194	0.12985	0.13794	0.14621	0.15463	0.16319	0.17189	0.18071	0.18964	0.20781	0.25459	0.30270
19	0.11955	0.12757	0.13577	0.14414	0.15267	0.16134	0.17015	0.17907	0.18811	0.20647	0.25366	0.30207
20	0.11746	0.12558	0.13388	0.14236	0.15099	0.15977	0.16867	0.17770	0.18682	0.20536	0.25292	0.30159
21	0.11563	0.12384	0.13225	0.14082	0.14955	0.15842	0.16742	0.17654	0.18575	0.20445	0.25233	0.30122
22	0.11401	0.12232	0.13082	0.13948	0.14831	0.15727	0.16636	0.17556	0.18485	0.20369	0.25186	0.30094
23	0.11258	0.12098	0.12956	0.13832	0.14724	0.15628	0.16545	0.17473	0.18410	0.20307	0.25149	0.30073
24	0.11130	0.11979	0.12847	0.13731	0.14631	0.15543	0.16468	0.17402	0.18346	0.20255	0.25119	0.30056
25	0.11017	0.11875	0.12750	0.13643	0.14550	0.15470	0.16402	0.17343	0.18292	0.20212	0.25095	0.30043

Source: Calculated by the UNCTAD secretariat.

TABLE IV

A table of 1,400 random units

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
1	10480	15011	01536	02011	81647	91646	69179	14194	62590	36207	20969	99570	91291	90700
2	22368	46573	25595	85393	30995	89198	27982	53402	93965	34095	52666	19174	39615	99505
3	24130	48360	22527	97265	76393	64809	15179	24830	49340	32081	30680	19655	63348	58629
4	42167	93093	06243	61680	07856	16376	39440	53537	71341	57004	00849	74917	97758	16379
5	37570	39975	81837	16656	06121	91782	60468	81305	49684	60672	14110	06927	01263	54613
6	77921	06907	11008	42751	27756	53498	18602	70659	90655	15053	21916	81825	44394	42880
7	99562	72905	56420	69994	98872	31016	71194	18738	44013	48840	63213	21069	10634	12952
8	96301	91977	05463	07972	18876	20922	94595	56869	69014	60045	18425	84903	42508	32307
9	89579	14342	63661	10281	17453	18103	57740	84378	25331	12566	58678	44947	05585	56941
10	85475	36857	53342	53988	53060	59533	38867	62300	08158	17983	16439	11458	18593	64952
11	28918	69578	88231	33276	70997	79936	56865	05859	90106	31595	01547	85590	91610	78188
12	63553	40961	48235	03427	49626	69445	18663	72695	52180	20847	12234	90511	33703	90322
13	09429	93969	52636	92737	88974	33488	36320	17617	30015	08272	84115	27156	30613	74952
14	10365	61129	87529	85689	48237	52267	67689	93394	01511	26358	85104	20285	29975	89868
15	07119	97336	71048	08178	77233	13916	47564	81056	97735	85977	29372	74461	28551	90707
16	51085	12765	51821	51259	77452	16308	60756	92144	49442	53900	70960	63990	75601	40719
17	02368	21382	52404	60268	89368	19885	55322	44819	01188	65255	64835	44919	05944	55157
18	01011	54092	33362	94904	31273	04146	18594	29852	71585	85030	51132	01915	92747	64951
19	52162	53916	46369	58586	23216	14513	83149	98736	23495	64350	94738	17752	35156	35749
20	07056	97628	33787	09998	42698	06691	76988	13602	51851	46104	88916	19509	25625	58104
21	48663	91245	85828	14346	09172	30168	90229	04734	59193	22178	30421	61666	99904	32812
22	54164	58492	22421	74103	47070	25306	76468	26384	58151	06646	21524	15227	96909	44592
23	32639	32363	05597	24200	13363	38005	94342	28728	35806	06912	17012	64161	18296	22851
24	29334	27001	87637	87308	58731	00256	45834	15398	46557	41135	10367	07684	36188	18510
25	02488	33062	28834	07351	19731	92420	60952	61280	50001	67658	32586	86679	50720	94953
26	81525	72295	04839	96423	24878	82651	66566	14778	76797	14780	13300	87074	79666	95725
27	29676	20591	68086	26432	46901	20849	89768	81536	86645	12659	92259	57102	80428	25280
28	00742	57392	39064	66432	84673	40027	32832	61362	98947	96067	64760	64584	96096	98253
29	05366	04213	25669	26422	44407	44048	37937	63904	45766	66134	75470	66520	34693	90449
30	91921	26418	64117	94305	26766	25940	39972	22209	71500	64568	91402	42416	07844	69618
31	00582	04711	87917	77341	42206	35126	74087	99547	81817	42607	43808	76655	62028	76630
32	00725	69884	62797	56170	86324	88072	76222	36086	84637	93161	76038	65855	77919	88006
33	69011	65795	95876	55293	18988	27354	26575	08625	40801	59920	29841	80150	12777	48501
34	25976	57948	29888	88604	67917	48708	18912	82271	65424	69774	33611	54262	85963	03547
35	09763	83473	73577	12908	30883	18317	28290	35797	05998	41688	34952	37888	38917	88050
36	91567	42595	27958	30134	04024	86385	29880	99730	55536	84855	29080	09250	79656	73211
37	17955	56349	90999	49127	20044	59931	06115	20542	18059	02008	73708	83517	36103	42791
38	46503	18584	18845	49618	02304	51038	20655	58727	28108	15475	56942	53389	20562	87338
39	92157	89634	94824	78171	84610	82834	09922	25417	44137	48418	25555	21246	35509	20468
40	14577	62765	35605	81263	39667	47358	56873	56307	61607	49518	89656	20103	77490	18062
41	98427	07523	33362	64270	01638	92477	60969	98420	04880	45585	46565	04102	46880	45709
42	34914	63976	88720	82705	34476	17032	87589	40836	32427	70002	70663	88863	77775	69348
43	70060	28277	39475	40473	23219	53416	94970	25832	69975	94884	19661	72828	00102	66794
44	53976	54914	00990	67245	08350	82948	11398	42878	80287	88267	47363	46634	06541	97809
45	76072	29515	40980	07391	58745	25774	22987	80059	39911	96189	41151	14222	60697	59583
46	90725	52210	83974	29992	65831	38857	50490	83765	55657	14361	31720	57375	56228	41546
47	64364	67412	33339	31926	14883	24413	59744	92351	97473	89286	35931	04110	23726	51900
48	08962	00358	31662	25388	61642	34072	81249	85648	56891	69352	48373	45578	78547	81788
49	95012	08379	93526	70765	10592	04542	76463	54328	02849	17247	28865	14777	62730	92277
50	15664	10493	20492	38891	91132	21999	59616	81652	27195	48223	46751	22923	32261	85653

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
51	16408	81899	04153	53381	79401	21438	83035	92350	36693	31238	59649	91754	72772	02338
52	18629	81953	05520	91962	04739	13092	97662	24822	94730	06496	35090	04822	86774	98289
53	73115	35101	47498	87637	99016	71060	88824	71013	18735	20280	23153	72924	35165	43040
54	57491	16703	23167	49323	45021	33132	12544	41035	80780	45393	44812	12515	98931	91202
55	30405	83946	23792	14422	15059	45799	22716	19792	09983	74353	08668	30429	70735	25499
56	16631	35006	85900	98275	32388	52390	16815	69298	82732	38480	72817	32523	41961	44437
57	96773	20206	42559	78985	05300	22164	24369	54224	35083	19687	11052	91491	60383	19746
58	38935	64202	14349	82674	66523	44138	00697	35552	35970	19124	63318	29686	03387	59846
59	31624	76384	17403	53363	44167	64486	64758	75366	76554	31601	12614	33072	60332	92325
60	78919	19474	23632	27889	47914	02584	37680	20801	72152	39339	34806	08930	85001	87820
61	03931	33309	57047	74211	63445	17361	62825	39908	05607	91284	68833	25570	38818	46920
62	74426	33278	43972	10119	89917	15665	52872	73823	73144	88662	88970	74492	51805	99378
63	09066	00903	20795	95452	92648	45454	09552	88815	16553	51125	79375	97596	16296	66092
64	42238	12426	87025	14267	20979	04508	64535	31355	86064	29472	47689	05974	52468	16834
65	16153	08002	26504	41744	81959	65642	74240	56302	00033	67107	77510	70625	28725	34191
66	21457	40742	29820	96783	29400	21840	15035	34537	33310	06116	95240	15957	16572	06004
67	21581	57802	02050	89728	17937	37621	47075	42080	97403	48626	68995	43805	33386	21597
68	55612	78095	83197	33732	05810	24813	86902	60397	16489	03264	88525	42786	05269	92532
69	44657	66999	99324	51281	84463	60563	79312	93454	68876	25471	93911	25650	12682	73572
70	91340	84979	46949	81973	37949	61023	43997	15263	80644	43942	89203	71795	99533	50501
71	91227	21199	31935	27022	84067	05462	35216	14436	29891	68607	41867	14951	91696	85065
72	50001	38140	66321	19924	72163	09538	12151	06878	91903	18749	34405	56087	82790	70925
73	65390	05224	72958	28609	81406	39147	25549	48542	42627	45233	57202	94617	23772	07896
74	27504	96131	83944	41575	10573	08619	64482	73923	36152	05184	94142	25299	84387	34925
75	37169	94851	39117	89632	00959	16487	65536	49071	39782	17095	02330	74301	00275	48280
76	11508	70225	51111	38351	19444	66499	71945	05422	13442	78675	84081	66938	93654	59894
77	37449	30362	06694	54690	04052	53115	62757	95348	78662	11163	81651	50245	34971	52924
78	46515	70331	85922	38329	57015	15765	97161	17869	45349	61796	66345	81075	49106	79860
79	30986	81223	42416	58353	21532	30502	32305	86482	05174	07901	54339	58861	74818	46942
80	63798	64995	46583	09785	44160	78128	83991	42865	92520	83531	80377	35909	81250	54238
81	82480	84846	99254	67632	43218	50076	21361	64816	51202	88124	41870	52689	51275	83556
82	21885	32906	92431	09060	64297	51674	64126	62570	26123	05155	59194	52799	28225	85762
83	60336	98782	07408	53458	13564	59089	26445	29789	85205	41001	12535	12133	14645	23541
84	43937	46891	24010	25560	86355	33941	25786	54990	71899	15475	95434	98227	21824	19585
85	97656	63175	89303	16275	07100	92063	21942	18611	47348	20203	18534	03862	78095	90136
86	03299	01221	05418	38982	55758	92237	26759	86367	21216	98442	08303	56613	91511	75928
87	79626	06486	03574	17668	07785	76020	79924	25651	83325	88428	85076	72811	22717	50585
88	85636	68335	47539	03129	65651	11977	02510	26113	99447	68645	34327	15152	55230	[illegible]
89	18039	14367	61337	06177	12143	46609	82989	74014	64708	00533	35398	58408	13261	[illegible]
90	08362	15656	60627	36478	65648	16764	53412	09013	07832	41574	17639	82163	60859	[illegible]
91	79556	29068	04142	16268	15387	12856	66227	38358	22478	73373	88732	[illegible]	[illegible]	[illegible]
92	92608	82674	27072	32534	17075	27698	98204	63863	11951	34648	88022	[illegible]	[illegible]	[illegible]
93	23982	25835	40055	67006	12293	02753	14827	23235	35071	99704	[illegible]	[illegible]	[illegible]	[illegible]
94	09915	96306	05908	97901	28395	14186	00821	80703	70426	75647	76310	88717	[illegible]	[illegible]
95	59037	33300	26695	62247	69927	76123	50842	43834	86654	70959	[illegible]	[illegible]	[illegible]	[illegible]
96	42488	78077	69882	61657	34136	79180	97526	43092	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
97	46764	86273	63003	93017	31204	36692	40202	35275	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
98	03237	45430	55417	63282	90816	17349	88298	90183	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
99	86591	81482	52667	61582	14972	90053	89534	76036	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
100	38534	01715	94964	87288	65680	43772	39560	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Source: Bureau of Transport Economics and Statistics of the Interstate Commerce Commission, Washington, DC

Annex II

MATHEMATICAL TECHNIQUES

A. Monte Carlo risk analysis

1. The Monte Carlo technique is a procedure for obtaining approximate evaluations of mathematical expressions, consisting of one or more probability distribution functions. In essence, the technique consists of simulating an experiment to determine the over-all statistical properties of a system by the random sampling of each component of the system. The actual taking of a physical sample from the real system is either impossible or too expensive and thus simulated sampling must be used. Simulated sampling involves replacing the actual component distribution by a theoretical assumed probability distribution, and then sampling from this theoretical distribution by means of a random number table.

2. The technique has wide practical applications and can be used for risk analysis when various investment alternatives are being evaluated. In the matter of port development, future events are probabilistic. For example, the planner does not know for certain that in three years' time the terminal will have to handle one million tonnes of break-bulk cargo. He may know that there is a high probability that the volume of cargo will be not less than 800,000 tonnes and not more than 1,400,000 tonnes. Thus, the future terminal throughput can be described in terms of a probability distribution function. Other elements, such as productivity and gangs per ship per shift can also be described by probability distributions. With estimates of these distributions, the Monte Carlo technique may be used to evaluate the performance and cost associated with various investment alternatives.

3. The probability for the occurrence of any given combination as the result of the throwing of a pair of six-sided dice is made up of the separate probabilities for the occurrence of each face of each individual dice. Where the individual probabilities are equal, as would be the case for unbiased dice, it is possible to calculate the joint probabilities. But where the individual probabilities are unequal and unknown—if the dice were biased, for example—the calculation is not possible and it is necessary to carry out an experiment to estimate the joint probability. The drawing of numbers from random number tables like the one given in annex I is a form of experiment.

4. The technique as applied to port planning can best be illustrated by a numerical example. Let us suppose that a planner has arrived at the following statistical estimates for a berth group in the year 1985:

Traffic demand probability

Tonnes	*Percentage*
400,000–600,000	15
600,000–800,000	20
800,000–1 million	30
1-1.2 million	20
1.2–1.4 million	15

Productivity probability

Tonnes per gang hour	*Percentage*
8-12	40
12–16	40
16–20	20

Gangs per ship per shift probability

Number of gangs	*Percentage*
2	20
3	50
4	30

5. If the planner now requires to find the joint probability distribution of the berth-day requirement he must carry out, either by hand or by computer, the drawing of random numbers to represent a large number of possible outcomes of each of the three parameters.

6. For traffic demand, the five different tonnage ranges are assigned the set of numbers chosen from 0–99 which gives them the appropriate range of probability:

Tonnes	*Probability percentage*	*Number range*
400,000–600,000	(15)	00–14
600,000–800,000	(20)	15–34
800–1 million	(30)	35–64
1–1.2 million	(20)	65–84
1.2–1.4 million	(15)	85–99

The productivity probabilities are allocated numbers similarly:

Tonnes per hour	*Probability percentage*	*Number range*
8–12	(40)	0–39
12–16	(40)	40–79
16–20	(20)	80–99

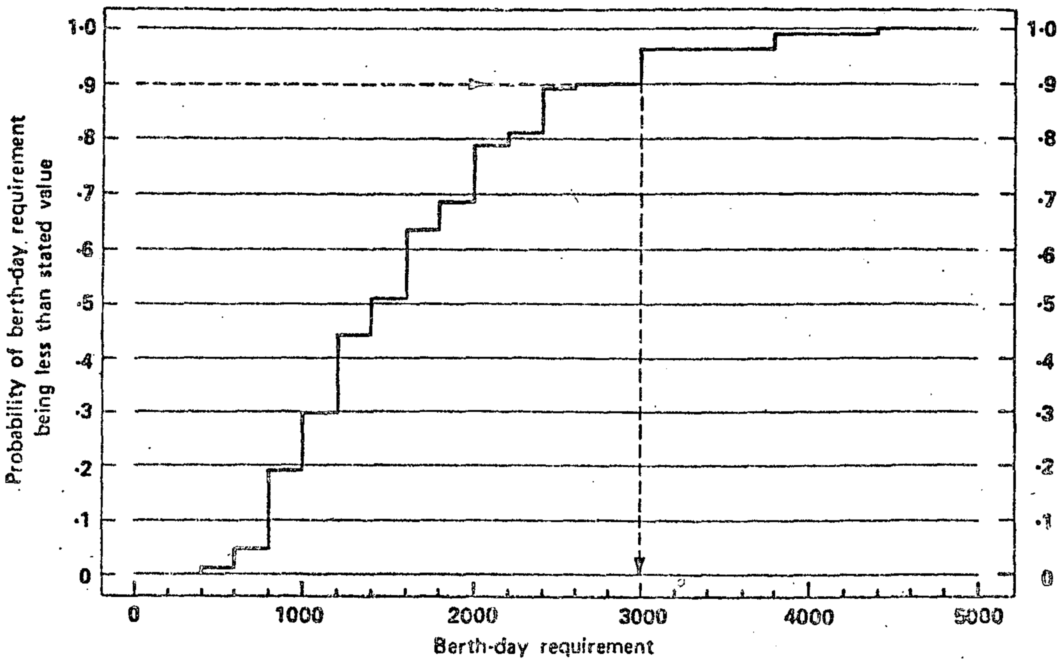
Finally, the gangs per ship per shift probabilities are allocated numbers:

Number of gangs	*Probability percentage*	*Number range*
2	(20)	0–19
3	(50)	20–69
4	(30)	70–99

7. The Monte Carlo experiment now proceeds by drawing a set of three random two-digit numbers—say the first two digits of the first three numbers in the column (1) of annex I, table IV, namely, 10, 22 and 24. The number 10 implies a tonnage of 400,000–600,000 tonnes; 22 implies a productivity of 8–12 tonnes per hour; 24 implies 3 gangs. A calculation for the first sample set of data is now carried out (using the mid-range figure to represent

FIGURE 1

Cumulative probability distribution for Monte Carlo numerical example



tonnage and tonnes per hour, and assuming a fixed fraction of time worked per day of 0.6).

First sample

$$\text{Berth-day requirements} = \frac{500{,}000 \text{ tonnes}}{10 \text{ tons/hour} \times 3 \text{ gangs} \times 0.6 \times 24}$$

$$= 1{,}157 \text{ berth-days.}$$

8. This single figure of 1,157 is recorded as the result of the first sample and the process is repeated—perhaps 50 to 100 times—to give a new probability distribution which can be drawn as shown in figure I which will be of interest to a decision-maker. The decision may then be taken that it is reasonable to plan for the 90 per cent berth-day requirement probability, i.e. 3,000 berth days.

9. This procedure would normally be carried right through to the more easily understood decision measure of the net present value of the investment proposal, and in that case a computer programme to carry out all the calculations would be justified. However laborious such a procedure is, it is always possible to do it manually and it may be more attractive to set a student to work on this for a fortnight than to go to the expense and trouble of computer programming. The queueing curves incorporated in the planning charts can be used to calculate the waiting-times, and in fact the planning charts can also be used to calculate the berth days for each sample of tonnage, productivity and gangs per shift.

B. Simulation

10. Simulation is a branch of modern management science and is a technique for modelling a complex process which would otherwise defy mathematical description, because of the stochastic[a] behaviour and non-linear characteristics of the process. In simulation, the system is broken down into a number of subsystems that are fairly easy to describe mathematically. These parts are then combined to give a model of the whole system, and their responses to various inputs can be measured. The parameters of the model can be varied, which enables the user to simulate proposed changes to existing or future processes and hence evaluate the economics of various alternatives without costly capital investment.

11. Because of the large number of repetitive calculations and the volume of data involved in a simulation model, many models are run on a computer. For this reason, various simulation languages have been developed to allow more rapid implementation of the conceptual model into a working model. The most commonly used languages are:

GPSS
SIMULA
GSL
SIMSCRIPT
SIMON
GASP II

In addition, non-simulation languages, also, can be employed, and models are often developed using computer languages such as FORTRAN, COBOL and ALGOL.

12. The following general points should be borne in mind when considering the use of computer simulation techniques:

(*a*) Simulation gives the model's response to a given situation;

(*b*) Simulation is a useful training aid and an excellent method for research into system behaviour;

(*c*) Simulation allows many alternatives to be tried;

(*d*) The cost of simulation, which may affect the decision whether or not to use the technique;

(*e*) Simulation development costs are difficult to forecast accurately;

(*f*) General models that can be applied without modification will normally provide only limited information;

(*g*) Very often, the formulation and "debugging" of the model will supply the answer without the need to run the model.

[a] Stochastic behaviour is behaviour which appears random but can be described by a definite statistical pattern.

13. The use of simulation for port development was recommended in a preliminary report by the secretariat as a method of practical value, although it was noted that the method can be used only in cases where adequate statistical data are available.[b] After subsequent research and applications of the method,[c] the secretariat was able to specify the following prerequisites to obtaining the full benefits from the technique:

(*a*) Accurate and precise traffic forecasts and future cargo handling rates;

(*b*) Expertise in simulation methods, both in model development and in model use;

(*c*) Sufficient time to allow for data collection, model definition, documentation, programming, testing and validation followed by a period to obtain results from the model for various investment alternatives.

C. Combination of traffic class uncertainties

14. The detailed analysis of traffic, category by category and route by route, is to some extent wasted unless a satisfactory method exists of re-combining them into the aggregated traffic of a berth group, for it is only at this level that performance calculations can be made.

15. A numerical example is used to illustrate the technique of combining traffic forecasts into an aggregate berth group traffic forecast. It is assumed that a terminal is to receive three different classes of traffic. The tonnages and probabilities for each traffic are forecast as shown in table V.

16. When the various traffic streams are independent, the joint probability is given by multiplying the individual probabilities together for each combination. Thus the probability of the highest forecast, namely, 250,000 tons, being fulfilled is $0.2 \times 0.3 \times 0.1$ or 0.006, while the probability for the lowest forecast, namely, 110,000 tons, is $0.3 \times 0.1 \times 0.4$ or .012.

17. Table VI tabulates the various combinations and the probability of their occurrence. The independent nature of each traffic

[b] *Development of ports: Improvement of port operations and connected facilities* (United Nations publication, Sales No. E.69.II.D.17), Introduction, para. 3.

[c] See "Technological progress in shipping and ports: the application of systems analysis to port planning" (TD/B/C.4/132), paras. 12-21.

TABLE V

Terminal cargo traffic forecast and probability

Traffic	*Traffic tonnage (thousands of tons) and probability estimates* — *High*	*Medium*	*Low*
A	100/.2	75/.5	50/.3
B	80/.3	60/.6	40/.1
C	70/.1	45/.5	20/.4

TABLE VI

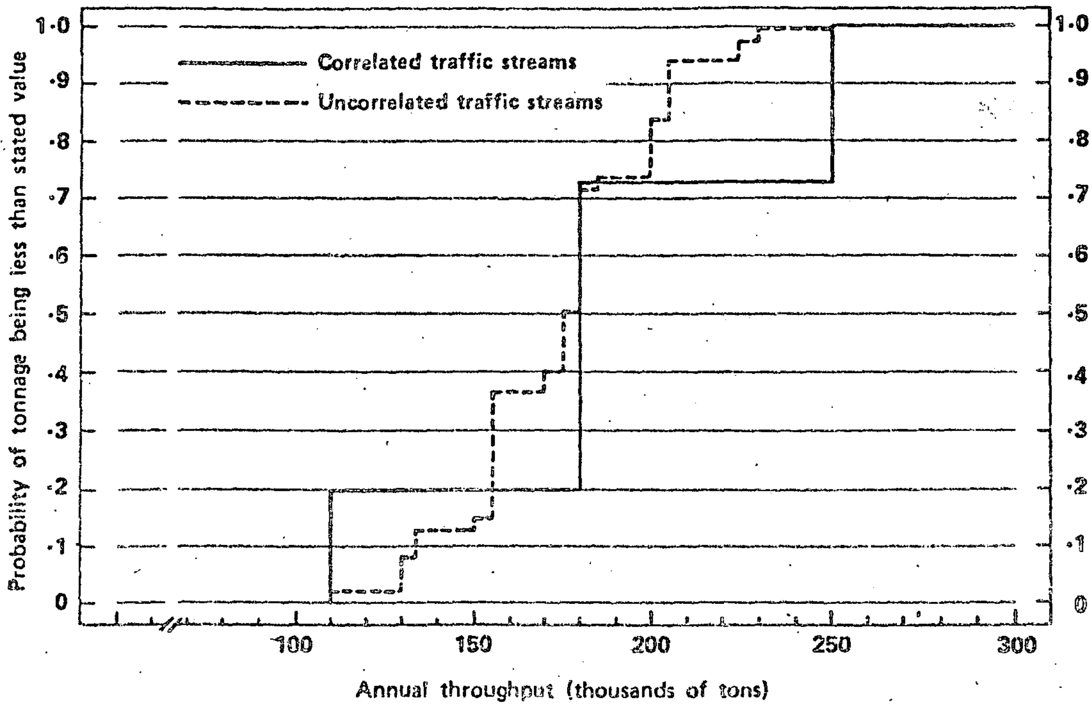
Combinations of traffic forecasts and probabilities

Combination			*Traffic forecast (thousands of tons)*	*Probabilities*	*Contribution to expected total traffic (thousands of tons).*
A	*B*	*C*			
H*	H	H	250	.006	1.5
H	H	M**	225	.030	6.75
H	H	L***	200	.024	4.80
H	M	H	230	.012	2.76
H	M	M	205	.060	12.30
H	M	L	180	.048	8.64
H	L	H	210	.002	4.2
H	L	M	185	.010	1.85
H	L	L	160	.008	1.28
M	H	H	225	.015	3.375
M	H	M	200	.075	15.00
M	H	L	175	.060	10.50
M	M	H	205	.030	6.15
M	M	M	180	.150	27.00
M	M	L	155	.120	18.60
M	L	H	185	.005	.925
M	L	M	160	.025	4.0
M	L	L	135	.020	2.7
L	H	H	200	.009	1.8
L	H	M	175	.045	7.875
L	H	L	150	.036	5.40
L	M	H	180	.018	3.24
L	M	M	155	.090	13.95
L	M	L	130	.072	9.36
L	L	H	160	.003	0.48
L	L	M	135	.015	2.025
L	L	L	110	.012	1.32
				1.000	177.78

* High forecast. ** Medium forecast. *** Low forecast.

FIGURE II

Comparison of total tonnage distribution for correlated and uncorrelated cases



stream smooths the demand on the berth group. However, when such separate forecasts are inter-dependent or, in mathematical terms, correlated, the combined probabilities will be quite different. When one factor is completely dependent on or correlated with another, then it is said to have a correlation coefficient of 1.0

18. For completely correlated traffic, the probability of the high, medium and low forecast for the numerical example given above would be 0.2, 0.533 and 0.267.[d] The expected volume of traffic is given by:

$$250 \times .2 + 180 \times .533 + 110 \times .267 = 175.3 \text{ thousand tons,}$$

as compared with the expected volume of traffic for the uncorrelated case of 177.78 thousand tons. Thus the factor of correlation affects the distribution in this case rather than the expected value. The cumulative probability for the two cases is shown in figure II. For this example, the throughput which would have only a 10 per cent probability of being exceeded would be 205,000 tons for the correlated case but 250,000 tons for the uncorrelated case.

19. Attempts to estimate the optimistic and pessimistic values of each separate category as well as their most likely values are not normally justified, since the combination of these estimates is itself sensitive to estimates of the degree of correlation between the various traffic categories, and these correlation coefficients will seldom be sufficiently accurately known. Instead, the estimates should be limited to the central, most likely, value of each category, with the assumption that the over-all trend of the aggregated traffic will apply equally to each.

20. The exception to this will be where particular categories clearly have a range of uncertainty which is substantially different from the over-all uncertainty. In that case the difference from the trend may be separated, combined with the differences in other categories according to whether these are independent or correlated, and then added to the aggregated estimates.

[d] For each forecast the probability is determined by adding the individual probabilities together and then dividing by the number of traffic streams, in this case 3.

21. However, these mathematical refinements are unlikely to add much accuracy to the final estimates and they bring their own dangers in giving an appearance of precision which is unjustified. It is more satisfactory to deal with uncertainty in a more practical way. For example, where within the context of an average annual growth rate of 10 per cent in a particular traffic, there is a possibility for each of two routes, that the growth will be higher than the average, the planner will be forced to contemplate the future picture or scenario with both such extraordinary trends. To make his scenario consistent and reasonable he will need to consider the extent to which the two above-average trends can co-exist. He should be able to arrive at a common-sense way of syunthesizing the over-all traffic which in reality will be as accurate as the mathematical way, and much more convincing.

D. Statistics of ship arrival, service distributions and waiting time

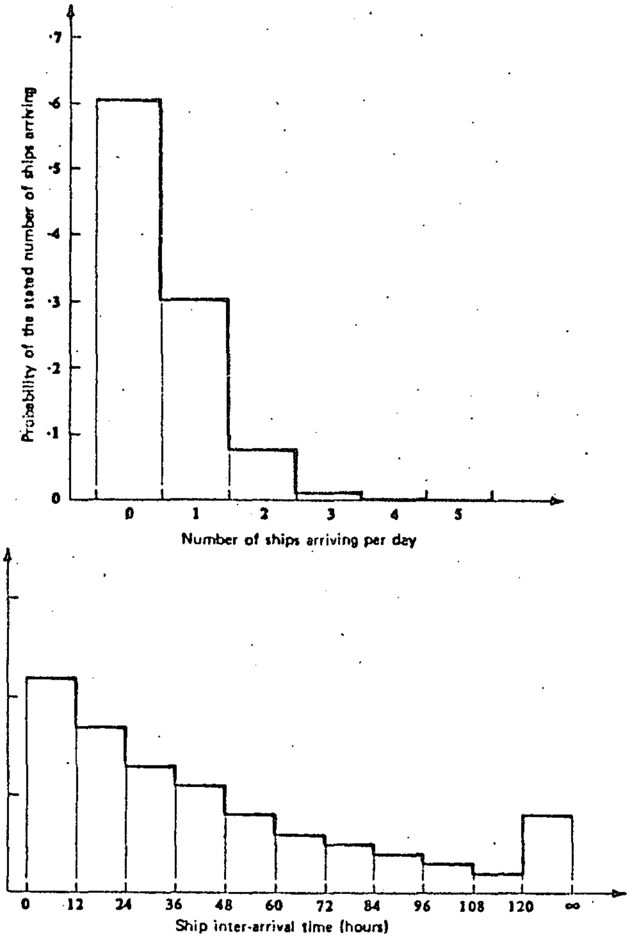
22. UNCTAD research has confirmed the widely-accepted view that the arrival pattern of break-bulk ships is best approximated by a Poisson distribution. This is equivalent to the distribution of the interval between arrivals being approximated by a negative exponential or Erlang 1 distribution. As an example, the probability distributions for the case where one ship arrives every two days is shown in figure III.

23. Based on data available to the UNCTAD secretariat (see table VI) the decision was taken to use an Erlang 2 distribution for the service or berth time distribution. The servicing operation can be regarded in the following way. There are two "stages", not necessarily with a physical significance, each with an Erlang 1 distribution. When the first stage is completed the second stage is immediately begun. The total service time then has the distribution of the sum of the two independent random variables and may be represented by an Erlang 2 distribution.

24. When the number of "stages" approaches a very large number, i.e. giving a high Erlang number, the service time tends to be constant, but it is necessary for the Erlang number to be

FIGURE III

Arrival pattern of break-bulk vessels with an average of one ship every two days



very high before this occurs, since the ratio of mean to standard deviation is given by the square root of the Erlang number.

25. At the other extreme, the Erlang 1 distribution for the service time distribution would result in a large number of service times clustered together at zero. While this is a plausible presumption for ship inter-arrival time, it is unrealistic to apply this presumption to ship time at berth. A comparison of the Erlang 1 and 2 cumulative frequency distributions for a mean service time of five days is shown in figure IV.

26. The application of queueing theory can be used to give a good approximation of the waiting time for various system capacities. The queueing system modelled for a break-bulk berth group is based on the assumptions of random arrivals and an Erlang 2 service distribution. In queueing theory notation this is the $M/E_2/n$ system (M for Markovian or random arrivals, E_2 for Erlang 2 service time and n for number of servers). The $M/E_2/n$ system is very cumbersome mathematically and has not been completely described for cases when $n > 2$. Fortunately, it is possible to use an approximation suggested in Page's book on queueing theory,[c] which in most practical cases gives sufficiently accurate results. Table VIII gives, for the $M/E_2/n$ system, the average waiting time of vessels in the queue, in units of average service time. These results have been used in the break-bulk planning chart II to define the relationship between berth utilization and total ship time in port.

27. For specialized terminals the assumption has been made that distribution of the intervals between arrivals is best described by an Erlang 2 distribution rather than by the negative exponential distribution. This is due primarily to the fact that a limited number of operators uses each specialized terminal, with the result that there is some rationalization of arrivals. The assumption of Erlang 2 distributed service times here will give higher estimates of queueing time than would be expected for a terminal where ship turn-round was nearly constant, but from data available to UNCTAD the latter is rarely the case. In those cases, particularly in vertically integrated bulk operations, where shiploads are fairly constant, high Erlang numbers of 8 or more have been used.

28. Table VIII quantifies the relationship between waiting time and berth utilization in units of average service time. As an example, a comparison of waiting times for a four-berth terminal for the three queueing systems ($M/M/4$, $M/E_2/4$ and $E_2/E_2/4$) is shown in figure V. The sensitivity of waiting time results to the assumed distribution should be noted and borne in mind when

[c] E. Page, *Queueing Theory in OR* (London, Butterworths, 1972).

TABLE VII

Summary of analysis of port data collected for congestion surcharge study

Port and year	*Number of observations in sample*	*Mean tonnage per ship*	*Mean berth time (hours)*	*Tons per ship-hour at berth*	*Erlang No.*[a]
Mourasa					
1970	190	2 122	180	19.60	2
1971	197	2 438	148	16.43	2
1972	196	2 179	120	18.20	2
Khorramshahr					
1971	143	2 617	121	21.56	3
1972	135	2 747	126	21.88	3
1973	123	3 718	133	27.86	3
Dar es Salaam					
1969	144	1 377	82	16.89	2
1970	144	2 027	119	17.01	2
1971	144	2 186	157	13.89	2
1972	143	1 833	135	13.59	2

Source: Data collected by the UNCTAD secretariat.

[a] Erlang number of theoretical distribution best fitting the observed berth time distribution.

Table VIII

Average waiting time of ships in the queue $M/E_2/n$

(In units of average service time)

A. For 1 to 15 berthing points

Utilization	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Number of berthing points														
0.10	.08	.01	0	0	0	0	0	0	0	0	0	0	0	0	0
0.15	.13	.02	0	0	0	0	0	0	0	0	0	0	0	0	0
0.20	.19	.03	.01	0	0	0	0	0	0	0	0	0	0	0	0
0.25	.25	.05	.02	0	0	0	0	0	0	0	0	0	0	0	0
0.30	.32	.08	.03	.01	0	0	0	0	0	0	0	0	0	0	0
0.35	.40	.11	.04	.02	.01	0	0	0	0	0	0	0	0	0	0
0.40	.50	.15	.06	.03	.02	.01	.01	0	0	0	0	0	0	0	0
0.45	.60	.20	.08	.05	.03	.02	.01	0	0	0	0	0	0	0	0
0.50	.75	.26	.12	.07	.04	.03	.02	.01	.01	.01	0	0	0	0	0
0.55	.91	.33	.16	.10	.06	.04	.03	.02	.02	.01	.01	.01	0	0	0
0.60	1.13	.43	.23	.14	.09	.06	.05	.03	.03	.02	.02	.01	.01	.01	.01
0.65	1.38	.55	.30	.19	.12	.09	.07	.05	.04	.03	.03	.02	.02	.02	.02
0.70	1.75	.73	.42	.27	.19	.14	.11	.09	.07	.06	.05	.04	.03	.03	.03
0.75	2.22	.96	.59	.39	.28	.21	.17	.14	.12	.10	.08	.07	.06	.05	.05
0.80	3.00	1.34	.82	.57	.42	.33	.27	.22	.18	.16	.13	.11	.10	.09	.08
0.85	4.50	2.00	1.34	.90	.70	.54	.46	.39	.34	.30	.26	.23	.20	.18	.16
0.90	6.75	3.14	2.01	1.45	1.12	.91	.76	.65	.56	.50	.45	.40	.36	.33	.30

B. For 16 to 30 berthing points

Utilization	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
	Number of berthing points														
0.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.60	.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.65	.01	.01	.01	.01	.01	.01	0	0	0	0	0	0	0	0	0
0.70	.02	.02	.02	.01	.01	.01	.01	.01	.01	.01	.01	.01	0	0	0
0.75	.04	.04	.03	.03	.03	.02	.02	.02	.02	.02	.02	.01	.01	.01	.01
0.80	.07	.07	.06	.05	.05	.04	.04	.04	.03	.03	.03	.03	.03	.03	.02
0.85	.14	.13	.12	.11	.10	.09	.09	.08	.07	.07	.06	.06	.06	.05	.05
0.90	.28	.26	.24	.22	.21	.19	.18	.17	.16	.15	.14	.14	.13	.12	.12
0.95	.74	.69	.65	.61	.58	.55	.51	.49	.46	.43	.41	.40	.38	.37	.36

Source: Calculated by the UNCTAD secretariat.

evaluating alternatives. The $M/E_2/n$ system is considered the best estimate of queueing time for break-bulk terminals while the $E_2/E_2/n$ system is best for specialized terminals.

E. Mathematical basis for planning charts

29. The mathematical relationships used to produce the curves in each quadrant of the planning charts are presented below. With this information the planner can reconstruct the curves to a different scale.

(a) *Break-bulk general cargo terminal, planning chart I. A and B: berth requirements*

Tons per day per gang = average number of tons per gang-hour × over-all fraction of time berthed ships worked × 24

Tons per ship per day = tons per day per gang × average number of gangs employed per ship shift

Berth-day requirement = annual tonnage forecast/tons per ship day

Approximate number of berths required = berth-day requirement/(commission days per year × typical berth utilization[f]).

(b) *Break-bulk general cargo terminal, planning chart II. A and B: ship cost*

Berth-day requirement per berth = berth-day requirement/number of berths

Berth utilization = berth-day requirement per berth/commission days per year

Total time at port (days) = 365 × number of berths × berth utilization × waiting time factor[g]

[f] The berth utilization figures used for 2, 3, 4, 5, 6, 7, 8, 9 and 10 berths were .50, .53, .56, .60, .62, .65, .66, .68, and .70 respectively.

[g] The factor is 1.0 plus the average waiting time of ships in the queue $M/E_2/n$ (in units of average service time), as given in table VII. This total time includes both berth time and queueing time.

TABLE IX

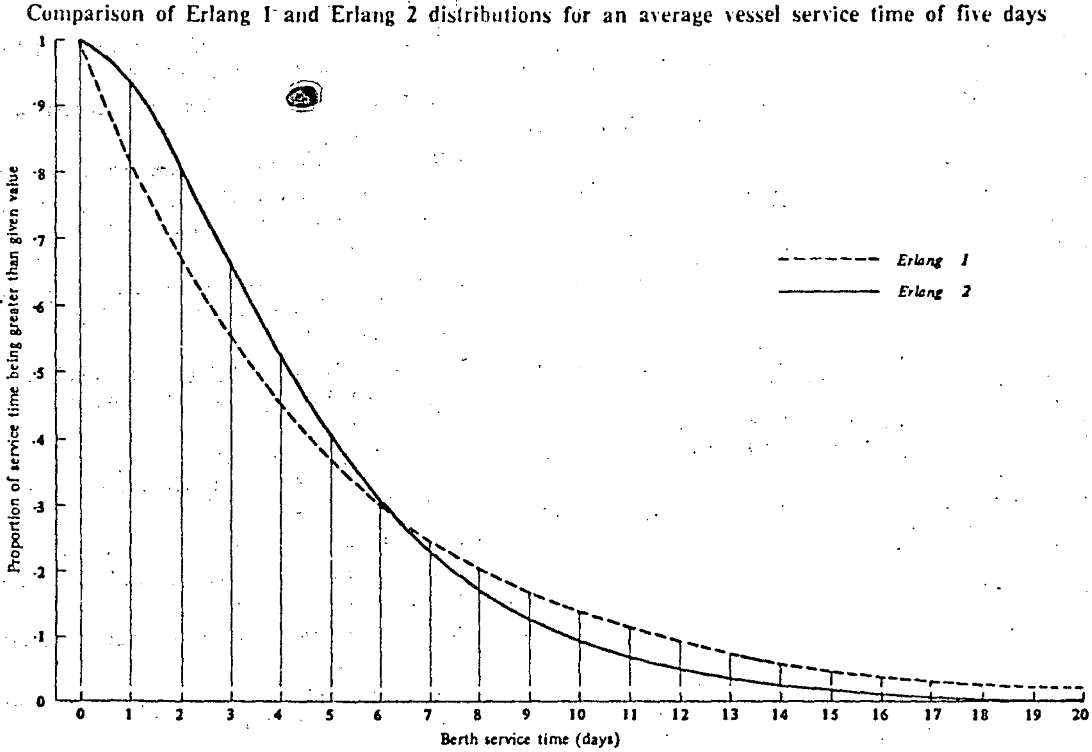
Average waiting time of ships in the queue $E_2/E_2/n$
(*In units of average service time*)

Utilization	Number of berthing points 1	2	3	4	5	6	7	8
0.10	.02	0	0	0	0	0	0	0
0.15	.03	.01	0	0	0	0	0	0
0.20	.06	.01	0	0	0	0	0	0
0.25	.09	.02	.01	0	0	0	0	0
0.30	.13	.02	.01	0	0	0	0	0
0.35	.17	.03	.02	.01	0	0	0	0
0.40	.24	.06	.02	.01	0	0	0	0
0.45	.30	.09	.04	.02	.01	.01	0	0
0.50	.39	.12	.05	.03	.01	.01	.01	0
0.55	.49	.16	.07	.04	.02	.02	.02	.01
0.60	.63	.22	.11	.06	.04	.03	.02	.01
0.65	.80	.30	.16	.09	.06	.05	.03	.02
0.70	1.04	.41	.23	.14	.10	.07	.05	.04
0.75	1.38	.58	.32	.21	.14	.11	.08	.07
0.80	1.87	.83	.46	.33	.23	.19	.14	.12
0.85	2.80	1.30	.75	.55	.39	.34	.26	.22
0.90	4.36	2.00	1.20	.92	.65	.57	.44	.40

Source: E. Page, *Queueing Theory in OR* (London, Butterworths, 1972), p. 155.

FIGURE IV

Comparison of Erlang 1 and Erlang 2 distributions for an average vessel service time of five days



Annual ship cost = total time at port × average daily ship cost (in port).

(c) *Break-bulk general cargo terminal planning chart III: storage area requirements*

Holding capacity required (in tons) = annual tonnage through store × average transit time (days)/365[h]

Net holding volume required = holding capacity required/density of cargo

Gross holding volume required = 1.2 × net holding volume required

Average stacking area required = gross holding volume required/average stacking height

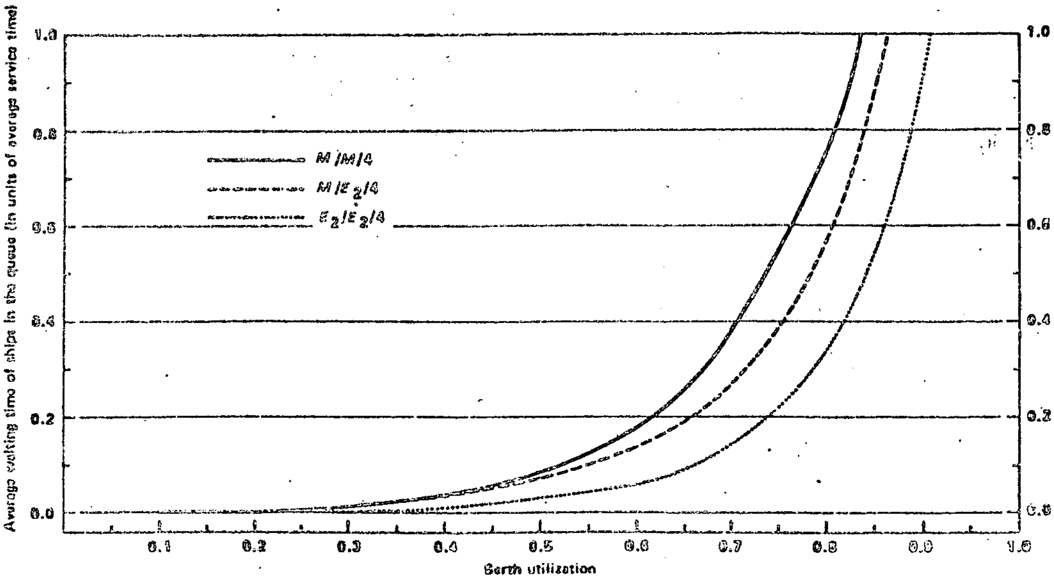
Average storage area required = 1.4 × average stacking area required

Design storage area = average storage area required × (1 + reserve capacity safety factor/100).

[h] The number of times contents of store are turned over during one year is equal to 365 divided by the average transit time.

FIGURE V

Graph showing relationship between average ship waiting time and berth utilization



(d) *Container terminal, planning chart I: container park area*

Holding capacity required (in TEUs) = container movements per year × average transit time/365[i]

Net transit storage requirements = holding capacity required × area requirement per TEU (square metres per TEU)[j]

Gross transit storage area requirements = net transit storage area requirements/ratio of average to maximum stacking height

Container park area = gross transit storage area requirements × (1 + reserve capacity safety factor/100).

(e) *Container terminal, planning chart II: container freight station (CFS) area*

Holding capacity required = CFS container movements per year × average transit time/365[l]

CFS stacking area = holding capacity required × 29[k] average stacking height

CFS average storage area = CFS stacking area × (1.0 + access factor)

CFS design storage area = CFS average storage area × (1.0 + reserve capacity safety factor/100[l]).

(f) *Container terminal, planning chart III: berth-day requirement*

TEUs per day per crane = standard ship operating hours per day × average TEUs per hour[m]

TEUs per day per berth = TEUs per day per crane × gantry crane-berth configuration factor[n]

Average berth time per ship (in hours) = 24 × shipload in TEUs/TEUs per day per berth + berthing-deberthing delay[o]

Berth-day requirement = average berth time per ship × number of ships per year/24.

(g) *Container terminal, planning chart IV: ship cost*

Berth-day requirement per berth = berth-day requirement/number of berths

Berth utilization = berth-day requirement per berth/commission days per year

Ship time at port = 365 × number of berths × berth utilization × waiting time factor[p]

Annual ship cost × ship time at port × average daily ship cost (in port).

(h) *Dry bulk cargo terminal, planning chart I: berth time*

Ship loader (unloader) effective capacity (tons per hour) = ship loader (unloader) rated capacity × through ship productivity ratio

Through ship gross loading (unloading) rate = ship loader (unloader) effective capacity × ship loader (unloader) berth configuration factor[q]

Through ship net loading (unloading) rate = through ship gross loading (unloading) rate × standard ship operating hours per day/24

Average berth time per ship (in hours) = average shipment size/through ship net loading (unloading) rate + berthing-deberthing delay.[r]

(i) *Dry bulk cargo terminal, planning chart II: ship cost*

Berth-day requirement = average berth time per ship × number of ships per year/24

Berth utilization = berth-day requirement/terminal commission days per year[s]

Ship time at port = 365 × number of berths × berth utilization × waiting-time factor[p]

---

[i] The number of times contents of store are turned over during one year is equal to 365 divided by the average transit time.

[j] Area requirement is dependent on operational method and maximum stacking height.

[k] The cubic capacity of an ISO container of the IC type is 29 m^3. The chart assumes that all containers are full.

[l] The safety margin factor has been applied both to access area requirements and to stacking area requirements.

[m] Idle time during standard ship operating hours per day is included in the TEUs per hour productivity factor.

[n] For one crane at one berth, factor is 1.0; for 2 cranes at one berth, factor is 1.8; and for 3 cranes at two berths, factor is 2.4.

[o] A typical berthing-deberthing delay would be 2.0 hours, and this figure has been incorporated in the chart.

[p] The factor is 1.0 plus the average waiting time of ships in the queue $E_2/E_2/n$ (in units of average service time), as given in table VIII.

[q] The factors for 1, 2, 3, 4 and 5 ship loaders (unloaders) per berth are 1.0, 1.75, 2.25, 2.60 and 2.85 respectively.

[r] A typical berthing-deberthing delay would be 2.0 hours and this figure has been incorporated in the chart.

[s] A terminal with two berthing locations each able to berth ships 300 days of the year would have 600 terminal commission days per year.

Annual ship cost = ship time at port × average daily ship cost (in port).

(j) *Dry bulk cargo terminal, planning chart III: stockpile dimensioning*

Maximum height = 0.5 × base × tan ∝

Maximum cross-sectional area = 0.5 × base × maximum height = 0.25 × base × base × tan ∝

Cross-sectional area = ratio of stockpile height to maximum height × (2.0 − ratio of stockpile height to maximum height) × maximum cross-sectional area[1]

Volume = cross-sectional area × length

Capacity (in tons) = volume/stowage factor.

(k) *Ro/ro terminal planning chart: vehicle storage area*

Vehicle holding capacity required = vehicle movements per year × average transit time/365

Vehicle parking area = vehicle holding capacity required × area requirement per vehicle

Vehicle parking and access area × vehicle parking area × (1.0 + access factor)

Vehicle storage area = vehicle parking and access area × (1.0 + reserve capacity safety factor/100.0).

F. Economic life calculation

30. To determine the economic life of a piece of equipment requires the calculation of the discounted value of all future costs associated with each replacement policy. In general, the costs to be included are all costs that depend upon the age of the machine. Costs that do not change with the age of the machine such as labour costs and power need not be considered. The costs are incurred over a period of time, and must be discounted to the present in the normal way.

31. The assumption is made that costs increase each year for items of equipment that deteriorate because of increased maintenance. For this assumption it can be shown that the following rules for minimizing costs apply:

Rule 1: If the cost of replacing every $n+1$ years is less than the cost of replacing every n years, the item should not be replaced.

Rule 2: If the cost of replacing every $n+1$ years is greater than the cost of replacing every n years, the item should be replaced.

The mathematical justification of these rules is as follows.

32. We may take a one-year period and call it i and the costs incurred during that period C_i. We may assume that each cost is paid at the beginning of the period in which it is incurred, that the initial cost of new equipment is A, and that the cost of money is r per period.

33. The discounted value K_n of relevant future costs associated with a policy of replacing equipment after every n years is given by summing the discounted costs for the first piece of equipment with the discounted cost for the second piece of equipment, etc., or, expressed mathematically:

$$K_n = A + C_1 + \frac{C_2}{1+r} + \frac{C_3}{(1+r)^2} + \dots + \frac{C_n}{(1+r)^{n-1}}$$

$$+ \frac{A+C_1}{(1+r)^n} + \frac{C_2}{(1+r)^{n+1}} + \dots + \frac{C_n}{(1+r)^{2n-1}}$$

$$+ \dots$$

which is equivalent to

$$K_n = \left(A + \sum_{i=1}^{n} \frac{C_i}{(1+r)^{i-1}}\right) + \frac{1}{(1+r)^n}\left(A + \sum_{i=1}^{n} \frac{C_i}{(1+r)^{i-1}}\right)$$

$$+ \frac{1}{(1+r)^{2n}}\left(A + \sum_{i=1}^{n} \frac{C_i}{(1+r)^{i-1}}\right) + \dots$$

The right-hand side of the equation may be written as a product of the common factor and the convergent geometric series.[u] Therefore

$$K_n = \frac{A + \sum_{i=1}^{n} [C_i/(1+r)^{i-1}]}{1 - [1/(1+r)]^n}$$

If K_n is less than K_{n+1} then replacing the equipment every n years is preferable to replacing every $n+1$ years. The two inequalities

$$K_{n+1} > K_n \quad \text{and} \quad K_{n-1} > K_n$$

must hold if the best policy is replacement every n years.

34. A worked example is given in table X for a fork-lift truck. The annual cost shown in the second column would be based on maintenance and operating costs from historic records. The third column shows the discount factors for a rate of interest of 10 per cent. For this example the optimum replacement period or economic life is 7 years. This can be determined by examining the last column. The estimated maintenance cost for the year $n+1$ is used to calculate K_{n+1}. If K_{n+1} is greater than K_n then replacement should take place after n years, which for this example is 7 years.

35. The existence of inflation will modify the weights[v] but the method will remain the same. In addition, if the piece of equipment has a scrap value the initial cost of new equipment can be reduced accordingly.

---

[1] This formula is derived as follows:

α – angle of repose
h – height of stockpile
b – base of stockpile
h_{max} – maximum height stockpile can attain
r – ratio of h to h_{max}
A – cross-sectional area of stockpile
A_{max} – maximum cross-sectional area of stockpile.

The cross-sectional area of the stockpile is given by:

$$A = (b - h \cot \alpha)h \text{ or } A = (b - rh_{max} \cot \alpha)rh_{max}$$

Substituting $0.5\,b \tan \alpha$ for the first h_{max} term gives:

$$A = (b - r(0.5\,b \tan \alpha) \cot \alpha)rh_{max}$$
$$= r(2-r)\ 0.5\,bh_{max}$$

But

$$A_{max} = 0.5\,bh_{max}$$

Therefore

$$A = r(2-r)\ A_{max}.$$

[u] The sum of the series $1+x+x^2+\dots+x^\infty$ is equal to $1/1-x$ when x is less than 1 and positive. In this case x is equal to $1/(1+r)^n$.

[v] X becomes $(1+i)/(1+r)$ where i is the rate of inflation and $X<1$. This assumes that the rate of inflation applies to the maintenance costs as well as to replacement costs.

TABLE X

Example of economic life or replacement period calculation for a fork-lift truck
(A = 25,000, r = 0.10)

Year (i)	Annual cost (C_i)	Discount factor (X^{i-1})°	C_iX^{i-1}	$A+\Sigma C_iX^{i-1}$	$1-X^i$	$\frac{A+\Sigma C_iX^{i-1}}{1-X^i}$
1	2000	1.0000	2000	27000	.0909	297030
2	3000	0.9091	2727	29727	.1736	171238
3	4000	0.8264	3306	33033	.2487	132832
4	5000	0.7513	3757	36790	.3170	116057
5	6000	0.6830	4098	40888	.3791	107855
6	7500	0.6209	4657	45545	.4355	104581
7	9000	0.5645	5081	50626	.4868	103998°°
8	11000	0.5132	5645	56271	.5335	105475
9	13000	0.4665	6065	62336	.5759	108241
10	16000	0.4241	6786	69122	.6144	112503

° Discount factors are given by the formula $X^{i-1} = \left(\frac{1}{1+r}\right)^{i-1}$

°° Since this figure is the lowest, it indicates that the equipment should be replaced after 7 years' use.

Annex III

THE PORT DEVELOPMENT REFERENCE LIBRARY

1. Authorities with port planning responsibility will require more information than can be provided in a single handbook. There is a large body of material available and it will often be difficult for the authority either to know what publications to select or to procure them in time for the specific planning need that may arise.

2. It is advisable for each such authority to assemble a satisfactory reference library in advance of any specific planning task so that when the time comes the project planners can have quick access to the information. For this purpose, the UNCTAD secretariat has prepared a recommended list of port development reference works, which is reproduced below.

3. The investment of the very large sums of money involved in port development should be based on the best information available and therefore justifies the allocation of modest funds to purchase the list given in its entirety. It might be advisable for authorities to order the entire list through a large commercial book agent rather than trying to order books individually.

Recommended list of publications on port development

Author	*Title*	*Publisher*
Agnew, J. and Huntley, J.	Container stowage: a practical approach	Container Publications Ltd., Dover (England), 1972.
American Association of Port Authorities	Port planning, design and construction: a manual prepared by Standing Committee IV, Construction and Maintenance	American Association of Port Authorities, Washington, D.C., 1973.
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SISTEMAS MARITIMOS Y PORTUARIOS

EVALUACION DE PROYECTOS MARITIMOS

"EVALUACION DE INVERSIONES PORTUARIAS"

NACIONES UNIDAS

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PREFACIO

El presente informe consta de dos partes, de las que la primera consiste en un análisis general de los conceptos de los costos y beneficios económicos y de los métodos utilizados para compararlos, mientras que en la segunda se exponen varios casos concretos para ilustrar las diversas cuestiones examinadas.

Los estudios de casos se refieren a países hipotéticos, pero están basados en la información de que dispone la secretaría de la UNCTAD acerca de determinados puertos y países. Los casos se han elegido para ilustrar los tipos de evaluación de las inversiones a que es probable que tengan que proceder los países en desarrollo.

En la medida de lo posible, el informe se ha redactado en un lenguaje que hiciera relativamente fácil para las personas no expertas en economía la comprensión de los conceptos económicos fundamentales.

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Capítulo II

EVALUACION ECONOMICA Y EVALUACION FINANCIERA

6. Para evaluar un proyecto de inversión portuaria es preciso calcular las corrientes de costos y beneficios que se registrarán en el futuro, a fin de poder compararlas con el costo de capital inicial de la inversión. El alcance y el valor de esos costos y beneficios serán, sin embargo, distintos, según el criterio que se utilice para evaluar la inversión.

7. Si la administración del puerto no se preocupa más que de la rentabilidad comercial y de un cierto rendimiento del capital invertido en la empresa, en la evaluación financiera del proyecto se tendrán simplemente en cuenta los ingresos y los costos de los distintos elementos tal y como figuren en el balance general. Si desea, en cambio, enjuiciar la inversión desde un punto de vista global:

i) el alcance de los beneficios y los costos considerados será más amplio, por cuanto incluirá también los obtenidos o efectuados fuera del puerto;

ii) algunos elementos del costo (divisas, terrenos, mano de obra) y algunos beneficios (por ejemplo, los ingresos en divisas) exigirán una evaluación adicional a fin de calcular su valor económico real para la economía nacional.

8. Para el puerto, el costo comprende únicamente los gastos de la inversión propiamente dicha. Para el país, en cambio, el costo es el insumo del ingreso nacional real asociado con recursos tales como la mano de obra, el capital (divisas), los materiales y los terrenos dedicados al proyecto. Del mismo modo, los impuestos percibidos constituyen un costo para la administración del puerto pero, en la medida en que no se produce un aumento correspondiente en el costo de los servicios públicos nacionales asociados con el proyecto de inversión de que se trate, no representan un costo para el país, sino simplemente un pago de transferencia dentro de la economía nacional. Es evidente, pues, la necesidad de distinguir entre los costos y beneficios del proyecto para el puerto y los costos y beneficios para el país.

9. Para evaluar la rentabilidad comercial de un proyecto suele tomarse como base el plazo de amortización, la tasa interna de rendimiento 4/ o el valor neto actualizado de la inversión. (Estos conceptos se explican con más detenimiento en los párrs. 50 a 63.) En realidad, el mecanismo empleado para calcular la rentabilidad comercial en función, por ejemplo, del criterio del valor neto actualizado, es idéntico al que se utiliza en el análisis de costos y beneficios económicos desde el punto de vista nacional. Ambos suponen la evaluación de las corrientes de costos y beneficios, actualizadas para permitir su comparación. Es evidente, pues, que, puesto que la técnica responde a los mismos principios de determinación del valor actualizado, la diferencia entre la rentabilidad comercial y el rendimiento económico (nacional) proviene del alcance y de los valores que se asignen a los costos y los beneficios y de la tasa de actualización utilizada.

10. Las utilidades comerciales representan por regla general el exceso de los ingresos sobre los costos, cuando tanto unos como otros son valores monetarios directos obtenidos o pagados por la empresa a precios de mercado. En el análisis de costos y beneficios económicos, en cambio, es preciso ir más allá de los precios de mercado de esos factores e imputar a la economía el verdadero costo de éstos. Un proyecto portuario entra, por lo general, dentro de la esfera del sector público, por lo que una evaluación exclusivamente basada en su rentabilidad comercial es sólo un aspecto, insuficiente de por sí, para adoptar una decisión sobre el proyecto.

4/ Que a veces se llama en los medios comerciales rendimiento de la corriente actualizada de efectivo.

Capítulo III

COSTO ECONOMICO DE LOS RECURSOS

11. Los precios de mercado de recursos tales como el terreno, la mano de obra, etc., no siempre reflejan el costo real de esos recursos para la economía. Tomemos como ejemplo el caso de los terrenos. Un puerto puede comprar a las autoridades locales o al gobierno terrenos por valor de un millón de dólares con fines de ampliación. Es posible, sin embargo, que si esos terrenos no se hubieran vendido al puerto, se hubieran utilizado para construir edificios de oficinas, de los que hay una escasez crónica. Si el valor de los terrenos para un promotor de inmuebles fuera de 5 millones de dólares (suponiendo, además que no haya otro posible usuario para el que los terrenos valieran todavía más), esos 5 millones representarían el verdadero costo económico de los terrenos utilizados para la ampliación del puerto, lo que significa que el costo económico es en ese caso cinco veces más alto que el precio pagado 5/.

12. En términos generales, el costo económico de un recurso es el costo de oportunidad del mismo, es decir, los beneficios máximos a que se ha renunciado al utilizar ese recurso para el propósito elegido y no para otro. Ese costo de oportunidad es el llamado por los economistas precio virtual o de cuenta (shadow price) del recurso.

13. Cuando un recurso es escaso (como los terrenos en el ejemplo citado), el precio virtual será a menudo más elevado que el que realmente se ha pagado. Cuando abunda, en cambio (como la mano de obra, por ejemplo, en muchos países en desarrollo), el precio virtual será inferior al precio de mercado.

14. Si existe un gran número de desempleados, es decir, de personas que no pueden utilizarse para otra cosa, esas personas no producen ni ganan nada. Si, debido a una mayor actividad portuaria, se les pudiera dar empleo, ganarían, por supuesto, un salario. Ahora bien, aunque el puerto pagara salarios a los trabajadores así empleados, si éstos no tuvieran ninguna otra posibilidad de empleo útil, el verdadero costo económico de su empleo en el puerto sería igual a cero. En la práctica siempre se renuncia a ciertos beneficios, aunque sólo sea en relación con ciertos tipos de trabajadores o con el trabajo estacional. Por lo general, el costo económico de la mano de obra puede obtenerse dirigiéndose, en cada país, al Ministerio de Trabajo o a la Oficina Central de Planificación
salarios mínimos

5/ En el estudio de la ONUDI Pautas para la evaluación de proyectos, se hacen las siguientes indicaciones sobre el costo de oportunidad de los terrenos: "Cuando los mercados del factor tierra son competitivos, y cuando la demanda del mismo para el proyecto no hace subir apreciablemente su precio, parece a primera vista que el precio de mercado de la tierra (o la tasa de arrendamiento prevaleciente en el mercado) pueden tomarse como medida de la disposición a pagar por la tierra (o por su utilización). Esto no sería del todo correcto, ya que la tasa de interés que quisiéramos emplear no es la tasa de mercado, sino la tasa de actualización social. Si la tierra exigida por un proyecto no tiene otro uso potencial, el precio de salida segura de la misma es igual a cero; y, sea cual sea el precio que efectivamente se pague por ella, esa tierra, en cuanto insumo para el proyecto, ha de medirse a un costo cero. Si existe otro uso posible para esta tierra pero el precio de mercado no ofrece una medida adecuada de su valor, puede ser posible medir el costo de la tierra por los beneficios netos a que se ha renunciado, por cuanto la tierra ya no puede dedicarse a ese otro uso." (Op. cit., pág. 66.)

15. Un tercer recurso cuyo precio no refleja necesariamente su verdadero valor económico son las divisas. En los países en desarrollo los tipos de cambio suelen fijarse a niveles a los que la demanda es superior a la oferta. En tal caso, el verdadero costo económico de una unidad de divisas tiene que reflejar ese valor de escasez y será, por lo tanto, más elevado que el precio de mercado. De la evaluación del costo económico de este recurso se encarga por lo general, en cada país, el Banco Central o el Ministerio de Hacienda.

16. Hay evidentemente un elemento de discrecionalidad en cuanto a la utilización o no utilización de un precio virtual y, en caso de utilización de dicho precio, en cuanto al valor que debe elegirse. Puesto que el precio virtual, o verdadero precio económico, de los terrenos, la mano de obra y las divisas supone una auténtica evaluación de esos recursos en una economía determinada, el planificador portuario debe discutir la utilización de los precios virtuales con el órgano nacional de planificación económica, a fin de asegurar el uso coherente de dichos precios para los distintos proyectos realizados en el mismo país.

17. Los derechos de aduanas y demás impuestos que gravan los materiales utilizados en la construcción de un puerto representan un costo financiero para el constructor que los tiene que pagar, pero no constituyen un costo económico para el país. Hay, de hecho, una suma de dinero que, en forma de derechos e impuestos, se transfiere del constructor del puerto al gobierno, pero ese "pago de transferencia" no representa pérdida ni ganancia alguna para la economía nacional. Por eso, en la evaluación económica de un proyecto portuario, esos derechos o impuestos no se incluyen entre los costos.

Capítulo IV

BENEFICIOS ECONOMICOS

18. El cálculo de los beneficios de una inversión portuaria presenta ciertos problemas teóricos y prácticos, debido a que esos beneficios no están circunscritos al puerto, sino que se extienden a otros sectores y grupos de intereses. De especial importancia para las cuentas portuarias son los derechos y demás gravámenes que han de pagar los buques y sus cargas, y que representan para el puerto una corriente directa de beneficio a diferencia de otros que el puerto reporta a sus usuarios, ya sean armadores, cargadore productores o consumidores, tanto nacionales como extranjeros. Los beneficios directos del puerto son beneficios financieros, mientras que los beneficios de los usuarios son por lo general considerados como beneficios económicos. El problema principal reside en la correcta cuantificación de esos beneficios de los usuarios. Porque, a menos que quienes tienen que adoptar las decisiones pertinentes sepan claramente cuáles son esos beneficios, cuáles deben considerarse como beneficios brutos en oposición a los netos, y cuáles son simplemente pagos de transferencia dentro de la economía, se corre el riesg real de estimar inadecuadamente la importancia y la cantidad de esos beneficios de los usuarios en el proceso de evaluación, provocando así serios errores de juicio.

19. Al calcular los beneficios, hay que tener cuidado de distinguir entre los brutos y los netos. Un proyecto puede dar lugar a una corriente de nuevos ingresos. Una vez deducidos, sin embargo, todos los gastos en que se ha incurrido para crear esa corriente es posible que la cifra resultante no constituya todavía un beneficio neto para la entidad de que se trate ya que, en relación con la misma corriente, es posible que se haya producido, por ejemplo, una pérdida de ingresos en otros centros de la misma entidad. De ahí la importancia de tener en cuenta los costos de oportunidad en la evaluación de los proyectos.

A. Beneficios de reducción de los costos por disminución de los gastos de explotación

20. Una inversión portuaria puede, dependiendo de la situación, aliviar la congestión, aumentar la productividad y mejorar en términos generales el tiempo de rotación, reduciendo así los costos de tiempo de espera de los buques, atraque, manipulación de la carga y, posiblemente, gastos globales del transporte interior. Algunas inversiones portuarias, al hacer posible el transporte de mercancías en buques de mayor tamaño, reducen considerablemente, gracias a las economías de escala, el costo del transporte marítimo por tonelada de carga.

21. Los beneficios de reducción de costos que supone la disminución de los gastos de explotación son importantes y relativamente fáciles de calcular en términos monetarios. Se trata de beneficios directos resultantes de la inversión portuaria que, por lo gener corresponden inicialmente a los usuarios (ya sean armadores o cargadores) y/o a la administración del puerto. El sector en el que recaerán en última instancia los beneficios de esa reducción de los costos dependerá de la política de tarificación aplicada y del poder económico relativo de las distintas partes. La reducción de costos que favorece a los armadores extranjeros como resultado de la existencia, gracias a la inversión, de servicios portuarios más amplios y más eficaces sólo se transforma en beneficios para los armadores del país inversionista si esa reducción de costos se traduce en una reducción de fletes. Ese no es necesariamente el caso cuando interviene

las conferencias marítimas debido a la forma en que éstas fijan los fletes 6/. En el caso de los buques fletados, en cambio, son mayores las posibilidades de que los beneficios de la reducción de costos se extiendan al país inversionista en forma de fletes más bajos, o de ganancias directas derivadas del pago de menos sobrestadías o del cobro de primas de celeridad.

22. Al calcular los beneficios de reducción de los costos, el criterio que hay que utilizar es la prueba de "con y sin", en la que se pregunta cuáles serán los costos con la inversión y cuáles habrían sido sin ésta. (Esta prueba no es la misma que la llamada de "antes y después", en la que se calcula cuáles eran los costos antes de la inversión y cuáles serán después de efectuarse ésta. La diferencia entre los resultados obtenidos con ambas pruebas puede ser importante en el caso de las inversiones portuarias.)

23. Para dar un ejemplo, si el costo total del tiempo de espera de los buques en un puerto es anualmente de tres millones de dólares ahora, y se reduce a dos después de una inversión en ampliación de las instalaciones, la prueba de "antes y después" dice que los costos se han reducido en un millón de dólares. El resultado es el mismo que daría la prueba "con y sin" siempre que entretanto no se haya producido un incremento de tráfico. En caso de aumento de volumen del tráfico que utiliza el puerto, en efecto, el costo total del tiempo de espera de los buques podría aumentar, a seis millones de dólares, por ejemplo, de no efectuarse la inversión. Partiendo de esa base, la prueba de "con y sin" arroja un beneficio de reducción de costos de cuatro millones de dólares. En general, la prueba de "antes y después" conduce muchas veces a una subestimación de los beneficios, razón por la cual no debe utilizarse.

24. Para calcular la reducción de los costos del transporte a que da lugar una inversión portuaria es preciso saber, no sólo el volumen, sino también el tipo de tráfico y de buques que utilizarán las instalaciones del puerto. Es, por lo tanto absolutamente indispensable contar con previsiones exactas, tanto del tráfico marítimo como del tonelaje de la carga. La cuestión de las previsiones del tráfico no se abordará, a pesar de su importancia, en el presente estudio, sino que se tratará a fondo en otra publicación de la UNCTAD (Manual de Planificación Portuaria). En el presente informe se da por supuesto que pueden obtenerse unas previsiones razonables y se evalúan sobre esa base los beneficios correspondientes.

B. Beneficios que reporta el aumento de las actividades económicas

25. Un proyecto portuario puede estimular el desarrollo económico o aumentar las actividades económicas, tanto en las inmediaciones del puerto como en otros sectores de la economía. En esta esfera los beneficios no son tan claros como los de reducción de los costos. En primer lugar, hay que demostrar que la actividad económica sólo podía desarrollarse en caso de llevarse a cabo el proyecto portuario. Tal sería, por ejemplo, el caso de un establecimiento industrial que dependiera en gran medida del suministro de materias primas baratas que hubieran de transportarse por vía marítima y requirieran por lo tanto un puerto especial 7/. Por otra parte, sólo si los recursos utilizados

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6/ Véase el informe de la secretaría de la UNCTAD, Los mercados de fletes y el nivel y la estructura de los fletes (TD/B/C.4/38/Rev.1), publicación de las Naciones Unidas, Nº de venta: S.69.II.D.13.

7/ Véase en la segunda parte del presente informe el estudio del caso Nº 3 El puerto industrial de Sunev.

en esa actividad económica hubieran quedado improductivos o se hubieran utilizado de manera menos productiva en otro lugar, cabe atribuir a la inversión portuaria los beneficios representados por ese aumento de actividad económica.

26. Cuando un proyecto portuario da lugar a un aumento de la producción agrícola o industrial debido a la reducción de los costos de transporte, y se dan las condiciones arriba expuestas, el beneficio económico de la inversión es el valor neto de esa producción adicional. Hay que recordar que el valor neto añadido del aumento de la producción y la reducción de los costos como consecuencia del abaratamiento del transpo debido al mayor tonelaje, no deben contarse dos veces; por lo tanto, en la medida en qu el proyecto portuario tenga como resultado una reducción del costo del transporte que permita un aumento de la producción, el beneficio será el valor neto de este aumento.

27. También es posible que la inversión portuaria tenga por objeto extender o ampliar los mercados de las mercancías producidas en ese momento. Piénsese, por ejemplo, en el caso de un aumento del calado de un puerto de un país A, o en la construcción de un nuevo puerto que permita la utilización de buques mineraleros de mayor tamaño 8/. Si, de no efectuarse la inversión, pueden utilizarse buques de 50.000 TPM, mientras que, en caso de efectuarla, puede acogerse a buques de 125.000 TPM, la reducción del costo del transporte permitirá vender el mineral en mercados que antes estaban fuera del alcance del país. Como el precio se fija probablemente en los mercados extranjeros, el beneficio de esa inversión sería el ingreso neto adicional resultante de los menores costos de transporte.

C. Otros beneficios: beneficios secundarios e intangibles

28. Muchos de los beneficios incluidos en esta categoría no son fácilmente cuantificab en términos monetarios. Un puerto puede construirse porque un país quiere ser autosuficiente y no depender de los puertos extranjeros vecinos, o por motivos de defensa y de seguridad nacional, o incluso por razones de prestigio. El proyecto portuario puede contribuir a la consecución de otros objetivos de carácter social y político, tales como la descentralización del crecimiento demográfico, la estabilidad política mediante un juicioso desarrollo regional y otras metas no económicas.

29. La mayor parte de estos beneficios son difíciles de encuadrar en una evaluación d costos y beneficios económicos. En todo caso, la inversión en un proyecto de desarroll portuario es sólo uno de los varios mecanismos mediante los cuales pueden obtenerse. Por lo general se emplean, además, otras políticas gubernamentales, fiscales y monetar y es improbable que los beneficios puedan con propiedad atribuirse exclusivamente a la inversión portuaria.

30. Relacionado con esta categoría de los beneficios secundarios se encuentra el cómo y tantas veces utilizado concepto de la extensión de los beneficios debida al "efecto multiplicador". El efecto multiplicador o, en términos más sencillos, el efecto de la reinversión de los beneficios de un proyecto a lo largo de la cadena constituida por cada uno de los sucesivos beneficiarios es muchas veces utilizado como argumento por los promotores de un proyecto portuario, que, de ese modo, dan una idea más favorable de los beneficios que, según ellos, reportará el proyecto. En el anexo a la primera p del presente informe se expone un sencillo ejemplo que demuestra la falacia, en ciertos casos, de ese argumento.

8/ Véase en la segunda parte del presente informe el estudio del caso Nº 4. El puerto de Nori.

31. En el caso de los países en desarrollo se afirma algunas veces que, dada la existencia de un alto nivel de desempleo en las zonas urbanas y de subempleo en las rurales, deben incluirse entre los beneficios de un proyecto los beneficios indirectos atribuibles al efecto multiplicador. Esto es cierto en la medida en que exista una capacidad excedentaria de producción que no se utiliza por falta de demanda. El efecto multiplicador se amortigua cuando la capacidad de producción es insuficiente, incluso por escasez de capital y de mano de obra capacitada, situación bastante frecuente en los países en desarrollo. En tales condiciones, un aumento de la demanda no provoca, por lo general, un aumento de la producción sino, más probablemente, un aumento de los precios o de las importaciones. No puede, por lo tanto, hablarse de otro aumento neto de los beneficios debido al efecto multiplicador puesto que, tomando como base el ejemplo anterior 9/, el ingreso real de las industrias productivas aumenta a costa de una disminución de los ingresos reales de los trabajadores. A menudo, este fenómeno de estrangulamiento del lado de la oferta suprime, ya al iniciarse el proceso, los posibles efectos multiplicadores. A menos que se pueda estar razonablemente seguro de que existen las condiciones necesarias para que se dé realmente el efecto multiplicador, debe considerarse con suma prudencia la justificación de un proyecto basado en los beneficios derivados de dicho efecto.

32. En resumen, los beneficios de un proyecto de inversión portuaria pueden agruparse en tres categorías: i) beneficios directos para el puerto; ii) beneficios para los usuarios de los servicios portuarios y iii) beneficios indirectos para los proveedores de los distintos insumos del proyecto. No todos estos beneficios son necesariamente beneficios netos para el país. Un beneficio para un grupo de interés puede representar un costo para otro. Por eso es importante determinar en quién recaen los beneficios, y quiénes van a sufragarlos. Un proyecto puede no ser financieramente interesante para el puerto, pero resultar económicamente acertado desde el punto de vista del país. La forma en que el puerto o el país puedan aprovecharse de los beneficios resultantes de una inversión depende del medio económico en que se encuentren y de la política de tarificación del puerto.

33. Es evidente que el tipo de beneficios de una inversión portuaria, depende de la naturaleza de la propia inversión. No es imposible, aunque sí improbable, que una inversión portuaria pueda dar lugar a todos los beneficios enumerados en el cuadro 1. Más probable es que los beneficios de determinado grupo no sean más que pagos por transferencia dentro del país, que no produzcan ningún aumento neto de los beneficios nacionales. Debido al carácter particular de la función portuaria, también es probable que parte de los beneficios vayan a parar, al menos de momento, a grupos de intereses de fuera del país.

9/ Véase el anexo a la primera parte del presente informe.

Cuadro 1

Posibles beneficios de la inversión portuaria

I	II	III
Beneficios directos para el puerto	Beneficios para los usuarios del puerto	Beneficios indirectos para los proveedores de los distintos insumos
i) Ingresos adicionales por derechos pagados por los buques ii) Aumento de los ingresos netos de manipulación de la carga iii) Alquiler adicional de terrenos hecho posible por la inversión	i) Ahorros en el costo del transporte terrestre ii) Ahorros en el costo de manipulación de la carga iii) Ahorros en el costo de los seguros iv) Ahorros en el costo de los intereses del capital inmovilizado en equipo v) Ahorros en el costo de la estancia de los buques en puerto vi) Ahorros en los costos de explotación de los buques, debidos a las economías de escala a que da lugar la utilización de buques de mayor calado, hecha posible por la inversión portuaria vii) Aumento de producción de las industrias usuarias del puerto hecho posible por la inversión portuaria	i) Aumento de los ingresos de la mano de obra relacionada con el puerto ii) Aumento de los ingresos de las industrias relacionadas con el puerto iii) Aumento de los beneficios en virtud del efecto multiplicador, si lo hubiere

Capítulo V

COMPARACION DE COSTOS Y BENEFICIOS

34. Ya se ha señalado que todo proyecto de inversión portuaria requiere una seria evaluación financiera por parte de la administración del puerto, evaluación que no es, sin embargo, suficiente por sí sola para determinar si el proyecto debe o no debe llevarse a cabo. Eso parece indicar que el proceso de evaluación tiene que llevarse más lejos, de modo que incluya elementos que escapan al control directo de la administración portuaria. La evaluación puede hacerse a nivel local, a nivel nacional, o incluso a nivel regional. En el presente informe se analizará el paso del nivel portuario al nivel nacional, teniendo presente que los principios básicos del proceso son fundamentalmente los mismos a todos los niveles.

35. Una vez calculados los costos y beneficios del proyecto para la parte de que se trate, es necesario compararlos con los de otros posibles proyectos a fin de determinar si merece la pena llevarlo efectivamente a cabo.

A. Actualización

36. Los costos y los beneficios de un proyecto se producen en diferentes períodos y no son directamente comparables, ya que un dólar de hoy vale más que un dólar de dentro de un año. Un dólar colocado en el banco aumentará a razón de i% (la tasa de interés) para convertirse en (1 + i) dólares al cabo de un año. Un dólar de ahora equivale, pues, a (1 + i) dólares de dentro de un año. Análogamente, una persona razonable preferirá un beneficio inmediato a ese mismo beneficio dentro de cierto tiempo. Eso explica la existencia y la necesidad de una tasa de actualización que permita comparar los costos y beneficios que se producen en distintos momentos.

37. Para conocer el valor actualizado de un dólar recibido dentro de n años puede consultarse una tabla de valores actualizados, que no es sino una tabla de rendimiento de las obligaciones, en la que se tiene en cuenta el interés compuesto.

38. Para ilustrar el proceso de actualización, tomemos el ejemplo siguiente: un proyecto cuesta 10 millones de dólares y requiere un año para su terminación. El proyecto reporta beneficios netos por valor de 3 millones de dólares durante cada uno de los 5 años de vida útil de las nuevas instalaciones. Para simplificar, se supone que los costos y beneficios se producen al final de cada año y se utiliza una tasa de actualización del 10%.

Año	Costo (millones de dólares)	Beneficio neto (millones de dólares)	Factor de actualización a/	Valor actualizado (millones de dólares)
0	-10		1,000	-10,000
1		3	0,909	2,727
2		3	0,827	2,481
3		3	0,751	2,253
4		3	0,683	2,049
5		3	0,621	1,863

El valor neto actualizado del proyecto es de 1,373 millones de dólares.

B. La tasa de actualización

39. Reviste una importancia decisiva la cuestión de la tasa de actualización que debe utilizarse en la evaluación de los proyectos. Para apreciar la importancia de la elección de dicha tasa y sus efectos, conviene examinar su relación con el valor neto actualizado, relación que puede resumirse diciendo que el valor neto actualizado disminuye a medida que aumenta la tasa de actualización, o que el primero es una función inversa de la segunda. Siguiendo con el ejemplo anterior y utilizando distintas tasas de actualización se obtienen los siguientes resultados:

Tasa de actualización (porcentaje)	Valor neto actualizado (millones de dólares)
5	2,843
8	1,832
10	1,247
15	0,049
18	-0,524

El proyecto es inaceptable cuando las tasas de actualización son ligeramente superiores al 15% 10/. Si se elige una tasa de actualización del 10%, el proyecto arroja un valor neto actualizado positivo de 1,249 millones de dólares y es, en consecuencia, aceptable.

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a/ Tomado de las tablas de valores actualizados. Cuando se trata, como en este caso, de una corriente constante de beneficios, hay un procedimiento directo para calcular ese factor, utilizando la fórmula del valor actualizado de la renta correspondiente a los beneficios constantes.

$$P_n = \frac{1}{r}\left[1 - \frac{1}{(1+r)^n}\right]$$

En el ejemplo dado, los beneficios sólo comienzan a partir del año 1 y, por consiguiente:

$$P_n = \frac{1}{0,1}\left[1 - \frac{1}{(1+0,1)^5}\right] = 3,791$$

Los beneficios actualizados se elevan, por lo tanto, a 3 millones de dólares x 3,791 = 11,373 millones de dólares. Si de esta última suma se deducen los costos actualizados por un total de 10 millones de dólares, el resultado es el mismo, o sea, 1,373 millones de dólares.

10/ En realidad, con una tasa de actualización del 15,24% el valor neto actualizado es nulo. Esa es, pues, la tasa interna de rendimiento que se examina en los párrafos 60 y 61.

40. Esto da lugar a la posibilidad de manipular indebidamente las tasas de actualización para justificar los proyectos. Se ha abogado por la utilización de tasas de actualización bajas para los proyectos públicos alegando que, a diferencia del sector privado, el gobierno está obligado para con las generaciones venideras. Aunque eso sea cierto, el cumplimiento de esa obligación mediante la reducción de las tasas de actualización no puede ser una solución. La solución reside, por el contrario, en la medición adecuada de los beneficios que reportará el proyecto a las generaciones futuras y en su inclusión entre los beneficios totales del proyecto 11/.

41. En lo que se refiere a la administración del puerto, la tasa de actualización que debe utilizar en su evaluación del proyecto es el costo de oportunidad del capital, que es la tasa requerida (mínimo aceptable) de rendimiento que puede obtener el puerto con ese capital dedicándolo a otro uso. La tasa de actualización utilizada no debe ser inferior al tipo de interés que ha de pagar el puerto por el capital tomado en préstamo. Es posible que, dadas las condiciones del préstamo (porque éste se haya obtenido, por ejemplo, para un proyecto determinado y no pueda utilizarse, o no se habría podido obtener, para otros fines), el costo de oportunidad del capital para el puerto sea precisamente el tipo de interés que paga por ese préstamo.

42. Desde el punto de vista de un país, los costos y beneficios nacionales deben actualizarse con arreglo a la tasa de actualización social, cuya determinación es una compleja cuestión que rebasa los límites del presente documento. El valor de dicha tasa se especifica a un nivel político muy superior al de la administración del puerto, pero no debe ser en ningún caso inferior al de la tasa efectiva de interés exento de riesgos que corrientemente se percibe (o sea, la tasa de interés corriente que devengan, por ejemplo, los bonos u obligaciones del Estado). La tasa de actualización social utilizada en el proyecto portuario debe estar, además, en armonía con la utilizada en otros proyectos públicos que se estén ejecutando.

43. En el presente informe se partirá del supuesto de que la tasa de actualización social es un elemento conocido y especificado por el gobierno nacional. El hecho de que las administraciones de los puertos sean entidades oficiales o semioficiales controladas por el Estado contribuye a que el costo de oportunidad del capital para el puerto sea igual a la tasa de actualización social establecida por el gobierno.

44. Aunque la tasa de actualización social no está determinada por la administración del puerto, los evaluadores de los proyectos portuarios deben tener conciencia de sus consecuencias y de su importancia, y no considerar exclusivamente la mecánica de su influencia en los cálculos numéricos de los estudios de costos y beneficios.

11/ La reducción de las tasas de actualización sólo se justifica cuando la sociedad advierte que el consumo actual es excesivo, y demasiado reducidas las inversiones, tanto en el sector privado como en el público, en cuyo caso hay que tratar de aumentar los dos tipos de inversión. Una decisión de esa categoría tendría que ser a un nivel mucho más alto que el nivel del proyecto. Eso significa que, en el caso de un proyecto portuario, la evaluación de la inversión no debe depender de una manipulación de las tasa de actualización encaminada a hacerlo más o menos favorable.

C. Métodos de evaluación

45. Son varios los métodos de evaluación que pueden emplearse dependiendo de la naturale... y la magnitud de la inversión. Los métodos más corrientemente utilizados son los siguientes: i) el de la tasa media de rendimiento; ii) el del plazo de amortización; iii) el del valor neto actualizado; iv) el de la relación beneficio-costo, y v) el de la tasa interna de rendimiento.

46. La evaluación financiera que realiza la administración del puerto podría efectuarse por cualquiera de los métodos mencionados. Para los análisis de costos y beneficios económicos, sin embargo, las técnicas más apropiadas son las tres últimas.

D. Evaluación financiera efectuada por la administración del puerto

47. La evaluación financiera que realizan las administraciones de los puertos se basa en los gastos e ingresos monetarios correspondientes a la inversión. Esta evaluación se hará en función del costo monetario real de la infraestructura, la conservación y las operaciones. A este respecto es importante la corriente de fondos del puerto, por lo que es preciso determinar año por año las entradas y las salidas en efectivo. Las entradas se compondrán principalmente de los derechos portuarios adicionales, los ingresos obteni... como consecuencia de la manipulación de carga adicional y, posiblemente, del alquiler de terrenos. Las salidas, por su parte, comprenden los reembolsos de los préstamos si los hubiere, los sueldos y salarios de la mano de obra calificada y no calificada, y los pagos por concepto de materiales y equipo. Estas corrientes constantes de fondos, ya se trate de costos o de beneficios, deben evaluarse con un criterio coherente.

48. Un sencillo ejemplo bastará para ilustrar la mecánica de los distintos métodos. El puerto va a comprar una grúa que cuesta 450.000 dólares, y necesita otros 50.000 para instalar el nuevo equipo, con lo que el importe total de la inversión ascenderá a 500.000 dólares. La administración portuaria estima que, con la nueva grúa, los gasto... de explotación y de mano de obra podrán reducirse en 110.000 dólares al año, antes de pagar los impuestos, durante los próximos 10 años, transcurridos los cuales no se prevén nuevos ahorros y el valor residual de la grúa será insignificante. Esa reducción representa los ahorros (beneficios) netos que realizará la administración del puerto si adquiere la grúa.

49. Lo primero que hay que tener en cuenta es que la inversión en estructura o equipo tiene una vida útil superior a un año, por lo que su costo no puede, a efectos fiscales, imputarse a los ingresos, sino que tiene que irse amortizando durante la vida del activo de que se trate. Para calcular el ingreso ~~imponible~~ gravable, hay que deducir de los ingresos la depreciación anual. Suponiendo que la administración del puerto utilice la depreciación lineal, los costos anuales de depreciación equivaldrán al 10% de la inversión total de 500.000 dólares, es decir, a 50.000 dólares al año. Por otra parte, se supone que lo... impuestos que gravan los ingresos del puerto se elevan al 33 1/3%. Las cifras contables y la cuenta de la corriente de efectivo 12/ serán las siguientes:

12/ En el cálculo de la corriente de efectivo sólo se tiene en cuenta el efectivo realmente pagado y recibido (o ahorrado). La corriente neta anual de efectivo aquí obtenida para todos los años después del primero es de 90.000 dólares, cifra que hay que comparar con la de los 40.000 dólares a que asciende el ingreso anual después de pagados los impuestos. La diferencia entre ambas cifras representa la cuantía de los costos de depreciación, la cual no es más que un concepto contable.

	Cifras contables (dólares)	Corriente de efectivo (dólares)
Ahorro anual en efectivo	110 000	110 000
Depreciación de la grúa	(50 000)	
Ingreso adicional antes de pagar los impuestos	60 000	
Impuesto sobre la renta, al 33 1/3%	(20 000)	(20 000)
Ingreso adicional después de pagados los impuestos	40 000	
Corriente anual neta de efectivo		90 000

50. La tasa media de rendimiento es un concepto contable que representa la relación entre los beneficios anuales medios, después de pagados los impuestos 13/, y la inversión neta media en el proyecto, o a veces la propia inversión inicial. En el ejemplo citado anteriormente, los ingresos contables anuales medios del decenio son de 40.000 dólares, y la inversión neta media, partiendo de la hipótesis de una depreciación lineal, es de 500.000 dólares/2, o sea de 250.000 dólares. La tasa media de rendimiento es, pues:

$$\frac{40.000}{250.000} = 16\%$$

Si se utiliza el valor de la inversión inicial, la tasa media de rendimiento será:

$$\frac{40.000}{500.000} = 8\%$$ 14/

La ventaja principal de este método es su simplicidad. En él se hace uso de la información contable de que ya se dispone. Una vez obtenida la tasa media de rendimiento, ésta puede compararse con una tasa umbral, o tasa requerida, de rendimiento para determinar si debe realizarse o no la inversión. Los principales inconvenientes del método de la tasa media de rendimiento residen en que está basado en el ingreso contable, más que las corrientes de efectivo, y en que no tiene en cuenta el momento en que se efectúan las entradas y las salidas de caja. Se pasa, pues, completamente por alto del valor del dinero en función del tiempo, partiéndose de la base de que los beneficios del último año son los mismos que en el primero. El método de la tasa media de rendimiento no puede, por consiguiente, utilizarse para elegir entre proyectos cuyas entradas y salidas de efectivo no corresponden al mismo período.

13/ Si el puerto no paga impuestos sobre los ingresos, como ocurre en la mayoría de los países en desarrollo, el ingreso anual adicional en el ejemplo citado es de 60.000 dólares en lugar de 40.000.

14/ Cualquiera de estas definiciones puede utilizarse siempre que se indique claramente a cuál de ellas se hace referencia.

Pay-back.

51. El método del plazo de amortización es aquel en que el criterio de evaluación es el número de años que se necesitan para recuperar o "amortizar" la inversión monetaria inicial, período que también se conoce con el nombre de plazo de resarcimiento. El plazo de amortización representa la relación entre la inversión inicial y las entradas netas anuales de efectivo. En el ejemplo citado, el plazo de amortización 15/ es:

$$\frac{500.000}{90.000} \simeq 5,6 \text{ años}$$

Si el plazo de amortización así calculado es inferior a un plazo máximo admisible de amortización previamente fijado, el proyecto es aceptable, pero si no, debe ser rechazado. Los principios básicos del cálculo de la amortización son los que se indican en el gráfico 1, que no necesita explicación. Además del inconveniente que representa el no tomar en consideración la magnitud y la distribución en el tiempo de las corrientes de efectivo durante el plazo de amortización, ni el distinto valor del dinero en función del tiempo, en ese método no se tienen en cuenta las corrientes de efectivo que se producen una vez transcurrido el plazo de amortización. No puede por consiguiente, ser considerado como un buen sistema de medición de la rentabilidad.

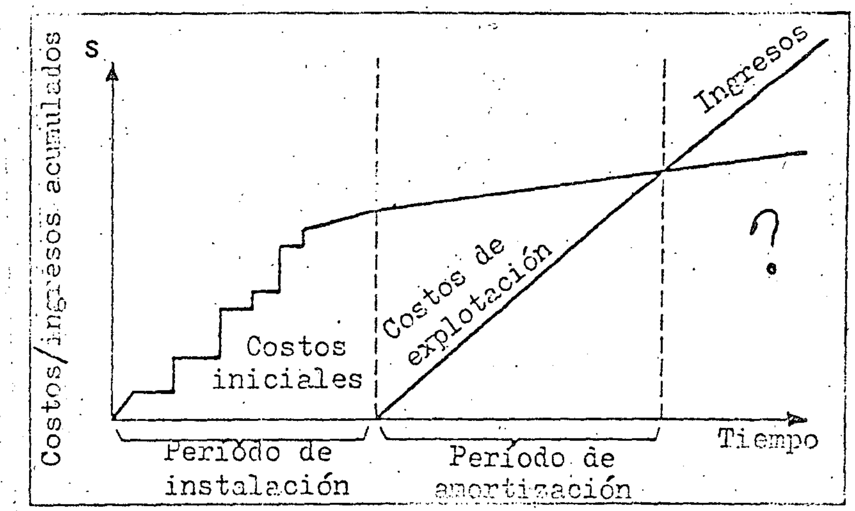
52. Debido a su simplicidad, el método de la amortización ha sido y sigue siendo, sin embargo, utilizado, y puede, desde luego, emplearse como técnica complementaria de otros métodos más perfeccionados, ya que, en cierto modo, sí proporciona a la administración una idea, aunque sea limitada, de los riesgos y la liquidez de un proyecto. El razonamiento lógico es que, cuanto más corto sea el plazo de amortización, menos arriesgado será el proyecto y mayor su liquidez. En este método no se toma, sin embargo, en consideración la dispersión de los posibles resultados, sino sólo la magnitud y la materialización en el tiempo del valor previsto de tales resultados con respecto a la inversión inicial. Aunque, cuando el riesgo es elevado, la brevedad del plazo de amortización puede constituir un buen indicador, dicho plazo no es generalmente un indicador adecuado del riesgo. El conocimiento del plazo de amortización puede resultar útil si se concibe como una limitación que hay que respetar, no como medida de una rentabilidad que hay que tratar de aumentar lo más posible 16/. A este respecto, el método del plazo de amortización puede servir de guía, no muy precisa, pero sí razonable, para evaluar las inversiones más pequeñas del puerto, tales como la compra de algunos remolques adicionales o de equipo de manipulación de la carga, cuya duración y cuyo costo no son tales que requieran técnicas más perfeccionadas.

15/ Cuando las entradas anuales de efectivo no son uniformes, el cálculo es algo más indirecto. Suponiendo, por ejemplo, que la inversión inicial sea de 5.000 dólares y la entrada de efectivo de 2.000 dólares en cada uno de los dos primeros años, y de 1.500 dólares en el tercero, en los dos primeros años se amortizarán 4.000 dólares, mientras que los otros 1.000 se recuperarán en $\frac{1.000}{1.500} = \frac{2}{3}$ de año, lo que significa que el plazo de amortización es de dos años y ocho meses.

16/ Para más detalles, véase H. M. Weingartner, Some new views on the pay-back period and capital budgeting decisions, Management Science, 15 (agosto de 1969), páginas 594 a 607.

Gráfico 1

EL METODO DEL PLAZO DE AMORTIZACION

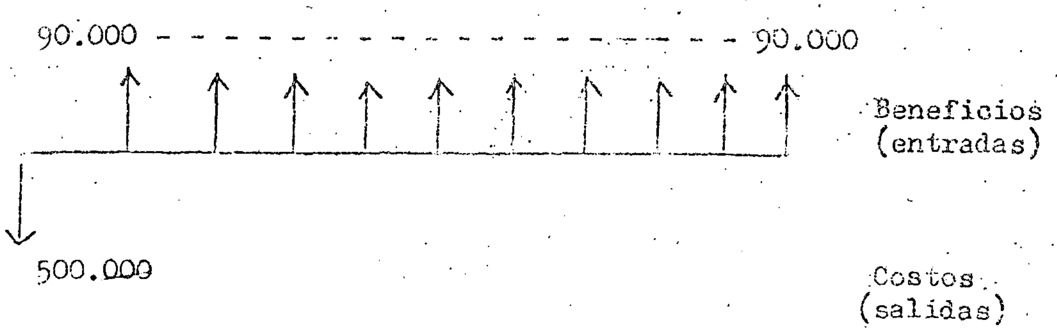


53. El método del valor neto actualizado (VNA) permite superar las deficiencias de que adolecen los métodos de la tasa media de rendimiento y del plazo de amortización, porque en él se tiene en cuenta el valor del dinero en el tiempo y, por lo tanto, la importancia del factor cronológico en relación con las corrientes de efectivo.

54. Utilizando el anterior ejemplo de la inversión en una grúa, en el gráfico 2 infra se representa la distribución en el tiempo de las entradas y las salidas de efectivo.

Gráfico 2

DISTRIBUCION EN EL TIEMPO DE LAS ENTRADAS Y LAS SALIDAS DE EFECTIVO



55. Cuando se utiliza el método VNA, hay que especificar la tasa de actualización utilizada 17/, tasa que, como se señala en el párrafo 41, sería en este caso el costo de oportunidad del capital para la administración del puerto.

Si $i = 0,1 = 10\%$,

el valor neto actualizado de los beneficios, VA (B) = 553.000 dólares, y
el valor neto actualizado de los costos, VA (C) = 500.000 dólares 18/.

El valor neto actualizado (VNA) de la grúa, con una tasa de actualización del 10%, es, por consiguiente:

$$VNA = VA(B) - VA(C)$$
$$= 53.000 \text{ dólares.}$$

Significa esto que la grúa podría haber sido adquirida mediante un préstamo al 10% de interés, y que, después de haberse pagado el préstamo y los intereses con los beneficios obtenidos, se habría registrado un superávit actualizado de 53.000 dólares. Con cada tasa de actualización, se obtendría un valor neto actualizado diferente. He aquí, por ejemplo, los VNA correspondientes a las distintas tasas de actualización en el caso de la inversión en la grúa.

17/ Véase el análisis anterior de la tasa de actualización. A efectos de cálculo comercial, como en el caso de la evaluación por el puerto de la inversión en la grúa, la tasa de actualización es también considerada como tasa mínima requerida de rendimiento.

18/ Si el costo se hubiera producido a lo largo de un período y no en el año 0 (en el momento actual), tendría que haber sido también actualizado, como la corriente de beneficios percibidos en el curso del tiempo.

Tasa de actualización	VA (B)	VA (C)	VNA
8	603 900	500 000	103 900
10	553 000	500 000	53 000
12	508 500	500 000	8 500
15	451 700	500 000	-48 300

El criterio utilizado en el método del VNA es aceptar el proyecto si el VNA es superior a cero y rechazarlo en el caso contrario. Si las diferentes variantes del proyecto se excluyen mutuamente, es decir, si hay distintas soluciones posibles para el mismo problema, conviene optar, en igualdad de circunstancias, por la variante cuya VNA sea más elevado. Para comparar proyectos de distinta vida útil, un procedimiento eficaz es determinar ante todo la renta anual que podría reportar el VNA de cada proyecto durante la vida útil de las instalaciones construidas con arreglo al mismo y elegir aquel que reporte mayor renta anual.

56. La conveniencia de la inversión en la grúa varía en función de la tasa de actualización utilizada. Cuando la explotación del puerto se base en consideraciones estrictamente comerciales, la tasa de actualización es la tasa requerida de rendimiento, que es a su vez el costo de oportunidad del capital para el puerto. Para un puerto cuya tasa requerida de rendimiento es del 15%, la inversión en la grúa es inaceptable, mientras que es, por el contrario, aceptable cuando esa tasa es del 10%. La razón es clara: si la tasa de rendimiento requerida por el puerto para las propuestas de inversión es del 10%, la aceptación de un proyecto con un VNA positivo actualizado al 10% significa que el puerto acepta un proyecto con un rendimiento más elevado que el necesario para que el "valor financiero" del puerto permanezca inalterable.

57. La utilización del método del VNA proporciona una base objetiva para la evaluación y selección de los proyectos de inversión. El proceso de actualización tiene en cuenta tanto la magnitud como el momento en que se producen las corrientes de efectivo previstas en cada fase de la vida del proyecto. Para utilizar el método del VNA hay que especificar sin embargo, la tasa de actualización o, lo que es lo mismo cuando se trata de un cálculo comercial, la tasa requerida de rendimiento del puerto. De ahí la necesidad de conocer el costo de oportunidad del capital para el puerto.

58. El método basado en la <u>relación beneficio-costo</u> utiliza el valor actualizado de los beneficios (VA (B)) y el valor actualizado de los costos (VA (C)), antes definidos, pero, en vez de sustraer el uno del otro como se hacía para obtener el VNA, la relación beneficio-costo se obtiene dividiendo el uno por el otro como a continuación se indica:

$$\text{Relación beneficio-costo} = \frac{\text{Valor actualizado de los beneficios}}{\text{Valor actualizado de los costos}}$$

Así, pues, un VNA positivo, que significa que el proyecto es aceptable, corresponde a una relación beneficio-costo superior a 1, mientras que un VNA negativo, que significa que el proyecto es inaceptable, corresponde a una relación beneficio-costo inferior a la unidad.

59. Como se verá más adelante, la relación beneficio-costo puede ser, en determinadas circunstancias, más significativa que el VNA.

60. El método basado en la <u>tasa interna de rendimiento</u> es otro de los métodos que implican actualización. La tasa interna de rendimiento (TIR, es la tasa de actualización más elevada que arrojará un VNA positivo. En otras palabras, es la tasa de actualización que hará que el valor neto actualizado del proyecto sea nulo, o sea, que el valor actualizado de los beneficios sea equivalente al valor actualizado de los costos.

Utilizando una vez más el ejemplo de la grúa, es el valor de i que hará VA (B) - VA (C) = O.

El valor de i que satisfará esa condición es i = 0,1241 19/. De ahí que la TIR de la inversión en la grúa sea del 12,4%.

61. Si la TIR de un proyecto excede de la tasa requerida de rendimiento, generalmente denominada tasa umbral, el proyecto es aceptable, pero no lo será, en cambio, en caso contrario. Esa tasa requerida de rendimiento es la misma a que se ha hecho referencia en relación con el método del VNA, es decir, el costo de oportunidad del capital para el puerto. La base lógica del criterio de aceptación es análoga a la expuesta en relación con el método del VNA. La aceptación de un proyecto con una TIR más elevada que la tasa requerida de rendimiento significa que el puerto acepta un proyecto con un rendimiento más elevado que el que se necesita para mantener el "valor financiero" actualizado del puerto. Si la tasa umbral es del 10% -lo que significa que el costo de oportunidad del capital para el puerto equivale asimismo al 10%- y la TIR del 12,4%, la inversión en la grúa es aceptable, como en el caso del VNA. En general, el método de la TIR y el método del VNA darán respuestas análogas con respecto a la aceptación o al rechazo de una propuesta de inversión, pero el primero hay que aplicarlo con cautela cuando la TIR es elevada.

62. Eso es lo que sucede a menudo en el caso de los puertos, ya que la inversión se hace con frecuencia en circunstancias de congestión y de largas esperas de los buques. En tal situación, la adición de uno o de varios puestos de atraque puede reducir considerablemente el tiempo que han de esperar los buques para conseguir uno de ellos, con la consiguiente reducción sustancial de los costos correspondientes. Esta reducción de los costos, considerada como un beneficio del puesto de atraque adicional, dará, en consecuencia, lugar a una tasa interna de rendimiento muy elevada, que puede encubrir

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19/ Calculado buscando un valor de i que haga que los beneficios actualizados sean equivalentes al costo inicial:

$$\sum_{n=1}^{10} \frac{90.000}{(1+1)^n} = 500.000$$

El valor de i tiene con frecuencia que determinarse por un método de aproximaciones sucesivas. Cuando se trata, sin embargo, de una corriente constante de beneficios y de un costo único de inversión, como en el caso señalado, una calculadora de bolsillo no muy complicada puede facilitar la respuesta en cuestión de segundos.

la siguiente falacia, particularmente peligrosa, de la inversión. Si se construyera, en efecto, un segundo puesto de atraque adicional, la reducción marginal del tiempo de espera de los buques sería mucho menor que la obtenida con la construcción del primero, lo que significa que la tasa interna de rendimiento calculada para el segundo puesto de atraque adicional será más reducida que la del primero, pudiendo incluso ser negativa. Por otra parte, si los dos puestos de atraque adicionales se consideraran como una sola inversión, la tasa interna de rendimiento, una vez calculada, será inferior a la correspondiente a un solo puesto de atraque adicional. Eso parece indicar que el nivel adecuado de la inversión portuaria no será muchas veces el que arroja la tasa interna de rendimiento más elevada. Del hecho de que dicha tasa sea alta en comparación con la requerida, sólo cabe deducir que la propuesta que se está considerando es aceptable pero sobre esa sola base no pueden establecerse comparaciones significativas entre los diferentes niveles posibles de inversión.

63. ~~En otras palabras~~, la propia naturaleza de la inversión destinada a reducir o a impedir la congestión hace que la primera capacidad adicional parezca una inversión mejor que la segunda o que las ulteriores, ya que entre sus beneficios figura una reducción muy considerable de los costos de congestión, reducción que no pueden en modo alguno producir los ulteriores aumentos de la capacidad. Esto no debe utilizarse como argumento para demostrar que esa primera inversión, limitada, es la más económica, ya que a la larga, ello equivaldría a la planificación de un elevado nivel permanente de congestión. Para reducir al mínimo los costos globales del transporte marítimo, el nivel correcto de inversión en un servicio tan variable es el que proporciona la máxima capacidad sin dejar de satisfacer el criterio, cualquiera que sea, que se utilice para la inversión.

E. Resumen de la aplicación de los criterios de inversión

64. Cada uno de los métodos de evaluación antes descritos puede tener un papel que desempeñar según la naturaleza de la situación que se examine. Son cuatro las preguntas concretas que se pueden hacer en relación con una propuesta de inversión portuaria:

a) ¿Está justificada la propuesta en sí desde el punto de vista económico y financiero?

b) ¿Garantiza esa propuesta la mejor utilización posible de los fondos disponibles?

c) ¿Es adecuado el nivel propuesto de inversión en instalaciones adicionales?

d) ¿Cuál es el momento más oportuno para realizar la inversión?

65. En todos los casos, lo primero que habrá que hacer será determinar las corrientes no actualizadas de costos y beneficios correspondientes a cada opción.

66. Para responder a la primera pregunta, el método elegido dependerá de que pueda llegarse a un acuerdo sobre la tasa "adecuada" de actualización que deba utilizarse. Cuando todos los interesados puedan convenir en una rentabilidad mínima requerida del capital (sea ésta el costo de oportunidad del capital u otra cifra en función de criterios locales), las corrientes podrán actualizarse con arreglo a esa tasa, y la justificación óptima del proyecto en sí se basará en la relación beneficio-costo o en el valor neto actualizado; una relación beneficio-costo superior a 1 equivale a un valor neto actualizado superior a cero, y ambos criterios demuestran que el proyecto está justificado. Cuando

sea difícil llegar a un acuerdo sobre la tasa adecuada de actualización, será preciso calcular la TIR. En algunos casos tal vez convenga optar desde el principio por este último método, simplemente para impedir que haya dudas y demoras en el programa de evaluación de los proyectos.

67. Para responder a la segunda pregunta, o sea, a la relativa al procedimiento que debe seguirse para distribuir una cantidad determinada de fondos a varios proyectos, el método más sencillo es clasificar los proyectos en función de su relación beneficio-costo y suspender las inversiones en el proyecto en el que esa relación sea apenas superior a la unidad, o cuando se hayan agotado los fondos, si esta segunda circunstancia se produce antes. Desgracidamente complica la situación el hecho de que generalmente habrá como mínimo, dos tipos de fondos, las reservas del puerto y los créditos aplicables a cada uno de ellos pueden ser distintos. Cabe sin embargo, aplicar a ambos un método único, como se indica en el gráfico 3, en el que los proyectos que compiten por los fondos se han clasificado según su TIR, indicándose, además, en la escala horizontal el punto en el que se agotan los fondos propios y se requerirá, por lo tanto, un préstamo. En el ejemplo utilizado, los cinco primeros proyectos están por encima de la tasa requerida de rendimiento (o tasa umbral) en cuanto al capital propio, mientras que el sexto está también por encima de ese nivel, pero sin llegar al nivel más elevado del interés que ha de pagarse por los fondos tomados en préstamo, fondos que en todo caso se requerirían. A partir del proyecto VI, son varias las posibilidades que se ofrecen:

a) Tal vez sea preferible no recurrir a un préstamo externo en tales circunstancias y, en vez del proyecto VI, realizar el proyecto VII que reporta un rendimiento superior a la tasa umbral interna;

b) Tal vez sea, en cambio, posible reducir el proyecto VI a fin de financiarlo con fondos propios, o aplazarlo hasta que mejore la situación.

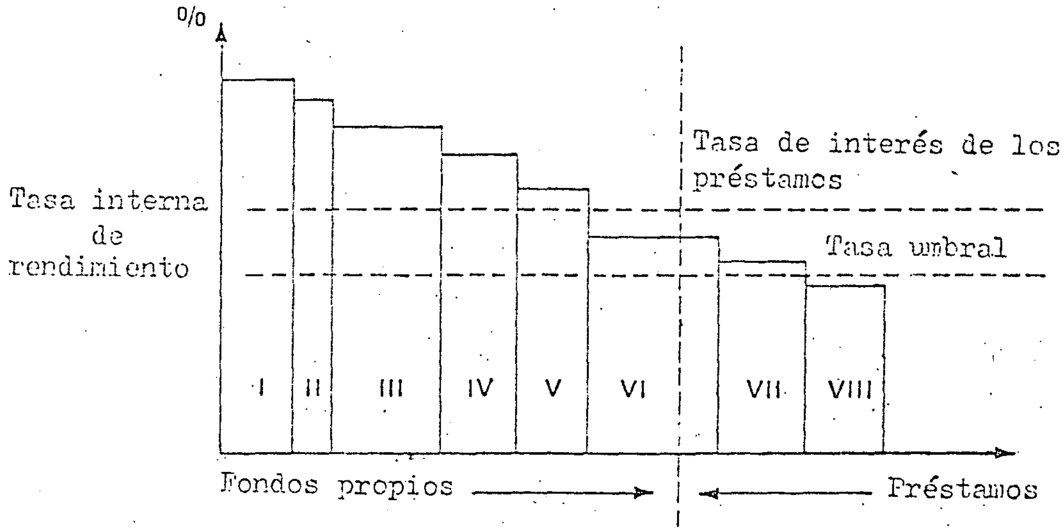
En lugar de aceptar la clasificación basada en la TIR como criterio único, habría que tener también en cuenta otros factores, entre los que figuran, por ejemplo, la prioridad que debe darse a los proyectos que den lugar a más empleo, que facilitan la descarga de productos alimenticios de primera necesidad en lugar de la de automóviles privados, o que reportan ventajas de las que se beneficia directamente el país.

68. En cuanto a la tercera pregunta, es decir, a la relativa a la elección del nivel adecuado de inversión en un servicio variable -cuál es, por ejemplo, el número adecuado de puestos de atraque en que debe invertirse en un momento determinado-, es preferible, en vista de la posible distorsión relacionada con los elevados costos de congestión a que se ha aludido anteriormente, emplear siempre que sea posible el VNA, más que la TIR. Esa precaución tiene, sin embargo, una importancia secundaria, comparada con la necesidad de no dejarse arrastrar por la impresión, basada en el cálculo de los costos de congestión, de que la inversión en el primer puesto de atraque es más interesante que la inversión en el segundo o en ulteriores puestos de atraque. El nivel correcto de inversión se determina aumentando gradualmente el número de puestos de atraque hasta que el VNA (o la TIR) del puesto de atraque marginal sean sólo ligeramente superior al valor requerido.

69. Finalmente, para determinar cuándo hay que invertir en instalaciones adicionales, una vez decidida la modalidad del proyecto, puede utilizarse como base el rendimiento del primer año. El proyecto debe llevarse a cabo de manera que el rendimiento del primer año sea igual al costo de oportunidad del capital o a la tasa mínima requerida de rendimiento.

Gráfico 3

ASIGNACION DE FONDOS A VARIOS PROYECTOS QUE COMPITEN ENTRE SI



Fuente: PNUD/UNCTAD, Manual on shipping management, Ginebra, marzo de 1976.

F. Análisis de costos y beneficios económicos a nivel nacional

i) Utilización de los precios de mercado

70. Esta fase de la evaluación del proyecto amplía los límites del mismo para abarcar todo el país en el que se hace la inversión portuaria. En ella deben tenerse en cuenta los beneficios de la inversión que no recaen necesariamente en el puerto, sino en el resto del país. Entre ellos se cuentan, por lo general, los beneficios de los usuarios del puerto y los beneficios indirectos descritos en la parte del presente estudio consagrada a los distintos tipos de beneficios de los proyectos portuarios. No deben incluirse en cambio, los beneficios que representan simplemente pagos por transferencia de un grupo de intereses a otro dentro del país. Los costos de los factores de insumo se calculan a los precios de mercado.

71. En la evaluación se utiliza la misma técnica que en el método del valor neto actualizado. La tasa de actualización aplicada debe ser la tasa de actualización social.

ii) Utilización de los precios virtuales

72. Como se dijo en los párrafos 11 a 17, los precios de mercado no representan necesariamente los verdaderos costos o valores de los recursos utilizados. Esos precios de mercado tienen que reajustarse para reflejar los costos de oportunidfad de los recursos. De especial importancia en las inversiones portuarias son los costos de oportunidad de la mano de obra, de las divisas y de los terrenos. Una vez reajustados esos costos, vuelve a aplicarse el método del valor neto actualizado aplicando la tasa de actualización social.

73. En el análisis de costos y beneficios económicos, los costos de capital del proyecto se miden por los fondos empleados en el momento en que se asume la obligación, no en función de los reembolsos o la amortización de los préstamos como se hace en la evaluación financiera. He aquí un sencillo ejemplo que indica los diferentes resultados que se obtienen en las diversas fases y niveles de la evaluación.

74. Un puerto obtiene el 1º de enero, de un banco internacional, un préstamo de 2 millones de dólares (equivalentes a 10 millones de unidades en moneda nacional -por ejemplo, rupias- a un tipo de cambio de 5 rupias por dólar), a un interés del 7%. El plazo de reembolso de ese préstamo es de cinco años contados a partir del primero después de terminado el proyecto. El puerto invierte esa suma en un proyecto que requiere la compra de equipo exclusivamente importado. El proyecto reportará al puerto un ingreso bruto de 3,5 millones de rupias al año, proveniente de los pagos efectuados por sus usuarios locales durante la vida útil de las nuevas instalaciones, que es de cinco años. El costo anual de explotación es de 0,5 millones de rupias. Como resultado del proyecto, los costos de los cargadores del país se reducen en unos 5,5 millones de rupias al año. Se supone que la instalación del equipo durará un año, y que el pago de los gastos de compra e instalación se realizará al final de ese año. El costo de oportunidad del capital para el puerto es del 10% 20/. También se ha fijado en un 10% la tasa de actualización social en el plano nacional.

20/ Si el capital que pueda obtener el puerto cuesta un 10% al año, el puerto no emprenderá lógicamente un proyecto cuyo rendimiento anual sea inferior a ese 10%.

Evaluación financiera desde el punto de vista del puerto

75. Al puerto le interesa principalmente la viabilidad financiera del proyecto desde el punto de vista del cumplimiento de sus obligaciones financieras y de la necesidad de obtener la tasa de rendimiento requerida, que en este caso es del 10%. En líneas generales, la proyección de la corriente de efectivo, en millones de rupias, será la siguiente

	Año 1	Años 2-6
Entradas en efectivo 21/	10	3,5
Salidas en efectivo		
Costo del capital	10	
Costos de explotación	-	0,5
Reembolso del préstamo	-	2,44 22/
Corriente neta de fondos	0	0,56

El valor neto actualizado para el puerto de la corriente neta de efectivo de 0,56 millones de rupias anuales para los años 2 a 6, sobre la base de una tasa de actualización del 10% 23/, es de 1,93 millones de rupias.

Análisis de costos y beneficios económicos desde el punto de vista del país

76. Se dan por supuestos una situación de pleno empleo, en la que por lo tanto no es necesario proceder a un reajuste del costo de la mano de obra, y una prima sobre el valor de las divisas, debida a la escasez de éstas, que hace que su precio virtual sea igual a 1,5 veces el tipo de cambio oficial.

77. El costo de capital del proyecto se mide ahora por el desembolso monetario en el momento de asumir la obligación. El beneficio del proyecto son los 5,5 millones de rupias en que se reducen anualmente (se supone, a efectos de cálculo, que en moneda nacional) los costos de los cargadores del país. El ingreso neto obtenido por el puerto en este caso no constituye un aumento de los beneficios netos del proyecto para el país. El puerto obtiene, en efecto, ese ingreso de los cargadores nacionales, por lo que se trata tan sólo de un pago por transferencia de los cargadores al puerto, dentro del país. El análisis de costos y beneficios económicos a precios de mercado será ahora el siguiente

21/ Ingresos, préstamos desembolsado para pagar el costo de la construcción y renta bruta anual percibida en los años 2 a 6.

22/ El factor de amortización es de 0,2439 para un período de reembolso de cinco años a un interés del 7%. El reembolso anual del préstamo equivale a 10 x 0,2439 ≃ 2,44 millones de rupias.

23/ Actualizado al año 0, es decir, al año actual.

	Año 0	Años 2-6
Costos	-10	-0,5
Beneficios	-	5,5
Beneficio neto	-10	5
Valor actualizado al 10%	-10	17,23 [24/]

Valor neto actualizado = (17,23) - 10,0 = 7,23 millones de rupias.

78. Obsérvese, sin embargo, que el costo del proyecto es en divisas, mientras que los beneficios que, en concepto de reducción de costos, obtienen en este caso los cargadores nacionales se computan en la moneda del país. Es necesario, pues, proceder a un reajuste del tipo de cambio, que refleje el verdadero valor del proyecto para la economía nacional. En el análisis de costos y beneficios económicos, basado en el precio virtual de las divisas, se calcula que el valor neto actualizado del proyecto es de 2,2 millones de rupias 25/.

79. En el ejemplo que acaba de exponerse se observan dos cosas: que el aumento de valor neto actualizado para el puerto, que pone de relieve el análisis financiero, es mucho menor que el valor neto actualizado de los beneficios que obtiene el país; y que, cuando se utiliza el precio virtual de las divisas, se reducen considerablemente esos beneficios económicos netos del país. Esto último se debe a que el costo económico del proyecto para el país es mucho más elevado que el desembolso efectivo, puesto que el costo representa gastos en divisas, a cuyo valor hay que añadir una prima que se refleja en su precio virtual.

80. Este sencillo ejemplo pone de relieve la diferencia entre los resultados de un análisis financiero y un análisis de costos y beneficios económicos. Ambos métodos son seguros y correctos. La diferencia se debe a que la evaluación de costos y beneficios por el puerto y por el país no tiene por qué coincidir necesariamente. Por eso no puede pretenderse que un resultado favorable para el puerto, basado en un análisis puramente financiero, signifique necesariamente un resultado también favorable para el país y viceversa. Un proyecto que quizá no presente utilidades financieras para el puerto puede suponer un importante beneficio económico para el país.

24/ Este valor representa el valor actualizado de la corriente de beneficios netos de 5 millones al año durante los años 2 a 6.

25/ Valor neto actualizado = (17,23) - (1,5) 10,0 = 2,23 millones de rupias.

Capítulo VI

OTRAS CUESTIONES RELACIONADAS CON LA EVALUACION DE PROYECTOS

A. Inflación

81. Para poder comparar los costos y beneficios registrados en diversos períodos de tiempo hay que actualizar debidamente los valores futuros. Este método resulta válido incluso en períodos de inflación. Hay dos maneras de tener ésta en cuenta en el proceso de actualización. Una de ellas es añadir, como hace el mercado privado, la tasa de inflación a la tasa de actualización, aumentando simultáneamente las corrientes futuras en función de la inflación. La otra es emplear la tasa de actualización "libre de inflación", o sea, la llamada tasa real de rendimiento, y utilizar precios y valores constantes. Ambos métodos son, de hecho, equivalentes y los dos pueden arrojar resultados idénticos en cuanto a la evaluación de costos y beneficios.

82. Tomemos un ejemplo sencillo. Si la tasa real de actualización (tasa de actualización libre de inflación) utilizada en el proyecto es del 10%- y del 9% la tasa de inflación anual, la tasa de actualización teniendo en cuenta la inflación será del 19,9% 26/.

83. Una grúa pórtico que cuesta ahora (1975) 1,7 millones de dólares costará 2.615.661 dólares dentro de cinco años (1980) 27/. El costo actualizado de esa grúa comprada en 1980 al precio de entonces se obtiene aplicando una tasa, "reajustada en función de la inflación", del 19,9%. El costo actualizado de la grúa es, por lo tanto de 1.055.566 28/. En dólares constantes (1975), el precio de la grúa pórtico sigue siendo en 1980 de 1,7 millones de dólares. El costo del valor actualizado se obtiene en este caso sobre la base de una tasa real "libre de inflación" del 10%, que arroja la cifra de 1.055.566 dólares 29/. Ambos métodos llevan, pues, al mismo resultado.

B. Incertidumbre y riesgo

84. Para tratar el riesgo, hay que tener en cuenta la multiplicidad de tipos de interés que existe en el mercado monetario. Los proyectos más arriesgados tienen que ofrecer intereses más elevados para atraer capital.

85. A efectos de evaluación de la inversión portuaria, el reajuste de la tasa de actualización con objeto de tener en cuenta el riesgo es un procedimiento muy poco preciso para enfocar el problema de la incertidumbre.

86. En la evaluación de una inversión portuaria tiene gran importancia el grado de precisión y de fiabilidad de las previsiones de tráfico y de tonelaje de carga, grado en el que

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26/ A ese resultado se llega de la manera siguiente: $(1 + 0{,}10)\ (1 + 0{,}09) - 1 = 0{,}19$

27/ $(1{,}7 \text{ millones de dólares})\ (1 + 0{,}09)^5 = 2.615.661$ dólares.

28/ $\dfrac{2.615.661 \text{ dólares}}{(1 + 0{,}199)^5} = 1.055.566$ dólares.

29/ $\dfrac{1{,}7 \text{ millones de dólares}}{(1 + 0{,}10)^5} = 1.055.566$ dólares.

pueden influir una multiplicidad de factores. Este elemento de incertidumbre en la demanda de servicios del puerto es lo que da lugar al factor riesgo en la inversión portuaria. No basta en este contexto reajustar la tasa de actualización añadiéndola una prima por riesgo; es más útil tener en cuenta directamente ese elemento de incertidumbre.

87. Para que resulte más claro, supongamos que se hacen tres previsiones de tráfico basadas respectivamente en hipótesis optimistas, moderadas y pesimistas sobre la economía, y que se evalúa la inversión en función de cada una de ellas, calculando el valor neto actualizado de cada posibilidad.

88. ¿Cuál es la probabilidad de que cada una de esas previsiones se realice? Suponiendo que se piense que la previsión optimista de una tasa de crecimiento del 25% tiene una probabilidad de 0,2, que la previsión pesimista de un crecimiento del 5% tiene una probabilidad de 0,3 y que la previsión moderada de un crecimiento del 15% tiene una probabilidad de 0,5, esas tres probabilidades deberán ser tenidas en cuenta para la evaluación. Supóngase que se obtienen las siguientes cifras:

Previsión	Valor neto actualizado (en millones de dólares)	Probabilidad estimada de que la previsión se realice
Optimista	50	0,2
Moderada	20	0,5
Pesimista	-15	0,3

89. El valor previsto 30/ de esos tres resultados sería de 15,5 millones de dólares. El valor neto actualizado previsto es, pues, positivo, por lo que el proyecto resulta aceptable 31/. Los resultados dependen, por supuesto, de las probabilidades que se asignen a cada previsión del tráfico, pero esas previsiones están basadas en la mejor información de que se dispone sobre el futuro en el momento de adoptar la decisión. Si se realiza el proyecto y la que se cumple es la previsión pesimista, se producirá una pérdida de 15 millones de dólares. Eso no significa necesariamente que la decisión fuese equivocada. Hay que comprender que una diferencia fundamental entre la adopción de decisiones con un elemento de incertidumbre y la adopción de decisiones cuando no se da ese elemento es que, en la primera de ellas, el acierto de la decisión no puede juzgarse por el resultado,

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30/ En el análisis del riesgo, el "valor previsto" es la media ponderada de los diversos resultados posibles, media que equivale a la suma de cada uno de ellos ponderado en función de su probabilidad. En este caso, el valor previsto es [(50 x 0,2) + (20 x 0,5) + (-15 x 0,3)] = 15,5.

31/ Cuando el costo de la inversión portuaria representa una pequeña parte de los gastos del gobierno, es de suponer que el puerto adoptará sus propias decisiones sobre el valor previsto. No es esto ajeno al hecho de que, dado que la suma arriesgada es pequeña en relación con la riqueza total, la decisión tiende a basarse precisamente en ese valor.

C. Análisis de sensibilidad

90. En vista de la incertidumbre, más o menos grande, que inevitablemente acompaña a cada una de las estimaciones de los futuros parámetros -no sólo en el caso de las previsiones de tráfico, sino también en las de costos, productividad, etc.-, es aconsejable examinar los efectos de esa incertidumbre en los argumentos que puedan aducirse en pro o en contra de determinada inversión. El análisis de sensibilidad puede tener dos formas principales.

91. El método más sencillo es repetir varias veces el análisis de costos y beneficios y el análisis financiero, dando cada vez a uno de los parámetros principales un valor correspondiente a una "situación de riesgo". La previsión de tráfico pesimista a que antes se ha hecho referencia sería la primera de esas variaciones, cada una de las cuales debe enfocarse por separado. En rigor puede haber interacciones entre los parámetros, pero éstas no suelen ser importantes. No es aconsejable calcular poniéndose "en el peor de los casos", es decir, partiendo de la hipótesis de que todos los riesgos se convertirán al mismo tiempo en realidad, ya que eso es muy poco probable que suceda.

92. A veces, estos cálculos de incertidumbre se han hecho variando los factores importantes -por ejemplo, los costos de construcción- en un 15% y estimando los efectos de esas variaciones en la TIR (la TIR es más útil en estos casos, en los que tiene un sentido incluso cuando es inferior al costo de oportunidad del capital, en tanto que el VNA no matiza generalmente la situación). Aunque este procedimiento da una buena idea de la sensibilidad relativa de cada factor, es posible que no proporcione a la persona que ha de decidir toda la información que necesita.

93. Un procedimiento más conveniente es el de invertir el cálculo y averiguar en qué medida tendrá que modificarse cada uno de los factores del insumo para que la TIR del proyecto descienda por debajo del mínimo aceptable. En el cuadro que figura a continuación, se indica, por ejemplo -en un caso hipotético- en qué medida tendrá que modificarse cada una de las seis variables importantes antes de que la TIR de un proyecto, que según la mejor estimación tendría un rendimiento del 15%, descienda por debajo de la tasa umbral del 10%. La productividad, por ejemplo, tendría que disminuir como puede apreciarse en un 30%, disminución que los administradores opinarán seguramente que no es probable que se registre. Cada variación se juzga con independencia, manteniendo todas las demás variables con arreglo a la mejor estimación.

	Mejor estimación	Cambio necesario para que la TIR se reduzca al 10%
Costo de las nuevas instalaciones	10 millones de dólares	aumento a 13 millones de dólares
Productividad	500 toneladas/buque diarias	disminución a 350 toneladas/buque diarias
Tasa de crecimiento del tráfico	5% anual	6% anual
Vida útil de las instalaciones	20 años	15 años
Costo del tiempo de los buques	5.000 dólares diarios	8.000 dólares diarios
Días de servicio al año	300	270

94. Estos cambios de la TIR en función de cada situación de riesgo se presentan a la autoridad que ha de pronunciarse sobre la inversión para que pueda tener en cuenta toda las posibilidades razonables.

95. Este sencillo método puede no ser adecuado para inversiones muy importantes, en las que es aconsejable utilizar un método que permita presentar a la autoridad competente una sola cifra de probabilidad que combine las distintas incertidumbres. Esto no puede hacerse satisfactoriamente recurriendo al método antes descrito, ya que exige una técnica más avanzada que se conoce con diversos nombres: análisis de Montecarlo o simulación de análisis de riesgo 32/, por ejemplo.

96. El método de Montecarlo consiste en describir cada una de las incertidumbres de los parámetros como una distribución aproximada de probabilidad estadística, y extraer seguidamente al azar un número de cada una de las distribuciones para obtener una combinación aleatoria de situaciones de riesgos, sobre cuya base se procederá al análisis de costos y beneficios y al análisis financiero. El proceso se repite para un gran número de esas combinaciones de números sacadas al azar hasta que se forme una nueva distribución de probabilidades conjunta. Esa distribución representa el riesgo global de la inversión, y es posible presentarla como un conjunto de probabilidades de que la TIR resulte superior o inferior la previsión central, o en forma de curva tal como se indica en el gráfico 4. Aunque es posible efectuar manualmente un análisis de riesgos por el método de Montecarlo, normalmente será preferible preparar un sencillo programa para confiar ese trabajo a una calculadora.

D. El factor cronológico en la inversión

97. El momento oportuno para la ejecución de un proyecto es aquel en que dicha ejecución produce el máximo valor neto actualizado (VNA).

98. Cuando se estudia la posibilidad de realizar un proyecto y el análisis demuestra que éste tiene VNA positivo, una de las cuestiones que se plantean es la de saber si ese proyecto debe ponerse inmediatamente en ejecución o aplazarse. El aplazamiento del proyecto durante un año retrasará en ese plazo los gastos, pero también demorará al mismo tiempo la obtención de beneficios. Si el VNA (0) del proyecto, ahora realizado, es inferior al VNA (1) obtenible si se realiza un año después, el proyecto debe aplazarse

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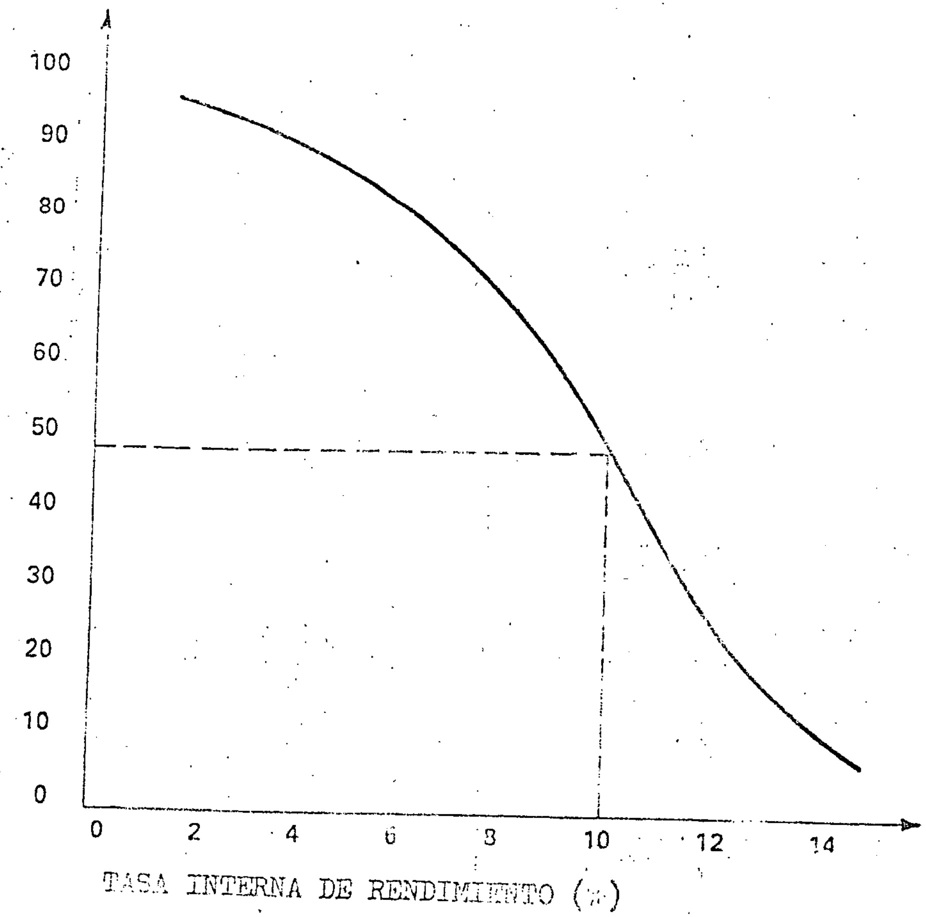
32/ Es ésta una expresión poco apropiada para designar el método de Montecarlo puesto que puede confundirse con la simulación digital basada en los acontecimientos, que es necesaria para "copiar" el comportamiento de un puerto como forma de análisis de los resultados.

Gráfico 4

PRESENTACION DE UN ANALISIS DE RIESGOS EFECTUADO POR EL METODO MONTECARLO

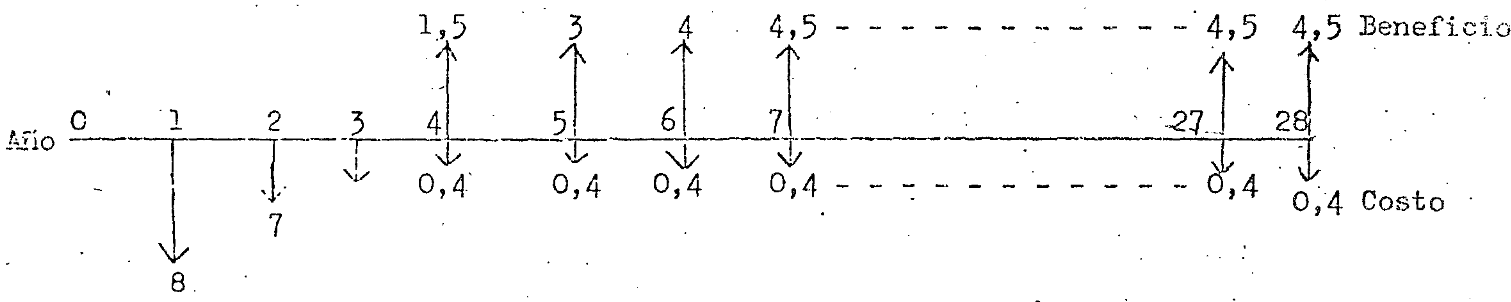
Probabilidades de que la TIR sea por lo menos tan elevada como el valor indicado.



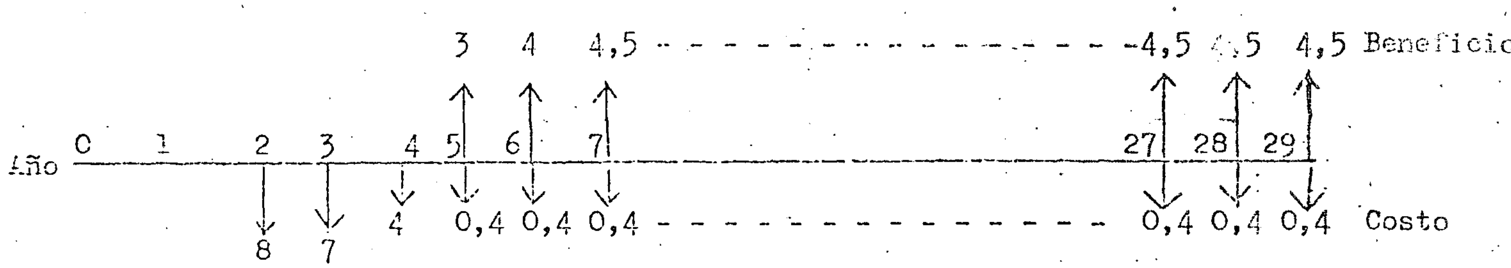
99. Para ilustrar lo expuesto mediante un ejemplo simplificado, véase en el gráfico 5 el perfil cronológico de los costos y los beneficios de un proyecto hipotético, que podría consistir en la construcción de un puesto de atraque que se tardaría tres años en terminar. Se da por supuesto que el tráfico está aumentando y que, caso de construirse, ahora, el puesto de atraque reportará 1,5 millones de dólares de beneficios en forma de costos evitados en el cuarto año, y una cifra que irá aumentando gradualmente con el incremento del tráfico hasta situarse en unos 4,5 millones de dólares anuales a partir del séptimo año. Los costos de explotación se calculan en 0,4 millones de dólares por cada año de vida útil de la nueva construcción.

Gráfico 5

PERFIL CRONOLOGICO DE COSTOS Y BENEFICIOS DE UN PROYECTO HIPOTETICO



i) De ejecutarse ahora, VNA = 8,62 millones de dólares



ii) De aplazarse un año, VNA = 9,6 millones de dólares.

100. El valor neto actualizado VNA (0) del proyecto es de 8,62 millones de dólares, lo que significa que el proyecto es aceptable (véase el cuadro 2 infra). De lo que se trata ahora es de saber si el proyecto debe ejecutarse ahora o dentro de un año.

101. En el supuesto de que la vida útil de las instalaciones siga siendo de 25 años, su aplazamiento durante un año retrasará los gastos en un año igualmente, y afectará los beneficios de dos, por cuanto se perderán los del año (4) pero se añadirán en cambio los del año (29) 33/. Por eso, si los costos ahorrados son mayores que los beneficios perdidos, el proyecto debería aplazarse durante un año.

102. El valor actualizado de los costos, si el proyecto se aplaza durante un año, es de 17,08 millones de dólares, lo que significa un ahorro de costos de 1,72 millones. La pérdida de beneficios debida al aplazamiento de un año es, por su parte, en términos de valor actualizado, de 0,74 millones. El proyecto debe aplazarse por consiguiente, para dentro de un año.

103. Con razonamientos y cálculos semejantes es posible saber si el proyecto debe aplazarse dos años, tres años, etc. Aplazar el proyecto por un año más supondría un nuevo ahorro de costos de 1,56 millones de dólares, pero provocaría también una nueva pérdida de beneficios de 1,6 millones que anularía las ventajas de tal ahorro. El aplazamiento del proyecto durante dos años es excesivo, ya que el valor neto actualizado del proyecto, aplazado por dos años (VNA (2)), sería en realidad de 9,56 millones, frente a 8,62 en caso de ejecución inmediata, y 9,6 millones con un aplazamiento de un año. Es lógico, por lo tanto, aplazar un año la ejecución del proyecto, pero no dos.

104. Una manera más sencilla de abordar el problema es estudiar la tasa de rendimiento del primer año. Este método es muy utilizado y las instituciones internacionales de crédito se sirven de él para determinar si el proyecto debe ejecutarse en un momento dado.

105. El método de la tasa de rendimiento del primer año supone la comparación de los beneficios del primer año completo con el costo del proyecto actualizado al año en que termina su construcción, es decir, al año anterior a aquel en que empiezan a percibirse los beneficios. Si la relación así obtenida es menor que la tasa de actualización (costo de oportunidad del capital), el proyecto deberá aplazarse durante un año. En el ejemplo antes citado, las cifras son las siguientes:

Beneficios del primer año = 1,5 millones de dólares

Valor de los costos de capital actualizados al año (3)

$$= (8)\ (1{,}10)^2 + 7\ (1{,}10) - 4$$

$$= 21{,}38 \text{ millones de dólares}$$

$$\text{Tasa de rendimiento del primer año} = \frac{1{,}5}{2{,}38} = 0{,}07 \text{ (i.e., 7\%)}$$

Esta cifra es menor que el costo previsto de oportunidad del capital, que es de un 10%, por lo que el proyecto deberá aplazarse durante un año.

33/ Por "beneficios" se entiende aquí los atribuidos al proyecto, que en este caso sencillo se supone que dependen del tiempo cronológico y no de la "edad" del proyecto.

Cuadro 2

Cálculo de costos y beneficos según el momento en que se realiza la inversión

(En millones de dólares)

COSTOS

Año	Costos	Valor actualizado Costos (al 10%)	Año	Costos	Valor actualizado Costos (al 10%)
			En caso de aplazamiento de un año		
0	-	-	0	-	-
1	8	7,27	1	-	-
2	7	5,79	2	8	6,61
3	4	3,01	3	7	5,26
4 a 28	0,4	2,73	4	4	2,73
			5 a 29	0,4	2,48
		18,80			17,08

BENEFICIOS

Año	Beneficios	Valor actualizado Beneficios (al 10%)	Año	Beneficios	Valor actualizado Beneficios (al 10%)
0	-	-	0	-	-
1	-	-	1	-	-
2	-	-	2	-	-
3	-	-	3	-	-
4	1,5	1,02	4	-	-
5	3	1,86	5	3	1,86
6	4	2,26	6	4	2,26
7 a 28	4,5	22,28	7 a 29	4,5	22,56
		27,42			26,68

VNA (0) = 27,42 - 18,80 = 8,62 millones de dólares

VNA (1) = 26,68 - 17,08 = 9,60 millones de dólares

Ahorro de costos en caso de aplazamiento de un año = 18,80 - 17,08 = 1,72 millones de dólares.

Beneficios perdidos en caso de aplazamiento de un año = 27,42 - 26,68 = 0,74 millones de dólares.

106. Si el proyecto se aplaza durante dos años, los beneficios del primer año aparecen ahora en el año (5) y se elevan a 3 millones de dólares. La tasa de rendimiento del primer año pasa a ser de 3/21,38 = 0,140 (es decir, el 14%) 34/, que es mayor que el costo de oportunidad del 10%. En consecuencia se llega a la misma conclusión, es decir, a la de que el proyecto no debe aplazarse más de un año. En general, un proyecto debe emprenderse cuando la relación entre los beneficios del primer año inmediatamente posterior a la construcción y el costo de capital actualizado al año de terminación/inauguración del proyecto es superior al costo de oportunidad del capital.

107. En el caso de que ya haya una grave congestión en el puerto, que indique que su capacidad es insuficiente y que se requieren nuevos puestos de atraque, tanto el razonamiento anterior como el método de la tasa de rendimiento del primer año pondrán de relieve que ya es hora de sobra de proceder a la inversión.

108. Siguiendo con el ejemplo anterior, pero dando ahora por supuesto que existe una situación de congestión, es razonable pensar que los beneficios del primer año después de completarse el proyecto serán mucho más elevados. Suponiendo que los beneficios sean de 4,5 millones de dólares anuales a partir del primer año de rendimiento, la relación obtenida con el método de la tasa de rendimiento del primer año sería de (4,5/21,38) = 0,21, valor muy superior al costo de oportunidad del capital, lo que significa que ya hace tiempo que debería haberse empezado a ejecutar el proyecto.

109. El método de la tasa de rendimiento del primer año es un instrumento útil y conveniente que debe utilizarse como indicador para determinar el momento más oportuno para la inversión 35/. El razonamiento es sencillo. El valor actual del costo de capital del proyecto actualizado al año (3) es de 21,38 millones de dólares. La inversión de esa suma al costo de oportunidad del capital, que es en este caso del 10%, dará un rendimiento de (0,1). (21,38) = 2,138 dentro de un año. Por lo tanto, si el rendimiento del primer año del proyecto es inferior esa cifra, conviene aplazar un año el proyecto.

110. El método de la tasa de rendimiento del primer año que se usa mucho por razones de comodidad, resulta un instrumento aceptable para determinar el momento más oportuno para la inversión 36/ cuando los beneficios se incrementan monotónicamente con el

34/ El denominador sigue siendo 21,38 millones de dólares, pero ahora se actualiza al año (4) en vez de al año (3).

35/ Tiene también la virtud de equivaler a la relación marginal costo-beneficio cuando los beneficios se incrementan monotónicamente con el tiempo, independientemente de la edad del proyecto. En rigor, para determinar lo mejor posible el momento más oportuno para la realización del proyecto debe utilizarse la relación marginal costo-beneficio.

36/ La cuestión del momento en que debe invertirse, en este caso en la construcción de un nuevo puesto de atraque, es estudiada con cierto detalle por J. W. Devanney III y L. H. Tan en "Port Pricing and Expansion" (véase E. Frankel, Studies on the future of Atlantic ports, Massachussets Institute of Technology, julio de 1973, National Technical Information Service, Departamento de Comercio de los Estados Unidos).

tiempo independientemente de la edad del proyecto 37/. Hay que recordar que el método de la tasa de rendimiento del primer año se refiere sólo a la oportunidad del proyecto en el tiempo y no sirve por sí misma de medida de su justificación económica. Por eso debe utilizarse en todos los casos teniendo, además, en cuenta el valor neto actualizado, la tasa interna de rendimiento y la relación costo/beneficio.

37/ Para un examen de la misma cuestión cuando no se dan esas condiciones, véase S. A. Marglin, Aproaches to Dynamic Investment Planning, North Holland, Amsterdam, 1963.

Anexo

EJEMPLO DE LA INFLUENCIA DEFORMADORA DEL EFECTO MULTIPLICADOR EN LA EVOLUCION DE PROYECTOS

1. El ejemplo siguiente demuestra cómo puede influir el efecto multiplicador en los resultados de la evaluación de un proyecto.

2. Un promotor puede afirmar que los beneficios indirectos del proyecto se reinvierten. Una inversión portuaria, por ejemplo, puede dar lugar a un aumento del empleo. Si la nómina global de sueldos de la región aumenta en 10 millones de dólares debido a la inversión, el promotor puede alegar que, de no ejecutarse el proyecto, se privará a la región de 10 millones de dólares de beneficios de los trabajadores, más los beneficios generados por el efecto multiplicador. El efecto multiplicador a que se hace referencia es la secuencia de la reinversión que supone el lucro de que los trabajadores utilicen sus nuevos ingresos para comprar alimentos, materiales y otros bienes y servicios. El promotor del proyecto de inversión portuaria puede afirmar que los comerciantes locales venderán más y reinvertirán a su vez sus utilidades, y así sucesivamente. De ese modo, los primeros 10 millones de dólares de salarios se "multiplicarán" por 3, por 4 o hasta por 5 al ir pasando de eslabón en eslabón de la cadena de reinversión de los beneficios.

3. En primer lugar, debe advertirse que los 10 millones de dólares de nuevos salarios no constituyen necesariamente un beneficio neto para los trabajadores, a menos que el desempleo esté tan extendido que el costo de oportunidad de la mano de obra sea cero, es decir, que esos trabajadores estuvieran antes desocupados y no produjeran nada. En la medida en que no exista un amplio desempleo, el costo de oportunidad de la mano de obra no equivaldría a cero, lo que quiere decir que algunos trabajadores dejarán otros puestos, sobre todo en el sector agrícola, donde pueden estar subempleados. Supóngase, por ejemplo, que el precio de mercado de la mano de obra sea un 25% más elevado que su costo de oportunidad. Eso significa que el aumento neto de beneficios de los trabajadores de la región relacionados con el proyecto no es de 10 millones de dólares, sino tan sólo de 2 millones, puesto que ya anteriormente eran capaces de producir 8 millones sin el proyecto. Supóngase ahora que esos 2 millones de beneficio neto que obtienen los trabajadores se invierten en alimentos y prendas de vestir. Los minoristas locales apreciarán un incremento de 2 millones de dólares en sus ingresos brutos, pero eso no significa un aumento neto equivalente del ingreso regional. La venta al por menor tiene gastos de mano de obra, capital y materiales, gastos todos cuyo importe hubiera podido destinarse a otros usos, es decir, que también en relación con esos recursos puede hablarse de costos de oportunidad.

4. Dependiendo también de la situación existente en el mercado de reinversión, el aumento neto del ingreso es un porcentaje de la primera ronda de reinversiones. Suponiendo, por ejemplo, que los precios de los productos ofrecidos en todos los mercados se fijen en un 25% más que el costo de oportunidad de sus insumos, la segunda reinversión de los 2 millones de dólares sería de (0,25 x 2 =) 0,5 millones de dólares; la tercera, de (0,25 x 0,5 =) 0,125 millones; la cuarta, de (0,25 x 0,125 =) 0,03125 millones, etc. Es evidente que, después de unas cuantas rondas más, la inversión desaparece. Aun suponiendo que fuera infinita, puede demostrarse que el caudal de reinversión se reduce a 2,667 millones de dólares, que es sólo el 26,67% de los 10 millones originales, y está muy lejos del triple, el cuádruple, o incluso el quíntuplo, de que hablaban los promotores y defensores del proyecto.

SEGUNDA PARTE

ESTUDIOS DE CASOS

CASO Nº 1: LOS PUERTOS DE ALFANIA

Proceso de evaluación de una determinada posibilidad de inversión

1. Las condiciones de Alfania son las típicas de varios países en desarrollo. Sus exportaciones principales son dos productos agrícolas: cacahuetes, transportados en sacos y aceite de coco, transportado en barriles; las importaciones están constituidas fundamentalmente por los fertilizantes, la pequeña maquinaria y los artículos domésticos.

2. El país tiene dos puertos, el principal de los cuales, que es el de Lamda, está situado al suroeste, cerca de la capital, Betaville, mientras que el otro, el de Mista, mucho más pequeño, se encuentra en la costa septentrional. La mayor parte de las plantaciones de cacahuetes y de cocoteros están situadas cerca de Betaville. La carretera que une el puerto de Mista con la capital pasa a través de una zona montañosa que, en la estación de las lluvias, puede quedar temporalmente cortada por corrimientos de tierras (véase el mapa).

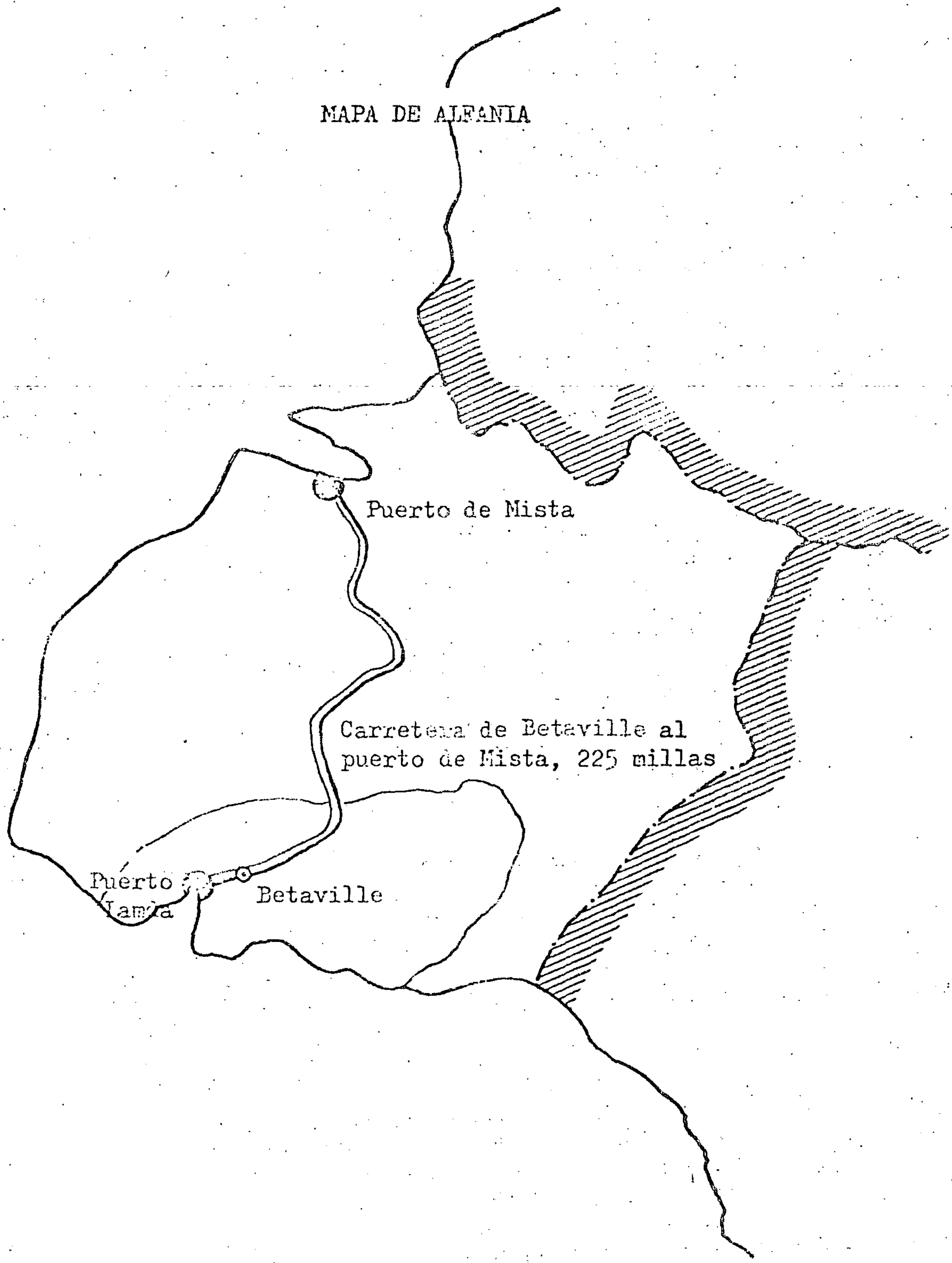
3. El puerto de Mista fue construido en los primeros días, cuando la extracción del estaño cerca de la costa septentrional resultaba rentable. Esa actividad ha ido posteriormente perdiendo importancia y el puerto de Mista está algo descuidado. En los tiempos más prósperos funcionaban con eficacia dos atracaderos.

4. El puerto de Lamda, en cambio, es un puerto más moderno, que fue construido a finales del decenio de 1960 y tiene cuatro atracaderos de carga general para las exportaciones agrícolas de la región de Betaville. Se espera que el tráfico siga aumentando a un ritmo uniforme del 5% en los próximos diez años y que después se estabilice. Los buques que ahora tocan en el puerto de Lamda tienen por término medio unas 10.000 TPM y no se espera que aumenten de tamaño, dado que la mayoría de los demás puertos que constituyen su ruta no admiten buques de mayor tonelaje.

5. Un reciente estudio del Ministerio de Transportes pone de manifiesto que, a menos que se aumente su capacidad, el puerto de Lamda no podrá hacer frente al mayor volumen de tráfico que se espera y habrá que desviar, por lo tanto, parte de la carga por la accidentada carretera que une el puerto de Lamda con el de Mista. La administración del puerto de Lamda ha realizado también un estudio independiente y ha llegado a las mismas conclusiones que el Ministerio de Transportes.

6. Para hacer frente a la situación, se está pensando en construir dos nuevos atracaderos, de la misma capacidad que los actuales, o sea de 250.000 toneladas cada uno, en el puerto de Lamda. El costo financiero de cada uno se calcula en 33,88 millones de unidades de la moneda nacional (Rp), de los que unos 31 millones corresponden a las obras de ingeniería civil, 2,80 millones a la adquisición de equipo y 0,08 millones a servicios de consultores. La construcción se ha calculado que durará tres años y la vida útil de cada atracadero se ha estimado en 16 años. Esta cifra es inferior a la vida física de las instalaciones, debido a que las innovaciones en los procedimientos de manipulación de la carga y contenerización pudieran dejarlas anticuadas. Los gastos de conservación y explotación de cada uno de los nuevos atracaderos se estiman en 0,66 millones de Rp al año.

7. La autoridad portuaria puede, por conducto del Ministerio de Transportes, obtener un crédito de 7.944 millones de dólares (que equivalen a 39,72 millones de Rp, al tipo de cambio oficial de 5 Rp por dólar) del Banco de Desarrollo Interregional del Pacífico (BDIP), al 8,5% y reembolsable en 16 años, debiendo pagarse el primer plazo en el cuarto año del proyecto. El crédito está destinado a sufragar los gastos del proyecto que han


MAPA DE ALFANIA
Puerto de Mista
Carretera de Betaville al
puerto de Mista, 225 millas
Puerto
Betaville

de hacerse en divisas. Los demás costos del proyecto se pagarán en moneda nacional mediante un empréstito del Gobierno de 28,04 millones de Rp al 5%, empréstito que deberá reembolsarse en 20 años, a partir del cuarto año del proyecto, una vez que los atracaderos estén en situación de funcionar. Estas aportaciones en efectivo se resumen en el cuadro 1.

8. El tráfico del año en curso (1975) es de 840.000 toneladas y el aumento previsto se indica en el cuadro 2.

Análisis

I. Evaluación financiera del puerto

9. Para la administración del puerto de Lamda, los costos del proyecto comprenden sólo los costos de capital de la construcción y los gastos corrientes de explotación, mientras que los beneficios representan la suma de los ingresos adicionales que se obtendrán con los atracaderos quinto y sexto.

10. En los tres primeros años de la fase de construcción del proyecto se incurrirá en gastos de capital, pero esos gastos se sufragarán con los créditos del BDIP y del Gobierno (véase el cuadro 3), lo que significa que los que realmente tendrán que sufragar la administración del puerto serán los intereses y la amortización de esos empréstitos. El costo total del proyecto estará representado, por consiguiente, por la suma de los reembolsos de los préstamos y los gastos anuales de explotación en que se incurra en el curso de los años 4 a 23, es decir, de 1979 a 1998.

11. En el cuadro 4 se hace un desglose de los gastos de construcción, en tanto que los de conservación figuran en el cuadro 5.

12. Los ingresos adicionales del puerto de Lamda procederán del mayor volumen de carga que el puerto podrá manipular con los nuevos atracaderos, carga que, de no construirse éstos, habría que desviar al puerto de Mista, situado muy al norte del país. A efectos de cálculo, los ingresos generados por tonelada de carga se estiman en 7,50 dólares o, lo que es lo mismo, en 37,5 Rp (al tipo de cambio oficial de 5 Rp/1 dólar). Tómese como ejemplo el año 1979, en el que, de no construirse los nuevos atracaderos, habría que desviar 21.000 toneladas de carga del puerto de Lamda. Con las nuevas instalaciones, el puerto aumentará sus ingresos (brutos) en 788.000 Rp (21.000 x 37,5 Rp). Análogamente se calculan los ingresos adicionales que producirá en los años siguientes la inversión portuaria en los nuevos puestos de atraque.

13. La evaluación financiera del puerto de Lamda se refiere principalmente a las corrientes netas de efectivo actualizadas sobre la base del costo de oportunidad del capital (última línea del cuadro 1). En el caso del puerto de Lamda, se calcula que el costo de oportunidad del capital, es decir, el rendimiento que podría obtenerse dedicando a otros usos sus fondos disponibles, es del 10%. Las corrientes netas de efectivo deben, por consiguiente, actualizarse al 10% para obtener el valor neto actualizado del proyecto.

14. En este caso, el valor neto actualizado para el puerto de Lamda es de 9,626 millones de Rp.

15. Esto indica que el proyecto es favorable desde el punto de vista del puerto y debe llevarse a la práctica.

Cuadro 1

Cuenta de la administración del puerto de Lemda

(En millones de Rp)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11) a (19)	(20)	(21)	(22)	(23)
PAGOS (SALIDAS)															
Gastos de construcción	27,652	18,852	21,256												
Gastos de explotación				1,32	1,32	1,32	1,32	1,32	1,32	1,32	1,32				
Reembolso del préstamo del BDIP				4,632	4,632	4,632	4,632	4,632	4,632	4,632	4,632				
Reembolso del préstamo del Gobierno				2,250	2,250	2,250	2,250	2,250	2,250	2,250	2,250	2,250	2,250	2,250	2,250
Total de pagos	27,652	18,852	21,256	8,202	8,202	8,202	8,202	8,202	8,202	8,202	8,202	2,250	2,250	2,250	2,250
INGRESOS (ENTRADAS)															
Empréstito del BDIP	14,04	10,04	15,64												
Empréstito del Gobierno	13,612	8,812	5,616												
Aumento de los ingresos del puerto				0,788	2,700	4,688	6,788	9,038	11,363	13,800	16,350				
Total de ingresos	27,652	18,852	21,256	0,788	2,700	4,688	6,788	9,038	11,363	13,800	16,350				
Corriente neta de efectivo	0	0	0	-7,414	-5,502	-3,514	-1,414	0,836	3,161	5,598	8,148	-2,250	-2,250	-2,250	-2,250
Corriente de efectivo actualizada al 10%	0	0	0	-5,064	-3,416	-1,984	-0,726	0,390	1,341	2,158	18,091 a/	← -1,166 b/ →			
Valor neto actualizado = 9,626															

Nota: Los números entre paréntesis de las cabeceras de las columnas se refieren al año (es decir, años 1-23).

a/ Suma de (11) a (19).

b/ Suma de (20) a (23).

II. Evaluación económica nacional basada en el análisis de los costos y los beneficios sociales a precios de mercado

16. Desde el punto de vista nacional, es preciso tener en cuenta otros elementos. Hay, en efecto, beneficios que lo son para el país, pero no para el puerto. Los costos de capital de los proyectos deberán medirse ahora, pues, por el desembolso real de fondos necesarios, más que por las condiciones de reembolso de los préstamos.

17. Examinemos, en primer lugar, la cuestión de los beneficios. El ahorro de costos de transporte interior es un beneficio, aunque no lo perciba el puerto. Y se trata de un beneficio real, porque si no se construyeran los atracaderos quinto y sexto, la carga tendría que ser enviada al puerto de Mista, en el norte, por una carretera sinuosa, lo que acarrearía gastos adicionales.

18. La carretera de la zona de Betaville al puerto de Mista tiene unas 225 millas y los gastos de transporte en camión se estiman en 0,45 Rp por tonelada/milla, incluido el viaje de regreso de vacío. Si en 1979 no se dispusiera de nuevos atracaderos, habría que expedir 21.000 toneladas de carga por el puerto de Mista. Los costos de transporte interior de esa carga se elevarían a 2.126.000 Rp (21.000 x 0,45 x 225). Ese costo de transporte interior sería innecesario y se economizaría con los nuevos puestos de atraque construidos en el puerto de Lamda. De ahí que, desde el punto de vista del país, el ahorro de costos de transporte interior deba incluirse entre los beneficios del proyecto. En las columnas 16 y 17 del cuadro 7 se indican las economías que por ese concepto se conseguirían en los años siguientes.

19. La reducción del costo del tiempo de espera de los buques es un beneficio que va a parar directamente a los armadores. En 1979, con cinco atracaderos en lugar de cuatro, el tiempo total de espera de los buques en ese año se habría reducido de 509 a 146 días 1/, lo que representa una reducción de 363 días y si el número de atracaderos fuera de seis, se conseguiría una nueva reducción de 102 días. Si se pusieran, pues, en funcionamiento seis atracaderos en lugar de cuatro, la reducción total del tiempo de espera de los buques en 1979 sería de (363 + 102 =) o (509 - 44 =) 465 días. (véanse las columnas 9, 10, 11 y y la línea 4 del cuadro 7.) El costo de inmovilización de los buques por día se calcula en (2.000 dólares =) 10.000 Rp. El dinero que se ahorraría, pues, en 1979 por concepto de reducción del tiempo de espera de los buques, con seis atracaderos en funcionamiento, sería de (465 x 10.000 Rp =) 4.650.000 Rp. Cálculos análogos se han hecho para los años siguientes.

20. La cuestión más interesante en lo que se refiere a la reducción de costos por tiempo de espera de los buques es la de si ese ahorro redunda en beneficio de los nacionales del país. A menos que éste tenga su propia línea nacional de navegación o compañías de transporte marítimo, propiedad de nacionales, que se beneficien directamente de esa reducción de los costos, la respuesta dependerá del grado del poder monopolístico que ejerzan las compañías de navegación que sirvan esa ruta. Esa reducción de costos sólo beneficiará a los nacionales del país si se traduce en una disminución de los fletes, cosa que puede suceder en condiciones de competencia. Sin embargo, la determinación de los fletes se hace de tal forma que, por lo general, se fijan para toda una serie de puertos, especialmente en el caso del transporte en buques de líneas regulares. La situación podría ser ligeramente diferente en lo que se refiere a los buques de carga de

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1/ Suponiendo que se dieran los factores siguientes: un tonelaje medio de 2.800 toneladas por buque; un movimiento diario de 1.000 toneladas; y 340 días de trabajo al año.

servicio irregular ("tramps") y a los buques fletados, ya que unos y otros tocan específicamente en los puertos de origen y de destino. Aquí también es importante, además del poder de negociación del cargador y del armador, el tipo de fletamento.

21. En el ejemplo estudiado, se supone que los buques de líneas regulares hacen escala en el puerto de Lamda, por ser éste uno de los puertos en que tocan los buques en la región. Las mejoras del puerto de Lamda no influirán apreciablemente en los fletes. Quizá se diga que muchos de los beneficios, si no todos, que lleva consigo la reducción de costos del tiempo de espera de los buques, irán a parar a los armadores extranjeros, pero también existe la posibilidad de utilizar un mecanismo adecuado de fijación de los precios portuarios que haga recaer esos beneficios sobre el propio puerto. También esto depende del carácter más o menos competitivo de los puertos de la región. Aun en el caso de que el puerto de Lamda pudiera conseguir sumas más elevadas de los armadores, no hay ninguna garantía de que éstos no vayan a repercutir sobre los importadores y los exportadores del propio país. A los fines de nuestro ejemplo se supone que la reducción de costos que supone la disminución del tiempo de espera de los buques redunda principalmente en beneficio de los armadores extranjeros, razón por la cual no se incluye en la evaluación de los beneficios que la inversión reporta al país 2/.

22. Por último, hay que considerar los beneficios que reporta el aumento de ingresos ocasionado por el mayor volumen de tráfico que admite el puerto gracias al aumento de su capacidad. Como se recordará, esos eran los principales beneficios que, desde el punto de vista de los ingresos brutos, obtendría el puerto de Lamda y que, en consecuencia, se trataban como tales en la evaluación financiera del puerto en la fase 1.

23. Se estima que cada tonelada adicional de carga que pase por el puerto de Lamda produce 37,5 Rp de ingresos brutos. Desde el punto de vista del puerto, se trata de ingresos que él percibe, sin que le preocupe su origen. Desde el punto de vista nacional, en cambio, es importante conocer la fuente o las fuentes de esos ingresos.

24. El análisis de las facturas de comercio exterior indica que en quien recae el grueso de los costos totales de transporte, incluidos los gastos en que incurre la carga en los puertos, es en los importadores y exportadores de Alfania. El Ministerio de Transportes ha tomado buena nota de esto, haciendo notar acertadamente que los ingresos obtenidos por el puerto provienen en último término de los importadores y exportadores nacionales, y poniendo esa información en conocimiento del Ministerio de Comercio y Desarrollo, al que ha advertido que, a menos que se consiga que los importadores y exportadores extranjeros compartan la carga de los gastos de transporte, el aumento de los ingresos brutos obtenidos por el puerto no representará un aumento neto de los beneficios del país 3/.

2/ No se plantea la cuestión de los beneficios para el país en forma de recargos evitados, porque se supone que los buques se dirigirían a otro lugar, en particular al puerto de Mista, tan pronto como el puerto de Lamda estuviera saturado y no se hubiera decidido construir otro atracadero. Los beneficios derivados de la existencia de las nuevas instalaciones están ya incluidos en las economías derivadas de la reducción de gastos de transporte interior.

3/ La situación sería distinta si el puerto de Mista estuviera situado en un país vecino. En ese caso, los ingresos brutos totales del puerto correspondientes a la carga adicional irían a parar a un puerto extranjero si la capacidad del puerto de Lamda no fuera suficiente para hacer frente al aumento de tráfico. En ese caso, la construcción de los nuevos atracaderos en el puerto de Lamda permitiría evitar esa salida de fondos pagados por los importadores y los exportadores locales. Los beneficios que obtendría

25. El Ministerio de Transportes señala, además, acertadamente, que, desde el punto de vista nacional, la expansión del puerto de Lamda se justifica por las ventajas que, desde el punto de vista de los costos, reportaría en relación con el transporte interior.

26. Una vez calculados, como se hace en el cuadro 8, los costos y los beneficios anuales del proyecto, el valor neto actualizado se obtiene mediante la aplicación de una tasa de actualización que va del 5 al 15% (véase el cuadro 9 - fase II).

27. Los beneficios nacionales netos (BNN) del proyecto serán, por consiguiente, el valor actualizado de las economías logradas en los costos del transporte interior menos el valor actualizado de los costos de los dos nuevos atracaderos 4/.

28. Este es el valor de los beneficios nacionales netos en términos de beneficios globales a los precios de mercado no ajustados de los factores del insumo. Hay que hacer notar que estos BNN no representan un verdadero aumento de los beneficios netos. Los recursos utilizados se evaluaron a sus precios de mercado, precios que, por diversas razones, no reflejan los costos de oportunidad de esos recursos. Para tener eso en cuenta, hay que introducir los precios virtuales.

III. Utilización de los precios virtuales

29. La tercera fase de la evaluación requiere un reajuste de los precios de los recursos utilizados. Consideremos, en primer lugar, el caso de la mano de obra no especializada. Ya es sabido que la tasa de desempleo en Alfania es elevada y que hay abundancia de trabajadores no calificados, muchos de los cuales trabajan en las plantaciones de cacahuetes y de cocos a un nivel de subsistencia. El costo de oportunidad de la mano de obra no calificada, es decir, la producción atribuida al trabajador no calificado que antes trabajaba en las plantaciones, es muy inferior al importe de los salarios de mercado pagados por el puerto. En general, el costo de oportunidad o precio virtual de la mano de obra no calificada viene dado por la fórmula $(1 + E) W$, en la que E es la prima de trabajo no calificado y la W la tasa de mercado de los salarios. En el caso de Alfania, el valor de E es negativo. El Centro de Planificación Económica del Gobierno calcula que el costo de oportunidad de la mano de obra equivale al 10% de la tasa de mercado de los salarios, lo que significa que E = -0,9.

30. En lo que se refiere, en cambio, a la mano de obra calificada, hay en Alfania generalmente una situación de pleno empleo. El mercado de este tipo de mano de obra es competitivo, por lo que cabe suponer que los salarios que se pagan a estos trabajadores representan su costo de oportunidad social y no es, por consiguiente, necesario reajustarlos a efectos de evaluación de la inversión.

31. En lo que respecta a las divisas, Alfania se encuentra ante una grave situación de déficit de la balanza de pagos. Existen diversas restricciones cuantitativas a la importación y es evidente que una unidad de divisa extranjera tiene más valor que la suma que se obtiene al cambio oficial de 5 Rp/1 dólar. El precio virtual de las divisas se puede

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el país en esa situación serían equivalentes a los ingresos brutos totales que devengara el puerto de Lamda. Si no existiera en absoluto el puerto de Mista, ni en el propio país ni en un país vecino bastante próximo, los beneficios derivados del aumento de capacidad del puerto de Lamda equivaldrían al aumento de beneficios de los importadores y exportadores nacionales ya que, sin medios de transportar la carga, ese aumento no podría realizarse.

4/ BNN = (2,51) + (2,61) - (3) - (4) - (5) - (6). En el presente estudio se supone que los ingresos del puerto indicados en la partida 7 del cuadro 8 provienen de los usuarios locales. Desde el punto de vista nacional, se trata, pues, de una transferencia de fondos dentro del país que no entra, por consiguiente, en el cómputo del BNN.

representar por (1+p) E, donde p es la pluvalía de una unidad de divisa y E representa tipo de cambio oficial. El Centro de Planificación Económica del Gobierno estima que el precio virtual de las divisas es un 75% más elevado que el tipo de cambio oficial, es decir, que p = 0,75.

32. Los beneficios sociales netos del proyecto evaluados a los precios virtuales de sus factores de insumo vienen ahora dados por los beneficios nacionales netos, ya mencionados pero sobre la base de los valores reajustados en cuanto al costo de la mano de obra no especializada y de las divisas 5/.

Examen de los aspectos económicos de la evaluación

33. Con una tasa de actualización social del 10%, el actual valor neto actualizado del proyecto a precios de mercado no reajustados (fase II) es de 94.861 millones de Rp, suma casi diez veces mayor que la obtenida en la fase I, en la que sólo se tomó en consideración el punto de vista del puerto. Como ya se ha indicado, sin embargo, desde el punto de vista nacional, los factores del insumo tienen que ser reajustados, utilizando los precios virtuales, para que reflejen su costo de oportunidad para la economía. En la fase III (véase el cuadro 9) se tiene en cuenta que el precio virtual de la mano de obra no calificada es sólo la décima parte del salario real de mercado, pero también que el precio virtual de las divisas es superior en 1,75 veces al tipo de cambio oficial. Como la proporción del costo correspondiente a las divisas es muy superior a la de la mano de obra no calificada, el costo económico del proyecto calculado sobre la base de los precios virtuales es efectivamente más elevado que su puro costo financiero. Como los beneficios del proyecto, es decir, las economías realizadas en el costo del transporte interior, se cifran en moneda nacional, no precisan ningún reajuste para reflejar su verdadero valor económico para el país, por lo que se mantienen igual que en la fase II. Por consiguiente, el valor neto actualizado en la fase III, tomando en consideración los costos de oportunidad de la mano de obra no calificada y de las divisas, es inferior al obtenido a los precios de mercado no ajustados. El valor neto actualizado del proyecto sigue siendo, sin embargo, muy superior al obtenido en la fase I.

Resumen y conclusiones

34. El estudio de este caso concreto sirve para ilustrar la mecánica del proceso de evaluación sobre la base de las tres fases examinadas en el texto. En él se ponen de manifiesto los aspectos más importantes y significativos de una correcta evaluación de los costos de los recursos utilizados a sus precios virtuales o costos de oportunidad.

35. Debe hacerse notar que en esta evaluación sólo se toma en consideración una determinada posibilidad de inversión. Hay, por supuesto, otras posibilidades y alternativas que, sometidas al mismo proceso de evaluación, producirían resultados diferentes.

36. Otra cuestión importante es la del análisis de sensibilidad. Los resultados obtenidos en la evaluación serán distintos si varían factores como la prima de las divisas o los costos de oportunidad de la mano de obra no calificada. Hay que conocer el grado de

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5/ BNN = (2,51) + (2,61) - (1+E) (3U) - (3L) - (3D) - (1+p) (3F) - (1+p) (4F) - (5D) - (1+p) (5F) - 1(+E) (6U) - (6L) - (6D) - (1+p) (6F).

sensibilidad de los resultados en relación con esos factores. Además, los parámetros macroeconómicos no suelen ser exactos, por lo que, dados sus importantes efectos en el proceso de evaluación, deben someterse también a análisis de sensibilidad.

37. El plan de inversión se basa en la proyección del tráfico dada. De ahí lo importante que es prever con la mayor exactitud posible el volumen de éste.

38. El beneficio neto actualizado obtenido por el puerto descontado al 10%, es decir, su costo de oportunidad de capital, es sólo de 9,624 millones de Rp. Evaluado al nivel nacional, en el que los beneficios representan sobre todo economías realizadas en los costos de transporte interior, y utilizando los precios virtuales para reflejar los verdaderos costos económicos, el proyecto resulta mucho más favorable y arroja un beneficio neto actualizado mucho mayor, de 77,450 millones de Rp. Eso puede hacer que un proyecto portuario no se justifique tomando meramente como base la relación financiera entre costos y beneficios considerada desde el punto de vista del puerto y resultar, sin embargo, una inversión muy interesante desde el punto de vista nacional. Pero puede también ocurrir que, aunque muy rentable desde el punto de vista del puerto, el proyecto represente una pérdida neta para el país.

39. Es, por consiguiente, indispensable evaluar los proyectos portuarios, no sólo al nivel del puerto mismo, sino también en términos de pérdidas o beneficios netos para el país. En los casos en que el puerto no obtenga ingresos suficientes para cubrir los costos de un proyecto y sufra una pérdida neta, pero el proyecto suponga beneficios netos para el país, es posible subvencionar el puerto mediante un plan fiscal o idear alguna forma de compensarle con transferencias de los sectores que efectivamente se beneficien del proyecto.

40. En este estudio de un caso concreto se exponen las consecuencias de los diferentes grados de evaluación de los proyectos y se señala que ningún compromiso importante de inversión portuaria, especialmente de infraestructura, debe contraerse de manera aislada, ya que el puerto es un nudo vital en el sistema económico del país.

Cuadro 2

Previsiones de tráfico

(En miles de toneladas)

	Año		
(0)	1975	840	
(1)	1976	882	5% de aumento
(2)	1977	926	
(3)	1978	972	
(4)	1979	1 021	
(5)	1980	1 072	
(6)	1981	1 125	
(7)	1982	1 181	
(8)	1983	1 241	
(9)	1984	1 303	
(10)	1985	1 368	
(11)	1986	1 436	
(12)	1987	1 436	
(13)	1988	1 436	
(14)	1989	1 436	
(15)	1990	1 436	
(16)	1991	1 436	
(17)	1992	1 436	
(18)	1993	1 436	
(19)	1994	1 436	

Cuadro 3

Sumas entregadas con cargo a los préstamos del Banco de Desarrollo Interregional del Pacífico

(En millones de Rp)

AÑO	(1)	(2)	(3)	Total
	14,04	10,04	15,64	39,72

del Gobierno

AÑO	(1)	(2)	(3)	Total
	13,612	8,812	5,616	28,04

Total de fondos recibidos para dos atracaderos = 67,76

Fondos necesarios por atracadero = 33,88

Préstamo del BDIP: 39,72 millones de Rp al 8,5% durante 16 años

Reembolso anual = 4,632 millones de Rp

Préstamo del Gobierno: 28,04 millones de Rp al 5% durante 20 años

Reembolso anual = 2,250 millones de Rp

Cuadro 4

Estimación de los costos por atracadero

(En millones de Rp)

	Costos totales	Componente en divisas
Obras de ingeniería		
a) Muelle	20,00	14,00
Muelle de pilotes		
b) Obras en tierra		
Cobertizo, almacén y taller	6,00	2,00
Servicios, electricidad, agua, alcantarillado y teléfonos	5,00	1,00
Total de obras de ingeniería	31,00	17,00
Equipo		
2 grúas móviles de 10 toneladas	1,34	1,34
4 carretillas elevadoras de horquilla de 4 toneladas	0,80	0,80
4 carretillas elevadoras de horquilla de 3 toneladas	0,66	0,66
Total de equipo de manipulación de carga	2,80	2,80
Servicios de consultores		
Ingeniero jefe residente	0,05	0,04
Otros servicios de expertos	0,03	0,02
Total de servicios de consultores	0,08	0,06
Total del costo del proyecto por atracadero	33,88	19,86

Cuadro 5

Gastos de conservación y explotación por atracadero y año de utilización de los recursos

(En millones de Rp)

Mano de obra no calificada	0,20
Mano de obra calificada	0,18
Materiales nacionales	0,16
Divisas	0,12
	0,66

Cuadro 6

Partidas de costo por atracadero y año de utilización de los recursos

(En millones de Rp)

	Año			Total
	(1)	(2)	(3)	
Obras de ingeniería				
Mano de obra no calificada	2,0	1,2	0,8	4,00
Mano de obra calificada	1,8	1,2	1,0	4,00
Materiales nacionales	3,0	2,0	1,0	6,00
Divisas	7,0	5,0	5,0	17,00
				31,00
Equipo				
Divisas	--	--	2,80	2,80
Servicios de consultores				
Moneda nacional	0,01	0,01	0,01	0,02
Divisas	0,02	0,02	0,02	0,06
	13,83	9,43	10,63	33,88
Total de costos por atracadero y año de utilización de los recursos				
Mano de obra no calificada	2,0	1,2	0,8	4,00
Mano de obra calificada	1,8	1,2	1,0	4,00
Materiales nacionales	3,06	2,01	1,01	6,02
Divisas	7,02	5,02	7,82	19,86
				33,88

Cuadro 7

Cálculo de las economías de costos debidas a la reducción del tiempo de espera de los buques y a la disminución de los transportes interiores

	Año	Tráfico de carga (en miles de toneladas)	Nº de buques: 4 atracaderos	Nº de buques: 5 atracaderos	Nº de buques: 6 atracaderos	Ocupación de los atracaderos: 4 atracaderos	Ocupación de los atracaderos: 5 atracaderos	Ocupación de los atracaderos: 6 atracaderos	Total anual del tiempo de espera de los buques (días): 4 atracaderos	Total anual del tiempo de espera de los buques (días): 5 atracaderos	Total anual del tiempo de espera de los buques (días): 6 atracaderos	Reducción de los costos por concepto de tiempo de espera de los buques, debida al 5º atracadero	Reducción de los costos por concepto de tiempo de espera de los buques, debida al 5º atracadero	Cantidad de carga desviada con sólo 4 atracaderos (miles de toneladas)	Cantidad de carga desviada con sólo 5 atracaderos (miles de toneladas)	Reducción de los costos por concepto de transportes interiores, debida al 5º atracadero (miles de Rp)	Reducción de los costos por concepto de transportes interiores, debida al 6º atracadero (miles de Rp)	Aumento global de los ingresos portuarios logrado con el 5º atracadero (miles de Rp)	Aumento total de los ingresos portuarios logrado con el 6º atracadero (miles de Rp)
0	1975	840	300			0,64													
1	1976	882	315			0,67													
2	1977	926	331			0,70													
3	1978	972	347			0,73													
4	1979	1 021	357	365		0,75	0,63	0,53	509	146	44	3 630	1 020	21		2 126		788	
5	1980	1 072		383			0,66	0,56	509	185	59	3 240	1 260	72		7 290		2 700	
6	1981	1 125		402			0,68	0,58	509	280	77	2 290	2 030	125		12 656		4 688	
7	1982	1 181		422			0,72	0,61	509	331	103	1 780	2 280	181		18 326		6 788	
8	1983	1 241		444			0,75	0,64	509	458	134	510	3 240	241		24 401		9 038	
9	1984	1 303			466			0,66	509	461	171	480	2 900	303	53	25 313	5 366	9 375	1 988
10	1985	1 368			490			0,69	509	461	242	480	2 190	368	118	25 313	11 948	9 375	4 425
11	1986	1 436			514			0,72	509	461	329	480	1 320	436	186	25 313	18 833	9 375	6 975
12	1987	1 436			514			0,72	509	461	329	480	1 320	436	186	25 313	18 833	9 375	6 975
13	1988	1 436			514			0,72	509	461	329	480	1 320	436	186	25 313	18 833	9 375	6 975
14	1989	1 436			514			0,72	509	461	329	480	1 320	436	186	25 313	18 833	9 375	6 975
15	1990	1 436			514			0,72	509	461	329	480	1 320	436	186	25 313	18 833	9 375	6 975
16	1991	1 436			514			0,72	509	461	329	480	1 320	436	186	25 313	18 833	9 375	6 975
17	1992	1 436			514			0,72	509	461	329	480	1 320	436	186	25 313	18 833	9 375	6 975
18	1993	1 436			514			0,72	509	461	329	480	1 320	436	186	25 313	18 833	9 375	6 975
19	1994	1 436			514			0,72	509	461	329	480	1 320	436	186	25 313	18 833	9 375	6 975
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)

Cuadro 8

Corriente de costos y beneficios

(En millones de Rp)

	Partida	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11) a (19)
	I. BENEFICIOS											
1,5S	Economías en los costos de tiempo de espera de los buques, obtenidas gracias al 5º atracadero				3,63	3,24	2,29	1,78	0,51	0,48	0,48	0,48
1,6S	Economías en los costos de tiempo de espera de los buques, obtenidas gracias al 6º atracadero				1,02	1,26	2,03	2,28	3,24	2,90	2,19	1,32
2,5I	Economías en los costos de transporte interior, obtenidas gracias al 5º atracadero				2,126	7,290	12,656	18,326	24,401	25,313	25,313	25,313
2,6I	Economías en los costos de transporte interior, obtenidas gracias al 6º atracadero									5,366	11,948	18,833
3	II. COSTOS											
	Trabajos de ingeniería											
3U	Mano de obra no calificada	4,0	2,4	1,6								
3L	Mano de obra calificada	3,6	2,4	2,0								
3D	Materiales nacionales	6,0	4,0	2,0								
3F	Divisas	14,0	10,0	10,0								
4	Equipo											
4F	Divisas			5,60								
5	Servicios de consultores											
5D	Moneda nacional	0,012	0,012	0,016								
5F	Divisas	0,04	0,04	0,04								
6	Costos de conservación y explotación											
6U	Mano de obra no calificada				0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40
6L	Mano de obra calificada				0,36	0,36	0,36	0,36	0,36	0,36	0,36	0,36
6D	Materiales nacionales				0,32	0,32	0,32	0,32	0,32	0,32	0,32	0,32
6F	Divisas				0,24	0,24	0,24	0,24	0,24	0,24	0,24	0,24
7	III. TRANSFERENCIAS											
	Aumento de los ingresos portuarios obtenidos gracias al 5º atracadero											
7,5D	Moneda nacional				0,473	1,620	2,813	4,073	5,423	5,625	5,625	5,625
7,5F	Divisas				0,315	1,080	1,875	2,715	3,615	3,750	3,750	3,750
	Aumento de los ingresos portuarios obtenidos gracias al 6º atracadero											
7,6D	Moneda nacional									1,193	2,655	4,185
7,6F	Divisas									0,795	1,770	2,790

Cuadro 9

Resultados obtenidos en las fases I, II y III

(En millones de Rp)

	5%	10%	15%
Fase I Evaluación financiera del puerto		9 624	
Fase II Evaluación económica nacional a precios de mercado	207 580	94 861	37 734
Fase III Evaluación económica nacional a precios virtuales	188 905	77 450	21 586

CASO Nº 2: EL PUERTO DE KANGKAH

Estudio comparado de varias posibilidades de inversión destinadas a satisfacer la creciente demanda de servicios portuarios

Introducción

1. En este estudio se expone una situación concreta en la que se está considerando la posibilidad de crear una mayor capacidad portuaria construyendo un puerto nuevo o ampliando el actual.

2. El puerto actual está situado a la orilla de un río, es decir, en el interior, y de un pequeño puerto comercial que era al principio se ha convertido con el desarrollo del país en un activo puerto internacional.

3. La evaluación de las distintas posibilidades se basa en una comparación de los beneficios y los costos económicos nacionales.

4. El actual puerto de Kangkah, situado a 60 millas de la desembocadura del río, tiene una profundidad máxima de 33 pies. Antes, esa profundidad era suficiente, pero ahora, con los grandes buques modernos, constituye una grave limitación. Los terrenos que se necesitarían para ampliar el puerto van escaseando y resultan caros debido al crecimiento de la capital, Kangkah.

5. Actualmente se prevé que con el programa intensivo de industrialización que se está llevando a cabo, aumentará considerablemente la importación de productos a granel como el carbón, el mineral de hierro, los abonos y el petróleo 1/. También se prevé un aumento de la carga general, tanto de importación como de exportación. En el cuadro I del apéndice se indica el tonelaje previsto para cada grupo de productos. Con el actual plan de ampliación se espera dotar al puerto de capacidad suficiente para el volumen de carga que posiblemente pasará por él de 1984 en adelante. Todo aumento adicional de dicho volumen después de 1984 requerirá nuevas inversiones. La vida económica del proyecto se ha calculado en 20 años, ya que los cambios que se produzcan en la utilización de la tierra, la situación de las industrias y otros aspectos económicos pueden modificar las necesidades industriales, y las modalidades y necesidades de transporte después de ese período.

Posibilidades

6. Actualmente, la elección se ha reducido debido a las limitaciones físicas, geográficas e institucionales, a dos posibilidades:

1/ En cuanto al petróleo se ha previsto que, de 1981 en adelante, los petroleros que hagan escala allí serán de la categoría de los de 50.000 o más TPM. Como no es práctico ni factible construir una terminal petrolera en el actual puerto de Kangkah, se ha proyectado otra terminal separada junto a la costa. Ese proyecto no influye, sin embargo, como tal en las conclusiones del presente estudio.

- ampliación del actual puerto de Kangkah mediante la construcción de las instalaciones necesarias en sus proximidades inmediatas; o
- creación de un nuevo puerto capaz de absorber el aumento de volumen del tráfico.

En el cuadro 1 se indican los costos estimados de las dos posibilidades.

Ventajas y desventajas

7. Debido a las diferencias que existen entre la configuración física del lugar en que actualmente se encuentra el puerto de Kangkah y aquel en que eventualmente podría establecerse un nuevo puerto, las instalaciones que podrían construirse en cada uno de esos lugares no serían exactamente las mismas. En el nuevo puerto, tanto las instalaciones como el equipo podrían ser de mayores dimensiones. El puerto de Kangkah tropieza con la falta de campo abierto de carácter continuo, mientras que el lugar donde se construiría el nuevo puerto está en una zona sin desarrollar y sin obstáculos. También hacia el interior plantearía un problema la congestión que se produciría en torno al puerto de Kangkah.

8. Más importancia tiene el hecho de que la profundidad del puerto de Kangkah haría imposible que atracaran en él buques de más calado. Incluso para mantener la profundidad actual de 33 pies habría que dragar periódicamente el puerto para limpiarlo del limo que en él se acumula. El nuevo puerto, situado en la costa frente al mar abierto, tendría una profundidad de unos 48 pies y los buques que se acercan al puerto de Kangkah maniobararían en aguas resguardadas.

9. Es cierto que el nuevo puerto supondría, por otra parte, un aumento de los gastos. Habría que construir, en efecto, nuevas conexiones ferroviarias con el interior, y habría que proporcionar protección contra las aguas mediante un rompeolas. En cambio, podría darse acogida a buques más grandes.

Programas de construcción

10. El nuevo puerto, de construirse, tardaría cinco años en estar terminado, mientras que la ampliación del puerto de Kangkah sólo llevaría tres años. Para contar con las nuevas instalaciones a fines de 1980, año en que estaría listo el nuevo puerto, habría que adoptar el siguiente programa, expresado en porcentajes del costo total de construcción:

	1976	1977	1978	1979	1980
Nuevo puerto	21,8	20,4	15,6	19,5	22,7
Ampliación del puerto de Kangkah			30,8	30,8	38,4

Examen de los beneficios

11. Los principales beneficios que reportaría la construcción del nuevo puerto serían los resultantes de la utilización de buques más grandes, que reduciría el costo por tonelada de producto transportado, sobre todo a granel. La posibilidad de acomodar buques más grandes haría, en efecto, que el costo por tonelada tanto de la estancia del buque en el puerto como de la travesía, fuera más reducido que si se utilizaran buques más pequeños.

Cuadro 1

Conversión del costo financiero al costo económico de la inversión de capital a/

	Componente de divisas (porcentaje)	Costo financiero		Costo económico	
		Ampliación del puerto de Kangkah	Nuevo puerto	Ampliación del puerto de Kangkah	Nuevo puerto
Rompeolas	40	-	142	-	170,5
Costos de dragado	40	25	10	30,0	12,0
Servicios de ingeniería y de consultores, e imprevistos	40	40	50	48,0	60,0
2 atracaderos de tipo corriente y equipo	40	100	100	120	120
1 atracadero polivalente y equipo	40	130	130	156	156
3 terminales de carga a granel	50	50	80	62,5	100
Equipo de manipulación de carga a granel	90	150	190	217,50	275,50
Terrenos b/	0	-	30	155	0
Derechos y otros gravámenes de aduanas	0	45	60	-	-
Total parcial, puerto		540	792	789	894
Conexión ferroviaria	86	-	193	-	276
Conexión por carretera	20	20	50	22	55,00
Viviendas y servicios locales (agua y electricidad)	0	-	57	-	57
Total parcial, transportes terrestres		20	300	22	388
TOTAL		560	1 092	811	1 282

a/ En millones de hiens.

b/ El costo económico del terreno es el valor que tendría si se destinara a otro uso. El terreno que se utilizaría para ampliar el puerto de Kangkah tendría en ese caso un valor de 155 millones de hien, valor que representa, pues, su costo económico, pese a que actualmente sea ya propiedad del puerto. El terreno previsto para el nuevo puerto, en cambio, no puede destinarse a otro uso, lo que significa que su costo económico es cero. Los 30 millones de hiens que pagaría la administración portuaria al Gobierno son sólo una transferencia interna.

12. Para ver cómo se pueden lograr esos ahorros, véanse los siguientes cálculos relativos a buques dedicados al transporte de carbón.

13. El carbón se expide en buques de 20.000 TPM por término medio, por el actual puerto de Kangkah. Con el nuevo puerto se espera que el tamaño medio de los buques se eleve a 50.000 TPM. En el curso del primer año, que sería 1981, se transportarían 2,35 millones de toneladas de carbón. Con los buques más grandes se reduciría a 50 el número de viajes que, ahora, con los buques más pequeños, es de 125. La consecuencia económica de esa reducción, reflejada en economías de escala es una disminución del costo del transporte por tonelada 2/. En el caso concreto que se considera en el cuadro II del apéndice, el costo total del transporte de 2,35 millones de toneladas de carbón es de 31,13 millones de dólares si se utilizan buques de 20.000 TPM y de 24,45 millones de dólares si se utilizan buques de 50.000 TPM, lo que supone un ahorro de 6,68 millones (=66,80 millones de hiens) 3/ en el segundo caso.

14. Pueden hacerse cálculos análogos para cada año y para cada producto. Los ahorros que se lograrían en los costos de transporte son los que se indican en el cuadro III del apéndice.

15. De la disminución de los costos de transporte se benefician los armadores, ya que, aunque se trata de beneficios para la economía mundial, sólo pueden estimarse como beneficios para el país, si de hecho, éste logra captarlos. En este caso, los productos a granel se transportan en graneleros fletados. Es lógico suponer que, una vez construido el nuevo puerto, los ahorros que se lograrán en los costos de transporte se traducirían plenamente en una reducción de los costos de fletamento. Como los productos a granel se compran a precios f.o.b., todos los ahorros que se lograran en el transporte marítimo beneficiarían a los importadores del país.

16. No puede decirse lo mismo de la carga general, que se transporta en buques de línea regular. Como se parte de la base de que los fletes se fijan para una serie de puertos, incluso si se construyera el nuevo puerto, esa construcción no produciría efectos inmediatos o importantes en los fletes. De cualquier modo, en este caso, el tamaño de los buques de línea regular que utilizarían los servicios ampliados del puerto de Kangkah o el nuevo puerto sería más o menos el mismo. Las economías que obtendrían los buques de carga general que utilizaran el nuevo puerto serían relativamente pequeñas y como esas economías no repercutirían en forma apreciable en el país, no se han incluido beneficios para éste.

17. De hecho, pues, los beneficios que reportaría la construcción de un nuevo puerto, en lugar de la ampliación del actual puerto de Kangkah, son los ahorros que se lograrían en las operaciones de los graneleros fletados y que reducirían las tarifas de fletamento. Se supone que el paso de éste se hace en divisas. En el cuadro III del apéndice se indican los

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2/ Suponiendo que los costos de fletamento corren por cuenta de la economía nacional, lo que significa que ésta se beneficia de cualquier reducción de las tarifas.

3/ El tipo de cambio oficial se estima en 10 hiens por un dólar de los EE.UU.

ahorros que se obtendrían en el costo del transporte a granel, ahorros cuyo valor económico 4/ para el país es el siguiente (en millones de hiens):

1981	1982	1983	1984 - 2000 (media anual)
223,05	245,36	269,90	296,87

Costos adicionales

18. El transporte por el nuevo puerto supondría un aumento de los costos de transporte interior, por cuanto los productos tendrían que ser transportados entre el nuevo puerto y la zona de Kangkah.

19. En el caso del carbón, en 1981, año en el que se transportarían 2,35 millones de toneladas, el costo adicional del transporte interior, a 0,20 hiens por tonelada-milla sería (incluidos los costos de capital y de conservación) de 2,35 x 0,2 x 60) = 28,20 millones de hiens. Análogamente puede calcularse el costo del transporte interior para cada año y cada producto. Los resultados son los que se indican en el cuadro IV del apéndice. La creación del nuevo puerto entrañaría también la construcción de viviendas para su personal del puerto y el costo de los correspondientes servicios de agua y electricidad (en tanto en cuanto no pudieron imputarse a la nueva conexión ferroviaria). Se calcula que esos costos sobrepasarían a los del puerto actual de 57 millones de hiens, pero no habría que efectuar ningún pago en divisas.

Factores y consideraciones económicas

20. El Centro de Planificación Económica del Gobierno, al examinar el proyecto en el contexto de la economía nacional y con respecto a otros proyectos recientes y en curso o otras partes del país, ha aceptado el nivel de salarios vigente en el mercado como una buena aproximación al costo de oportunidad de la mano de obra, teniendo en cuenta la situación de pleno empleo que casi existe en el país como resultado del programa de industrialización. En cambio, el valor de las divisas se ha estimado en 1,5 veces su tipo de cambio oficial de 10 hiens por un dólar de los EE.UU.

21. El Centro de Planificación Económica del Gobierno reconoce que, para optar, basándose en los factores económicos, por la construcción del nuevo puerto, en lugar de ampliar el de Kangkah, los beneficios económicos que se piense obtener con dicho nuevo puerto deberían ser superiores a los gastos adicionales.

Análisis

22. Para comparar las dos posibilidades de ampliar el puerto de Kangkah o crear uno nuevo a fin de satisfacer la creciente demanda de tráfico, hay que proceder a un análisi

4/ Los beneficios económicos se obtienen reajustando los valores monetarios en función del precio virtual de las divisas, que es 1,5 veces el tipo de cambio oficial (véase párr. 20).

económico. Los desembolsos y ahorros de dinero contante y sonante no siempre reflejan el valor "real" de la inversión para la economía. Aunque el puerto de Kangkah es ya propietario de los terrenos que podrían utilizarse para la ampliación y no se precisaría ningún desembolso monetario para utilizarlos, eso no significa que no haya que sufragar ningún costo. El costo económico de utilización de esos terrenos es el valor que tendrían si se destinaran a otro uso. Por otra parte, la administración del puerto tendría que pagar al Gobierno 30 millones de hiens por la tierra en que se construiría el nuevo puerto. No obstante, eso no constituye un costo para el país, ya que, si, de hecho, es un costo para la administración del puerto, representa en cambio un beneficio para el Gobierno, no tratándose por lo tanto más que de una transferencia interna que no supone ni pérdida ni ganancia para el país. Como los terrenos en que se construiría el nuevo puerto no pueden destinarse, de hecho, a otro uso, su costo de oportunidad es nulo.

23. Los ahorros que se obtendrían en concepto de costos de fletamento son ahorros en divisas, y como el valor de éstas es superior al oficial, el valor económico de esos ahorros debe calcularse en función del precio virtual de las divisas. Del mismo modo debería evaluarse el componente de divisas de los costos. Los derechos y demás gravámenes de aduanas que entrarían en el costo del proyecto no deberían considerarse como un costo para el país, ya que son pagos de transferencia del proyecto al Gobierno, con lo que el país ni pierde ni gana.

24. La creación del nuevo puerto sería una mejor elección económica si los ahorros logrados en los costos de transporte fueran superiores a los costos adicionales de capital, unidos a los de transportes interiores y a los de viviendas y servicios locales 5/.

25. El costo económico de la inversión de capital de las dos posibilidades, en este caso se obtiene valorando el componente de divisas del costo a su precio virtual de 1,5 veces el tipo de cambio oficial. Los resultados son los que se indican en el cuadro 1.

26. Los costos y beneficios económicos del nuevo puerto son los que se indican en el cuadro 2, en el que los valores actualizados se han obtenido aplicando sucesivamente tasas de actualización que van del 10 al 20%.

Discusión

27. Desde el punto de vista económico, la creación del nuevo puerto es la mejor solución siempre que el costo de oportunidad del capital (es decir, la tasa de actualización) sea inferior al 18%. En el caso actual, el Centro de Planificación Económica del Gobierno ha fijado ese costo de oportunidad en un 12%. A esa tasa el nuevo puerto produce unos beneficios netos actualizados de 300,6 millones de hiens, lo que significa que el valor neto actualizado de los ahorros que se obtendrían gracias al nuevo puerto es superior al de la cantidad en que el costo del nuevo puerto excede al costo de ampliación del puerto de Kangkah. Está, pues, económicamente justificado optar por la construcción de un nuevo puerto.

5/ Se parte de la hipótesis de que los costos de sustitución y los costos de explotación y conservación serán los mismos cualquiera que sea la solución que se adopte.

Cuadro 2

Costos y beneficios económicos de un nuevo puerto y corrientes de fondos actualizados

(En millones de hiens)

Año	Costos		Beneficios				Valores actualizados a/									
							10%		12%		15%		18%		20%	
	Costo de capital del nuevo puerto	Costo adicional del transporte interior	Total	Costo de capital de la ampliación de Kingkah que se evitaría	Ahorros en el costo del transporte marítimo	Total	Costos	Beneficios	Costos	Beneficios	Costos	Beneficios	Costos	Beneficios	Costos	Beneficios
1976	280		280				254,6		250,0		243,5		237,3		235,3	
1977	261		261			...	215,7		208,1		197,4		187,5		181,3	
1978	200		200	250		250	150,3	187,8	142,4	178,0	131,5	164,4	121,7	152,2	115,7	144,7
1979	250		250	250		250	170,8	170,8	158,9	158,9	142,9	142,9	128,9	128,9	120,6	120,6
1980	291		291	311		311	180,7	193,1	165,1	176,5	144,7	154,6	127,2	135,9	117,0	125,0
1981		89,40	89,40		223,05	223,05	50,4	126,0	45,3	113,2	38,7	96,4	33,0	82,6	30,0	74,8
1982		98,34	98,34		245,36	245,36	50,4	126,0	44,4	111,1	36,9	92,2	30,9	77,0	27,6	68,5
1983		108,17	108,17		269,90	269,90	50,4	126,0	43,8	109,0	35,4	88,3	28,8	71,7	25,2	62,8
1984		118,99	118,99		296,88	296,88	445,2	1 111,4	342,1	854,0	235,2	586,9	165,3	412,5	132,0	229,8
↓		↓	↓		↓	↓										
2000		118,99	118,99		296,88	296,88										
						Total	1 568,5	2 041,1	1 400,1	1 700,7	1 296,2	1 325,7	1 060,6	1 060,8	982,7	926,2
						VNA	472,6		300,6		119,6		0,2		-56,5	
						B/C	1,30		1,21		1,10		1,00		0,94	

a/ Actualizados al año en curso (1975).

28. Es evidente que si el costo total del nuevo puerto, incluidos los costos adicionales de transporte interior, viviendas, etc., es inferior al de la ampliación del puerto actual reportando al mismo tiempo los beneficios resultantes de la reducción de costos del transporte marítimo, la elección es evidente sin necesidad de efectuar ningún otro cálculo.

29. Si, en el mismo caso, el costo de oportunidad del capital hubiera sido, en cambio, del 13%, desde un punto de vista puramente económico no habría razón ninguna para optar por una de las dos posibilidades, y no por la otra. La eleccion del Centro de Planificación dependerá de otros factores, tales como las posibilidades de reasentamiento de la población en las zonas costeras próximas al nuevo puerto, el desarrollo de la industria pesada fuera de la zona de Kangkah y otras consideraciones políticas, sociales y ambientales no cuantificadas en el análisis económico.

30. Las dos posibilidades podrían modificarse habida cuenta de que los ahorros logrados en el transporte marítimo de la carga general son pequeños y de difícil captación por el país, mientras que el paso de esa misma carga general por el nuevo puerto aumentará los costos de transporte interior. Quizá pudiera resolverse la cuestión dedicando el nuevo puerto exclusivamente a los productos a granel, y construir en el puerto de Kangkah instalaciones para la carga de tipo general.

31. Si hubiera habido más de dos posibilidades, se habría podido utilizar un criterio de minimización del costo, viendo cuál de esas posibilidades resulta financieramente menos costosa teniendo en cuenta el volumen de carga que hay que transportar 6/.

32. Aplicando ese criterio al caso anterior 7/, se ve que, sobre la base de un costo de actualización del capital del 12%, la solución menos costosa es la de la construcción del nuevo puerto. Se llega, por lo tanto, al mismo resultado que por el otro procedimiento. En el de minimización de los costos, sin embargo, no se tiene en cuenta la cuestión de quiénes son los beneficiarios de las reducciones de costos. Cuando las posibilidades de elección no son más que dos, el trabajo que supone la aplicación de uno o de otro de los dos criterios viene a ser equivalente.

33. En este estudio se ha examinado el proceso de evaluación de dos posibilidades que pueden servir para el mismo fin, y entre las que cabe hacer una elección basada en consideraciones económicas. También se puede proceder a un análisis de sensibilidad modificando los factores más importantes, tales como el volumen de tráfico previsto, el precio virtual de las divisas, las distintas etapas de construcción, los distintos tamaños de buques que se utilizarían, etc., y repitiendo la comparación entre los costos y los beneficios para ver en qué circunstancias podría ser distinta la elección entre las dos posibilidades.

6/ Esto corresponde al tipo I de evaluación descrita en la primera parte del presente estudio (párrs. 47 a 63).

7/ Véase el cuadro V del apéndice.

Apéndice

Cuadro I

Estimaciones del volumen del tráfico que utilizaría las nuevas instalaciones

(En millones de toneladas)

Producto	1981 a/	1982	1983	1984-2000
Carbón	2,350	2,585	2,844	3,128
Mineral de hierro	3,000	3,300	3,630	3,993
Abonos	1,500	1,650	1,815	2,000
Carga general	0,500	0,550	0,605	0,666

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a/ Primer año.

Cuadro II

Costos del transporte de carbón en buques graneleros de 20.000 y 50.000 TPM por el puerto de Kanglah y por el nuevo puerto, respectivamente

		Puerto de Kanglah	Nuevo puerto
I.	Tamaño del buque y volumen de la carga		
1)	Cantidad que se transportaría (millones de toneladas)	2,35	2,35
2)	Tamaño del buque (TPM)	20 000	50 000
3)	Carga media del buque (toneladas)	18 800	47 000
4)	Número de viajes necesarios [(1)/(3)]	125	50
II.	Costos del buque en el puerto		
5)	Días en puerto (de origen y de destino) [a]	3	5
6)	Número total de días que permanece el buque en el puerto [(4) x (5)]	375	250
7)	Costo por buque y día en el puerto (dólares de los EE.UU.)	6 000	12 000
8)	Costos totales de estancia de los buques en puerto (millones de dólares) [(6) x (7)]	2,25	3,00
III.	Costos del buque en el mar		
9)	Tiempo medio de navegación por viaje de ida y vuelta	28	26
10)	Total de días de navegación [(4) x (9)]	3 500	1 300
11)	Costo por buque y día de navegación (dólares)	8 250	16 500
12)	Costos totales de navegación (millones de dólares) [(10) x (11)]	28,88	21,450

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a/ Tarifas de carga y descarga en toneladas/día:

Tamaño del buque	Carga	Descarga
20 000 TPM	18 800	9 400
50 000 TPM	23 500	16 000

El tiempo de rotación se reduce en el nuevo puerto gracias a las mayores dimensiones y velocidad del equipo en él instalado.

Cuadro II (continuación)

	Puerto de Kangkah	Nuevo puerto
IV. Costos totales de los buques		
13) Costos totales del buque (millones de dólares) [(8) + (12)]	31,13	24,450
14) Costo del transporte por tonelada (dólares)	13,25	10,40
15) Costo del transporte por tonelada (hiens)b/	132,50	104,0
V. Reducción total de los gastos de transporte marítimo		
16) En millones de dólares	6,68	
17) En millones de hiensb/	66,80	

b/ Un dólar de los EE.UU. = 10 hiens.

Cuadro II (continuación)

	Puerto de Kangkah	Nuevo puerto
IV. Costos totales de los buques		
13) Costos totales del buque (millones de dólares) [(8) + (12)]	31,13	24,450
14) Costo del transporte por tonelada (dólares)	13,25	10,40
15) Costo del transporte por tonelada (hiens)[b/]	132,50	104,0
V. Reducción total de los gastos de transporte marítimo		
16) En millones de dólares	6,68	
17) En millones de hiens[b/]	66,80	

b/ Un dólar de los EE.UU. = 10 hiens.

Cuadro III

Ahorros en los costos de transporte (en el mar y en puerto)

(En millones de hiens)

Producto	1981	1982	1983	1984-2000 (media anual)
Carbón	66,80	73,48	80,83	88,91
Mineral de hierro	59,60	65,56	72,12	79,33
Abonos	22,30	24,53	26,98	29,68
Ahorros en el transporte marítimo de la carga	148,70	163,57	179,93	197,92

Cuadro IV

Costos adicionales de transporte interior[a/]

(En millones de hiens)

Producto	Costo por tonelada-milla (hiens)	1981	1982	1983	1984-2000 (media anual)
Carbón	0,20	28,20	31,02	34,12	37,53
Mineral de hierro	0,20	36,00	39,60	43,56	47,92
Abonos	0,20	18,00	19,80	21,78	23,96
Carga general	0,24	7,20	7,92	8,71	9,58
Total		89,40	98,34	108,17	118,99

a/ Calculados tomando como base el costo por tonelada-milla que se indica en la primera columna, multiplicado por el volumen de tráfico futuro que se prevé en el cuadro I del apéndice y por 60 (cifra esta última que representa el número de millas que separan el nuevo puerto de Kangkah).

Cuadro V

Costos del transporte en caso de:

Producto	Ampliación del puerto de Kengkeh				Construcción del nuevo puerto			
	1981	1982	1983	1984-2000	1981	1982	1983	1984-2000
			(En millones de dólares)					
n	31,13	34,24	37,67	41,43	24,45	26,90	29,58	32,54
al de hierro	16,70	18,37	20,21	22,23	10,74	11,81	13,00	14,30
s	8,35	9,19	10,10	11,11	6,12	6,73	7,41	8,15
general	25,00	27,50	30,25	33,28	21,50	23,65	26,02	28,62
(millones dólares)	81,18	89,3	98,23	108,05	62,81	69,09	76,01	83,61
(millones de ns) a/	1 217,7	1 339,5	1 473,5	1 620,8	942,2	1 036,4	1 140,2	1 254,2
lizado al 12% 975 (millones niens)	616,9	605,9	595,1	4 660,6	477,4	468,8	460,5	3 606,5
actualizado transporte 12%		6 478,5				5 013,2		
de capital actualizado (del dro 2)		513,4				924,5		
adicional del nsporte interior (actualizado l cuadro 2)		-				475,6		475,6
total del nsporte		6 991,9				6 413,3		

a/ Utilizando el precio virtual de las divisas.

CASO Nº 3. EL PUERTO INDUSTRIAL DE SUNEV

Medida de evaluación necesaria para el desarrollo de un puerto que presta servicio a un polígono industrial

1. El país de Ollapa había emprendido en 1965 un programa de industrialización de gran envergadura. Una de las principales características del plan era la creación de industrias orientadas hacia la exportación que se establecerían en polígonos industriales de diversas ciudades satélites, alejadas de la zona metropolitana de la capital. Uno de los complejos previstos en el plan será el polígono industrial de Sunev, seleccionado por tratarse en gran parte de una zona no explotada y que, por consiguiente, planteaba pocos problemas de reasentamiento y pago de indemnizaciones. Además, reunía las características materiales adecuadas para el desarrollo de un moderno puerto marítimo que podría satisfacer directamente las necesidades de las industrias. Sunev constituye un emplazamiento ideal para industrias susceptibles de contaminar el aire y el agua, poco indicadas por lo tanto para zonas densamente pobladas, y para aquellas que necesitan extensiones de terreno bastante grandes y utilizan como insumos materiales a granel. El puerto de Sunev fue diseñado como parte integrante del desarrollo de la zona y en función de tal fue concebido y encargado como puerto industrial independiente.

2. La carga que pasa por Sunev está integrada por productos de escaso valor, sensibles al costo, e importados a granel para ser luego combinados, mezclados, elaborados y reexportados, generalmente en sacos o balas. Los principales productos acabados son, entre otros, abonos y piensos para aves y otros animales. Los buques que hacen escala en Sunev para descargar productos importados son buques graneleros y los utilizados para la exportación son buques fletados.

3. El puerto de Sunev ha sido estudiado de forma que puedan utilizarlo grandes buques de 40.000 a 50.000 TPM, a fin de que los costes de transporte se mantengan al nivel más bajo posible.

4. Se reconoce que el puerto es un componente esencial e integral del complejo de Sunev. Sin él, el establecimiento en Sunev no resultaría en absoluto rentable para estas industrias orientadas hacia la exportación, que necesitan importar gran parte de sus materias primas a granel y que exportan sus productos acabados principalmente en sacos, y Ollapa perdería seguramente los beneficios inherentes a la existencia de tales industrias.

Descripción del proyecto

5. El proyecto comprende:

a) 750 metros de muelles de gran calado (de 11 a 13 m de profundidad);

b) 3 tinglados para mercancías en tránsito de 20.000 m^2 cada uno, y un almacén de 7.000 m^2 de superficie;

c) 20 acres de superficie abierta pavimentada;

d) enlaces por ferrocarril y carretera con las plantas industriales;

e) trabajos de dragado y saneamiento de tierras.

6. El equipo requerido consiste principalmente en equipo de manipulación de cereales alimenticios y una instalación para la carga de abonos, además de otros elementos entre los que figuran locomotoras y otro material rodante, grúas, tractores, carretillas elevadoras, una grúa móvil y un autocargador para sacos.

Derechos de aduana y otros impuestos

7. Los derechos de aduana y otros impuestos que gravan el equipo importado ascienden en total a 150.000 duits.

Empleo y divisas

8. Gracias al éxito del programa de industrialización, no hay prácticamente en el país desempleo ni subempleo digno de mención. En cambio, como Ollapa está sólo en los principios de su esfuerzo de industrialización, hay escasez de divisas y se calcula que el precio virtual de éstas es 1,5 veces mayor que el tipo de cambio oficial. El Ministerio de Hacienda ha ordenado que para la evaluación del proyecto se utilice ese precio virtual. El tipo de cambio oficial es de 2,5 duit = 1 dólar de los EE.UU.

Sistema de financiación del puerto de Sunev

9. La Sociedad Sunev, corporación gubernamental legalmente constituida, ha conseguido del Banco Industrial Cooperativo del Pacífico Oriental (BICPO) un préstamo destinado a financiar los costos en divisas del proyecto. El préstamo, que asciende a 30,66 millones de duits al 8% de interés, es reembolsable en un plazo de 15 años, debiendo comenzar el reembolso durante el primer año de explotación del proyecto.

10. El Gobierno de Ollapa financiará el resto de los costos del proyecto en moneda local mediante un préstamo de 15,84 millones de duits al 4,5% de interés, reembolsable en un plazo de 20 años, debiendo también comenzar el reembolso durante el primer año de explotación del proyecto.

Escalonamiento de los costos de construcción y del desembolso de los préstamos

11. El puerto de Sunev tardará cuatro años en quedar terminado y los costos, escalonados durante todo ese tiempo, se cubrirán en cada período con los importes desembolsados de los préstamos que se indican a continuación (en miles de duits):

	Primer año	Segundo año	Tercer año	Cuarto año	Total
Costos de construcción	5 800	16 700	11 000	13 000	46 500
Préstamo del BICPO	2 430	9 605	8 600	10 025	30 660
Préstamo del Gobierno	3 370	7 095	2 400	2 975	15 840

Duración del proyecto

12. La vida útil del proyecto se calcula en 20 años, aun cuando la duración material efectiva de los muelles pueda ser mucho mayor. En lo que se refiere al equipo, su vida

Cuadro 1

Presupuesto de gastos del proyecto

(En miles de [illegible])

	Costo total	Componente de divisas
		(Porcentaje)
Obras de ingeniería civil		
1. Dragado	3 000	40
2. Muelles	17 000	75
3. Terraplenado	1 000	60
4. Pavimentado	1 800	35
5. Servicios públicos	500	30
6. Enlaces por ferrocarril y carretera	5 000	40
Total parcial	28 300	
Construcciones		
1. Tinglados para mercancías en tránsito	2 000	40
2. Almacén	700	40
Total parcial	2 700	
Equipo		
1. Equipo de manipulación de abonos	8 000	80
2. Equipo de manipulación de cereales	6 000	80
3. Otros equipos	1 000	80
Total parcial	15 000	
Honorarios de consultores	350	50
Derechos de aduana y otros impuestos	150	0
Total general	46 500	

Cuadro 2

Gastos por año

(en miles de duits)

	1976	1977	1978	1979
Obras de ingeniería civil				
Moneda nacional	5 370	5 475	1 000	1 125
Divisas	2 430	8 525	5 000	5 375
Construcciones				
Moneda nacional	-	1 620	-	-
Divisas	-	1 080	-	-
Equipo				
Moneda nacional	-	-	1 400	1 600
Divisas	-	-	5 600	6 400
Honorarios de consultores				
Moneda nacional	-	-	-	175
Divisas	-	-	-	175
Derechos de aduana y otros impuestos				
Moneda nacional	-	-	-	150

útil es inferior a 20 años. Para la reposición del equipo y la sustitución de piezas se ha previsto el siguiente calendario:

Año de reposición	Cantidad (en miles de duits)
5º - 1984	1 000
10º - 1989	2 500
15º - 1994	1 000

Se supone que el 80% de estos gastos serán en divisas.

Gastos de explotación y conservación

13. Los gastos de explotación y conservación del proyecto portuario se han calculado (en miles de duits, aunque el 20% de ellos serán en divisas) como se indica a continuación:

Año	1980	1981	1982	1983	1984-1999
	1 760	1 760	1 840	2 160	2 640

Previsiones de tráfico

14. Para el año de inauguración (1980), se espera que el movimiento de mercancías por los muelles del puerto de Sunev sea de 1,89 millones de toneladas y que aumente constantemente, como se indica a continuación, hasta llegar a 2,88 millones de toneladas en 1984, nivel al que probablemente se estabilizará:

	1980	1981	1982	1983	1984	1985-1999
		(Miles de toneladas)				(Promedio anual)
Importaciones						
Carga a granel	1 050	1 050	1 100	1 300	1 600	1 600
Importaciones						
Carga fraccionada a/	840	840	880	1 040	1 280	1 280
Total	1 890	1 890	1 980	2 340	2 880	2 880

a/ Compuesta de un 40% de fertilizantes elaborados y mezclados y de un 60% de cereales alimenticios y piensos elaborados y mezclados.

Ingresos provenientes de la explotación del puerto de Sunev

15. Los ingresos del puerto de Sunev proceden de los derechos portuarios cobrados a los buques y de los derechos de manipulación de la carga. Estos derechos son pagados en definitiva por las empresas industriales que utilizan el puerto empleando buques fletados. Otros ingresos del puerto de Sunev proceden de sus instalaciones de almacenamiento.

16. Se espera que la estructura de las tarifas permanecerá invariable durante toda la duración del proyecto. El puerto de Sunev ofrece una "tarifa combinada" a los graneleros que transportan ininterrumpidamente cargas homogéneas con destino a las industrias locales. Esa "tarifa combinada" comprende los derechos de muelle y de carga y descarga a razón de 1,8 duits por tonelada, más un recargo de 1 duit por tonelada por uso de las instalaciones. En el caso de los productos exportados en sacos, el puerto cobra 4 duits por tonelada.

Cuadro 3

Presupuesto de ingresos del puerto de Sunev

(en miles de duits)

	1980	1981	1982	1983	1984-1999
Manipulación de la carga					(Promedio anual)
Carga a granel (importaciones)	2 940	2 940	3 080	3 640	4 480 a/
Carga fraccionada (exportaciones)*	3 360	3 360	3 520	4 160	5 120 b/
Almacenaje	252	252	264	312	384 c/
Otros ingresos	168	168	176	208	256 d/
	6 720	6 720	7 040	8 320	10 240

* De cada tonelada de productos importados a granel se obtienen sólo 0,8 toneladas por término medio de productos de exportación elaborados, lo que significa que 1 tonelada de exportaciones requiere 1,25 toneladas de importaciones a granel.

a/ Carga a granel (según previsión de tráfico del cuadro 5) a razón de 2,8 duits por tonelada.

b/ Carga fraccionada (según previsión de tráfico del cuadro 5) a razón de 4,00 duits por tonelada.

c/ Carga fraccionada (según previsión de tráfico del cuadro 5) a razón de 0,30 duits por tonelada.

d/ Carga fraccionada (según previsión de tráfico del cuadro 5) a razón de 0,20 duits por tonelada.

Cuadro 4

Costo de los productos exportados para las industrias de Sunev

(En duits)

	Fertilizante ureico	Cereales alimenticios
Costo de producción por tonelada a/	16,00	45,00
Costo del transporte por tonelada		
Cantidades pagadas al puerto de Sunev b/	8,00	8,00
Fletes c/	5,00	4,00
Costo total por tonelada	29,00	57,00

a/ Del que un 60% es en divisas.

b/ Por cada tonelada exportada, el puerto de Sunev recibe 4,5 (es decir, 4 + 0,3 + 0,2) duits por manipulación de las exportaciones y 1,25 x 2,80 = 3,5 duits por manipulación de las importaciones necesarias, ya que, para elaborar y obtener 1 tonelada de productos de exportación, se requieren 1,25 toneladas de productos a granel.

c/ Pagados en divisas.

Cuadro 5

Toneladas exportadas

(En miles de toneladas)

	1980	1981	1982	1983	1984-1999 (Promedio anual)
Toneladas exportadas	840	840	880	1 040	1 280
Fertilizante ureico	336	336	352	416	512
Cereales alimenticios	504	504	528	624	768

Cuadro 6

Valor de las exportaciones

(En miles de duits)

	1980	1981	1982	1983	1984-1999
					(Promedio anual)
Fertilizante ureico (a 38 duits por tonelada)	12 768	12 768	13 376	15 808	19 456
Cereales alimenticios (a 70 duits por tonelada)	35 280	35 280	36 960	43 680	53 760

Cuadro 7

Costo de los productos exportados

(En miles de duits)

	1980	1981	1982	1983	1984-1999
					(Promedio anual)
Fertilizante ureico					
Costo de producción	5 376	5 376	5 632	6 656	8 192
Cantidades pagadas al puerto de Sunev	2 688	2 688	2 816	3 328	4 096
Fletes	1 680	1 680	1 760	2 080	2 560
Cereales alimenticios					
Costo de producción	22 680	22 680	23 760	28 080	34 560
Cantidades pagadas al puerto de Sunev	4 032	4 032	4 224	4 992	6 144
Fletes	2 016	2 016	2 112	2 496	3 072

I. Evaluación del proyecto desde el punto de vista de la administración del puerto de Sunev

17. En lo que se refiere al puerto de Sunev, los costos consisten en los reembolsos de los préstamos en las fechas de vencimiento y en sus gastos de explotación. Sus ingresos proceden del cobro de los servicios de manipulación de la carga y de otros derechos. Las tarifas han sido estudiadas de forma que el puerto de Sunev pueda bastarse a sí mismo, obteniendo ingresos suficientes para cubrir sus gastos.

18. Durante el período de construcción, el puerto de Sunev no incurre en ningún gasto, en el sentido de que los gastos de cada período se financian con los correspondientes préstamos recibidos (véase el cuadro del párrafo 11).

El reembolso del préstado del BICPO se extiende desde 1980 hasta 1994.

Reembolso anual de 30,66 millones de duits al 8% de interés durante 15 años = 30.660.000 x 0,1168

= 3.582.000 duits.

El reembolso del préstamo del Gobierno se extiende desde 1980 hasta 1999.

Reembolso anual de 15,84 millones de duits al 4,5% de interés durante 20 años = 15.840.000 x 0,0769

= 1.218.000 duits.

En el cuadro 3 se indican los ingresos anuales provenientes de la explotación del puerto, y en el cuadro del párrafo 12, el costo de las reposiciones y el calendario de las mismas.

Cuadro 8

Cuenta de la administración del puerto de Sunev

(En miles de duits)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985-1988	1989	1990-1993	1994	1995-1999
Ingresos														
Préstamo bancario del BICPO	2 430	9 605	8 600	10 025										
Préstamo del Gobierno	3 370	7 095	2 400	2 975										
Ingresos de explotación	-	-	-	-	6 720	6 720	7 040	8 320	10 240	10 240	10 240	10 240	10 240	10 240
Total de ingresos	5 800	16 700	11 000	13 000	6 720	6 720	7 040	8 320	10 240	10 240	10 240	10 240	10 240	10 240
Gastos														
Costo de construcción	5 800	16 700	11 000	13 000										
Costo de explotación	-	-	-	-	1 760	1 760	1 840	2 160	2 640	2 640	2 640	2 640	2 640	2 640
Costos de reposición	-	-	-	-	-	-	-	-	1 000	-	2 500	-	1 000	-
Reembolso del préstamo bancario del BICPO	-	-	-	-	3 582	3 582	3 582	3 582	3 582	3 582	3 582	3 582	3 582	-
Reembolso del préstamo del Gobierno	-	-	-	-	1 218	1 218	1 218	1 218	1 218	1 218	1 218	1 218	1 218	1 218
Total de gastos	5 800	16 700	11 000	13 000	6 560	6 560	6 640	6 960	8 440	7 440	9 940	7 440	8 440	3 858
Corriente neta de efectivo	0	0	0	0	160	160	400	1 360	1 800	2 800	300	2 800	1 800	6 382

Cuadro 9

Administración del puerto de Sunev (costos-beneficios)

(En miles de duito)

Costos y beneficios actualizados al año 1976 (fecha actual)

Año	Beneficios	Costos	VNA actualizado al 8%	12%	18%
1976	5 800	5 800	0	0	0
1977	16 700	16 700	0	0	0
1978	11 000	11 000	0	0	0
1979	13 000	13 000	0	0	0
1980	6 720	6 560	108,9	90,8	69,9
1981	6 720	6 560	100,8	81,1	59,3
1982	7 040	6 640	233,4	180,9	125,6
1983	8 320	6 960	734,8	549,3	361,8
1984	10 240	8 440	900,5	649,1	405,8
1985		7 440	1 296,9	901,5	535,0
1986		7 440	1 200,9	804,9	453,4
1987		7 440	1 111,9	718,7	384,2
1988		7 440	1 029,6	641,7	325,6
1989		9 940	102,1	61,4	29,6
1990		7 440	882,7	511,6	233,8
1991		7 440	817,3	456,7	198,2
1992		7 440	756,8	407,8	167,9
1993		7 440	700,7	364,1	142,3
1994		8 440	417,1	209,0	77,5
1995		3 858	1 369,5	661,6	233,0
1996		3 858	1 267,8	590,7	197,4
1997		3 858	1 173,9	527,4	167,3
1998		3 858	1 087,0	470,9	141,8
1999		3 858	1 006,4	420,5	120,2
Valor neto actualizado			16 290,8	9 599,7	4 489,6

II. Evaluación del proyecto a nivel nacional

19. Desde el punto de vista del país de Ollapa, los costos del proyecto se producen en el momento de contraer el compromiso. El país tuvo que desviar fondos y solicitar préstamos para financiar el proyecto del puerto.

20. El puerto de Sunev fue construido como parte del programa nacional de industrialización. Su objeto era servir de medio para importar y exportar materias primas y productos acabados a costo razonable, de forma que pudiesen funcionar los polígonos industriales "satélites", como Sunev. Desde el punto de vista de la economía nacional, los beneficios del proyecto debían ser el valor de la producción de las industrias de Sunev.

21. El proyecto del puerto ha de ser evaluado juntamente con los costos y el valor de la producción de esas industrias. La parte de los costos pagada por las industrias de Sunev al puerto es un pago de transferencia que no crea nuevos beneficios para el país. El beneficio que por ese concepto obtiene el puerto constituye un costo para las industrias de Sunev. Análogamente, los derechos de aduana y otros impuestos pagaderos en relación con el proyecto constituyen un pago de transferencia al Gobierno. Los resultados de la evaluación del proyecto a nivel nacional son los que se indican en el cuadro 10.

Cuadro 10

Costos y beneficios a nivel nacional

(En miles de duito)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985-1988	1989	1990-1993	1994	1995-1999
Beneficios (valor de la producción industrial)														
1 Fertilizante ureico														
1F Divisas	-	-	-	-	12 768	12 768	13 376	15 808	19 456	19 456	19 456	19 456	19 456	19 456
2 Cereales alimenticios														
2F Divisas	-	-	-	-	35 280	35 280	36 960	43 680	53 760	53 760	53 760	53 760	53 760	53 760
3 Costos	5 800	16 700	11 000	13 000	-	-	-	-	-	-	-	-	-	-
3.1 Costos de construcción														
3.1D Moneda nacional	3 370	7 095	1 000	1 125	-	-	-	-	-	-	-	-	-	-
3.1F Divisas	2 430	9 605	3 000	3 375	-	-	-	-	-	-	-	-	-	-
3.2 Costos de equipo														
3.2D Moneda nacional	-	-	1 400	1 600	-	-	-	-	-	-	-	-	-	-
3.2F Divisas	-	-	5 600	6 400	-	-	-	-	-	-	-	-	-	-
3.3 Honorarios de consultores														
3.3D Moneda nacional				175	-	-	-	-	-	-	-	-	-	-
3.3F Divisas				175	-	-	-	-	-	-	-	-	-	-
4 Costos de reposición														
4D Moneda nacional	-	-	-	-	-	-	-	-	200	-	500	-	200	-
4F Divisas	-	-	-	-	-	-	-	-	800	-	2 000	-	800	-
5 Costos de explotación y de conservación														
5D Moneda nacional	-	-	-	-	1 408	1 408	1 472	1 728	2 112	2 112	2 112	2 112	2 112	2 112
5F Divisas	-	-	-	-	352	352	368	432	528	528	528	528	528	528
6 Costos de las industrias de Sunev														
6.1 Costos de producción	-	-	-	-										
6.1D Moneda nacional	-	-	-	-	11 222	11 222	11 757	13 894	17 101	17 101	17 101	17 101	17 101	17 101
6.1F Divisas	-	-	-	-	16 834	16 834	17 635	20 842	25 651	25 651	25 651	25 651	25 651	25 651
6.2 Fletes														
6.2F Divisas	-	-	-	-	3 696	3 696	3 872	4 576	5 632	5 632	5 632	5 632	5 632	5 632
7 Pagos de transferencia														
7.1 Pagos al puerto de Sunev	-	-	-	-										
7.1D Moneda nacional	-	-	-	-	6 720	6 720	7 040	8 320	10 240	10 240	10 240	10 240	10 240	10 240
7.2D Derechos de aduanas y otros impuestos														
Moneda nacional	-	-	-	150	-	-	-	-	-	-	-	-	-	-

Cuadro 11

Valores actualizados de costos y beneficios

(En miles de duits)

		8%	12%	18%
	Beneficios (valor de la producción industrial)			
1	Fertilizante ureico			
1F	Divisas	126 123	80 950	45 436
2	Cereales alimenticios			
2F	Divisas	348 495	223 678	125 536
3	Costos			
3.1	Costos de construcción			
3.1D	Moneda nacional	10 824	10 092	9 141
3.1F	Divisas	15 347	14 107	12 524
3.2	Costos de equipo			
3.2D	Moneda nacional	2 287	2 013	1 677
3.2F	Divisas	8 562	8 053	6 709
3.3	Honorarios de consultores			
3.3D	Moneda nacional	129	111	90
3.3F	Divisas	129	111	90
4	Costos de reposición			
4D	Moneda nacional	316	297	103
4F	Divisas	1 266	790	411
5	Costos de explotación y de conservación			
5D	Moneda nacional	13 738	8 825	4 960
5F	Divisas	3 435	2 205	1 240
6	Costos de las industrias de Sunev			
6.1	Costos de producción			
6.1D	Moneda nacional	110 855	71 151	39 935
6.1F	Divisas	166 281	106 727	59 904
6.2	Fletes			
6.2F	Divisas	36 508	23 433	17 936
7	Pagos de transferencia			
7.1	Pagos al puerto de Sunev			
7.1D	Moneda nacional	66 381	42 606	23 912
7.2D	Derechos de aduanas y otros impuestos			
	Moneda nacional	110	95	77

22. El valor neto actualizado del proyecto a nivel nacional es igual a los beneficios actualizados, representados por el valor de los productos industriales, menos el costo actualizado del proyecto y el costo de los productos industriales 1/. He aquí los valores netos actualizados calculados con diferentes tasas de descuento:

	8%	12%	18%
	(En miles de duits)		
VNA (II)	104 941	56 713	16 252

III. Evaluación a precios virtuales

23. La anterior evaluación se efectuó a los precios de mercado, sin reajuste alguno para tener en cuenta el precio virtual de las divisas 2/.

24. Muchas de las partidas de costos han de ser pagadas, en efecto, en divisas. Pero también los productos industriales exportados por el puerto deben valorarse con arreglo al precio virtual de las divisas, que se calcula en 1,5 veces el tipo de cambio oficial.

25. El valor neto actualizado del proyecto, teniendo en cuenta el reajuste correspondiente a las divisas, se obtiene fácilmente multiplicando por 1,5 todos los componentes en divisas 3/:

	8%	12%	18%
	(En miles de duits)		
VNA (III)	226 487	131 314	52 351

Resumen y conclusión

26. A continuación se indican los resultados obtenidos según las tasas de actualización utilizadas (en miles de duits):

	8%	12%	18%
VNA (I)	16,2	9,3	4,4
VNA (II)	104,9	56,7	16,3
VNA (III)	226,5	131,3	52,3

1/ VNA (II) = (1F) - (2F) - (3.1D) - (3.1F) - (3.2D) - (3.2F) - (3.3D) - (3.3F) - (4D) - (4F) - (5D) - (5F) - (6.1D) - (6.1F) - (6.2F). Véase cuadro 11.

2/ El hecho de que, como ya se ha indicado anteriormente, no haya en Ollapa desempleo ni subempleo de importancia, hace innecesario, en cambio, reajustar los costos de mano de obra.

3/ VNA (III) = 1,5 [(1F) + (2F)] - (3.1D) - (3.2D) - (3.3D) - (4D) - (5D) - (6.1D) - (6.2D) - 1,5 [(3.1F) + (3.2F) + (3.3F) + (4F) + (5F) + (6.1F) + (6.2F)].

27. El valor neto actualizado en las distintas fases de la evaluación es positivo y disminuye a medida que aumenta la tasa de actualización.

28. El VNA (I) es positivo incluso a la tasa del 18%. Este resultado es favorable para el puerto de Sunev. Al establecer las tarifas del puerto, se tuvo presente el objetivo de hacer del puerto una entidad autosuficiente.

29. El VNA (II) evaluado a nivel nacional a precios del mercado representa un valor casi seis veces mayor que el VNA (I). Si los precios de exportación estuvieran a ese nivel, el Gobierno de Ollopa alcanzaría, pues, satisfactoriamente su objetivo.

30. Resultado asimismo de una evaluación a nivel nacional, pero con aplicación de precios adecuados a las divisas, no es de extrañar que el VNA (III) sea casi el doble que el VNA (II). Esto se debe a que los productos exportados constituyen una fuente de divisas, cuyo valor compensa con creces los componentes en divisas del costo del proyecto.

31. Una vez calculados los VNA (I), (II) y (III), se reconoce la posibilidad de rebajar las tarifas portuarias sin consecuencias desfavorables para el proyecto. Los VNA (II) y (III) son superiores al VNA (I). Si el VNA (I) hubiera resultado negativo, el proyecto podría estar justificado todavía, ya que el beneficio producido por el proyecto del puerto está constituido de hecho por el valor de la producción industrial vendida en el extranjero. De haber sido así, el Gobierno habría podido subvencionar el puerto de Sunev gravando de algún modo los beneficios de las industrias de Sunev para mantener el puerto en funcionamiento.

32. El factor esencial que hay que tener en cuenta en este caso es que, dado que el puerto de Sunev fue diseñado como parte integrante del desarrollo de la zona, su justificación debe basarse en los beneficios procedentes de las industrias allí situadas. En sí mismo, el puerto puede no ser otra cosa que un lujo costoso y desprovisto de utilidad, pero en combinación con el desarrollo industrial de Sunev contribuye al éxito de un programa de industrialización.

33. Esta misma metodología de evaluación podría aplicarse al caso del puerto que se construye para facilitar medios de transporte a una zona forestal hasta el momento inexplotada o a un territorio rico en minerales metalíferos. Ni la madera que puede obtenerse de los árboles del bosque ni los metales que contienen los yacimientos tienen valor económico alguno a menos que puedan ser extraídos y expedidos para su venta en el mercado.

CASO Nº 4: EL PUERTO DE NORI (FERROLANDIA)

Las instalaciones portuarias reducen los gastos de transporte, lo que conduce a un aumento de la producción y a una ampliación del mercado

Parte I: La inversión portuaria como factor de ampliación del mercado

1. Una de las principales exportaciones de Ferrolandia es el mineral de hierro. En la actualidad, ese mineral se vende fundamentalmente a los países de la Comunidad Económica Europea (CEE). Ferrolandia no está en situación de influir en los precios que prevalecen en los distintos mercados. Su producción no representa más que alrededor del 7% del comercio mundial de mineral de hierro. El precio c.i.f. que pagan los países de la CEE oscila en torno a los 9 dólares por tonelada métrica, que es el precio que se paga por los minerales suministrados por fuentes cercanas dentro de la Europa continental.

2. En el mercado japonés, el precio c.i.f. es de 11,50 dólares por tonelada, que es el precio que se paga por los minerales procedentes de Australia, la más barata y más cercana de las fuentes importantes de suministro con que cuenta el Japón.

3. Actualmente, Ferrolandia expide su mineral por el puerto de Nori, en el que no pueden atracar buques de más de 50.000 TPM. Con buques de este tamaño, el costo del transporte marítimo por tonelada de mineral es de unos 4,20 dólares para los países de la CEE y sería de 7,34 dólares en el caso del Japón.

4. Sobre la base de los datos relativos a la producción y al costo de manipulación de la carga, se calcula que el costo medio por tonelada de mineral es de unos 4,50 dólares.

Exportaciones de mineral de hierro

5. La producción total de mineral de Ferrolandia viene, de hecho, determinada por la cantidad que decide comprarle la CEE, la cual ha firmado con ella contratos para la compra de 8 millones de toneladas de mineral a un precio c.i.f. de 9 dólares por tonelada, que es el precio que paga por los minerales procedentes de las cercanas fuentes noruegas y suecas.

6. En el cuadro 1 se indica la situación actual de las exportaciones de mineral de hierro de Ferrolandia.

Cuadro 1

Exportaciones a	Tamaño del buque	Flete/tonelada	Precio c.i.f.	Precio f.o.b.	Costo medio por tonelada	Beneficio por tonelada	Cantidad anual (en millones de toneladas)	Afluencia neta total de capital al año (en millones de dólares)
CEE	50 000 TPM	$4,20	$9,00	$4,80	$4,50	$0,30	8	2,4
Japón	50 000 TPM	$7,34	$11,50	$4,16	$4,50	(-$0,34)	0	-

7. Actualmente Ferrolandia no exporta mineral de hierro al Japón, ya que los gastos de transporte a ese mercado son prohibitivos 1/. El precio c.i.f. que paga el Japón es sólo de 11,50 dólares por tonelada de mineral procedente de fuentes australianas. A menos que Ferrolandia pueda reducir los costos de transporte, quedará de hecho excluida del mercado japonés.

8. Los Ministerios de Fomento del Comercio y Transportes han decidido encargar un estudio sobre la posibilidad de mejorar la posición de su mineral de hierro para la exportación. Los expertos que participan en este estudio reconocen que, en el caso del mineral de hierro, Ferrolandia no tiene más remedio que aceptar los precios que le imponen. El país no dispone, en efecto de cantidad suficiente para fijar condiciones de monopolio, ni tiene la posición geográfica indicada para beneficiarse de la proximidad de zonas industriales consumidoras. En el estudio se llega rápidamente a la conclusión de que la única posibilidad real que tiene Ferrolandia es la de tratar de reducir los costos de transporte del mineral al mercado.

Conclusiones de los expertos ~~técnicos~~

9. Aunque no todos los puertos de la CEE tienen capacidad para graneleros de más de de 50.000 TPM, hay varios en los que pueden atracar buques de 125.000. Los datos sobre el comercio indican que alrededor del 37,5% de las exportaciones a la CEE podrían enviarse a puertos europeos en buques de ese tonelaje, buques que también pueden atracar en los puertos japoneses.

10. Las acerías japonesas están dispuestas a comprar cierta cantidad de mineral a Ferrolandia, siempre que ésta pueda proporcionárselo al mismo precio competitivo de 11,50 dólares por tonelada c.i.f. que le cobra Australia. La cantidad prevista es de 2 millones de toneladas anuales durante 15 años.

11. Ferrolandia tiene, por consiguiente, la oportunidad de ampliar y diversificar su mercado.

12. El costo del transporte marítimo por tonelada puede reducirse utilizando graneleros mineraleros más grandes. Los más prácticos son los de unas 125.000 TPM, teniendo presente que el tamaño del buque está limitado tanto por las instalaciones en el puerto de carga como por las del de descarga.

13. Sobre la base de la utilización de buques de 125.000 TPM, la posición de Ferrolandia en cuanto a la exportación de mineral de hierro es la que se indica en el cuadro 2 infra.

1/ Véase en el apéndice I la posición relativa de Ferrolandia en los mercados de la CEE y el Japón.

Cuadro 2

Exportaciones a	Tamaño del buque (TPM)	Flete/tonelada	Precio c.i.f. por tonelada a/	Precio f.o.b. por tonelada	Costo medio por tonelada	Beneficio por tonelada	Cantidad anual de mineral exportado (en millones de toneladas)	Afluencia neta total de capital al año (en millones de dólares)
				(Dólares)				
CEE	50 000	4,20	9,0	4,8	4,50	0,30	5	1,5
	125 000	2,10	9,00	6,90	4,50	2,40	3	7,2
								8,7
Japón	125 000	5,25	11,50	6,25	4,50	1,75	2	3,5
								12,2

a/ Sobre la base de los contratos concertados y previstos, Ferrolandia está bastante segura del precio c.i.f. que puede obtener por su mineral de hierro en el mercado.

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SISTEMAS MARITIMOS Y PORTUARIOS

ADMINISTRACION Y OPERACION PORTURIA

ING. JAIME JARAMILLO VAZQUEZ

MARZO, 1979.

Palacio de Minería Calle de Tacuba 5, primer piso. México 1, D. F.

ADMINISTRACION PORTUARIA

EL PUERTO

DESDE EL PUNTO DE VISTA ESTRICTO DE LA DERIVACION DE LA PALABRA, UN PUERTO ES UNA PUERTA, UNA VIA DE ACCESO, Y EN EL USO MODERNO, GENERALMENTE EMPLEAMOS LA PALABRA PARA SIGNIFICAR UN PUERTO MARITIMO Y ALGUNAS VECES UN PUERTO FLUVIAL (O DE CANAL). ESTO ES, UNA PUERTA O UN ACCESO ENTRE TIERRA Y AGUA.

ADEMAS DE SER UNA PUERTA DE ACCESO, UN PUERTO PUEDE SER MUCHAS OTRAS COSAS. QUIZA UNA DE LAS MAS IMPORTANTES ES: QUE DEBE SER UN ABRIGO. ESTO ES UN AREA PROTEGIDA DONDE LOS BARCOS PUEDAN FONDEAR A SALVO EN SUFICIENTE PROFUNDIDAD DE AGUA Y RESGUARDOS DE LOS PELIGROS DE LA MAR DURANTE EL MAL TIEMPO.

POR SUPUESTO NO TODAS LAS BAHIAS SON PUERTOS, PERO CADA PUERTO EFICIENTE DEBERA SER UNA BAHIA DE ABRIGO.

LOS REQUERIMIENTOS BASICOS ESENCIALES PUEDEN SER PROVISTOS POR LA NATURALEZA, TALES COMO UNA ENTRADA NO EXPUESTA, AGUA PROFUNDA Y ALGUN PROMONTORIO O CERROS QUE RESGUARDEN DE LOS VIENTOS REINANTES O QUIZA TODAS ESAS CONDICIONES TENGAN QUE SER PROVISTAS POR EL HOMBRE:

V.GR.: ROMPEOLAS Y ESCOLLERAS PARA ASEGURAR AGUAS TRANQUILAS, DRAGADO PARA DAR LA PROFUNDIDAD REQUERIDA EN EL CANAL DE ENTRADA, CANALES DE ACCESO Y EN LOS ATRACADEROS.

OTROS MEDIOS DE SEGURIDAD:

FAROS, SEÑALES DE NIEBLA RADAR DE TIERRA, RADIO TELEFONIA DE TIERRA A BARCO, BOYAS Y BALIZAS.

UN PUERTO PUEDE SER:

UN PUERTO PARA CARGA O UN PUERTO PARA PASAJEROS O AMBOS.

##..

EL DESARROLLO DE ORGANIZACIONES PORTUARIAS

NOSOTROS ESPERAMOS QUE CADA COSA NOS SEA PUESTA ANTE LA MESA EN EL TRABAJO; SI ES ASI, ENTONCES DIREMOS QUE ES UNA BUENA ORGANIZACION; Y SI NO, QUE ES UNA MALA ORGANIZACION.

NO ES DEBIDO AL AZAR O A BUENAS INTENCIONES QUE UN BARCO SE ATRAQUE A UN MUELLE, QUE LOS HOMBRES SEAN RACIONALMENTE OCUPADOS, QUE EL NUMERO NECESARIO DE GRUAS SEAN DISPUESTAS, QUE MAQUINARIA Y EQUIPO DE TRABAJO ESTEN LISTOS, LA CARGA ACLARADA Y DESPEJADA POR ADUANAS, Y COMERCIANTES PRESTOS A RECIBIR SUS CARGAMENTOS. TODO ELLO ES EL RESULTADO DE PLANEACION, TOMAR DECISIONES, EL CONSTRUIR EN UN MARCO EFICIENTE Y ADECUADO DE GENTE, EQUIPO, FACILIDADES, METODOS Y PROCEDIMIENTOS, PARA ASEGURARSE DE QUE LAS ACTIVIDADES SEAN PREVISTAS, Y QUE ACONTEZCAN CONFORME A PROGRAMAS.

ES DENTRO DE ESTE MARCO, QUE LA ORGANIZACION DE LA INDUSTRIA PORTUARIA SERA EXAMINADA POR NOSOTROS.

CON LOS VASTOS RECURSOS ECONOMICOS ACTUALMENTE A LA DISPOSICION DE GOBIERNOS Y CONSORCIOS EMPRESARIALES, LOS PUERTOS PUEDEN SER CONSTRUIDOS DONDE SE NECESITEN.

V.GR.: EL PUERTO DE TEMA, ES GHANA, FUE CONSTRUIDO EN UNA COSTA NATURALMENTE INADECUADA; PRINCIPALMENTE EN ANTICIPACION A LOS EMBARQUES DE ALUMINIO CONECTADOS CON EL PROYECTO DEL RIO VOLTA.- KING-BAY/DAM PIER FUE DESARROLLADO AL MARGEN DEL GRAN DESIERTO ARENOSO DE AUSTRALIA OCCIDENTAL, PARA APROVECHAR LOS ENORMES DEPOSITOS DE MINERAL DE HIERRO DEL INTERIOR, EN LAS CORDILLERAS DE HAMERSLEY.- PUERTO DE LAZARO CARDENAS, FUE CONSTRIDO PRINCIPALMENTE A BASE DE DRAGADO Y DESVIANDO LA DESEMBOCADURA NATURAL DEL RIO BALSAS EN LA COSTA DEL PACIFICO, PARA APROVECHAR TAMBIEN LOS DEPOSITOS DE MINERAL DE HIERRO DEL ESTADO DE MICHOACAN.

SIN EMBARGO, HASTA TIEMPOS RELATIVAMENTE RECIENTES NO EXISTIAN

##..

NI EL CONOCIMIENTO TECNICO (KNOW-HOW); NI LA ESTRUCTURA FINANCIERA; NI TAN SIQUIERA LA HABILIDAD ORGANIZATIVA PARA CONCEBIR Y LLEVAR A CABO TALES PROYECTOS, AUNQUE HUBIESE HABIDO LA NECESIDAD DE ELLOS.

HABLANDO A GRANDES RASGOS, LOS PUERTOS FUERON EVOLUCIONANDO GRADUALMENTE, AUTO-ADAPTANDOSE A CIRCUNSTANCIAS CAMBIANTES A TRAVES DE LOS AÑOS. SUS ESTRUCTURAS Y ORGANIZACIONES FUERON DESARROLLADAS, ALGUNAS VECES DE MALA GANA, OTRAS TARDIAMENTE, SEGUN SURGIERON LAS NECESIDADES.

ALGUNOS FACTORES QUE DECIDEN LA LOCALIZACION DE PUERTOS

EN PRINCIPIO, CIERTAS CARACTERISTICAS PROVEERAN LA MEZCLA CORRECTA PARA ESTABLECER Y FERTILIZAR, EL CRECIMIENTO DE UN PUERTO:

1. UNA PARTE DE LA COSTA, SEGURA Y ABRIGADA O, MAS A MENUDO, DE UN RIO CON UN LUGAR FIRME PARA DESEMBARCAR;
2. GENTE QUE VIVA EN LA VECINDAD QUE ABASTEZCA Y PROVEA MERCANCIAS;
3. ACCESO AL INTERIOR PARA UN CONTINUO COMERCIO EN DOS DIRECCIONES;
4. ACCESOS SEGUROS POR AGUA, ORIENTADOS HACIA OTRAS AREAS DE COMERCIO:
5. SUFIECIENTES ALMAS AVENTURERAS, AMBICIOSAS Y TENACES.

EL USO REGULAR DE UN SITIO CONDUCIRA A UNA CONCENTRACION DE COMERCIO Y EL PERIODO DE DESARROLLO EMPEZARA.

PRIMEROS DESARROLLOS

INICIALMENTE FUERON NECESARIAS PEQUEÑAS ORGANIZACIONES (AQUI DESPRECIAREMOS LA ORGANIZACION DE MATERIALES, CONOCIMIENTO Y HABILI

DADES, NECESARIAS A UNO O AMBOS EXTREMOS DE UNA RUTA COMERCIAL PARA CONSTRUIR Y NAVEGAR LOS BARCOS).

LOS BUQUES ERAN SENTADOS EN TIERRA SOBRE LA PLAYA Y LAS MERCANCIAS TRANSFERIDAS HACIA, Y DE, LOMOS DE BESTIAS DE CARGA.

LA NECESIDAD DE PROVEER BODEGAS DE ALMACENAMIENTO (FUE) SERIA EL PRIMER MOVIMIENTO HACIA ORGANIZACION, REQUERIDA POR:

(1) LA RELATIVA MAYOR CAPACIDAD DE ACARREO DEL BARCO COMPARADA A LA DE TRENES TIRADOS POR CABALLOS.

(2) EL NO PROGRAMADO ARRIBO DE LOS BUQUES.

CUANDO SE DIERON CUENTA QUE SERIA MAS FACIL EL MANEJO DE MERCANCIAS AL MISMO NIVEL (O QUIZA POR QUE LA GENTE SE HASTIO DE ENLODARSE LOS PIES) PARTE DEL BANCO DEL RIO; O DE LA PLAYA, SE NIVELO Y CONSTRUYO A LA ALTURA DE TIERRA FIRME; Y POR OTRA PARTE SE PROVEYO DE SUFICIENTE PROFUNDIDAD DE AGUA PARA LOS BARCOS DISPUESTOS A USAR EL SITIO. FUE ENTONCES QUE LA CIUDAD O EL PUEBLO MINISTRARON EL PRIMER MUELLE.

EL FLUJO DE MERCANCIAS REPRESENTABA RIQUEZA Y POR LO TANTO, TARDE O TEMPRANO, EL GOBIERNO CANALIZARIA ESTA FUENTE DE INGRESOS Y, PARA FACILITAR LA CAPTACION DE DERECHOS, ERIGIO UNA GARITA ADUANAL. DE IGUAL FORMA, SE AUTORIZO A LA CIUDAD O AL MUNICIPIO A COBRAR PEAJES Y LAS PARTES INTERESADAS, PARA PROTEJER Y DESARROLLAR SUS INGRESOS, EXTENDIENDO LOS LUGARES DE DESEMBARCO, CONSTRUYENDO MAS ATRACADEROS Y, QUIZA CONSTRUYENDO BARCAZAS O CHALANES PARA SERVIR A LOS BARCOS QUE SE ENCONTRASEN FONDEADOS.

ORGANIZACION INICIAL

V.GR.: SE CONCEDIO AUTORIDAD TOTAL, SOBRE EL PUERTO, AL MUNICIPIO OTORGANDOLE UN TITULO O CEDULA CON ESTATUTOS QUE MARCABAN LOS DERECHOS Y OBLIGACIONES DE LA MUNICIPALIDAD; TALES COMO ADUANAS,

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CONSERVACION, ETC.- BRISTOL RECIBIO SU PRIMER CEDULA EN 1171.

LOS MERCADERES MEJORARON GRADUALMENTE SUS ORGANIZACIONES PARA REGULAR SU COMERCIO, COMPAÑIAS DE MERCADERES AVENTUREROS CRECIERON DESARROLLANDO SU COMERCIO CON PAISES EXTRANJEROS, Y CONFORME SE INCREMENTO EL NEGOCIO, ALGUNOS MERCADERES CONSTRUYERON SUS PROPIOS MUELLES.

EL EQUIPAR UN BARCO PARA TRAVESIAS AL EXTRAJERO ERA UN RIESGO, ASI QUE LA AVENTURA ERA COMPARTIDA POR ASOCIACIONES DE MERCADERES. DE ESTAS ASOCIACIONES NACIERON CORPORACIONES TALES COMO LA COMPAÑIA DE RUSIA (RUSSIA COMPANY) LOS MERCADERES DE ESPAÑA (THE MERCHANTS OF SPAIN) Y LA COMPAÑIA DE LA INDIA ORIENTAL. A ESTAS ORGANIZACIONES, Y OTRAS SIMILARES, SE LES OTORGARON UN MONOPOLIO COMERCIAL EN LAS REGIONES DESIGNADAS EN SUS TITULOS (CEDULAS) Y POR AÑOS SIRVIO EXITOSAMENTE PARA EL DESARROLLO DE SUS RESPECTIVOS COMERCIOS, ACUMULANDO EXPERIENCIA EN SUS MERCADOS DE ULTRAMAR.

CON EL CRECIMIENTO DEL COMERCIO DE GRAN BRETAÑA LA ORGANIZACION PORTUARIA SE ENCONTRO ESPERANDO. MEDIANTE UN ACTA DEL PARLAMENTO, 1558, SE LES HABIA ORDENADO A LOS PUERTOS EL ESTABLECER MUELLES FISCALES EN DONDE TODAS LAS MERCANCIAS SUJETAS A DERECHOS DE ADUANA DEBERIAN DE SER DESEMBARCADAS. (EJEMPLOS: HULL Y LIVERPOOL). ESTO HIZO QUE LA ORGANIZACION DE COLECTAR INGRESOS FUESE MUCHO MAS EFICIENTE; DESPUES DE ESA FECHA LOS INGRESOS POR CONCEPTO ADUANAL FUERON DOBLADOS. PERO ELLO VINO A SER TAMBIEN UN FACTOR MILITANDO EN CONTRA DE LA COMPLETA BUENA ORGANIZACION PORTUARIA: CON EL TIEMPO AYUDO A QUE SE ORIGINARAN CONGESTIONAMIENTOS DE LOS PUERTOS MAS GRANDES CONFORME SE INCREMENTO EL TRAFICO Y CRECIERON LOS BARCOS DE SUS DIMENSIONES.

OTRO FACTOR, FUE EL DEFICIENTE CONTROL MUNICIPAL DE PUERTOS GRANDES. Y LAS QUEJAS SE EMPEZARON A SUSCITAR EN VARIOS DE LOS PUERTOS MAS ANTIGUOS, CONFORME PASO EL TIEMPO.- SIGLO XVII-XIX-CONTRA LA INCOMPETENCIA DE LOS MUNICIPIOS PARA CONTROLAR EL PUERTO.

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DERECHOS DE PUERTO DESVIADOS A LOS ARCONES DE LA CIUDAD, MIENTRAS QUE LOS CANALES SE AZOLVABAN Y NO HABIAN SUFICIENTES ATRACADEROS.-(EJEMPLOS: NEWCASTLE Y L'POOL).

CAMBIOS EN LAS OPERACIONES PORTUARIAS

BAJO LA PRESION DE ESOS EVENTOS Y MEDIANTE MANIOBRAS ENTRE LOS HOMBRES INTERESADOS, EL CONTROL DE LA ORGANIZACION PORTUARIA PASO DE LAS MANOS DE HOMBRES CON OBLIGACIONES DIVIDIDAS A LAS DE ESPECIALISTAS.

DEBIDO A LA FACILIDAD DE MAYORES FACILIDADES PARA ATRACADEROS, SE BUSCO EL PODER DEL PARLAMENTO PARA LA CONSTRUCCION DE DARSENAS PARA USO COMERCIAL (LA PRIMERA QUE SE CONSTRUYO EN INGLATERRA, FUE EN 1715 EN L'POOL). SE FORMARON TAMBIEN COMPAÑIAS PARA CONSTRUIR Y OPERAR DARSENAS. LA WEST INDIA DOCK COMPANY ABRIO EL PRIMER MUELLE ENCERRADO, TIPO DARSENA, EN LONDRES (1802).

TAMBIEN SE FORMARON, DURANTE LOS SIGLOS ANTERIORMENTE MENCIONADOS, CORPORACIONES PARA LA CONSERVACION Y MEJORAMIENTO DE RIOS NAVEGABLES QUE CONDUJERAN A CENTROS DE COMERCIO.

"TEES NAVIGATION COMPANY"	1808
RIVER TYNE COMMISSION	1850
LONDRES: DESDE 1197	EL MUNICIPIO (CTY. CORP)
EN 1771	COMITE PORTUARIO (CORP)
HASTA 1857	JUNTA DE CONSERVACION
SE FORMO	DEL TAMESIS
1888	26' LWOST CHANNEL HASTA TILBURY
1892	22' ROYAL ALBERT DOCKS
CANAL DE SUEZ 30'	30' HASTA TILBURY, POSIBLEMENTE HASTA RAD.

DURANTE EL SIGLO XIX, LAS DIVERSAS COMPAÑIAS DE MUELLES Y ATRA

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CADEROS DE LONDRES ESTABAN EN FIERA COMPETENCIA UNA CON OTRA Y CON LOS ALMACENES Y BODEGAS DE LAS RIBERAS. HACIA FINES DEL SIGLO, COMO CONSECUENCIA, SUS RANGOS CREDITICIOS ERAN MUY BAJOS Y EL FINANCIA--- MIENTO NECESARIO NO ERA MUY FACIL DE CONSEGUIR, PARA EFECTUAR MEJORAS.

LO QUE SE HACIA NECESARIO, ERA UNA ORGANIZACION QUE UNIFICARA TODAS LAS COMPAÑIAS Y CORPORACIONES; CON LO BUENO DEL PUERTO DE LONDRES, CONSIDERANDO UN TODO, COMO SU PRIMERA PREOCUPACION.

.. CREACION DE PUERTOS AUTO GOBERNADOS O (AUTONOMOS) COMPAÑIAS FIDUCIARIAS "TRUST".

FUNCION DE LA AUTORIDAD PORTUARIA

HOY, EN NUESTROS DIAS, LA AUTORIDAD PORTUARIA DEBE ENCONTRARSE A LA CABEZA. DEBE RECONOCER QUE TIENE UNA PARTE IMPORTANTE QUE DESARROLLAR EN LA ECONOMIA DEL PAIS.

UNA CANTIDAD RAZONABLE DEBERA DESTINARSE A LA INVESTIGACION (MERCADEO) Y ES NECESARIO TAMBIEN QUE LA ADMINISTRACION DEL PUERTO, TOMASE UN INTERES EN LO QUE OTROS PUERTOS, Y NO SOLAMENTE AQUELLOS DE SU PROPIO PAIS, ESTAN HACIENDO;

- CUALES SON LAS POLITICAS QUE DETERMINAN LA OPERACION DE LOS PUERTOS EN PAISES EXTRAJEROS;
- CUALES SON SUS INTENCIONES, POR MEDIO DE DESARROLLOS, ENTRENAMIENTO Y CAPACITACION DE PERSONAL Y TRABAJADORES;
- SI VEN SU FUTURO EN TERMINOS DE CARGA GENERAL, DE CONTAINERS, DE TRAFICO A GRANEL, O COMO UN PUERTO INTEGRADO.

EN EL PASADO LAS AUTORIDADES PORTUARIAS TENDIAN A SOBRE-CENTRALIZAR. INICIATIVAS O NUEVAS FORMAS DE HACER LAS COSAS ERAN VISTAS CON MALOS OJOS, POR UNA ADMINISTRACION QUE DESAPROBABA EL SER EMPRENDEDOR O CREATIVO, Y DEMANDABA UNA ESTRICTA ADHERENCIA A LAS REGLAS Y NORMAS ASENTADAS EN LOS LIBROS RELATIVOS.

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CIERTO ES TAMBIEN, QUE MUY POCAS SUGERENCIAS SUBSTANCIALES PARA MEJORAR LA EMPRESA FUERON ALGUNA VEZ RECIBIDAS, DE PARTE DEL PERSONAL DE ESTOS PUERTOS. ANTES DE QUE EL PERSONAL PUEDA PRODUCIR IDEAS APRECIABLES, ESTE DEBERA SER PRIMERAMENTE, ANIMADO, MOTIVADO Y ENTRENADO; LO CUAL NO ES UN PROCESO RAPIDO.

FUNCION DE LOS PRIMEROS PUERTOS

HACE MEDIO SIGLO, EL HECHO DE QUE UN PUERTO, O DARSENA, NO SE ENCONTRASE DE SI AISLADO; NO LE PERMITIA A SU PROPIETARIO EL INMISCUIRSE EN SU PROPOSITO PRINCIPAL DE PAGAR DIVIDENDOS A SUS ACCIONISTAS Y DE CONTAR CON SUFICIENTE DINERO PARA MANTENER EL RECINTO PORTUARIO EN FORMA PRESENTABLE, SUFICIENTE PARA RETENER SU ACTUAL COMERCIO, Y PARA ATRAER ALGUN NUEVO NEGOCIO.

ERA APARENTE PARA ALGUNAS DE LAS COMPAÑIAS PORTUARIAS, DE ANTES DE 1914, QUE MIENTRAS ELLAS ESTABAN DANDO, FIGURADAMENTE, A SUS INSTALACIONES UNA NUEVA MANO DE PINTURA, EL RIO SOBRE EL QUE CORRIAN LOS EMBARQUES EN LOS CUALES ELLOS CONFIABAN, SE ESTABA AZOLVANDO GRADUALMENTE. MIENTRAS TANTO, OTROS PUERTOS, DE SU PROPIO PAIS Y EXTRANJEROS, ESTABAN ATRAYENDO NUEVAS INDUSTRIAS Y NUEVAS IDEAS.

Y DE ESA FORMA, LA NECESIDAD POR UNA AUTORIDAD PORTUARIA, SE HIZO RECONOCER UN CUERPO QUE SE HARIA A SI MISMO RESPONSABLE POR EL PUERTO, PRIMORDIALMENTE COMO UN PUERTO Y NO COMO UN ESTABLECIMIENTO COMERCIAL.

CONFORME PASARON LOS AÑOS, AQUELLAS FUNCIONES NO FUERON INCREMENTADAS REMUNERATIVAMENTE EN FORMA DIRECTA. EMPEZANDO CON LA MAS URGENTE, (EN MUCHOS DE LOS CASOS) EL DRAGADO; ESTO CONDUJO INEVITABLEMENTE A LA CONSERVACION DEL RIO, SUPERVISION DE REPARACIONES Y EL HACERSE CARGO DE LOS PODERES PARA REGULAR Y CONTROLAR EL TRAFICO

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FLUVIAL. LLEGANDO HASTA NUESTRO DIAS EN QUE SE HAN INSTALADO RADARES EN TIERRA, A GRAN ESCALA, A LO LARGO DE LOS ESTUARIOS. LAS AUTORIDADES PORTUARIAS HAN SOPESADO AHORA UNA GUERRA, EN LA CUAL PARECE NO HABRA TREGUA, EN CONTRA DE LA DESCARGA DE CONTAMINANTES PROVENIENTES DE DESPERDICIOS INDUSTRIALES Y DEL MUNICIPIO.

TIPOS DE ADMINISTRACION PORTUARIA

COMO TANTAS COSAS CONCERNIENTES A LOS PUERTOS, LA DIFICULTAD CUANDO CONSIDERAN PROBLEMAS A LA ADMINISTRACION ES EVIDENTE.

- NO HAY UNA ADMINISTRACION PORTUARIA STANDARD, DE LA CUAL UNO PUEDA COMPARAR O EN SI TRABAJAR SOBRE ELLA.

NO HAN SIDO UNICAMENTE LAS DEMANDAS QUE HAYAN HECHO CAMBIAR O INFLUENCIADO CONTINUAMENTE SOBRE LAS AUTORIDADES PORTUARIAS, DURANTE ESTE SIGLO, SINO QUE AUN SE ENCUENTRAN LEJANAS DE PODER ESTABILIZARSE.

¿QUE TIPO DE OBLIGACIONES DEBERAN TENER LAS AUTORIDADES PORTUARIAS Y CUALES LOS USUARIOS?

NO EXISTE UN ACUERDO SOBRE LAS FUNCIONES DE LA AUTORIDAD PORTUARIA, INCLUSO EN LO MAS BASICO, TAL COMO: ¿QUIEN DEBERA EFECTUAR EL TRABAJO DIARIO DE CAPATAZ O JEFE DE CUADRILLA, O DEL ENCARGADO DE BODEGA? LA POSICION ES TAN COMPLEJA QUE UNA EXPLICACION LOGICA DE LAS PRACTICAS, O COMO SE HACE, EN LOS MAYORES PUERTOS DEL MUNDO NOS CONFUNDIRIA AUN MAS.

CUANDO HECHAMOS UN VISTAZO A LA FORMA EN QUE LOS PUERTOS SE HAN IDO DESARROLLANDO, REALMENTE NOS SORPRENDEMOS.

EL DISEÑO DE UNA ESTRUCTURA ADMINISTRATIVA ESTA DETERMINANDO, EN GRAN PARTE, POR LA SITUACION GEOGRAFICA DEL PUERTO, LOS ANTECEDENTES INDUSTRIALES Y SOCIALES, Y OBVIAMENTE EL TIPO DE MERCANCIAS A MANEJARSE.

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CONSIDEREMOS LOS INTERMINABLES PROBLEMAS QUE ENCARAN LAS ADMINISTRACIONES DE LONDRES Y LIVERPOOL DEBIDO A QUE SON PUERTOS SOBRE ESTUARIOS, POR LO QUE DEBEN DE MANTENER LAS DARSENAS A UN NIVEL CONSTANTE MEDIANTE ESCLUSAS.

Y COMPAREMOS ESTOS, CON LOS PROBLEMAS QUE, POR EJEMPLO: LOS PUERTOS DE NAPOLES Y GENOVA, EN DONDE EL MOVIMIENTO DE MAREAS PUEDE SER DESPRECIABLE Y EL DRAGADO NO ES UNA CUESTION DIARIA O NECESARIA; EXCEPTO EN LAS INMEDIACIONES DE LAS ENTRADAS DONDE PUEDEN OCURRIR AZOLVES.

LOS PROBLEMAS DE UN PUERTO QUE ESTE IDEALMENTE SITUADO COMO CENTRO DE ARRIBO EN TRANSITO, DEBERAN SER VISTOS EN FORMA DIFERENTE A LOS DE UN CENTRO DE TRANSPORTE; CUYOS INGRESOS PROVIENEN GENERALMENTE DE CARGOS POR ALMECENAMIENTO Y EL MANIPULEO DE CARGAS ESPECIALIZADAS.

POR EJEMPLO: LAS ADMINISTRACIONES EN LOS PUERTOS DE ALEMANIA OCCIDENTAL NOS PUEDEN ILUSTRAR LO EXTENSO SOBRE LO QUE EL PRINCIPIO DE DESCENTRALIZACION DE PODERES, PUEDE OPERAR. EL SECTOR PRIVADO PARTICIPA EN EL DIARIO OPERAR DE HAMBURGO Y BREMEN, CADA UNO DE LOS CUALES TIENE SU PROPIO PUERTO LIBRE.

EN OTROS PAISES LAS AUTORIDADES LOCALES TOMAN UNA PARTE ACTIVA; V. GR.: EN LOS PAISES BAJOS, LAS ACTIVIDADES PORTUARIAS OCUPAN UN RENGLON IMPORTANTE EN LA ECONOMIA NACIONAL.

EL PATRON GENERAL ES QUE LA AUTORIDAD LOCAL TOME LA RESPONSABILIDAD DE LA ADMINISTRACION, CON LA INTERVENCION DEL ESTADO EN MUCHOS DE LOS ASPECTOS MAS IMPORTANTES DE LA OPERACION DEL PUERTO; INCLUYENDO ACCESO AL MAR Y PILOTAJE. AL MISMO TIEMPO, TENEMOS QUE EL PUERTO DE ROTTERDAM HA ASENTADO UN PATRON MUNDIAL EN EL DESARROLLO PORTUARIO, MIENTRAS QUE HA TRIUNFADO EN RETENER AL SECTOR PRIVADO COMO EL FACTOR DOMINANTE EN LA OPERACION DEL PUERTO.

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EN EL REINO UNIDO, HAY CUATRO FORMAS PRINCIPALES DE ADMINISTRACION PORTUARIA. LA MAS IMPORTANTE ES EL "TRUST" ESTATUTORIO PORTUARIO, TALES COMO LOS DE LONDRES Y LIVERPOOL. ESTA FORMA DE ADMINISTRACION HA TENIDO EXITO DURANTE VARIAS DECADAS; ESTA SE ENCUENTRA COMPUESTA DE REPRESENTANTES EN UN CONSEJO ADMINISTRATIVO O SIMILAR, MAS UNA MAYORIA QUE REPRESENTA A LOS USUARIOS DEL PUERTO. CUANDO LOS PUERTOS SE ENCUENTRAN SITUADOS EN ESTUARIOS, LAS RESPONSABILIDADES INCLUYEN LA CONSERVACION DE ACCESO ASI COMO EL CONTROL DE BUQUES Y EMBARCACIONES QUE SE MUEVAN DENTRO DE LOS LIMITES DE LA AUTORIDAD PORTUARIA.

A PESAR DE LOS INTERESES CONFLICTIVOS QUE APARENTEMENTE SE ENCUENTRAN ENTRE LOS USUARIOS DEL PUERTO Y LA AUTORIDAD PORTUARIA, DE LA CUAL ELLOS FORMAN PARTE, TALES COMO LA ASIGNACION DE DEBERES DEL PATRON DE ESTIBADORES, NO HA HABIDO DEMANDA PARA REEMPLAZAR ESTE TIPO DE ADMINISTRACION. EL TRABAJO DIARIO ES HECHO POR UN GERENTE GENERAL; COMITES ESPECIALES CUBREN CADA FASE DEL TRABAJO; Y HAY UN PRESIDENTE Y VICE-PRESIDENTE ELEGIDOS POR LA JUNTA, DE LA CUAL NO NECESARIAMENTE SON MIEMBROS ESTOS. ALGUNOS PUERTOS HAN SIDO NACIONALIZADOS, DESDE 1948, Y OPERADOS POR LA JUNTA BRITANICA DEL TRANSPORTE PORTUARIO (BTDB). DE LOS PUERTOS DE PROPIEDAD MUNICIPAL, EL MAS IMPORTANTE ES BRISTOL. DE LOS PRIVADOS, MANCHESTER, QUE ES OPERADO POR LA COMPAÑIA MARITIMA DEL CANAL DE MANCHESTER.

LAS CONDICIONES DE LOS PUERTOS FRANCESES SON DIFERENTES. DESPUES DE LA REVOLUCION FRANCESA SE CONVIRTIERON EN PROPIEDAD DEL ESTADO, QUEDANDO BAJO LA AUTORIDAD DEL MINISTERIO DE MARINA (AQUELLOS QUE TENIAN ALGUNA IMPORTANCIA ESTRATEGICA) O LA DEL MINISTERIO DEL INTERIOR. CUANDO FUE CREADO EL MINISTERIO DE OBRAS, LOS PUERTOS PASARON A QUEDAR BAJO SU CONTROL.

DESDE ENTONCES, HA HABIDO DOS FORMAS DE ADMINISTRACION -PUERTOS ESTATALES Y PUERTOS AUTOGOBERNADOS (AUTONOMOS). EL DIRECTOR

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DEL PUERTO TIENE LA RESPONSABILIDAD DE ADMINISTRAR Y OPERAR EL PUERTO, Y EJERCITA SUS PODERES BAJO LAS ORDENES DEL MINISTRO. EN LOS PUERTOS DE MAYOR IMPORTANCIA ESTE CUENTA CON LOS SERVICIOS DE UN COMITE CONSEJERO COMPUESTO POR REPRESENTANTES DEL CONCILIO LOCAL, CAMARAS DE COMERCIO Y DE LOS USUARIOS DEL PUERTO.

LOS PUERTOS ITALIANOS SON, CON EXCEPCION DE GENOVA, PROPIEDAD DEL ESTADO Y SON ADMINISTRADOS POR EL MINISTERIO DE MARINA; EN TANTO QUE EL MANTENIMIENTO Y TRABAJOS DE CONSTRUCCION SON CONTROLADOS POR EL MINISTERIO DE OBRAS PUBLICAS. GENOVA ES OPERADO POR UN CONSEJO DE ADMINISTRACION COMPUESTO POR FUNCIONARIOS DEL GOBIERNO Y REPRESENTANTES, DE ENTRE OTROS, DE LOS CABILDOS MUNICIPALES DE GENOVA, MILAN Y TURIN Y DE LAS CAMARAS DE COMERCIO.

EN BELGICA EXISTE GRAN DIVERSIDAD EN LOS SISTEMAS ADMINISTRATIVOS DE SUS PUERTOS. AMBERES,GHENT Y OSTEND SON DE ADMINISTRACION MUNICIPAL.

EL PUERTO MAS GRANDE, AMBERES, ESTA GOBERNANDO POR UN CONSEJO; SIENDO ENCOMENDADOS LOS TRABAJOS A UN COMITE DE BURGOMAESTRE Y CONSEJEROS. HAY UN DIRECTOR GENERAL QUIEN ES EL RESPONSABLE DE LA COORDINACION DE LOS DIVERSOS SERVICIOS. AUNQUE EMPRESAS PRIVADAS NO TOMAN PARTE EN LA ADMINISTRACION DEL PUERTO, SI SON RESPONSABLES DEL SERVICIO DE ESTIBADORES ASI COMO DEL ALMACENAMIENTO Y DESPACHO DE CARGAS (TRABAJO QUE NORMALMENTE SERIA EFECTUADO POR LA AUTORIDAD PORTUARIA). ZEEBRUGGE PERTENECE A UNA FIRMA PRIVADA, EN LA CUAL EL GOBIERNO BELGA SE ENCUENTRA BASTANTE INTERESADO.

DIFERENTES TIPOS DE ADMINISTRACION PORTUARIA

1. ADMINISTRACION PORTUARIA GUBERNAMENTAL MEDIANTE UN MINISTERIO O DEPARTAMENTO DEL GOBIERNO.
2. AUTORIDAD PORTUARIA AUTONOMA, EN SUS CONTEXTOS NACIONAL, ESTATAL O MUNICIPAL.
3. ADMINISTRACION PORTUARIA MUNICIPAL.

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4. ADMINISTRACION PORTUARIA PRIVADA.
5. OTROS TIPOS DE ADMINISTRACION PORTUARIA TALES COMO: ADUANAS; PUERTOS LIBRES, JUNTAS DE CONSERVACION DE CANALES Y DARSENAS; O UNA CORPORACION MERCANTIL MIXTA (VALORES)

DESDE LUEGO QUE NO EXISTE UNA GUIA GENERAL ACERCA DEL MEJOR TIPO DE ADMINISTRACION PORTUARIA, ASI QUE NOS CONCENTRAREMOS EN ESTUDIAR LOS PRIMEROS DOS TIPOS DE ADMINISTRACION PORTUARIA ANOTADOS ARRIBA; LA RAZON PARA ESTO, ES QUE ESTOS SON LOS QUE MAS SE ACERCAN AL "CUERPO ADMINISTRATIVO UNICO", QUE SE ENCARGARIA DE TODOS LOS ASUNTOS MARITIMOS PORTUARIOS, Y BAJO EL CUAL OPERARIAN TODOS LOS PUERTOS NACIONALES ACTUALES Y LOS QUE PLANEA CONSTRUIR EL GOBIERNO.

CON RESPECTO A LA RESPONSABILIDAD PARA ADMINISTRAR PUERTOS DE PROPIEDAD PUBLICA, HAY DOS POSIBILIDADES: (1) YA SEA QUE EL GOBIERNO MANTUVIERA ESA FUNCION COMO UN CARGO O DEBER MINISTERIAL, (2) QUE LO TRANSFIERA MEDIANTE LEY A UNA CORPORACION PUBLICA QUE SEA AUTO-FINANCIABLE Y QUE OPERE SIN FINES DE LUCRO: ESTO ES, UNA AUTORIDAD PORTUARIA AUTONOMA.

CON RESPECTO A LA NO JUSTIFICACION DE VARIAS AUTORIDADES PORTUARIAS DISEMINADAS POR EL PAIS, PODRIAMOS CITAR LO SIGUIENTE:

"LA AUTONOMIA NO PUEDE SER POSIBLE EN TODOS LOS PUERTOS. LOS PUERTOS PEQUEÑOS NO PODRIAN SOPORTAR LA CARGA DE UNA ESTRUCTURA ADMINISTRATIVA TAN PESADA. ESTO ES POR LO QUE ALGUNOS PAISES, TANTO DESARROLLADOS COMO EN VIAS DE DESARROLLO HAN AGRUPADO EXITOSAMENTE VARIOS PUERTOS (PEQUEÑOS Y GRANDES) BAJO UNA JUNTA AUTONOMA. *

* NACIONES UNIDAS-TARIFAS PORTUARIAS.

1. ADMINISTRACION PORTUARIA GUBERNAMENTAL.

AQUI EL GOBIERNO TIENE PODERES Y CONTROL ABSOLUTO SOBRE LOS PUERTOS; Y LA RESPONSABILIDAD DE ADMINISTRAR LOS PUERTOS DE PROPIEDAD PUBLICA SE ESTABLECE EN UN DEPARTAMENTO O DEPENDENCIA GUBERNAMENTAL TALES COMO: EL MINISTERIO DE COMERCIO, DE TRANSPORTE, DE OBRAS PUBLICAS, DE COMUNICACIONES, Y ASI POR EL ESTILO. POR LO TANTO, LA POLITICA A SEGUIR QUEDA GENERALMENTE EN LAS MANOS DEL SECRETARIO DE ESTADO A CARGO DE LA ADMINISTRACION DE LOS PUERTOS Y CONSECUENTEMENTE, SU INTERVENCION EN LAS TOMAS DE DECISIONES SOBRE LA POLITICA PORTUARIA ES EN ESTRECHA COLABORACION CON LAS PRIMERAS AUTORIDADES DEL PAIS: EL PRESIDENTE Y SU GABINETE, ASI COMO EL PODER LEGISTATIVO.

EN ESTAS CONDICIONES, LA AUTORIDAD PORTUARIA TIENE QUE LABORAR DENTRO DEL MARCO FINANCIERO Y POLITICO DEL GOBIERNO.

COMO PODEMOS NOTAR, ESTE TIPO DE ADMINISTRACION PORTUARIA SUFRE DE UN ALTO GRADO DE INFLEXIBILIDAD COMERCIAL: OPERACIONES DE NEGOCIOS SON MUY DIFICILES DE LLEVAR A CABO DEBIDO A LOS REQUERIMIENTOS DE SOMETER CADA DECISION RUTINARIA A LA APROBACION DEL MINISTERIO, Y ESTA INFLEXIBILIDAD NO CORRESPONDE CON LA AGILIDAD REQUERIDA POR LOS USUARIOS PARA SUS BUQUES Y CARGAS.

OTRAS CARACTERISTICAS PRINCIPALES DE ESTE TIPO DE ADMINISTRACION PORTUARIA SON:

- QUE A MENUDO HA RESULTADO DE ALGUN OTRO TIPO DE PROPIEDAD DE MEDIOS DE TRANSPORTE; V.GR.: LOS PUERTOS DEL FERROCARRIL BRITANICO, LOS CUALES PASARON DESPUES A FORMAR PARTE DE LA JUNTA BRITANICA DE TRANSPORTE PORTUARIO (BTDB).

- QUE EN LA JUNTA DIRECTIVA, DE ESTE TIPO DE ADMINISTRACION PORTUARIA, NO HAY REPRESENTACION FORMAL DE LOS USUARIOS DEL PUERTO;

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DE CUALQUIER MANERA, EXISTE UNA FORMA DE CONSULTA INFORMAL CON ELLOS.

2. AUTORIDAD PORTUARIA AUTONOMA.

ESTA ES UNA CORPORACION SIN CAPITAL COMERCIAL, DE CARACTER NO LUCRATIVO, AUTO-SOPORTADA FINANCIERAMENTE y AUTO-GOBERNABLE, LA CUAL SE FORMA MEDIANTE ESTATUTO CON UNA IDENTIDAD LEGAL QUE LE PERMITE DEMANDAR Y/O SER DEMANDADA, RETENER PROPIEDADES, HACER CONTRATOS, ADOPTAR PRESUPUESTOS, EMPLEAR SU PROPIO PERSONAL Y FUNCIONA CON AUTONOMIA FINANCIERA CONSIDERABLE.

ESTE TIPO DE ADMINISTRACION PORTUARIA ES GENERALMENTE DIRIGIDA POR UNA JUNTA INTEGRADA POR USUARIOS DEL PUERTO, ARMADORES Y PROPIETARIOS DE CARGAS, ASI COMO MIEMBROS DESIGNADOS POR EL GOBIERNO A TRAVES DEL MINISTERIO QUE ESTE A CARGO DE LOS ASUNTOS PORTUARIOS O POR EL EJECUTIVO.

UNA BUENA DEFINICION DE UNA AUTORIDAD PORTUARIA AUTONOMA ES LA SIGUIENTE:

> "....UNA CORPORACION PUBLICA FORMADA FUERA DEL MARCO REGULAR DEL GOBIERNO FEDERAL, ESTATAL O LOCAL, LIBERADA DE PROCEDIMIENTOS Y RESTRICCIONES DE LAS OPERACIONES RUTINARIAS DEL GOBIERNO; DE TAL MANERA QUE PUEDE INCORPORAR LAS MEJORES TECNICAS DE LA ADMINISTRACION PRIVADA, A LA OPERACION DE UNA EMPRESA PUBLICA AUTO-SOPORTABLE O PRODUCTORA DE INGRESOS...."(*)

AQUI, EL GOBIERNO TRANSFIERE SU RESPONSABILIDAD, CON RESPECTO A LA ADMINISTRACION DE LOS PUERTOS, MEDIANTE LEY ESPECIAL A UNA AUTORIDAD PORTUARIA AUTONOMA. PARA LOS PUERTOS ESTO SIGNIFICA QUE ESTA FORMA DE ADMINISTRACION PORTUARIA REPRESENTA LA MANERA DE HACER POSIBLE EL USO DE LOS PRINCIPIOS DE GERENCIA PROGRESIVA FUNCIONANDO SOBRE UNA BASE EMPRESARIAL, PERO TENIENDO SIEMPRE EN CUENTA

(*) HEDDEN W.P.- "MISSION: PORT DEVELOPMENT-WITH CASE STUDIES"

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EL OBJETIVO DE UNA EMPRESA AUTO-SOPORTABLE Y DE CARACTER NO LUCRATIVO.

ESTA ES SOLAMENTE OTRA FORMA DE ADMINISTRACION Y DE GERENCIA DIFERENTE DE, Y MAS FLEXIBLE QUE, LOS MEDIOS DE ADMINISTRACION GENERALMENTE EFECTUADO EN ACTIVIDADES GUBERNAMENTALES, AUN MAS, EL GOBIERNO TIENE QUE MANTENER ALGUN NIVEL DE SUPERVISION Y CONTROL SOBRE LOS PUERTOS PORQUE ELLOS SON IMPORTANTES HERRAMIENTAS DE LA POLITICA ECONOMICA NACIONAL. HACIENDO ESTO, EL GOBIERNO PUEDE ESTAR SEGURO DE QUE LOS PUERTOS SERAN ADMINISTRADOS Y DESARROLLADOS DE ACUERDO CON LA POLITICA ECONOMICA NACIONAL, Y POR LO TANTO, UNA SALVAGUARDA DE LOS INTERESES NACIONALES ESTARA ASEGURADA.

POR LO TANTO, LA ADMINISTRACION EFICIENTE DEPENDE DE NORMAS Y REGLAMENTOS MAS FLEXIBLES QUE AQUELLAS USADAS POR EL GOBIERNO; Y SE REQUIERE UN SISTEMA GERENCIAL SEMEJANTE AL DE UN NEGOCIO, PARA ESTAR LIBRE DE FLUCTUACIONES Y PRESIONES POLITICAS, Y POR ENDE, UN GRAN NIVEL DE FLEXIBILIDAD COMERCIAL DEBERA EXISTIR.

EL EXITO DE ESTE TIPO DE ADMINISTRACION PORTUARIA DEPENDERA DE LAS SIGUIENTES CARACTERISTICAS:

AUTONOMIA, INDEPENDENCIA FINANCIERA Y EL EMPLEO DE LAS MEJORES TECNICAS EN EL CAMPO DE LA GERENCIA COMERCIAL.

ENTRE OTROS AUTORES, B. NAGORSKI APOYA LA CREACION DE UNA AUTORIDAD PORTUARIA AUTONOMA, CUANDO DICE QUE:

> "....SIN NINGUNA DUDA, PARECE ESTAR ESTABLECIDO QUE UNA FORMA AUTONOMA DE ADMINISTRACION PORTUARIA, HA SIDO LA DE MAYOR EXITO EN LOS PRINCIPALES PUERTOS DEL MUNDO, MIENTRAS QUE LA ADMINISTRACION DIRECTA MEDIANTE DEPENDENCIAS DEL GOBIERNO CENTRAL HA DADO RESULTADOS MENOS SATISFACTORIOS...." (**)

(**) NAGORSKI, B.- "PORT PROBLEMS IN DEVELOPING COUNTRIES"

ARGUMENTO A FAVOR DE LA AUTORIDAD GUBERNAMENTAL

1. EL BIENESTAR NACIONAL DEL PAIS DEPENDE, ENTRE OTRAS CONDICIONES, DE LA EFICIENTE OPERACION, MANTENIMIENTO Y DESARROLLO DE LOS PUERTOS; Y DESDE ESTE PUNTO DE VISTA, EL GOBIERNO DEBERA POSEER Y OPERAR LOS PUERTOS DEL PAIS.
2. EL GOBIERNO PODRA HACER ESTO DE ACUERDO CON UN PLAN NACIONAL A LARGO PLAZO UNICO.
3. EL GOBIERNO PUEDE PREVENIR GASTOS INNECESARIOS EN EL DESARROLLO DE LOS PUERTOS.
4. SIENDO EL PROPIETARIO DE LOS PUERTOS, EL GOBIERNO PODRA COORDINAR E INTEGRAR ESTOS CON OTROS MEDIOS DE TRANSPORTE.
5. PODRA MANTENER ALGUN GRADO DE IMPARCIALIDAD CON CUALQUIER MEDIO DE TRANSPORTE USADO POR EL PUERTO.

ARGUMENTOS A FAVOR DE LA AUTORIDAD AUTONOMA

1. EMPRESAS PORTUARIAS ESTAN MAS RELACIONADAS CON EL COMERCIO QUE EL GOBIERNO.
2. UNA AUTORIDAD PORTUARIA AUTONOMA PODRIA ESTAR CONTROLADA Y SUPERVISADA POR EL GOBIERNO.
3. EL GOBIERNO CONTROLA Y SUPERVISA TODOS LOS CONSTREÑIMIENTOS EN LAS DECISIONES Y POLITICAS HECHAS POR EL DIRECTOR GENERAL DE LA AUTORIDAD PORTUARIA, CONTROL POR PARTE DEL GOBIERNO PUEDE RESTRINGIR LA LIBERTAD DEL DIRECTOR GENERAL A LA AUTORIDAD PORTUARIA EN SU POLITICA DE TOMA DE DECISIONES.
4. LOS PUERTOS SON MUY IMPORTANTES PARA EL DESARROLLO DEL COMERCIO DEL PAIS.

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VENTAJAS Y DESVENTAJAS DE CADA SISTEMA

ADMINISTRACION GUBERNAMENTAL

VENTAJAS:

(a) UNA POLITICA NACIONAL PORTUARIA INTEGRADA CON LOS OTROS MODOS DE TRANSPORTE SERA FACTIBLE, CONTANDO CON FONDOS ADECUADOS;

(b) PLANEACION A NIVEL NACIONAL SERA FACTIBLE;

(c) REGULARIZACION DE FORMAS, PROCEDIMIENTOS Y TIPO DE CARGOS;

(d) FUERZA FINANCIERA;

(e) ENTRENAMIENTO PORTUARIO CONSISTENTE;

(f) BUENA TRANSFERENCIA DE CONOCIMIENTO TECNOLOGICO (EXPERIENCIA, EQUIPO, NUEVAS TENDENCIAS).

DESVENTAJAS:

(a) CENTRALIZACION DE EMPLEO, O DESARROLLO DE POSIBILIDADES;

(b) INFLUENCIA POLITICA;

(c) EXTENCION E INTERFERENCIA BUROCRATICA Y TUTELAJE POLITICO;

(d) SUBSIDIOS DEL GOBIERNO PUEDEN CONDUCIR A INEFICIENCIA ECONOMICA LOCAL;

(e) CARECE DE IDENTIDAD LEGAL INDEPENDIENTE;

(f) ALTO GRADO DE INFLEXIBILIDAD COMERCIAL.

ADMINISTRACION AUTONOMA.

VENTAJAS:

(a) ES UNA CORPORACION LIBRE E INDEPENDIENTE;

(b) ADMINISTRACION BASADA EN EL TIPO EMPRESARIAL;

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(c) NO HAY PRESIONES POLITICAS;

(d) REPRESENTACION DE USUARIOS EN LA JUNTA;

(e) POSEE IDENTIDAD LEGAL;

(f) TIENE UN ALTO GRADO DE FLEXIBILIDAD COMERCIAL.

DESVENTAJAS:

(a) EXTENSION BUROCRATICA;
(b) GASTOS ADICIONALES (PARA EL GOBIERNO);
(c) FONDOS PARA DESARROLLO SON LIMITADOS;
(d) GENERALMENTE PUEDE CONSEGUIR CREDITOS O PRESTAMOS UNICAMENTE CON EL CONSENTIMIENTO DEL GOBIERNO.

PROPIEDAD Y ADMINISTRACION PORTUARIAS.

LA GERENCIA DE LA MAYORIA DE LOS PUERTOS EN EL MUNDO ESTA INVESTIDA EN UNA AUTORIDAD PORTUARIA, LA CONSTITUCION Y OBJETIVOS DE ESTOS ORGANISMOS DIFIERE CONSIDERABLEMENTE DE PAIS A PAIS, E INCLUSO DENTRO DE FRONTERAS NACIONALES. QUIZA LA CARACTERISTICA MAS RELEVANTE DE LA ADMINISTRACION PORTUARIA EN LOS PUERTOS MAS GRANDES DEL MUNDO, ES LA DIVERSIDAD DE FORMAS ADAPTADAS DE PROPIEDAD Y LOS NUMEROSOS MODOS EN LOS CUALES SE HA DELEGADO LA RESPONSABILIDAD PARA PROVEER FACILIDADES Y SERVICIOS. SIN EMBARGO, EXISTE UNA CIERTA SIMILITUD ENTRE LOS DIVERSOS TIPOS DE ADMINISTRACION PORTUARIA ADAPTADA EN MUCHOS PAISES EN VIAS DE DESARROLLO; PUES LA MAYORIA EXHIBE UN GRADO DE CONTROL CENTRAL GUBERNAMENTAL CON UNA CLARA DISTINCION ENTRE LO QUE ES EL PUERTO LOCALMENTE Y LA RESPONSABILIDAD NACIONAL. LA INFLUENCIA DEL GOBIERNO EN LA ADMINISTRACION PORTUARIA Y EL CONCEPTO DE PLANEACION PORTUARIA, A NIVEL CENTRAL O NACIONAL, LO DISCUTIREMOS POSTERIORMENTE.

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DERECHOS Y OBLIGACIONES DE LAS AUTORIDADES PORTUARIAS

LOS DERECHOS Y OBLIGACIONES DE AUTORIDADES PORTUARIAS, ESTAN GENERALMENTE CONTENIDAS EN LEYES ESTATALES O NACIONALES, MIENTRAS QUE LOS DEBERES Y FACULTADES VARIAN DE UNA ADMINISTRACION A OTRA, SIN EMBARGO, GUARDAN CIERTAS CARACTERISTICAS COMUNES. ESTAS SON: EL PROVEER, MANTENER Y OPERAR EL PUERTO Y LAS FACILIDADES PORTUARIAS BAJO JURISDICCION Y EL TOMAR LAS PROVIDENCIAS NECESARIAS PARA EL MEJORAMIENTO GENERAL DEL PUERTO. LAS LEYES BASICAS TAMBIEN PROVEEN A LA AUTORIDAD PORTUARIA CON FACULTADES PARA OCUPARSE EN ACTIVIDADES QUE LES PAREZCAN VENTAJOSAS, O NECESARIAS, PARA DESCARGAR SUS RESPONSABILIDADES.

QUE FUNCIONES DEBIERA EFECTUAR LA AUTORIDAD PORTUARIA.

UN PUERTO MODERNO ES UNA OPERACION COMPLEJA CON NUMEROSAS INSTALACIONES Y SERVICIOS QUE DEBERAN SER PROVISTOS PARA SATISFACER LAS DEMANDAS DEL PRINCIPAL CLIENTE; EL ARMADOR. DENTRO DEL AREA BAJO LA JURISDICCION DE LA AUTORIDAD PORTUARIA, MUCHAS ORGANIZACIONES, CONSTRUIDAS DE DIVERSAS FORMAS, PUEDEN SER LAS RESPONSABLES DE PROVEER DICHAS FACILIDADES Y SERVICIOS.

DURANTE ESTA CLASE DISCUTIREMOS QUE FUNCIONES SON LAS QUE MEJOR PROPORCIONA LA AUTORIDAD PORTUARIA Y CUALES DEBERAN SER DELEGADAS A OTRAS ORGANIZACIONES. UN PUNTO IMPORTANTE A CONSIDERAR ES; QUE CONFORME AUMENTA EL NUMERO DE COMPAÑIAS OPERANDO DENTRO DEL PUERTO, TAMBIEN AUMENTA LA NECESIDAD DE COORDINACION Y COMUNICACION. LA NECESIDAD DE COORDINAR Y MEJORAR LA PLANEACION TOTAL DE LAS OPERACIONES PORTUARIAS HA ALENTADO A LAS AUTORIDADES PORTUARIAS A ASUMIR UNA MAYOR RESPONSABILIDAD SOBRE LAS FUNCIONES QUE TRADICIONALMENTE SE HABIAN RESERVADO A COMPAÑIAS PRIVADAS.

EN LA MAYORIA DE LOS PUERTOS DEL MUNDO, LA FUNCION TRADICIONAL DE LA AUTORIDAD PORTUARIA HA SIDO EL PROPORCIONAR LAS FACILI-

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DADES ESTATICAS, V.GR.: ESCOLLERAS, MUELLES, ESCLUZAS, ETC.; CONFIANDOSE EN COMPAÑIAS PRIVADAS PARA QUE PROPORCIONEN LOS SERVICIOS.

LAS PRINCIPALES FUNCIONES DE UN PUERTO SON:

1) CONSERVACION Y AYUDAS A LA NAVEGACION
   QUE PUEDEN ESTAR BAJO LA RESPONSABILIDAD DE:
   (a) LA AUTORIDAD PORTUARIA;
   (b) UNA JUNTA DE CONSERVACION;
   (c) ALGUNA DEPENDENCIA DEL GOBIERNO (V.GR.: CUERPO DE INGENIEROS DEL EJERCITO EN LOS EE.UU.).

EN DONDE UNA CORPORACION DIFERENTE A LA AUTORIDAD PORTUARIA ASUME ESTA FUNCION, ELLO HA CONDUCIDO A LIMITES DE RESPONSABILIDAD NO DEFINIDOS Y A DUPLICIDAD DE ACTIVIDADES. EL ARGUMENTO DE QUE, SI LA AUTORIDAD PORTUARIA DEBERA O NO RECIBIR APOYO MONETARIO POR PARTE DEL GOBIERNO, PARA AYUDARLE A REDUCIR LA CARGA FINANCIERA IMPUESTA POR DESVENTAJAS FISICAS, ES UN TOPICO COMUN. PUES LA MAYORIA DE LOS PUERTOS DEL MUNDO ESTAN OCUPADOS EN EL DRAGADO DE CANALES DE ACCESO, PARA PODER ACOMODAR LOS BUQUES CON DIMENSIONES MAS GRANDES QUE SE ENCUENTRAN AHORA EN SERVICIO.

LA INVERSION EN PROGRAMAS DE DRAGADO GENERALMENTE IMPORTA MILLONES DE DOLARES, QUE PUEDA SER QUE JAMAS SEAN RECUPERADOS DIRECTAMENTE, PORQUE EL HACERLO ASI FORZARIA AL COMERCIO HACIA OTROS PUERTOS, DEBIDO A LAS TASAS DE CARGOS Y DERECHOS QUE DEBERIAN COBRARSE. LA DEMANDA POR ASISTENCIA GUBERNAMENTAL ES HECHA CON BASE EN QUE EL PUERTO ES UNA EMPRESA DE SERVICIO PUBLICO Y ES VITAL PARA EL CRECIMIENTO ECONOMICO DEL PAIS. PERO ESTA POLITICA ES OPUESTA AL ARGUMENTO DE QUE LOS SUBSIDIOS SON UNA FORMA ARTIFICIAL DE CUBRIR INEFICIENCIAS Y ADEMAS REDUCEN LA SANA COMPETENCIA. TAMBIEN INTRODUCE FALSOS ARGUMENTOS SOBRE LA UBICACION OPTIMA DE LAS FACILIDADES PORTUARIAS.

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EL CONTROL DE CONSERVACION POR PARTE DE LA AUTORIDAD PORTUARIA PUEDE CONDUCIR HACIA PROGRAMAS DE CAPITAL NACIONAL Y MANTENIMIENTO DRAGADO.

2) PILOTAJE

LA ORGANIZACION DE LOS DEBERES DE PILOTAJE PUEDE SER ADMINISTRADA POR DIVERSOS ORGANISMOS, DE LOS CUALES LOS CUATRO MAS COMUNES SON:

(a) LA AUTORIDAD PORTUARIA;
(b) ALGUNA CORPORACION MUNICIPAL;
(c) JUNTAS DE PILOTAJE, COMPAÑIAS PRIVADAS, ETC.;
(d) OTROS ORGANISMOS, (V.GR.: TRINITY HOUSE EN EL REINO UNIDO.

LA RESPONSABILIDAD COMPLETA POR SERVICIOS DE PILOTAJE DEBERIA SER DEL GOBIERNO. ESTE, JUNTO CON EL ORGANO EJECUTIVO RESPONSABLE DE ADMINISTRAR EL PILOTAJE, DEBERA ASEGURAR QUE:

a) NORMAS Y REGLAMENTOS PARA LA SEGURA NAVEGACION DE LOS BUQUES SEAN PROVISTAS;
b) SE PROPORCIONE ENTRENAMIENTO Y PROCEDIMIENTOS PARA EXAMEMENES DE PILOTOS;
c) EXISTA CONTROL EN EL RECLUTAMIENTO Y SE EXIJAN ESTANDARES MINIMOS EN CALIFICACIONES;
d) SE ESTABLEZCA UN CODIGO DE CONDUCTA Y PROCEDIMIENTOS DISCIPLINARIOS.
e) SE OFREZCA A LOS PILOTOS UNA CARRERA ESTRUCTURADA.

3) REMOLQUE

EN MUCHOS PUERTOS DEL MUNDO ESTA FUNCION ES EFECTUADA POR COMPAÑIAS PRIVADAS. LA ESCALA DE OPERACIONES ES SIN EMBARGO, UNA INFLUENCIA RESTRICTIVA ACERCA DE LA ADOPCION DE ESTA POLITICA, EN LOS PAISES EN DESARROLLO.

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4) OPERACIONES DEL MANEJO DE CARGA

LOS PUERTOS DEL MUNDO OFRECEN UN PATRON MUY DIVERSO SOBRE PROCEDIMIENTOS EN EL MANEJO DE CARGA, ALGUNOS DE LOS CUALES SON:

a) COMPAÑIAS PRIVADAS A CARGO DE TODAS LAS ACTIVIDADES DE ESTIBADORES Y SIMILARES;
b) EL TRABAJO A BORDO DE LOS BUQUES HECHO UNICAMENTE POR ESTIBADORES;
c) OPERACIONES EN LOS ALMACENES DE TRANSITO EFECTUADO UNICAMENTE POR PERSONAL DE LA AUTORIDAD PORTUARIA;
d) AUTORIDAD PORTUARIA EN COMPETENCIA DIRECTA CON COMPAÑIAS PRIVADAS DE ESTIBADORES;
e) AUTORIDAD PORTUARIA RESPONSABLE POR TODOS LOS SERVICIOS DEL MANEJO DE CARGA.

EL CONTROL DE LA AUTORIDAD PORTUARIA SOBRE LAS OPERACIONES DEL MANEJO DE CARGA, TIENE LAS SIGUIENTES VENTAJAS:

(a) UNA MEJOR COORDINACION E INTEGRACION DE LAS ACTIVIDADES PORTUARIAS;
(b) MEJOR PLANEACION;
(c) ACCESO A INGRESOS ADICIONALES;
(d) ESTRECHO CONTROL DE CARGOS;
(e) RACIONALIZACION EN EL USO DEL EQUIPO;
(f) FLEXIBILIDAD;
(g) POLITICA COMERCIAL Y DE MERCADEO MAS EFECTIVA;
(h) EVITA LA DUPLICIDAD DE CIERTAS FUNCIONES.

SIN EMBARGO, TAMBIEN ADOLECE DE LAS SIGUIENTES DESVENTAJAS:

a) FALTA DE COMPETENCIA;
b) UNA ORGANIZACION DIFICIL DE MANEJAR;
c) DEMANDA EXCESIVA SOBRE RECURSOS FINANCIEROS DE LA AUTORIDAD PORTUARIA.

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5) EQUIPO MECANICO PARA EL MANEJO DE CARGA.

PROPORCIONADO POR:

a) LA AUTORIDAD PORTUARIA;
b) COMPAÑIAS PRIVADAS;
c) ALQUILADO, ARRENDADO O RENTADO.

TAMBIEN DEBERA CONSIDERARSE LA PROVISION DE GRUAS SOBRE EL MUELLE, MODOS DE TRANSPORTE USADOS DENTRO DEL RECINTO PORTUARIO Y METODOS PROMOCIONALES DEL PUERTO MEDIANTE UNA POLITICA DE MERCADEO COLECTIVA.

OPERACION PORTUARIA

EL SISTEMA DEL PUESTO DE ATRAQUE

A. ¿POR QUE NO ALCANZAR UN MOVIMIENTO DE 360,000 TONELADAS AL AÑO?

SI LOS PUESTOS DE ATRAQUE ESTUVIERAN SIEMPRE OCUPADOS POR BUQUES Y ESTOS BUQUES ESTUVIERAN SIEMPRE CARGANDO O DESCARGANDO, EL MOVIMIENTO ANUAL DE UN MUELLE DE CARGA GENERAL SERIA ENORME. CUANDO ANTE UNA FUERTE DEMANDA DE TRAFICO LAS ADMINISTRACIONES PORTUARIAS SE FIJAN, POR EJEMPLO, UNA META DE 200,000 TONELADAS ANUALES POR PUESTO DE ATRAQUE TENDRIAN QUE COMPRENDER QUE INCLUSO ESTE OBJETIVO QUEDA MUY POR DEBAJO DE LAS POSIBILIDADES TEORICAS. EN OTRAS PALABRAS, YA HAN TENIDO SOBRADAMENTE EN CUENTA LAS DIFICULTADES DE EXPLOTACION.

¿CUAL ES EL MOVIMIENTO TEORICAMENTE RAZONABLE? SUPONGAMOS, POR EJEMPLO, QUE CADA AÑO SE PIERDEN DIEZ DIAS EN JORNADAS FESTIVAS Y OTROS QUINCE DIAS EN LA CONSERVACION INEVITABLE DEL PUESTO DE ATRAQUE. LA TASA DE OCUPACION DEL PUESTO DURANTE LOS 340 DIAS RESTANTES NO PUEDE SER DEL 100% SI SE QUIERE EVITAR QUE SE FORMEN LARGAS COLAS DE BUQUES, SUPONGAMOS, POR CONSIGUIENTE, QUE EL PUESTO ESTA OCUPADO UNICAMENTE 275 DIAS (80%) Y QUE EN 25 DE ELLOS NO SE REALIZA TRABAJO ALGUNO. SUPONGAMOS, ADEMAS, QUE CADA DIA CUENTA CON 18 HORAS DE TRABAJO EFECTIVO (PUESTO QUE, CUALQUIERA QUE SEA EL SISTEMA DE TURNOS, SE PERDERA EL TIEMPO EN PAUSAS Y RELEVOS), QUE, DEBIDO A DESIGUALDADES EN LA ESTIBA, SOLAMENTE UN PROMEDIO DE CUATRO GRUAS TRABAJAN A LA VEZ EN UN BUQUE, QUE LAS GRUAS SOLO ELEVAN CADA VEZ CARGAS DE UNA TONELADA (INCLUSO SI SU CAPACIDAD ES IGUAL O SUPERIOR A TRES TONELADAS) Y QUE LO HACEN 20 VECES POR HORA (AUNQUE EL ENGANCHE, EL DESPLAZAMIENTO Y EL DESENGANCHE TARDAN GENERALMENTE MENOS DE TRES MINUTOS). EL RESULTADO DE TODAS ESTAS SUPOSICIONES TOTALMENTE RAZONABLES ES UN MOVIMIENTO ANUAL DE 250 x 18 x 4 x 20 = 360,000 TONELADAS.

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... ¿PORQUE EL MOVIMIENTO DE MERCANCIAS EN LOS MUELLES DE CARGA GENERAL ES CONSIDERABLEMENTE INFERIOR A ESA CIFRA? ¿POR QUE HA DE SER TAN IMPORTANTE LA REDUCCION RESULTANTE DE DIFICULTADES DE EXPLOTACION? LOS ADMINISTRADORES DE PUERTOS TIENEN DERECHO A SABER EXACTAMENTE QUE ELEMENTO DEL SISTEMA ES EL QUE ENTORPECE LAS ACTIVIDADES PORTUARIAS.

B. EL SISTEMA DEL PUESTO DE ATRAQUE

ALGUNOS PUERTOS PUEDEN DIVIDIRSE EN VARIOS PUESTOS DE ATRAQUE DISTINTOS, CADA UNO DE LOS CUALES SOLO PUEDE ATENDER UN BUQUE A LA VEZ; EN OTROS, LAS OPERACIONES DE UN GRUPO DE PUESTOS DE ATRAQUE ESTAN DEMASIADO RELACIONADAS ENTRE SI PARA QUE CADA UNO DE ELLOS PUEDA SER TOMADO EN CONSIDERACION POR SEPARADO; EN OTROS, POR ULTIMO, UN MUELLE ATIENDE SIMPLEMENTE A TANTOS BUQUES COMO CABEN EN EL Y NO EXISTE NADA PARECIDO A UN PUESTO DE ATRAQUE INDIVIDUAL. EN CUALQUIERA DE ESTOS CASOS, EXISTEN EN CADA PUERTO ZONAS EN QUE SE MANIPULA LA CARGA ENTRE LOS BUQUES Y LOS MEDIOS DE TRANSPORTE TERRESTRE, INDEPENDIENTEMENTE DE OTRAS ZONAS. CADA UNA DE ELLAS ES UN SISTEMA DEL PUESTO DE ATRAQUE.

EL SISTEMA DEL PUESTO DE ATRAQUE NO ES UNA UNIDAD HOMOGENEA; ESTA FORMADO POR VARIOS ELEMENTOS RELACIONADOS ENTRE SI. LA FIGURA 1 INDICA LOS DIVERSOS ELEMENTOS DE UN PUERTO EN QUE SE PUEDEN LLEVAR A CABO LOS DISTINTOS TIPOS DE OPERACIONES*. MUCHOS PUERTOS UTILIZAN SOLAMENTE UN NUMERO LIMITADO DE DICHOS ELEMENTOS Y EN CUALQUIER PUERTO CADA ELEMENTO SOLAMENTE TIENE QUE ATENDER UNA FRACCION DETERMINADA DE LA DEMANDA TOTAL DE TRAFICO.

TODAS LAS MERCANCIAS HAN DE PASAR A TRAVES DEL SISTEMA DE MANIPULACION A BORDO, QUE ABARCA LAS OPERACIONES DE DESCARGA Y CARGA. ESTE ES, POR CONSIGUIENTE, EL ELEMENTO DOMINANTE DEL SISTEMA. SI LOS DEMAS ELEMENTOS, QUE SON ALIMENTADOS POR EL SISTEMA DE MANIPULACION, TIENEN CAPACIDADES INFERIORES A LO QUE EXIGEN LAS

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OPERACIONES DEL BUQUE, RESTRINGIRAN ESTAS OPERACIONES Y , POR CONSIGUIENTE, LA CAPACIDAD DE TODO EL SISTEMA.

CUANDO LAS MERCANCIAS DE IMPORTACION HAN SIDO DESCARGADAS DEL BUQUE, PUEDEN SEGUIR UNA DE LAS TRES VIAS SIGUIENTES:

LA VIA INDIRECTA:

- TRASLADO Y ALMACENAMIENTO EN UN COBERTIZO DE TRANSITO O EN UNA ZONA DE ALMACENAMIENTO AL AIRE LIBRE, SEGUIDO DE ENTREGA AL VEHICULO DE CARRETERA O VAGON DE FERROCARRIL.

LA VIA SEMIDIRECTA:

- LAS MERCANCIAS SE DEPOSITAN PROVISIONALMENTE EN LA EXPLANADA DE MUELLE (O QUIZA EN UNA GABARRA O VAGON DE FERROCARRIL) PORQUE NO PUEDEN SER MANIPULADAS INMEDIATAMENTE POR EL SISTEMA DE TRANSPORTE POR CARRETERA O FERROCARRIL.

LA VIA DIRECTA:

- AL FERROCARRIL, VEHICULO DE CARRETERA O GABARRA. LOS SISTEMAS DE TRANSPORTE INTERIOR POR CARRETERA, FERROCARRIL Y GABARRA TIENEN UNA INCIDENCIA IMPORTANTE EN LAS OPERACIONES DE LOS MUELLES, PERO NO SUELEN HALLARSE BAJO EL CONTROL DEL PUERTO. RESULTA DIFICIL DETERMINAR LA CAPACIDAD DE DICHAS VIAS, PERO DEBERIAN INTENTARSE ALGUNAS ESTIMACIONES PARA PODER COMPRENDER SU INFLUENCIA SOBRE LA CAPACIDAD DE LOS PUESTOS DE ATRAQUE.

EN CONDICIONES IDEALES, TODOS LOS ELEMENTOS DEL SISTEMA TENDRIAN QUE ADAPTARSE A LA DEMANDA DE SERVICIO DE QUE SON OBJETO INDIVIDUALMENTE. ESTO PUEDE SER NECESARIO CADA HORA, CADA DIA O

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CADA SEMANA, SEGUN LA NATURALEZA DEL ELEMENTO DE QUE SE TRATE. EL SISTEMA DE TRASLACION Y LOS SISTEMAS DE ENTREGA DIRECTA HAN DE SER CAPACES DE SEGUIR EL SISTEMA DE MANIPULACION A BORDO HORA POR HORA, SI SE QUIERE EVITAR QUE LAS GRUAS ESPEREN O QUE LAS MERCANCIAS SE AMONTONEN EN EL MUELLE. EL SISTEMA SEMIDIRECTO PROPORCIONA UN MARGEN DE FLEXIBILIDAD A CORTO PLAZO ENTRE LA DESCARGA Y LA ENTREGA, PERO COMO LA EXPLANADA DEL MUELLE TIENE UNA SUPERFICIE LIMITADA Y ES ESENCIALMENTE UNA ZONA DE TRABAJO Y NO UN AREA DE ALMACENAMIENTO, NO ES PRUDENTE DEJAR LA CARGA EN ELLA DURANTE MAS DE 24 HORAS.

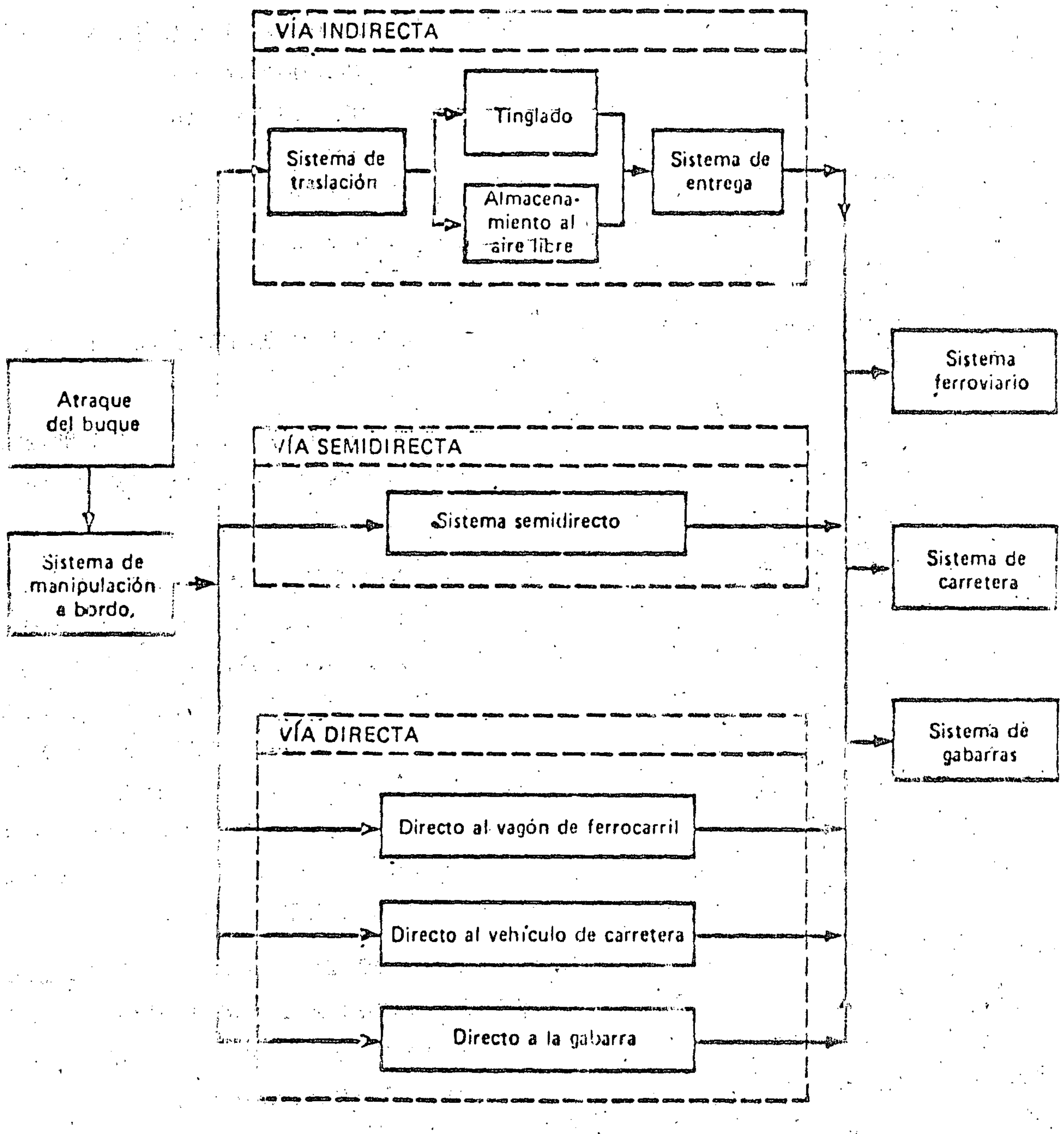
LOS COBERTIZOS Y LAS ZONAS DE ALMACENAMIENTO AL AIRE LIBRE SON LIGERAMENTE DISTINTOS. EN TAL CASO LO QUE SE NECESITA ES CONSEGUIR LA ROTACION DE LAS MERCANCIAS A UN RITMO SUFICIENTEMENTE ALTO COMO PARA SATISFACER LA DEMANDA A QUE DICHOS ESPACIOS ESTEN SOMETIDOS A LO LARGO DE UN PERIODO ALGO MAS LARGO, QUE SUELE SER APROXIMADAMENTE DE DOS SEMANAS.

EL NIVEL DE DEMANDA APARENTE DE CUALQUIERA DE LOS ELEMENTOS DEL SISTEMA PUEDE RESULTAR ENGAÑOSO, PUESTO QUE ES POSIBLE QUE, DEBIDO A ANTERIORES ESTRANGULAMIENTOS, LAS MERCANCIAS SE HAYAN DESVIADO YA DE DICHO ELEMENTO DEL SISTEMA HACIA OTROS. POR EJEMPLO, UN TIPO DE MERCANCIAS PUEDE DESCARGARSE NORMALMENTE EN GABARRAS y TRASLADARSE A MUELLES DE GABARRAS PARA SU ALMACENAMIENTO EN UN COBERTIZO DE TRANSITO; ESTO PUEDE SER DEBIDO A LA ANTERIOR CONGESTION DE LOS COBERTIZOS DE TRANSITO EN LOS MUELLES DE GRAN CALADO O A OTRAS RAZONES ANTERIORES A LA CONSTRUCCION DE ESTOS MUELLES. DADO QUE ESTA DOBLE MANIPULACION ES COSTOSA Y NORMALMENTE TENDRIA QUE DESACONSEJARSE, ES POSIBLE QUE PARA LLEGAR A LA "DEMANDA LATENTE" DE CADA UNO DE LOS ELEMENTOS SEA PRECISO EFECTUAR ALGUNOS AJUSTES.

* LA DIRECCION DE LAS FLECHAS DEL DIAGRAMA INDICA, JUNTO CON EL TEXTO QUE APARECE A CONTINUACION, LA UTILIZACION DEL SISTEMA PARA LAS MERCANCIAS DE IMPORTACION. LAS MISMAS VIAS SON APLICABLES, AL REVES, PARA LAS MERCANCIAS DE EXPORTACION. EN REALIDAD, EN LOS PUERTOS ESCOGIDOS PARA EL ESTUDIO, LA VIA SEMIDIRECTA ERA MUCHO MAS UTILIZADA PARA LAS EXPORTACIONES QUE PARA LAS IMPORTACIONES.

FIGURA 1

ELEMENTOS DEL SISTEMA DEL PUESTO DE ATRAQUE



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C. CAPACIDAD INTRINSECA Y MARGEN

SI UN ELEMENTO DEL SISTEMA TRABAJARA SIN INTERRUPCIONES, AL RITMO MAS ELEVADO QUE NORMALMENTE PUDIERA MANTENER DURANTE UN TURNO ENTERO, ALCANZARIA LO QUE PUEDE CALIFICARSE COMO SU CAPACIDAD INTRINSECA*. ESTA MEDIDA DESEMPEÑA UN PAPEL PRINCIPAL EN EL METODO BASICO DE ANALISIS. LA DIFERENCIA ENTRE EL RENDIMIENTO REAL Y LA CAPACIDAD INTRINSECA SE DENOMINARA EL MARGEN. LO ANTEDICHO QUEDA ILUSTRADO EN LA FIGURA 2. EL OBJETO FUNDAMENTAL DEL METODO BASICO ES LOCALIZAR EL MARGEN Y DESCUBRIR LA RAZON DE SU EXISTENCIA. EL MARGEN PUEDE SER DEBIDO A UNA DE LAS SIGUIENTES CAUSAS:

O BIEN LA DEMANDA NO LLEGA A EXIGIR LA UTILIZACION DE LA TOTALIDAD DE LOS RECURSOS,

O BIEN HAY INTERRUPCIONES PROCEDENTES DE OTROS ELEMENTOS DEL SISTEMA, Y ES IMPORTANTE SABER CUAL DE ESTAS CAUSAS INTERVIENE EN CADA ELEMENTO.

EL MARGEN HA DE CALCULARSE COMO PROMEDIO. NO SE HA DE INFERIR, POR LO TANTO, QUE PUEDA ABSORBERSE EN SU TOTALIDAD PARA ELEVAR EL RENDIMIENTO HASTA LA PLENA CAPACIDAD INTRINSECA. UNA PARTE DEL MARGEN SERA UN "EXCESO DE CAPACIDAD" DELIBERADO, MANTENIDO CON OBJETO DE QUE SE PUEDA HACER FRENTE A LOS PERIODOS DE MAXIMA DEMANDA EN UN ELEMENTO DEL SISTEMA. LA FIGURA 3 INDICA, POR MEDIO DE UN EJEMPLO HIPOTETICO, UN CASO EN QUE EL RENDIMIENTO REAL, QUE VARIA A LO LARGO DEL TIEMPO, ALCANZA ALGUNA VEZ LA CAPACIDAD INTRINSECA, AUNQUE SU VALOR MEDIO SEA LIGERAMENTE INFERIOR.

ASI, POR EJEMPLO, UN CIERTO EXCESO DE CAPACIDAD DE ATRAQUE ES ACONSEJABLE, PUESTO QUE LOS BUQUES LLEGAN A PUERTO EN FORMA IRREGULAR. DICHO EXCESO DE CAPACIDAD AUMENTARA LA PROBABILIDAD DE QUE, A SU LLEGADA, LOS BUQUES PUEDEN ATRACAR RAPIDAMENTE.

NO SE PUEDEN ESTABLECER REGLAS GENERALES ACERCA DEL MARGEN QUE HABRIA QUE MANTENER CON OBJETO DE HACER FRENTE A LOS PERIODOS DE MAXIMA ACTIVIDAD, PUESTO QUE ELLO DEPENDE DE LA VARIABILIDAD DE

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LA DEMANDA. NO OBSTANTE, LOS RESULTADOS DEL METODO DE SIMULACION PROPORCIONAN ALGUNAS DIRECTRICES INTERESANTES, PERO COMO DICHOS RESULTADOS PROCEDEN DEL ANALISIS DE CASOS CONCRETOS, CONVIENE UTILIZARLOS CON CAUTELA.

POR ENCIMA DE UN DETERMINADO NIVEL, CUALQUIER INCREMENTO ADICIONAL DEL MOVIMIENTO MEDIO DE MERCANCIAS SOLO PUEDE OBTENERSE MEDIANTE SACRIFICIOS DURANTE LOS PERIODOS DE MAXIMA DEMANDA, DE UNA DE LAS TRES MANERAS SIGUIENTES:

- HACIENDO ESPERAR A LOS BUQUES O A LAS MERCANCIAS;
- ABANDONANDO LA VIA DE MENOR COSTO (POR EJEMPLO, TRABAJANDO POR AMBOS COSTADOS DEL BUQUE O UTILIZANDO UN ALMACEN LEJANO);
- EMPLEANDO RECURSOS MAS CAROS (POR EJEMPLO, UTILIZANDO UN MUELLE INADECUADO O AUMENTANDO LAS HORAS EXTRAORDINARIAS).

LA CAPACIDAD INTRINSECA NO ES UN MAXIMO ABSOLUTO. QUEDO DEFINIDA SOLAMENTE COMO TRABAJO ININTERRUMPIDO AL RITMO MEDIO NORMAL. EVIDENTEMENTE, PODRIA AUMENTARSE EL PROPIO RITMO DE TRABAJO, LO QUE LLEVARIA A UNA CAPACIDAD INTRINSECA MAS ELEVADA. PERO, A PESAR DE QUE EL AUMENTO DE PRODUCTIVIDAD PUEDE REDUCIR LOS COSTOS, NO PROVOCARA UN MAYOR MOVIMIENTO DE MERCANCIAS EN EL PUESTO DE ATRAQUE SI NO EXISTIERA UN ESTRANGULAMIENTO EN ESE PUNTO.

LA FUERTE DEMANDA DE QUE ES OBJETO UN ELEMENTO DEL SISTEMA (EN RELACION CON SU CAPACIDAD INTRINSECA) PUEDE HACER EN UN DETERMINADO MOMENTO QUE SEA UTIL AUMENTAR DE MODO PERMANENTE LA CAPACIDAD INTRINSECA DE ESE ELEMENTO. EL MECANISMO DE ESE AUMENTO SE MUESTRA EN LA FIGURA 6 "ILUSTRACION DE LA RELACION ENTRE LA CAPACIDAD INTRINSECA, EL MARGEN Y EL RENDIMIENTO REAL".

* EN EL EJEMPLO CITADO AL PRINCIPIO DE ESTE CAPITULO, LA CAPACIDAD INTRINSECA DE MANIPULACION A BORDO ERA LIGERAMENTE SUPERIOR A LAS 360,000 TONELADAS ANUALES.

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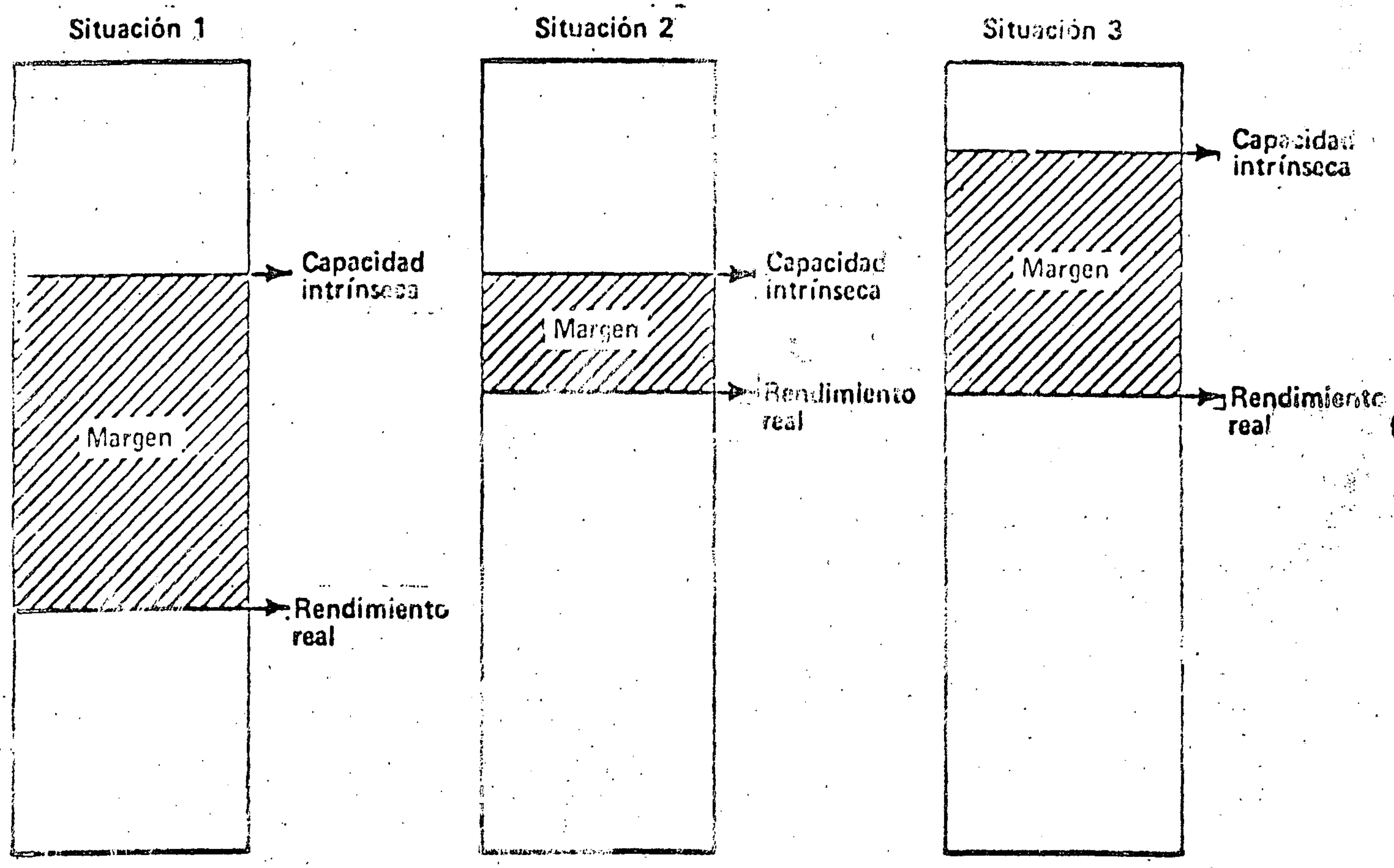
FIGURA 6

RELACION ENTRE LA CAPACIDAD INTRINSECA, EL MARGEN Y EL RENDIMIENTO REAL



D. COMO MEJORAR LA CAPACIDAD DEL SISTEMA

UNA VEZ LOCALIZADOS LOS ESTRANGULAMIENTOS QUE IMPIDEN UNA MAYOR MOVIMIENTO DE MERCANCIAS, EXISTEN FUNDAMENTALMENTE DOS PROCEDIMIENTOS PARA INCREMENTAR LA CAPACIDAD DEL SISTEMA. SON LOS SIGUIENTES:

(a) MEDIANTE MEJORAS EN LOS METODOS DE EXPLOTACION;
(b) MEDIANTE INVERSIONES EN NUEVAS INSTALACIONES.

MUCHAS VECES EL PROBLEMA PUEDE SER RESUELTO DE CUALQUIERA DE LAS DOS FORMAS. POR EJEMPLO, SI SE DEMOSTRARA QUE LO QUE LIMITA EL MOVIMIENTO ES LA CONGESTION EN LOS TINGLADOS, LA SOLUCION PODRIA SER:

(a) AUMENTAR LA CAPACIDAD DE LOS ALMACENES DE TRANSITO; O
(b) REDUCIR EL TIEMPO DE TRANSITO DE LAS MERCANCIAS.

UNA FORMA (PERO NO LA UNICA) DE LOGRAR LA SOLUCION (a) ES CONSTRUIR NUEVOS ALMACENES O AMPLIAR LOS EXISTENTES, CUYO COSTO PUEDE DETERMINARSE FACILMENTE. EN CAMBIO, LA SOLUCION (b) PUEDE EXIGIR QUE SE SIMPLIFIQUEN LOS TRAMITES ADMINISTRATIVOS RELATIVOS AL DESPACHO ADUANERO, QUE SE AVISE A LOS DESTINATARIOS DE QUE LAS MERCANCIAS PUEDEN SER RECOGIDAS, QUE SE ESTABLEZCA EL PAGO DE TARIFAS PORTUARIAS, ETC., O QUIZA QUE SE ELEVEN LAS TARIFAS DE ALMACENAMIENTO EN LOS TINGLADOS, OPERACIONES ESTAS CUYOS COSTOS SON MUCHO MENOS TANGIBLES.

LA BUSQUEDA DE UN RENDIMIENTO MAYOR, ESPECIALMENTE CUANDO SUPONE CAMBIOS EN LOS METODOS DE EXPLOTACION, PUEDE TROPEZAR CON LA OPOSICION DE LOS TRABAJADORES DEL PUERTO, DE LOS NAVIEROS O DE OTROS USUARIOS. POR CONSIGUIENTE, ANTES DE EFECTUAR UN CAMBIO ES INDISPENSABLE ESTAR SEGURO DE QUE LOS BENEFICIOS QUE PUEDA PRODUCIR JUSTIFICAN LOS PROBLEMAS QUE PUEDA CAUSAR.

EL BENEFICIO PUEDE SER UNA GANANCIA FINANCIERA DIRECTA PARA LA ADMINISTRACION DEL PUERTO. POR EJEMPLO, SI UN PUESTO DE ATRAQUE

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MANIPULA 200,000 TONELADAS POR AÑO A UN COSTO DE 6 DOLARES POR TONELADA (3 DOLARES DE COSTOS FIJOS DE ATRAQUE Y 3 DOLARES DE GASTOS VARIABLES COMO, POR EJEMPLO, MANO DE OBRA), UN AUMENTO DEL 10% EN EL MOVIMIENTO DE MERCANCIAS HASTA ALCANZAR 220,000 TONELADAS SIGNIFICA QUE EL COSTO POR TONELADA SE REDUCE DE 6 DOLARES A 5.7 DOLARES. EN EL SUPUESTO DE QUE LAS TARIFAS SE MANTUVIERAN INALTERADAS, EL PUERTO OBTENDRIA UNOS INGRESOS SUPLEMENTARIOS DE 120,000 DOLARES MIENTRAS QUE SUS GASTOS SE ELEVARIAN EN 60,000 DOLARES SOLAMENTE, LO QUE REPRESENTA UN BENEFICIO NETO ANUAL DE 60,000 DOLARES.

ALGUNOS DE LOS BENEFICIOS QUE SE DERIVAN DEL CAMBIO PUEDEN PASAR DIRECTAMENTE A LOS USUARIOS DEL PUERTO; POR EJEMPLO, EN FORMA DE UN MOVIMIENTO MAS RAPIDO DE LOS BUQUES O DE LAS MERCANCIAS. EL PUERTO PUEDE COMPARTIR TALES BENEFICIOS MEDIANTE SU POLITICA TARIFARIA.

CLASIFICACION DE LA CARGA

DE POCO SIRVE REFERIRSE AL MOVIMIENTO DE MERCANCIAS EN UN PUESTO DE ATRAQUE SIN ESPECIFICAR LA NATURALEZA DE ESAS MERCANCIAS NI LA VIA QUE SIGUEN. NO SE PUEDE COMPARAR UN PUESTO DE ATRAQUE QUE MANIPULE 200,000 TONELADAS ANUALES DE CARGA GENERAL MIXTA QUE HA DE CLASIFICARSE Y DESPACHARSE EN ADUANAS Y QUE, POR CONSIGUIENTE, HA DE PASAR POR UN PATIO DE TRANSITO, CON OTRO QUE MANIPULE EL MISMO TONELAJE DE MINERAL DE HIERRO QUE SE DESCARGA DIRECTAMENTE EN VAGONES DE FERROCARRIL. EN REALIDAD, ES PRECISAMENTE LA NATURALEZA HETEROGENEA DE LAS MERCANCIAS QUE SE MANIPULAN EN LOS PUERTOS LA QUE ORIGINA MUCHOS DE LOS PROBLEMAS. DISTINTAS CARGAS TRANSPORTADAS EN DIFERENTES BUQUES NO SOLO EXIGEN NIVELES MUY DIFERENTES DE INSTALACIONES PORTUARIAS, SINO QUE TAMBIEN IMPONEN EXIGENCIAS DESIGUALES A LOS DISTINTOS ELEMENTOS DEL SISTEMA DEL PUESTO DE ATRAQUE. ASI PUES, PARA ANALIZAR EL RENDIMIENTO DE UN PUERTO, LO PRIMERO QUE HAY QUE HACER ES CLASIFICAR LAS MERCANCIAS.

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Clasificación de mercancías en los puertos seleccionados para el estudio

	KARACHI	LA VALETTA	VALPARAISO
IMPORTACIONES.	Trigo en sacos Fertilizantes en sacos Carbón y coque Productos siderúrgicos/maquinaria Carga general procedente del extranjero Carga general de cabotaje	Productos siderúrgicos/maquinaria Carga refrigerada Carga general	Carga en sacos Carga a granel Carga general
EXPORTACIONES.	Cemento en sacos Arroz en sacos Balas de algodón/textiles Sal (a granel) Carga general a/	Carga general	Lingotes de cobre Mercancías perecederas Carga general

Fuente: Elaborado con datos reunidos por la secretaría de la UNCTAD.

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a/ Incluye todas las mercancías a las que no se haga referencia en un partida más específica.

LAS MERCANCIAS PUEDEN CONSIDERARSE DIVIDIDAS EN CLASES MUCHO MAS AMPLIAS Y MUCHO MENOS NUMEROSAS QUE LAS EMPLEADAS NORMALMENTE A EFECTOS ARANCELARIOS; EN REALIDAD, ES RECOMENDABLE QUE SEA BAJO EL NUMERO DE CLASES, DEBIDO A LA GRAN CANTIDAD DE ANALISIS QUE SE HAN DE REALIZAR PARA CADA UNA DE ELLAS. EN GENERAL, SE NECESITA UNA CLASE DE CARGA APARTE PARA CADA GRUPO DE MERCANCIAS QUE ES CLARAMENTE DISTINTO DE LOS DEMAS EN CUANTO A LA DENSIDAD, METODO DE MANIPULACION O VIA QUE SIGUE PREFERENTEMENTE EN EL SISTEMA*. NO OBSTANTE, NO ES NECESARIO MANTENER UNA CLASE DISTINTA, AUNQUE TENGA CARACTERISTICAS ESPECIALES, SI NO REPRESENTA POR LO MENOS UN 2.5% DEL MOVIMIENTO TOTAL, YA QUE LAS CANTIDADES INFERIORES A ESTE PORCENTAJE TENDRAN MUY POCO EFECTO SOBRE LA CAPACIDAD TOTAL DEL PUESTO DE ATRAQUE.

A. DATOS QUE ES NECESARIO REUNIR

LOS DATOS QUE SE REUNEN EN LOS PUERTOS ESTUDIADOS CORRESPONDEN A CUATRO SECTORES PRINCIPALES:

1. EL BUQUE
2. LA CARGA MANIPULADA
3. LAS OPERACIONES
4. LA UTILIZACION DE ELEMENTOS REGULADORES

PARA LA REUNION DE LOS DATOS REFERENTES AL BUQUE, LO MAS CONVENIENTE ES UTILIZAR EL FORMULARIO A -MOVIMIENTO DE BUQUES- QUE FIGURA EN EL ANEXO I DEL MANUAL DE LA UNCTAD TITULADO "ESTADISTICAS PORTUARIAS". LAS UNICAS MODIFICACIONES SUGERIDAS EN LOS PUERTOS ESTUDIADOS FUERON LA SUSTITUCION DEL ARMADOR DEL BUQUE POR EL OPERADOR Y LA SUPRESION DE LA COLUMNA 14, "PABELLON". UN PUERTO QUE NO REUNA REGULARMENTE DATOS RELATIVOS A LOS TURNOS DE TRABAJO PUE

* ANTES DE LLEGAR A ESTAS CLASIFICACIONES SIMPLIFICADAS, ES NECESARIO LLEVAR A CABO ANALISIS PRELIMINARES CON UN MAYOR NUMERO DE CLASES CON OBJETO DE DETERMINAR SI LAS CATEGORIAS PODRIAN COMBINARSE EN FORMA CONVENIENTE.

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DE AGREGAR UNA SERIE DE COLUMNAS PARA INDICAR EL ITINERARIO DE LA CARGA EN RELACION CON EL BUQUE. EL SIGUIENTE FORMULARIO, -- "HOJA DEL BUQUE", SIRVE DE EJEMPLO PARA LA REUNION DE DATOS A MANO (VEASE EL CUADRO 1), Y LAS COLUMNAS ADICIONALES SE PUEDEN REGISTRAR COMO EN EL CUADRO 2.

LA"HOJA DEL BUQUE" LA LLENA NORMALMENTE EL CAPITAN DE PUERTO O LA AUTORIDAD EQUIVALENTE; EL CUADRO ADICIONAL RELATIVO AL ITINERARIO LO LLENAN LOS INSPECTORES DE MUELLES.

ESTOS ULTIMOS TAMBIEN ESTAN ENCARGADOS DE LOS REGISTROS DE TURNOS DE TRABAJO, QUE CONTIENEN INFORMACION SOBRE LA CARGA Y LAS OPERACIONES. ESTOS FORMULARIOS SE PUEDEN UTILIZAR PERMANENTEMENTE O COMO MUESTRAS. CADA PUERTO DEBE DECIDIR POR SI MISMO EL GRADO DE IMPORTANCIA DE LA INFORMACION Y LA FRECUENCIA NECESARIAS.

EL CUADRO 3 ES UN EJEMPLO DEL REGISTRO DE TURNOS DE TRABAJO QUE SE UTILIZO EN VALPARAISO (PARA LAS OPERACIONES DE DESCARGA). EN KARACHI Y MALTA SE EMPLEARON FORMULARIOS ANALOGOS, QUE DIFERIAN LIGERAMENTE DEL DE VALPARAISO EN QUE CADA FORMULARIO HA DE TENER EN CUENTA LOS PROCEDIMIENTOS EXISTENTES DE REUNION DE DATOS. LO IDEAL SERIA QUE SE PUDIESE LLENAR UN FORMULARIO POR CUADRILLA Y TURNO. ES EVIDENTE QUE SE NECESITAN FORMULARIOS SEPARADOS PARA LA DESCARGA Y PARA LA CARGA.

LOS DATOS RELATIVOS A LOS ELEMENTOS REGULADORES (TINGLADOS, ZONAS DE ALMACENAMIENTO AL AIRE LIBRE) HAN DE SER MUY DETALLADOS PARA ESTE ESTUDIO. ASI PUES, SE UTILIZAN VARIAS FUENTES. UN FORMULARIO PROPORCIONA LAS CIFRAS DIARIAS DE RECEPCION Y ENTREGA EN UNA ZONA DE ALMACENAMIENTO Y DE LA CARGA RESTANTE. DICHO FORMULARIO SE REPRODUCE EN EL CUADRO 4.

HAY UN FORMULARIO PARA CADA ZONA DE ALMACENAMIENTO.

BASANDOSE EN UNA MUESTRA SE PUEDE OBTENER INFORMACION ACERCA

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DE:

- LAS ALTURAS DE APILAMIENTO EN LOS COBERTIZOS Y EN LAS ZONAS DE ALMACENAMIENTO AL AIRE LIBRE (QUE SE HAN DE INDICAR PARA CADA TIPO DIFERENTE DE ESPACIO DE ALMACENAMIENTO);
- LAS DISTANCIAS DE TRASLACION (NECESIDAD DE UN METODO DE ESTUDIO PRACTICO);
- LA COMPOSICION DE LA CARGA (ESPECIALMENTE LA RELACION PESO/ DIMENSIONES DE LA CARGA) EN LOS COBERTIZOS Y EN LAS ZONAS DE ALMACENAMIENTO AL AIRE LIBRE;
- EL TIEMPO DE TRANSITO DE LA CARGA EN COBERTIZOS Y ZONAS DE ALMACENAMIENTO AL AIRE LIBRE (QUE SE HA DE DETERMINAR ASIMISMO PARA CADA TIPO DE ALMACENAMIENTO). SE RECOMIENDA ENCARECIDAMENTE LA OBSERVACION DE LAS OPERACIONES PARA EVALUAR FACTORES COMO:
- LA VELOCIDAD DEL EQUIPO DE TRASLACION;
- LAS INTERRUPCIONES DEL CICLO DE TRASLACION;
- LAS INTERRUPCIONES DEL CICLO DE ELEVACION;
- LA DURACION DEL CICLO DE ELEVACION;
- EL PESO DEL EQUIPO Y CARGAMENTO TRANSPORTADOS EN CADA TRASLACION;
- EL FACTOR DE ESPACIO PERDIDO EN LAS ZONAS REGULADORAS;
- EL SISTEMA DE APILAMIENTO Y LA CANTIDAD DE ESPACIO PERDIDO EN LOS PASILLOS DE LOS COBERTIZOS Y ZONAS DE ALMACENAMIENTO AL AIRE LIBRE;
- Y TODOS LOS FACTORES QUE INFLUYEN PODEROSAMENTE EN LAS OPERACIONES EN EL MUELLE (POR EJEMPLO, EL MAL ESTADO DEL PAVIMENTO Y SU EFECTO EN EL CICLO DE TRASLACION, UN APILAMIENTO DEFECTUOSO Y LA FORMA EN QUE AUMENTA EL RIESGO DE OBSTRUCCION DEL TINGLADO, LAS DIMENSIONES DEL ENVIO Y SU EFECTO EN LA PO-

SIBILIDAD DE ENTREGA DIRECTA, Y LA ESLORA DEL BUQUE Y SU EFECTO EN LA POLITICA DE UTILIZACION DE LAS INSTALACIONES DE ATRAQUE).

SEGUIDAMENTE, SE HA DE ELABORAR LA INFORMACION ASI CUMPLIDA DURANTE UN PERIODO DETERMINADO DE REUNION DE DATOS.

B. EL PERIODO DE REUNION DE DATOS

ES DIFICIL ENUNCIAR UNA REGLA GENERAL REFERENTE A LA DURACION DEL PERIODO DE REUNION DE DATOS O A LA REGULARIDAD CON QUE SE HAN DE OBTENER LAS MUESTRAS O LA AMPLITUD DE ESTAS. LA REGLA VARIARA DE UN PUERTO A OTRO Y DEPENDERA, ENTRE OTRAS COSAS, DEL GRADO DE VARIACION DE LOS VALORES, DEL EFECTO DE LAS INFLUENCIAS ESTACIONALES Y DE LA CUANTIA DE LAS MODIFICACIONES DEL TRAFICO Y DE LAS OPERACIONES. LA DECISION LA DEBE ADOPTAR EL PUERTO, PERO NO SE HA DE TENER PRESENTE UNA REGLA GENERAL: LOS DATOS REUNIDOS HAN DE REFLEJAR LAS CONDICIONES EXISTENTES EN EL PUERTO DURANTE EL PERIODO DEL ANALISIS Y, SI SE INTENTA HACER UNA PREVISION DEL COMPORTAMIENTO DE LOS ATRACADEROS, DURANTE EL PERIODO DE LA PREVISION.

LA EXPERIENCIA TAMBIEN HA DEMOSTRADO QUE LA CANTIDAD DE DATOS QUE SE HA DE REUNIR DEPENDE PRINCIPALMENTE DEL FIN PARA EL QUE SE REGISTREN LOS DATOS. ASI PUES, ES NECESARIO REUNIR CONTINUAMENTE LAS CIFRAS DE DISTRIBUCION ENTRE MODOS DE TRANSPORTE, MIENTRAS QUE, POR OTRA PARTE, EN RELACION CON EL SISTEMA DE APILAMIENTO EN LOS TINGLADOS SE PUEDEN UTILIZAR DATOS PROCEDENTES DE UNA MUESTRA PEQUEÑA OBTENIDA UNA SOLA VEZ, QUE LUEGO SE PUEDE EMPLEAR DURANTE UN LARGO PERIODO (EN REALIDAD, MIENTRAS LAS OBSERVACIONES NO INDIQUEN MODIFICACIONES CRITICAS DEL SISTEMA).

PARA LOS FINES DEL ESTUDIO DEL MOVIMIENTO DE MERCANCIAS EN LOS MUELLES SE EFECTUO LA REUNION DE DATOS QUE SE INDICA SEGUIDAMENTE EN EL CUADRO 5 (EL CUAL SE PRESENTA UNICAMENTE COMO EJEMPLO, SIN SUGERIR QUE DEBA SEGUIRSE AL PIE DE LA LETRA).

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Cuadro 1

Hoja del buque

Mes:

No. del buque 1/	Nombre del buque	Tipo del buque 2/	Tonelaje 3/	Eslora	Día y hora de llegada	Día y hora de atraque	Día y hora de salida	Toneladas de mercancías descargadas	Toneladas de mercancías cargadas	Calado del buque	Puerto de origen	Puerto de destino	Operado
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)

1/ Por orden cronólogico de llegada.

2/ Buques de carga general fraccionada, buque cisterna, buque granelero, buque especializado, buque de pasajeros, otros buques.

3/ Expresado en TRB, TRN o TPM.

Los datos de las columnas (1) a (10) son indispensables.

Los datos de las columnas (11) a (13) son importantes.

Los datos de la columna (14) son útiles.

Cuadro 2

Datos relativos al itinerario de la carga

No. del buque	Nombre del buque	Mercancías descargadas							Mercancías cargadas							
		en gabarra	en camión	en vagón	en tinglado	en zona de almacenamiento al aire libre	en explanada	en otros lugares	desde gabarra	desde camión	desde vagón	desde tinglado	zona de almacenamiento al aire libre	desde explanada	desde otros lugares	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	

Cuadro 3

MOVIMIENTO DE LA CARGA

DESCARGA

Nombre del buque:.................... No. del muelle:................. Fecha:................... Turno:..................

El turno trabajó de.......... a.......... No. de cuadrillas.......... (horas-descanso)

Composición de las cuadrillas: En el buque En el muelle

Equipo utilizado:............ grúas de muelle........... grúas de a bordo........... carretillas elevadoras ......tractor

......plataformas de remolque.

Horas de inactividad: De............ a.......... No. de cuadrillas............ Motivos...............

TONELAJE DE LAS MERCANCIAS DESCARGADAS EN

Tipo de productos	Tinglado	Zona de almacenamiento al aire libre	Zona reguladora a corto plazo	Carretera	Ferrocarril	Gabarra	Total
TOTAL							

Observaciones acerca de las condiciones de trabajo:

Cuadro 4

FORMULARIO PARA LA REUNION DE DATOS EN ZONAS REGULADORAS

Informe correspondiente al tinglado No. ....

Zona de apilamiento al aire libre No. ....

Fecha	Tonelaje total al principio del día	Procedente de					Destinado a					Tonelaje total al final del día
		Gabarra	Camión	Vagón	Otros	Total	Gabarra	Camión	Vagón	Otros	Total	
1.												
2.												
3.												
4.												
5.												
etc.												

Cuadro 5

RESUMEN DE LA REUNION DE DATOS EN LOS PUERTOS ESTUDIADOS

	Karachi	Valparaiso	Malta
Reunión de datos en los formularios de los cuadros: 1/2	contínua durante dos meses	contínua durante seis meses	contínua durante seis meses
3	idem	idem	idem
4	idem	idem	no se facilitaron
Datos sobre apilamiento en tinglados/ transbordo de buque a tinglado/composición del equipo/ciclo de elevación/ prácticas de trabajo	tres semanas de observaciones por el equipo	cuatro semanas de observaciones por el equipo	tres semanas de observaciones por el equipo
Demora en la entrega	una muestra sacada de los archivos del puerto	una muestra sacada de los archivos del puerto	una muestra sacada de los archivos del puerto
Sistema ferroviario	de los archivos del puerto sobre oferta y demanda	no se facilitó información	no hay sistema ferroviario

El formulario más importante para este estudio es el de registro de los turnos de trabajo (cuadro 3), que proporciona información sobre los elementos siguientes:

1. Mano de obra utilizada
2. Asignación de cuadrillas
3. Tiempo de inactividad
4. Equipo utilizado
5. Ritmo de trabajo
6. Itinerario seguido por la carga
7. Clases de carga
8. Participación de cada clase de carga en el tráfico total.

MOVIMIENTO DE MERCANCIAS EN LOS PUESTOS DE ATRAQUE, OCUPACION DE ESTOS Y TIEMPO DE ROTACION DE LOS BUQUES.

SI LOS BUQUES LLEGARAN A LOS PUERTOS CON ABSOLUTA REGULARIDAD Y EL TIEMPO PARA DESCARGARLOS Y CARGARLOS FUESE CONSTANTE, SERIA MUY FACIL DETERMINAR EL NIVEL DE CAPACIDAD DE ATRAQUE QUE GARANTIZARIA TANTO LA PLENA UTILIZACION DE LOS PUERTOS COMO LA SUPRESION DEL TIEMPO DE ESPERA. DESGRACIADAMENTE, ESTA SITUACION IDEAL NUNCA SE PRODUCE EN LA PRACTICA. EN REALIDAD, LOS BUQUES LLEGAN A LOS PUERTOS DE MODO IMPREVISIBLE, Y ASI SUCEDE NO SOLO CON LOS TRAMPS, SINO TAMBIEN CON LOS DE LINEA REGULAR. POR OTRA PARTE, EL TIEMPO NECESARIO PARA DESCARGAR Y CARGAR LOS BUQUES VARIA CONSIDERABLEMENTE, NO SOLO DEBIDO A LAS DISTINTAS CANTIDADES Y CATEGORIAS DE MERCANCIAS QUE SE MANIPULAN, SINO TAMBIEN A UNA MULTITUD DE FACTORES QUE SE COMBINAN PARA AFECTAR EL RITMO DE MANIPULACION DE LA CARGA.

DE ESTA COMBINACION DE FACTORES - RITMO VARIABLE DE LLEGADA DE LOS BUQUES Y VARIACION DEL TIEMPO DE DESCARGA Y CARGA - RESULTA QUE SOLO SE PODRIA GARANTIZAR UNA TASA DE OCUPACION DE LOS PUESTOS DE ATRAQUE DEL 100% MEDIANTE UNA COLA CONTINUA Y A MENUDO MUY LARGA - DE BUQUES. DE MODO ANALOGO, SOLO SE PODRIA GARANTIZAR QUE LOS BUQUES NUNCA TENDRIAN QUE HACER COLA PARA ATRACAR SI SE ACEPTARA UNA TASA MEDIA MUY BAJA DE OCUPACION DE LOS PUESTOS DE ATRAQUE. NINGUNA DE ESTAS DOS SOLUCIONES ES ACEPTABLE. LO QUE SE BUSCA ES UN TERMINO MEDIO ENTRE ESTOS DOS EXTREMOS.

EXAMINEMOS PRIMERO LOS COSTOS PORTUARIOS. SE COMPONEN DE DOS PARTES:

- UN COMPONENTE FIJO QUE ES INDEPENDIENTE DEL TONELAJE MANIPULADO (ENTRAN EN ESTA CATEGORIA LOS COSTOS DE CAPITAL DE LOS MUELLES, ALMACENES, GRUAS, ETC.)

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- UN COMPONENTE VARIABLE QUE DEPENDE DEL TONELAJE MANIPULADO -- (ENTRAN EN ESTA CATEGORIA LOS COSTOS DE MANO DE OBRA Y DE PERSONAL, COMBUSTIBLE, CONSERVACION, ETC).

A MEDIDA QUE AUMENTA EL TONELAJE QUE PASA POR UN PUESTO DE ATRAQUE, DISMINUYE EL COMPONENTE FIJO EXPRESADO COMO COSTO POR TONELADA. EL COMPONENTE VARIABLE, SI SE EXPRESA TAMBIEN COMO COSTO POR TONELADA, PERMANECERA PROBABLEMENTE BASTANTE ESTABLE HASTA QUE EL PUESTO DE ATRAQUE SE VEA OBLIGADO A ACEPTAR UN TONELAJE MUY ELEVADO, PUNTO A PARTIR DEL CUAL EL COSTO VARIABLE POR TONELADA TENDERA A CRECER PORQUE HABRA QUE TRABAJAR HORAS EXTRAORDINARIAS Y RECURRIR A METODOS MAS COSTOSOS PARA ELEVAR EL RITMO DE MANIPULACION DE LA CARGA. LA FIGURA 1 ILUSTRA EN FORMA DE DIAGRAMA LA RELACION EXISTENTE ENTRE EL COSTO PORTUARIO POR TONELADA Y EL VOLUMEN DEL TRAFICO.

SE PUEDE OBSERVAR QUE LA CURVA DEL COSTO PORTUARIO (QUE ES LA SUMA DE LOS COMPONENTES FIJO Y VARIABLE) ALCANZA UN VALOR MINIMO CUANDO LA TASA DE REDUCCION DEL COSTO FIJO POR TONELADA ES IGUAL A LA TASA DE INCREMENTO DEL COSTO VARIABLE POR TONELADA (PUNTO A EN LA GRAFICA).

EXAMINEMOS A CONTINUACION EL COSTO DEL TIEMPO DE PERMANENCIA EN PUERTO. DICHO TIEMPO SE COMPONE TAMBIEN DE DOS PARTES:

- EL TIEMPO DE PERMANENCIA DEL BUQUE EN EL PUESTO DE ATRAQUE (INCLUIDO EL TIEMPO NECESARIO PARA ATRACAR Y DESATRACAR);

- EL TIEMPO QUE EL BUQUE PASA ESPERANDO A QUE HAYA UN PUESTO DE ATRAQUE DISPONIBLE.

A MEDIDA QUE AUMENTA EL TRAFICO Y EL PUERTO SE VE OBLIGADO A INTENSIFICAR EL MOVIMIENTO DE MERCANCIAS, SE PRODUCEN DOS EFECTOS. EL TIEMPO DE PERMANENCIA DEL BUQUE EN EL PUESTO DE ATRAQUE SE REDUCE LIGERAMENTE MEDIANTE UN TRABAJO MAS INTENSIVO (HORAS EXTRAORDINARIAS, ETC), PERO EL TIEMPO DE ESPERA DE LOS BUQUES ANTES DE ATRACAR AUMENTA DEBIDO AL INCREMENTO DE LA TASA DE OCUPACION DE

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LOS PUESTOS DE ATRAQUE PRODUCIDO POR EL MAYOR TRAFICO. A NIVELES ALTOS DE OCUPACION EL AUMENTO DEL TIEMPO DE ESPERA ES VERDADERAMENTE ESPECTACULAR (VEASE LAS FIGURAS 4 A 6). ESTE EFECTO SE RESUME TAMBIEN GRAFICAMENTE EN LA FIGURA 2.

PARA COMPRENDER LA RELACION EXISTENTE ENTRE EL MOVIMIENTO DE MERCANCIAS EN LOS PUESTOS DE ATRAQUE Y LOS GASTOS TOTALES QUE SE SOPORTAN EN EL PUERTO, ES NECESARIO SUMAR LOS COSTOS PORTUARIOS Y LOS COSTOS TOTALES DE PERMANENCIA. ASI SE HACE EN LA FIGURA 3.

SE PUEDE OBSERVAR QUE LOS GASTOS TOTALES EN PUERTO POR TONELADA TIENEN TAMBIEN UN PUNTO MINIMO (PUNTO B EN EL GRAFICO), PERO ESTE MINIMO (INCLUIDO EL COSTO DE PERMANENCIA) SE ALCANZA A UN NIVEL DE MOVIMIENTO DE MERCANCIAS MUY INFERIOR AL QUE CONDUCE AL COSTO PORTUARIO MINIMO (PUNTO A). ES PRECISO QUE LAS ADMINISTRACIONES PORTUARIAS TENGAN CONCIENCIA DE ESTE ASPECTO TAN IMPORTANTE. AL TRATAR DE REDUCIR AL MINIMO SUS PROPIOS GASTOS EN DETRIMENTO DE LOS ARMADORES, UNA ADMINISTRACION CORRERIA EL RIESGO DE QUE SE PRODUJERAN LARGAS COLAS DE BUQUES CON LA PROBABLE CONSECUENCIA DE QUE SE IMPUSIERA UN RECARGO PORTUARIO QUE PODRIA TENER GRAVES REPERCUSIONES PARA LA ECONOMIA DEL PAIS.

EL NIVEL DE MOVIMIENTO DE MERCANCIAS Y DE OCUPACION DE LOS PUESTOS DE ATRAQUE EN QUE SE OBTENGA EL COSTO PORTUARIO TOTAL MINIMO DEPENDERA DE LA MAGNITUD DE LOS DISTINTOS ELEMENTOS DEL COSTO. ESTA ES LA RAZON POR LA CUAL LAS FIGURAS 1, 2 Y 3 NO TIENEN ESCALAS CUANTIFICADAS. POR OTRA PARTE, EL PUNTO DE COSTO MINIMO DEPENDE DE LA RELACION ENTRE LA OCUPACION DEL PUESTO DE ATRAQUE Y EL TIEMPO DE ESPERA DE LOS BUQUES.

LA RELACION ENTRE LA OCUPACION DEL PUESTO DE ATRAQUE Y EL TIEMPO DE ESPERA DE LOS BUQUES ES MUY COMPLEJA. PUEDE SER ESTUDIADA MEDIANTE UNA TECNICA MATEMATICA CONOCIDA COMO TEORIA DE LAS COLAS. SI SE ANALIZAN EL SISTEMA DE LLEGADAS Y LOS TIEMPOS DE DESCARGA Y CARGA DE LOS BUQUES, ES POSIBLE CALCULAR LA RELACION

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EXISTENTE ENTRE EL NUMERO DE PUESTOS DE ATRAQUE, LA TASA MEDIA DE OCUPACION DE LOS MISMOS Y EL TIEMPO DE ESPERA PREVISTO. LAS FIGURAS 4, 5 Y 6 ILUSTRAN ESTA RELACION PARA LOS CASOS DE 2, 6 Y 10 PUESTOS DE ATRAQUE, RESPECTIVAMENTE. EL CUADRO 1 ES MAS DETALLADO Y PERMITE OBTENER CURVAS SIMILARES PARA DISTINTOS NUMEROS DE PUESTOS DE ATRAQUE.

AHORA BIEN, CUANDO SE COMPARAN LOS RESULTADOS OBTENIDOS EN DICHAS CURVAS CON LA SITUACION EXISTENTE EN LOS PUERTOS, SE DESCUBRE QUE LOS RESULTADOS DE LA TEORIA DE LAS COLAS TIENDEN A EXAGERAR EL TIEMPO MEDIO DE ESPERA DE LOS BUQUES. ESTE FENOMENO ES PARTICULARMENTE VISIBLE A NIVELES ALTOS DE OCUPACION DE LOS ATRAQUES. ELLO SE DEBE A QUE UN PUERTO DISPONE DE DIVERSOS PROCEDIMIENTOS PARA HACER FRENTE A LOS PERIODOS DE MAXIMA DEMANDA, QUE LE PERMITEN EVITAR LAS COLAS EXTREMADAMENTE LARGAS QUE PODRIAN DE OTRO MODO PRODUCIRSE. ENTRE LOS PROCEDIMIENTOS MAS IMPORTANTES CABE MENCIONAR LOS DOS SIGUIENTES:

- UN INCREMENTO PROVISIONAL DE LA CAPACIDAD DE ATRAQUE MEDIANTE LA UTILIZACION DE AMARRES (O EL DOBLE ATRAQUE DE BUQUES);

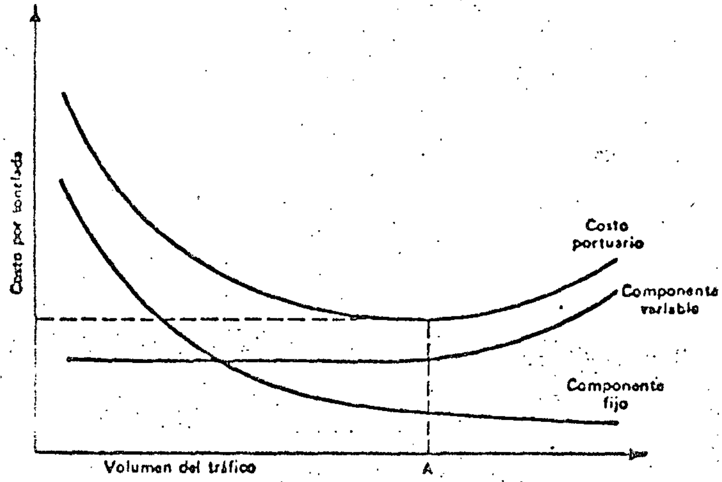
- UN INCREMENTO PROVISIONAL DEL RITMO DE MANIPULACION DE LA CARGA MEDIANTE LA UTILIZACION DE UN NUMERO MAYOR DE CUADRILLAS, O DE CUADRILLAS MAYORES, Y RECURRIENDO A LAS HORAS EXTRAORDINARIAS.

AMBOS METODOS ENTRAÑAN CIERTOS COSTOS ADICIONALES, PERO ESTOS SERAN PROBABLEMENTE MUCHO MENORES QUE EL DE LA CONGESTION QUE DE LO CONTRARIO SE PROVOCARIA.

EL HECHO DE QUE UN PUERTO PUEDA INCREMENTAR PROVISIONALMENTE SU CAPACIDAD EN LAS FORMAS ANTERIORMENTE SEÑALADAS NO INVALIDA LA RELACION EXISTENTE ENTRE LA OCUPACION DE LOS PUESTOS DE ATRAQUE Y EL TIEMPO DE ROTACION DE LOS BUQUES. EN REALIDAD, UNAS CURVAS COMO LAS QUE APARECEN EN LAS FIGURAS 4, 5 Y 6 PERMITEN MEDIR EL BENEFICIO PROBABLE DE UN INCREMENTO PERMANENTE DE LA CAPACIDAD. DADO

FIGURA 1

Variación del costo portuario al aumentar el tráfico



* En las figuras 1, 2 y 3 se parte del supuesto de que hay un número determinado de puestos de atraque y se utilizan métodos de trabajo normales.

FIGURA 2

Variación del costo de permanencia en puerto al aumentar el tráfico

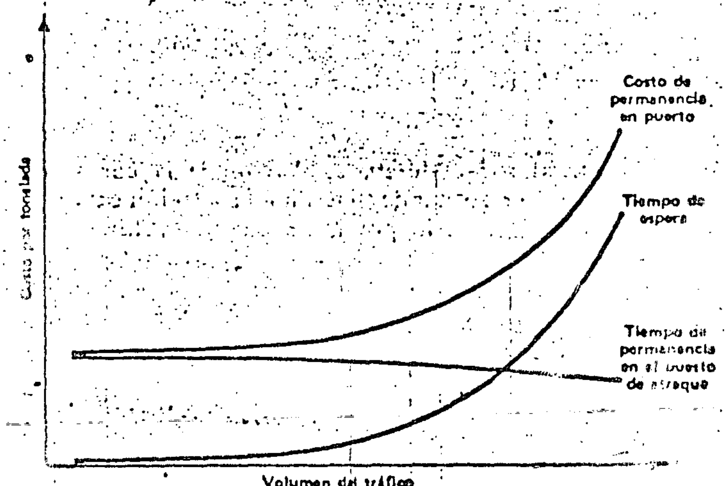


FIGURA 3

Variación de los gastos totales en el puerto al aumentar el tráfico

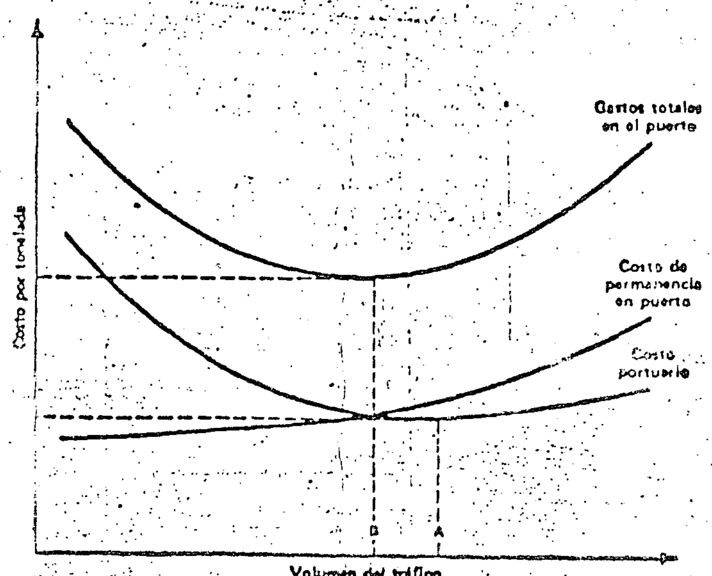


FIGURA 4

Relación entre la ocupación de los puestos de atraque y el tiempo de espera de los buques: caso de 6 puestos de atraque

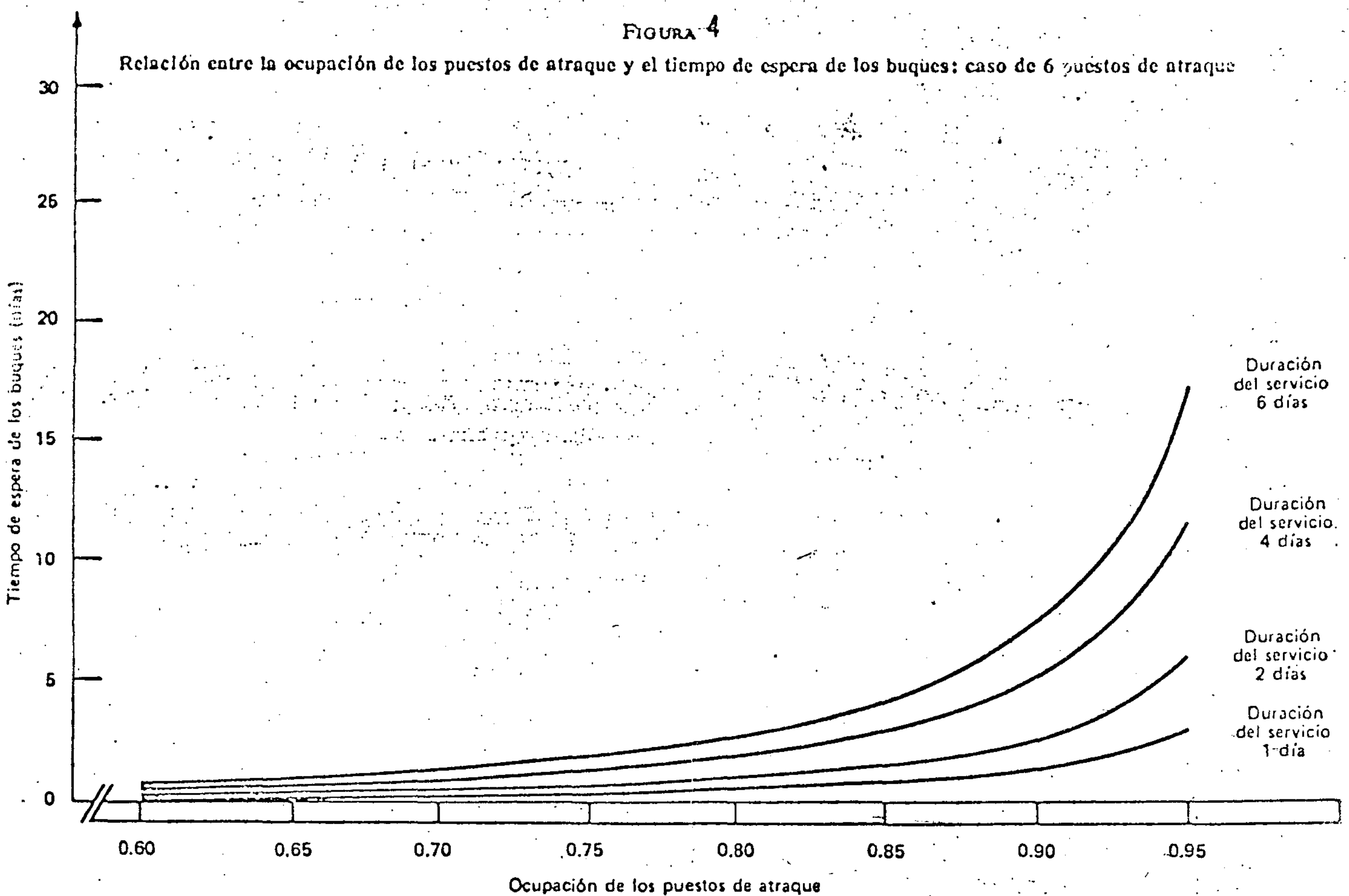


FIGURA 5

Relación entre la ocupación de los puestos de atraque y el tiempo de espera de los buques: caso de 10 puestos de atraque

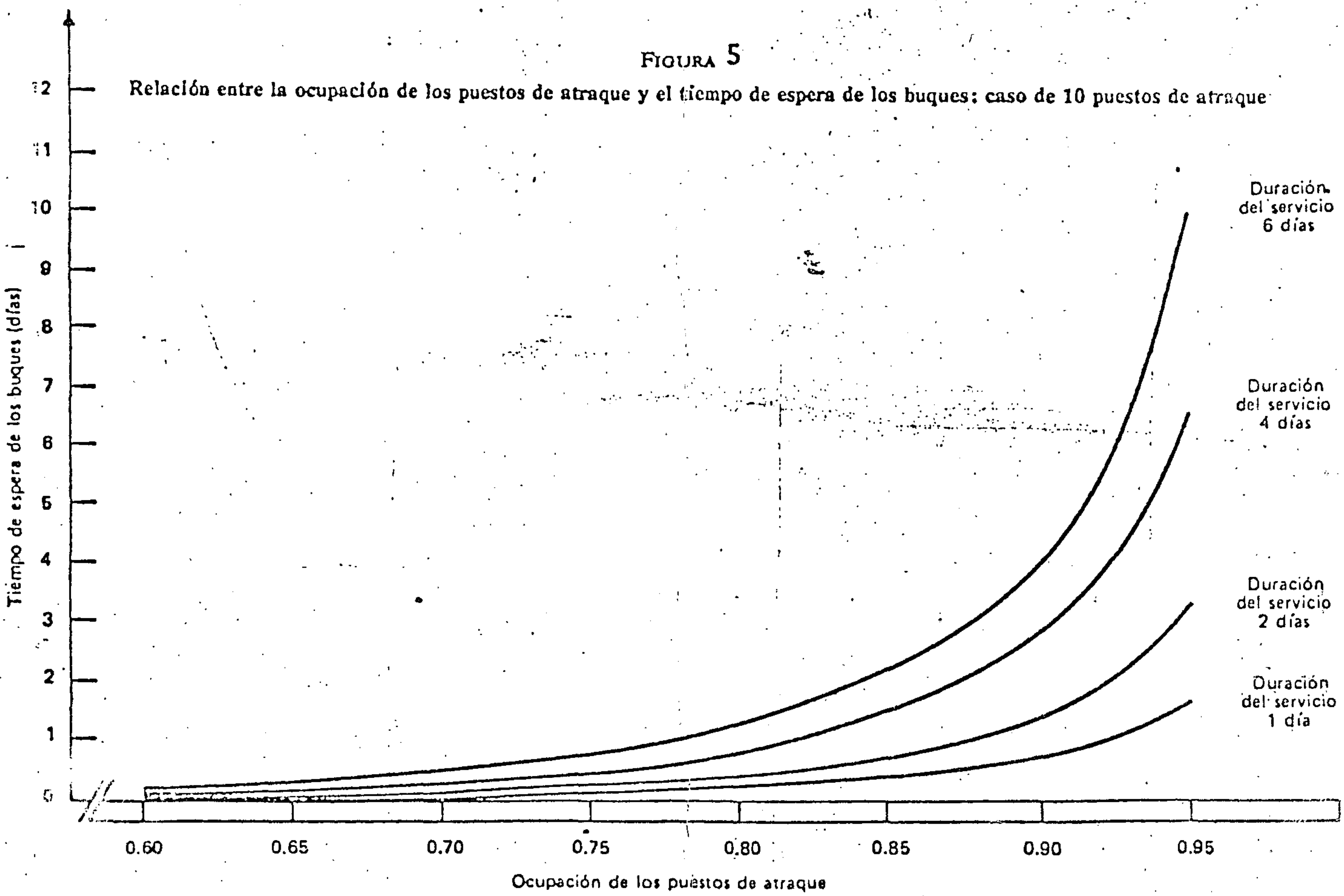


Figura 6

Relación entre la ocupación de los puestos de atraque y el tiempo de espera de los buques: caso de 2 puestos de atraque

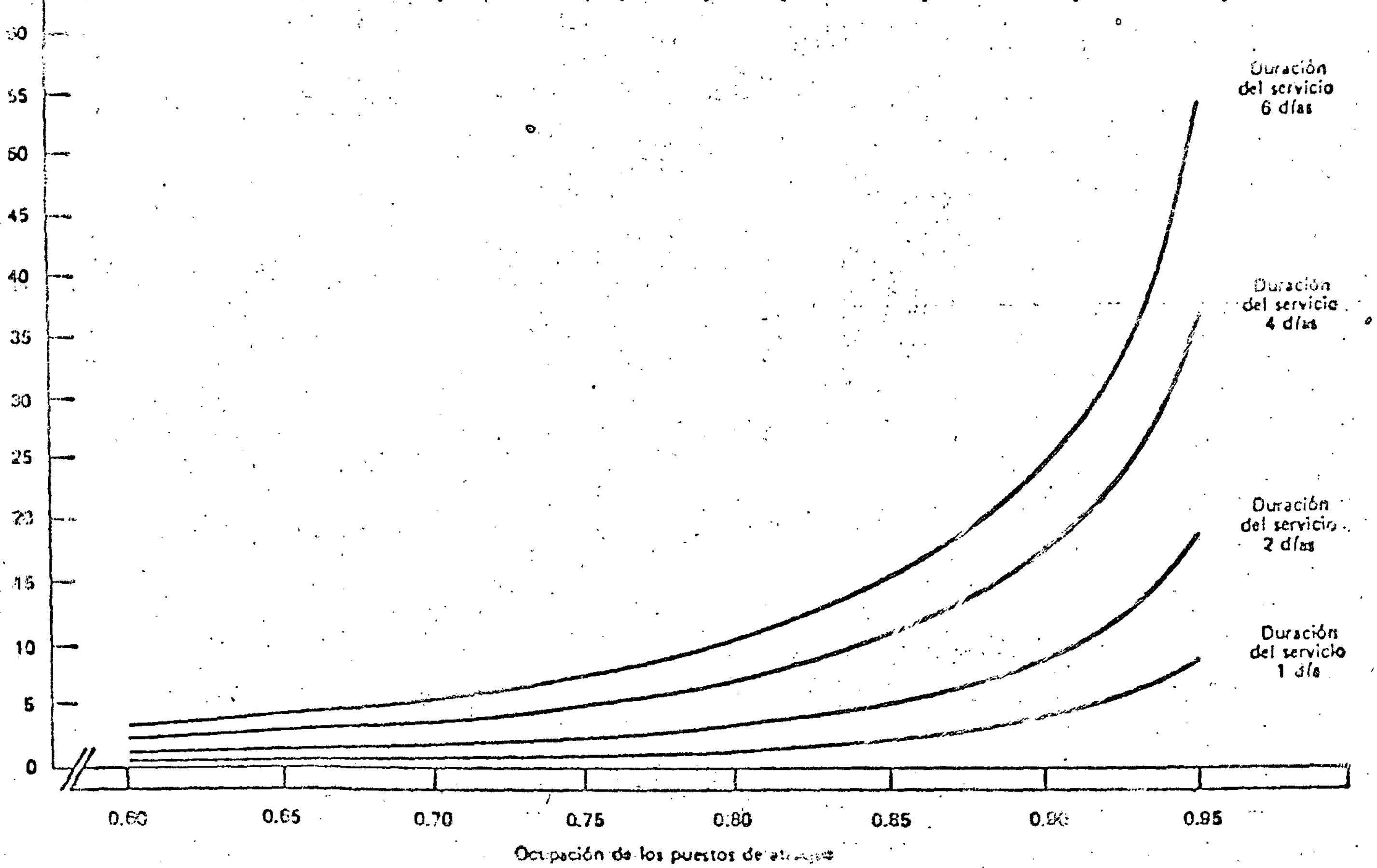
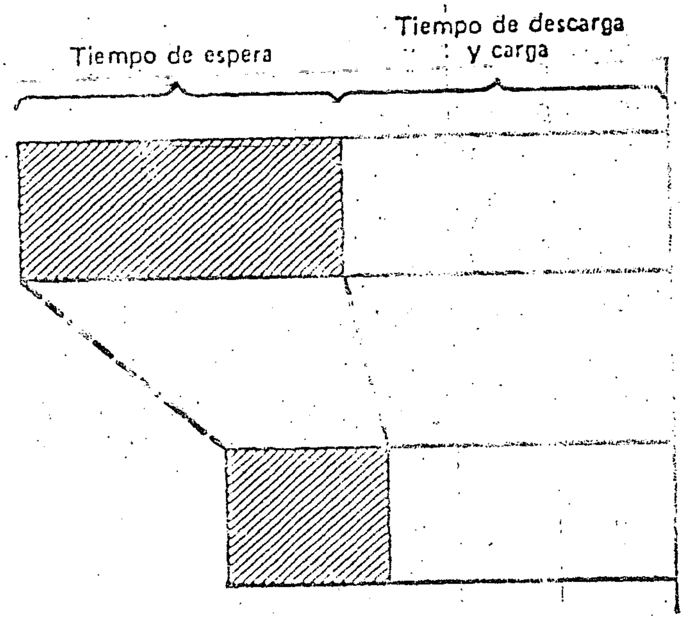


Figura 7

Efecto de la reducción del tiempo de descarga y carga en el tiempo de rotación



Cuadro 1

Relación entre el tiempo de espera y el tiempo de servicio

Tasa de ocupación de los puestos de atraque	Número de puestos de atraque															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
0,050	0,053	0,003	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,050
0,100	0,111	0,010	0,001	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,100
0,150	0,176	0,023	0,004	0,001	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,150
0,200	0,250	0,042	0,010	0,003	0,001	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,200
0,250	0,333	0,067	0,020	0,007	0,003	0,001	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,250
0,300	0,429	0,099	0,033	0,013	0,006	0,003	0,001	0,001	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,300
0,350	0,538	0,140	0,053	0,023	0,011	0,006	0,003	0,002	0,001	0,001	0,0	0,0	0,0	0,0	0,0	0,350
0,400	0,667	0,190	0,078	0,038	0,020	0,011	0,006	0,004	0,002	0,001	0,001	0,001	0,0	0,0	0,0	0,400
0,450	0,818	0,254	0,113	0,058	0,033	0,020	0,012	0,008	0,005	0,003	0,002	0,002	0,001	0,001	0,001	0,450
0,500	1,000	0,333	0,158	0,087	0,052	0,033	0,022	0,015	0,010	0,007	0,005	0,004	0,003	0,002	0,002	0,500
0,550	1,222	0,434	0,217	0,126	0,079	0,053	0,037	0,026	0,019	0,014	0,010	0,008	0,006	0,005	0,004	0,550
0,575	1,353	0,494	0,254	0,151	0,097	0,066	0,047	0,034	0,025	0,019	0,014	0,011	0,009	0,007	0,005	0,575
0,600	1,500	0,562	0,296	0,179	0,118	0,082	0,059	0,044	0,033	0,025	0,020	0,016	0,012	0,010	0,008	0,600
0,625	1,667	0,641	0,344	0,213	0,143	0,101	0,074	0,056	0,043	0,034	0,027	0,021	0,017	0,014	0,012	0,625
0,650	1,857	0,732	0,401	0,253	0,173	0,124	0,093	0,071	0,055	0,044	0,035	0,029	0,024	0,020	0,016	0,650
0,675	2,007	0,837	0,468	0,301	0,209	0,152	0,115	0,090	0,071	0,057	0,047	0,038	0,032	0,027	0,023	0,675
0,700	2,333	0,961	0,547	0,357	0,252	0,187	0,143	0,113	0,091	0,074	0,061	0,051	0,043	0,037	0,031	0,700
0,725	2,636	1,108	0,642	0,426	0,305	0,229	0,178	0,142	0,115	0,095	0,080	0,067	0,058	0,049	0,043	0,725
0,750	3,000	1,286	0,757	0,509	0,369	0,281	0,221	0,178	0,147	0,123	0,104	0,089	0,076	0,066	0,058	0,750
0,775	3,444	1,504	0,899	0,614	0,451	0,347	0,276	0,225	0,187	0,158	0,135	0,117	0,102	0,089	0,079	0,775
0,800	4,000	1,778	1,079	0,746	0,554	0,431	0,347	0,286	0,240	0,205	0,176	0,154	0,135	0,119	0,106	0,800
0,825	4,714	2,131	1,311	0,917	0,689	0,543	0,441	0,367	0,311	0,267	0,232	0,204	0,181	0,161	0,145	0,825
0,850	5,667	2,604	1,623	1,149	0,873	0,693	0,569	0,477	0,408	0,353	0,310	0,274	0,245	0,220	0,199	0,850
0,875	7,000	3,267	2,062	1,476	1,132	0,908	0,751	0,635	0,547	0,478	0,422	0,376	0,338	0,306	0,278	0,875
0,900	9,000	4,263	2,724	1,969	1,525	1,234	1,028	0,877	0,761	0,669	0,594	0,533	0,482	0,439	0,402	0,900
0,925	12,333	5,926	3,829	2,796	2,185	1,782	1,497	1,285	1,122	0,993	0,888	0,802	0,729	0,668	0,614	0,925
0,950	19,000	9,256	6,047	4,457	3,511	2,885	2,441	2,110	1,855	1,651	1,486	1,348	1,233	1,134	1,049	0,950
0,975	38,999	19,252	12,708	9,451	7,504	6,211	5,291	4,602	4,068	3,642	3,295	3,006	2,762	2,553	2,373	0,975

Fuentes: Cálculos efectuados por la secretaría de la UNCTAD según la fórmula de la teoría de las colas (distribución de Poisson para las llegadas de buques y distribución exponencial para los tiempos de servicio). Se supuso que los puestos de atraque se asignaban por orden riguroso de llegada de los buques.

QUE EL TRAFICO DEL PROXIMO AÑO SERA MAYOR QUE EL DEL ACTUAL, -- SERA PRECISO CREAR UNA MAYOR CAPACIDAD PARA EVITAR LA CONGESTION DEL PUERTO. ESTE TENDRA QUE CREAR NUEVOS PUESTOS DE ATRAQUE O AUMENTAR LA CAPACIDAD DE LOS EXISTENTES (O QUIZA HACER AMBAS COSAS A LA VEZ). EL EJEMPLO SIGUIENTE ILUSTRA LA FORMA EN QUE CURVAS SIMILARES A LAS ANTERIORES PUEDEN SER UTILIZADAS TANTO POR LOS PLANIFICADORES COMO POR LOS ADMINISTRADORES DE PUERTOS PARA INDICAR EL TIPO DE MEDIDAS QUE SON NECESARIAS SI SE QUIERE EVITAR UN AUMENTO DEL TIEMPO DE ROTACION DE LOS BUQUES.

EJEMPLO

UN PUERTO MANIPULA ACTUALMENTE 900,000 TONELADAS DE CARGA GENERAL AL AÑO CON 6 PUESTOS DE ATRAQUE. LA TASA MEDIA DE OCUPACION DE ESOS PUESTOS ES DEL 75%, EL TIEMPO MEDIO DE DESCARGA Y CARGA ES DE CUATRO DIAS Y LOS BUQUES PASAN UN PROMEDIO DE 1,1 DIAS (VEASE LA FIGURA 5) ESPERANDO A QUE UN ATRAQUE QUEDE LIBRE. LAS PREVISIONES INDICAN QUE EN UN PLAZO DE DOS AÑOS LA CANTIDAD DE CARGA MANIPULADA HABRA AUMENTADO HASTA 1.050,000 TONELADAS ANUALES. SE PUEDEN COMPARAR LAS DOS MANERAS DE HACER FRENTE A ESTE AUMENTO, A SABER:

- LA CONSTRUCCION DE NUEVOS PUESTOS DE ATRAQUE;
- UN AUMENTO DE LA CAPACIDAD DE LOS EXISTENTES CON OBJETO DE QUE NO AUMENTE EL TIEMPO TOTAL DE PERMANENCIA DE LOS BUQUES EN EL PUERTO.

SOLUCION A - CONSTRUIR UN NUEVO PUESTO DE ATRAQUE LLEVARIA A LA SITUACION SIGUIENTE:

MOVIMIENTO TOTAL	: 1.050,000 TONELADAS POR AÑO
NUMERO DE PUESTOS DE ATRAQUE	: 7
MOVIMIENTO MEDIO DE MERCANCIAS POR PUESTOS	: 150,000 TONELADAS POR AÑO (COMO ANTES)

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TASA DE OCUPACION DE LOS PUESTOS	: 75% (COMO ANTES)
TIEMPO DE DESCARGA Y CARGA	: 4 DIAS (COMO ANTES)
TIEMPO MEDIO DE ESPERA DE LOS BUQUES	: 0.88 DIAS (VEASE EL CUADRO 1)
TIEMPO MEDIO DE PERMANENCIA DE LOS BUQUES EN EL PUERTO	: 4,88 DIAS

ASI PUES, UNA FORMA DE HACER FRENTE A UN INCREMENTO DEL TRAFICO DEL 17% CONSISTE EN AUMENTAR EN LA PROPORCION CORRESPONDIENTE EL NUMERO DE PUESTOS DE ATRAQUE. CON ELLO SE CONSIGUE TAMBIEN UNA LIGERA REDUCCION DEL TIEMPO TOTAL DE PERMANENCIA DE LOS BUQUES EN EL PUERTO (4,88 DIAS EN VEZ DE 5,1).

SOLUCION B - AUMENTAR LA CAPACIDAD INTRINSECA DE LOS PUESTOS EXISTENTES:

AL AUMENTAR LA CAPACIDAD EN UN 17% (COMO CONSECUENCIA DE UN INCREMENTO DEL 17% EN EL RITMO EFECTIVO DE DESCARGA Y CARGA) SE LLEGARIA A LA SIGUIENTE SITUACION:

MOVIMIENTO TOTAL	: 1,050,000 TONELADAS POR AÑO
NUMERO DE PUESTOS DE ATRAQUE	: 6
MOVIMIENTO MEDIO DE MERCANCIAS POR PUESTO	: 175,000 TONELADAS POR AÑO
TIEMPO DE DESCARGA Y CARGA	: 3.43 DIAS
TASA DE OCUPACION DE LOS PUESTOS	: 75% (COMO ANTES)
TIEMPO MEDIO DE ESPERA DE LOS BUQUES	: 0.96 DIAS (VEASE EL CUADRO 1)
TIEMPO MEDIO DE PERMANENCIA DE LOS BUQUES EN EL PUERTO	: 4.39 DIAS

PUEDE VERSE QUE UN INCREMENTO DEL 17% EN LA PRODUCTIVIDAD EFECTIVA CUBRE EL AUMENTO DEL TRAFICO MUCHO MEJOR QUE UN INCREMENTO

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DEL 17% EN EL NUMERO DE PUESTOS DE ATRAQUE, DADO QUE REDUCE EN MEDIO DIA EL TIEMPO MEDIO DE PERMANENCIA DE LOS BUQUES EN EL PUERTO. TAL INCREMENTO DE LA PRODUCTIVIDAD EFECTIVA PODRIA CONSEGUIRSE SIMPLEMENTE MEDIANTE UNA REDUCCION DEL TIEMPO MUERTO.

DURANTE LOS PERIODOS DE TRAFICO INTENSO, EN QUE EL TIEMPO DE ESPERA DE LOS BUQUES PUEDE SER IGUAL O SUPERIOR AL TIEMPO DE DESCARGA Y CARGA, EL EFECTO DE UNA REDUCCION EN EL TIEMPO DE DESCARGA Y CARGA PUEDE SER VERDADERAMENTE ESPECTACULAR. UN EXPERIMENTO REALIZADO CON EL MODELO DE SIMULACION DEL PUERTO DE KARACHI INDICO QUE CUANDO LOS BUQUES PERMANECIAN UN PROMEDIO DE 8 DIAS EN EL PUERTO (4 DIAS ESPERANDO A QUE HUBIESE UN ATRAQUE DISPONIBLE Y 4 DIAS DESCARGANDO Y CARGANDO) UN TRABAJO MAS INTENSIVO, QUE PROVOCO UNA REDUCCION DE MEDIO DIA EN EL TIEMPO DE DESCARGA Y CARGA, PERMITIO DISMINUIR EN LA MITAD EL TIEMPO DE ESPERA DEL BUQUE: DE 4 DIAS A 2 DIAS. ESTO QUEDA ILUSTRADO EN LA FUGURA 7.

ESTE FENOMENO REVISTE UNA EXTRAORDINARIA IMPORTANCIA. CONDUCE A LA CONCLUSION GENERAL DE QUE , DURANTE LOS PERIODOS DE CONGESTION PORTUARIA, UN SERVICIO LO MAS INTENSIVO POSIBLE FAVORECE LOS INTERESES DE TODOS LOS USUARIOS DEL PUERTO. LOS COSTOS ADICIONALES DE UN TRABAJO MAS INTENSIVO SERAN, SIN DUDA, MENORES QUE LOS ELEVADOS COSTOS QUE ENTRAÑA LA INMOVILIZACION DE LOS BUQUES.

CONSIDEREMOS EL EJEMPLO SIGUIENTE. DOS BUQUES LLEGAN SIMULTANEAMENTE A UN PUERTO. HAY PRECISAMENTE DOS PUESTOS DE ATRAQUE LIBRES, PERO COMO TODOS LOS DEMAS ESTAN OCUPADOS, LOS RECURSOS DISPONIBLES (MANO DE OBRA Y EQUIPO MECANICO) NO BASTAN PARA UN SERVICIO COMPLETO EN TODAS LAS ESCOTILLAS DE AMBOS BUQUES. HAY DOS MANERAS DE UTILIZAR ESOS RECURSOS : O BIEN SE EFECTUA UN TRABAJO INTENSIVO EN UN SOLO BUQUE PARA DESCARGARLO EN DOS DIAS, O BIEN AMBOS BUQUES COMPARTEN POR IGUAL DICHOS RECURSOS EN CUYO

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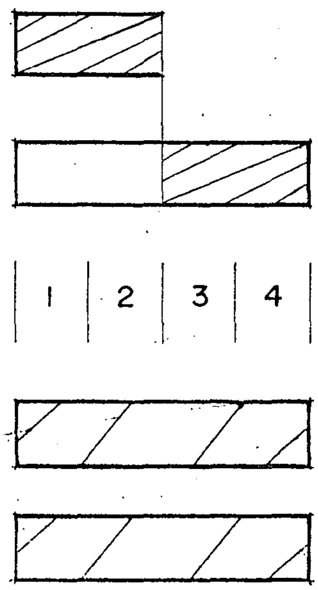
CASO LLEVARA CUATRO DIAS DESCARGARLOS. ¿CUAL DE LAS DOS SOLUCIONES HA DE ESCOGER EL PUERTO?

LA FIGURA 8 ILUSTRA EL EFECTO DE CADA UNA DE ESAS SOLUCIONES EN LOS TIEMPOS DE ROTACION DE AMBOS BUQUES.

FIGURA 8

COMPARACION ENTRE EL TRABAJO INTENSIVO Y EL REPARTO DE LOS RECURSOS DISPONIBLES.

SOLUCION A
"TRABAJO INTENSIVO"



TIEMPO TOTAL DE PERMANENCIA DEL BUQUE EN EL PUERTO:
6 DIAS
DIAS

SOLUCION B
"REPARTO DE RECURSOS"

TIEMPO TOTAL DE PERMANENCIA DEL BUQUE EN EL PUERTO: 8 DIAS

ES EVIDENTE QUE, A LA LARGA, EL TRABAJO INTENSIVO ES VENTAJOSO PARA EL ARMADOR, AUN CUANDO PUEDE HABER MOMENTOS EN QUE NO SE PRESTE NINGUN SERVICIO A SU BUQUE.

DESGRACIADAMENTE, LAS ADMINISTRACIONES PORTUARIAS NO SIEMPRE DISPONEN DE LOS MEDIOS SUFICIENTES PARA GARANTIZAR LA PRESTACION DE LOS SERVICIOS INTENSIVOS A LOS BUQUES. EL RITMO DE CARGA SUELE DEPENDER DE LOS CONSIGNATARIOS, QUE, SI EL BUQUE VA ADELANTA-

DO EN RELACION CON LAS PREVISIONES, PUEDEN PREFERIR DELIBERADAMENTE QUE LA DESCARGA Y CARGA DUREN UN NUMERO DETERMINADO DE DIAS. ESTA LENTITUD DELIBERADA DEL RITMO DE DESCARGA Y CARGA PUEDE TENER, EN PERIODOS DE ESPERA PROLONGADA, UN EFECTO DESASTROSO SOBRE EL TIEMPO TOTAL DE ROTACION DE LOS BUQUES.

RELACION ENTRE EL SISTEMA DE MANIPULACION A BORDO Y EL SISTEMA DE TRASLACION

1. COORDINACION DE LAS OPERACIONES

CADA UNO DE LOS ELEMENTOS DEL SISTEMA DEL PUESTO DE ATRAQUE CUENTA CON SU PROPIA DEMANDA Y CON SU PROPIA CAPACIDAD. SIN EMBARGO, ALGUNOS DE ESOS ELEMENTOS ESTAN ENLAZADOS ENTRE SI DE TAL MODO QUE CADA TONELADA DE MERCANCIAS QUE PASA POR UNO DE ELLOS HA DE PASAR A TRAVES DE LOS OTROS. LOS DOS ENLACES MAS IMPORTANTES SON LOS EXISTENTES ENTRE EL SISTEMA DE MANIPULACION A BORDO Y EL SISTEMA DE TRASLACION O UNO DE LOS SISTEMAS DIRECTOS, SEGUN LA VIA POR LA QUE PASEN LAS MERCANCIAS. LAS OPERACIONES ENLAZADAS HAN DE COORDINARSE CADA HORA, YA QUE, DE LO CONTRARIO, O BIEN UNA OPERACION TENDRA QUE ESPERAR A LA OTRA, O BIEN LAS MERCANCIAS SE IRAN AMONTONANDO EN EL MUELLE Y PROVOCARAN UNA CONGESTION. PARA COMPROBAR SI ESTAN COORDINADAS ES PRECISO CONOCER LA CAPACIDAD HORARIA DE CADA UNA; PERO EN ELLO RESIDE PRECISAMENTE EL PROBLEMA. ES DIFICIL MEDIR UNA CON INDEPENDENCIA DE LA OTRA. EL RENDIMIENTO REGISTRADO SERA EL DE LA OPERACION COMBINADA.

2. LA VIA INDIRECTA

EXAMINEMOS POR EJEMPLO, LA OPERACION DIRECTA. ¿ACASO ESTAMOS REGISTRANDO EL CICLO DE ELEVACION O EL CICLO DE TRASLACION? (VEASE LA FIGURA 1).

LA UNICA FORMA DE DESCUBRIR CUAL DE ESTAS OPERACIONES ENLAZADAS CREA EL ESTRANGULAMIENTO ESTRIBA EN EFECTUAR UN CALCULO ADI-

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CIONAL CONSISTENTE EN COMPARAR EL RENDIMIENTO REGISTRADO DE LA OPERACION EN SU CONJUNTO CON LA CAPACIDAD INTRINSECA DE CADA ELEMENTO POR SEPARADO. NO BASTA CON COLOCARSE EN EL MUELLE Y OBSERVAR LA OPERACION PARA AVERIGUAR QUE ES LO QUE ESTA FRENANDO EL FLUJO DE MERCANCIAS. ESTO PUEDE SER UTIL SI EL DESFASE ES -- MUY PATENTE, PERO CON FRECUENCIA RESULTA DIFICIL DETERMINAR LA CAUSA DE LA INTERRUPCION. LO NATURAL ES QUE FLUCTUE EL RITMO DE CADA OPERACION Y, POR CONSIGUIENTE, LA OBSTRUCCION PUEDE TRASLADARSE DE UN LUGAR A OTRO. UN EQUIPO DE ESTUDIO COMPUESTO POR TRES OBSERVADORES (UNO EN CUBIERTA, OTRO EN EL MUELLE Y EL TERCERO EN LA ZONA DE ALMACENAMIENTO) PODRIA, POR SUPUESTO, LLEVAR A CABO ESTA TAREA, PERO SU PRESENCIA AFECTARIA PROBABLEMENTE AL TRABAJO Y HARIA DUDOSOS LOS RESULTADOS. ES MEJOR ENCONTRAR LA RESPUESTA ESTIMANDO LA CAPACIDAD INTRINSECA DE CADA UNO DE LOS ELEMENTOS - ES DECIR, LA CAPACIDAD QUE TENDRIA SI TRABAJASE ININTERRUMPIDAMENTE A SU RITMO NORMAL.

A CORTO PLAZO, LA CAPACIDAD INTRINSECA DEL SISTEMA DE MANIPULACION A BORDO ES SENCILLAMENTE LA CAPACIDAD DE ELEVACION MULTIPLICADA POR EL PESO MEDIO DE LA ESLINGADA, PARA CADA CATEGORIA DE MERCANCIAS. SE HAN HECHO MUCHOS ESTUDIOS SOBRE EL NUMERO DE CICLOS POR HORA QUE PUEDEN REALIZAR DURANTE TODO UN TURNO LAS GRUAS DE MUELLE CORRIENTES DE 3 A 6 TONELADAS*. CUANDO SE UTILIZA UNA CUADRILLA DE A BORDO LO SUFICIENTE GRANDE, CON SISTEMAS ADECUADOS DE MANIPULACION DENTRO DE LA BODEGA, NO HAY RAZON ALGUNA PARA QUE CON CUALQUIER TIPO DE MERCANCIAS Y DE ESCOTILLA LA GRUA NO PUEDA MANTENER UN RITMO DE 20 CICLOS POR HORA DURANTE TODO UN TURNO. SI, ADEMAS, EL PESO MEDIO DE LA ESLINGADA PARA UNA CATEGORIA DETERMINADA DE CARGA ES DE UNA TONELADA, ENTONCES LA CAPACIDAD INTRINSECA DE LA GRUA PARA DICHO TIPO DE MERCANCIAS SERA DE 20 TONELADAS POR HORA. SE PARTE DEL SUPUESTO DE QUE UNA CUADRILLA ES LA UNIDAD DE MA-

* SAN FRANCISCO PORT STUDY II. NATIONAL ACADEMY OF SCIENCES (VEASE, POR EJEMPLO, PAGINAS 18 Y 19).

NO DE OBRA ASIGNADA A UNA GRUA, LO QUE DA UNA CAPACIDAD DE ELEVACION DE 20 TONELADAS POR HORA-CUADRILLA.

LA CAPACIDAD INTRINSECA DEL SISTEMA DE TRASLACION ES MAS DIFICIL DE ESTIMAR Y DEPENDE EN GRAN MEDIDA DEL METODO ADOPTADO. --- EXISTEN DOS TIPOS PRINCIPALES DE OPERACION: LA IZADA Y EL TRANSPORTE CON UNA CARRETILLA ELEVADORA; Y EL ARRASTRE DE UN TREN DE REMOLQUES POR MEDIO DE UN TRACTOR. EN EL ULTIMO CASO, SE OBSERVAN GRANDES DIFERENCIAS EN LA DURACION DEL CICLO DE TRASLACION SEGUN LA DISTANCIA RECORRIDA O EL HECHO DE QUE EL TRACTOR ARRASTRE UNO, DOS O TRES TRENES DE REMOLQUE (QUE PERMANECEN ENGANCHADOS, SE DESENGANCHAN A UN EXTREMO DEL RECORRIDO O SE DESENGANCHAN A AMBOS EXTREMOS). LA CARGA TRANSPORTADA PUEDE TAMBIEN VARIAR MUCHO, PERO UNA VEZ MAS LA CAPACIDAD INTRINSECA DEL SISTEMA DE TRASLACION ES LA DURACION DEL CICLO MULTIPLICADA POR LA CARGA MEDIA TRASLADADA, PARA CADA CATEGORIA DE MERCANCIAS.

EL MAS IMPORTANTE DE LOS FACTORES QUE INCIDEN EN LA DURACION DEL CICLO DE TRASLACION ES EL TIEMPO DE INMOVILIZACION DEL TRACTOR O DE LA CARRETILLA ELEVADORA. TANTO SI SE DEBE AL TIEMPO DE CARGA Y DESCARGA, AL TIEMPO DE ENGANCHE Y DESENGANCHE O AL TIEMPO UTILIZADO PARA CLASIFICAR SEGUN LAS MARCAS, COMO SI SE DEBE A LA CONGESTION EN EL MUELLE O EN LOS TINGLADOS, PUEDE PRODUCIR EFECTOS CONSIDERABLES, PARTICULARMENTE EN DISTANCIAS CORTAS. ESTA CUESTION SE DISCUTE AMPLIAMENTE EN LA CONFERENCIA SOBRE SISTEMA DE TRASLACION.

SUPONGAMOS QUE SE DETERMINA LA CAPACIDAD INTRINSECA DEL SISTEMA DE TRASLACION Y SE VE QUE ES DE 11 TONELADAS POR CUADRILLA Y HORA. LA CAPACIDAD INTRINSECA DEL SISTEMA DE MANIPULACION A BORDO Y LA DEL SISTEMA DE TRASLACION PUEDEN COMPARARSE CON EL RENDIMIENTO REGISTRADO DE 10 TONELADAS POR CUADRILLA Y HORA, COMO EN LA FIGURA 2.

EL EXAMEN DE ESTAS CIFRAS REVELA CUAL DE LAS CAPACIDADES, LA DE ELEVACION O LA DE TRASLACION, LIMITA EL RITMO TOTAL DE TRASLA-

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Figura 1: Capacidad combinada del sistema de manipulación a bordo y del sistema de traslación

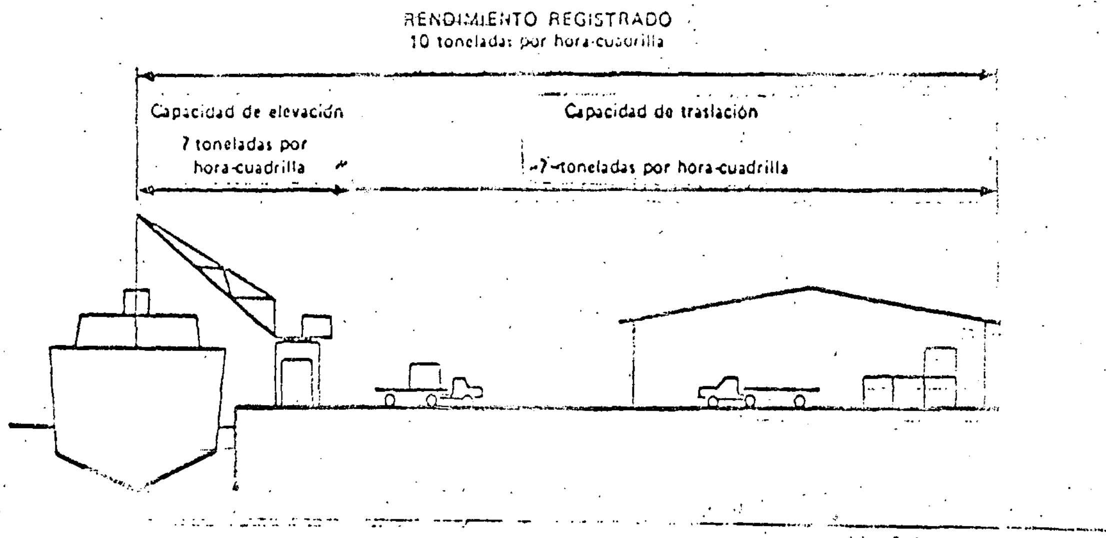
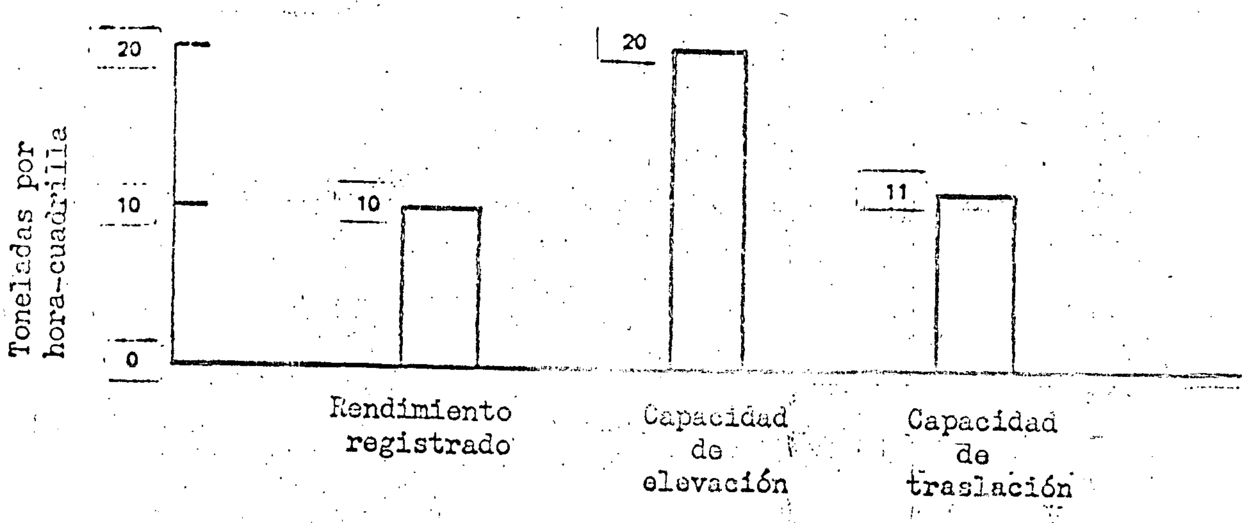


Figura 2:



CION ENTRE LA BODEGA DEL BUQUE Y LA ZONA DE ALMACENAMIENTO. EN EL EJEMPLO ANTERIOR, DADO QUE LA CAPACIDAD DEL CICLO DE TRASLACION ESTA SOLO LIGERAMENTE POR ENCIMA DEL RENDIMIENTO REGISTRADO Y MUY POR DEBAJO DE LA CAPACIDAD DE ELEVACION, ES EL CICLO DE TRASLACION EL QUE ACTUA COMO ESTRANGULAMIENTO.

EL EJEMPLO PRECITADO ES UN CASO TIPICO. SE PRESENTO EN LOS TRES PUERTOS ESCOGIDOS CON RELACION A DIVERSAS CATEGORIAS DE MERCANCIAS. UNA DE LAS ENSEÑANZAS QUE PUEDEN DERIVARSE DE ELLO ES QUE, EN TERMINOS DE TIEMPO DE ROTACION DE LOS BUQUES, NO SE GANA MUCHO UTILIZANDO BUQUES CON ELEVADOS RITMOS DE DESCARGA Y CARGA, A NO SER QUE SE PROCURE MEJORAR LAS OPERACIONES DE TRASLACION.

3. LA VIA DIRECTA

LA OTRA VIA PRINCIPAL QUE PUEDEN SEGUIR LAS MERCANCIAS ES LA DESCARGA DIRECTA EN EL VEHICULO DE CARRETERA, EL VAGON DE FERROCARRIL O LA GABARRA, O BIEN LA CARGA DIRECTA DESDE DICHOS MEDIOS. EN ESTE CASO, EL PROBLEMA CONSISTE EN DETERMINAR - POR EJEMPLO, EN LA OPERACION DE DESCARGA - SI EL FACTOR LIMITADO ES LA CAPACIDAD DE ELEVACION, LA CAPACIDAD DE CARGA DEL VEHICULO O LA DISPONIBILIDAD DE VEHICULOS (VEASE LA FIGURA 3).

SUPONGAMOS QUE UNA GRUA QUE DEPOSITA LA MERCANCIA EN DOS PLATAFORMAS CARGA SIMULTANEAMENTE DOS VEHICULOS SITUADOS EN EL MUELLE Y QUE CADA UNO DE ESTOS TARDA UN PROMEDIO DE 15 MINUTOS EN CARGAR 5 TONELADAS DE UN DETERMINADO TIPO DE MERCANCIAS Y 5 MINUTOS EN SER SUSTITUIDO POR OTRO; ENTONCES LA CAPACIDAD INTRINSECA DEL SISTEMA DE DESCARGA DIRECTA SERA:

$$2 \times \frac{60}{20} \times 5 = 30 \text{ TONELADAS POR HORA}$$

SUPONGAMOS QUE EL RENDIMIENTO REGISTRADO PARA ESTE TIPO DE MERCANCIAS - POR EJEMPLO, GRANDES ENVIOS DE BALAS O SACOS - ES

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UN PROMEDIO DE 18 TONELADAS POR HORA-CUADRILLA. LA SITUACION QUE DARIA REPRESENTADA COMO EN LA FIGURA 4.

APARECE AQUI UNA SITUACION COMPLETAMENTE DISTINTA DE LA QUE VIMOS EN EL EJEMPLO ANTERIOR. AHORA ES LA CAPACIDAD DE ELEVACION LA QUE DETERMINA EL RITMO TOTAL DE DESCARGA EN LOS VEHICULOS DE CARRETERA. SOLO SE PODRA ACELERAR EL RITMO DE DESCARGA EN SU CONJUNTO SI SE AUMENTA LA CAPACIDAD DE ELEVACION.

4. VARIACIONES A CORTO PLAZO DEL RITMO DE TRABAJO

EN EL CASO DE QUE LA SITUACION FUERA COMO EN LA FIGURA 5, EL BAJO RENDIMIENTO PODRIA OBEDECER A DOS RAZONES: O BIEN ES FALSO EL SUPUESTO DE QUE LA CUADRILLA SITUADA EN LA BODEGA PARA MANIPULAR LAS MERCANCIAS ES LO SUFICIENTEMENTE NUMEROSA QUIZAS LA CLASIFICACION SEGUN LAS MARCAS SE LLEVE A CABO EN LA BODEGA - Y AQUI RESIDE PRECISAMENTE EL PROBLEMA; O BIEN LA CAPACIDAD INTRINSECA DE LAS GRUAS, CARRETILLAS O REMOLQUES SE VE DISMINUIDA POR LAS VARIACIONES A CORTO PLAZO EN EL RITMO DE TRABAJO POR LOS TIEMPOS MUERTOS.

LAS VARIACIONES A CORTO PLAZO DEL RITMO DE TRABAJO PUEDEN SER ENORMES. EL RITMO DE DESCARGA DE LA CARGA GENERAL DE UNA BODEGA PUEDE VARIAR DE 4 A 40 TONELADAS POR HORA Y DEPENDE DE UNA MULTITUD DE FACTORES TALES COMO LA NATURALEZA DE LAS MERCANCIAS, LA CLASE DE BUQUE, EL TIPO DE INSTALACIONES DE DESCARGA, ETC. SEGUN SE DEMOSTRO ANTERIORMENTE, SI DURANTE UN PERIODO CORTO UNA GRUA CAPAZ DE MANIPULAR 30 TONELADAS POR HORA ALIMENTA UN CICLO DE TRASLACION CAPAZ DE MANEJAR SOLAMENTE 10 TONELADAS POR HORA, LAS MERCANCIAS PASARAN DE LA BODEGA DEL BUQUE A LA ZONA DE ALMACENAMIENTO A UN RITMO DE 10 TONELADAS POR HORA SOLAMENTE. PERO PUEDE OCURRIR QUE LAS MERCANCIAS SEAN MANIPULADAS DE MODO QUE SALGAN DE LA BODEGA A UN RITMO DE SOLAMENTE 10 TONELADAS POR HORA CUANDO EL CICLO DE TRASLACION PODRIA SER DE 30 TONELADAS POR HORA. TAMBIEN EN ESTE CASO LAS MERCANCIAS CIRCULARAN AL MENOR DE

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Figura 3: Capacidad combinada de descarga directa en vehículos de carretera

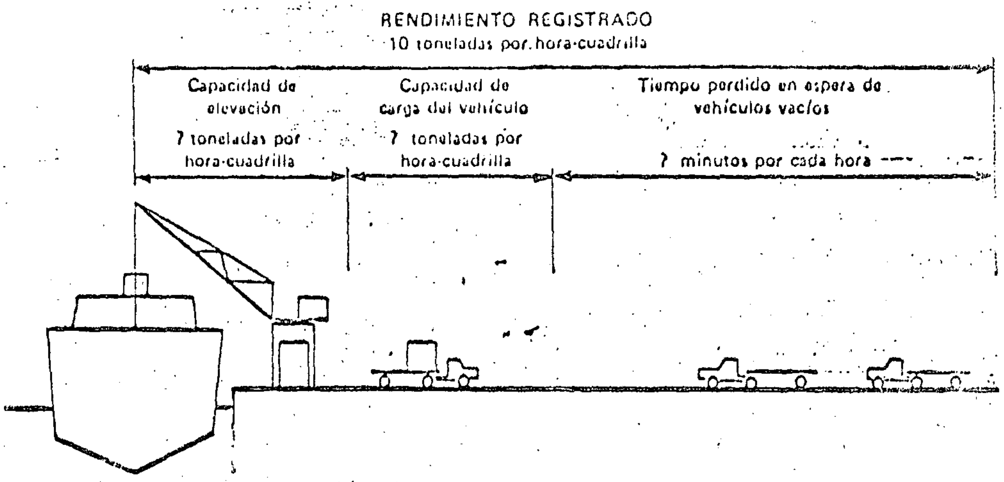


Figura 4:

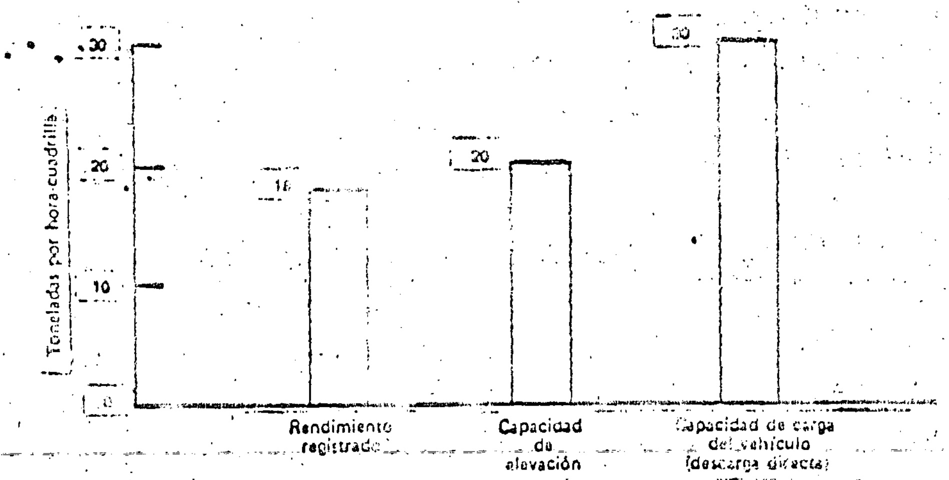
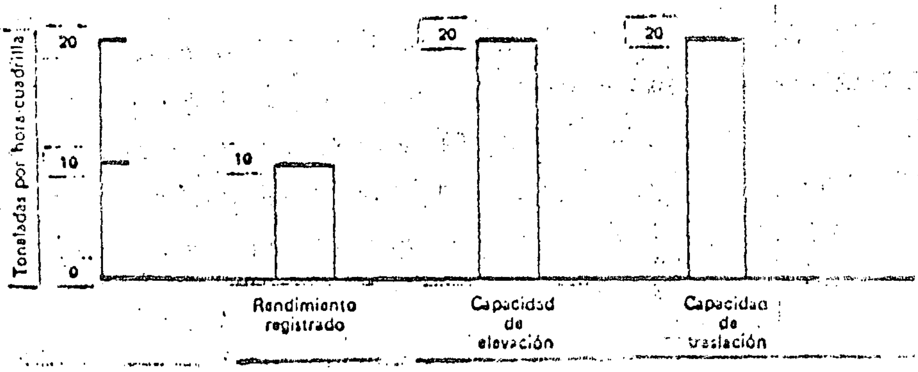


Figura 5:



LOS RITMOS CITADOS.

ESTE FENOMENO SIRVA PARA EXPLICAR LA SITUACION ILUSTRADA EN EL GRAFICO ANTERIOR, EN QUE EL RENDIMIENTO REGISTRADO PUEDE SER MUY INFERIOR TANTO A LA CAPACIDAD MEDIA DE ELEVACION COMO A LA CAPACIDAD MEDIA DE TRASLACION. LA CONSTITUCION DE RESERVAS REGULADORAS A CORTO PLAZO - COMO POR EJEMPLO, PERMITIR QUE TRES O CUATRO REMOLQUES CARGADOS PERMANEZCAN EN EL MUELLE Y EN LA ZONA DE ALMACENAMIENTO - PUEDE CONTRIBUIR A ATENUAR ESTAS VARIACIONES A CORTO PLAZO DE LOS RITMOS DE TRABAJO.

EL BAJO RENDIMIENTO REGISTRADO TAMBIEN PUEDE DEBERSE A LOS TIEMPOS MUERTOS. MUCHAS VECES, RESULTA DIFICIL DESCUBRIRLOS. NATURALMENTE, CUANTO MAYOR SEA EL TRAFICO EN EL PUERTO, TANTO MAS GRAVES PUEDEN SER LAS PERDIDAS DEBIDAS A LOS TIEMPOS MUERTOS.

UNA FORMA DE TIEMPO MUERTO ES LA QUE ~~SE DERIVA DE~~ LOS USOS QUE SE ESTABLECEN EN TODOS LOS TURNOS. MUCHOS PUERTOS AFIRMAN QUE TRABAJAN POR TURNOS DE OCHO HORAS, CUANDO EN REALIDAD PIERDEN POR LO MENOS DOS HORAS POR TURNO DEBIDO A LA LENTITUD DE LA PUESTA EN MARCHA. AL HECHO DE TERMINAR ANTES DE LA HORA, A LAS ESPERAS MOTIVADAS POR LAS GRUAS O LOS ENCARGADOS DE ANOTAR LAS MERCANCIAS, ETC. LA MAYOR PARTE DE ESTAS CAUSAS PUEDEN SER EVITADAS Y AUNQUE POSIBLEMENTE NO SEA FACIL CAMBIAR UNAS COSTUMBRES QUE HAN IDO ESTABLECIENDOSE LENTAMENTE Y CONTRIBUYEN A UNAS FAVORABLES CONDICIONES DE TRABAJO, LA ELIMINACION DE DICHAS PERDIDAS PODRIA PRODUCIR UN GRAN INCREMENTO EN LA PRODUCTIVIDAD EFECTIVA Y UNOS BENEFICIOS SUPERIORES A LOS QUE CABRIA ESPERAR DE CUANTIOSAS INVERSIONES O DE CAMBIOS IMPORTANTES EN LAS OPERACIONES.

OTRAS FORMAS DE TIEMPO MUERTO SON LAS CAUSADAS POR FALLOS GRAVES DE COORDINACION (MERCANCIAS DE EXPORTACION QUE NO LLEGAN CUANDO ESTABA PREVISTO, RETRASO EN EL ATRAQUE DE LOS BUQUES, ETC.), AVERIAS GRAVES EN EL MATERIAL, RETIRADA DE MANO DE OBRA O MALAS CONDICIONES ATMOSFERICAS. LAS TRES ULTIMAS CAUSAS QUEDAN FUERA

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DEL AMBITO DE ESTE INFORME, PERO LA PRIMERA - LA FALTA DE COORDINACION - NO.

5. CONTROL UNIFICADO DE LAS OPERACIONES

LA FALTA DE COORDINACION PUEDE SER EVITADA UNAS VECES POR MEDIO DE METODOS DE PLANIFICACION MAS ESTRICTOS, PERO LO QUE EN GENERAL TIENDE A AGRAVAR LA SITUACION ES LA AUSENCIA DE UN PLAN DE EMERGENCIA AL QUE SE PUEDA RECURRIR CUANDO LAS COSAS VAYAN MAL. PARA MODIFICAR UN PLAN EN EL ULTIMO MINUTO SON NECESARIAS TRES COSAS:

a) LA RAPIDA NOTIFICACION DE QUE ALGO NO FUNCIONA;

b) OTRAS LINEAS DE ACCION POSIBLES (LO QUE SIGNIFICA LA INCLUSION DE SOLUCIONES DE RESERVA EN EL PLAN);

c) UN RESPONSABLE SOBRE EL TERRENO PARA TOMAR LAS DECISIONES OPORTUNAS.

EN MUCHOS PUERTOS EL CONTROL DE LAS OPERACIONES SE DIVIDE ENTRE UNA EMPRESA DE MANIPULACION DE LA CARGA Y LA ADMINISTRACION DEL PUERTO. ESTO HACE QUE SEA EXTREMADAMENTE DIFICIL MEDIR Y CONTROLAR EL RENDIMIENTO. LA NECESIDAD DE ARMONIZAR LAS OPERACIONES DESDE LA BODEGA DEL BUQUE HASTA EL PUNTO DE ENTREGA O LA ZONA DE ALMACENAMIENTO ES UN SOLIDO ARGUMENTO EN FAVOR DEL CONTROL UNIFICADO. SI ELLO NO ES POSIBLE, LO MENOS QUE SE PUEDE PEDIR ES QUE LAS OPERACIONES ESTEN COORDINADAS, TANTO EN SU PLANIFICACION DIARIA COMO EN LA FLEXIBILIDAD HORARIA.

EL FUNCIONAMIENTO DE UN GRUPO DE PUESTOS DE ATRAQUE DE CARGA GENERAL, INCLUSO SI ES REDUCIDO, ES LO BASTANTE COMPLEJO COMO PARA EXIGIR LA PRESENCIA CONSTANTE DE UN COORDINADOR QUE NO SOLO PARTICIPE EN LA PLANIFICACION DIARIA DE LAS OPERACIONES PORTUARIAS, --- SINO QUE PERMANEZCA TAMBIEN EN EL MUELLE PARA SUPERVISAR LA EJECUCION DEL PLAN Y ADOPTAR DECISIONES EN EL ACTO PARA INTRODUCIR CAMBIOS CUANDO LOS CONSIDERE NECESARIOS. EL EJEMPLO SIGUIENTE INDICA EL TIPO DE SITUACION QUE REQUIERE LA ADOPCION DE TALES DECISIONES.

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- SUPONGAMOS QUE DURANTE LA PARTE INICIAL DE UN TURNO LAS MERCANCIAS SE DESCARGAN DE UNA ESCOTILLA A UN RITMO DE 20 TONELADAS POR HORA, Y QUE DICHAS MERCANCIAS SON TRASLADADAS AL TINGLADO A UN RITMO EQUIVALENTE. ASI, PUES, EL RENDIMIENTO REGISTRADO ENTRE LA BODEGA DEL BUQUE Y EL TINGLADO ES DE 20 TONELADAS POR HORA.

AL CABO DE UNA HORA APROXIMADAMENTE, CAMBIA LA NATURALEZA DE LAS MERCANCIAS Y ELLO HACE NECESARIO SU TRASLADO A UN TINGLADO DISTINTO Y MUCHO MAS ALEJADO. DEBIDO A LA MAYOR DISTANCIA, LA CAPACIDAD INTRINSECA DEL CICLO DE TRASLACION SE REDUCE A 10 TONELADAS POR HORA, POR EJEMPLO. TAL COMO SE INDICO ANTERIORMENTE, DADO QUE LAS CAPACIDADES INTRINSECAS DE LA GRUA Y DEL SISTEMA DE TRASLACION YA NO COINCIDEN, EL EFECTO NETO SERA UNA REDUCCION DEL RENDIMIENTO GLOBAL DE LA OPERACION DE DESCARGA A 10 TONELADAS POR HORA.

MAS TARDE, EN EL MISMO TURNO, VUELVE A CAMBIAR LA NATURALEZA DE LAS MERCANCIAS Y ESTAS RESULTAN MUCHO MAS DIFICILES DE ALCANZAR EN LA BODEGA DEL BUQUE. POR LO TANTO, LA CUADRILLA DE A BORDO NECESITA MAS TIEMPO PARA REUNIR LAS ESLINGADAS, DE MODO QUE LA CAPACIDAD INTRINSECA DE LA OPERACION DE DESCARGA QUEDA REDUCIDA A 10 TONELADAS POR HORA, POR EJEMPLO. PERO ELLO COINCIDE CON UN RETORNO A LA OPERACION DE TRASLACION DEL PRINCIPIO DEL TURNO, QUE TENIA UNA CAPACIDAD INTRINSECA DE 20 TONELADAS POR HORA. NO OBSTANTE, TAMBIEN EN ESTE PERIODO EL RENDIMIENTO GLOBAL SE LIMITARA A 10 TONELADAS POR HORA, AUNQUE ESTA VEZ LA RESPONSABLE SERA UNA OPERACION DISTINTA, LA OPERACION DE DESCARGA.

EN MUCHOS PUERTOS QUE FUNCIONAN CON CUADRILLAS DE DIMENSION FIJA Y QUE APLICAN REGLAMENTOS RIGIDOS CON RESPECTO A LA ASIGNACION DE MATERIAL A LAS CUADRILLAS, LA SITUACION DESCRITA ANTERIORMENTE LLEVARIA A UN RENDIMIENTO REGISTRADO MEDIO PARA LA TOTALIDAD DEL TURNO SOLO LIGERAMENTE SUPERIOR A 10 TONELADAS POR HORA-CUADRILLA. EN CAMBIO, DE HABER EXISTIDO UN COORDINADOR CON AUTO

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RIDAD PARA REALIZAR LOS AJUSTES NECESARIOS A BORDO DEL BUQUE, EN EL MUELLE Y EN LOS TINGLADOS, ES EVIDENTE QUE SE HUBIERAN PODIDO TOMAR MEDIDAS PARA CONSEGUIR UN MAYOR RENDIMIENTO GLOBAL.

DURANTE EL PERIODO EN QUE ERA MAYOR LA DISTANCIA DE TRASLACION SE HUBIERA PODIDO DISPONER DE MAS EQUIPO, UTILIZANDO QUIZAS UNA CARRETILLA ELEVADORA Y UNA CUADRILLA CUYA CAPACIDAD DE TRASLACION FUESE EN AQUEL MOMENTO SUPERIOR A LA ADECUADA. TAMBIEN SE HUBIERA PODIDO DEJAR QUE LA CARGA SE ACUMULARA MOMENTANEAMENTE EN EL MUELLE, ESPECIALMENTE SI EL COORDINADOR HUBIESE PODIDO PREVER LA SITUACION QUE SURGIRIA POSTERIORMENTE. LA MAYOR LENTITUD DE LA OPERACION DE DESCARGA PODRIA HABERSE EVITADO AUMENTADO LA DIMENSION DE LA CUADRILLA DE DESCARGA; EN REALIDAD, EL TRASLADO DE MANO DE OBRA ENTRE EL BUQUE Y EL MUELLE OFRECE UNOS DE LOS PROCEDIMIENTOS MAS SENCILLOS PARA REDUCIR EL DESEQUILIBRIO ENTRE LAS OPERACIONES DE DESCARGA Y DE TRASLACION.

HUELGA DECIR QUE HUBIERAN PODIDO TOMARSE MUCHAS OTRAS MEDIDAS PARA ALIVIAR ESTA SITUACION, PERO TODAS ELLAS EXIGEN LA PRESENCIA DE UN COORDINADOR CON LA AUTORIDAD APROPIADA. SOLO CON ESTA COORDINACION DEL CONJUNTO DE LAS OPERACIONES SE PODRA CONSEGUIR HORA POR HORA EL AJUSTE DE LOS RITMOS DE TRABAJO QUE ES TAN NECESARIO PARA ELEVAR LA PRODUCTIVIDAD Y EVITAR EL DESPILFARRO DE RECURSOS.

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SISTEMAS MARITIMOS Y PORTUARIOS

ADMINISTRACION Y OPERACION PORTUARIA (COMPLEMENTO)

Ing. Jaime Jaramillo Vázquez

marzo, 1979

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I. PROBLEMATICA ADMINISTRATIVA Y OPERACIONAL EN LOS PUERTOS NACIONALES

1. ANTECEDENTES.

a) Concepto de operación y administración portuarias.

El objeto de la presente plática es dar a conocer en términos muy generales, debido a limitaciones de tiempo, la organización y funcionamiento de nuestro sistema marítimo portuario, pero antes de ello, para aclarar y unificar criterios en este sentido, definiremos lo que es Operación y Administración Portuarias.

Entendemos como operación portuaria el conjunto de actividades tendientes a lograr el correcto desarrollo de las funciones naturales de un puerto.

De esta difinición se desprende la pregunta ¿cuáles son las funciones naturales de un puerto? La primordial función de un puerto comercial es manejar carga con el objeto de transferirla entre los diferentes medios de transporte que la llevarán a su destino final, al consumidor final. Existen numerosas combinaciones entre los diversos medios de transporte que pueden darse en un puerto comercial marítimo. Así por ejemplo tenemos que en éste pueden confluír carreteras, ferrocarriles, navegación fluvial e incluso transporte aéreo, de tal manera que un puerto marítimo es de hecho un centro de transporte, un enlace de los varios modos de transportación.

La función primordial de manejo de carga trae consecuentemente las otras funciones naturales del puerto que comprenden desde el almacenamiento de las mercancías hasta los servicios auxiliares a los buques y a la navegación.

Hasta aquí se ha tratado de establecer una visión panorámica de lo que es la operación portuaria para ahora definir el concepto de administración portuaria, viéndolo desde un punto de vista un poco simplista para no caer en disertaciones sobre la naturaleza de la administración.

La administración portuaria es la búsqueda de la máxima eficiencia en la operación de los puertos a través de la aplicación de los principios administrativos a las actividades particulares desarrolladas en un puerto con el fin de asegurar su eficiente operacionalidad.

Dado lo anterior, las funciones a desarrollar por la administración portuaria son las que señala como fundamentales la teoría administrativa general, es decir Previsión, Planeación, Organización, Integración, Dirección y Control.

b) El Sistema Portuario Nacional.

El régimen administrativo de los puertos nacionales tiene su fundamento en disposiciones legales ya que dentro de la administración pública toda organización debe establecerse con base a leyes, decretos, acuerdos y disposiciones diversas que determinen y regulen el marco de competencia y las atribuciones de los organismos ejecutivos responsables de los negocios públicos.

Mencionaré a continuación las principales disposiciones legales que regulan la administración de nuestro Sector Marítimo Portuario.

La Constitución Política de los Estados Unidos Mexicanos que en su artículo 27 establece la propiedad de la Nación sobre las aguas de los mares territoriales y el dominio directo de todos los recursos naturales de la plataforma continental.

Así mismo los artículos 42 y 48 Constitucionales determinan como parte integrante del Territorio Nacional y de la Federación las aguas de los mares territoriales, las marítimas interiores, islas, cayos y arrecifes, riberas, etc.

De lo anterior se infiere que la Federación es la responsable de ejercer la administración en materia marítima; sin embargo además de los artículos constitucionales mencionados, es necesario que existan leyes específicas que regulen las relaciones que se desprenden en el ejercicio de las actividades marítimas y portuarias y que delimiten las áreas de competencia de las dependencias oficiales que intervienen. A estas leyes podemos denominarlas leyes ordinarias que a su vez se dividen en leyes substantivas, competenciales y reglamentarias.

Las leyes substantivas son aquellas que establecen las disposiciones básicas y fundamentales para lograr armonía en la materia entre las actividades que desarrollan los sectores público, privado y obrero. Como principal fuente de derecho en este aspecto debemos mencionar a la Ley de Navegación y Comercio Marítimos y como supletoria de ésta a la Ley de Vías Generales de Comunicación en sus partes relativas.

Las Leyes Competenciales son aquellas que establecen la división de funciones y atribuciones entre las dependencias del Ejecutivo Federal para determinar la esfera de competencia de cada una de ellas en los negocios públicos. Básicamente tenemos entre éstas la Ley Orgánica de la Administración Pública Federal siendo de especial interés para nuestra materia el artículo 36 fracciones XIV a la XXIII en el cual se atribuye a la Secretaría de Comunicaciones y Transportes la competencia de los asuntos relativos a puertos, marina mercante e infraestructura marítima portuaria.

Refiriéndonos a las normas reglamentarias las más importantes en lo que se refiere a la administración portuaria son:

Reglamento Interior de la Secretaría de Comunicaciones y Transportes, que marca la división de funciones para las diversas dependencias de este organismo que intervienen en la actividad marítimo-portuaria.

Reglamento de Operación en los Puertos de Administración Estatal que señala los lineamientos y procedimientos en que deben desarrollarse las actividades en los puertos.

c) Organismos que intervienen en la Administración de los Puertos.

La Ley de Navegación y Comercio Marítimos en su capítulo II sección A, artículo 44 "sobre los puertos" establece en su segundo párrafo: "Por su régimen de funcionamiento, los puertos pueden ser de administración estatal o de administración descentralizada en los términos y con las limitaciones que establece esta Ley":

En la actualidad nuestro País cuenta con el siguiente número de puertos habilitados: 31 de altura, cabotaje y pesca; 17 de cabotaje y pesca y 8 para tráficos específicos, todos ellos bajo el régimen de administración estatal por lo que, el Gobierno Federal es el encargado de administrar y operar los puertos propiedad de la Nación a través de la Secretaría de Comunicaciones y Transportes; para tal efecto dependiendo de ésta fué creada la Subscretaría de Puertos y Marina Mercante para la atención exclusiva de todos los asuntos de la navegación y de los puertos, la cual dentro de su estructura orgánica engloba cinco Direcciones Generales que son: Operación Portuaria, Marina Mercante, Obras Marítimas, Dragado y Señalamiento Marítimo; las dos primeras con una intervención administrativa directa y las otras con intervención de tipo técnico.

Además de los organismos ya mencionados, se cuenta también con la participación directa de otras entidades en la administración portuaria producto de la creciente preocupación que el Gobierno Federal ha tenido en esta materia; las entidades a que nos referimos son:

- Empresas de Servicios Portuarios.
- Fondo Nacional para los Desarrollos Portuarios.
- Fideicomiso para la compra de Equipo Marítimo y Portuario.
- Comisión Nacional Coordinadora de Puertos.

A continuación daremos una breve descripción de cada uno de los organismos mencionados.

DIRECCION GENERAL DE OPERACION PORTUARIA.

Sus objetivos generales comprenden la eficiente operación de las instalaciones portuarias de uso público, la aplicación de los sistemas de operación más adecuados a las características de cada uno de los puertos; la conservación y mantenimiento de los puertos; la regulación del tráfico marítimo y la prestación y/o supervisión de los servicios portuarios auxiliares y conexos.

Para efectos de lo anterior la Dirección se encuentra estructurada a nivel Central en cinco departamentos: Operaciones, Mantenimiento de Instalaciones, Planeación, Estadística y Administrativo.

Para desarrollar sus funciones en los puertos se crearon Superintendencias de Operación Portuaria las cuales están diseñadas orgánicamente de tal for cuentan con Superintendencias en unos casos; delegaciones en otros y encargados de faros en algunos más.

EMPRESAS DE SERVICIOS PORTUARIOS.

Estas Empresas fueron creadas por la necesidad de contar con entidades con personalidad jurídica propia que para la prestación de servicios públicos de maniobras en zonas bajo jurisdicción Federal; servicios marítimos portuarios y servicios conexos y auxiliares a las vías de comunicación por agua; tuvieran la capacidad de afrontar todas las responsabilidades legales frente a los trabajadores portuarios mediante contratos colectivos de trabajo y que por otra parte inspiraran suficiente confianza a los usuarios de que dispondrían de un eficiente servicio para el manejo de sus mercancías garantizado por la solvencia de las Empresas.

Están constituídas como sociedades anónimas de capital variable y lógicamente sujetas a las disposiciones contenidas en la Ley de Sociedades Mercantiles.

Su patrimonio está constituído por un 51% de aportaciones del Gobierno Federal y un 49% por aportaciones de particulares (usuarios, trabajadores, inversionistas, etc.).

FONDO NACIONAL PARA LOS DESARROLLO PORTUARIOS.

Es un fideicomiso cuyo objetivo fundamental es, entre otros, la realización de estudios orientados a determinar la conveniencia de establecer nuevos polos de desarrollo que abarquen la instalación de nuevos recintos portuarios y paralelamente a ellos, en ma que cuenta con las unidades de Trabajo necesarias para cumplir con los objetivos previstos por la Dirección General.

DIRECCION GENERAL DE MARINA MERCANTE.

Su propósito es atender los asuntos relacionados con la navegación y la marina mercante debiendo controlar los requisitos técnicos y legales de las embarcaciones, el personal de la marina mercante; las agencias navieras, etc. Para el ejercicio de sus funciones en los puertos cuenta con Capitanías de Puerto.

DIRECCION GENERAL DE OBRAS MARITIMAS.

Su misión consiste en construír, reconstruír, conservar y modificar las obras marítimas y portuarias. En los puertos donde exista alguna obra de esta naturaleza cuenta con Residencias de Obras.

DIRECCION GENERAL DE DRAGADO.

Como su nombre lo indica su función se limita ejecutar en los puertos los trabajos necesarios de dragado, tanto de construcción como de mantenimiento. Sus representaciones en los puertos son Superintendencias de Dragado.

DIRECCION GENERAL DE SEÑALAMIENTO MARITIMO.

Este organismo es el responsable de proporcionar seguridad a la navegación a través del señalamiento. Faros, balizas, boyas y mecanismos que indiquen peligros, rutas y orientación a la navegación, deben ser administrados por esta Dependencia. En los puertos su caso, los desarrollos turísticos, industriales y pesqueros que sean viables en función de las características del área. Está considerado dentro del sector paraestatal y funciona con fondos del Gobierno Federal e ingresos que percibe de acuerdo a las facultades que le otorga el decreto de su creación.

FIDEICOMISO PARA LA COMPRA DE EQUIPO MARITIMDO Y PORTUARIO.

Es también un fideicomiso creado para facilitar a las organizaciones de trabajadores y a las empresas de servicios portuarios la compra de maquinaria y equipo adecuado para el eficiente desarrollo de las actividades portuarias.

Este fideicomiso fué constituído por la Secretaría de Hacienda y Crédito Público en el año de 1971. y encomendada su operación a Nacional Financiera, S.A.

COMISION NACIONAL COORDINADORA DE PUERTOS.

Esta Dependencia perteneciente al sector Paraestatal fué creada para lograr en los puertos una efectiva coordinación entre las entidades involucradas en la administración y operaciones portuarias y que principalmente son usuarios, trabajadores y autoridades. Cuenta con Delegaciones Coordinadoras en los puertos que son los responsables de lograr esa coordinación a nivel local.

La coordinación que ésta dependencia debe lograr, es principalmente entre las siguientes entidades:

AUTORIDADES.

- Secretaría de Gobernación.- Encargada de los asuntos de migración.
- Secretaría de Comercio.- Responsable de los permisos de importación y exportación.
- Secretaría de Programación y Presupuesto.- Atiende el estudio y aprobación de las inversiones del Estado en Obras de Infraestructura Portuaria.
- Secretaría de Agricultura y Recursos Hidráulicos.- Controla lo referente al movimiento de especies vegetales y animales por los puertos.
- Secretaría de Salubridad y Asistencia.- Regula los aspectos sanitarios del movimiento marítimo.
- Departamento de Pesca.- Interviene en los asuntos referentes a la explotación de la actividad pesquera.
- Secretaría de Hacienda y Crédito Público.- Encargada de controlar la importación y exportación de mercancías asegurando el respectivo pago de derechos en favor de la Federación.

USUARIOS.

- Agentes Navieros.
- Armadores.
- Agentes Aduanales.
- Representantes en general.

TRABAJADORES.

- Empresas de Servicios.
- Sindicatos, Gremios y Uniones.

EL PUERTO COMO ENTIDAD FISICA.

Hemos ya hablado sobre la función primordial de los puertos que consiste en el manejo de carga y la transferencia de ésta entre los diversos modos de transporte, sin embargo para que ésto pueda realizarse eficientemente es necesario que se cumplan dos requisitos:

A) Que el puerto cuente con la infraestructura adecuada.
b) Que el puerto preste los servicios necesarios.

A). INFRAESTRUCTURA.

La moderna tecnología en el transporte marítimo exije cada día con mayor fuerza, que los puertos cuenten con instalaciones adecuadas propias para el arribo de buques que presentan diversas características.

En la actualidad ningún puerto presenta condiciones naturales que por sí mismas permitan un adecuado desarrollo de las actividades relacionadas con el transporte marítimo; por lo que el hombre se ha visto obligado a modificar, construír, cambiar y complementar las condiciones naturales de los lugares que se presentan adecuados para establecer puertos marítimos.

Todas estas acciones que el hombre emprende para adaptar las condiciones naturales a sus necesidades particulares se conoce con el nombre de creación de infraestructura. A continuación vamos a comentar brevemente los aspectos principales que deben considerarse dentro de la infraestructura portuaria y que son:

A.1. Elementos de acceso.

A.2. Elementos de protección.

A.3. Elementos de señalamiento.

A.4. Elementos de atraque, tráfico y almacenamiento.

A.5. Maquinaria y equipo.

A.1. Los elementos de acceso son aquellos que permiten la libre y segura navegación de los buques que utilizan el puerto. Se conocen con el nombre de canales de acceso o de navegación y pasos de entrada al puerto.

Los primeros son las rutas que, en las cercanías de los puertos, deben de tomar los buques para poder llegar a ellos (canales exteriores) y para transitar dentro (canales interiores) cruzando por los pasos de entrada. Generalmente las condiciones de anchura y profundidad de estos canales deben lograrse a base del dragado, especialmente cuando frecuentan el puerto buques de grandes dimensiones.

A.2. Los elementos de protección son aquellos que proporcionan seguridad a los buques y a las instalaciones portuarias, resguardándolos de la acción del viento, el oleaje, las corrientes y logrando aguas calmadas que permitan las operaciones dentro del puerto.

Se conocen con el nombre de diques de abrigo y los más usuales son los diques rompeolas o de escollera y los diques verticales; los primeros con el propósito de romper el oleaje y los segundos para reflejarlo.

A.3. Los elementos de señalamiento son aquellos que se emplean para dar seguridad a la navegación en las inmediaciones de las costas.

Para este fin se utilizan regularmente faros, boyas simples, boyas luminosas y balizas, éstas últimas no tienen homogeneidad en su presentación, pudiendo ser desde simples estacas pintadas e hincadas en el fondo hasta flotadores más elaborados.

A.4. Elementos de atraque, tráfico y almacenamiento.

Al referirnos a estos elementos vamos a hablar sobre las obras que darán a los buques y a los otros medios de transporte las facilidades para la transferencia de la carga.

Los muelles de atraque que son obras que ofrecen un paramento vertical de suficiente calado para que puedan atracar de costado los buques y una superficie horizontal de suficientes dimensiones para que pueda depositarse y manejarse la carga.

Las estaciones de clasificación o patios de estacionamiento donde se detienen los trenes o camiones y se realiza la transferencia de la carga y los almacenes cuyas características deben variar en relación a la carga que se maneje pudiendo ser desde bodegas para carga general hasta silos o almacenes refrigerados.

A.5. Maquinaria y equipo.

Aunque propiamente dicho éste no es un concepto -

que responda a la categoría clásica de infraestructura, es muy importante mencionarla en este capítulo ya que la eficiencia real en el manejo de la carga se ve afectada en gran parte por la existencia o nó de adecuada maquinaria y equipo.

En la actualidad se cuenta con una infinidad de inventos para el desarrollo de las actividades portuarias. Montacargas, trasvasadoras, plataformas, grúas de pórtico son elementos indispensables en la mayoría de los puertos. Es por ello que una adecuada planeación portuaria debe de contemplar como aspecto muy importante buenas inversiones en maquinaria y equipo.

B) Servicios que presta un puerto.

El segundo requisito que hemos mencionado para que un puerto sea eficiente es que preste servicios adecuados para el comercio marítimo. Sobre este aspecto clasificaremos los servicios con que debe contar un puerto en servicios básicos o primarios y servicios secundarios o de apoyo.

Los primeros son aquellos directamente relacionados con el manejo y movimiento de los buques y las mercancías. Comprenden el pilotaje, el remolque, las maniobras, almacenamiento y transporte, siendo los dos primeros conceptos servicios prestados directamente al buque y los últimos servicios para la carga.

Los servicios secundarios son aquellos cuyo objeto es proporcionar a la navegación y al comercio marítimos los elementos para permitir un cómodo y seguro desarrollo de sus operaciones. Comprenden los renglones de seguridad, reparaciones, servicios telefónicos y de fuerza electromotriz, abastecimiento de agua y avituallamiento en general.

II. TECNICAS MODERNAS PARA EL MANEJO DE CARGA EN LOS PUERTOS.

A) FLUJO DE LAS CARGAS.

Ya hemos visto que la función primordial de los puertos comerciales radica en el manejo de cargas; sin embargo el quid del asunto no radica simplemente en el movimiento de mercancías, sino que éste movimiento se realice cumpliendo tres requisitos: El manejo de grandes volúmenes de carga en el menor tiempo posible al mínimo costo y con la máxima seguridad.

El principal de estos tres requisitos es la obtención del mínimo costo, ya que el precio de los artículos para los consumidores finales se verá incrementado directamente por la estadía de las cargas y los buques que las transportan en el puerto, así como por los daños que sufran; y se verá disminuído en forma inversamente proporcional al volúmen que se maneje (a mayor volumen de carga menor costo).

El lograr la optimización de estos tres requisitos es la principal preocupación de la administración portuaria ya que para lograrlo se requiere establecer eficientes controles sobre todos los factores que afectan el manejo de la carga.

Así tenemos que el administrador portuario debe coordinar y establecer controles para los aspectos relativos a mano de obra (trabajadores portuarios), medios de transporte terrestres y fluvial, maquinaria y equipo, usuarios del puerto, autoridades y en general cualquier factor que administrativa u operacionalmente influya en el desarrollo de las actividades relativas al manejo de la carga.

Ahora bien, para que la carga salga del puerto, ya sea -- por mar, por río o por tierra, está sujeta a que su flujo se realice en tres diferentes formas; a éstas les llamaremos vía directa, vía semidirecta y vía indirecta. Esta - clasificación se establece en base al número de operaciones que sufre la carga y al tiempo de estadía de ella en puerto.

La vía directa consiste en la transferencia de la carga - realizada directamente de un medio de transporte a otro, - realizándose por ejemplo del buque al transporte carretero, del buque a la gabarra, etc. sin operación intermedia de depósito o espera de la carga.

En la vía semidirecta existe una operación intermedia en la que la carga es depositada en explanadas o tinglados de tránsitos en espera de que llegue el transporte que la sacará del puerto. La estadía de la carga en los tinglados no debe ser de mucho tiempo estimándose un promedio de 24 horas máximo.

La vía indirecta requiere de mayor número de operaciones y una estadía larga de las mercancías en el puerto. Consiste en la descarga de las mercancías, su translación hasta zonas de depósito o almacenamiento y las consecuentes operaciones que se suscitarán cuando llegue el transporte que las sacará del puerto.

Obviamente la vía más adecuada es la directa, sin embargo existen disposiciones legales y administrativas así como factores fuera del control de la autoridad portuaria que -

impiden que su aplicación pueda realizarse rutinariamente por lo que deben de utilizarse las otras dos vías.

B) TIPOS DE CARGA.

Las cargas para su manejo se clasifican en 4 tipos principales:

- Carga General
  - fraccionada
  - unitarizada
- Carga seca a granel
  - agrícolas
  - minerales
- Carga líquida a granel (fluídos)
- Carga perecedera.

Cada uno de estos tipos de carga requiere de diferentes métodos de trabajo, sin embargo la frecuencia con que se manejen las cargas en un puerto determinará la necesidad de establecer o nó instalaciones, mano de obra y equipo especializado para la recepción o embarque con lo cual se logra que los costos se reduzcan grandamente. La especialización puede referirse a maquinaria e instalaciones para manejo de granos (carga seca a granel) bodegas refrigeradas (para carga perecedera) equipo para manejo de carga general unitarizada y en general cualquier facilidad que permita cargar o descargar los buques en forma más rápida segura y a bajo costo o que permita manejar la mercancía sin que pierda cualidades.

Las modalidades que se establezcan en los puertos para el manejo de la carga, dependerán indudablemente tanto de las características de éstas como de las características del puerto en particular ya que a pesar de que existen métodos y procedimientos preestablecidos, éstos deben adecuarse a las necesidades específicas de cada caso.

C) <u>LA UNITARIZACION DE LA CARGA COMO FACTOR DE LOS TRANSPORTES.</u>

La unitarización de la carga es un concepto sumamente sencillo el término se refiere a los diversos métodos de reunir cierto número de bultos pequeños para manipularlos como una unidad de dimensiones normalizadas, mediante la utilización de equipo mecánico, o de embalar bultos grandes y difíciles de manejar y estibar en unidades de dimensiones normalizadas, que también puedan manipularse por medios mecánicos. Esta técnica tiene por objeto disminuír y simplificar las operaciones eliminando la manipulación de cargas fraccionadas y reduciendo así los gastos generales de transporte. La carga unitarizada se maneja mecánicamente, lo que reduce la mano de obra necesaria y acelera las operaciones de manipulación.

La utilización de contenedores (containers), si bien es la -

técnica más conocida no constituye en modo alguno el único método de unitarización de la carga y de eliminación del manejo de carga fraccionada. En la actualidad los métodos más difundidos son los siguientes:

- Preslingado de la carga;
- Paletización;
- Utilización de buques de autotransbordo de vehículos, remolques y contenedores (roll-on/roll-off);
- Contenerización;
- Utilización de buques portagabarras.

Cada uno de estos métodos exige buques de características diferentes. Las gabarras sólo pueden embarcarse en buques de diseño especial. El transporte de paletas y contenedores resulta más económico si se efectúa en barcos especialmente construídos para su transporte, si bien es posible cargarlos en buques de carga fraccionada. En particular, es fácil colocar paletas en buques de tipo corriente. Para el autotransbordo se requieren buques ideados para que los vehículos puedan entrar y salir por sus propios medios o remolcados; pero ese tipo de buques puede tener también dispositivos específicos para el transporte de paletas y contenedores, y en tal caso se trata de un buque mixto o -

para usos múltiples. Los cargamentos previamente eslingados no necesitan buques especiales y pueden colocarse en barcos convencionales. Para embarcar cargamentos paletizados en buques de tipo convencional es muy conveniente, desde el punto de vista económico, que las operaciones se efectúen por los portalones y se puedan emplear carretillas de horquilla elevadora en las bodegas.

EL TRANSPORTE MARITIMO Y SUS IMPLICACIONES EN LOS PUERTOS.

La evolución tecnológica en el Transporte Marítimo, no solamente ha confrontado a los armadores, a compañías navieras y a Ingenieros Navales, con nuevas dimensiones de buques, sino también a las Autoridades Portuarias; muchos puertos necesitaron y necesitan de grandes inversiones para ser capaces de enfrentarse a esta evolución tecnológica y a la creciente competencia entre los puertos mismos.

Los cambios básicos en la Tecnología del Transporte Marítimo pueden ser sumarizados bajo tres encabezados:- Incremento en las dimensiones de los buques; -Especialización de los barcos; y -Unitarización de las cargas.

La tendencia hacia dimensiones más grandes de barcos es relevante para buques-tanque, graneleros, e incluso barcos de línea regular.

La especialización de los buques refleja los esfuerzos que se están haciendo para agilizar el tiempo de estadía de barcos de línea en los puertos, y reducir los costos de cargar y descargar dichos barcos transportando cargamentos heterogéneos.

El objetivo es establecer una cadena de transportación, donde el embarque viaje sin que se efectúe una re-manipulación o realmacenamiento, desde el punto de origen hasta su destino final (Movimiento puerta-a-puerta). Términos tales como tarimas, palets, contenedores, barcazas, gabarras, sistema de carga unitarizada, roll-on/roll-off, Lift-on/lift-off y Lash o Seabee, caracterizan los esfuerzos múltiples de porteadores, armadores, navieros e Ingenieros Industriales y Navales, para racionalizar el manejo de carga general, de manera de lograr reducciones en el costo del transporte marítimo.

En respuesta a la introducción de buques especializados, se presenta la necesidad de instalar facilidades especializadas o convertir y adaptar instalaciones convencionales, lo que se ha hecho en casi todos los principales puertos del mundo.

Las nuevas tendencias no solamente afectan la técnica de manejos de carga, también afecta actitudes der la Sociedad hacía la clase trabajadora. Las tendencias en el trabajo portuario durante el último par de décadas han tenido un propósito principal --- la sustitución de unos pocos dtrabajadores portuarios manejando sofisticada maquinaria, en lugar de varias cuadrillas de estibadores con equipo manual.

Vistos pues estos procesos y tendencias, es mi opinión que, un puerto ya no es más un mero lugar de tránsito ni un simple eslabón de la cadena del transporte;.sino un polo alrededor del cual la economía tiene que crecer y puede crecer. Los puertos son medios del desarrollo económico nacional.

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SISTEMAS MARITIMOS Y PORTUARIOS

INSTALACIONES PESQUERAS

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INSTALACIONES PESQUERAS

EN GENERAL, REALIZAR OBRAS MARITIMAS Y CONSTRUIR O ADAPTAR PUERTOS PESQUEROS, ES ACTIVIDAD TAN ANTIGUA COMO LA APARICION DEL HOMBRE EN SU VIVIR SOCIAL Y POLITICO DENTRO DEL INEVITABLE PROCESO ECONOMICO. EMPERO, NO SE EXPLORA FACILMENTE EL VASTO PANORAMA QUE LA PESCA OFRECE Y QUE DA LUGAR AL TEMA QUE TRATARE DE DESARROLLAR.

HOY, A TRAVES DEL PLAN NACIONAL DE DESARROLLO PESQUERO, APENAS NOS ASOMAMOS AL PROBLEMA Y POR ELLO, ROGANDOLES PERDONEN QUE USE DE SU TIEMPO Y PACIENCIA, CREO CONVENIENTE PARA ACCEDER A LA COMPRENSION Y AL CONOCIMIENTO, VOLVER LOS OJOS A LOS ANTECEDENTES QUE EXPLICAN LOS PORQUÉS DE NUESTRO PRESENTE Y PUEDEN MOVERNOS HACIA LO FUTURO.

EN LA EPOCA PREHISPANICA, NUESTRAS DIFERENTES RAZAS, TRIBUS E IMPERIOS, INCLUYENDO EL AZTECA, DESTINABAN A LOS PROBLADORES A LAS ACTIVIDADES AGRICOLAS, MINERAS, ARTESANALES Y COMERCIALES, PARA MANTENER VIGOROSOS LOS IMPERIOS MILITARES DONDE PREDOMINABA LA NOBLEZA EN LAS CASTAS SACERDOTAL Y MILITAR QUE COMPARTIA EL TIEMPO DE ENTRENAMIENTO PARA LA GUERRA CON LA CAZA Y LA CULTURA, PRIVILEGIOS DEL ESTADIO. LOS POBLADORES RIBEREÑOS PESCABAN EN PEQUEÑA ESCALA PARA ALIMENTARSE; EN EL INTERIOR SE ENCUENTRAN ANTECEDENTES PESQUEROS EN LAGOS Y LAGUNAS DEL ALTIPLANO; PATZCUARO, CHAPALA, XOCHIMILCO Y ALGUNOS RIOS, DE DONDE EL PRODUCTO SE DESTINABA A LA ATENCION DE NECESIDADES DE GRANDES JEFES, NOBLES, SACERDOTES, REYES Y EMPERADORES; EL COMERCIO POPULAR ERA CASI NULO.

LA CONQUISTA Y LA COLONIA SIGUIERON TAL PROCEDER EN LA PESCA. LA ACTIVIDAD AGROPECUARIA FUE RECURSO EXTREMO, "MAL NECESARIO" OBLIGADO PARA SUBVENIR A NECESIDADES Y EXIGENCIAS DE LOS CONQUISTADORES Y DEL PUEBLO INDIGENA, A EFECTO DE MANTENER LA VIDA Y LA CAPACIDAD DE EXPLOTAR RECURSOS MINEROS EN BENEFICIO DE ESPAÑA.

LA INDEPENDENCIA NO SE APARTO DE LA LINEA. LA REFORMA Y LA DICTADURA APENAS SE ASOMARON AL PROBLEMA. TRAS LA REVOLUCION, ALGUNOS ARMADORES INICIARON LA ACTIVIDAD, DESPERTANDO LA CONCIENCIA DE UN ESCASO NUMERO DE PESCADORES. AVANZADO EL PROCESO, UN GRUPO LIMITADO CON AFANES DE JUSTICIA SOCIAL RECURRIO AL GOBIERNO FEDERAL EN DEMANDA DE APOYO Y COMPRENSION. EL GOBIERNO RECONOCIO EL OLVIDO Y EL DESCONOCIMIENTO DE LAS NECESIDADES DEL SECTOR, REALIZANDOSE ASI EL PRIMER INTENTO POR CONOCER Y ATENDER LA ACTIVIDAD PESQUERA.

HOY CONFRONTAMOS QUE LOS HABITANTES DE LAS ZONAS RIBEREÑAS SE UNEN AL GOBIERNO POR ESA MISMA CONCIENCIA EN DESARROLLO, POR EL MEJOR CONOCIMIENTO DE LA GEOGRAFIA Y, POR LOS DETERMINISMOS SOCIOECONOMICOS Y POLITICOS. ESTO HACE AVIZORABLE QUE LAS DEMANDAS PLANTEADAS A TRAVES DEL TIEMPO, SI SE COMPRENDE EL PROBLEMA PESQUERO EN SU VERDAD MARITIMA, SE LLEVEN ADELANTE LOS ESFUERZOS Y SE ALCANCEN LAS METAS FIJADAS EN EL PLAN NACIONAL DE DESARROLLO PESQUERO POR MEDIO DE UN ORDENADO Y BIEN DELINEADO CONCEPTO DE LO EXIGIBLE. COMPRENDEMOS QUE EN LA SITUACION, LOS TIEMPOS SON DIFICILES Y QUE NO SIENDO EL PETROLEO UN FETICHE, EL PAIS HACENDARIAMENTE RECURRE A MAYOR SOBRIEDAD Y AUSTERIDAD. ELLO ES VERDAD; PERO CONTRA LO QUE COMUNMENTE SE SUPONE, EN LAS CONVENCIONES DE ECONOMISTAS E INGENIEROS, MANIFESTANDO QUE LAS OBRAS MARITIMAS Y PORTUARIAS PESQUERAS SON NATURALMENTE COSTOSAS Y REQUIEREN INVERSIONES GIGANTESCAS. PERO ELLO NO SE AJUSTA A LA REALIDAD. SON OBRAS DE SUYO AUTOFINANCIABLES PRODUCTIVAS DESDE SU INICIO Y ORIGINADORAS DE INNUMERABLES ACTIVIDADES ECONOMICAS QUE MULTIPLICAN LAS FUENTES DE TRABAJO Y FINALMENTE ACRECENTAN EL AHORRO.

AL EFECTO, TRATAMOS DE UTILIZAR AL MAXIMO LAS INSTALACIONES - EXISTENTES; CONSTRUIMOS LAS NECESARIAS PARA INTEGRAR COMPLEJOS DE DESARROLLO ECONOMICO Y DAMOS PREFERENCIA JERARQUICA A LAS INVERSIONES QUE PRONTAMENTE REDITUAN Y QUE AL MENOR PLAZO - INCORPORAN A LA ECONOMIA GENERAL RECURSOS RENOVABLES DE PROBADA POTENCIALIDAD. PERO ENTRANDO AL TEMA, VEAMOS :

I.- LA PESCA ES UNA ACTIVIDAD Y NO SOLAMENTE UN TERMINO EN LA ECONOMIA MARITIMA; A ESTA ACTIVIDAD CONCURREN ELEMENTOS Y FACTORES QUE SUMADOS DAN LUGAR AL LLAMADO TRAFICO PESQUERO, PERO PREVIAMENTE LA ACTIVIDAD SUPONE INTEGRACION EN LOS SECTORES, ZONAS O REGIONES EN QUE SE REALIZA, LIGANDO ENTRE SI MEDIOS, RECURSOS Y PERSONAS CON LO CUAL, , SE PRODUCE DESARROLLO INDIVIDUAL FAMILIAR Y SOCIAL, ESTABLECIENDO TAMBIEN LOS FUNDAMENTOS Y PROCESOS DE LOS DESENVOLVIMIENTOS ECONOMICO Y POLITICO.

II.-EL TRAFICO PESQUERO ES ACTIVIDAD DERIVADA QUE SE MANIFIESTA TANTO EN LAS AGUAS CONTINENTALES, PRESAS, LAGOS, LAGUNAS, EMBALSES, - ETC., A TRAVES DE LA PISCICULTURA COMO DE LA ACUACULTURA, DANDO LUGAR AL ABASTECIMIENTO DE LA LOCALIDAD, DE LAS ZONAS DEFICITARIAS Y AL COMERCIO INTERIOR; AL REALIZARSE EN LAS AGUAS PROTEGIDAS A LO LARGO DE LOS LITORALES EN LOS ESTEROS, ALBUFERAS Y LAGUNAS, ASI COMO EN LAS AGUAS MARINAS DE BAJURA, MEDIAS O DE ALTURA, DA LUGAR AL COMERCIO INTERIOR, A LAS DIVERSAS ETAPAS DE LA INDUSTRIALIZACION, AL ABASTECIMIENTO DE LAS ZONAS INTERIORES DEFICITARIAS Y AL

COMERCIO EXTERIOR QUE SUPONE INGRESO DE DIVISAS.

PARA QUE LAS ACTIVIDADES PESQUERAS SE REALICEN, CONCURREN COMO ELEMENTOS BASICOS Y POR SUPUESTO, TRAS POLITICAS SENSATAS:

III.- LOS RECURSOS NATURALES, ES DECIR, FAUNA Y FLORA; LOS RECURSOS HUMANOS, ES DECIR, PESCADORES, MARINEROS, MAQUINISTAS, INDUSTRIALIZADORES, ETC.; LOS RECURSOS MATERIALES A LOS QUE CORRESPONDEN LAS OBRAS DE INFRAESTRUCTURA COMO INSTALACIONES, SERVICIOS, VIALIDAD, TRANSPORTES, COMUNICACIONES, INDUSTRIAS, COMERCIALIZACION, ETC., ASIMISMO, A LOS RECURSOS MATERIALES CORRESPONDEN LOS FINANCIEROS COMO CAPITALES, CREDITOS, FINANCIAMIENTOS, SUBSIDIOS, ETC., Y TAMBIEN LOS BUQUES Y LAS ARTES.

IV.- DE LA MISMA SUERTE, EN LAS ACTIVIDADES PESQUERAS INTERVIENEN DIVERSOS FACTORES QUE SON PRINCIPALMENTE: EL PESCADOR EN TODA LA EXTENSION DEL TERMINO, EL BIOLOGO, EL OCEANOLOGO, EL TECNOLOGO EL INTERMEDIARIO OFICIAL, EL INTERMEDIARIO PRIVADO, EL INDUSTRIALIZADOR, LOS DISTRIBUIDORES DE MAYOREO Y MENUDEO, Y POR ULTIMO, EL CONSUMIDOR.

TODOS ELLOS SON IMPORTANTES, PERO CABE REFLEXIONAR EN QUE LOS EXTREMOS, ES DECIR, EL PESCADOR Y EL CONSUMIDOR EN NUESTRO MEDIO, TODAVIA SE ENCUENTRAN DESPROTEGIDOS. EL BIOLOGO, EL OCEANOLOGO Y EL TECNOLOGO, NORMALMENTE PROCEDEN DE LAS DEPENDENCIAS FEDERALES Y EL GOBIERNO DE LA REPUBLICA LES AMPARA. EL RESTO,

SON PROTEGIDOS POR LAS DEPENDENCIAS PARAESTATALES O POR SI MISMOS. EL PLAN NACIONAL DE DESARROLLO PESQUERO CONTEMPLA ESTA REALIDAD Y DA PREFERENCIA AL PESCADOR Y AL CONSUMIDOR. NO RECHAZA LA EXISTENCIA Y CONVENIENCIA DE LOS INTERMEDIARIOS Y DISTRIBUIDORES, SON NECESARIOS, PERO BASICAMENTE, "ES EL PESCADOR EL QUE CAPTURA" EN TAN COMPLEJA ACTIVIDAD PUEDEN HACERSE MUCHOS ESTUDIOS BIOLOGICOS, OCEANOGRAFICOS, TECNICOS, ETC., Y TAMBIEN EXISTIR LOS DEMAS FACTORES COMPONENTES; PERO ES SOLO EL PESCADOR QUIEN CAPTURA EL PRODUCTO Y SOLAMENTE EL CONSUMIDOR QUIEN LO ADQUIERE Y PAGA POR EL, SIN EMBARGO, EN ESTA ACTIVIDAD UNO Y OTRO NO HAN GOZADO DE LA ATENCION QUE REQUIEREN.

EL PLAN NACIONAL DE DESARROLLO PESQUERO CONTEMPLA COMO PRIMER PASO DE LA POLITICA PESQUERA, EL ESTABLECIMIENTO DE COMPLEJOS PESQUEROS DOTADOS DE LOS ELEMENTOS MATERIALES QUE POSIBILITEN LOS DESARROLLOS DE LAS ZONAS O REGIONES A QUE SIRVEN JERARQUIZANDO LA INFRAESTRUCTURA EN EL ORDEN SIGUIENTE :

1. OBRAS PARA EL MEJORAMIENTO BIOECOLOGICO
2. OBRAS PARA PREVENIR Y CONTROLAR LA CONTAMINACION.
3. LABORATORIOS DE INVESTIGACIONES
4. ESTRUCTURAS DE CONTROL DE NIVELES
5. DRAGADOS
6. CENTROS ACUICOLAS
7. GRANJAS ACUICOLAS
8. PLANTAS DE PROCESAMIENTO PRIMARIO

9.- RAMPAS

10. ATRACADEROS

11. MUELLES

12. CENTROS DE RECEPCION

13. CENTROS DE DISTRIBUCION

14. BODEGAS Y PLANTAS DE ENHIELADO

15. BODEGAS REFRIGERADAS

16. MERCADOS

17. FABRICAS DE HIELO

18. OBRAS DE APOYO

19. ESCOLLERAS Y ROMPEOLAS

20. REFUGIOS PESQUEROS

21. TERMINALES PESQUERAS

22. PUERTOS PESQUEROS

23. OBRAS DE INGENIERIA SANITARIA

DE LO ANTERIOR PODEMOS DEDUCIR QUE UNA INVESTIGACION DETALLADA DE NUESTRAS INSTALACIONES PESQUERAS, HA EXIGIDO Y EXIGE ANALIZAR LAS ACTUALES CONDICIONES Y DISCUTIR EXHAUSTIVAMENTE LAS CONCLUSIONES ALTERNATIVAS PARA PERMITIR AL EJECUTIVO QUE CON BASES SOLIDAS, ORDENE AL DEPARTAMENTO DE PESCA LAS SOLUCIONES MAS ADECUADAS A CADA INSTALACION, A CADA COMUNIDAD Y CADA PROBLEMA, SIN RECURRIR AL "SENTIMIENTO" O A LA "INSPIRACION", SINO APOYANDOSE EN LA REALIDAD TECNICA Y EN LA VERDAD ECONOMICA.

ESPERO HABERLES SERVIDO, LES REITERO MI GRATITUD POR SU - PACIENCIA Y ME MANTENGO A SUS ORDENES APROVECHANDO LA - OPORTUNIDAD PARA SALUDARLES CORDIALMENTE.

- I ACTIVIDAD PESQUERA
  - INTEGRACION
    - ECONOMICA
    - SOCIAL
    - POLITICA
  - DESARROLLO
    - ECONOMICO
    - SOCIAL
    - POLITICO

- II TRAFICO PESQUERO
  - AGUAS INTERIORES O CONTINENTALES
    - ABASTECIMIENTO LOCAL
    - ABASTECIMIENTO A ZONAS DEFICITARIAS.
    - COMERCIO INTERIOR
  - AGUAS PROTEGIDAS LITORALES Y MARITIMAS
    - COMERCIO INTERIOR
    - INDUSTRIALIZACION
    - ABASTECIMIENTO A ZONAS DEFICITARIAS.
    - COMERCIO EXTERIOR

- III ELEMENTOS BASICOS
  - RECURSOS NATURALES
  - RECURSOS HUMANOS
  - RECURSOS MATERIALES
    - INFRAESTRUCTURA
      - INSTALACIONES
      - SERVICIOS
      - VIALIDAD
      - TRANSPORTES
      - INDUSTRIAS
      - COMERCIALIZACION
    - FINANCIEROS
      - CAPITALES
      - CREDITOS
      - FINANCIAMIENTOS
    - BUQUES
    - ARTES

- IV FACTORES
  - EL PESCADOR
  - EL BIOLOGO
  - EL OCEANOLOGO
  - EL TECNOLOGO
  - EL INTERMEDIARIO OFICIAL
  - EL INTERMEDIARIO PRIVADO
  - EL INDUSTRIALIZADOR
  - EL DISTRIBUIDOR DE MAYOREO
  - EL DISTRIBUIDOR DE MENUDEO
  - EL CONSUMIDOR

V OBRAS DE INFRAESTRUCTURA PESQUERA.

- **MEJORAMIENTO BIOECOLOGICO.**
  - MEJORAR LAS CONDICIONES DE SALINIDAD EN LAGUNAS, ESTEROS, ALBUFERAS, ETC., PARA DESARROLLAR ESPECIES PESQUERAS ABRIENDO COMUNICACIONES CON LA MAR POR MEDIO DE CANALES DE GASTO CONTROLADO.
- **PREVENCION Y CONTROL DE LA CONTAMINACION.**
  - SISTEMAS DE RECOLECCION, TRATAMIENTO Y DISPOSICION DE AGUAS NEGRAS Y RESIDUALES, PARA PREVENIR Y CONTROLAR LA CONTAMINACION Y POLUCION DE AGUAS Y AMBIENTES PARA EVITAR Y CONTROLAR DEGRADACIONES DE LOS ELEMENTOS BIOLOGICOS; DETECTANDO CONTAMINANTES Y REDUCIENDOLOS POR MEDIOS FISICOS, BACTERIOLOGICOS Y QUIMICOS. ESTO SE APOYA EN LA LEGISLACION VIGENTE O PROPUESTA.
- **LABORATORIOS DE INVESTIGACION.**
  - INSTALACIONES DESTINADAS AL ESTUDIO DEL COMPORTAMIENTO DE LAS DIFERENTES ESPECIES BIOLOGICAS, FAUNA Y FLORA, CON EL FIN DE CONOCER LAS CARACTERISTICAS ECOLOGICAS Y ALIMENTARIAS Y LAS CONDICIONES OPTIMAS PARA SU DESARROLLO Y APROVECHAMIENTO.
- **ESTRUCTURAS DE CONTROL DE NIVELES.**
  - SU OBJETO ES CONTROLAR EL INTERCAMBIO DE AGUAS ENTRE LOS MEDIOS LAGUNARIO O ESTUARINO Y LA MAR, PARA CONTROLAR LA SALINIDAD EN LOS CUERPOS INTERIORES Y ASEGURAR LOS CICLOS BIOLOGICOS DE LAS ESPECIES, LA ESTABILIDAD DE LA FLORA Y EL EQUILIBRIO ECOLOGICO. GENERALMENTE DISPONEN DE ARTIFICIOS COMO MALLAS PARA IMPEDIR EL RETORNO A LA MAR DE LARVAS, POSTLARVAS Y JUVENILES, DE LAS ESPECIES PESQUERAS A LA MAR, ASEGURANDO SUS DESARROLLOS Y PROCREACION EN LAS LAGUNAS O ESTUARIOS. SE CONSTITUYEN POR COMPUERTAS CONTROLADAS, SOBRE ESTRUCTURAS CUYA CUMBRERA SIRVA COMO PUENTE; ESTAS PUEDEN SER, SEGUN ENVERGADURA DE CONCRETO, MADERA, ACERO, PLASTICOS, ETC.

VI OBRAS DE INFRAESTRUCTURA PESQUERA

DRAGADOS

EXCAVACION EN ZONAS EN CONTACTO CON LOS CUERPOS DE AGUA CUYOS FONDOS PRESENTAN DIFERENTES TIPOS DE SUELO QUE DETERMINAN LAS CARACTERISTICAS DE LAS HERRAMIENTAS, EQUIPOS O MAQUINARIAS A EMPLEAR. LAS DRAGAS MECANICAS PUEDEN SER:

- DE CUCHARON
  - DE BOTE
  - DE ALMEJA
  - DE PALA
- DE ROSARIO O DE CANJILONES
- HIDRAULICAS
  - ESTACIONARIAS
  - AUTOPROPULSADAS
  - MIXTAS

POR SUS CARACTERISTICAS, LOS DRAGADOS QUE CONSISTEN EN PROFUNDIZACIONES, OBTENCION DE MATERIALES DE CONSTRUCCION O EXPLOTACION DE RECURSOS SUBACTUATICOS CON VALOR COMERCIAL, PUEDEN SER DE CONSTRUCCION, MANTENIMIENTO, SUPERPOSICION O INDUSTRIALES.

POR SUS OBJETIVOS SE SUBDIVIDEN EN :

DRAGADOS DE ACCESO EN CANALES
DRAGADOS EN DARSENAS Y BAHIAS.
DRAGADOS EN CANALES DE NAVEGACION.
DRAGADOS EN BOCAS Y DESEMBOCADURAS.
DRAGADOS EN CANALES INTERIORES.
DRAGADOS DE DISTRIBUCION DE CUÑAS SALINAS.
DRAGADOS DE RECTIFICACION DE CAUCES.
DRAGADOS PARA TRAMPAS DE AZOLVES.
DRAGADOS PARA CONSTRUIR BORDOS CANALES DE ENGORDA, FOSAS DE RECRIA, ETC...
DRAGADOS PARA CONTROL DE AVENIDAS.
DRAGADOS DE SUPERPOSICION PARA ENTARQUINAMIENTO DE PANTANOS Y GANAR TERRENOS.
DRAGADOS DE CONSTRUCCION.
DRAGADOS DE NAVEGACION.
DRAGADOS DE MANTENIMIENTO
DRAGADOS INDUSTRIALES PARA EXPLOTACION DE YACIMIENTOS SUBACUATICOS DE PRODUCTOS CON VALOR COMERCIAL E INDUSTRIAL -

COMO MINERALES, PLANTAS ALIMENTICIAS, MEDICINALES O INDUSTRIALES, CORALES, ESPONJAS, FERTILIZANTES Y MATERIALES DE CONSTRUCCION, METALES, ETC.

VII OBRAS DE INFRAESTRUCTURA PESQUERA

- **CENTROS ACUICOLAS**
  - INSTALACIONES CUYO OBJETO ES LOGRAR CULTIVOS DE ESPECIES, PESCADOS, ETC., CON FINES DE EXPERIMENTACION Y ACCESORIAMENTE INVESTIGACION. LAS INSTALACIONES NORMALMENTE CONSISTEN EN ESTANQUES, PILETAS, OBRAS HIDRAULICAS PARA ALIMENTACION Y DESFOGUE, CANALES Y DARSENAS DE ENGORDA, LABORATORIOS, AULAS, BIBLIOTECAS, ALMACENES, BODEGAS, COBERTIZOS, PATIOS, HABITACIONES, SERVICIOS, VIALIDAD, URBANIZACION, ETC.
- **GRANJAS ACUICOLAS**
  - INSTALACIONES CUYO OBJETO ES LOGRAR CULTIVOS DE ESPECIES, PESCADOS, MARISCOS, ETC., CON FINES DE EXPLOTACION COMERCIAL. DICHAS INSTALACIONES, CONSISTEN TAMBIEN EN ESTANQUES, PILETAS, OBRAS HIDRAULICAS PARA ALIMENTACION Y DESFOGUE, CANALES Y DARSENAS, LABORATORIOS, MATADEROS, BIBLIOTECAS, OFICINAS, ALMACENES Y BODEGAS REFRIGERADAS O NO, CONGELADORAS, COBERTIZOS Y PATIOS, HABITACIONES, SERVICIOS, VIALIDAD, URBANIZACION, ETC.
- **PLANTAS DE PROCESAMIENTO. PRIMARIO**
  - INSTALACIONES CUYA FINALIDAD ES APROVECHAR ESPECIES DE AGUAS MARINAS O CONTINENTALES PARA TRANSFORMARLAS EN PRODUCTOS COMERCIALES, ALIMENTICIOS E INDUSTRIALES. EL PROCESAMIENTO PRIMARIO DEPENDE DE LAS ESPECIES Y POR TANTO SE REQUIEREN DIVERSAS AREAS DE TRABAJO QUE SE GENERALIZAN COMO:
  - AREAS DE
    - RECEPCION DE MATERIA PRIMA.
    - SELECCION Y LAVADO
    - TRABAJO ESPECIALIZADO.
      - EVISCERADO
      - FILETEADO
      - SECADO

- DESCONCHADO
- PRECOCIDO
- EMPAQUETADO.
- ETC.

- ANTECAMARA Y BODEGA REFRIFERADA
- ANDEN DESPACHO PRODUCTO TERMINADO.
- DEPOSITO Y TRATAMIENTO DE DESPERDICIOS.
- MAQUINARIA
- SERVICIOS
- OFICINAS
- SANITARIOS
- MANIOBRAS.

VIII OBRAS DE INFRAESTRUCTURA PESQUERA

ENLACES

RAMPAS: ESTRUCTURA INCLINADA DE MADERA, CONCRETO O HIERRO, DESTINADA AL AMARRAJE O DESLIZAMIENTO DE EMBARCACIONES MENORES, PARA REALIZAR OPERACIONES DE CARGA Y DESCARGA Y TRANSBORDO O ESTACIONAMIENTO Y OCASIONALMENTE REPARACIONES. SUS DIMENSIONES DEPENDEN DEL NUMERO DE EMBARCACIONES A OPERAR Y SE CONSTRUYEN SOBRE EL TERRENO NATURAL CON ANCLAJES, O SOBRE PILOTES, LAS PLATAFORMAS SON INCLINADAS Y HORIZONTALES, DOTADAS DE ANDEN

ATRACADEROS.: ESTRUCTURAS DESTINADAS AL ATRAQUE Y ACODERAMIENTO DE EMBARCACIONES, PARA EFECTUAR MANIOBRAS DE CARGA, DESCARGA, Y TRANSBORDO DE PRODUCTOS, MATERIAS O MATERIALES; ASIMISMO PARA AMARRAJE Y OCASIONALMENTE PARA REPARACIONES A FLOTE DE TIPO MENOR. SUS DIMENSIONES SE RIGEN POR LAS CARACTERISTICAS DE LAS EMBARCACIONES, SU NUMERO Y LA NATURALEZA DE LAS OPERACIONES. LOS TIPOS EN GENERAL PUEDEN SER: FLOTANTES, SOBRE PILOTES MUROS DE GRAVEDAD, PAREDES TABLESTACADAS, GAVIONES O MIXTOS, SEGUN SE UTILICEN PILOTES, FLOTADORES, TABLESTACAS O MUROS Y DISPONDRAN DE CUBIERTA O PLATAFORMA, ORGANOS DE AMARRAJE COMO BITAS, CORNAMUZAS O POSTES, DEFENSAS, ANDENES Y AREAS DE MANIOBRAS.

MUELLES

ESTRUCTURAS DE MAYOR ENVERGADURA QUE LOS ATRACADEROS. ENLAZAN LOS SISTEMAS MARITIMOS, FLUVIALES Y LACUSTRES CON TIERRA. DISPONEN DE INSTALACIONES, UTILERIA Y EQUIPAMIENTO, FRECUENTEMENTE MECANIZACION. ESENCIALMENTE CONSTAN DE INFRAESTRUCTURA Y SUPERESTRUCTURA, ORGANOS DE AMARRAJES, DEFENSAS, LUCES DE SITUACION, ALUMBRADO, PATIOS DE MANIOBRA, ENLACES VIALES, ESTACIONAMIENTOS Y SERVICIOS. SE CLASIFICAN POR SU FORMA EN: MARGINALES, EN ESPIGON, T Y L; POR SU DESTINO EN: PESQUEROS, MINERALEROS, PETROLEROS, DE CABOTAJE, ALTURA, CARGA GENERAL, GRANELEROS Y ESPECIALIZADOS. COMO LOS ATRACADEROS, PUEDEN SER FLOTANTES, SOBREPILOTES O PILAS, TABLESTACADOS, GAVIONES, MUROS DE GRAVEDAD O MIXTOS. SUS DIMENSIONES DEPENDEN DE LAS CARACTERISTICAS Y NUMERO DE LOS BARCOS Y DE LA NATURALEZA DE LAS OPERACIONES QUE DEBAN REALIZARSE EN TIEMPOS DETERMINADOS SEGUN SEAN SERVICIOS ESPECIALIZADOS, CARGA, DESCARGA, TRANSBORDO, AVITUALLAMIENTO, APROVISIONAMIENTO, AGUAJE, HIELO, COMBUSTIBLES, ETC.

IX OBRAS DE INFRAESTRUCTURA PESQUERA.

- **CENTROS DE RECEPCION**
  - SON INSTALACIONES CUYA FINALIDAD ES PROPORCIONAR A LOS PESCADORES LUGAR ADECUADO PARA LAVAR, CLASIFICAR, PREPARAR Y ALMACENAR SU PRODUCCION DURANTE EL TIEMPO COMPRENDIDO ENTRE EL ARRIBO DE EMBARCACIONES CON PRODUCTO Y SU COMERCIALIZACION. EN GENERAL CONSTAN DE LAS PARTES SIGUIENTES:
  - AREAS DE
    - ZONA DE PESAJE
    - ZONA DE CLASIFICACION
    - ZONA DE PROCESAMIENTO PRIMARIO.
    - ZONA DE DEPOSITO Y TRATAMIENTO DE DESPERDICIOS.
    - ANTECAMARA.
    - BODEGA REFRIGERADA O DE ENHIELADO.
    - CONGELADOR SI ES CONVENIENTE
    - MAQUINARIA
    - LONJA PARA VENTAS
    - ANDENES PARA EMBARQUE DE PRODUCTO.
    - OFICINAS
    - SANITARIOS
    - MANIOBRAS.
- **CENTROS DE DISTRIBUCION**
  - SON INSTALACIONES QUE COMPLEMENTAN A LOS CENTROS DE RECEPCION Y SE DESTINAN A LA CONSERVACION DE PRODUCTOS, REGULAR LOS PRECIOS EN EL MERCADO Y ABASTECER DE PRODUCTOS FRESCOS Y/O PROCESADOS A LOS DIFERENTES MERCADOS EN LA ZONA DE INFLUENCIA ECONOMICA A QUE SIRVEN. TALES INSTALACIONES CONSTAN DE:
  - AREAS DE
    - RECEPCION Y PESAJE
    - CLASIFICACION
    - ANTECAMARA
    - BODEGAS REFRIGERADAS
    - CONGELADORES
    - DEPOSITO Y TRATAMIENTO DE DESPERDICIOS.
    - VENTAS
    - OFICINAS
    - SERVICIOS
    - SANITARIOS
    - ANDENES DE EMBARQUE
    - MANIOBRAS
    - ESTACIONAMIENTOS.
    - MAQUINARIA.

X OBRAS DE INFRAESTRUCTURA PESQUERA

- **BODEGAS Y PLANTAS DE ENHIELADO**
  - SON INSTALACIONES DESTINADAS AL ALMACENAJE Y CONSERVACION DE LOS PRODUCTOS PESQUEROS DISPUESTOS EN HIELO. CONSTAN DE :
    - AREA DE
      - RECEPCION Y PESAJE
      - CLASIFICACION
      - PROCESAMIENTO PRIMARIO
      - ANTECAMARA
      - CUARTO FRIO
      - OFICINAS
      - SANITARIOS
      - MANIOBRAS
      - ANDENES DE EMBARQUE
      - ESTACIONAMIENTO.
- **BODEGAS REFRIGERADAS.**
  - SON INSTALACIONES CON AISLANTES TERMICOS Y EQUIPOS DE REFRIGERACION DESTINADOS A MANTENER A MUY BAJAS TEMPERATURAS (-4°C APROXIMADAMENTE) LOS PRODUCTOS PESQUEROS A EFECTO DE CONSERVARLOS EN ESTADO FRESCO. CONSTAN DE :
    - AREA DE
      - RECEPCION Y PESAJE
      - CLASIFICACION
      - PROCESAMIENTO PRIMARIO.
      - EMPAQUE
      - ANTECAMARA
      - BODEGA REFRIGERADA
      - OFICINAS
      - MAQUINARIA
      - SANITARIOS
      - ESTACIONAMIENTO
      - ANDENES DE EMBARQUE.
- **MERCADOS**
  - SON INSTALACIONES DESTINADAS A OFRECER AL PUBLICO PRODUCTOS PESQUEROS PROCESADOS PROVENIENTES DE LOS CENTROS DE DISTRIBUCION QUE ACTUAN COMO MERCADOS DE MAYOREO. PARA QUE CUMPLAN SU FUNCION DE MERCADOS DE MENUDEO ESTAS INSTALACIONES CONSTAN DE :
    - AREA DE
      - RECEPCION Y PESAJE
      - BODEGAS REFRIGERADAS
      - VITRINAS REFRIGERADAS Y MOSTRADORES PARA VENTA AL PUBLICO.
      - DEPOSITO Y ELIMINACION DE DESPERDICIOS.

OFICINAS
SERVICIOS
CIRCULACION
MANIOBRAS.

XI OBRAS DE INFRAESTRUCTURA PESQUERA.

- FABRICAS DE HIELO
  - ESTAS INSTALACIONES TIENEN COMO FUNCION PRINCIPAL PRODUCIR HIELO PARA APROVISIONAR BUQUES, INSTALACIONES, NEVERAS, ETC., EN CANTIDADES SUFICIENTES PARA CONSERVAR PRODUCTOS PESQUEROS A BORDO, DURANTE EL ALMACENAJE O TRANSPORTE ENHIELADO, ETC. ES SERVICIO INDISPENSABLE PARA PROMOVER LA ACTIVIDAD PESQUERA Y PROTEGER AL PESCADOR. CONSTAN DE :
  - AREAS DE
    - TANQUE SALMUERA DE CONGELACION
    - CISTERNA Y/O TANQUE ALMACENADOR.
    - SERVICIOS AUXILIARES
    - TRATAMIENTO DE AGUAS
    - CONDENSADOR Y TORRE DE ENFRIAMIENTO.
    - TANQUE DE INMERSION Y LLENADOR
    - VACIADO DE MOLDES
    - BODEGA PARA HIELO
    - OFICINAS
    - ANDEN PARA DESPACHO
    - SUBESTACION ELECTRICA
    - GENERADOR AUXILIAR
    - ESTACIONAMIENTO
    - DE RESERVA PARA AMPLIACION
- OBRAS DE APOYO
  - ESTAS OBRAS SON COMPLEMENTARIAS DE TODO PROYECTO Y SE REQUIEREN PARA LOGRAR MAYORES EFICIENCIA Y FUNCIONALIDAD Y PARA OBTENER MEJORES VENTAJAS Y ESTETICA EN LAS OBRAS PROYECTADAS. CONSISTEN NORMALMENTE EN CAMINOS DE ACCESO, AREAS DE SOMBRA, ARBOLADO, ENJARDINADO, OBRAS URBANAS, SERVICIOS, VIALIDAD, ETC.

XII OBRAS DE INFRAESTRUCTURA PESQUERA

ESCOLLERAS Y ROMPEOLAS

SON OBRAS MARITIMAS-PORTUARIAS DEFINIDAS COMO EXTERIORES O DE PROTECCION Y ABRIGO CUYAS FUNCIONES SON DEFINIR Y ENCAUZAR CANALES DE ACCESO Y NAVEGACION EN SEGURIDAD, MANTENER LA COMUNICACION Y EL INTERCAMBIO, DISPERSAR LA ENERGIA, DETENER LOS AZOLVES EN CANALES, DARSENAS Y BAHIAS, OBSTACULIZAR LA INCIDENCIA DEL OLEAJE PROPORCIONANDO ZONAS CALMA PARA NAVEGACION, ESTADIA, CIABOGAS, MANIOBRAS Y OPERACIONES PORTUARIAS. SU ENVERGADURA ES LA MISMA PERO DIFIEREN EN FUNCIONES; LAS ESCOLLERAS ENCAUZAN Y NORMALMENTE SE CONSTRUYEN EN LAS DESEMBOCADURAS DE LOS RIOS O PARA FORMAR CANALES; LOS ROMPEOLAS PARA MEJORAR LA PROTECCION DE LAS BAHIAS, DARSENAS O REFUGIOS. SU DISEÑO SE REALIZA SEGUN LOS PARAMETROS:

1. MAREAS. NIVELES GENERADOS.
2. OLEAJE. ESTADISTICO Y CICLONICO
3. CARACTER FISICO DE LA COSTA
4. CORRIENTES
5. MATERIALES POR EMPLEAR
6. TALUDES REQUERIDOS
7. CORONAMIENTO

EN PLANTA SE CONSTITUYEN POR:

1. ARRANQUE Y EMPOTRAMIENTO
2. CUERPO
3. MORRO

EN CORTE O ELEVACION POR :

1. NUCLEO
2. CAPA O CAPAS SECUNDARIAS
3. CORAZA
4. CORONAMIENTO

SU CONSTRUCCION DEPENDE DE LOS MATERIALES Y RECURSOS DISPONIBLES PUDIENDO SER ESTOS :

PIEDRAS NATURALES
PIEDRAS ATIFICIALES O BLOCKS
TETRAPODOS Y OTRAS FORMAS PATENTADAS.
BOLSACRETO.

- ENFAGINADOS RELLENOS
- HUACALES RELLENOS
- GAVIONES TABLESTACADOS.
- ETC.

XIII OBRAS DE INFRAESTRUCTURA PESQUERA.

- **REFUGIOS PESQUEROS**
  - SE ENTIENDEN ASI LAS AREAS NATURALES O ARTIFICIALES QUE PROPORCIONAN PROTECCION Y SEGURIDAD A LAS EMBARCACIONES TANTO DURANTE LOS TEMPORALES O EPOCAS CON PROBLEMAS METEOROLOGICOS, COMO PARA PERNOCTAR, ARRIBO POR DESCOMPOSTURA O ARRIBADA FORZOZA POR ACCIDENTE, VIAS DE AGUA, ETC., DEPENDIENDO DE SU LOCALIZACION, UN REFUGIO PUEDE INTEGRARSE POR SEÑALAMIENTO; OBRAS EXTERIORES, CANALES DE ACCESO, Y/O COMUNICACION Y FONDEADEROS. NORMALMENTE LOS REFUGIOS NO IMPLICAN OPERACION.
- **TERMINALES PESQUERAS**
  - SON INSTALACIONES IMPLEMENTADAS EN ZONAS NATURALES O ARTIFICIALES PARA PROPORCIONAR SERVICIOS A LAS FLOTAS PESQUERAS QUE SE MUEVEN Y DISPONEN DE HINTERLANDS INMEDIATO, MEDIATO O LEJANO. ESTOS SERVICIOS PRINCIPALMENTE CONSISTEN EN FACILIDADES PARA DESCARGA DE PRODUCTOS PESQUEROS, PROCESAMIENTO, AVITUALLAMIENTO, APROVISIONAMIENTO, AGUADA, COMBUSTIBLE, HIELO, SECADO Y REPARACION DE REDES Y ARTES PESQUERAS, RELACIONES ADMINISTRATIVAS Y REPARACIONES MENORES. LAS TERMINALES SON ADEMAS, ALIMENTADORAS DE LOS PUERTOS PESQUEROS; DIRECTA E INDIRECTAMENTE BENEFICIAN A LAS POBLACIONES PROPIAS Y A LAS ASENTADAS EN LAS AREAS DE SUS INFLUENCIAS ECONOMICAS, YA SEA GENERANDO EMPLEOS, MEJORANDO SERVICIOS Y EN GENERAL PROPICIANDO Y GARANTIZANDO DESARROLLOS SOCIOECONOMICOS EN LAS REGIONES QUE SIRVEN.
  - DICHAS INSTALACIONES PRINCIPALMENTE SON:
    - SEÑALAMIENTO Y AYUDAS A LA NAVEGACION
    - SERVICIOS DE COMUNICACIONES
    - OBRAS EXTERIORES O DE PROTECCION Y ABRIGO.

XIV OBRAS DE INFRAESTRUCTURA PESQUERA.

PUERTOS PESQUEROS

OBRAS INTERIORES COMO DARSENAS, FONDEADEROS, MUELLES, AGUA POTABLE, ELECTRIFICACION, COMBUSTIBLES Y LUBRICANTES, AVITUALLAMIENTO Y APROVISIONAMIENTO, HIELO; INSTALACIONES DE RECEPCION, ALMACENAJE Y CONSERVACION DE PRODUCTOS PESQUEROS, OBRAS URBANAS, VIALIDAD, ETC.

SON INSTALACIONES IMPLEMENTADAS EN ZONAS PROPICIAS, NATURALES O ARTIFICIALES, PARA DAR SERVICIOS A LAS FLOTAS Y A LOS ASENTAMIENTOS QUE OPERAN O RADICAN EN LOS HINTERLANDS O ZONAS DE INFLUENCIA ECONOMICA, INMEDIATAS, MEDIATAS Y LEJANAS. DEBEN COMUNICARSE POR VIAS TERRESTRES, MARITIMAS, FLUVIALES Y AEREAS. LOS SERVICIOS PORTUARIOS SE INTEGRAN PARA CARGA, DESCARGA Y TRANSBORDO DE PRODUCTOS PESQUEROS, PROCESAMIENTO, INDUSTRIALIZACION, AVITUALLAMIENTOS, APROVISIONAMIENTOS, COMBUSTIBLES Y LUBRICANTES, AGUA, HIELO, ELECTRICIDAD, SECADO, REPARACION Y FABRICACION DE ARTES Y REDES, RELACIONES ADMINISTRATIVAS, REPARACIONES MENORES Y MAYORES, HABITACION, ESCUELAS, HOSPITALES, ETC.

SU LOCALIZACION Y DESARROLLO BENEFICIA DIRECTAMENTE A LA POBLACION ASENTADA EN SU REGION DE SERVICIO Y DIRECTA E INDIRECTAMENTE A LOS ASENTAMIENTOS DE LAS TERMINALES GENERANDO EMPLEOS Y NUEVAS ACTIVIDADES, MEJORANDO SERVICIOS URBANOS, DE VIALIDAD, COMUNICACION, ETC.

ESTOS PUERTOS, COMO LOS DE INTERES GENERAL, PUEDEN SER MARITIMOS, FLUVIALES Y LAGUNARIOS; EL EQUILIBRIO DE SUS ELEMENTOS CONSTITUTIVOS DETERMINA SU BUEN FUNCIONAMIENTO, LOS COMPONENTES DEL PUERTO SON PRINCIPALMENTE:

I. OBRAS EXTERIORES, DE PROTECCION Y ABRIGO, QUE GARANTICEN LA ENTRADA, SALIDA Y ESTADIA EN SEGURIDAD, DE LAS EMBARCACIONES EN PUERTO.

II. OBRAS INTERIORES O DE TRANSFERENCIA, QUE GARANTICEN LOS TRANSBORDOS Y OPERACIONES EN SEGURIDAD Y RAPIDEZ, REDUCIENDO AL MINIMO LAS ESTADIAS DE LAS EMBARCACIONES EN PUERTO.

III. QUE EL HINTERLAND PROPIO Y LOS CORRESPONDIENTES A LAS TERMINALES, SEA INMEDIATO, MEDIATO O LEJANO, PERO RICO Y PERMANENTE EN PRODUCCION Y CONSUMO PARA QUE LAS FLOTAS PESQUERAS DISPONGAN DE INCENTIVOS Y DE SEGURIDAD.

IV. QUE LAS CONDICIONES URBANAS GARANTI - CEN LA SALUD Y EL BIENESTAR SOCIAL DE LAS COMUNIDADES.

V. QUE EL REGIMEN ADMINISTRATIVO AMPARE LO MISMO AL PESCADOR COOPERATIVADO - QUE AL LIBRE, AL ARMADOR, INDUSTRIAL, - TRANSPORTISTA, COMERCIANTE Y EN GENE RAL, A TODA LA FUERZA ACTIVA QUE OPE- RE EN EL PUERTO.

XV OBRAS DE INFRAESTRUCTURA PESQUERA.

OBRAS DE INGENIERIA SANITARIA.

SON LAS QUE SE REALIZAN EN LAS COMUNIDA - DES RURALES, TERMINALES Y PUERTOS PESQUE ROS; CENTROS Y GRANJAS ACUICOLAS, MERCA - DOS, ETC. CON FINES DE PROTECCION DE LA -- SALUD ABASTECIENDO DE AGUA POTABLE, RE- COLECCION DE AGUAS NEGRAS Y RESIDUALES, BASURAS Y DESPERDICIOS SOLIDOS, PLANTAS - DE TRATAMIENTO Y DISPOSICION FINAL DE - RESIDUOS.

LA DOTACION DE AGUAS SE ANALIZA SEGUN - LOCALIZACION, CAPTACION, CONDUCCION Y DISTRIBUCION, CALIDAD Y NECESIDAD O DE TRATARLAS PARA SU POTABILIZACION Y/O TRATAMIENTO. SE PROYECTAN TAMBIEN SISTEMAS - DE DRENAJES COLECTORES Y PLANTAS DE TRATAMIENTO DE AGUAS NEGRAS Y RESIDUALES - CON SISTEMAS SEPARADOS PARA LOS DRENES- PLUVIALES. TODO ELLO, CONFORME A LO ESPECIFICADO EN LA LEGISLACION DE SANEAMIENTO AMBIENTAL Y DE PREVENCION Y CONTROL DE LA CONTAMINACION DEL AGUA Y DEL AMBIENTE. TAMBIEN SON IMPORTANTES LOS- SISTEMAS DE RECOLECCION Y DISPOSICION DE BASURAS Y RESIDUOS SOLIDOS MEDIANTE - RELLENOS SANITARIOS, INCINERACION TRATAMIENTO INDUSTRIAL Y/O RECICLO DE MATERIALES.

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SISTEMAS MARITIMOS Y PORTUARIOS

D R A G A D O

ING. MARIO R. DE LA GALA.

MARZO, 1979.

DRAGADO

I.- DATOS HISTORICOS

II.- DIFERENTES TIPOS DE DRAGAS Y SUS APLICACIONES

III.- TRABAJOS PREVIOS AL DRAGADO

IV.- USOS DEL MATERIAL EXTRAIDO

V.- METODOS PARA ESTABILIZAR LOS RELLENOS

VI.- GENERALIDADES SOBRE EL DRAGADO DE LOS PUERTOS MEXICANOS.

MARIO R. DE LA GALA.

DRAGADO

DATOS HISTORICOS.

DIFERENTES TIPOS DE DRAGAS. SUS APLICACIONES.

DATOS HISTORICOS.- La palabra dragado en Español, es una derivación del inglés antiguo draw, que significa extraer material bajo el espejo del agua ya sea en ríos, lagunas, esteros o el mar, bien por medios manual ó mecánico.

El dragado es un arte antiguo. Los Chinos y los pueblos que vivían en las márgenes de los ríos Tigris y Eúfrates, ya lo practicaban hace miles de años no solo para profundizar las aguas sino para fertilizar las tierras aledañas en época de sequía.

Quizá uno de los primeros aparatos para dragar, fuera la "Cuchara y bolsa" consistente en una pieza larga de madera que en su extremo tenía un recipiente con el que se extraía el material del fondo. Este aparato era accionado por dos personas una que manipulaba la bolsa y otra encargada de bajarla al fondo, subirla y girar la vara para depositar el material en el lugar adecuado.

Holanda e Italia reclaman la paternidad de haber introducidoeste sistema en Inglaterra, pero hay más probabilidades de que los Fenicios o los Romanos, lo hayan traído a este último país, en sus viajes al Oriente.

En un principio, la fuerza con que estos aparatos eran movidos, fue la humana habiéndose sustituído por la fuerza animal con - lo cual paradójicamente, se aumentó la eficiencia de los mis-- mos, amén de las mejoras que fueron llevándose a cabo a través de las épocas, aunque siempre efectuando trabajos a muy escasa profundidad.

Sin embargo, los cambios trascedentales se efectuaron alrede-- dor del año de 1860, cuando se aplicó el acero a la construc-- ción naval y las máquinas de vapor fueron instaladas en las -- dragas.

Aún cuando existen lugares donde los trabajos de dragado toda- vía se realizan como en épocas remotas, los requerimientos im- puestos por la expansión mundial en cuanto al comercio maríti- mo se refiere, han obligado a esta rama de la Ingeniería a in- vestigar permanentemente y en forma exhaustiva, ideando nuevos sistemas en base a la experiencia y a las necesidades presen-- tes y futuras; que si bien en un principio solo se pensaba en- extraer materiales tales como fango, arena o roca, al pasar el tiempo se ha ido incursionando en los campos de la minería y en el de la obtención de alimentos bajo las aguas, llevándose a -cabo dragados que hace algunas centurias se juzgaban impracticables.

Entre los países que se encuentran a la cabeza de importantes-aportaciones tanto en obras, como en investigación en esta rama, se pueden mencionar Holanda, Inglaterra, Francia, Estados-Unidos y Japón.

Se pueden resumir en cinco los objetivos principales del dragado:

1) Profundizar o mantener la profundidad de ríos, lagunas, canales o puertos marítimos.

2) Elevar el nivel de áreas bajas del terreno para mejorar sus condiciones.

3) Construir diques y otras obras de control de corrientes y -de la línea de costa.

4) Explotar depósitos subacuáticos con valor comercial tales -como minerales, plantas para productos alimenticios, coral, esponjas, grava, arena y fertilizantes.

5) El relleno de áreas ganadas al mar que sin ser necesariamen

EB

te bajas, se requieren para determinado fin.

El concepto de dragado en la actualidad, es aplicable a la extracción de material bajo las aguas pero en volúmenes importantes.

En Italia, Leonardo Da Vinci diseñó varios aparatos para profundizar las aguas de los pantanos y puertos.

Henry Emile Bazin en 1836, inventó una bomba hidráulica, empleando en 1867 bombas centrífugas para la excavación del canal de Suez, que en su primer corte se extrajeron no menos 30,000.000 de Tons.

En 1855 se construyó una draga de tolva con autopropulsión empleada en el dragado del puerto de Charleston, EUA.

DIFERENTES TIPOS DE DRAGAS Y SUS APLICACIONES.- Los diseños de dragas no han permanecido estáticos, sino que han sufrido constantes cambios de acuerdo a la experiencia y a los materiales a dragar, propios de cada región donde se ejecutan los trabajos.

La primera gran clasificación de las dragas queda integrada en los 3 siguientes grupos:

I. Si pueden navegar con sus propios medios.

II. Si son capaces de almacenar el producto del dragado en su interior.

III. De acuerdo con el equipo de ataque de que dispongan.

En el primer caso, la forma del casco que soporte el equipo de dragado es fundamental. Así, se tiene que si la draga esta provista de medios de autopropulsión, las formas del casco serán hidrodinámicas es decir, con líneas tales que le permitan su desplazamiento en el agua, sin demasiada resistencia. En el caso de no contar con autonomía para trasladarse de un lugar a otro, el casco podrá tener formas rectangulares sin que esto tenga mayor importancia.

Las formas del casco son indicio del lugar donde ha de trabajar la draga, siendo aquellas con forma de barco, las que operen en aguas abiertas o poco protegidas y las de casco rectangular, en aguas tranquilas o de relativa protección.

El segundo grupo se divide en dragas que en su construcción incluyen una tolva para almacenar el material transitoriamente durante la operación de dragado, o las que simplemente lo extraen y lo vierten acto seguido mediante canalones, bandas transportadoras o tuberías al lugar de depósito, pudiéndose llamar a las primeras dragas portadoras o de tolva y a las segundas no portadoras o estacionarias.

Con respecto al tercer grupo o sea de acuerdo con el equipo de-
taque de que están dotadas, se subdividen en:

I.- De pala

II.- De bote de arrastre

III.- De almeja o de gajos de naranja

IV.- De canjilones

V.- Hidráulica

El tamaño de las dragas incluídas en los tipos I, II y III se - da en función del tamaño del recipiente (pala, bote o almeja) - con que estén dotadas.

En las dragas del grupo IV se mide su tamaño de acuerdo al número de canjilones y el volumen útil de cada uno de estos.

En las hidraúlicas estacionarias, está en función del diámetro- de su tubería de descarga y en las de tolva de acuerdo a la capacidad de ésta.

Aún cuando estos son los equipos básicos, se han desarrollado - una gran variedad en cada uno de ellos y combinaciones entre sí, con el fin de mejorar la eficiencia y aumentar sus posibilidades; así, se han ideado cabezas cortadoras, discos, rastras con o sin escrepas, chorros de agua y aire, etc.

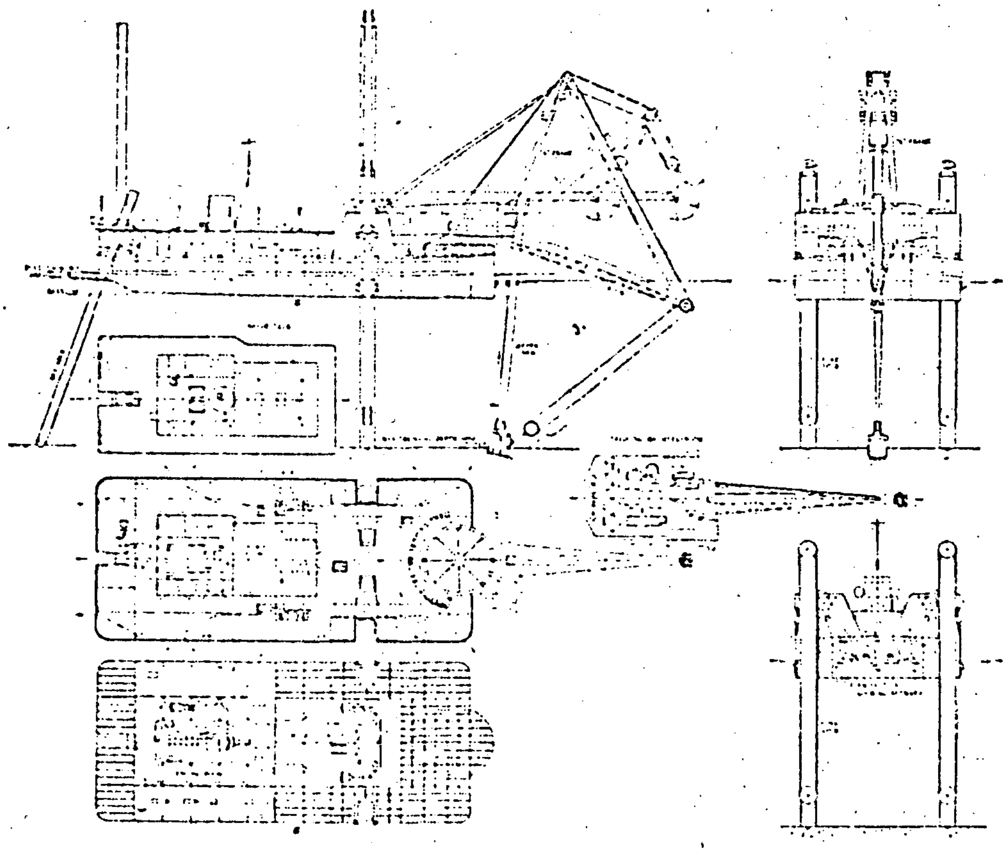
Sin embargo, la producción de las dragas está gobernada por la-profundidad de dragado, tipo de material, altura y distancia -- de descarga, habilidad del operador, porcentaje de sólidos en - la mezcla y las condiciones meteorológicas del lugar.

De la selección adecuada del tipo de draga para un cierto trabajo, depende el éxito tanto técnico como económico de la obra.

Por tanto a continuación se describe cada uno de los tipos, sus- usos, ventajas y limitaciones que permitirán servir de guía en - la selección del equipo cuando se tiene la oportunidad de tomar- esta decisión.

DRAGA DE PALA.- Puede trabajar prácticamente en todo tipo de material incluyendo roca disgregada hasta una profundidad de 15 metros. Su invención se atribuye a William S. Otis en 1837.

El aparato fundamental constituído por una estructura tubular metálica de sección rectangular en cuyo extremo inferior esta la - pala con que ataca el material, está montado en un chalán (embarcación de líneas rectas de mucha manga y poco calado).
(Fig.1).



Specifications

Max. dredging depth:	14.5 m
Dredging capacity:	144 m^3/h (at a depth of 14.5 m)
Dipper capacity:	4 m^3
Digging force:	45tons
Discharge distance:	13-20 m
Lpp × B × D × d:	34.00 m × 14.00 m × 3.30 m × 1.95 m
Main generator engine:	Diesel 1,013 PS × 600 rpm × 1
Main generator:	AC 720 kVA, 450 V, 60 c/s × 1
Main hoisting motor:	DC 350 kw × 1
Dipper thrusting motor:	DC 70 kw × 1
Spud winch motor Fore:	AC 100 kw × 2
Aft:	AC 20 kw × 1
Date of delivery:	March 1959
Owner:	Ministry of Transportation, Japan

Builder: ....Ishikawajima-Harima Heavy Industries Co., Ltd.

Fig. 1

La pala baja a través de una pluma que a la vez le sirve de guía, atacando el material hacia adelante con el fondo del bote cuya -- parte frontal está provista de dientes. Una vez que el material - ha entrado en él, el brazo es izado, girando la grúa que opera el sistema, un ángulo generalmente de 90° hacia cualquiera de las -- dos bandas, donde se abre la parte posterior del bote y el mate-- rial cae en unos chalanes tolva, mismos que transportarán el mate rial al lugar de depósito también llamado lugar de tiro o de des- carga. Ver fig. (2)

4 m³ Dipper-Dredger "Negishi Go"

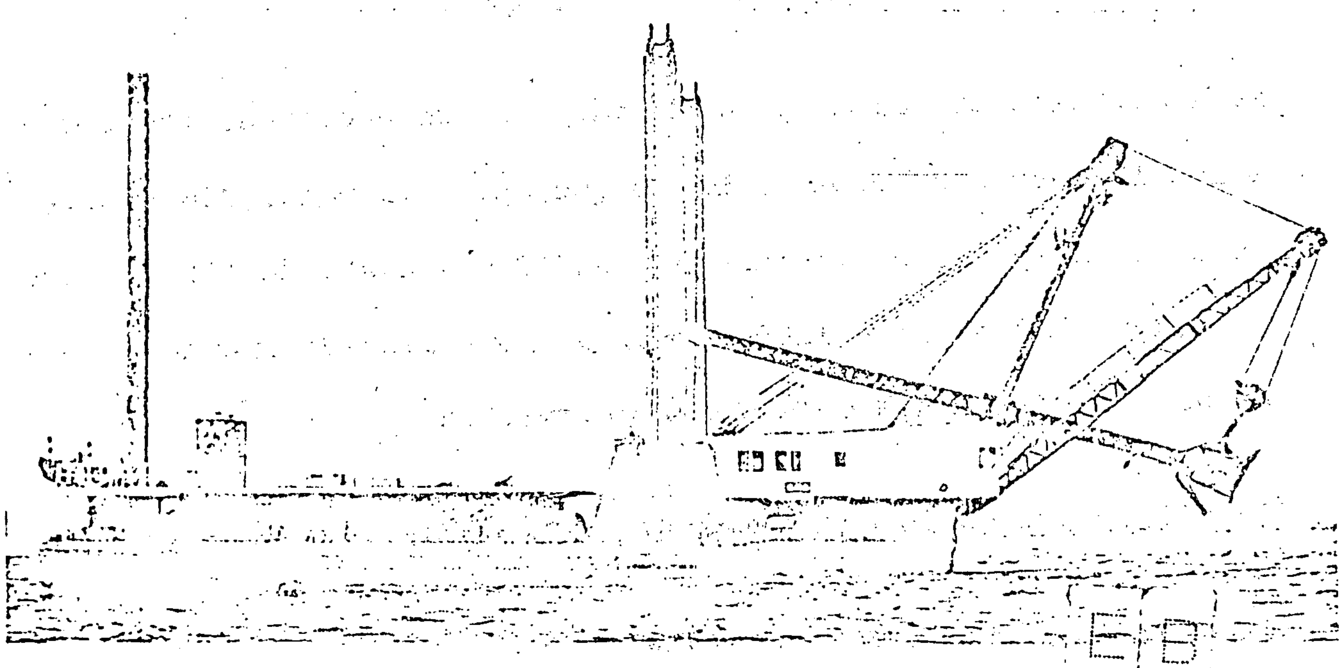


Fig. 2.

Las maniobras de bajar, subir, abrir y cerrar el bote, así como el de izar o arriar la pluma, se realizan mediante un sistema de cables y poleas.

Es una draga ideal para dragados angostos tales como canales, ya que el ancho necesario para su operación es prácticamente el de su manga pues para dragar, el casco no ejecuta ningún giro.

Para posicionarse en el lugar donde trabajará, fondea los 3 zancos de que está dotada, (1 en cada costado y uno por la popa) utilizando para moverse el mismo cucharón apoyándolo en el fondo.

Tanto el fondeo como el izado de los zancos se lleva a cabo con cables que van a un malacate o mediante fuerzas neumáticas o hidráulica. La estructura del equipo de dragado así como la embarcación que lo soporta, deberá ser de gran robustez para soportar los esfuerzos a que estarán sometidos.

Su limitación principal para dragados a profundidades mayores a los 15 metros se debe al brazo que operá la pala. Sin embargo, existen equipos que alcanzan profundidades hasta de 18.5 m. con una capacidad en la pala de 6 m3, 50 toneladas de fuerza de excavación, con un radio de descarga de 18 m.

Su eficiencia no es muy grande y quizá alcance 200 ó 250 M3/hr. volumen que disminurá rápidamente con la profundidad y la dureza del material.

DRAGA DE BOTE DE ARRASTRE. - Este equipo tiene ciertas características similares al anteriormente descrito en cuanto a la embarcación en que se aloja el aparato de dragado es decir, también es un chalán suficientemente amplio tanto en eslora como en manga para garantizar su estabilidad y de poco calado para entrar en lugares bajos. Cuenta con 3 zancos para su posicionamiento.

A diferencia de la draga de pala, que opera mediante un brazo rígido, la de bote de arrastre conecta éste con la pluma (con giro de 360°) mediante cables flexibles que le permiten lanzarlo a mayor distancia a la que el brazo puede llegar; sin embargo, por su forma de romper el material del fondo que es de adelante hacia atrás, y en sentido horizontal, la profundidad de excavación no puede ser demasiado grande.

Su mayor utilidad es en la de muestreo superficial del fondo y para lugares estrechos.

También en esta draga si el lugar de tiro no está al alcance de la pluma, se requiere del uso de chalanes tolva que transportarán el material al lugar de depósito.

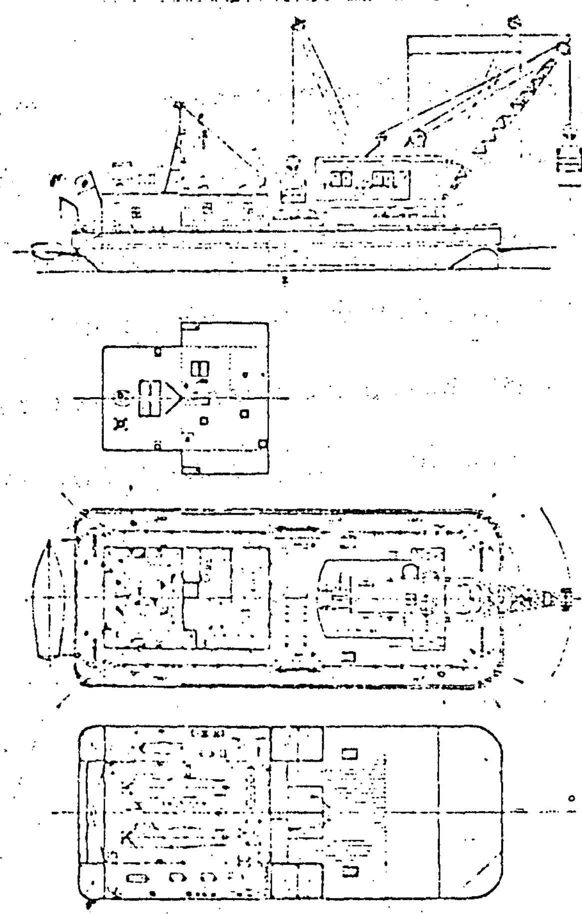
La eficiencia de las dragas de bote de arrastre es menor que la de pala.

DRAGA DE ALMEJA O DE GAJOS DE NARANJA.- Como en los dos tipos - anteriores, el nombre de la draga se debe al tipo de elemento - de ataque del material pudiendo ser de almeja, si el cucharón - está formado por dos partes (valvas) abriendo el interior en un solo plano o de gajos de naranja formados por segmentos de una- esfera que se separan radialmente.

Cada tipo es aplicable a una clase de suelo, por ejemplo, el bo te de almeja es útil en prácticamente todo tipo de material ya- que cuando se trata de suelos consolidados o roca disgregada, - se le cambia la cuchilla de los extremos de ataque de las val-- vas, por dientes de acero al manganeso, sumamente resistentes - al desgaste.

En cambio, el bote de gajos de naranja tiene su mayor aplicación en roca disgregada pudiendo tomar algunas de gran tamaño.

Esta clase de dragas puede montarse en dos tipos de embarcacio- nes: de formas rectilíneas. (ver fig. No. 3)



Specifications

Max. dredging depth:	20 m
Dredging capacity:	240 m^3/h
Grab capacity:	4 m^3 (half-tine type)
Hoisting capacity:	16 tons
Dredging radius:	10 m
Hoisting speed:	70 m/min
Lowering speed:	100 m/min
Slewing speed:	2.5 rpm
Luffing speed:	2.3 m/min
Lpp × B × D × d:	26.40 m × 11.00 m × 2.50 m × 1.30 m
Generator engine:	Diesel 320 PS × 600 rpm × 2
Generator:	DC 150 kw × 600 rpm × 2, DC 50 kw × 600 rpm × 1
Date of delivery:	November 1957
Owner:	Ministry of Transportation, Japan

Builder: ....Ishikawajima-Harima Heavy Industries Co., Ltd.

Fig. 3

o con formas adecuadas a la navegación con medios propios de -- propulsión según sea o no protegido el lugar donde se ejecuten- los trabajos. Generalmente las que están dotadas de autonomía,- cuentan con una sección dentro de la estructura del casco destinada a tolva, donde se almacena transitoriamente el material para posteriormente llevarlo al lugar de tiro. (Ver fig.No. 4)

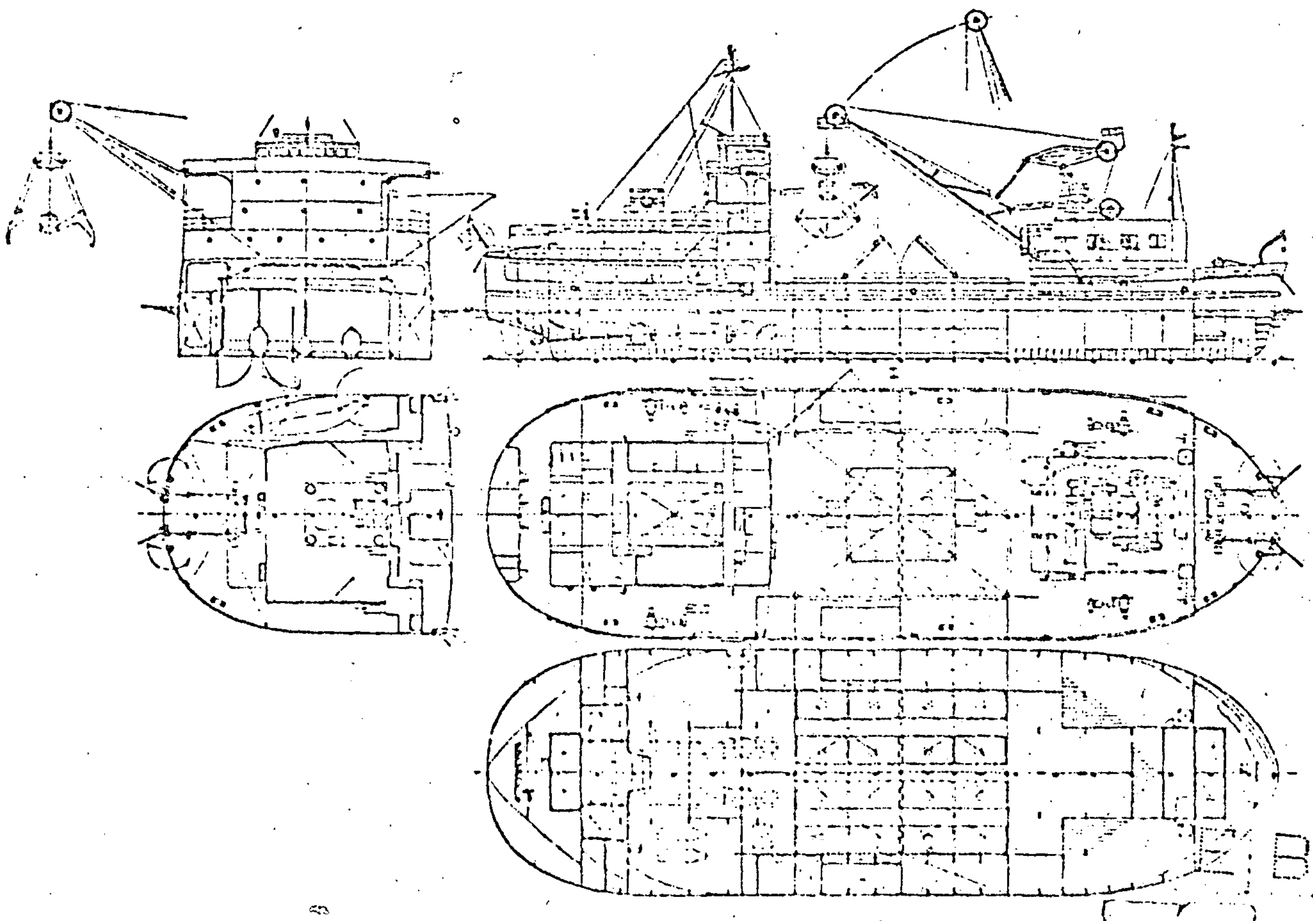


Fig. 4

Specifications

Max. dredging depth:	24 m
Dredging capacity:	150 m³/h (at a 10 m depth)
Hopper capacity:	1,107 m³
Grab bucket:	10 m³ (orange peel type), 13 m³ (clamshell)
Hoisting capacity:	60 tons
Dredging radius:	9-20 m
Hoisting speed:	60 m/min
Lowering speed:	70 m/min
Slewing speed:	1 rpm
Luffing speed:	Approx. 25 m/min
Loa X Lpp X B X D X d:	62.19 m X 59.00 m X 17.50 m X 5.00 m X 3.79 m
Gross tonnage:	1,992 tons
Navigation area:	Greater coasting
Speed at trial:	8.5 knots
Propulsion motor:	DC 400 kw X 350 rpm X 2
Propeller:	3 blade solid X 2
Main generator engine:	Diesel 900 PS X 600 rpm X 2
Main generator:	DC 450 kw X 2
Hoisting motor:	Ward-Leonard DC 400 kw X 600 rpm X 2
Date of delivery:	March 1964
Owner:	Ministry of Transportation, Japan

Builder: Uraga Heavy Industries, Ltd.

Fig. 4

Las dragas montadas en chalanes o embarcaciones de formas rectilíneas, requieren de chalanes tolva donde descargar el material dragado.

El sistema para posicionarse en el caso de las autopropulsadas- es a base de 4 anclas (2 por proa y 2 por popa), con las cuales puede moverse hacia adelante, hacia atrás y a ambos lados.

Su forma de trabajar es estacionaria.

En las dragas montadas en chalán existen algunas que utilizan - 3 zancos como los descritos para las dragas antes mencionadas,- y otras que prefieren maniobrar a base de anclas aún cuando para estas últimas, quede restringido el dragado a zonas amplias - y de poco tráfico.

Pero sea cual fuere el sistema, el principio fundamental en cualquiera de ellos es el mismo, es decir, una pluma que puede o no- girar 360°; un cable flexible y en su extremo el bote que cae -- verticalmente al agua.

La profundidad de dragado es prácticamente ilimitada aún cuando- pierde eficiencia como las otras, al aumentar la profundidad por el tiempo que tarda el bote en ser arriado e izado.

Las dragas de cucharón de almeja autopropulsadas, pueden tener - uno o varios equipos a bordo operando simultáneamente, lo que aumenta la eficiencia.

Si bien las dragas de bote de almeja montadas en cascos autopropulsados tienen la ventaja de no ocupar chalanes tolva para complementar su operación, su eficiencia se ve mermada al tener que dejar el área de dragado para transladarse a la zona de depósito.

Otros inconvenientes de las dragas de bote de almeja en general, son la no uniformidad de la excavación y la de enredar los cables debido a que el bote gira.

Según el material que extraiga, cuyo rango incluye desde el fango hasta la roca disgregada, se dotará o no (si es de almeja) de -- dientes de acero al manganeso.

Cuando el material por dragar es suave, el bote deberá dejarse - caer a 1m/seg. para evitar que la presión del agua lo cierre.

En caso de material compactado, la velocidad es la misma solo -- que el bote es de mayor peso.

Un ejemplo de draga de un solo cucharón de almeja de dimensiones importantes, es la KANMON No. 6 que opera en el estrecho de KAN-MON en Japón, entre las Islas de Honshu y Kiushu a la cual se le pueden instalar cualesquiera de los 3 cucharones siguientes:

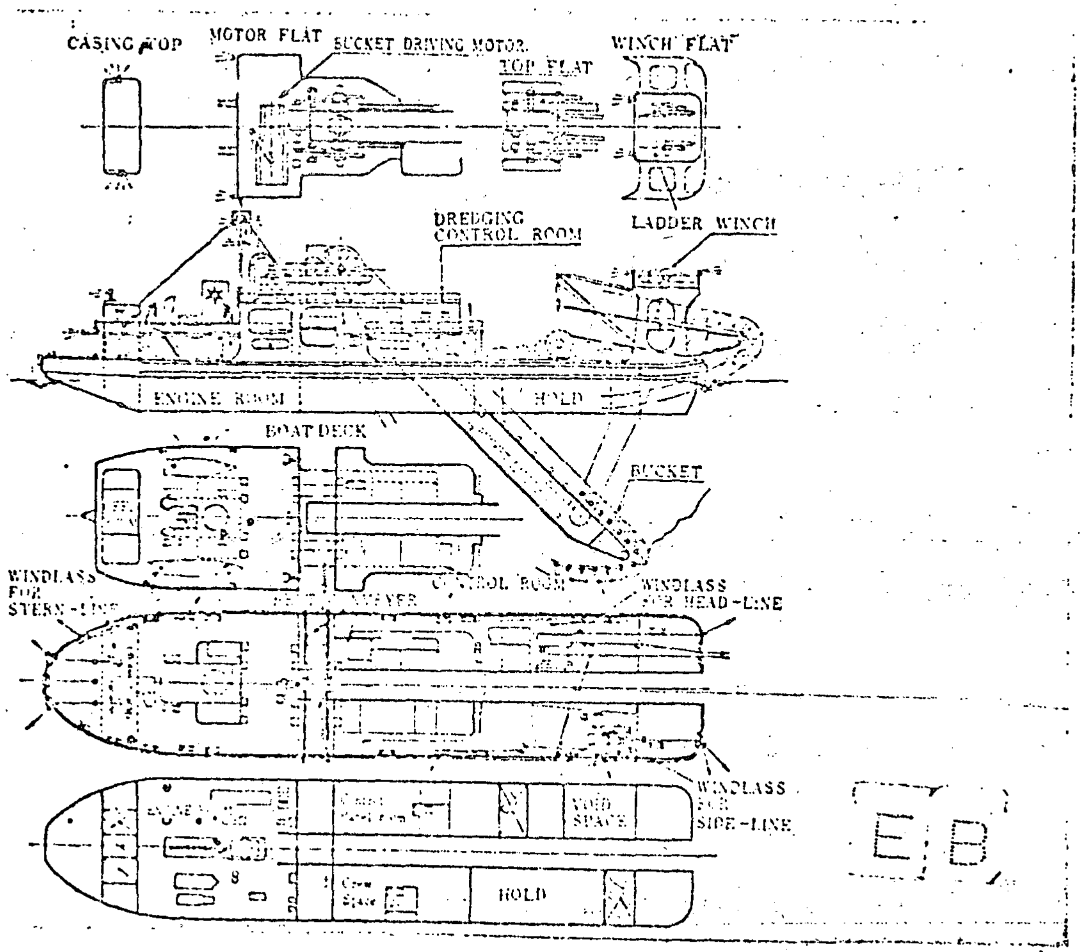
Para terreno duro:	Uno de 7 m3. y 63 tons. de peso
Para terreno suave:	Uno de 12.5 m3. y 45 tons. de peso
	Uno de 20.0 m3. y 100 tons. de peso

Los pesos son sin material.

<u>DRAGAS DE ROSARIO O DE CANJILONES.-</u> Puede ser montado el aparato de dragado tanto en casco hidrodinámico autopropulsado como en -- uno de líneas rectas sin autonomía, dependiendo si las aguas donde opere sean desprotegidas o no.

De los sistemas mecánicos de extracción de material es el único - que tiene una producción contínua debido a que su aparato de dragado esta constituído por una cadena sin fin de botes o canjilo-- nes, apoyada sobre una estructura llamada escala la cual es accio nada a través de un hueco o ranura al centro del casco de proa - a popa conocido como pozo.

Esta escala es arriada hasta adquirir un ángulo máximo de 45° ó- menor, de acuerdo a la profundidad de dragado. (Ver fig. No. 5)



Specifications

Max. dredging depth:	16.5 m
Dredging capacity:	630 m³/h
Bucket:	0.5 m³ X 68 pcs: 20-30 pcs per min
Loa X Lpp X B X D X d:	59/50 m X 54.00 m X 12.00 m X 4.20 m X 2.70 m
Main generator engine:	Diesel 1.000 PS X 325 rpm X 1
Main generator:	No. 1 DC 450 kw. 450 V X 1
	No. 2 DC 200 kw. 225 V X 1
Bucket driving motor:	DC 400 kw X 1
Head line winch motor:	DC 60 kw X 1
Side line winch motor:	DC 35 kw X 2
Stern line winch motor:	DC 35 kw X 1
Ladder hoist winch motor:	DC 90 kw X 1
Date of delivery:	August 1962
Owner:	Harbor Bureau, Tokyo Metropolitan Office

Builder: ....Ishikawajima-Harima Heavy Industries Co., Ltd.

Fig. 5

Los canjilones que se mueven por debajo de la escala, van vacíos, hasta llegar al fondo donde se cargan y suben por la parte superior de la estructura hasta su punto más alto, volteando el material en una banda transportadora o canalón que a su vez vierte en un chalán tolva que lo transportará al lugar de depósito o tiro.

Su forma de operar no es solamente en línea recta sino en forma radial o de abanico, ya que para posicionarse o avanzar, se auxilia de anclas y cables que le permiten girar un determinado ángulo a uno y otro lado, amplitud ésta que recibe el nombre de ancho de corte el cual variará de acuerdo a la longitud de la escala. A la acción de moverse a uno y otro lado se llama abanicar o abanicado.

El corte que ejecuta del terreno es muy regular y se recomienda esta draga principalmente para terrenos duros o roca disgregada.

Su capacidad como en los otros tipos, estará en función de la dureza del suelo, ya que si ataca material duro deberá utilizarse una draga más potente, con canjilones de mayor peso dotados de dientes pero con una separación mayor entre ellos. En estas dragas lleva un papel importante la adecuada planeación del transporte de chalanes tolva al lugar de tiro ó depósito.

Gozan de gran popularidad en Asia y Europa y tienen bastante aplicación en la explotación de minas subacuáticas y para la extracción de grava y arena con propósitos de construcción.

En Nueva Zelandia y Australia se utilizaron para la extracción de oro, habiéndose mejorado el diseño de estas dragas en 1860 para el mismo uso en California y Alaska.

Sus desventajas se pueden resumir en:

1) Desgaste y esfuerzos importantes de las piezas que componen el aparato de dragado.

2) Su poca estabilidad debido a lo pesado y alto de su obra muerta. Este aspecto se ha ido solucionando disminuyendo la altura de la superestructura y aumentando la eslora de la embarcación.

Su profundidad de dragado puede ser hasta de 50 m. (aplicado a la minería) y su máximo rendimiento es de alrededor de 500 m3/Hr.

Para profundidades de 18 m. su rendimiento puede llegar a ser de 800 m3/Hr.

En todas las dragas antes mencionadas se ha hablado de la intervención de los chalanes tolva como complemento de su operación, siendo oportuno decir algo acerca de estos.

Los chalanes tolva pueden ser, de acuerdo a la forma de transporte:

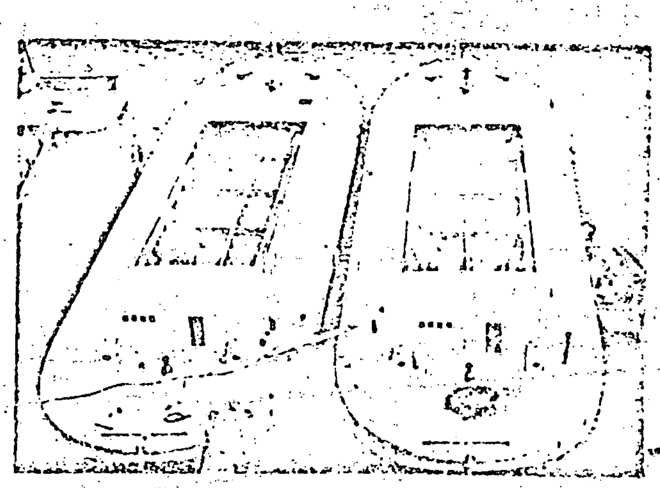
1.- Remolcadores

2.- Empujados

3.- Propulsión propia

y de acuerdo a la forma de descarga:

1.- Por el fondo (Ver fig. No. 6)



Specifications

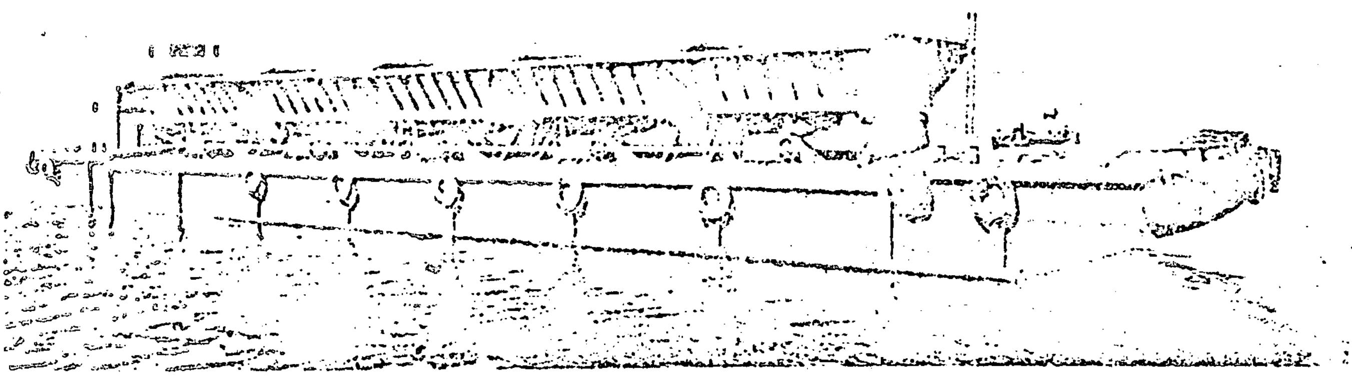
Length:	40.00 m
Breadth:	10.2[illegible] m
Depth:	[illegible] m
Draft:	[illegible] m
Date of delivery:	[illegible] 1960
Owner:	Ministry of Agriculture and Forestry, Japan

Builder: The Hakodate Dock Co., Ltd.

Fig. 6

2.- Lateralmente. (Ver fig. No. 7)

Stone Dump Barge "Seikun Go No. 1"



Characteristics

1. Capable of dumping 40 m^3 of stone in only 3 minutes.
2. Dumping operation can easily be done by one person.
3. Rolling and listing of the barge at the moment of dumping are negligible.
4. The barge, made of steel, hardly sustains damage.

Specifications

Length:	40.00 m
Breadth:	9.00 m
Depth:	2.50 m
Draft:	1.80 m
Stone Vessel capacity	200 m^3
Date of delivery:	July 1963
Owner:	Yorigami Kaiji Kogyosho, LTD.

Builder: ... The Hakodate Dock Co., Ltd.

Fig. 7

Giro completo de la embarcación. (Ver fig. No. 8.

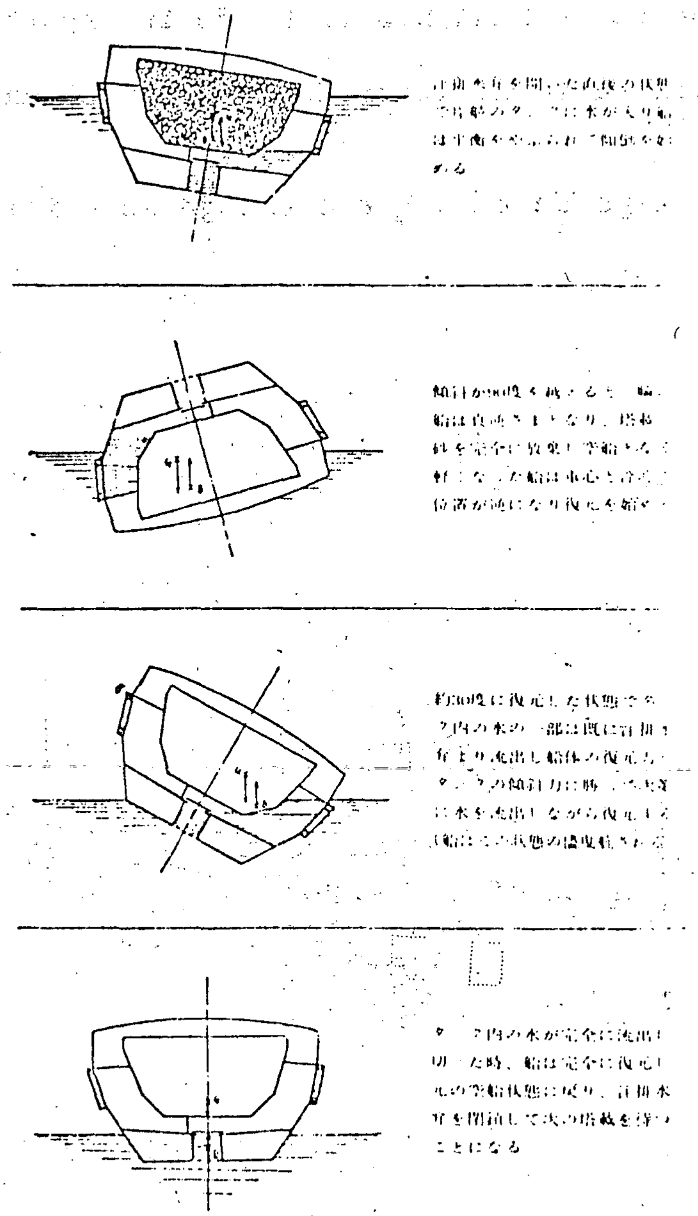


Fig. 8

Con respecto a la forma de la tolva:

1.- Angular (de sección transversal triangular)

2.- Circular (de sección transversal semicircular)

La función de estos chalanes es la de transportar desde el costa do de la draga hasta el lugar de descarga el material extraído.

Para las del tipo de remolque o empuje se utilizan remolcadores- (Ver Fig. No. 9)

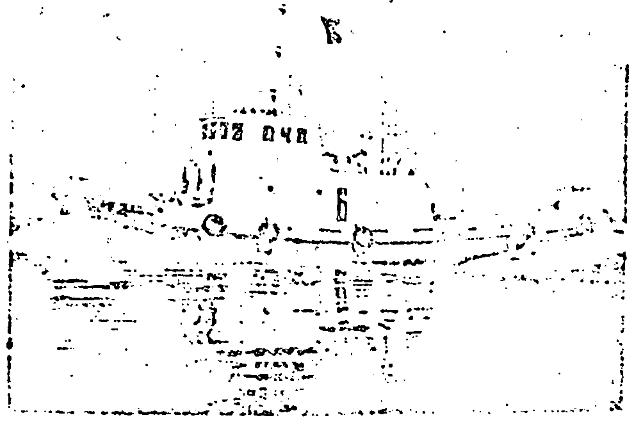


Fig. 9

cuya potencia estará en función del tamaño del chalán a mover --

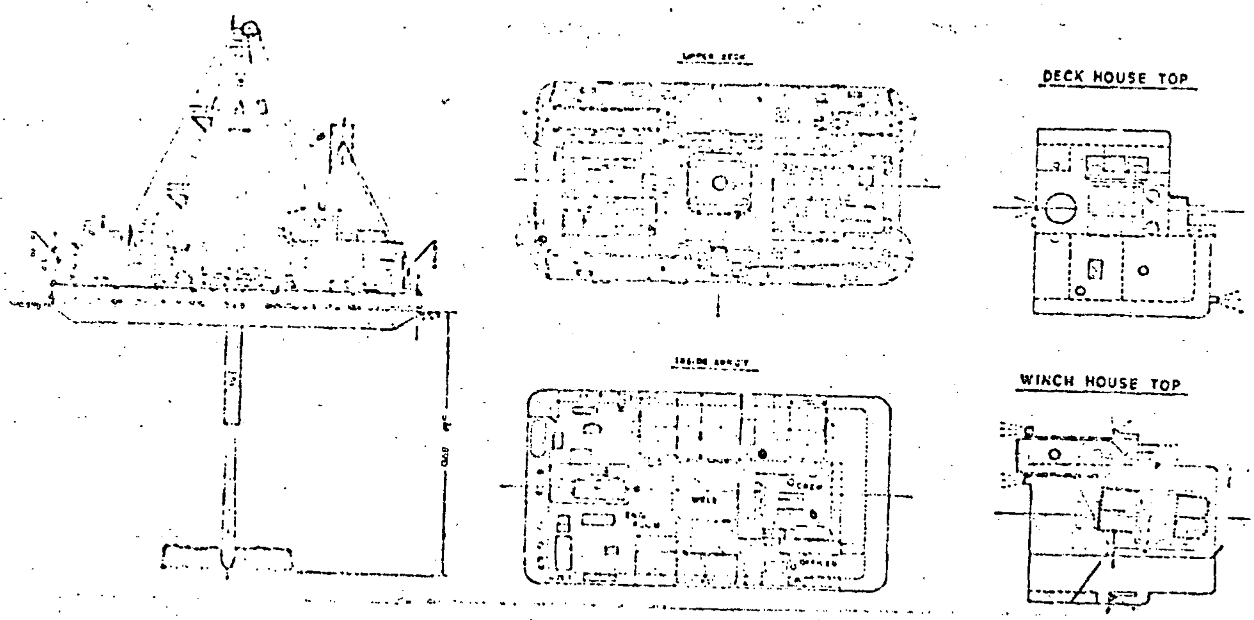
que puede llegar a tener una capacidad de 200 ó 300 m3.

Aunque en la mayor parte de los casos el material extraído puede ser llevado hasta el mismo lugar de depósito y ahí vertirlo, en algunas ocasiones no es accesible a la embarcación por requerirse el depósito en lugares expuestos o tierra adentro, en lugares bajos, por lo que puede presentarse el caso de que el sistema de transporte se transfiera al terrestre, ya sea hidráulica o mecánicamente; siendo en este caso que los chalanes tolva de sección semicircular, son utilizados para permitir que una rueda de canjilones extraiga el material de la tolva y lo coloque sobre bandas transportadoras hasta un lugar donde se reinicie el transporte con camiones, tuberías o nuevamente bandas transportadoras.

Antes de continuar con la descripción de los otros tipos de dragas y por ser también común a los equipos ya descritos, se mencionará la quebradora de roca, que es un equipo complementario importante cuando se trata de atacar suelos rocosos.

La quebradora de roca es un equipo destinado a romper el material en fragmentos que después puedan ser extraídos por cualesquiera de los tipos de draga antes mencionados.

Consiste de un chalán donde se monta una estructura piramidal que sirve de sostén y guía del martillo cuya profundidad de caí da puede ser entre los 18 y 20 m. Ver Fig. 10)



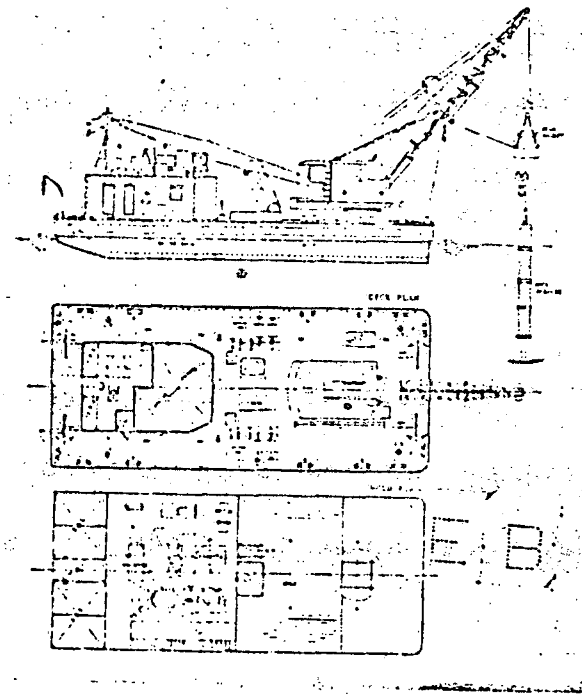
Specifications

Lpp × B × D × d:	23.00 m × 12.50 m × 2.40 m × about 1.20 m
Main generator engine:	Diesel 170 PS × 1,200 rpm × 1
Main generator:	140 kVA × 450 V × 1
Rock breaker	About 25 tons
Guide:	About 12 tons
Hoisting winch:	45 tons × 10 m/min with 85 kw motor × 1
Date of delivery:	March 1962
Owner:	Ministry of Transportation, Japan

Builder: ... Sasebo Heavy Industries Co., Ltd.

Fig. 10

El martillo es de caída libre o percusión. En el primer caso, la energía está en función del peso del martillo (25 ó 30 tons) y - la altura de caída; en el segundo, de la capacidad del sistema - neumático principalmente. Los equipos neumáticos son más eficien tes debido al número de golpes que pueden dar por minuto. (Ver fig. 11)



Specifications

Type of rock breaker	Compressed air driven percussion hammer type
Maximum rockbreaking depth:	15 m under water
Rock breaking capacity:	Striking force 1,800 kg-m
	Number of blows 105/min
Lpp × B × D × d:	19.60 m × 8.40 m × 2.00 m × 1.00 m
Generator	AC 30 kVA × 225 V, 60 cycle × 1
Generator engine:	Diesel 40 PS × 1,200 rpm × 1
Dredging equipment:	
Air compressor:	2 cylinder double acting, 2 stage type × 1
Air compressor engine:	Diesel 220 PS × 1,800 rpm × 1
Derrick apparatus	1
Prime mover	Diesel 125 PS × 1
Maximum lift above W.L.:	9 m
Maximum lift under W.L.:	15 m
Working radius	8.5 m
Hoisting load:	8 tons
Slewing speed:	3 rpm
Grab bucket capacity:	1.3 m³
Date of delivery:	March 1960
Owner	Hokkaido Development Agency

Builder: Ishikawajima-Harima Heavy Industries Co., Ltd.

Fig. 11

Su rendimiento difícilmente sobrepasa los 10 m3/Hr. Existiendo - otros tipos que combinan la perforación de las rocas con tala- - dros y el uso de explosivos. Sin embargo para lugares próximos a instalaciones, no es recomendable amén de que existen países que cuidan celosamente la fauna marina y no permiten el uso de explosivos bajo el agua.

Un sistema que aún se encuentra en vías de experimentación, es el de utilizar uno o varios chorros de agua a muy alta presión que pasan a través de boquillas que cortan la piedra por dura que esta sea.

DRAGAS HIDRAULICAS.- Representan el más grande adelanto tecnológico aplicado a las operaciones de dragado y son las que más innovaciones han recibido, volviéndolas el equipo más versátil de todos los existentes.

En estos como en los anteriores, también existen los siguientes tipos:

1.- De tolva

2.- Estacionarias

3.- Fijas

DRAGAS DE TOLVA.- Las dragas de tolva en su totalidad son autopropulsadas y consecuentemente, su casco es de formas finas que le permiten navegar sin demasiada resistencia. (Ver fig. 12)

Specifications

Max. dredging depth:	17 m (drag arm inclination 40°)
Hopper capacity:	2.050 m^3
Dredging pump:	5.000 m^3/h X 17.0 m X 210 rpm X 2
Max. discharge distance:	2.000 m
Suction and discharge pipe dia:	Suction 630 mm, Discharge 560 mm
Loa X lpp X B X D X d:	91.05 m X 85.00 m X 16.00 m X 7.00 m X 5.80 m
Gross tonnage and deadweight:	3,212 tons and 3,521 tons
Speed at trial:	13.27 knots
Dredging speed:	About 3 knots (against the tidal current of 3 knots for soft mud)
Navigation area:	Greater coasting
Class:	Japanese Government
Propulsion motor:	AC 1.000 kw X 1.200 rpm X 2
Propeller:	3 blade controllable pitch propeller 2.7 m diameter X 240 rpm X 2
Main generator engines	Diesel 2.400 PS X 514 rpm X 2
Main generator:	AC 1.900 kVA X 514 rpm X 3.300 V X 2
Dredging pump motor:	AC 500 kw X 1.200 rpm X 2 Static Krämer control
Bow thruster:	3 blade, reversible, adjustable pitch propeller type driven by a 3 stage pole change 220/110/55 kw AC motor
Drag arm:	Side trailing type X 2
Drag head:	Self adjustable type and adjustable type 2 sets each
Trunnion:	Sliding type X 2
Oil hydraulic motor	
Drag head winch:	50 kw X 1.100/550 rpm X 2
Ball joint winch:	20 kw X 1.680/840 rpm X 2
Trunnion winch:	20 kw X 1.680/840 rpm X 2
Complement:	61 persons (3 shifts)
Date of delivery:	March 1964
Owner:	Ministry of Transportation, Japan

Builder: ....Ishikawajima-Harima Heavy Industries Co., Ltd.

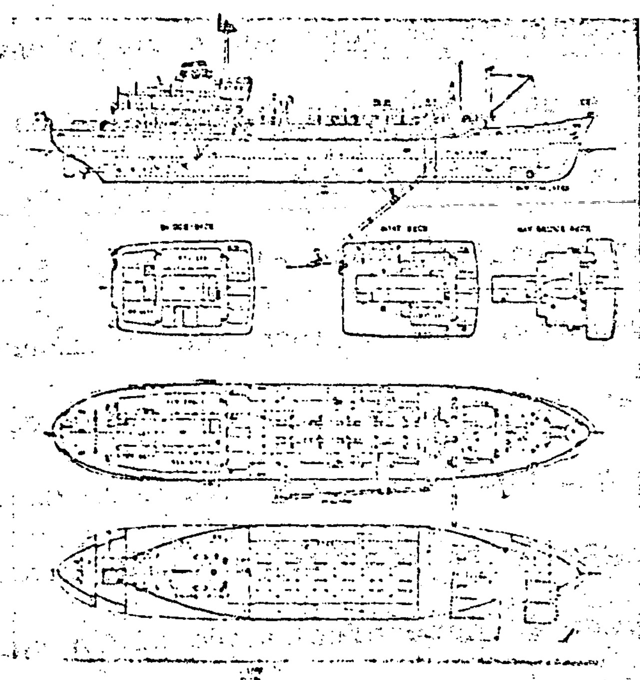


Fig. 12

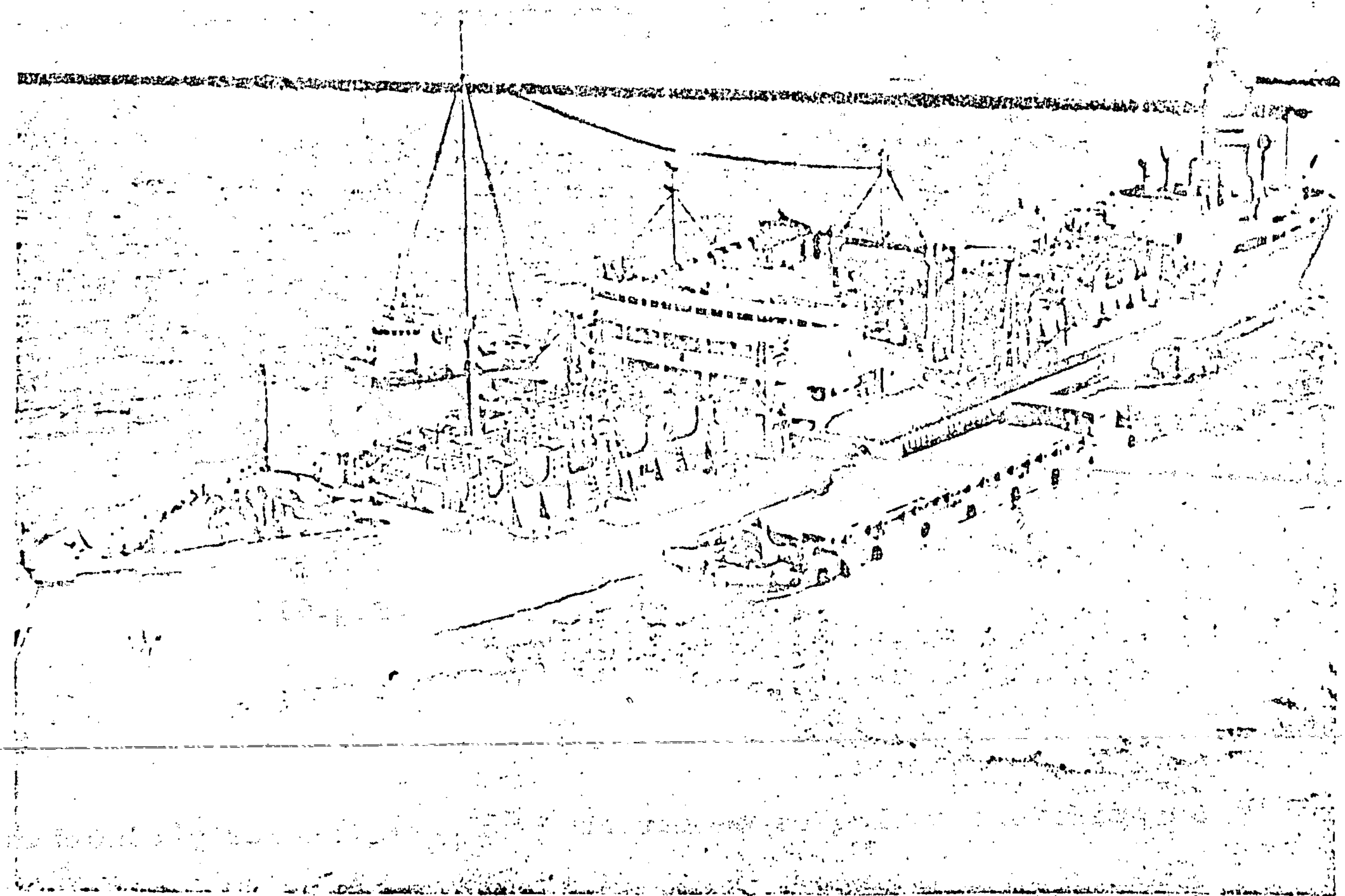
Su forma de dragar es navegando a una velocidad lenta que varía entre uno y tres nudos (1 nudo = 1 milla marina/hora).

El material es levantado del fondo mediante una tubería que en su extremo inferior tiene una rastra o cabeza, ascendiendo aquel por el tubo debido a la acción de una bomba centrífuga instalada a bordo de la embarcación.

El material succionado pasa por la bomba, para después mediante tuberías de distribución, enviarlo a las secciones en que está dividida la tolva. La razón de los mamparos divisorios es la de aumentar la longitud del trayecto del material dentro de la tolva a fin de disminuir la velocidad del agua y provocar la decantación de los sólidos.

Es importante hacer notar que el material dragado es transportado en un alto porcentaje de agua (85 ó 90%) siendo el resto de material. El agua es derramada por los vertedores dispuestos por ambas bandas de la tolva y en toda su longitud. Una vez que la draga completa su capacidad deja el lugar de trabajo para transladarse al de descarga, travesía en que la embarcación puede normalmente, alcanzar una velocidad de 10 a 15 nudos descargando en el lugar de tiro que pueden ser en alta mar, donde el depósito no afecte la navegación ni produzca azolvamientos en otras áreas o, en el lugar donde se esté efectuando algún relleno.

Estas dragas pueden ser muy versátiles; hay algunas con zancos y cortadora en el extremo de la tubería de succión; con instalaciones para descargar por tubería hacia los costados hasta 100 m. de distancia o a chalanes tolva. (Ver fig. 13).



Specifications

Main pump:	Vertical, single suction, single stage spiral pump. 4,200 m^3/h × 18 m × 220 rpm × 2
Suction pipe dia:	580 mm
Discharge pipe dia:	580 mm
Pump engine:	Diesel, 600 PS × 600 rpm
Jet pump:	Vertical, double suction, single stage spiral pump. [illegible] 800 m^3/h × 20 m × 2
Suction pipe dia:	[illegible] 65 mm
Discharge pipe dia:	[illegible] mm
Pump engine:	Diesel [illegible] × 2
Vessels fitted with the equipment:	Kouchi Maru and Harima Maru
Date of completion:	January 1963
Owner:	Mitsui O.S.K. Lines, Ltd.

Builder: Watanabe Steel Works, Ltd.

con uno, dos ó más tubos de succión; con dos hélices y dos timones en popa y una hélice en proa para hacerlas altamente maniobrables en espacios reducidos. (Ver fig. 14).

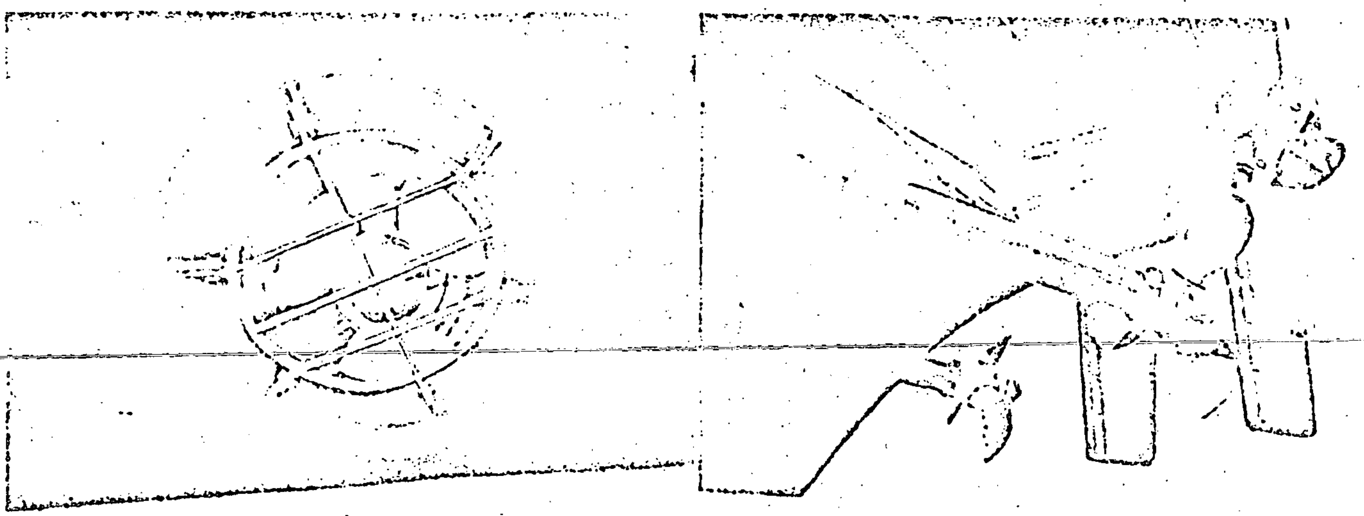


Fig. 14

Su principal empleo es en mar abierto o en canales y dársenas donde una draga estacionaria podría ser un obstáculo.

Las cabezas de succión están divididas en dos tipos principales:

1.- Coral (Ver fig. 15)

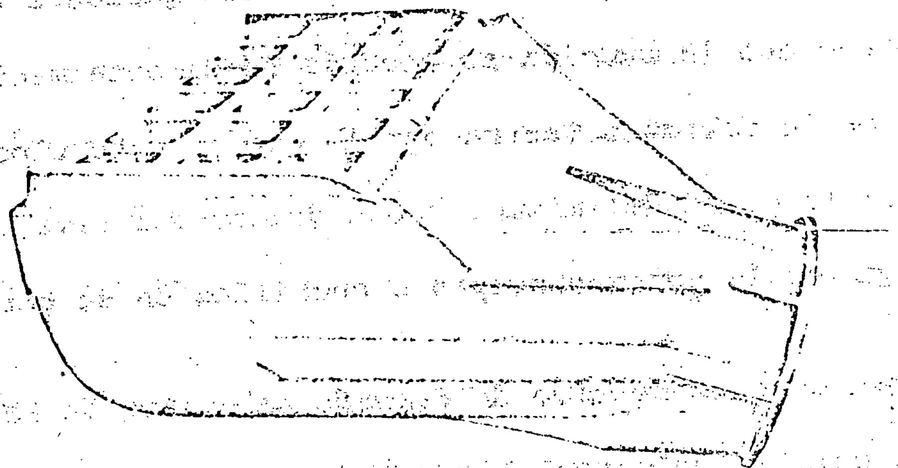


Fig. 15

2.- California. (Ver fig. 16).

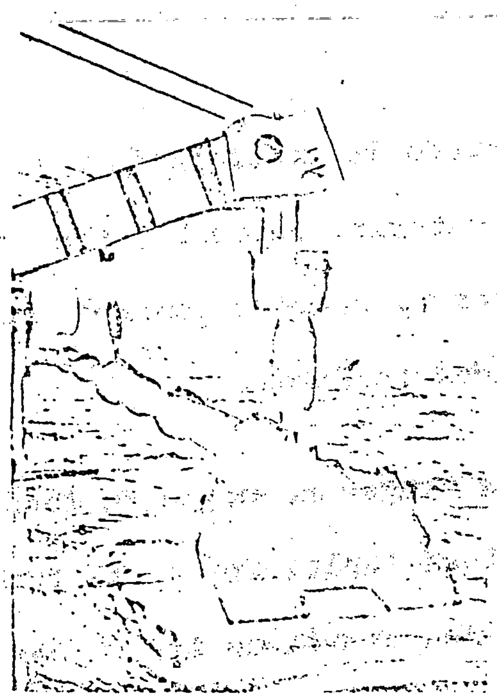


Fig. 16

La primera destinada al dragado de material suave.

La segunda ha sido resultado de investigaciones donde se ha comprobado que la succión se efectúa fundamentalmente por el perímetro de la cabeza o rastra por lo que en este tipo se ha aumentado la longitud del mismo. Puede dragar una gama mayor de materiales si se le ponen escrepas o cuchillas en su parte posterior.

Normalmente el sentido de dragado en contra de la corriente si esta existe (de marea, litorales o fluviales).

Existen dos métodos para dragar:

1.- Sistema Americano

2.- Sistema Europeo

El primero se efectúa con la draga en movimiento, arando el fondo.

El segundo es fijando la embarcación y succionando del mismo lugar hasta que el material derrumba, Sin embargo, en lugares próximos a instalaciones, no se recomienda por la posibilidad de amenazar la estabilidad de éstas.

Debido a que estas dragas no dejan un fondo con una cota uniforme, se ha ideado instalarles dos o mas tubos de succión de tal forma que se eliminen el máximo los s[illegible]cos.

Cuando en el lugar en que se draga la corriente es importante -- (por ejemplo en los ríos en época de avenidas) y el material es fino, se utiliza el método de dragado por agitación consistente en dejar que la corriente lo transporte en suspensión siempre y cuando el lugar donde se deposite no cause azolvamientos perjudiciales.

Con respecto a la eficiencia de estas dragas por su trabajo continuo mientras draga, es alto. Sin embargo, se ve afectada por la necesidad de suspender el dragado para ir al lugar de tiro -- donde deposita el material mediante la apertura de las compuertas que forman la parte inferior de la tolva.

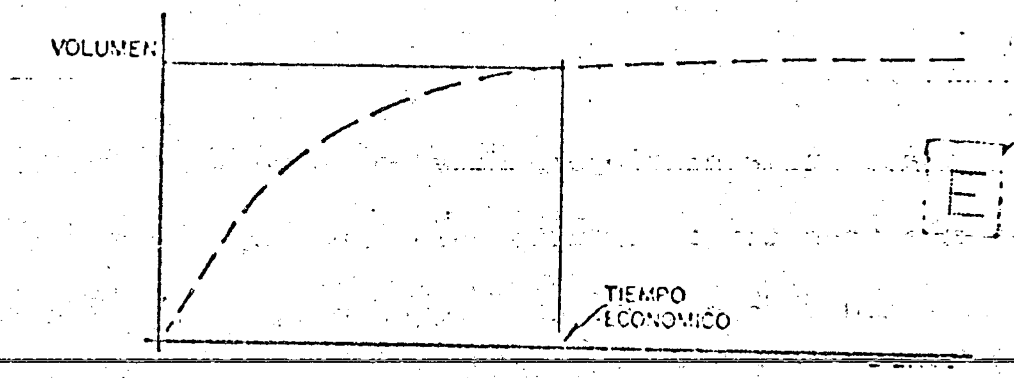
Solo es factible hablar de que la tolva se llena al máximo, cuando el material dragado es pesado; pero si este es ligero, la tolva no completa su capacidad ya que el material no alcanza a decantar regresando nuevamente al agua por los vertedores.

En este caso, se recurre al tiempo económico de dragado consistente en encontrar el tiempo mínimo con que puede obtenerse el mayor depósito de azolve dentro de la tolva.

Aún cuando existen ecuaciones para determinar este tiempo, se -- puede aplicar una forma práctica de hacerlo, que consiste en sondar la tolva cada determinado tiempo; cuando el volúmen ya no -- tiene incrementos importantes para los mismos intervalos, se de-

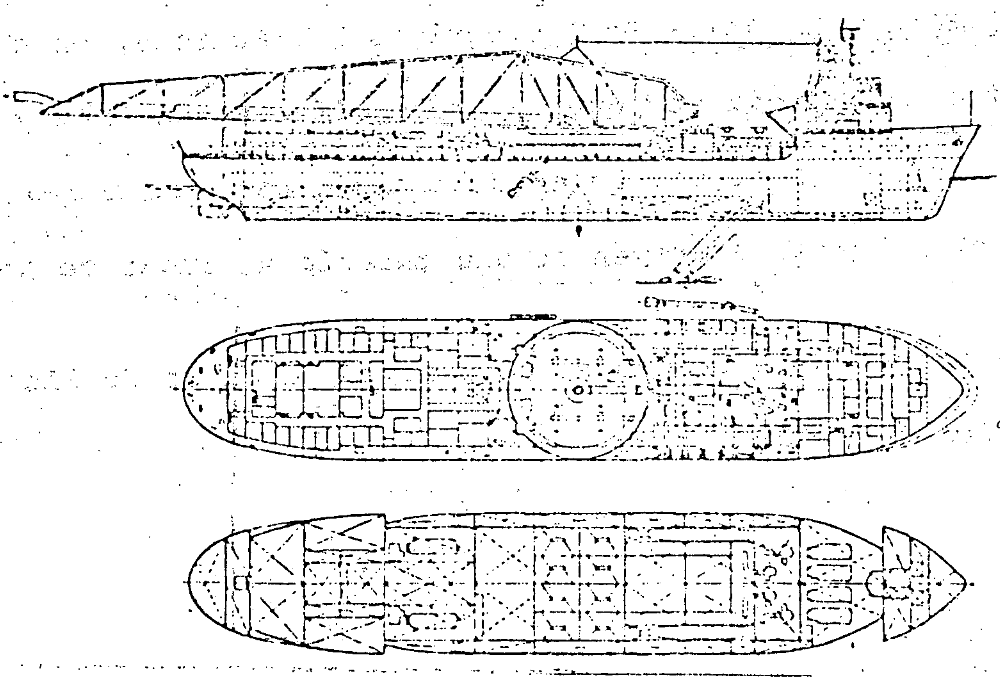
EB

be suspender el dragado e ir al lugar de descarga. La gráfica si guiente lo ejemplifica:



Esto es sin hacer intervenir otros paramétros como son: el tiempo navegando y descarga en el lugar de tiro, costo del equipo,condiciones de trabajo,etc.

De estas dragas se han construído algunas de gran capacidad para- operar en áreas remotas aprovechando buques tanque que ya no son- útiles para este fin, como por ejemplo: las dragas Zulia para dragar en el lago Maracaibo y Kamachi Maru(Fig. 12) que son equipos- que pueden almacenar en su tolva o descargar a chalanes; otras ya construídas exprofeso con la MC FARLAND y la ICOA. (Ver fig:17)



Specifications

Max. dredging depth:	18.3 m
Hopper capacity:	2,330 m^3
Dredging pump:	19,300 m^3/h × 235 rpm × 4
Suction and discharge pipe dia:	Suction 510 mm, Discharge 440 mm
loa × lpp × B × D × d:	162.20 m × 149.40 m × 29.00 m × 12.20 m × 7.20 m
Gross tonnage:	15,000 tons
Deadweight:	10,279 tons
Speed at trial:	13.98 knots
Speed while dredging:	3–6 knots
Navigation area:	Ocean going
Propulsion engines:	Diesel 5,250 PS × 255 rpm × 2
Main generator engine:	Diesel 2,000 PS × 514 rpm × 4
Main generator:	AC 1,250 kw × 4
Dredging pump engine:	Diesel 3,420 PS × 235 rpm × 4
Bow thruster:	Electric 170 kw × 2
Drag arm:	Side drag type 2, center drag type × 2
Drag head:	California type × 4
Trunnion:	Sliding type × 2 fixed type × 2
Date of delivery:	June 1961
Owner:	Universe Tankership Inc.

Fig. 17.

esta última con capacidad en la tolva de 2,330 m3., construída - para el dragado del río Orinoco en Venezuela!

DRAGAS ESTACIONARIAS.- De los equipos hidráulicos, es el de mayor eficiencia toda vez que su producción es continua y no requiere de retirarse del lugar de trabajo para descargar, ya que envía el material a través de una tubería al lugar de depósito.

Generalmente estas dragas se construyen en casco de líneas rectas. (Ver fig. 18).

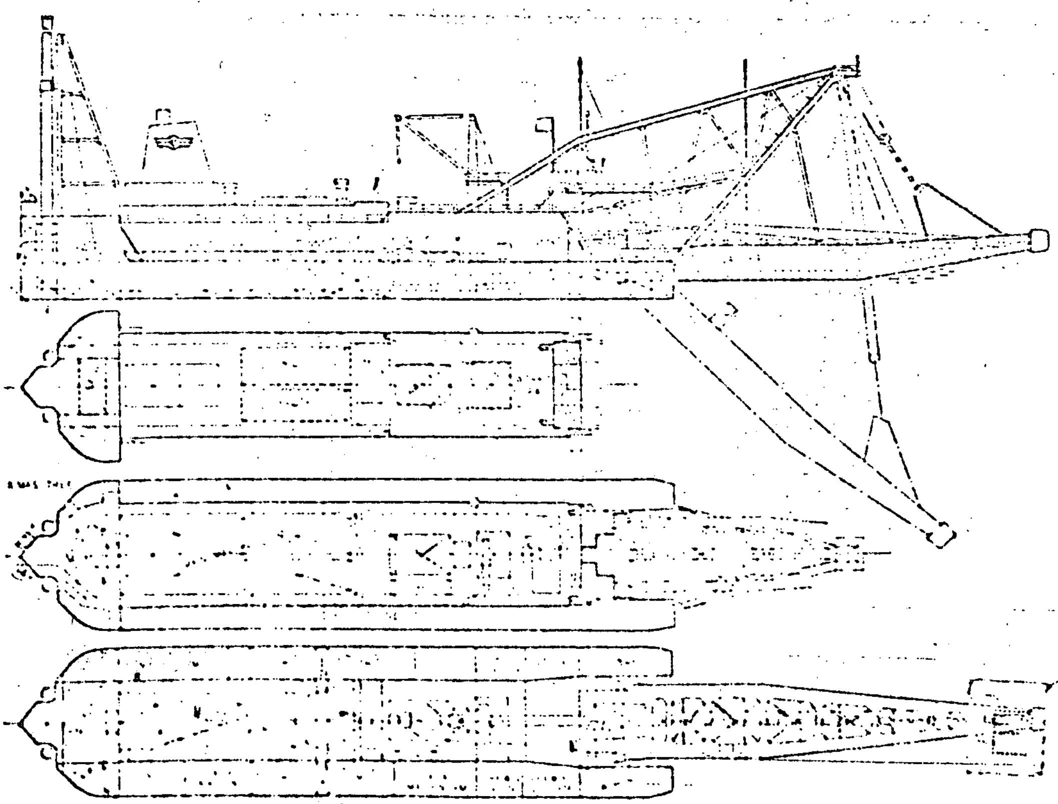


Fig. 18

Specifications

Max. dredging depth:	30 m
Nominal discharge distance:	6,000 m
Max. discharge distance:	8.000 m
Nominal dredging capacity:	1,500-2.000 m³/h
loa X lpp X B X D X d:	114.00 m X 72.57 m X 17.50 m X 4.27 m X 3.10 m
Dredging pump:	10,000 m³/h X 100 m X 350 rpm X 1
Suction and discharge pipe dia.:	Suction 915 mm, Discharge 760 mm
Dredging pump motor:	AC 6.000 kw X 270-350 rpm X 1
Cutter:	5 or 6 blade enclosed type max. 36 rpm
Cutter motor:	Ward-Leonard DC 1,500 kw X 1
Ladder and swing winch motor:	Ward-Leonard DC 260 kw X 1
Spud and Christmas-tree winch motor:	Ward-Leonard DC 140 kw X 1
Main generator:	AC 13.524 kVA X 6.600 V X 60 c/s X 3.600 rpm X 1
Main generator steam turbine:	12,650 kw X 3.600 rpm X 1
Main boiler:	44 kg/cm² X 440°C X 55.300 kg/h
Date delivery:	April 1964
Owner:	Japan Development & Construction Co., Ltd.

Builder: ...Mitsubishi Heavy Industries, Ltd.

Fig. 18

Básicamente están constituídas por los mismos elementos hidráulicos que las de autopropulsión, a excepción de la tolva que -- las estacionarias no tienen.

El posicionamiento y avance de esta draga es mediante zancos y- anclas.

Sus partes fundamentales de trabajo aparte del aparato hidráulico, son:

1.- Escala (con o sin cortadora)

2.- Zancos

3.- Cables para abanicar

4.- Tubería flotante de descarga

5.- Tubería terrestre de descarga

6.- Plumas para los cables través (opcional)

Escala.- Es el elemento a través del cual baja el tubo de succión hasta el fondo de donde extrae el material.

Si el fondo es suave la simple succión es suficiente para hacerlo ascender por la tubería. (Ver fig. 19)

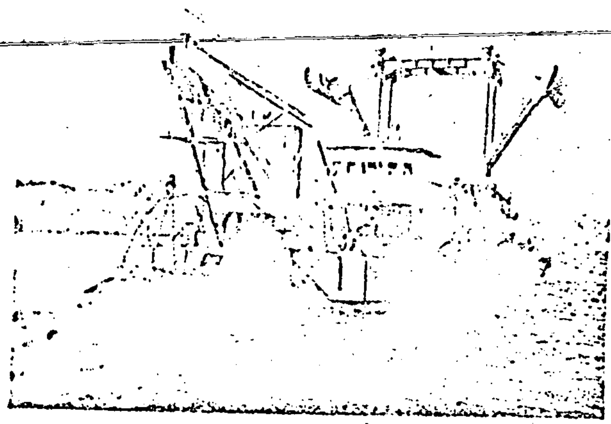


Fig. 19

Si el fondo es material compactado, entonces la escala en su extremo inferior, se dota de una cabeza cortadora que afloja el material para que este sea succionado por la bomba.

Existen varios tipos de cortadoras dependiendo del material que - ataquen pudiendo ser: abiertas para arcillas; de corona para arena y dentadas para materiales, muy duros y conglomerados. (Ver figs. 20, 21 y 22).

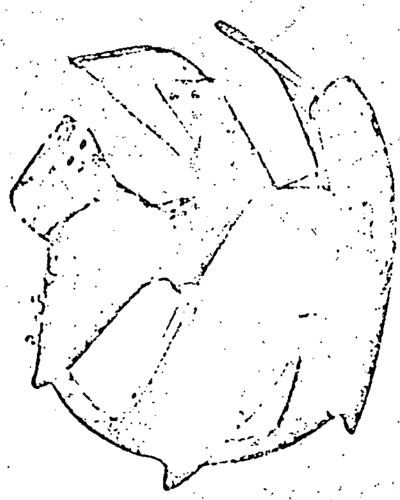


Fig. 20

Fig. 21

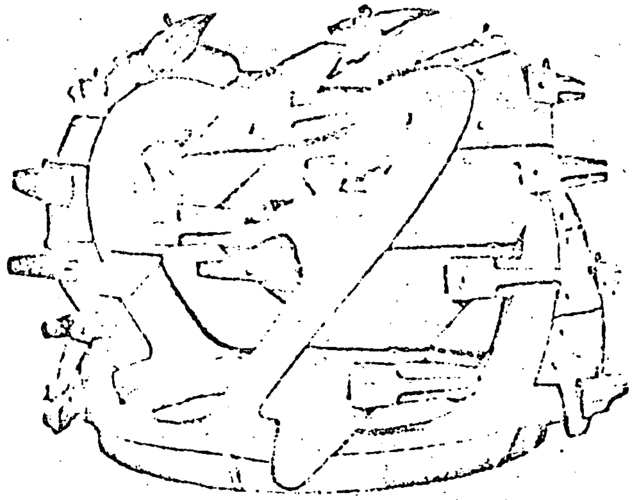
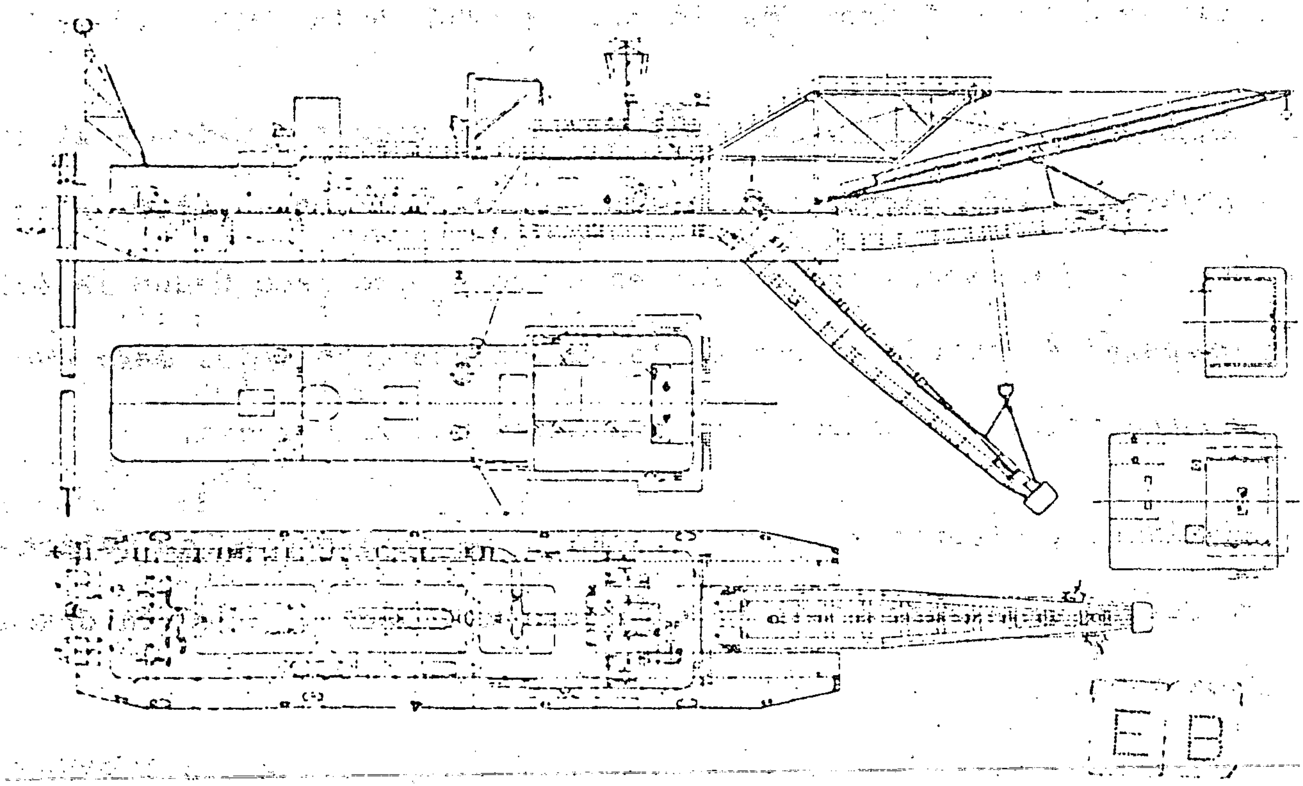


Fig. 22

Zancos.- Son dos elementos tubulares de gran longitud, de sección circular o cuadrada, que le sirven para posicionarse y avanzar, localizados en la popa de la embarcación. (Ver fig. 23).



Specifications

Max. dredging depth:	25 m
Nominal discharge distance:	2,000 m
Max. discharge distance:	4,000 m
Suction and discharge pipe dia:	Suction 915 mm, Discharge 760mm
Loa × Lpp × B × D × d:	97.20 m × 67.10 m × 15.85m × 4.27 m × 2.80 m
Dredging pump engine:	7,000 PS × 330 rpm × 1
Dredging pump:	8,000 m³/h × 25 m × 1
Main generator engine:	3,850 PS × 600 rpm × 1
Main generator:	AC 875 kVA × 1, DC 1,200 kw × 1, DC 300 kw × 1
Cutter:	Basket sheaths type × 1, Basket teeth type × 1
Cutter motor:	DC Ward-Leonard 570 kw × 2
Swing motor:	DC 140 kw × 1
Spud motor:	AC 150 kw × 1
Ladder motor:	AC 220 kw × 1
Date of delivery:	September 1962
Owner:	Toa Harbor Works Co., Ltd.

Builder: .... Nippon Kokan K.K.

Fig. 23

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El zanco de trabajo, (que es el más próximo a la tubería de descarga) es hincado en el fondo y servirá de pivote durante su operación de dragado.

El otro zanco o zanco de avance, es el que le servirá para avanzar en cuanto el área dragada haya quedado a la cota requerida.

Cables para abanicar.- De un lugar de la escala próximo a la cabeza cortadora parten dos cables de acero que en su otro extremo tienen un ancla que se fondea a uno y otro lado donde la draga este efectuando su corte, lo suficientemente lejos para que no sea necesario enmendarlas con demasiada frecuencia.

Arriando y virando simultáneamente estos cables con los malacates de proa y apoyándose en el zanco de trabajo, podrá la draga abanicar.

Tubería flotante de descarga.- Es la continuación de la tubería de a bordo. Por la misma condición de trabajo, esta deberá ser suficientemente flexible por lo que los tramos que la forman serán cortos (entre 6 y 15 m), unidos entre sí por conexiones de rótula o tramos de manguera de hule.

Para mantener la línea a flote a fin de hacer sencilla la maniobra de desconexión, inspección y aumento de tramos de tubería, esta descansa sobre flotadores o pontones que pueden ser colocados con su eje mayor paralelo o perpendicular al eje de la tubería .

<u>Tubería terrestre de descarga.-</u> Es la que se tiende en las zonas bajas terrestres donde se pretende llevar a cabo el depósito del material.

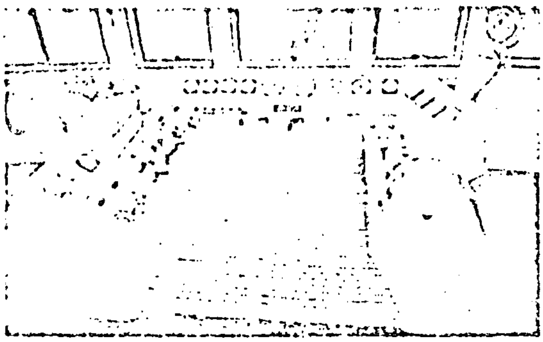
Generalmente se apoya sobre trozos de madera o caballetes con -- su extremo de descarga elevado a fin de evitar que la tubería se sepulte. Los tramos de tubería terrestres se conectan enchufándo los unos con otros, en vista de tener uno de sus extremos forma-troncocónica.

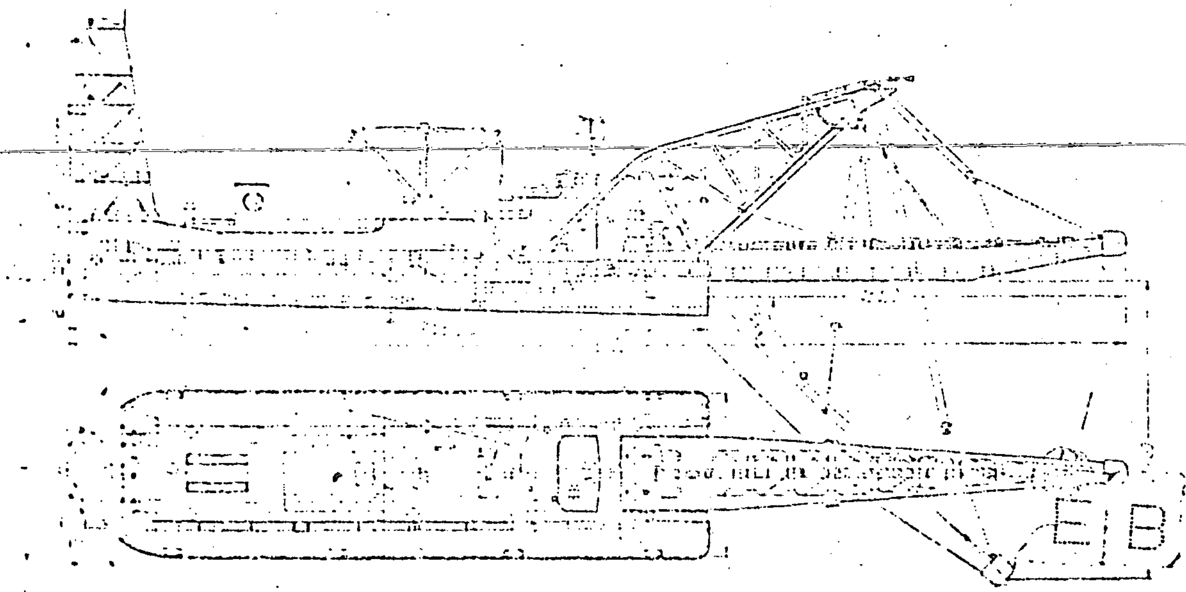
<u>Plumas para los cables través.-</u> Las dragas estacionarias se han-dotado en la proa y por ambas bandas, de dos plumas que sirven - para enmendar las anclas de los cables través con que abanica, - eliminando así el chalán grúa encargado de esta operación.

Las ventajas principales de estas dragas son la continuidad del-trabajo y la uniformidad de la cota después del dragado.

Aunque estos equipos fueron diseñados para operar en aguas protegidas debido a que los zancos resultan demasiado frágiles en lugares expuestos al oleaje, este inconveniente se ha superado - - substituéndolos por tres cables que trabajan por la popa, sistema conocido como árbol de navidad.

El cual permite el dragado en aguas con cierto oleaje. (Ver fig.- 24).





Specifications

Max. dredging depth:	30 m
Nominal discharge distance (fine sand):	4,000 m
Loa × Lpp × B × D × d:	107.50 m × 64.80 m × 17.20 m × 4.50 m × 2.84 m
Dredging pump engine:	Diesel 4,000 PS × 330 rpm × 2
Dredging pump:	7,200 m³/h × 105 m × 330 rpm × 1
Main generator engine:	Diesel 3,600 PS × 514 rpm × 1
Main generator:	AC 2,500 kw × 1
Suction pipe dia:	900 mm
Discharge pipe dia:	760 mm
Cutter revolution:	24, 16, 12 rpm
Cutter motor:	AC 800 kw × 2
Swing winch motor:	200 kw × 1
Spud winch motor:	150 kw × 1
Ladder winch motor:	260 kw × 1
Date of delivery	June 1963
Owner:	Saeki Kensetsu Kogyo Co., Ltd.

Builder:..........Uraga Heavy Industries, Ltd.

Fig. 24

Otro inconveniente superado también, es el obstáculo de las tuberías flotantes que dificultan la navegación sobre todo en áreas - de intenso tráfico marítimo.

Aunque no se elimina totalmente la tubería flotante, sí una granparte se hace permanecer en el lecho marino.

Estas dragas se construyen en una amplia gama de tamaños pudiendo ir desde los 40 m3/Hr. hasta 2,000 m3/Hr. de material sólido.Las- pequeñas se diseñan de tal forma que su casco pueda seccionarse en 3 ó más partes, lo que les permite ser transportadas por vía te-- rrestre por cualesquiera de los medios existentes, facilidad que- las torna en equipos portátiles que pueden dragar en zonas tierra adentro, sin que éstas tengan acceso a vías de navegación para el transporte del equipo.

Muchos son los aditamentos que se le han incluído a estas dragas- para aumentar su eficiencia, entre ellos, los chorros de agua que ayudan a la fuerza de succión a elevar el material, lográndose -- dragados a mayor profundidad cuyo mayor problema es la cavitación.

Actualmente existe una draga con escala de 69 m. que efectúa dragados hasta a 61 m. de profundidad.

La eficiencia de estos equipos está regida por la profundidad de-

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dragado, dureza del material, altura y longitud de descarga y habilidad del operador.

La distancia máxima de descarga es de 4,000 m.(dependiendo del material y altura de descarga). Cuando se requiere que el material- sea enviado a distancias mayores, se hace uso de subestaciones de bombeo distribuídas convenientemente a lo largo de la tubería, para mantener la velocidad del transporte y evitar sedimentaciones- en la línea.

DRAGAS FIJAS.- Desde el punto de vista de la forma hidráulica de- extraer el material así como de transportarlo, utiliza el mismo - sistema mencionado para los dos últimos tipos de draga antes descritos. Sin embargo, la draga fija carece de movimiento, es decir, que es una estructura convenientemente situada, donde se localizan las bombas.

En la costa de California (en Sta.Bárbara actualmente en operación y aquí en México (en Salina Cruz) fueron instaladas dragas de este tipo.

Desafortunadamente, la de Salina Cruz no tuvo el éxito esperado - por haber quedado en poco tiempo aislada del agua necesaria para- el transporte de la arena. La difusión de este tipo de draga la - cual trabaja por derrumbe, ha sido muy poca, debido a que una falla en la localización, la deja inutilizada o trabajando con muy bajo rendimiento.

EQUIPOS DE DRAGADO PARA GRANDES PROFUNDIDADES.- Aún cuando por mucho tiempo la función primordial del dragado fue la de extraer material del fondo a fin de hacer la navegación segura dentro de los puertos y accesos a éstos, la Ingeniería a aceptado el reto de extraer minerales, materiales pétreos para construcción e intentar obras bajo las aguas cuya superficie es 3 veces mayor que la de la corteza terrestre.

En un principio, esto se llevó a cabo con cierto éxito en aguas relativamente bajas, con los mismos tipos de dragas con que se profundizaban los puertos y canales; sin embargo, cada vez se requiere ir a mayores profundidades con equipos más eficientes y sofisticados.

Las dragas de canjilones, han sido aplicadas en la extracción de oro en Australia, California y Alaska; en la explotación de estaño en el Sudeste Asiático y en E.U. y Japón, para extraer materiales tales como arena y grava para obras portuarias.

Aunque los equipos para grandes profundidades en sus diseños avanzados se encuentran todavía en etapa de estudio, el sistema de dragado con aire (Air lift) ya desde hace tiempo, se aplica con buenos resultados.

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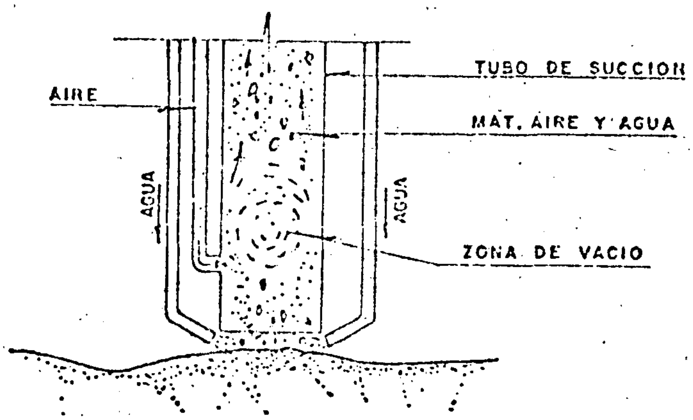
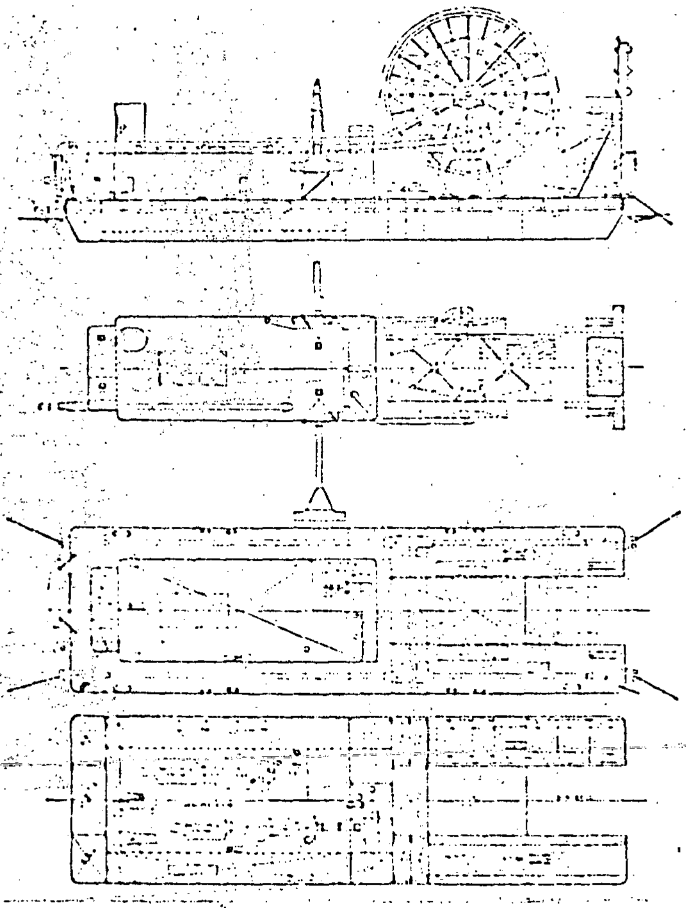
El sistema consiste de un tubo con una conexión lateral para - - una tubería de aire que enrarece el ambiente interior del tubo - y por diferencia de presiones ascienden las particulas sólidas. Se han aplicado chorros de agua en el extremo de la tubería para ayudar a desprender los materiales del fondo, con lo que se ha - aumentado la eficiencia. El siguiente esquema ejemplifica el sis tema.



Asímismo, para la explotación de bancos de arena ó grava, se uti lizan las dragas dotadas del sistema de chorro de agua y succión.

El chorro de agua sirve para retirar la capa de fango que se en- cuentre sobre la arena o grava y la succión toma el material de- buena calidad depositándolo en chalanes tolva, auxiliándose con-los chorros de agua. Su profundidad de dragado es a la fecha de -100 m. (Ver figs. 25 y 26).



Specifications

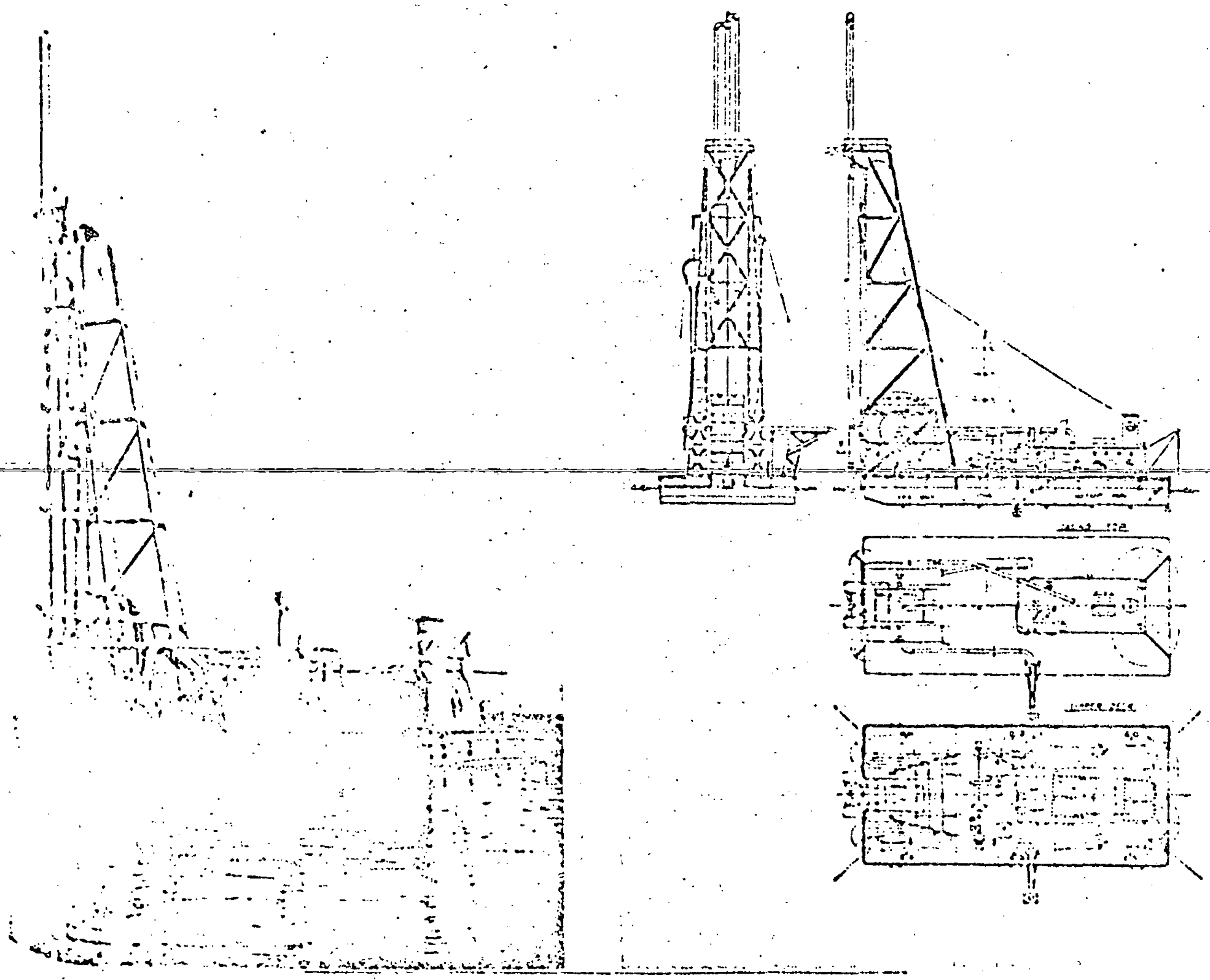
Max. dredging depth:	100 m
Nominal discharge distance (using a booster pump):	2.000 m
Nominal dredging capacity (gravel content 11.5%):	240 m^3/h
Main pipe dia:	
Jet and ejector water line:	300mm each
Mud line:	445 mm
Loa X lpp X B X D X d:	49.00 m X 47.40 m X 14.50 m X 3.50 m X 2.10 m
Ejector pump:	1.200 m^3/h X 160 m X 1.880 rpm X 1
Jet pump:	1.100 m^3/h X 180m X 2.010 rpm X 1
Ejector and jet pump engine:	Diesel 2.500 PS X 540 rpm X 1
Booster pump:	2.200 m^3/h X 90 m X 485 rpm X 1
Booster pump engine:	Diesel 2.000 PS X 500 rpm X 1
Main generator:	AC 125 kVA X 225 V X 2
Main generator engine:	Diesel 150 PS X 900 rpm X 2
Hose reel winch motor:	60 kw X 1
Mooring winch motor:	19 kw/10 kw X 2
Date of delivery:	October 1963
Owner:	Ajia Shunsetsu Co., Ltd.

Builder: Ishikawajima-Harima Heavy Industries Co., Ltd.

Fig. 25

E B

E B



Specifications

Dredging depth:	40 m
lpp × B × D × d:	22.00 m × 10.00 m × 2.0 m × 1.10 m
Water pump for ejector and drill:	450 m^3/h × 100 m × 1,800 rpm × 1
Jet water pump:	100 m^3/h × 150 m × 1
Water pump engine:	Diesel 300 PS × 1,800 rpm × 1
Jet water pump engine:	Diesel 150 PS × 1
Air compressor for ejector and general use:	3 m^3/min × 6 kg/cm^2 × 1
Generator	Diesel driven 4 kw × 1
Generator engine:	10 PS × 900 rpm × 1
Dredging equipment	
Double pipes with an ejector and a rubber hose:	1
Drill and a rubber hose:	1
Compressed air pipe and a rubber hose:	1
Suspensioning and mooring winch:	Diesel driven 18 t × 5 m/min × 1
Date of delivery	November 1961
Owner	Toa Harbor Works Co., Ltd.

Builder: .... Hitachi Shipbuilding & Engineering Co., Ltd.

Fig. 26

No solo para la minería sino también para el dragado de cepas que alojen túneles submarinos o tuberías a gran profundidad se estudian equipos cuya operación no se vean interferida por las condiciones meteorológicas en la superficie, como acontece con los equipos convencionales.

Los diseños siguientes muestran los sistemas propuestos para obras de ingeniería y extracción de elementos útiles al hombre, a grandes profundidades. (Ver figs. 27,28,29,30,31,32 y 33).

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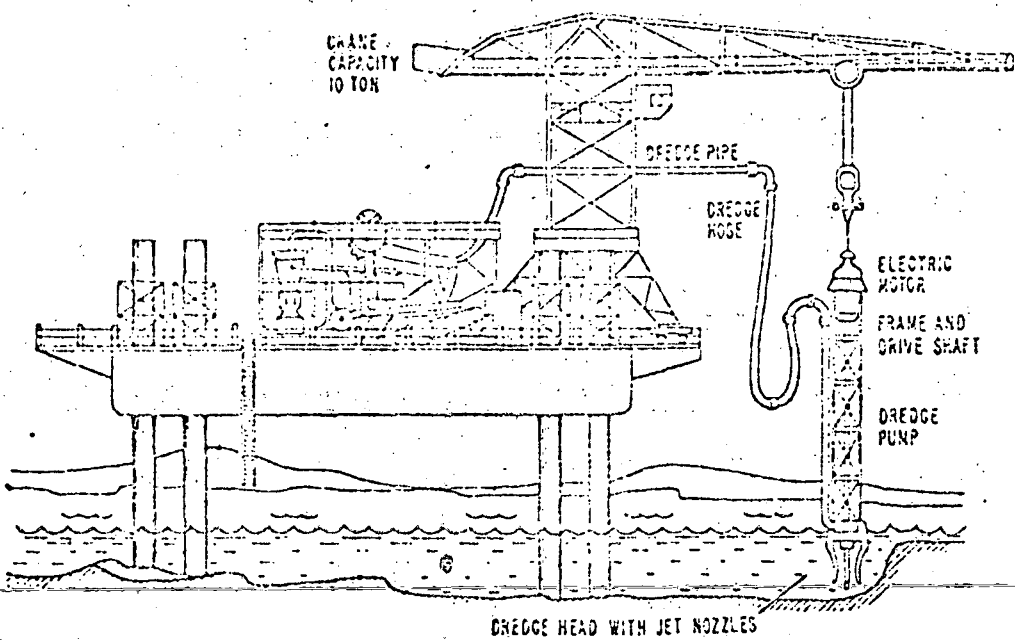

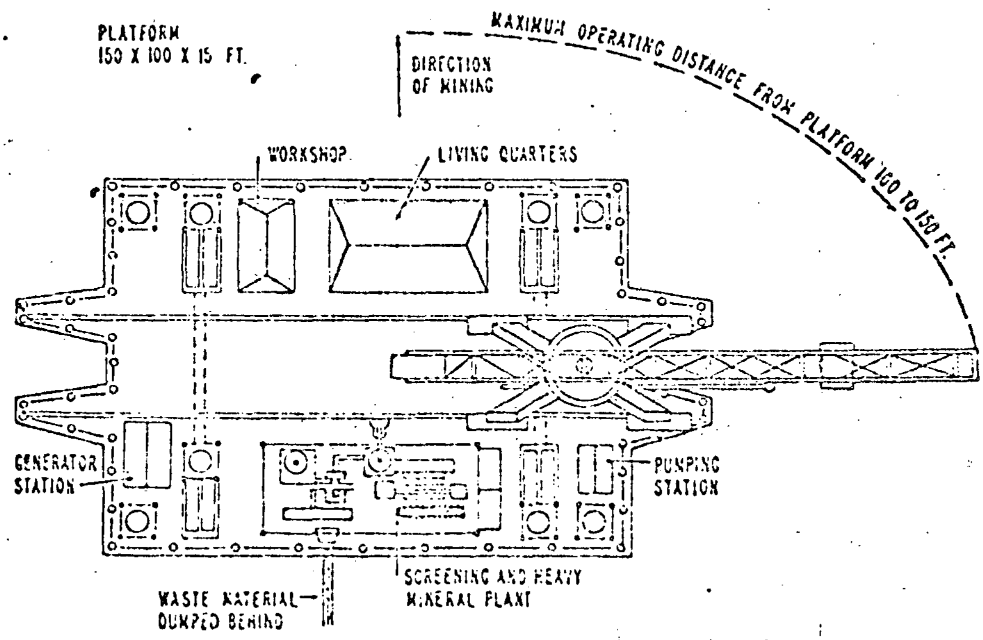

Fig

Walking platform for mining in shallow water.

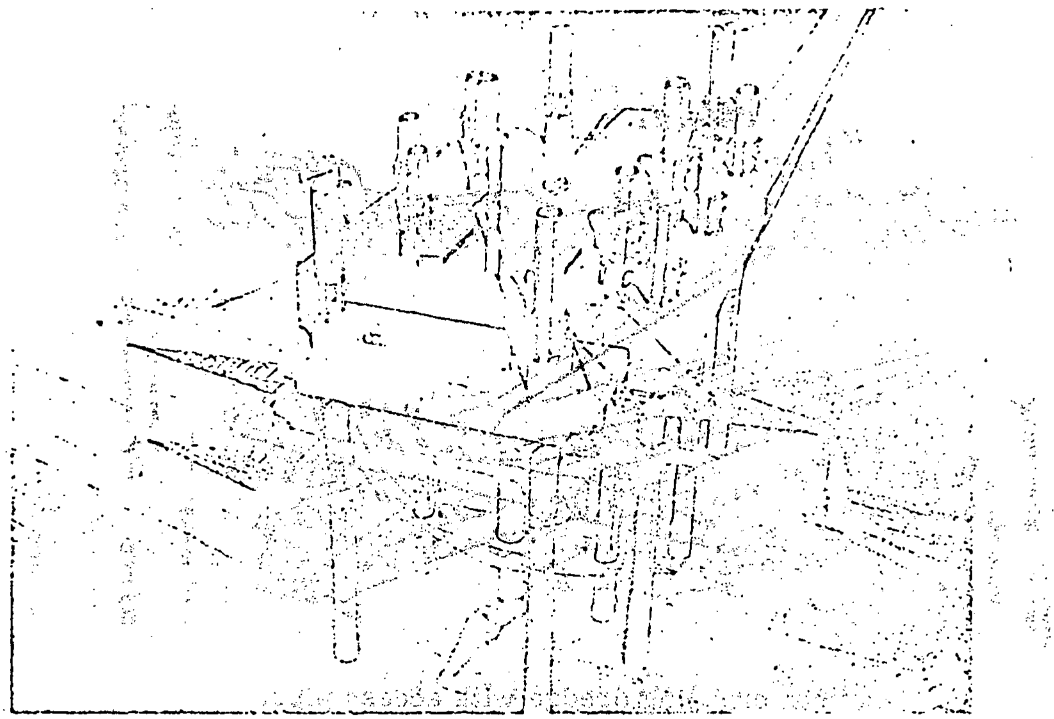

Fig. 29

Walking platform developed for digging a tunnel trench.

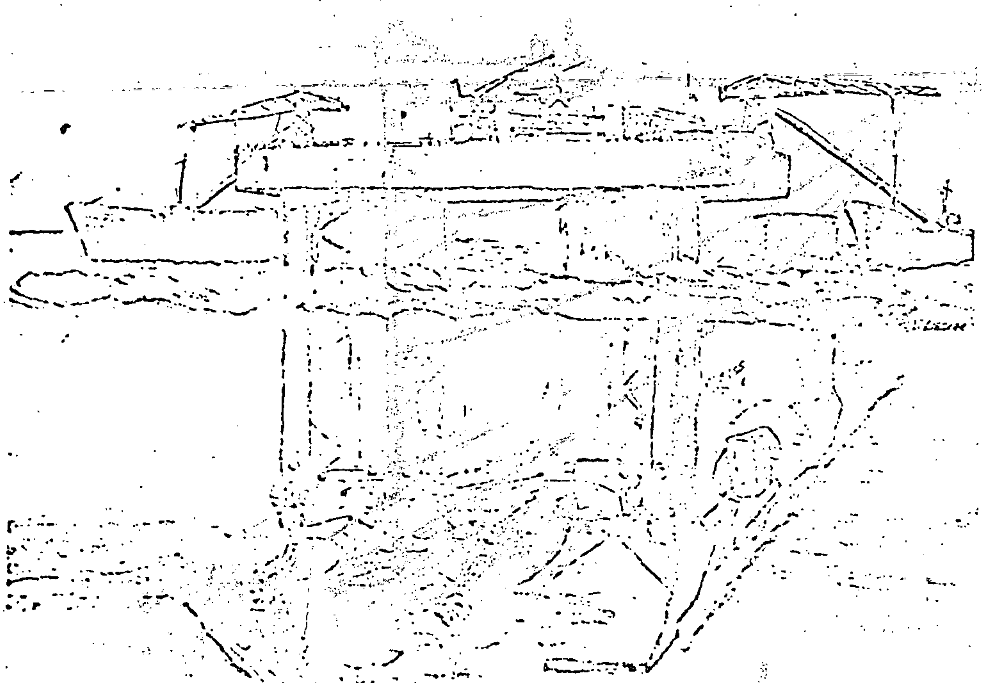

Fig. 28

Bottom crawling dredge for digging tunnel trench.

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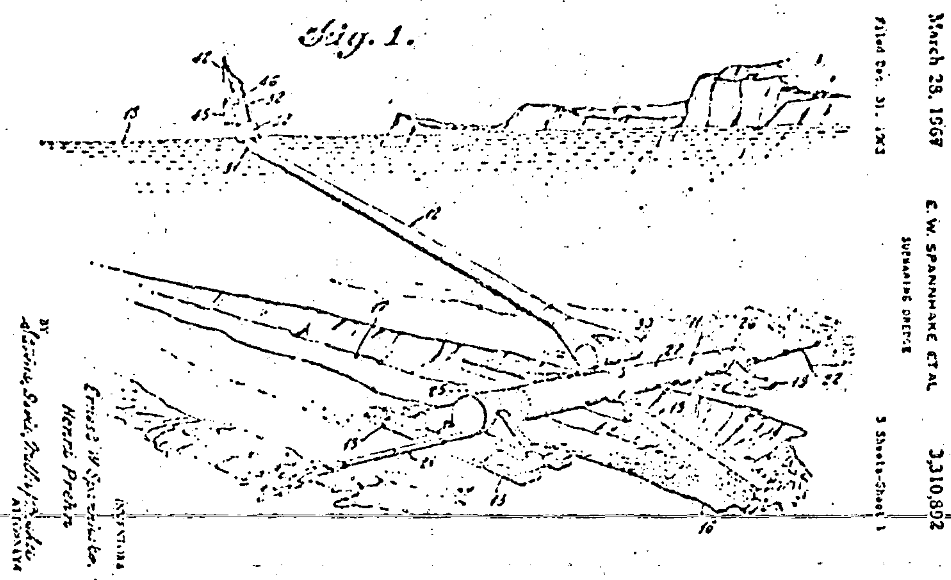
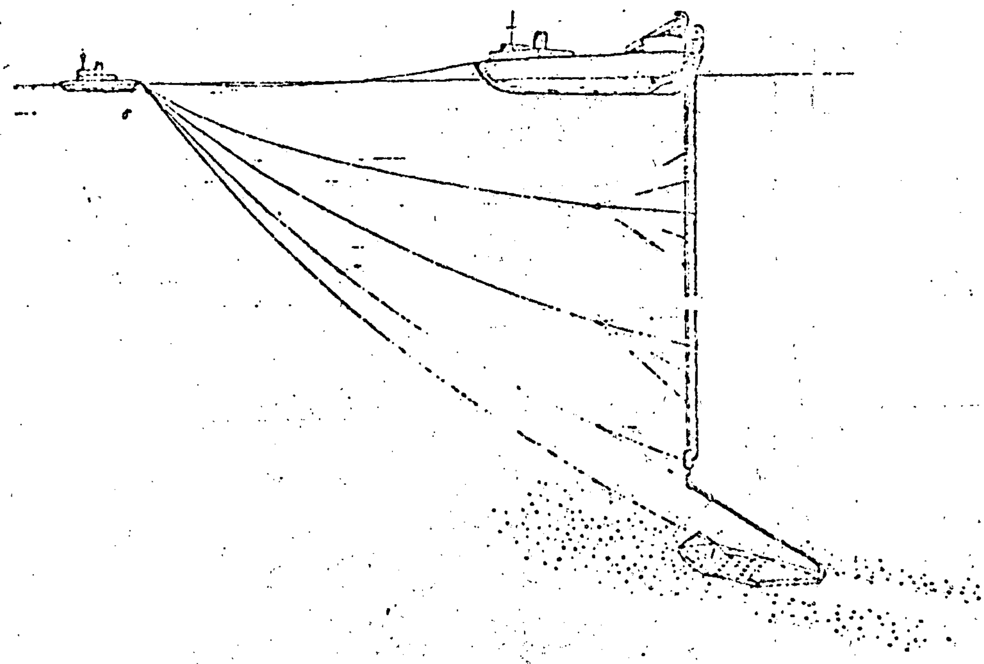


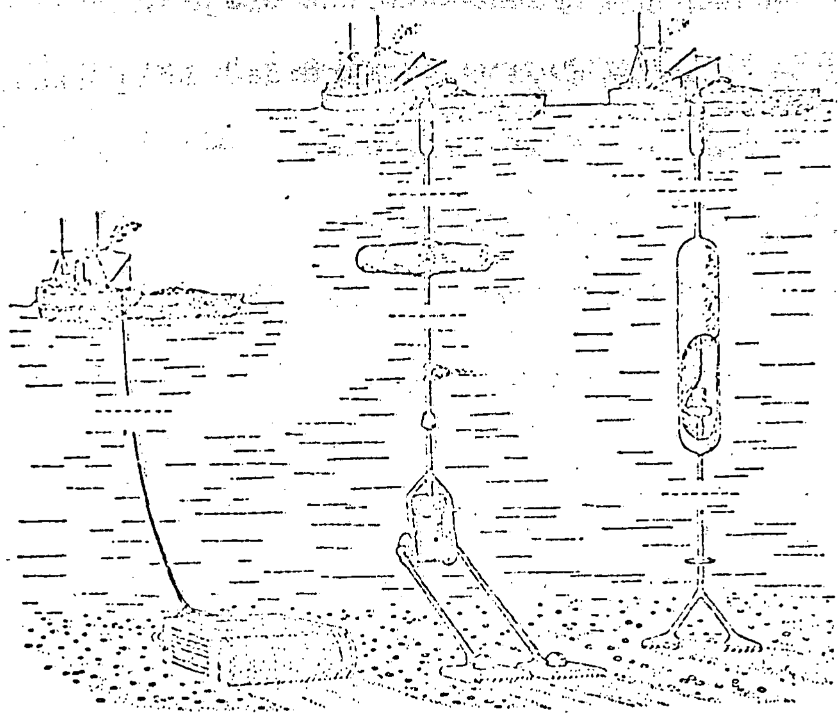
Bottom crawling dredge with access pipe.

Fig. 30



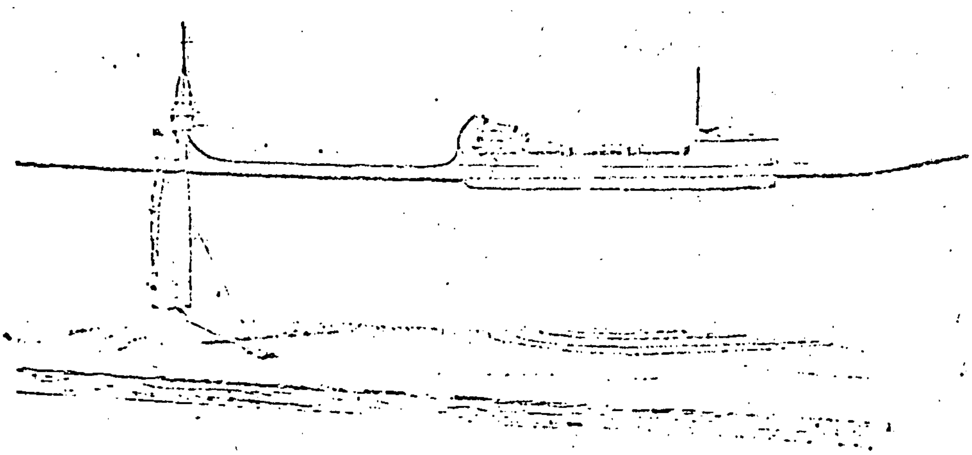
J. Ball proposed module mining by use of light-media lifting system.

Fig. 31



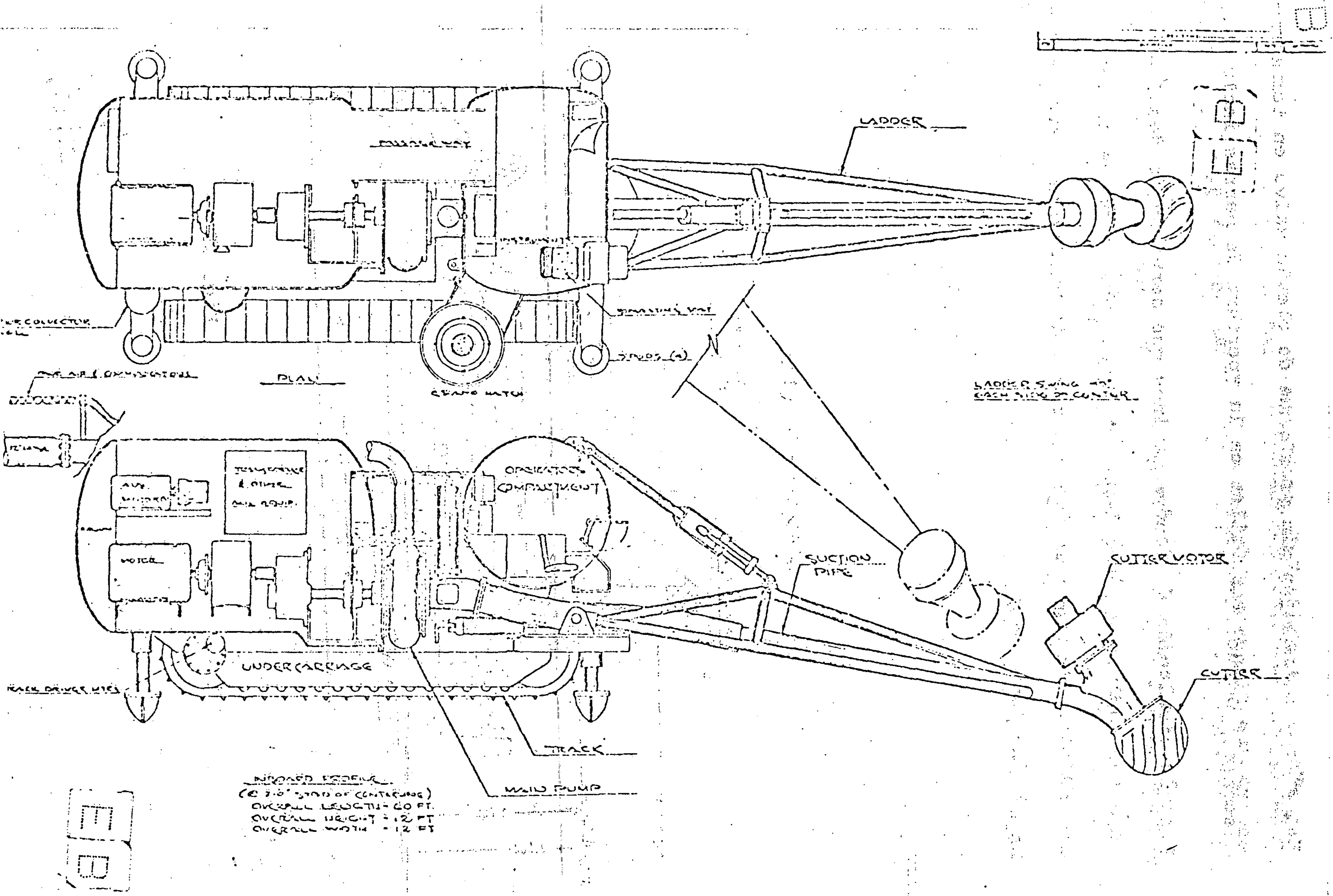
Dr. Mero envisioned mining of manganese modules from deep sea floor deposits.

Fig. 32



Flip ship dredge for mining from sea floor of the continental shelf.

En Estados Unidos han diseñado una draga submarina actualmente trabajando en Florida cuya profundidad de operación es de 30 m., con la finalidad de extraer arena y reponer la que es retirada por el mar en los cambios de estación, de playas de gran atractivo turístico como son las de Florida, Carolina, Nueva Jersey, Redondo, California o Waikiki en Hawaii. (Ver fig. 34).


LADDER
PLAN
STUDS (4)
LADDER SWING 45° EACH SIDE OF CENTER
OPERATOR'S COMPARTMENT
MOTOR
SUCTION PIPE
CUTTER MOTOR
CUTTER
UNDERCARRIAGE
TRACK
MAIN PUMP
INBOARD PROFILE
OVERALL LENGTH = 60 FT.
OVERALL HEIGHT = 12 FT
OVERALL WIDTH = 12 FT

Estas dragas trabajan sin problemas de oleaje salvo en tormentas severas, pudiendo ser útiles en la apertura de barras inclusive.

Para la nivelación de fondos marinos que servirán de desplante de obras marítimas (escolleras, tanques submarinos de almacenamiento, etc) se han diseñado dos tipos de buldozers: para aguas bajas (Ver. fig. 35).

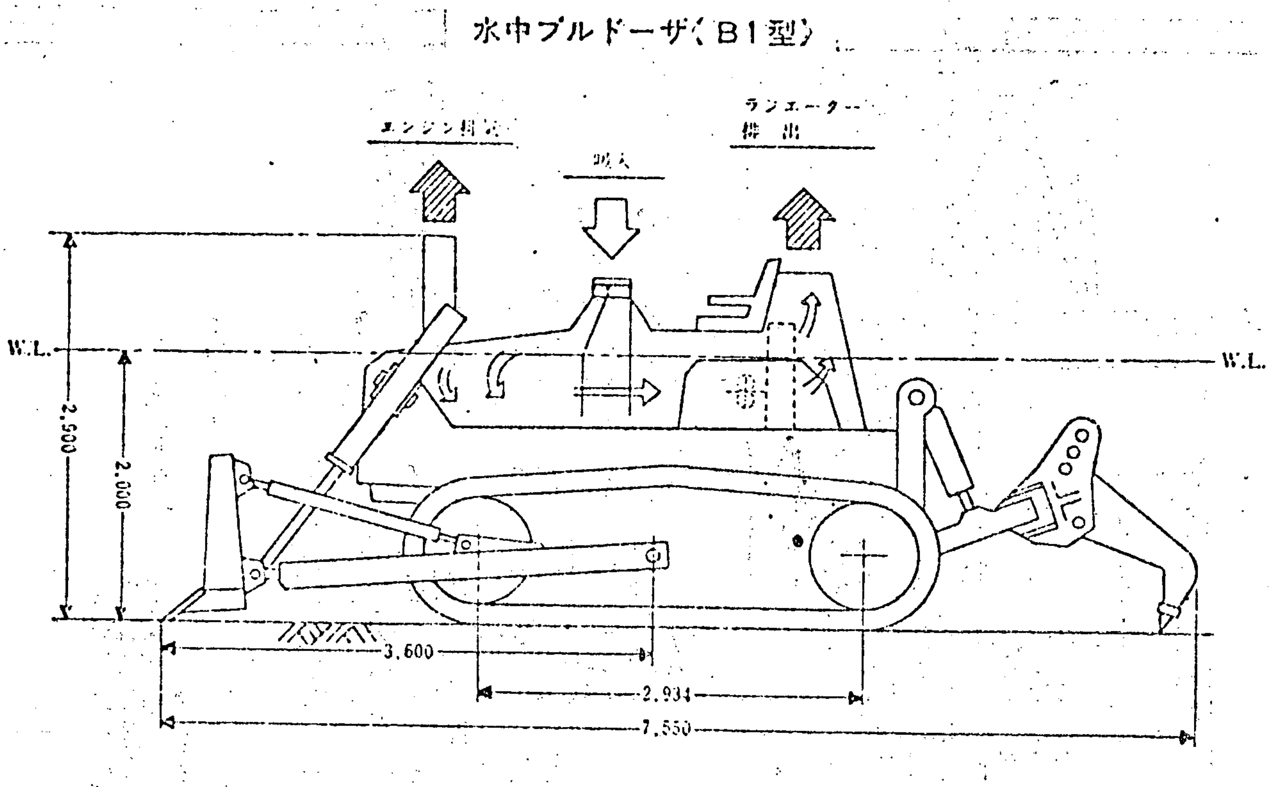
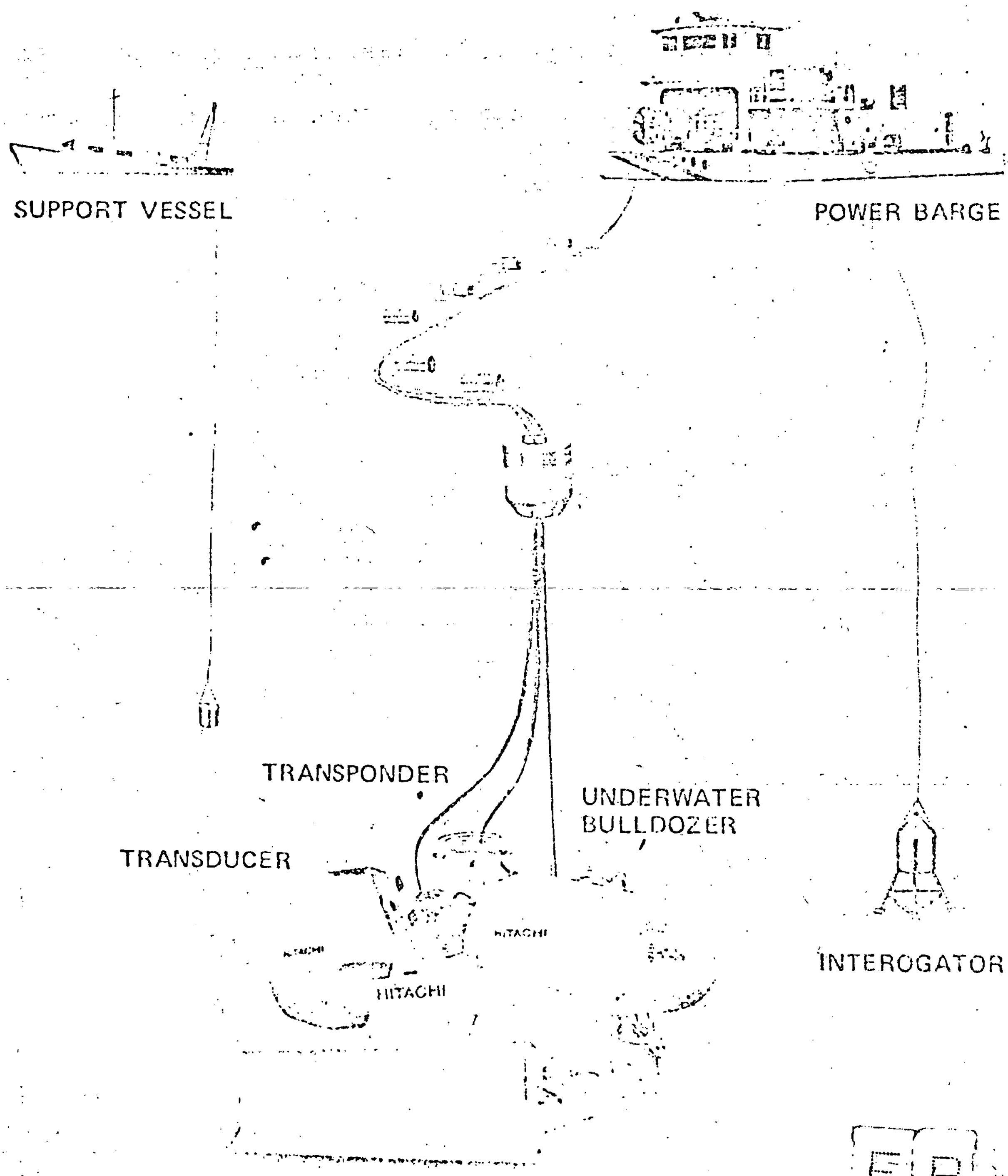


Fig. 35

y submarinos (Ver fig. 36).

JH360 UNDERWATER BULLDOZER SYSTEM



Estos últimos pueden ser operados desde a bordo ó a control remoto. En Japón ya se encuentran trabajando ambos tipos en vías de-experimentación, con resultados satisfactorios.

LA TABLA No. 1.- Muestra los costos comparativos para diferentes tipos de dragas y materiales.

LA TABLA No. 2.- Incluye todas las dragas estacionarias con sus-principales características que operaron en el puerto de Kashima, Japón en el año de 1970.

DRAGADO

I.- Trabajos Previos al Dragado

II.- Usos del material extraído.

III.- Métodos para estabilizar los rellenos

IV.- Generalidades sobre el dragado de los puertos Mexicanos.

I.- TRABAJOS PREVIOS AL DRAGADO.- No solo para la ejecución del dragado sino también para la adecuada selección del equipo, es necesario ejecutar ciertos trabajos previos, que pueden dividirse en:

1.- Muestreo del área por dragar.

2.- Elección de la zona de tiro.

3.- Construcción de bordos y vertederos en el área de tiro.

4.- Levantamiento batimétrico de la zona por dragar.

5.- Balizamiento de la misma.

6.- Tendido de la tubería flotante y terrestre.

1.- MUESTREO DEL AREA POR DRAGAR.- Cuando el lugar donde se van a ejecutar los trabajos nunca ha sido dragado ó se va a incrementar la profundidad en forma importante, es necesario muestrear el fondo a base de sondeos para conocer la estratigrafía y poder determinar la dureza de los materiales que se atacarán. En rigor y de acuerdo con la tabla No. 2, los precios de dragado varían con los equipos a usar y las características del material. Por -

lo que es primordial el conocimiento del suelo para fines de contrato ó selección del equipo, así como para determinar los ángulos de reposo del material para el cálculo de los taludes.

2.- ELECCION DE LA ZONA DE TIRO.- Esto solamente es válido cuando el material extraído no se ha destinado para un propósito determinado, es decir, para el relleno de una zona específica.

Las zonas de tiro pueden ser:

a) Bajo el agua

b) En tierra

a) Bajo el agua.- En mar abierto sin mayor utilidad, donde el depósito del material no afecte la navegación o en los lugares predeterminados para efectuar un relleno.

b) En tierra.- Puede o no estar elegida la zona de descarga. Si se trata del último caso, se buscará que dicha área de ser posible, se encuentre lo más próximo a la zona por dragar lo que aumenta la eficiencia del dragado y disminuye la tubería de descarga necesaria.

Para esto se hará un reconocimiento topográfico de la zona, eligiendo la que de acuerdo con el volumen por dragar, esté disponible y sea la más adecuada, buscando que sea un área baja la que -

se beneficie amén de lograr con esto una carga estática menor.

3.- CONSTRUCCION DE BORDOS Y VERTEDORES EN EL AREA.- Una vez determinada la zona habrá de protegerse mediante bordos para confinar el material.

Cuando se cuenta con áreas superiores a las necesarias, solo se protegerán las partes que eviten que el material regrese al agua o dañe zonas pobladas ó de cultivo.

Los bordos deberán ser si es posible, de material arcilloso tomado de préstamo del terreno para evitar al máximo el problema de tubificación, limpiando el área de desplante con tractores, pues si se construye sobre monte bajo, habrá hoquedades que propiciarán el rompimiento de los bordos.

El bordo será lo suficientemente ancho en su base para soportar el empuje del material de relleno con una cota que le permita tener como mínimo, 50 cm. de libre bordo después de terminado el relleno.

El ancho de la corona permitirá el tránsito de una persona que recorrerá los bordos permanentemente, vigilando el estado en que se encuentran.

Los bordos deberán ser bandeados con tractor para darles una mejor compactación.

En las partes más bajas del terreno o en aquellas más distantes del punto de descarga, se construirán en el bordo, vertedores - que permitirán la salida del agua en que va suspendido el material, después de que éste se sedimente.

La razón de buscar la mayor distancia entre la descarga y el vertedor, es la de aumentar la longitud de recorrido de la mezcla- lo cual permite que el agua pierda velocidad propiciando la decantación del material. Sí el vaso de captación de azolve es demasiado reducido, se construirán bordos interiores en forma semejante a los de un tanque decantador, con la misma función de- aumentar la distancia de recorrido.

Cuando por el vertedor principia a pasar material en suspensión, indica que debe incrementarse la altura de aquel, lo cual se logra insertando tablones en las ranuras guía que se dejan exprofeso en los lados de la estructura. El aumento oportuno de los- tablones es importante para el control del depósito.

El agua excedente que se vierte fuera del vaso se enviará de regreso al mar, río etc., drenándola a través de canales construídos con este fin.

Es conveniente que la plantilla del vaso sea demontada retirando la yerba y el monte bajo, para evitar futuros asentamientos- diferenciales.

4.- LEVANTAMIENTOS BATIMETRICOS DE LA ZONA POR DRAGAR.- El primer levantamiento batimétrico servirá para conocer el estado actual del fondo así como para poder estimar el volumen teórico a dragar. Este plano llamado "plano antes de dragar", servirá conjuntamente con el "levantamiento después de dragar", para calcular los volúmenes en forma precisa, Por lo general, si los trabajos se llevan a cabo por contrato, los levantamientos se harán con la intervención del contratista, el contratante y una autoridad marítima local que certifique que el levantamiento tiene la precisión debida.

De acuerdo a lo que se especifique en el contrato, los levantamientos podrán hacerse uno solo al final del trabajo, o por etapas. Generalmente cuando el dragado es de magnitud importante y existe el peligro de depósito de material, se harán estimaciones parciales en base a planos levantados a lapsos regulares o de acuerdo a dragados parciales previamente establecidos.

Sin embargo, aún cuando se haya estipulado una sola estimación se harán levantamientos diarios, semanales etc., dependiendo del avance de los trabajos, para verificar si el dragado se ejecuta de acuerdo a lo planeado.

Para los levantamientos, se requerirá un equipo que registre la profundidad y otro que la sitúe.

Los aparatos para determinar la profundidad pueden ser tan simples o complicados como lo requiera el trabajo.

El método más sencillo para conocer la profundidad, es utilizando un pedazo de plomo de forma de cono o pirámide truncada, llamado-escadallo unido a una cadena o cordón marcado con barbetes en - - pies o metros, llamado sonda o sondeleza.

El escandallo podrá ser de alta mar o de puerto, dependiendo de - la profundidad donde se sondee, siendo el de alta mar de mayor peso que el de puerto. Con este aparato simple es posible, hacer levantamientos de importancia; no obstante estos son lentos en su - ejecución con la desventaja de solo conocer la profundidad en el-punto sondado.

Se requiere el uso de una embarcación de remos o una lancha cuya-velocidad sea muy lenta, para permitir un mayor número de sondeos. Los puntos donde se obtenga la profundidad, se marcarán desde tierra mediante un teodolito a una señal dada desde la lancha, o con un sextante desde a bordo con respecto a marcas en tierra.

Generalmente para ejecutar los sondeos, estos se registran sobre-líneas o enfilaciones que facilitan el seccionamiento del área y-permiten hacer un trabajo más ordenado.

Se recomienda el sistema con sondaleza para trabajos de reconoci-miento rápido, para áreas pequeñas o en lugares próximos a muelles donde pudiera haber variación en el registro de profundidades con-aparatos electrónicos mismos que se describirán más adelante.

El aparato más generalizado en la actualidad es la ecosonda, cu yo funcionamiento se basa en la emisión de un sonido dirigido,- que toca el fondo y se refleja recibiendo la señal un transductor que lo envía a un registrador.

Las formas de registro de un ecosonda puede ser:

a) De destello

b) De gráfica

c) Digital

a) De destello.- Es el equipo más liviano y portátil. El transductor recibe la señal y la pasa a una carátula circular en la- cual se emite un destello, indicando la profundidad en la carátula graduada. Son útiles solo para reconocimiento, ya que son- poco prácticas para trabajos formales, por carecer de registro- permanente.

b) De Gráfica.- Pueden ser circulares ó líneales. La señal recibida es registrada en un papel sensible dando una gráfica continua de la profundidad.

Este ecosonda se instala a bordo de una lancha de motor, mandando mediante un botón, un impulso a la gráfica haciendo una marca que coincide con la situación tomada por los topógrafos en - tierra.

E B

Se tomará la hora de inicio y terminación de cada sección sondada, para fines de hacer la corrección por marea en cada punto marcado en tierra y reducir las profundidades a un plano fijo, que puede ser el nivel de marea baja media de sicigias.

c) Ecosonda Digital.- Es el equipo más moderno que existe, en la cual, las profundidades son registradas mediante una computadora en forma numérica, evitándose la interpretación de la gráfica. - Se usa en trabajos oceanográficos.

Para situar los puntos de los que se ha registrado la profundidad mediante sondaleza ó ecosonda, se utilizarán, dependiendo de la distancia a tierra, los dos métodos siguientes:

a) Métodos topográficos Convencionales

b) Utilizando el Shoran, Loran ó sistema Decca.

a) Métodos Topográficos Convencionales.- Estos dependerán del tipo de trabajo que se vaya a ejecutar pudiendo ser:

a.1) Marcaciones a ojo con objetos en tierra.- Se hacen secciones paralelas a la costa ó márgenes para reconocimientos preliminares con escandallo o ecosonda (Fig. 1)

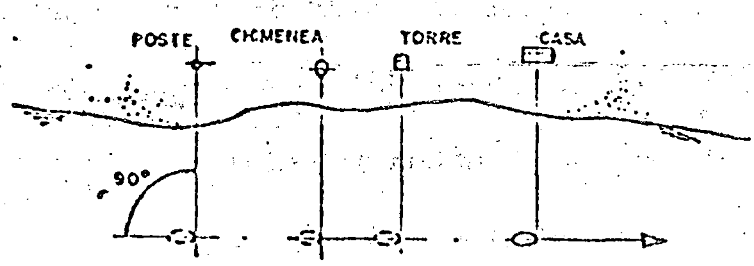


Fig. 1

a.2) Con una enfilación y un aparato.- Si el lugar es protegido - y no hay corriente, es fácil llevar enfilada una lancha sobre las marcaciones, utilizando un teodolito para tomar el ángulo entre - la lancha donde va instalado el ecosonda y la línea de base. (Fig. 2).

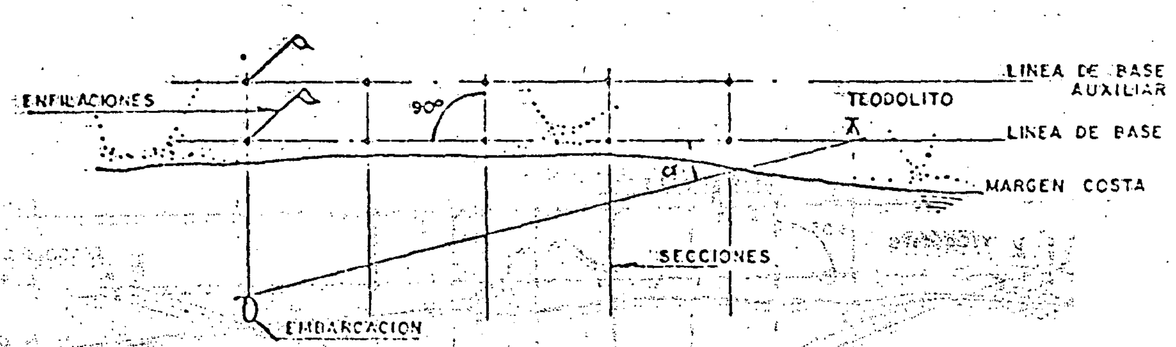


Fig. 2

En este método el aparato deberá colocarse en la línea de base,- lo suficientemente retirado de la sección que se esté sondando - a fin de evitar lecturas erróneas.

En función de la longitud de la sección, de la irregularidad del fondo, de la importancia del trabajo y de la destreza del topó-- grafo, se podrán situar puntos a cada 10 ó 15 metros. Si el tra- bajo efectuado es con ecosonda y los puntos localizados no fue-- ran suficientes, se pueden interpolar otros puntos, dado que se-cuenta con una gráfica continua.

a.3) Con una enfilación y dos aparatos.- Si se requiere mayor precisión o no es posible mantener la embarcación completamente enfilada, se utilizan dos aparatos en tierra que a una señal, marcarán la lancha quedando situada la sonda por intersección de los ángulos con respecto a la línea de base. (Fig. 3).

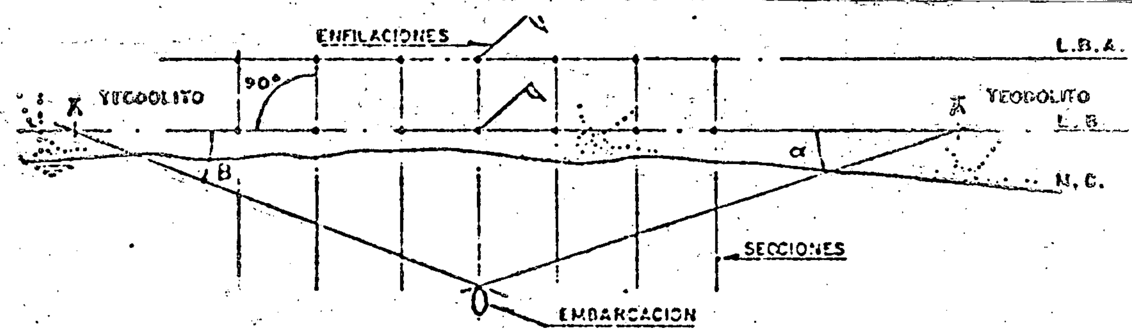


Fig. 3

Aunque algunas veces los puntos no queden sobre las enfilaciones éstas son de gran utilidad para efectuar un levantamiento ordenado.

a.4) Enfilación y carrete.- Cuando se trata de áreas pequeñas (dársenas de muelle principalmente) se trabaja con enfilaciones y un carrete de alambre marcado a cada 5 ó 10 m.

El carrete se lleva a bordo de la lancha y el extremo libre se deja en tierra en cada estación.

Llevando la lancha enfilada cada vez que pase una marca en el alambre, se le envía un impulso a la gráfica de la ecosonda o se bota la sondaleza. (Fig. 4)

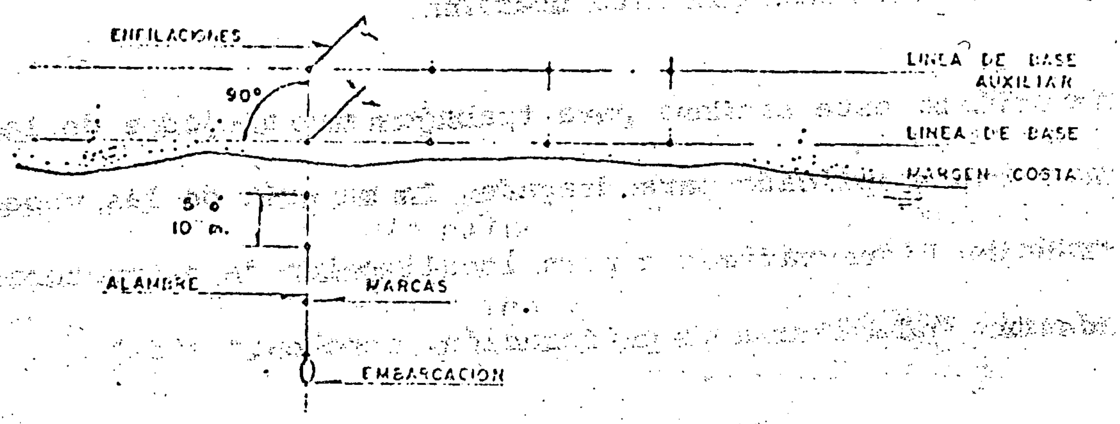


Fig. 4

a.5) Enfilación y sextante.- En este método solo se requiere tener en tierra señaleros pues el ángulo con respecto a las enfilaciones se toma desde a bordo. (Fig. 5)

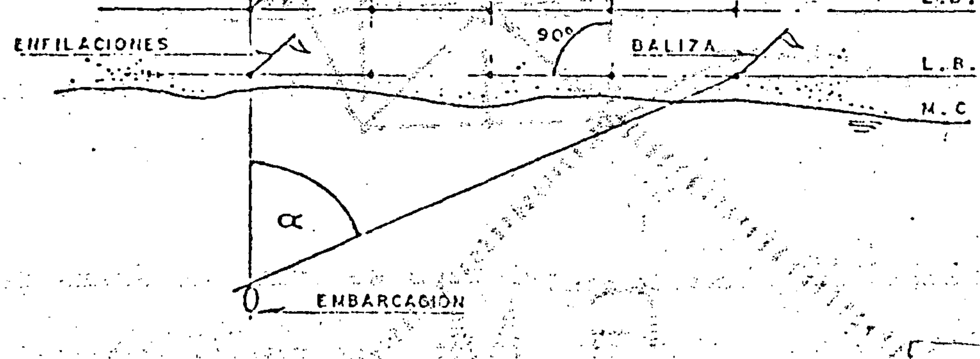


Fig. 5

La separación de las secciones dependerá del trabajo que se ejecute pero normalmente, esta varía entre 20 y 100 metros.

b) Levantamientos con sistemas Shoran, Loran o Decca.- Fundamentalmente todos los equipos trabajan en base al mismo principio:- dos transmisores en puntos en tierra perfectamente definidos (estaciones esclavas) que emiten una señal de radio, situando el -- punto en alta mar por intersección.

Se utiliza este sistema para trabajos muy alejados de la costa,- no siempre aplicado para dragado. La mayoría de las veces para - trabajos hidrográficos o para localización de estructuras mar -- adentro (plataforma de perforación, monoboyas etc.)

Su aplicación consiste en localizar con precisión boyas que limiten el área a levantar y, apoyándose en estas marcas, efectuar - el levantamiento abordo de una embarcación con ecosonda mandándole impulsos al papel a intervalos regulares de tiempo.(Fig.6)

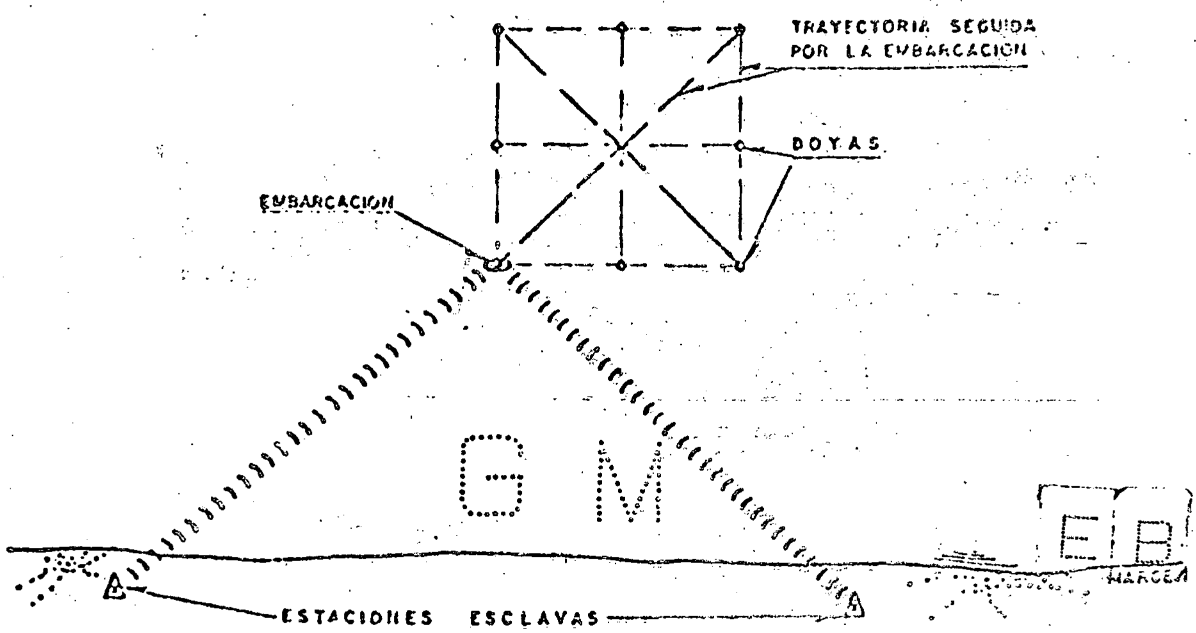


Fig.

5.- BALIZAMIENTO DE LA ZONA POR DRAGAR.- Una vez levantado el plano batimétrico antes de dragar, elegido el lugar de descarga, construídos los bordos y tendida la tubería, se elige el lugar donde se iniciará el dragado colocando para ello, las enfilaciones que permitirán a la draga operar en el lugar preciso.

Por ejemplo, si se trata de dragar un canal, se marcará el eje y los plafones del mismo delimitando así su plantilla, evitando dragados adicionales que originarán pérdidas para el contratista ya que los trabajos en exceso, (fuera de un cierto margen) generalmente no son pagados por el contratante. (Fig. 7)

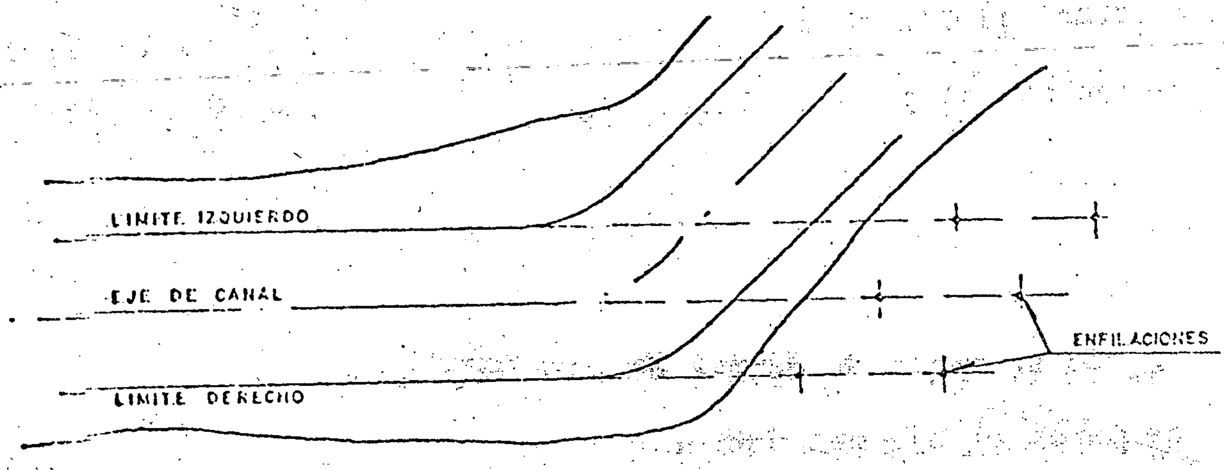


Fig. 7

Si la amplitud de corte de la draga alcanza para dragar todo el ancho del canal, hará un solo corte.

Si se trata de un canal más ancho o del dragado de una dársena- se requerirá de varios cortes paralelos siempre a son de corrien te pasando las enfilaciones al siguiente corte. (Fig. 8)

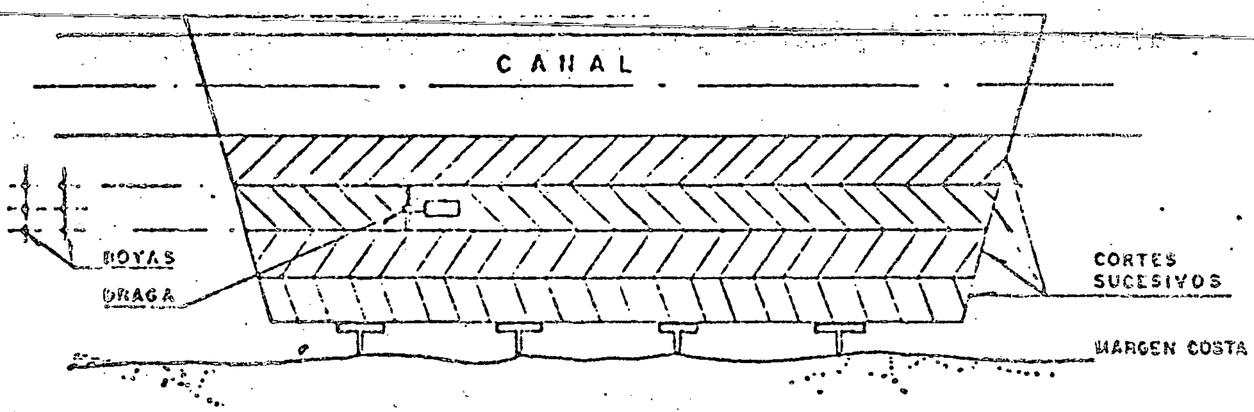


Fig. 8

Cuando se trata de dragas de autopropulsión, generalmente solo se marca el eje del corte.

En los demás tipos se marca el canal y los plafones.

6.- TENDIDO DE LA TUBERIA FLOTANTE Y TERRESTRE.- Este concepto se circunscribe a aquellas dragas que requieren de éste medio de conducción para transportar el material. Tales equipos son: dragas estacionarias o de autopropulsión con equipo adicional.

La tubería flotante se coloca sobre pontones. La unión de los tubos se lleva a cabo mediante juntas esféricas o tramos de manguera Ambas formas, con el fin de darle flexibilidad a la línea.

La tubería terrestre se arma sobre el terreno apoyada en caballetes o trozos de madera para evitar que se sepulte con el material de relleno.

Los tubos generalmente de 6 metros de longitud, tienen uno de sus extremos troncocónico a fin de permitir enchufarlos unos con otros.

SISTEMA DE BONIFICACIONES.- Aunque a últimas fechas se han desarrollado aparatos que regulan la uniformidad del dragado (sobre todo con dragas estacionarias) tratando de evitar al máximo errores humanos, que dan como resultado la disminución de la eficiencia de los trabajos, estos equipos opcionales aún no tienen una amplia aplicación por lo que se puede decir que el éxito o fracaso económico del trabajo, está en manos del operador de la draga.

Por tanto, el sistema de bonificaciones al dragador en forma - - principal, así como el resto del personal tanto de abordo como - de tierra por el dragado que excede a partir de un volumen tope, mantiene la buena disposición de la gente para el trabajo y rinde magníficos resultados al contratista.

II.- USOS DEL MATERIAL EXTRAIDO.- Los trabajos de dragado tienen dos cualidades: la de profundizar los lugares requeridos para la navegación y la de elevar terrenos bajos que en ese estado son:

Los rellenos como anteriormente se mencionó, no siempre se realizan en áreas terrestres sino también mar adentro, trabajos que - se conocen como reclamación de áreas o terrenos ganados al mar.

En un principio, se elegía el área de tiro con la sola característica de que fuera bajo y próximo a la zona por dragar.

Posteriormente, se observó que el terreno se mejoraba notablemente al elevarse su cota quedando fertilizado, si el material depositado no era salobre, sirviendo para la agricultura, terrenos - que antes no tenían ningún uso.

En vista de lo anterior muchos poblados ribereños y costeros, -- han visto beneficiadas sus zonas aledañas y la salubridad del --

ambiente que los rodea, al eliminarse por completo las zonas pantanosas que propician enfermedades tales como la tifoidea, paludismo, etc.

Sin embargo, existe otra utilización que rinde grandes beneficios económicos a corto plazo y es la creación de áreas industriales mediante rellenos.

Estos rellenos pueden ser sobreelevando el nivel de terrenos bajos o bien ganando áreas que anteriormente fueron mar.

Aunque se pueden citar muchos casos de áreas industriales alojadas en terrenos mejorados, para hacer más patentes los ejemplos, se mencionan los rellenos con motivo del dragado de los puertos de San Pedrito en Manzanillo, Col., Yukalpetén, Yuc., y Pajaritos, Ver. En este último se localiza el complejo industrial más importante del Sureste del País.

Los terrenos que circundaban la Laguna de Pajaritos, eran sumamente bajos y sin utilidad alguna; sin embargo, cuando se depositaron los primeros cinco millones de metros cúbicos se observaron las amplias posibilidades de los terrenos a los que se les había elevado el nivel, prácticamente sin costo adicional al necesario para el dragado del canal de acceso y la dársena de maniobras, en comparación con el costo erogado para rellenar con material de los cerros cercanos, una plataforma donde se construyó la pri mera etapa del complejo.

No obstante, no siempre se cuenta para los rellenos con el material de dragado adecuado; puede ser que la zona dragada sea un manto grueso de arcilla que si bien es un magnífico cementante cuando se mezcla con arena, conchuela o grava, la arcilla sola no es el material más conveniente. Pero si el relleno se ve precisado a realizarse con el material existente, dá como resultado que aún pasado algún tiempo (a veces meses, según el espesor de la capa) no es posible caminar encima de él y mucho menos transitar equipos o intentar construcción alguna.

Hace algunas décadas, había que esperar que la consolidación del terreno se hiciera en forma natural drenándose el agua lentamente a través del terreno o por evaporación, lo cual tomaba demasiado tiempo con fuertes inversiones inactivas efectuadas en la adquisición de terrenos.

Por tanto se comenzaron a desarrollar técnicas de estabilización de suelos, las cuales permitieran la utilización de los terrenos en tiempos relativamente cortos.

III.- METODOS PARA ESTABILIZAR LOS RELLENOS.- Son dos los métodos principales para la estabilización de suelos arcillosos.

1.- Método mecánico

a) Precarga simple (superficial y en sandwich)

b) Con pilotes de arena y precarga

c) Con papel de drenado y precarga

2.- Método químico

a) Pilotes de carbonato de cal

b) Carbonato de cal mezclado con la arcilla

1.- Método mecánico

a) Precarga simple.- Consiste en tender una capa de arena - sobre el relleno arcilloso la que con su peso comprimirá a la - arcilla haciendo que éste expulse el agua. Una vez logrado ésto, la arena se retira del lugar o permanece con él, como compensación de la disminución de altura. La rapidez de estabilización- de este método dependerá del espesor del relleno, del peso de - la sobrecarga y de las facilidades que el terreno adyacente - - brinde para drenar el agua. (Fig. 9)

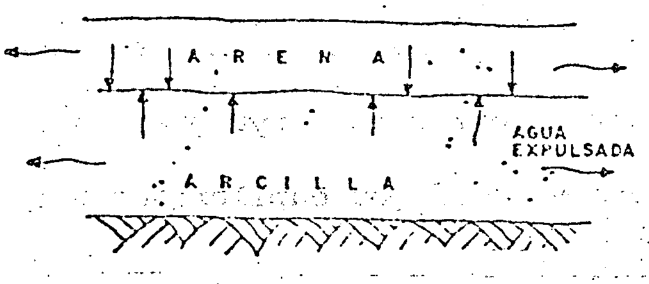


Fig. 9

Este sistema tiene otra variante: la de alternar el relleno con material de dragado, y capas de arena (método del sanwich) traída de los cerros. (Fig. 10)

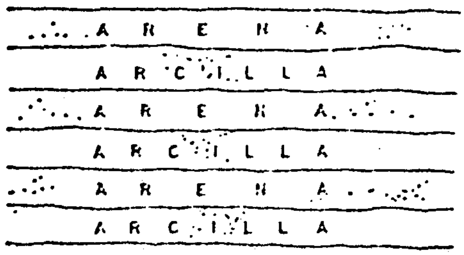


Fig. 10

b) Con pilotes de arena y precarga.- Este es una modificación del anterior que incluye un medio efectivo de drenar el agua.

El método consiste en hincar unos pilotes de arena a cada uno ó dos metros formando una cuadrícula con una profundidad de hinca equivalente al espesor del relleno arcilloso. El diámetro de los pilotes generalmente es de 40 cms. y la arena utilizada es gruesa.

Una vez hincados los pilotes de arena, se tiende una capa superficial de arena como precarga con cuya presión el agua contenida en la arcilla tenderá a subir por capilaridad a la superficie a través de los pilotes.

Este método como el anterior, puede aplicarse a la estabilización-de suelos tanto arriba como abajo del agua. (Fig. 11)

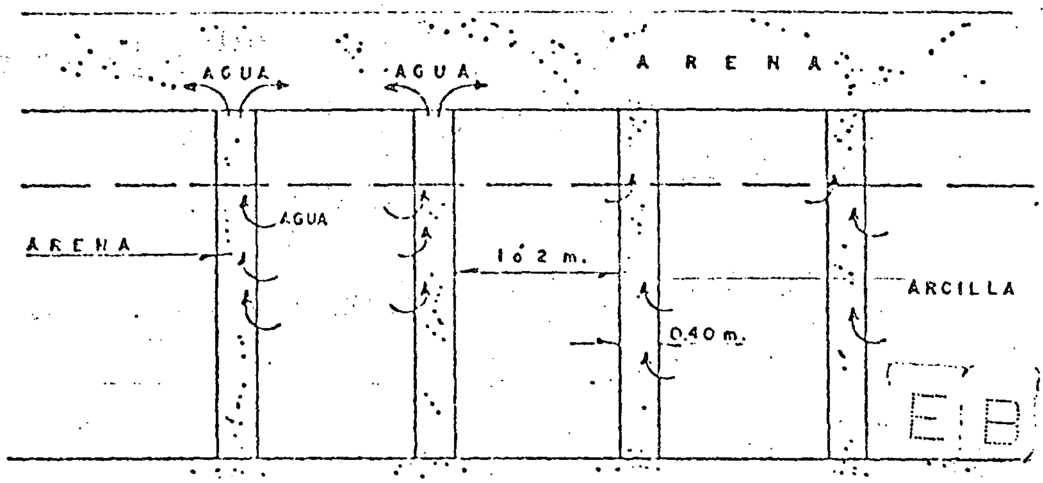
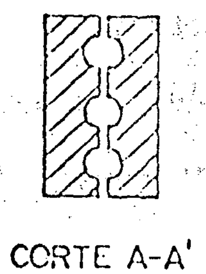


Fig. 11

c) Con papel de drenado y precarga.- El lugar de pilotes de - arena, se hinca una tira de papel absorbente con la misma separación aproximadamente de los pilotes (1 ó 2) metros), que servirá de dren al agua que contiene la arcilla. Se usa una sobrecarga formada por una capa de arena. (Fig. 12)

(Fig. 12)



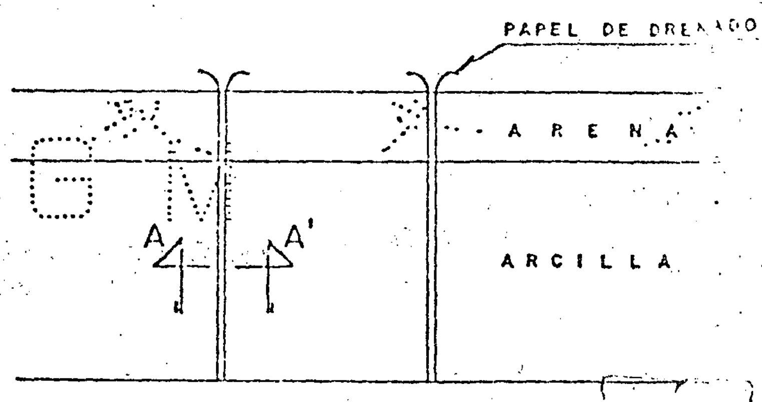


Fig. 12

2.- Métodos químicos.

a) Pilotes de carbonato de cal.- Aún en vías de experimentación, funciona a base de la reacción química que se genera al entrar el $CaCO_3$ en contacto con el agua, en la siguiente forma:

$$Arcilla + CaCO_3 + H_2O = Ca(OH)_2 + CO_2 + \Delta \uparrow$$

Se perfora con espaciamientos similares a los de los métodos anteriores y se llenan con $CaCO_3$.

b) Carbonato de cal mezclado con la arcilla.- También aún en experimentación. En este método no solo se incluye la cal en las perforaciones sino que se mezcla con la arcilla adyacente, logrando la eliminación del agua y mejorando la resistencia del terreno.

A la fecha el método más económico y eficiente es el del papel de drenado.

Estos sistemas son costeables siempre y cuando el espesor del relleno arcilloso sea de 10 m. como mínimo.

Existen en muchos países del mundo áreas reclamadas; Estados Unidos, Holanda, Japón, etc., cuya utilidad puede ir desde la localización de refinerías, aeropuertos, hasta áreas portuarias comerciales.

Se construyó una Isla artificial en el puerto de Kobe, Japón, cuyo costo fue de 389 millones de dólares habiéndose programado su terminación para 1975. Su área fue de 4.364 millones de m2. destinada para la operación de 9 muelles de contenedores y 21 muelles de carga general con una profundidad de 12 m. lo cual arroja un volumen de relleno de 70 millones de metros cúbicos aproximadamente.

Estando en proyecto la construcción de otra Isla similar en el mismo puerto.

Como obras de dragado importantes mundialmente, se puede citar el Canal de Suez, el de Panamá y el de Corinto en Grecia.

IV.- GENERALIDADES SOBRE EL DRAGADO DE LOS PUERTOS MEXICANOS.-

El dragado de los puertos en México es efectuado, ya sea con equipo propio o de contratistas, por la Dirección General de Dragado, dependiente de la Secretaría de Comunicaciones y Transportes quien controla y aprueba las obras a ejecutar en las aguas mexicanas.

Los puertos mexicanos principales en la Costa del Golfo de México, en su mayoría se encuentran localizados en las vías fluviales por ser éstas las que en forma natural comunican centros de población y zonas de producción. Con el aprovechamiento del río y construyendo obras exteriores, así como con un dragado de poca importancia, se contaba con un lugar abrigado para construir - -

instalaciones portuarias mismas que en algunos casos se encuentran a una distancia considerable río arriba de la desembocadura. Tal- es el caso de los puertos de Minatitlán 40 kms. aguas arriba en - el río Coatzacoalcos y Tampico 14 kms. rio arriba del Pánuco.

Esta solución generalizada en todo el mundo, aquí en México empe- zó a dejar sentir sus efectos negativos, al arribar embarcaciones de porte cada vez mayor que no sólo tuvieron problemas con el ca- lado sino también con las dimensiones físicas de canales y dárse- nas.

Sirva de ejemplo en canal de navegación del río Coatzacoalcos has ta Minatitlán que por las características del torno de Paso Nuevo (de 180°), la eslora de los barcos que por él navegan, está limi- tada a 143 m., ya que embarcaciones mayores no alcanzan a librar, varándose indefectiblemente.

Visto desde éste punto de vista, el problema se reduciría a dra- gar los canales a la profundidad y ancho requeridos por los bar-- cos; sin embargo, por ser puertos de ría, el río recibe de sus -- afluentes y através de todo su recorrido, una gran cantidad de -- aporte de sólidos que se depositan en los últimos kilómetros de - su desembocadura debido, fundamentalmente, a la escasa pendiente- de su lecho y a lo bajo de las márgenes, dando como resultado la- disminución de la velocidad del agua y la sedimentación del azol- ve.

En la época de avenidas que se presente anualmente, pueden suceder dos fenómenos: si la velocidad de la corriente se mantiene constante y de cierta intensidad durante su período más o menos largo (una semana o algo así), su enorme caudal unido a la velocidad, tiene efectos positivos arrastrando la corriente los sólidos depositados con anterioridad, profundizando el río considerablemente; pero si la velocidad tiene un valor máximo y decrece con rapidez, el resultado es un depósito que puede llegar a disminuir la profundidad en uno ó dos metros en sólo unos días, volumen que para retirarlo mediante dragado, toma varias semanas y en algunas ocasiones meses, dependiendo de la cantidad de material depositado.

Si al dragado permanente de mantenimiento de los puertos fluviales, se agrega el de emergencia y los dragados de obra, la situación se torna realmente crítica y a veces con resultados catastróficos para aquellos barcos de itinerario fijo que se ven obligados a disminuir notablemente su calado y con ello su capacidad de carga, haciendo sus travesías con flete muerto lo que resulta a todas luces incosteable para el armador, viéndose obligado a elevar las tarifas o a evitar la escala en ese puerto.

Aunque la Secretaría de Comunicaciones y Transportes a últimas fechas ha puesto especial atención al problema del dragado de los puertos, adquiriendo varias dragas de autopropulsión sumamente modernos para subs tituir equipos ya ineficientes, son muchos los puertos que tiene que atender los aspectos de mantenimiento y de dragado de obra, siendo pocos los que su calado oficial sobrepasa los 10 metros, en algunos casos referidos a la pleamar del día.

Si bien esto nos deja a la zaga con respecto a otros puertos extranjeros (ya que los hay con condiciones más desfavorables) si pone en desventaja competitiva a nuestra flota mercante en cuanto a fletes se refiere, los cuales serán menos redituables comparados con las que tienen barcos de mayor porte para el mismo tipo de producto, así como para nuestras exportaciones que no se realizan a tarifas bajas y con las cualidades del transporte moderno.

Citemos el ejemplo del transporte mediante contenedores que tanta difusión ha tenido en el mundo por su eficiente servicio y que en México se lleva a cabo en solo un puerto con embarcaciones cuya capacidad está muy por abajo del barco contenedor media actual, que transporta entre 400 y 700 cajas.

Como éste, pueden mencionarse los casos de barcos graneleros, mineraleros, petroleros, etc.

Una solución acertada y que ya se ha puesto en práctica aquí en México, que es un país con escasos recursos económicos, es la de aprovechar parte de las obras de infraestructura de los puertos existentes (escolleras por ejemplo) y construir puertos río arri ba o internos lo más próximo posible a la bocana minimizando los - trabajos de dragado de mantenimiento. Este es el caso del puerto - de Pajaritos en la márgen derecha del río Coatzacoalcos, ya en --- operación y el que se planea construir en la márgen derecha del -- río Pánuco aguas abajo del canal de Chijol.

Quizá también el puerto de Túxpam, por ser la terminal marítima actual más próxima a la Capital de la República (100 kms. más cerca que Veracruz), se habilite bajo la misma solución.

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SISTEMAS MARITIMOS Y PORTUARIOS

INSTALACIONES PETROLERAS

ING. MARIO R. DE LA GALA.

MARZO, 1979.

INSTALACIONES PETROLERAS

Este tipo de instalaciones es a la fecha el que más evolución ha tenido por la demanda mundial cada vez mayor de hidrocarburos y productos petroquímicos, ya que los pasos por los estrechos de Panamá y Suez limitante el primero por sus dimensiones físicas y el segundo obstruído en una época, obligaron a efectuar una revisión de los costos de transporte contra el tonelaje de las embarcaciones de hace veinte años, encontrándose que doblando los cabos de Hornos y Buena Esperanza, resultaban incosteables los fletes por las distancias tan considerables por recorrer desde las zonas de producción generalmente muy alejadas de los centros principales de consumo, con embarcaciones relativamente pequeñas.

Fué así como los grandes consorcios petroleros iniciaron los estudios tendientes a incrementar el porte de las embarcaciones de tal forma de abatir los costos, habiendo llegado paulatinamente a barcos de 100 000 TPM creyendo que el límite máximo serían las 200 000 TPM. Sin embargo, este tipo de embarcaciones tuvo problemas en un principio, propiciándose accidentes principalmente de quebrantamiento, ocasionando contaminaciones no solo del lugar del siniestro sino también de amplias zonas, debido a las corrientes oceánicas que transportaban los derrames a grandes distancias dañando la ecología, con el consiguiente desequilibrio de ésta.

Después de estudios en modelos y prototipos, se encontró que la relación entre vibraciones producidas por la máquina del barco y la eslora, propiciaban efectos que fatigaban el material estructural del barco propiciando su quebranto.

Solucionado este problema y deseando los armadores abatir al máximo los costos de transporte ya que estos crecen en una proporción menor que sus incrementos en capacidad, se inició la construcción en 1966 de barcos de 150 000 (Tokyo Maru de 153 687 TPM) y 200 000 (Idemitsu Maru de 209 000 TPM), en 1973 de 300 000 (Universe Ireland de 326 000 TPM) y 500 000 (Globtik Tokyo de 483 664 TPM), sin que este último sea la capacidad límite prevista ya que existe el proyecto para fines del presente año, de poner en servicio un buque tanque de 707 000 TPM y el de un millón de toneladas de peso muerto, ya se encuentra en proyecto.

Como una justificación económica de la razón del aumento en tamaño de los barcos petroleros, es el ejemplo de una ruta tomada al azar (del Medio Oriente a Japón) con buques tanque de 48 000, 102 000, 153 000, 209 000 y 326 000 TPM.

Si se considera como unidad el precio por barril transportado en el barco de 48 000 TPM, los demás tendrían el costo mostrado en el siguiente cuadro:

T.P.M.	COSTO POR BARRIL
48 200	1.0
102 000	0.672
153 000	0.562
209 000	0.485
326 000	0.457

Valores que por sí solos explican el por qué del incremento en tamaño de los buques tanque.

Ante este desenfrenado deseo de incrementar el porte de las embarcaciones que se inicio en 1959 con la construcción de los barcos superiores a las 100 000 TPM pensando solo en abatir los costos de transporte sin detenerse a meditar en el daño que pudieran ocasionar a la vida marina, los puertos principalmente de recibo de productos tanto en Asia como Europa, se dieron a la tarea de adecuar sus puertos existentes para poder recibir a estas embarcaciones, no previstas aún dentro de las planeaciones portuarias más futuristas.

Sin embargo, en vista de que la construcción de un barco de los portes mencionados toma del orden de 12 meses para su botadura, tiempo varias veces menor que el necesario para efectuar los trabajos tendientes a construir las instalaciones portuarias y profundización de los canales y dársenas adecuadas, ha sido necesario que las autoridades portuarias y las compañías directamente interesa--

das se aboquen a la investigación de sistemas en los cuales el -- puerto no fuera imprescindible para la operación de estos verdaderos gigantes del mar.

Así, se ha caído en soluciones de instalaciones mar adentro, algunas de ellas que recuerdan a las utilizadas hace 50 años ó más.

Para seguir un orden cronológico, las instalaciones petroleras -- pueden dividirse en:

1. Portuarias

2. Mar adentro

INSTALACIONES PETROLERAS PORTUARIAS.- Son aquellas localizadas como su nombre lo indica, dentro de la protección del puerto mismo. Estas a su vez, por su tipo pueden dividirse en:

Tipo "T"

Tipo "L"

Tipo "Marginal"

Tipo "Espigón" (perpendicular a la línea - de costa ó margen o esviajado).

Por ser los barcos petroleros los de mayor porte navegando actualmente, por razones de seguridad y de economía, se deberán localizar sus instalaciones de atraque lo más próximo a la entrada del-puerto, ya que en caso de un siniestro, es más fácil que el barco se aleje del puerto sin causar mayores daños al resto de las instalaciones.

En cuanto a la economía, es obvio que estando los muelles más cercanos a la bocana menor será el volumen necesario a dragar.

MUELLE EN "T"

Este muelle puede considerarse como el pionero de los muelles petroleros en los puertos bien sean de mar o fluviales, fundamentalmente porque estas obras fueron construídas en sus inicios por -- las propias compañías explotadoras del petróleo en países ajenos, en donde más les interesaba la extracción desmedida en el menor - tiempo posible, que efectuar obras que reportaran beneficios duraderos al país propietario del petróleo.

Así, se encuentra que para evitar dragados, se llevaba la plataforma de operación del muelle hasta encontrar la profundidad natural necesaria, comunicándola con una pasarela hasta tierra en la-cual se colocaban las tuberías y servía para el tránsito de peatones y vehículos.

Este muelle tiene la particularidad por ser generalmente paralelo a la margen del río o costa, de ocupar un espacio de éstas igual a la eslora del barco mayor que se espera recibir, más un margen de seguridad a proa y popa, con respecto a las instalaciones adyacentes.

En las figuras (1), (2), (3), (4) y (5) se muestran algunos ejemplos de muelles "T".

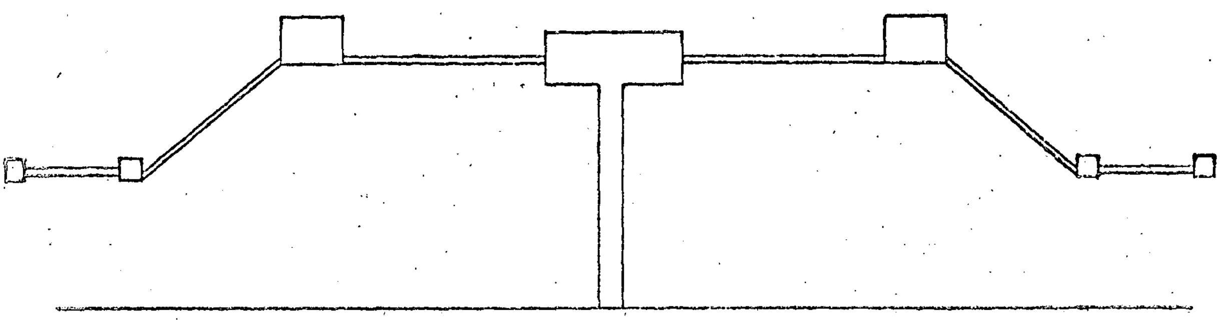

Fig. 1

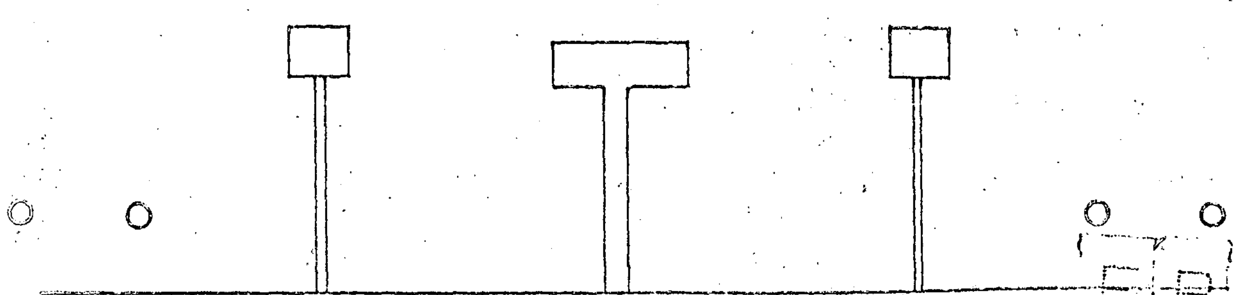

Fig. 2

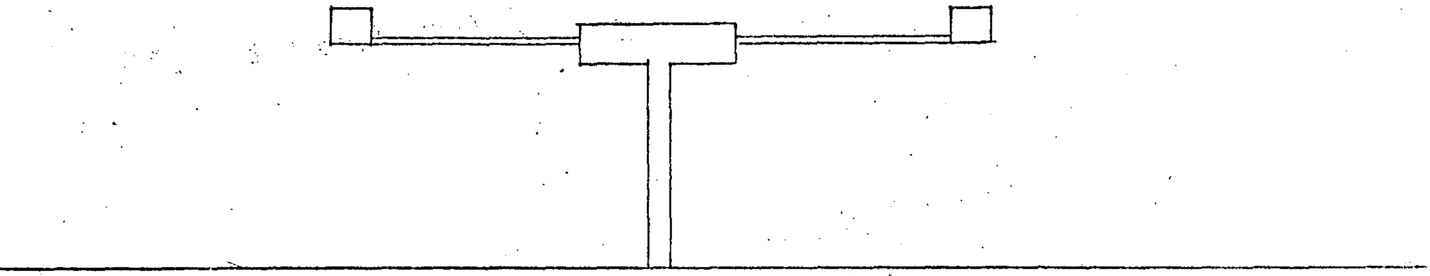

Fig. 3

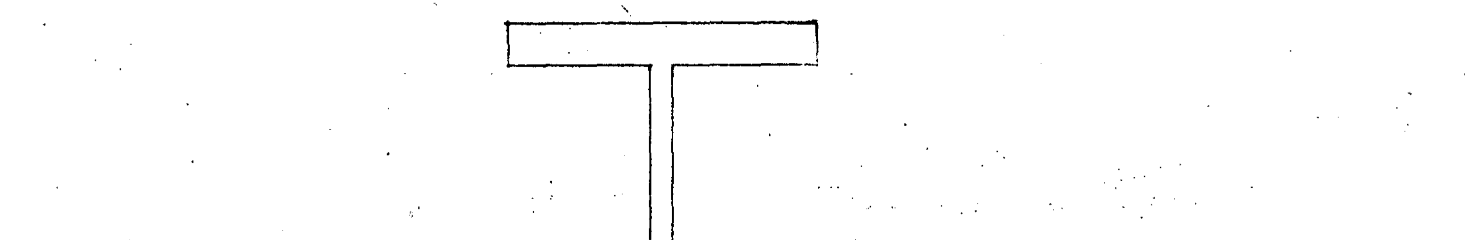

Fig. 4

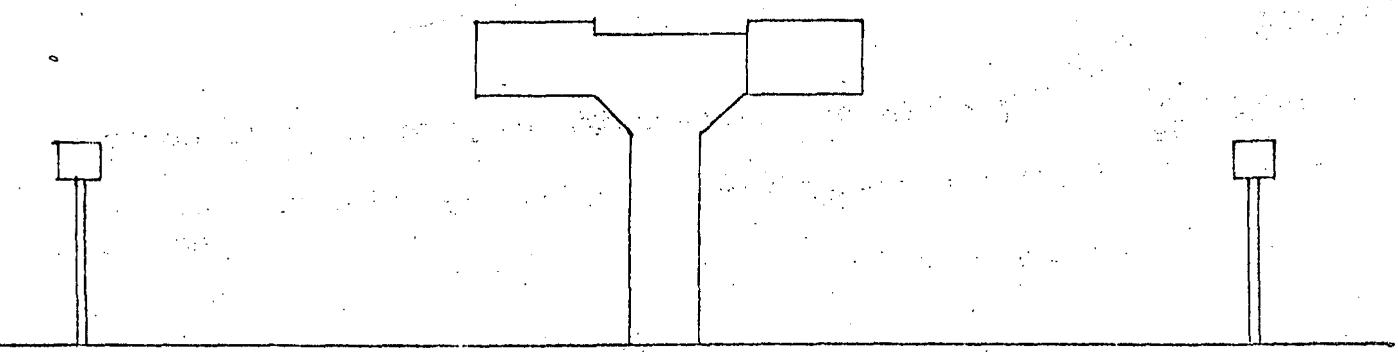

Fig. 5

MUELLE EN "L"

Este tipo es una variante del muelle en "T" con el mismo criterio de operación con la diferencia de que la pasarela de comunicación en lugar de localizarse al centro de la plataforma de operación se sitúa en uno de sus extremos. Ver figuras (6) y (7).

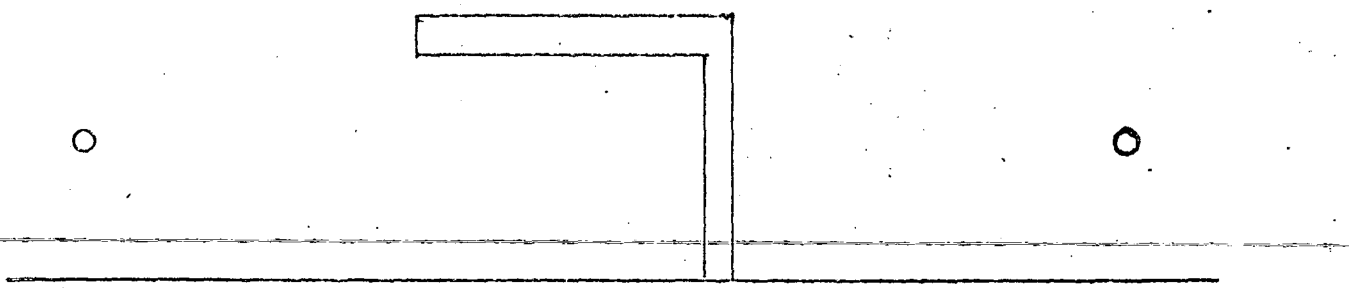

Fig. 6

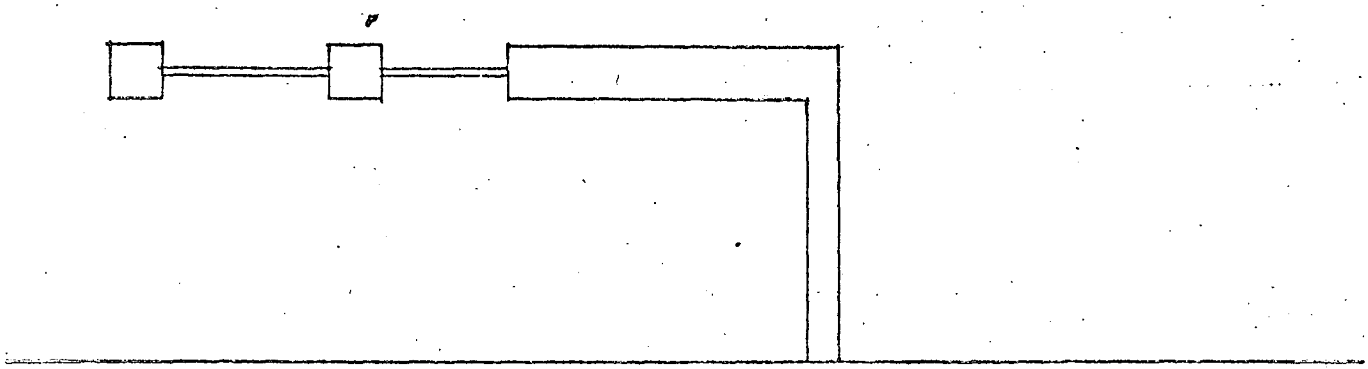

Fig. 7

MUELLE MARGINAL

Como su nombre lo indica, su construcción es paralela a la costa o margen muy próxima a éstas. Generalmente se hacen continuos para el atraque de varias embarcaciones simultáneas.

...ce la ventaja de poder transitar por él facilitando el amarre ...os cabos del barco. Sin embargo, su longitud es equivalente a ...eslora del barco más una longitud adicional a proa y a popa co... margen de seguridad con las embarcaciones adyacentes. Ver Fig.

Fig. 8

MUELLE EN ESPIGON

...los pueden ser perpendiculares o esviajados con respecto a la - margen del río o costa.

...os buques tanque, son embarcaciones cuya carga es destribuida a - ...us compartimentos mediante una red de tuberías a bordo sin que -- ...sea necesario mover el barco para llenarlo en su capacidad total - como sucede con otro tipo de barcos ó que los equipos terrestres - ...quieran sufrir desplazamientos para tal fin, ya que a bordo exis te una zona determinada en la cual están los extremos de la red - de tuberías que conducen el ó los productos, la cual es común que se localice sensiblemente a la mitad de la eslora del barco, quizá un poco hacia proa.

Partiendo de este hecho, se puede considerar que el barco siempre atracará en la misma posición: la localización de las tomas de -- producto, los puntos de contacto del barco en los elementos de -- atraque así como los de amarre, tendrán su situación perfectamente definida con lo que se logra una economía al no ser necesario construir el muelle en toda su longitud con la misma rigidez es-- tructural, concentrando ésta en los puntos donde se requiere. Ver Figs. (9) y (10).

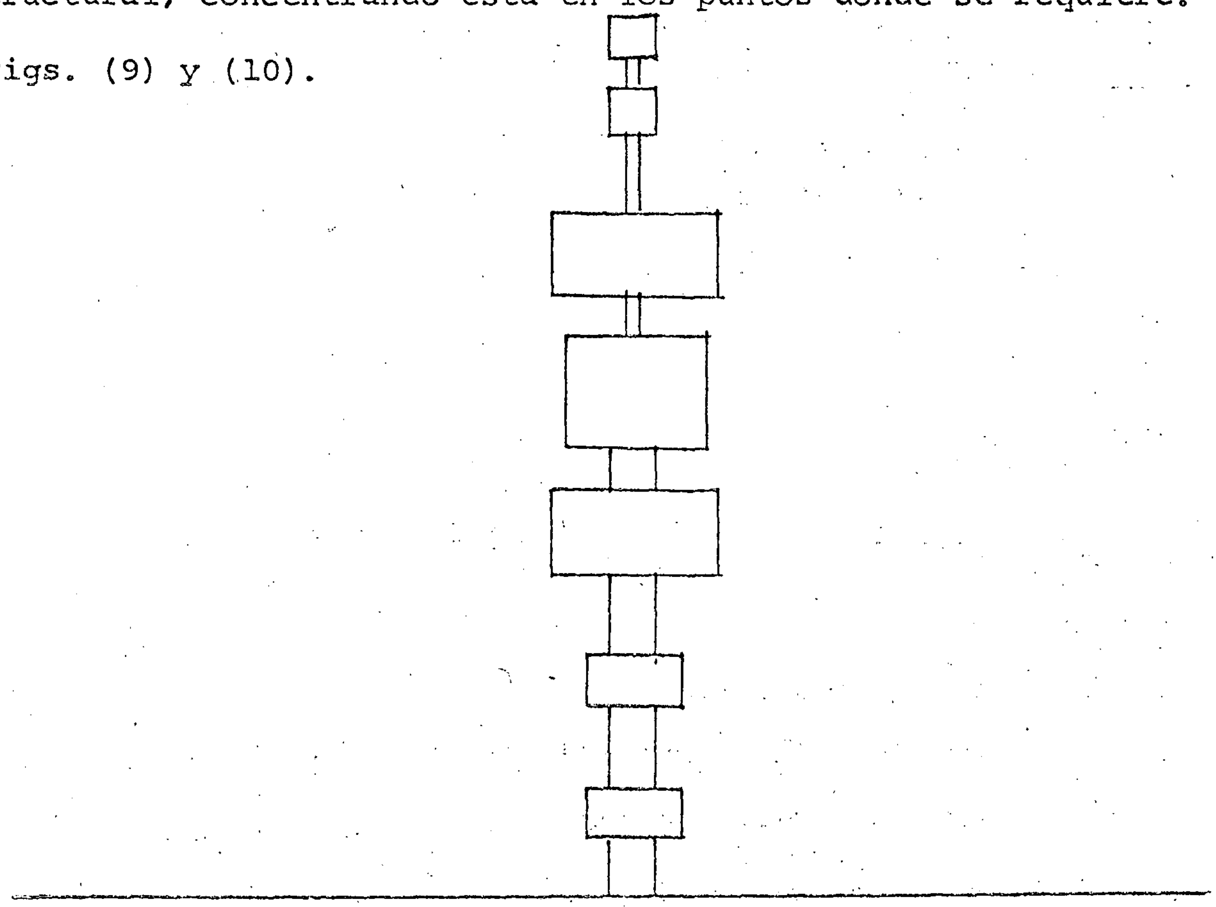

Fig. 9

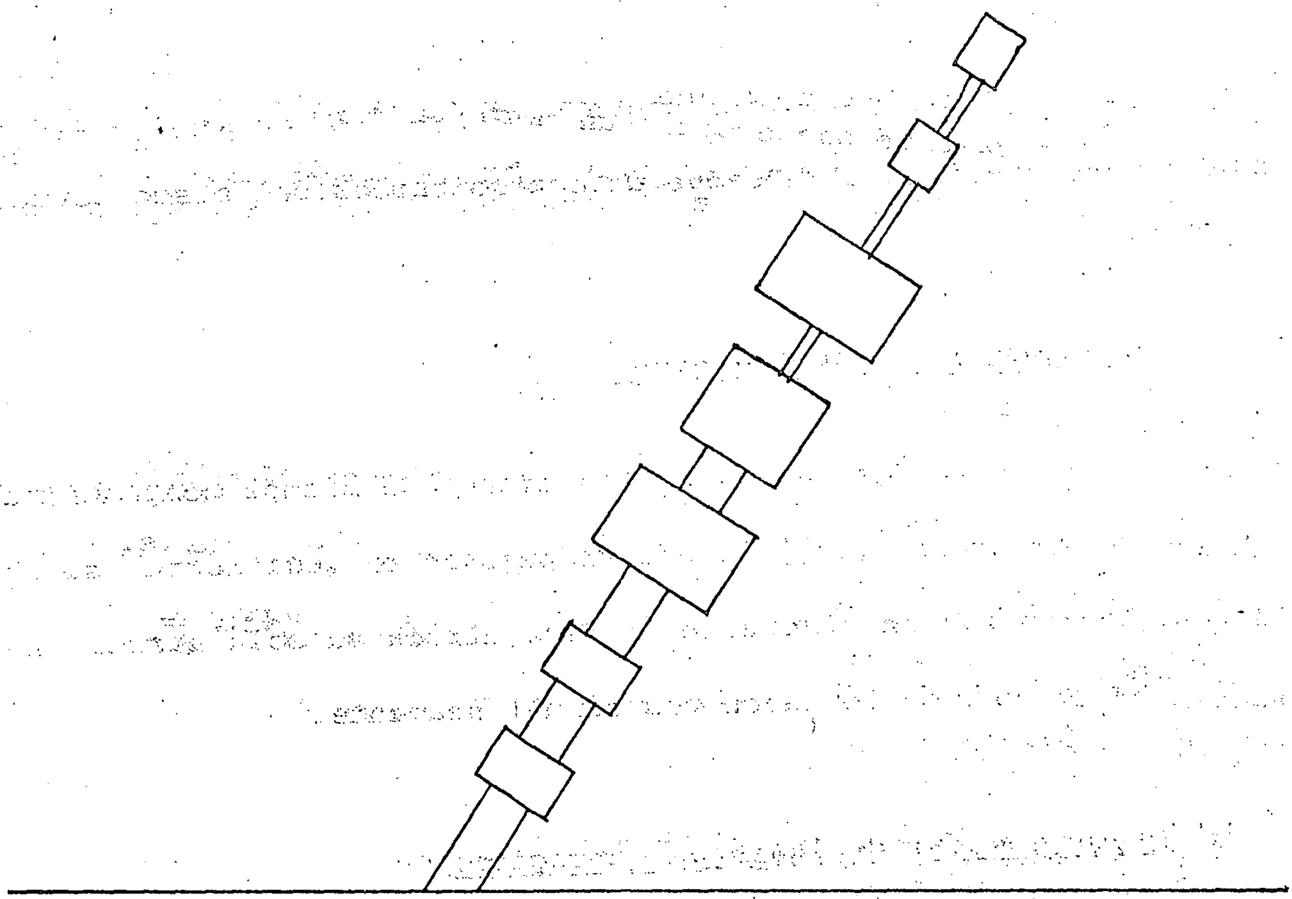

Fig. 10

Cuando la localización de la instalación portuaria así lo permite, el muelle en espigón es el tipo más adecuado por los siguientes -- motivos principales:

1) Menor ocupación de margen o dicho en otras palabras, ocupación de la margen con mayor eficiencia.

2) Mayor economía en construcción.

3) Mejor control de las áreas de operación.

1) <u>Ocupación de la margen con mayor eficiencia.</u>

Esto es obvio ya que al quedar perpendiculares los muelles a la --

margen ó costa, prácticamente donde opera un barco en un muelle marginal es factible el atraque de cuatro barcos del mismo porte.

2) Mayor economía en construcción.

Si se considera que un muelle en "T" tiene los mismos componentes que un muelle en espigón solo que dispuestos en otra forma, se observa que mientras en un muelle en "T", atraca un solo barco, en el muelle en espigón lo hacen dos simultáneamente.

3) Mayor control de las áreas de operación.

Esto es resultado de la concentración de las instalaciones en una menor longitud de margen o costa, reduciéndose la vialidad, vigilancia y demás servicios terrestres, principalmente tuberías de producto.

Como se puede observar, cada tipo de muelle cumple con su cometido según las condiciones del lugar donde se localice pues aunque alguno de ellos puede ser más eficiente que otro, existen ciertas limitaciones que no permiten el uso del muelle en espigón que resulta ser el más adecuado según se mencionó en párrafo anterior.

Estas limitaciones principales pueden ser:

1. Vientos reinantes

2. Dimensiones físicas del puerto

3. Corrientes acuáticas

4. Resonancia del vaso portuario

5. Vida útil de la instalación

1. Vientos reinantes.

Lo ideal para un muelle en espigón es que los vientos reinantes sean en el sentido de su eje longitudinal, lo que algunas veces no es posible lograrlo por la planeación misma del puerto.

2. Dimensiones físicas del puerto.

Esto es común en aquellos puertos fluviales cuya ría es de poca anchura. No obstante esta limitación podría superarse dragando hacia adentro de alguna de las márgenes; sin embargo, la ampliación del área hidráulica traería como resultado la disminución de la velocidad del agua y consecuentemente el depósito de azolve.

3 Corrientes acuáticas.

Aún en rías de suficiente anchura, con dirección de vientos en la condición ideal, puede existir el problema de fuertes velocidades de corriente que dificulten las maniobras de atraque y desatraque.

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4. Resonancia del vaso portuario.

Cuando se presenta este caso, se deberá buscar la orientación má adecuada que contenga la resultante de los parámetros anteriores así como el de la resonancia que podría estar produciendo consta tes movimientos de acercamiento y alejamiento del barco al muell con los consiguientes perjuicios para la estructura del muelle y los equipos instalados y por que no, de la embarcación misma.

5. Vida útil de la instalación.

Este aspecto también puede definir en cierta forma el tipo de mu lle a construir.

En cuanto a los materiales que se utilicen, dependerán de las si guientes condiciones:

1. Tiempo disponible para ponerlo en operación.
2. Dimensiones propias del muelle.
3. Disponibilidad de materiales
4. Condiciones ambientales.

1. Tiempo disponible para ponerlo en operación.

Cuando la instalación se requiere con urgencia habrá que pensar utilizar los materiales existentes en el área. Una solución muy

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común en el caso de muelles petroleros, es la de utilizar tubería (generalmente de recuperación) con la cual la fabricación de pilotes es sumamente rápida. Asímismo, por estar sometidos estos muelles principalmente a cargas horizontales, la tubería es también una buena solución para la fabricación de la superestructura incluyendo los elementos que le proporcionan la rigidez adecuada.

2. Dimensiones propias del muelle.

Si por el porte de las embarcaciones que atraquen al muelle se requieren elementos de cimentación muy robustos y dependiendo del tipo de suelo, pueden utilizarse pilotes de acero ó pilotes huecos de concreto, ambos de gran diámetro .

Sin embargo, siempre existe una relación directa entre el porte de la embarcación y la profundidad del agua e hinca de los pilotes donde se desplante la obra. Por tal motivo y por la facilidad de fabricación y manejo los pilotes de tubería de acero, son los más recomendables, para muelles que reciban embarcaciones de porte mayor.

Es evidente que al proyectar una instalación portuaria petrolera no es solamente ésta en sí, sino que debe de tomarse en cuenta para fines de la planeación terrestre, la necesidad de contar con -

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las áreas suficientes para la localización de tanques de almacenamiento bien sea para recibo de los productos o para la expedición de estos por vía marítima.

Dependiendo del área de influencia que esta terminal de almacenamiento tenga, serán las dimensiones de los terrenos necesarios.

En algunos países altamente industrializados, no solo consideran las áreas para los patios de tanques sino también los espacios necesarios para la erección de refinerías desde donde parten los productos elaborados.

Para la localización de estas áreas terrestres, se sigue el mismo criterio seguido para los muelles: es decir, alejados del puerto comercial y en lo posible, lo más próximo a los muelles para disminuir los tiempos necesarios de operación de los barcos.

Cuando se trata de puertos prácticamente saturados de instalaciones y cuyas posibilidades de expansión son nulas o carecerían de las reglamentaciones de seguridad para los grandes supertanques, se opta por construir terminales ó puertos petroleros independientes de los antiguos puertos convencionales.

Sin embargo, por lo cuantioso de las inversiones y el tiempo que estas requieren para su construcción, no es común encontrar muchos de estos puertos que den cabida a barcos que exceden al tonelaje - del orden de 250 000 TPM.

INSTALACIONES PETROLERAS MAR ADENTRO

Aunque es indiscutible que para condiciones normales el puerto es- sinónimo de abrigo seguro para los barcos como se mencionó al principio de este capítulo, los barcos han rebasado con creces el tonelaje de 250 000 TPM causando problemas operativos principalmente - en los lugares de destino del petróleo crudo principalmente.

Como quiera que en algunos casos no es posible someter al puerto a sucesivas modificaciones ya sea por limitaciones físicas ó económicas, se ha tenido que recurrir a instalaciones que para la descarga de los barcos no dependan del abrigo del puerto para su operación. Desde luego es deseable que exista alguna protección natural lo -- que asegurará un porcentaje mayor de días aprovechables.

Las instalaciones petroleras mar adentro pueden dividirse en dos - grupos principales:

1. Flotantes
2. Fijas

1. Instalaciones flotantes.

a) Fondeadero

b) Amarradero convencional

c) Monoboya con sistema de fijación con cadenas en catenaria.

d) Monoboya con sistema de fijación con un solo ramal de cadena.

e) Monoboya con sistema de fijación con brazo rígido.

2. Instalaciones fijas.

a) Torre para amarre de buques tanque

b) Muelles Isla

Instalaciones flotantes.

1.a) La forma más elemental para alijar o cargar un barco petrolero es al ancla lo cual sucede cuando no se cuenta con las instalaciones portuarias adecuadas o porque no existe suficiente profundidad para que en forma económica se aproxime a la costa. Tal cosa sucede actualmente para abastecer Lerma, Camp., fondeando el barco alejado de la costa donde haya profundidad suficiente para operar con seguridad y mediante chalanes de poco calado se alija el barco llevando el producto a tierra.

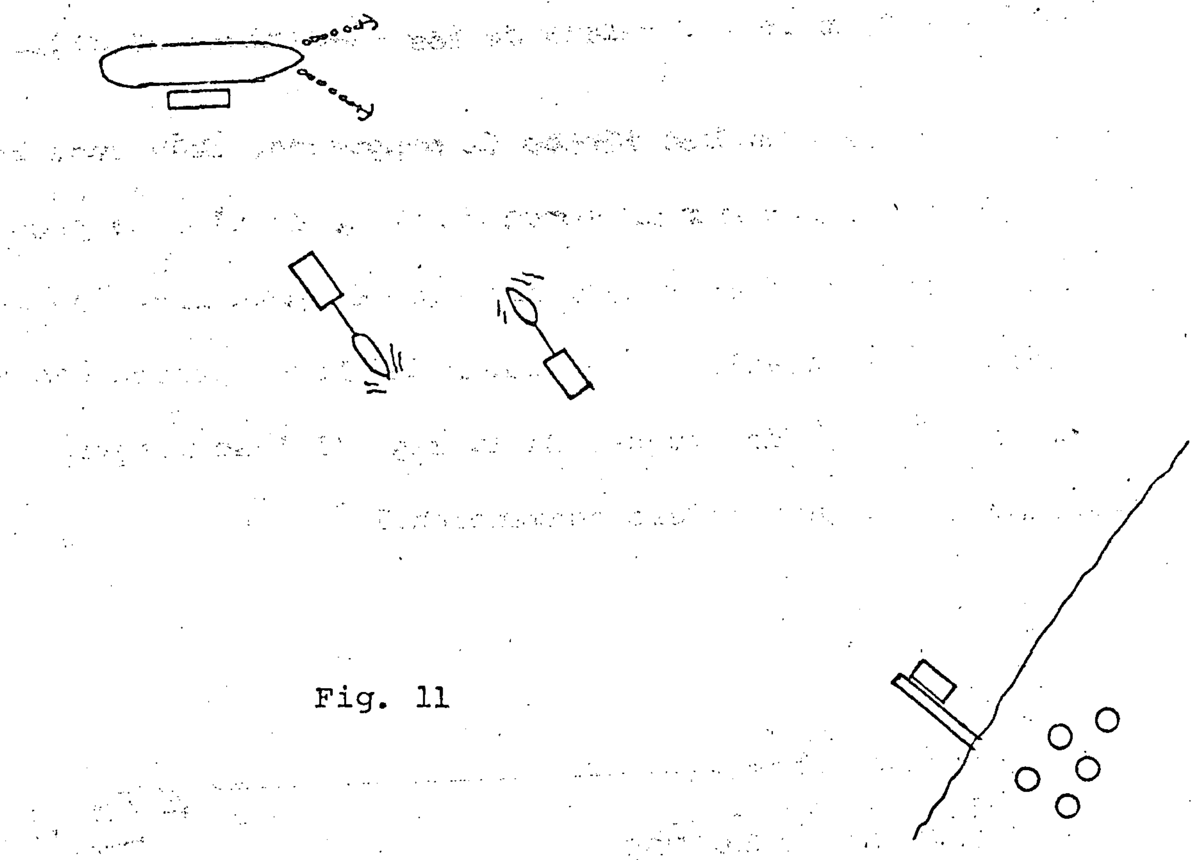


Fig. 11

1.b) <u>Amarradero convencional ó SPM (Spread Point Mooring).</u>

Posiblemente esta instalación haya sido la primera que se -- ideó como solución de operación más o menos continua para -- evitar el uso de un puerto o por la carencia de éste.

Consiste fundamentalmente en un número de boyas de amarre -- (4,5 ó 6) convenientemente distribuídas para recibir los cabos de amarre del barco que lo tienden a mantener en una posición sensiblemente fija, una o varias tuberías submarinas- de producto que van desde los tanques de almacenamiento en - tierra hasta el centro de gravedad del conjunto de las boyas.

En este extremo, se conectan varios tramos de manguera de hule que permitirán los movimientos relativos propios de la em barcación debido a la influencia de los elementos naturales.

En el extremo libre de las líneas de mangueras, irán unos boyarines que identificarán por su forma ó color, el tipo de producto - que cada tubería conduce y servirán también para izar las mangueras a bordo y conectarlas a las tomas del barco procediéndose a - la carga ó descarga del buque. En la fig. (12) se muestra en forma esquemática un amarradero convencional.

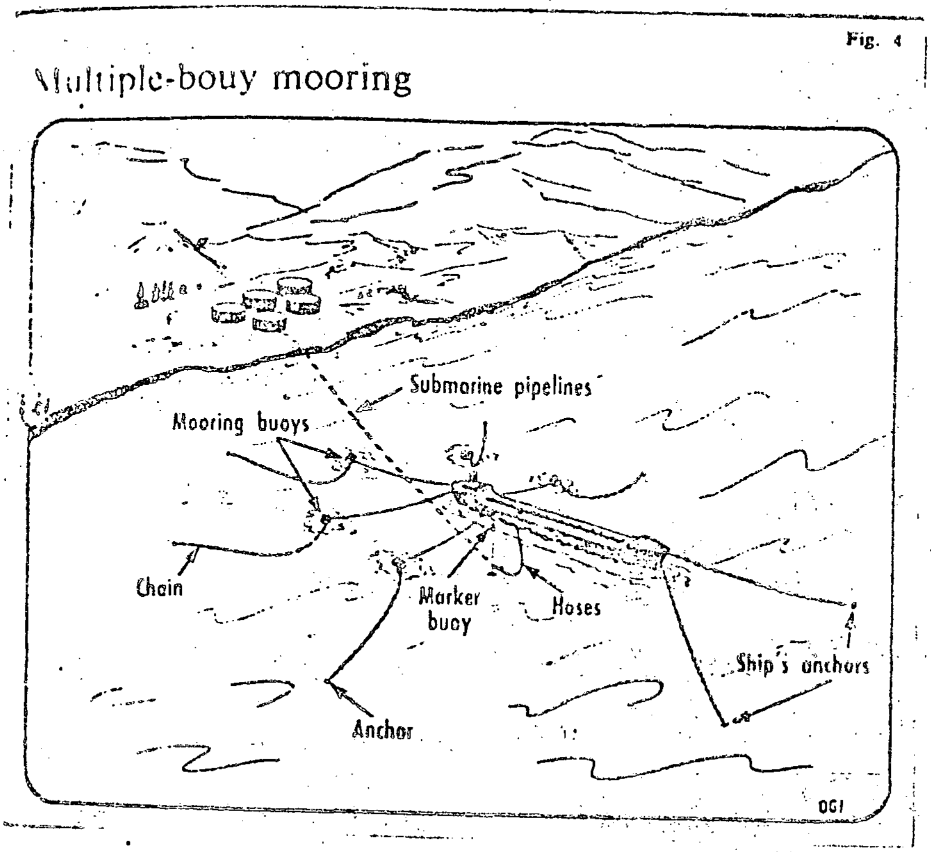


Fig. 12

Con este sistema simplista y hasta cierto punto económico (si - las profundidades necesarias están próximas a la costa), los -- costos por concepto de dragado no existen porque las líneas se- prolongarán mar adentro tanto como se requiera.

No obstante, adolece de serios inconvenientes debidos a que como se mencionó anteriormente, este tipo de instalaciones generalmente tienen una protección natural precaria quedando expuestas a las condiciones naturales del lugar, como son: el oleaje, las corrientes, viento y mareas.

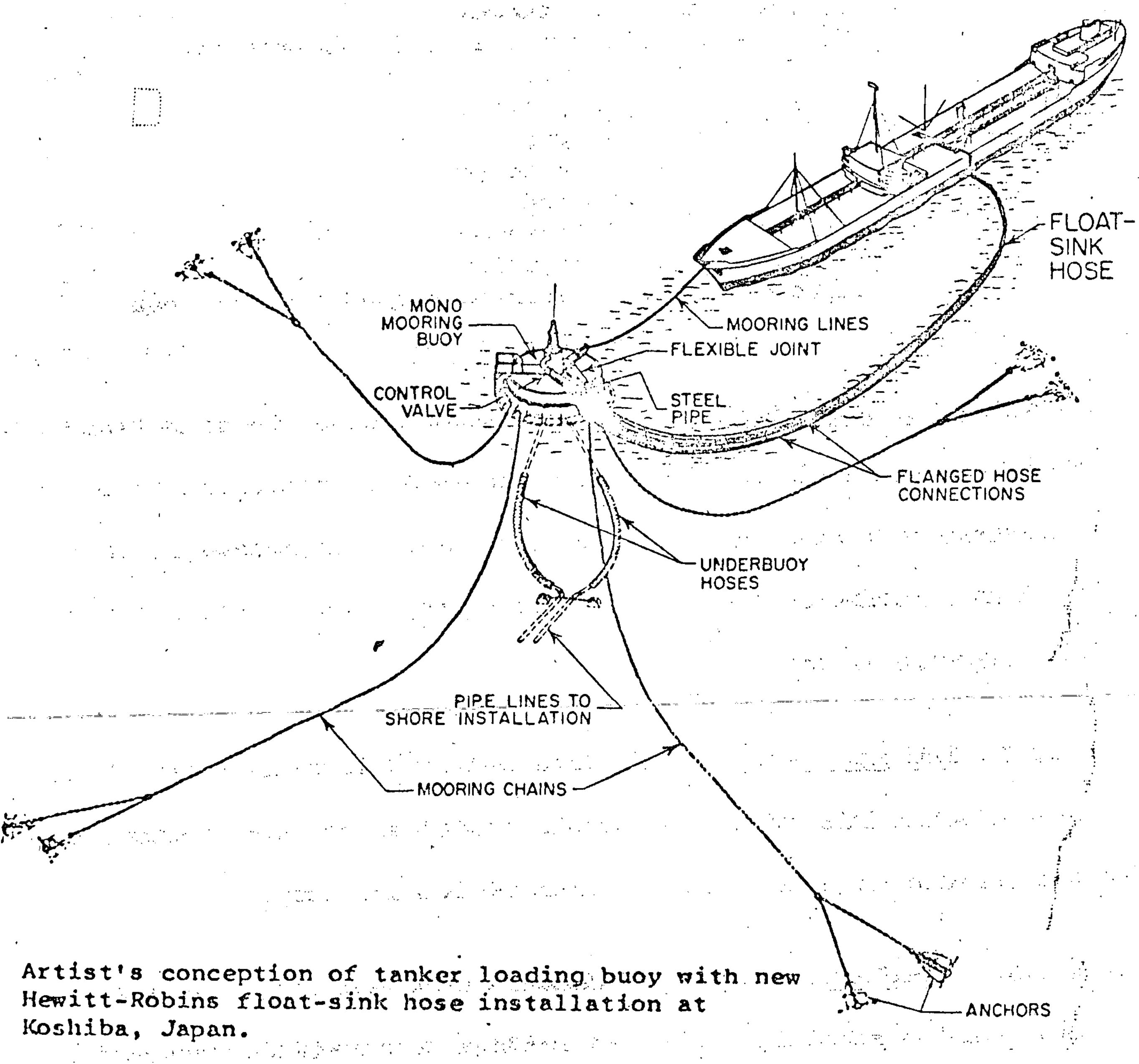
Si bien el barco se amarra en dirección de la resultante de los elementos antes dichos, estos pueden cambiar sorpresivamente - de dirección, principalmente el viento y el oleaje, incidiendo estos sobre el costado del barco obligando a la embarcación a- largar el amarradero y si el tiempo lo permite, enmendar la maniobra, amarrándose en una nueva posición más favorable. Lo anterior puede tomar de 4 a 5 horas, pero si el oleaje y el viento son tales que esta operación no pueda realizarse, el barco- deberá fondearse a esperar a que mejore el tiempo con las consiguientes pérdidas que se derivan de una operación intermitente.

1.c) <u>Monoboya con sistema de fijación con cadenas en catenaria.</u>

Observando los inconvenientes que tiene un amarradero con--

vencional de boyas múltiples debido a las maniobras que hay que realizar cuando existen cambios en las condiciones meteorológica locales, varios laboratorios de investigación hidráulica marítim se dieron a la tarea de encontrar algún sistema, que permitiera al barco seguir operando aún cuando las condiciones variaran en intensidad y dirección.

Así, hace aproximadamente 15 años salió al mercado una boya a la cual el barco podría amarrarse y girar en ambos sentidos 360° alrededor de ella, según las condiciones del tiempo, dando como resultado la monoboya conocida como CALM (Catenary Anchor Leg Mooring). Ver fig. (13).



Artist's conception of tanker loading buoy with new Hewitt-Robins float-sink hose installation at Koshiba, Japan.

Fig. 13

Las partes fundamentales de esta monoboya son:

1. Tubería submarina
2. Múltiple submarino
3. Mangueras submarinas
4. Casco de la monoboya
5. Múltiple de distribución de productos a bordo de la monoboya.
6. Brazo de operación
7. Brazo de amarre
8. Brazo de contrapeso
9. Cabos de amarre
10. Mangueras flotantes
11. Cadenas de fijación
12. Anclas o pilotes para fondeo de la boya.

1.c.1.- <u>Tubería submarina</u>.- Es la tendida en el lecho marino desde la playa hasta el lugar donde se localice la monoboya. Generalmente cuando los diámetros son mayores de 12", es necesario lastrarlas para evitar que traten de flotar propiciando su desplazamiento del lugar previsto.

1.c.2.- <u>Múltiple submarino</u>.- Este elemento localizado en el extremo de la tubería submarina, es la unión de ésta con las mangueras que conectan con el fondo del casco de la monoboya.

1.c.3.- <u>Mangueras submarinas.</u>- Como se mencionó en el párrafo anterior, es la parte flexible de la línea submarina de conducción que absorberan los movimientos de la monoboya debidos fundamentalmente al oleaje y las mareas.

1.c.4.- Casco de la monoboya.- Es prácticamente un flotador de suficiente capacidad para soportar el peso de los equipos instalados a bordo y las cadenas que lo fijan al lecho marino.

1.c.5.- Múltiple de distribución a bordo de la monoboya.- Este componente es la parte vital del funcionamiento del sistema. Está formado por varias cámaras concéntricas (según el número de productos que se piensen mover a través de él) separados por sellos que evitan la mezcla de productos, teniendo un sistema giratorio que permite que el conjunto gire según se oriente el barco sin suspender la operación.

1.c.6.- Brazo de operación.- Es una estructura donde se apoyan las tuberías que salen de cada una de las secciones del múltiple de distribución de productos y que gira conjuntamente con éste.

1.c.7.- Brazo de amarre.- Este elemento está dotado de las bitas y cáncamos de amarre de los cabos donde se hará firme el barco por la proa. Como el brazo de operación, gira conjuntamente el múltiple de operación.

1.c.8.- Brazo de contrapeso.- Para mantener adrizada la monoboya debido al peso de los brazos anteriormente mencionados se requiere de otro en el cual se coloque peso suficiente para mantener la monoboya nivelada.

1.c.9.- Cabos de amarre.- Son dos y se encuentran fijos en un - extremo a los cáncamos del brazo correspondiente. Se encuentran flotando mientras no existe barco amarrado.

1.c.10.-Mangueras flotantes.- Partiendo de las tuberías de producto localizadas en el brazo de operación, se encuentran conectadas un número de líneas flotantes equivalente a igual número de productos que se muevan por el múltiple de distribución. Estas mangueras tendrán suficiente longitud para que lleguen por uno de los costados del barco hasta la parte media de su eslora, conectando a las tuberías de distribución que se localizan sobre la cubierta del buque tanque.

1.c.11.- Cadenas de fijación.- Son los elementos necesarios para transmitir los esfuerzos en la monoboya directamente al lecho marino, manteniéndola justo arriba del múltiple submarino - bajo cualesquiera de las condiciones meteorológicas previstas - en el diseño.

El número de cadenas dependerá del tamaño de los barcos que amarren, de la profundidad de localización y por supuesto, de las condiciones reinantes.

1.c.12.- Anclas o pilotes para fondeo de la boya.- Estas se localizan en los extremos de las cadenas que parten de la monoboya y harán presa en el lecho marino. Dependiendo del tipo de fondo, si es arenoso el uso de anclas es el adecuado; sin embar go, si es arcilloso el sistema de anclaje más conveniente es a - base de pilotes.

Este tipo de monoboya es el que más frecuentemente se encuentra- instalado, llegando a operar en él buques tanque hasta de - - -- 250 000 TPM.

Las limitaciones que presenta este tipo de instalación, son principalmente durante las maniobras de amarre, ya que es una embarcación de porte menor la que tiene a su cargo las operaciones de dar los cabos de amarre y los extremos de mangueras al barco, situación que se vuelve díficil si la altura de ola es superior a- 8 pies.

Asímismo, existe la posibilidad de que si el barco no tiene precaución durante el tiempo que esté operando, y no existe viento- ni oleaje, tiende a irse sobre la monoboya ocasionándose averias a una estructura que tiene poco margen de amortiguamiento.

1.d.- <u>Monoboya con sistema de fijación con un solo ramal de cadena.</u>

Esta monoboya conocida por las siglas S.A.L.M. (Single Anchor -- Leg Mooring) trata de evitar los inconvenientes mencionados en - el último párrafo de la monoboya C.A.L.M. Ver. Fig. (14).

EB

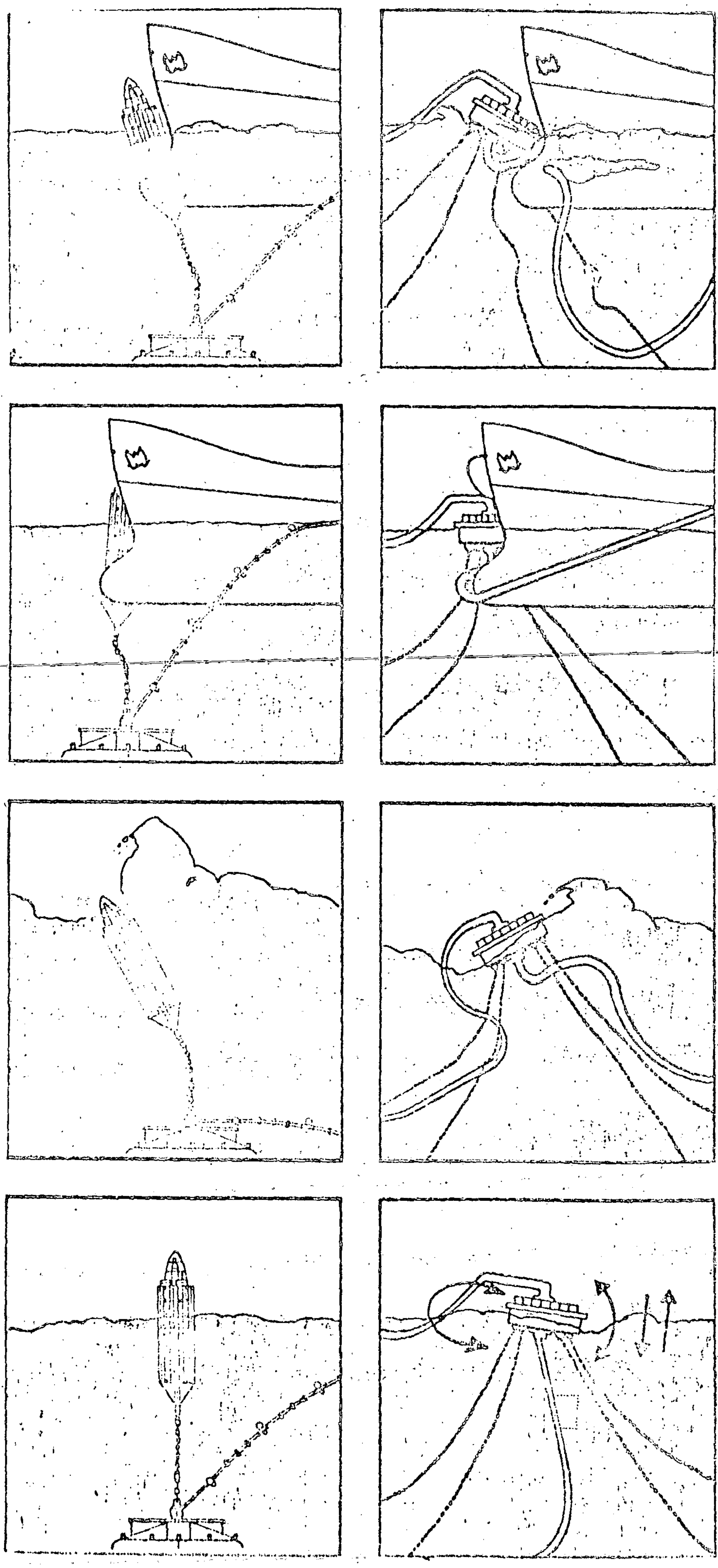


Fig. 14

Al quedar fondeada con un solo ramal de cadena tiene mayor facilidad de evadir o amortiguar un impacto directo del buque tanque. Ver, figs. (15) y (16).

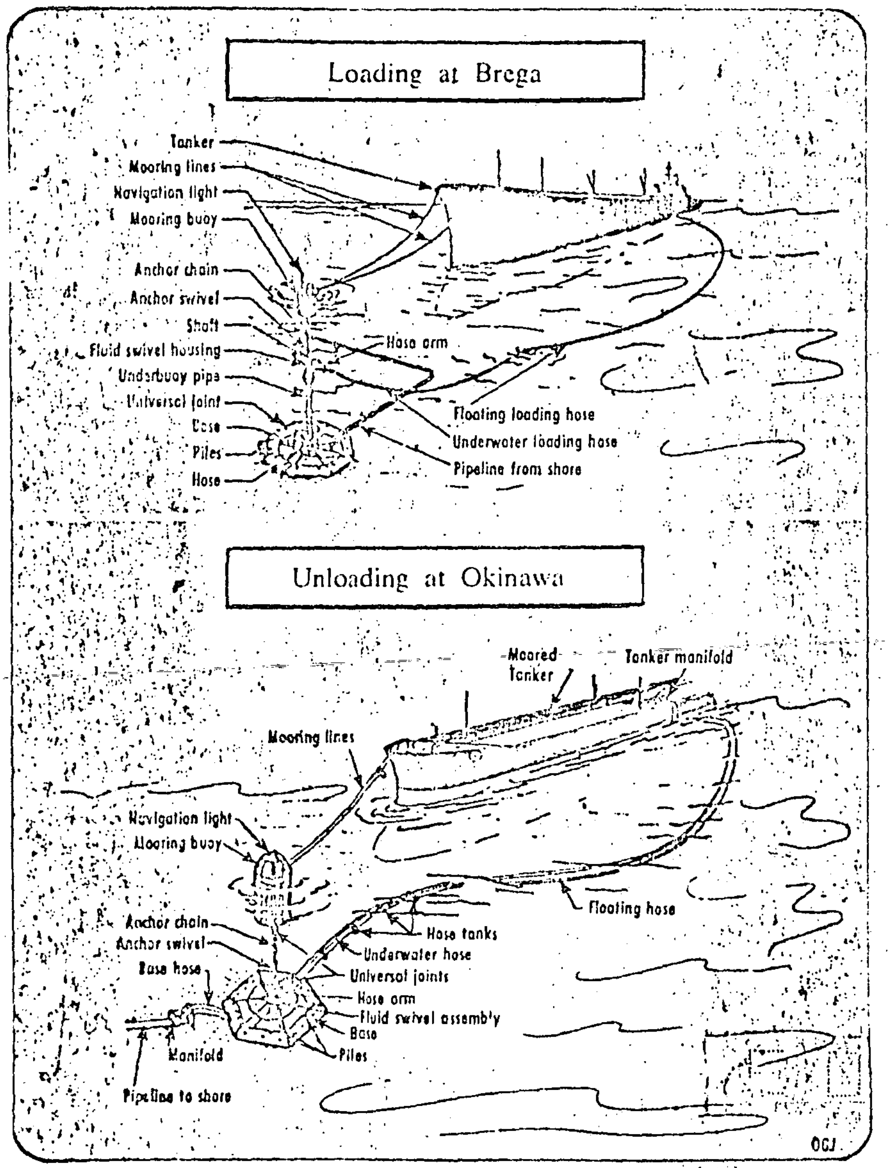
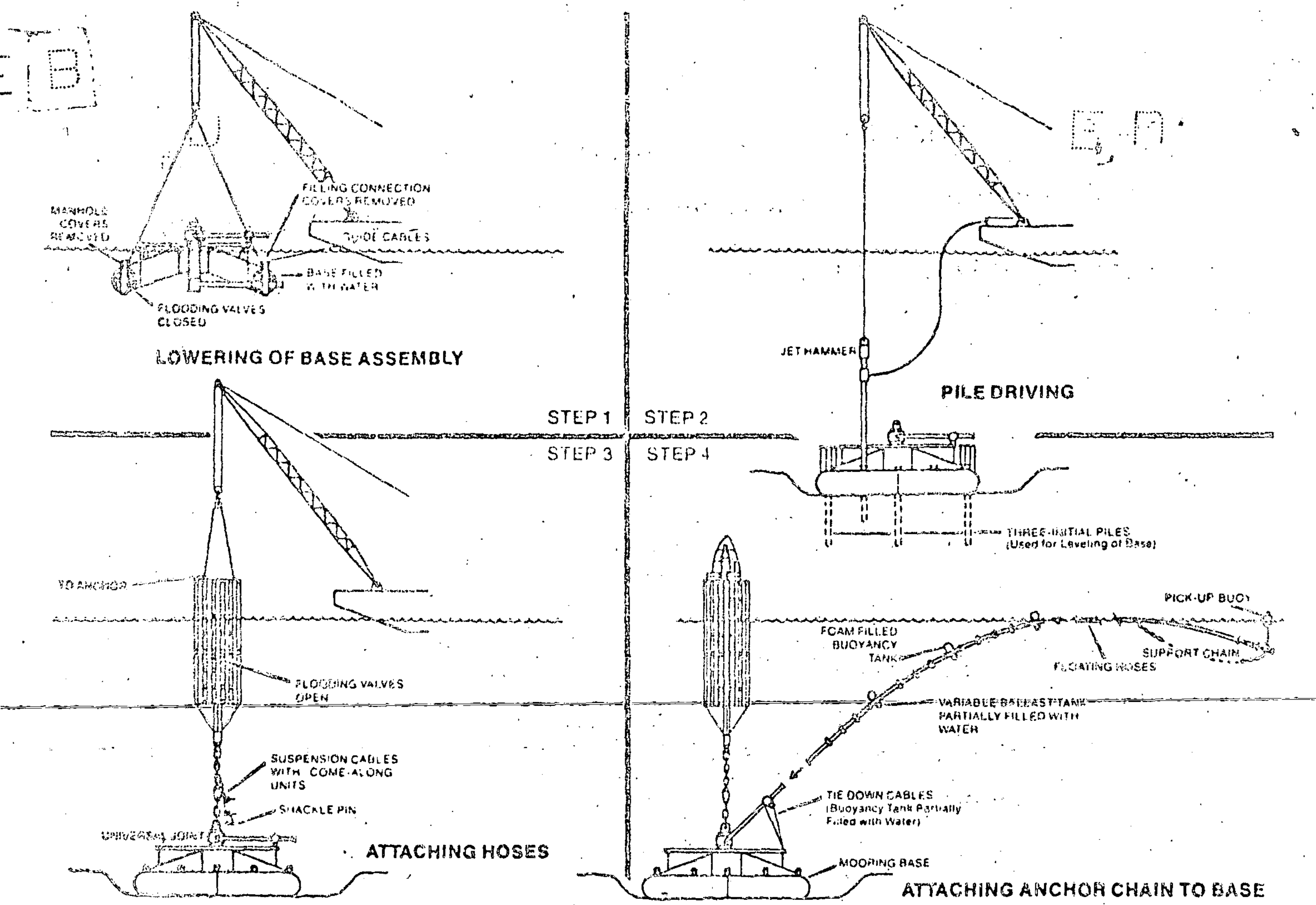


Fig. 15

TYPICAL SALM INSTALLATION



NOTE: SALM MOORING BASE CAN BE MADE OF ALTERNATIVE MATERIAL WHERE SEA BED SOILS DO NOT PERMIT PILES.

TYPICAL DIMENSIONS

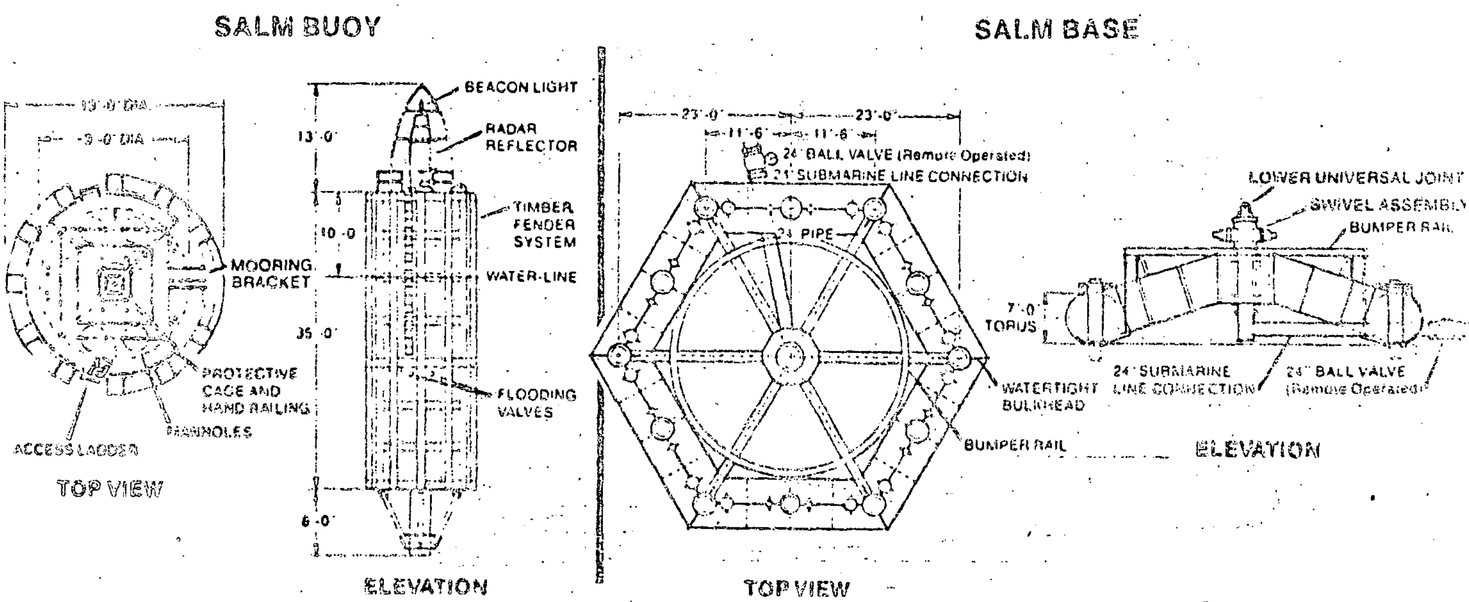


Fig. 16

Prácticamente consta de las mismas partes principales mencionadas para la monoboya C.A.L.M. a excepción hecha de que las cadenas de fijación se reducen a una solamente y que las mangueras-flotantes en vez de partir desde la monoboya, parten del múltiple submarino.

Este tipo de monoboya es generalmente usado para buques tanque-de gran porte (hasta 250 000 TPM) y en lugares que por gran profundidad la monoboya C.A.L.M. tendría que ser de grandes dimensiones para soportar el peso de las cadenas.

De estas monoboyas hay instaladas una cantidad muy reducida en-el mundo.

1.e) Monoboya con sistema de fijación con brazo rígido.

Esta monoboya es una variante del S.A.L.M. y es conocida como - R.A.M. (Rigid Arm Mooring).

Este sistema substituye la cadena por un brazo metálico estructurado con celosía y la manguera que partía desde el múltiple - submarino se convierte en una junta flexible y un tubo dentro - del brazo metálico. Ver fig. (17).

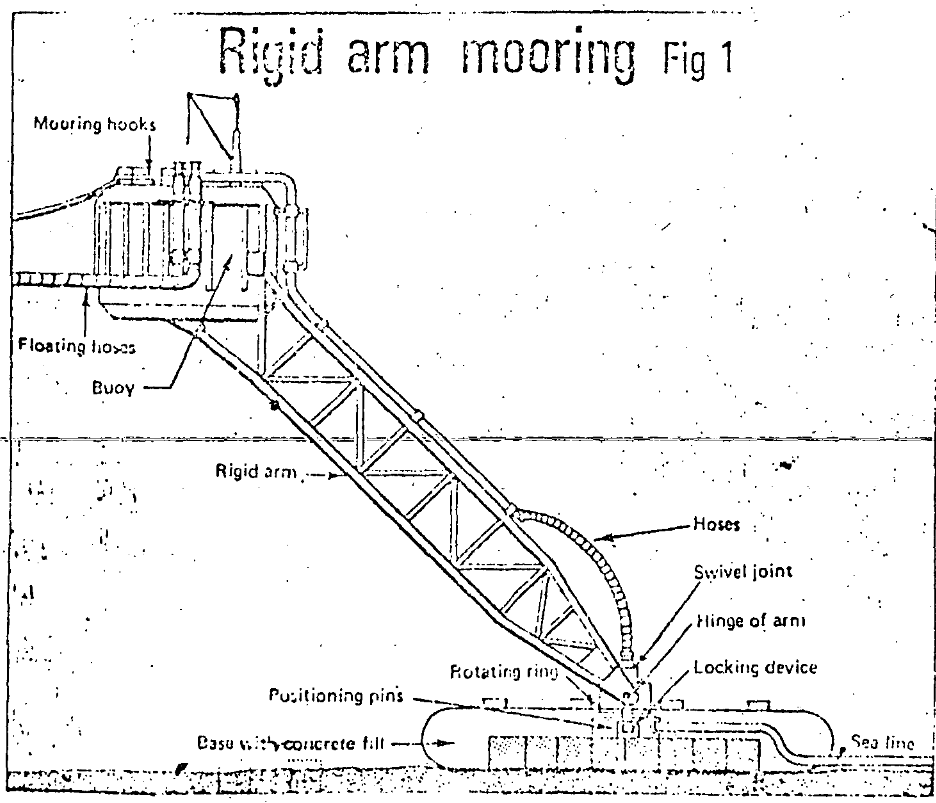
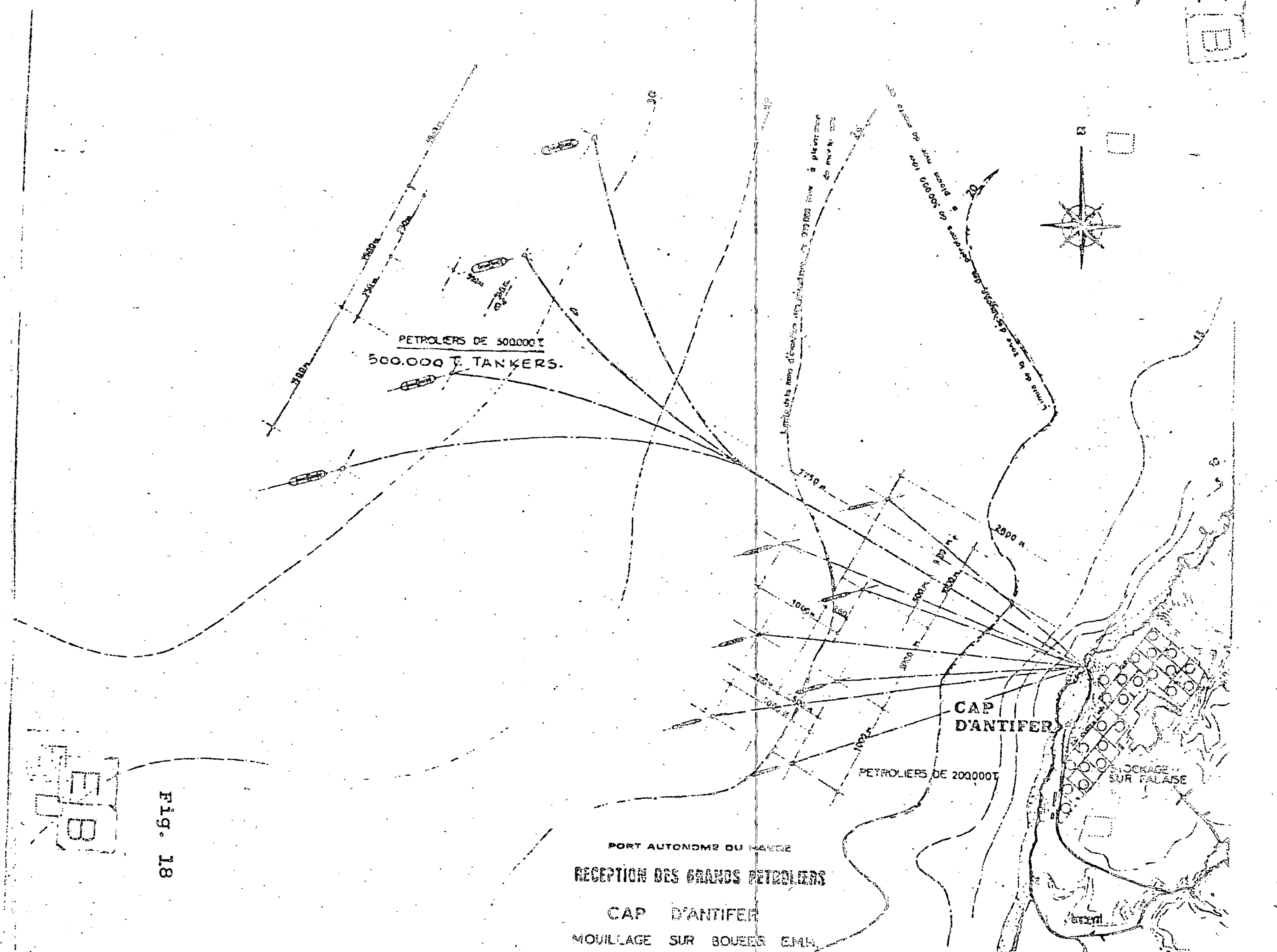


Fig. 17

En el múltiple para permitir el libre giro de la monoboya, tiene un sistema Cardán además del múltiple de distribución de productos que en el sistema CALM está sobre la cubierta de la monoboya.

De este tipo de boyas se proyectan instalar 5 en las proximidades del puerto del Havre para B/T hasta de 500 000 TPM. Ver fig. 18.



PETROLIERS DE 500.000 T
500.000 T TANKERS.
PETROLIERS DE 200.000 T
CAP D'ANTIFER
STOCKAGE SUR FALAISE
2800 m
PORT AUTONOME DU HAVRE
RECEPTION DES GRANDS PETROLIERS
CAP D'ANTIFER
MOUILLAGE SUR BOUEES E.M.H.

Fig. 18

2. INSTALACIONES FIJAS

2.a) Torre para amarre de buques tanque.

Como una variante de las monoboyas pero bajo el mismo principio - de permitir el libre giro de la embarcación alrededor de la instalación de carga o descarga, se desarrolló un sistema que no se encontrara flotando sino apoyado firmemente en el fondo.

Así se inventó el sistema T.T.M. (Tower Tanker Mooring) cuya es-- tructura de apoyo tiene mucha similitud con las plataformas de -- perforación marina, consistente en una torre prefabricada con tubos de acero huecos que se coloca en el lugar apoyándola simple-- mente en el fondo. Para su empotramiento, se pilotea a través de- los tubos verticales que forman la estructura (Jacket Type) me- - diante tubos de menor diámetro hasta encontrar la capa resistente.

Acto seguido, se sueldan los pilotes a las tuberías exteriores en su parte superior.

Posteriormente, se instala sobre la estructura previamente fijada, la parte propiamente que constituye el sistema de giro, amarre y- carga.

Esta instalación tiene la particularidad de cargar los barcos por la proa a diferencia del resto de los demás sistemas antes mencionados en que las mangueras van hasta la mitad de la eslora del -- barco. Ver fig. (19).

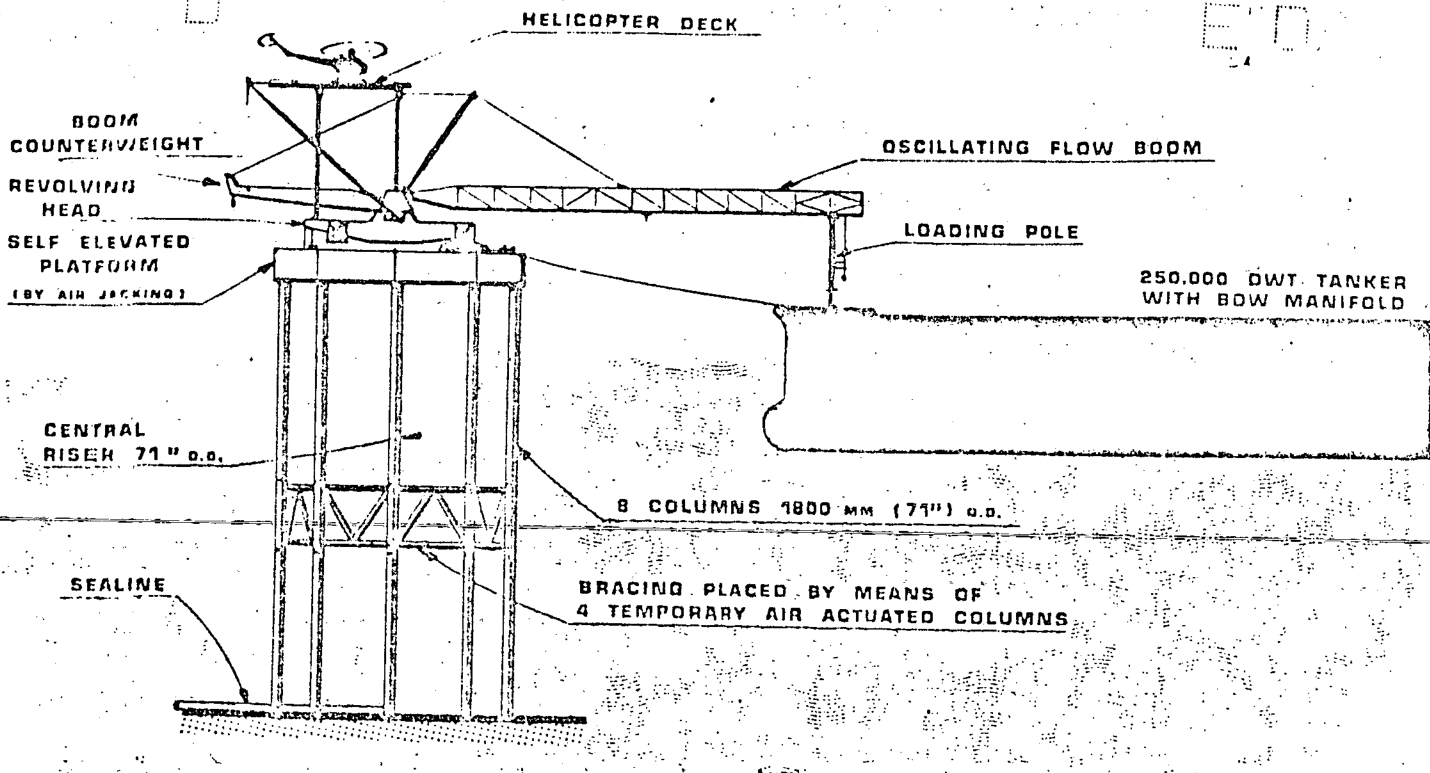


Fig. 19

De todos los sistemas enumerados anteriormente, en los cuales de acuerdo a sus diseñadores tienen ventajas unos sobre los otros,- se tiene algo en común:

La limitación del número de mangueras flotantes con el que pue-- den operar ya que por experiencia, se ha podido comprobar que -- más de 3 mangueras y sobre todo de diámetros grandes (24"Ø), - - tienden a enredarse y a dificultar las maniobras de conexión.

Además por el número reducido de mangueras por las que puede ope rar, el gasto generalmente nunca es superior a los 50 000 bls/hr. lo que incrementa notablemente el tiempo de estadía de las embarcaciones, sobre todo cuando sobrepasan las 200 000 tons., los - - tiempos se vuelven muy significativos.

2.b. Muelle Isla

Ante los inconvenientes que presentan las instalaciones antes descritas y donde las condiciones locales lo permiten, la instalación mar adentro más eficiente es el muelle isla. Ver. figs. (20), (21) y (22).

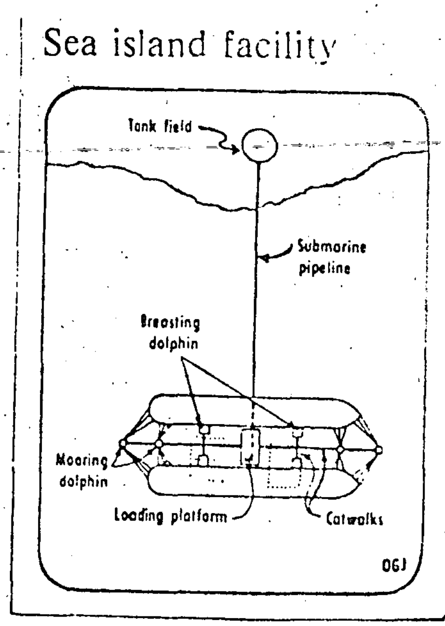


Fig. 20

EB

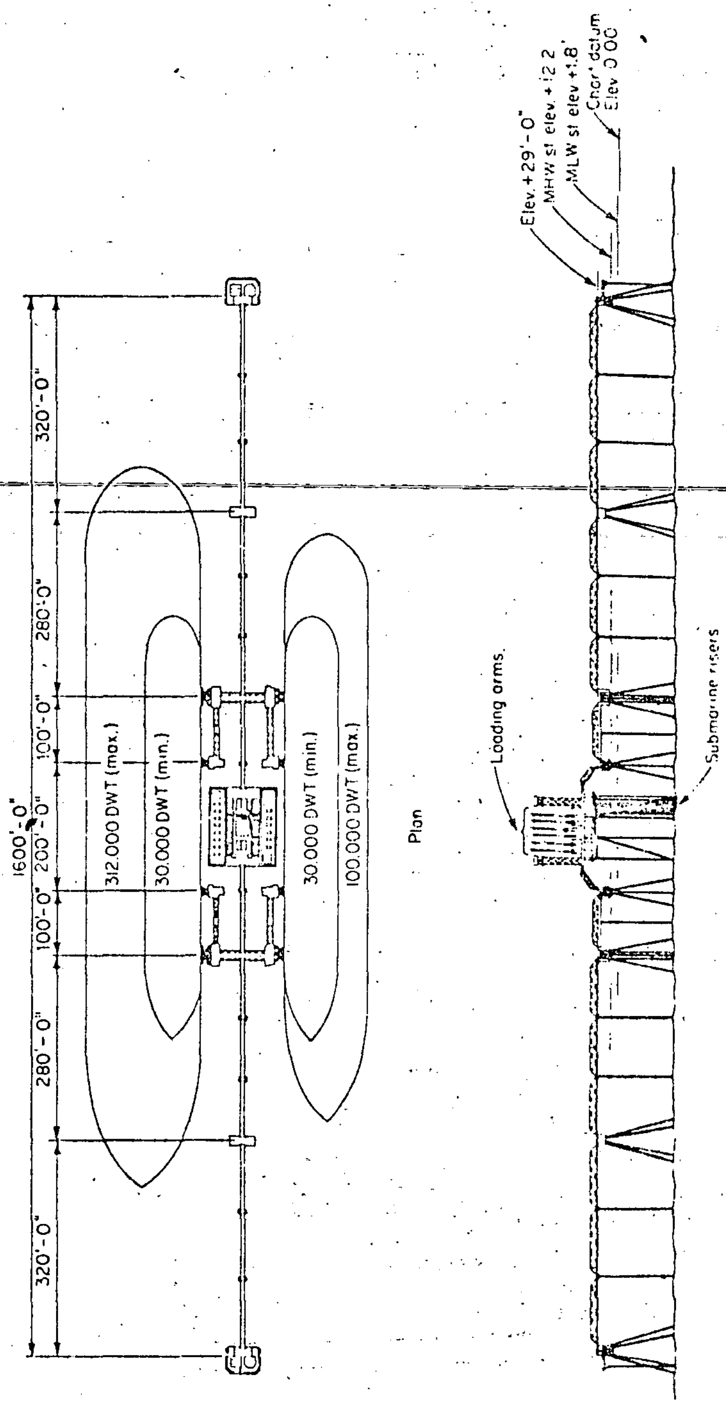

320'-0"
280'-0"
100'-0"
200'-0"
100'-0"
280'-0"
320'-0"
1600'-0"
312,000 DWT (max.)
30,000 DWT (min.)
30,000 DWT (min.)
100,000 DWT (max.)
Plan
Loading arms
Submarine risers
Elev. +29'-0"
MHW st elev. +12.2
MLW st elev. +1.8'
Chart datum
Elev. 0.00

Fig. 21

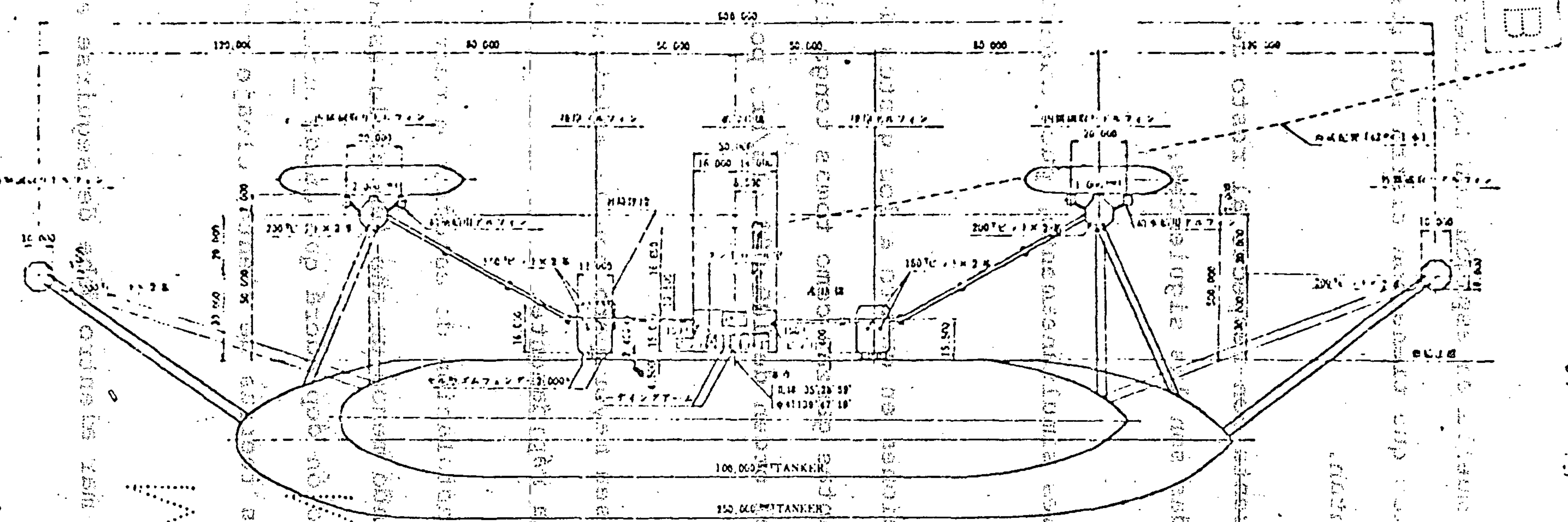


Fig. 13

シーバースの概要

位　置　北緯 35°28′59″, 東経 139°47′19″
(川崎市[illegible]約3,000m)

型　式　固定式シーバース（杭式ドルフィン）

接岸可能最大船舶　250,000DWT

規　模　全長510m　巾57m（水深－26m）

荷役能力　Max. 18,000KL/Hr

[illegible]

1. ムアリング設備
[illegible]（250,000DWT）　2 基
[illegible]（[illegible]400T）　2 基
[illegible]（[illegible]400T）　2 基
[illegible]　1 基
[illegible]　1 式

2. [illegible]
[illegible]アーム　16B×4 基

3. バンカー[illegible]
[illegible]　2,000DWT　1 基
[illegible]アーム　10B×1 基

4. 飲料水[illegible]
[illegible]　1,000DWT　1 基

5. [illegible]
動力ケーブル（50mm²×3C×3KV）約3,350m
通信ケーブル　6回線約3,350m

6. 安全・防災設備
灯火標識
中心部[illegible]中央[illegible]
300m/mレンズ×100W[illegible]×赤色×1基
[illegible]4基の[illegible]ドルフィン上および
[illegible]
200m/mレンズ×25W[illegible]×[illegible]色×5基
[illegible]　1式
[illegible]装置　1式
消火設備
消火ポンプ60m³/Hr×10kg/cm²　1台
エヤーフォーム[illegible]ポンプ50l/min×12.5kg/cm²　1台
エヤーフォーム原液タンク1.5KL　1基
エヤーフォーム[illegible]400l/min.　3基
エヤーフォーム[illegible]2½B×2口×400l/min.　2基
消火用[illegible]350l/min.　4
消火用[illegible]2½B×2口×350l/min.　4
消火ホース　2½B×20m　1
大型[illegible]消火器100ポンド型　1
小型[illegible]消火器 20ポンド型　2
オイルフェンス、油中和剤……[illegible]に常備

7. その他設備
[illegible]式　1
[illegible]（10m×[illegible].5m×2[illegible]）
1階……[illegible]、ポンプ室、倉庫
2階……[illegible]、休憩室、[illegible]、便所

海底管　42B×約3,350m
土被り　4 m
埋戻し　砂および[illegible]

総工費　17億円

建設期間　着工　昭和44年10月
竣工　昭和45年8月

Esta instalación es similar a un muelle en espigón con la diferencia de que el único contacto físico que tiene con tierra son las tuberías submarinas que lo alimentan.

Las ventajas principales que presenta con respecto al resto de las instalaciones antes mencionadas son las siguientes:

1. Pueden atracar dos embarcaciones simultáneamente, pues cuenta con dos paramentos.

2. Prácticamente no tiene limitaciones en cuanto a los gastos de carga porque pueden conectarse tantas garzas como tomas tenga el barco a bordo, pudiendo cargar del orden de 100 000 bls/hr. por paramento.

3. Su costo inicial posiblemente sea mayor pero con la eficiencia de operación que tiene se amortiza rápidamente.

El muelle isla requiere para su instalación de estudios meteorológicos sumamente cuidadosos de cuando menos un año (un ciclo estacional) pues el éxito de su operación dependerá que quede orientado a la resultante obtenida de las fuerzas de viento, oleaje y corrientes principalmente.

Para diseñar una instalación fija mar adentro debe de seguirse el siguiente criterio:

1. Orientación del muelle.

a) Consideraciones

a.1) Influencia del paso de otros barcos en las proximidades de la instalación.

a.2) Futuras ampliaciones del puerto.

a.3) Zonas pesqueras próximas.

a.4) Evitar derrames de producto que contaminen la zona.

a.5) Seguridad del barco (durante los atraques y operación)

a.6) Construcción segura.

Condiciones críticas para atraque y operación.

Se presentan cuando viento, oleaje y corrientes suman sus efectos incidiendo de través al barco y al muelle. Ver fig. (23).

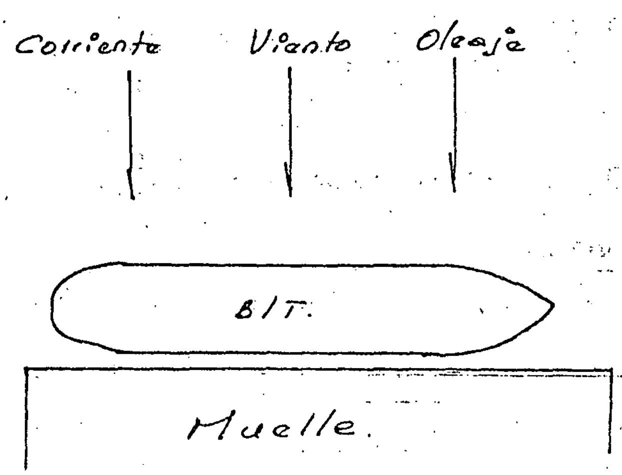


Fig. 23

En la tabla de la Fig. No. 24 se resumen los valores máximos de los factores antes mencionados para instalaciones fijas y flotantes, durante el atraque y operación de la embarcación.

Tipo de Instalación.	Viento atracando	Oleaje atracando.	Corriente atracando.	Viento Operando	Oleaje Operando	Corriente Operando.
Tipo fijo(con estructura de pilotes.	15m/seg.	0.7 m.	0.5 nudos	15m/seg.	0.7 m.	0.5 nudos
Tipo flotantes (SMS, CALM, SALM, RAM).	15m/seg.	0.4 m.	0.5 nudos	15m/seg.	0.7 m.	0.5 nudos

Fig. 24

Criterio para decidir el tipo de instalación.

1. Condiciones naturales.
2. Método de construcción
3. Seguridad de operación
4. Gastos requeridos de carga ó descarga.
5. Costo de Construcción
6. Costo de mantenimiento
7. Area de la dársena de maniobras.

En la tabla de la fig. 25 se mencionan en forma comparativa los requerimientos mencionados.

EB

INSTALACIONES MAR ADENTRO

	MUELLE	TTM	CALM	SALM	RAM	MBS
LIMITACIONES DURANTE EL ATRAQUE:						
OLAS	3-4 Pies	———	———	6-8 Pies	———	———
VIENTOS	25 Nudos	———	———	25 Nudos	———	———
YA AMARRADO EL BARCO:						
OLAS	4-10 Pies	———	———	Más de 15 Pies	———	3-10 Pies
VIENTOS	50 Nudos	———	———	60 Nudos	———	30-50 Nudos
DURANTE LA OPERACION:						
OLAS	4-10 Pies	———	———	10-12 Nudos	———	3-10 Pies
VIENTOS	35 nudos	———	———	40 Nudos	———	25-35 Nudos
AREA DE MANIOBRA	LA MENOR	———	———	LA MAYOR	———	MEDIA
FACILIDAD DE ALCANZAR LA INSTALACION	REGULAR	———	———	LA MAS FACIL	———	LA MAS DIFICIL
REMOLCADORES EN LAS MANIOBRAS	SI	———	———	NO	———	NO USUALMENTE
LANCHAS EN LAS MANIOBRAS	ALGUNAS VECES	———	———	SI	———	SI
SUSCEPTIBILIDAD DE DAÑOS	MODERADO A ALTO	MODERADO A ALTO	MODERADO ———	MODERADO A BAJO	MODERADO ———	BAJA ———
INVERSION	ALTA	MODERADO A ALTO	MODERADO	MODERADO	MODERADO	BAJA
CAPACIDAD DE DE OPERACION	LA MAS ALTA	———	———	ALTA	———	BAJA
COSTO DE MANTO	MODERADO	———	———	MODERADO A ALTO	———	MODERADO

Fig. 25

Dimensiones del canal y dársena necesarios para instalaciones petroleras mar adentro (criterio japonés).

<u>Canal</u>

Profundidad: * Calado + 0.2 calado
* Se refiere al del mayor barco esperado.

Ancho.- La misma que para la del canal de acceso al puerto.

<u>Dársena</u>

1. Profundidad.- Igual a la del puerto pero con una tolerancia de 3 metros para buques tanque mayores de 100 000 TPM.

2. Area.-

a) Para muelle. Ver fig. 26

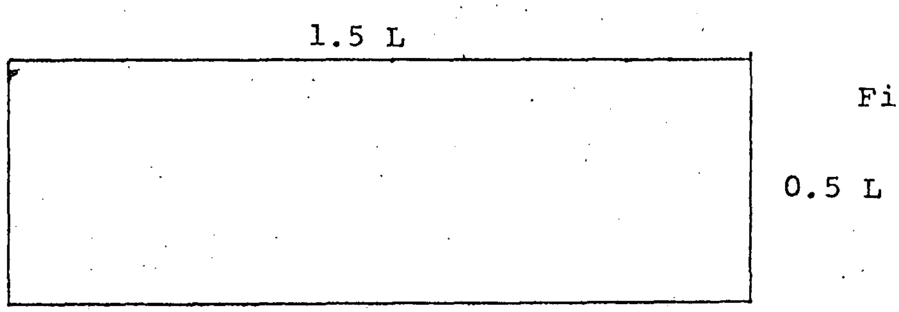
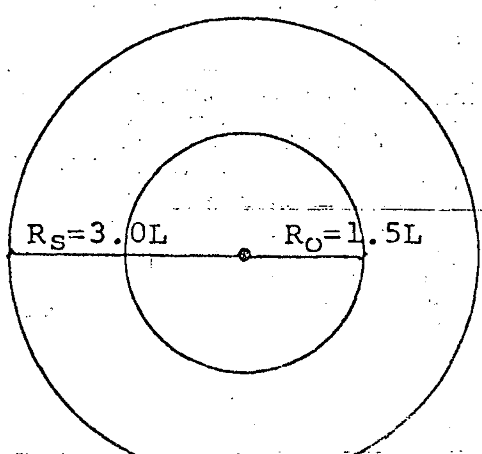


Fig. 26

L = La eslora del mayor barco esperado.

b) Para monoboya. Ver fig. 27



Ro =Radio de operació
R_s =Radio de segurida
L =Eslora del mayor barco esperado.

c) Amarradero convencional. Ver fig. 28

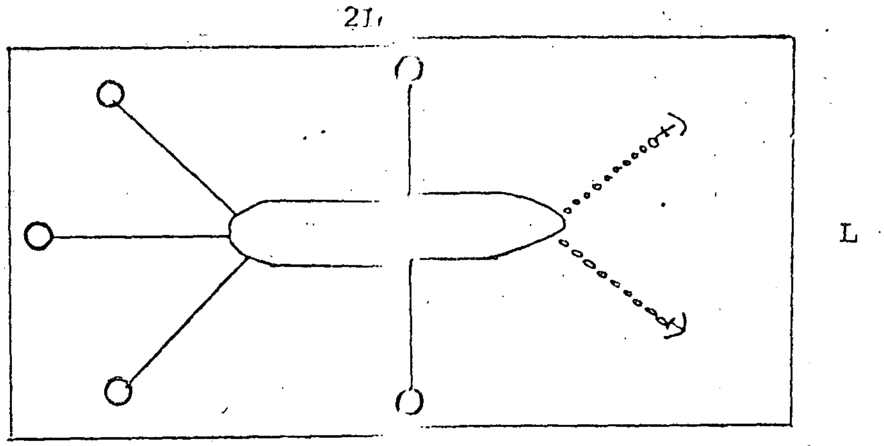


Fig. 28

L= Eslora del mayor barco esperado.

Profundidad de tuberías submarinas.

En el caso de tuberías submarinas que se fondeen para comunicar la instalación marítima con las de tierra en áreas de tráfico intenso o posibles áreas de fondeo, se deberán alojar en cepas cubiertas con arena y grava a una profundidad al lomo del tubo de 4.0 m. bajo la cota máxima futura del área. Ver fig. (29).

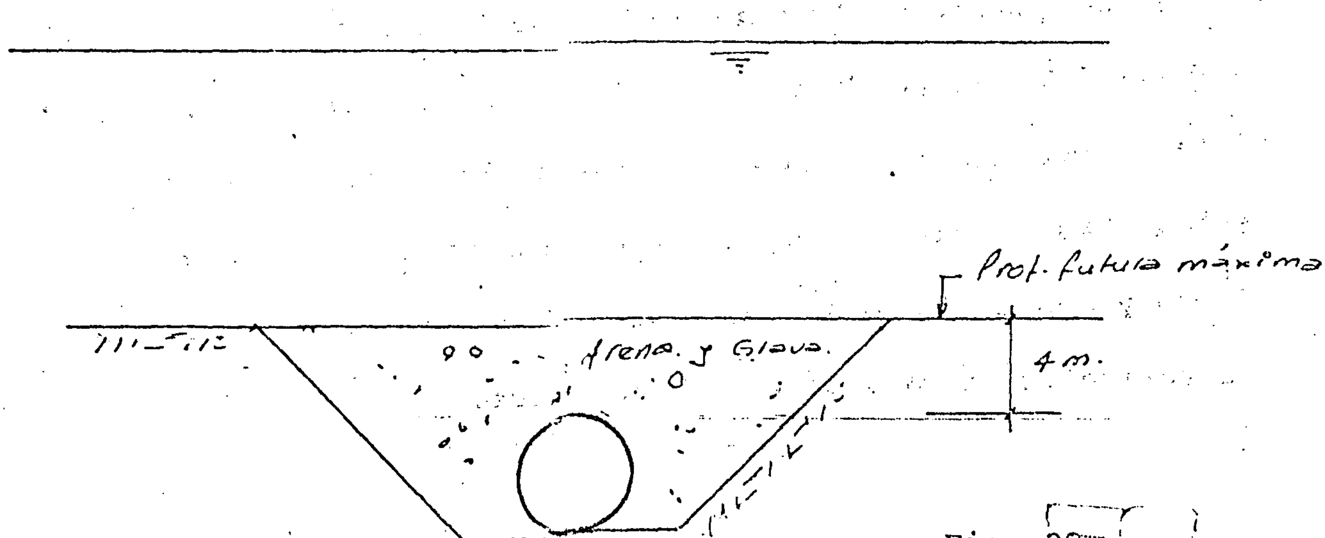


Fig. 29

Esta profundidad se decide actualmente de acuerdo con el lugar particular donde se vaya a localizar la línea, estando en función de lo que penetre el ancla del barco mayor al fondearse. Ver. fig. (30).

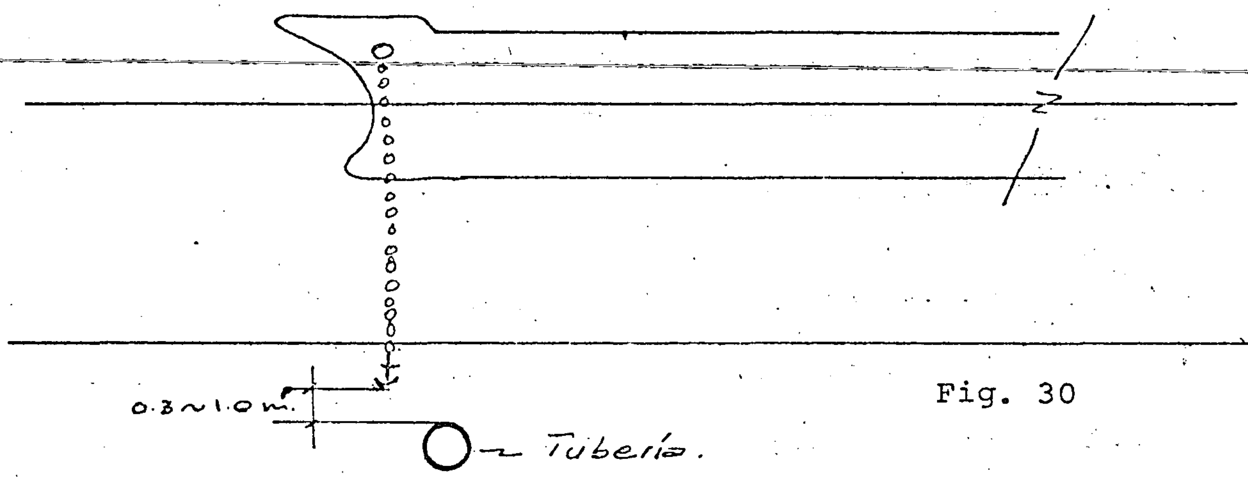


Fig. 30

Una vez que se ha dimensionado todas y cada una de las instalaciones del puerto tanto marítimas como terrestres, se procederá al diseño detallado de cada una de ellas, debiendo darse al proyectista una serie de datos con los cuales tendrá suficientes elementos para llevarlo a cabo. Esta información es llamada Bases de Diseño y consta fundamentalmente de los siguientes conceptos con las variantes propias de cada instalación:

1. Alcance.
2. Sistema de coordenadas
3. Localización
4. Tipo de muelle
5. Orientación de la instalación
6. Tipo de buques que atracarán
7. Nivel de referencia
8. Amplitud de marea
9. Nivel de operación
10. Partes principales que constituyen el muelle. Su dimensionamiento en planta.
11. Velocidad de atraque
12. Angulo de acercamiento al muelle
13. Cálculo del peso virtual de la embarcación
14. Fuerza del viento de diseño
15. Cargas verticales
16. Zona sísmica
17. Materiales de construcción
18. Guarniciones
19. Drenaje pluvial
20. Sistema de amarre
21. Defensas
22. Ancho de la cama de tubería en tierra
23. Productos manejados
24. Capacidad y presión de bombeo
25. Sistema de carga y descarga
26. Charolas de derrame
27. Tomas de combustible económico
28. Caseta de operación
29. Alumbrado
30. Luces de situación
31. Sistema de protección contra descargas eléctricas naturales.
32. Sistema contra incendio
33. Caseta de vigilancia a la entrada del muelle, estacionamiento y barrera.
34. Servicios complementarios
35. Escaleras de acceso
36. Profundidad de dragado
37. Dársena de maniobras
38. Prevención contra la contaminación de las aguas del puerto.

No solo bastará con especificar escuetamente las características de cada parte de la instalación, sino que deberá incluirse en cada uno de ellos, previamente una justificación o explicación del motivo - de cada uno de los valores impuestos.

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Proyecto que se propone

14. El proyecto consiste en ampliar el puerto de Nori, que geográficamente se encuentra en la situación ideal, por estar cerca de las minas Old Man River y bien comunicado con ellas por ferrocarril.

15. En dicho puerto se construirá un nuevo atracadero con instalaciones de almacenamiento. También se instalará un cargadero de buques con una capacidad de 8.000 t/h. Por otra parte, se dragará el canal de acceso y se ampliará la dársena de maniobras. El calado previsto es de 16 m. Además, se necesita un rompeolas.

16. Las principales partidas de gastos del proyecto son las que se indican en el cuadro 3. De ellas se han deducido los derechos de aduana y otros impuestos.

Cuadro 3

	Millones de dólares de los EE.UU.
Rompeolas (1.000 m a 15.000 dólares m)	15,0
Dragado (4,0 millones de m^3 a 2,50 dólares por m^3)	10,0
Atracadero	3,5
Cargadero de buques	3,0
Instalaciones de almacenamiento y recogida del mineral	2,0
Otros trabajos de ingeniería civil	4,5
Costo total	38,0

17. Los trabajos de ampliación durarán unos tres años, entre los cuales se distribuirán los gastos a razón de 16 millones de dólares el primer año, 12 millones el segundo, y 10 millones el tercero.

18. Se ha estimado que, aunque la vida física del proyecto es posible que sea más larga, su vida económica será de 15 años.

19. Los costos anuales de conservación y funcionamiento se han calculado en 1 millón de dólares.

Análisis de los beneficios

20. Si no se hace la inversión necesaria para utilizar graneleros de 125.000 TPM, la afluencia neta anual de fondos que se obtiene de la venta de 8 millones de toneladas de mineral de hierro a la CEE es de 2,4 millones de dólares 2/.

2/ Véase el cuadro 1.

21. Con la construcción de las instalaciones requeridas para buques de 125.000 TPM, la afluencia neta anual de fondos se eleva a 12,2 millones de dólares 3/. En esa cifra se incluyen los 8,7 millones de dólares que produciría la venta a la CEE de 8 millones de toneladas de mineral, de las que 5 millones se transportarían a un costo inferior por tonelada, y los 3,5 millones de dólares que se obtendrían de las ventas efectuadas en el mercado japonés, que entonces resultaría económicamente accesible para Ferrolandia.

22. El resultado de construir instalaciones para graneleros de 125.000 TPM es, pues, un aumento de la afluencia neta de fondos de 9,8 millones de dólares (12,2 - 2,4 millones) al año 4/.

23. Estos cálculos se basan en la existencia de contratos con la CEE y el Japón para suministrarles la cantidad convenida al precio negociado.

Condiciones económicas generales

24. Ferrolandia está dotada de muchos recursos naturales y tiene una economía floreciente, sostenida por actividades de explotación de minerales y de industrialización, sobre todo en el sector de la manufacturas orientadas hacia la exportación. Estas últimas han sido fomentadas y promovidas por una acertada política gubernamental de concesión de generosos subsidios e incentivos a los inversionistas extranjeros.

25. La economía de Ferrolandia ha logrado una rápida expansión en el último decenio. De 1965 a 1975, en efecto, el producto interno bruto aumentó casi dos veces y media, lo que representa una tasa anual de aumento del 9,5%. Las inversiones brutas aumentaron, por su parte, más de 8 veces; las inversiones brutas en maquinaria y equipo se elevaron de 100 a 700 millones de dólares, y el componente de manufacturas de la producción interna bruta aumentó en cerca del 15% al año.

26. El empleo en las industrias minera y manufacturera se ha triplicado; de hecho, en algunas minas hay que contratar a trabajadores migrantes del otro lado de la frontera.

27. Las reservas de divisas son favorables y la balanza global de pagos se ha mantenido constantemente bajo control. Como las divisas no escasean, su adquisición no supone el pago de ninguna prima cambiaria 5/.

28. Pese a esta considerable expansión financiera y monetaria, los precios se han mantenido bastante estables.

29. El Centro de Planificación Económica del Gobierno cree que los precios son relativamente competitivos y, dada la situación de pleno empleo en el país, los salarios que se pagan representan el costo de oportunidad de la mano de obra 6/.

3/ Véase el cuadro 2.

4/ Dicho de otro modo, el incremento de la afluencia neta de fondos proviene del aumento de 6,3 millones de dólares (8,7 - 2,4 millones) de los beneficios procedentes de la exportación de mineral de hierro a la CEE, el 37,5% del cual (3 millones de toneladas) puede transportarse entonces a un costo inferior y la afluencia neta de 3,5 millones de dólares de efectivo, resultante de las ventas al Japón. La suma es de 9,8 (6,3 + 3,5) millones.

5/ En el proyecto de inversión no hay, por lo tanto, que reajustar esas partidas.

6/ No hay, por lo tanto, que reajustar tampoco esas partidas de gastos en el proyecto.

30. El Centro de Planificación Económica del Gobierno ha fijado en el 15% la tasa de actualización que se utilizará para evaluar el proyecto.

Análisis

31. La evaluación del proyecto de inversión es relativamente sencilla. No obstante, dado que costos y beneficios se producen en distintos años, es necesario actualizarlos.

Cuadro 1

Año	Costos de capital a/	Costos de conservación y explotación	Costo total	Beneficios	Beneficios netos	Valor neto actualizado b/		
						12%	15%	18%
1)	16	-	16	-	-16	-14,3	-13,9	-13,6
2)	12	-	12	-	-12	-9,6	-9,1	-8,6
3)	10	-	10	-	-10	-7,1	-6,6	-6,1
4)		1	1	9,8	8,8	42,7	33,8	27,3 c/
5)		1	1	9,8	8,8			
.		.	.	.	.			
.		.	.	.	.			
.		.	.	.	.			
.		.	.	.	.			
18)		1	1	9,8	8,8			
Valor neto actualizado						11,7	4,2	-1,0 d/

a/ Todos los costos y beneficios se computan en millones de dólares.

b/ Actualizado al año 0 (año en curso) y redondeado hasta las décimas.

c/ Los valores de esta fila representan el valor actualizado de la corriente de beneficios netos de 8,8 millones de dólares desde el año (4) hasta el año (18).

d/ La tasa de actualización a la que el VNA = 0 (la llamada tasa interna de rentabilidad) puede obtenerse aproximadamente como sigue:

$$\frac{4,2}{(x - 15)} = \frac{1}{(18 - x)}$$, siendo x (tasa de rentabilidad interna) = 17,4%.

32. El proyecto, tal como se analiza en el cuadro 4, permite prever resultados favorables en forma de un valor actual neto positivo actualizado al costo de oportunidad del capital del 15%. El valor actual neto sólo se convierte en 0 a una tasa de actualización del 17,4%, la llamada tasa interna de rentabilidad.

33. Basándose en un análisis puramente económico, el proyecto es aceptable. Si se dispone de fondos para realizarlo, debe, por lo tanto, llevarse a cabo.

34. La tasa de rentabilidad del primer año es en este caso del 0,22, es decir, el 22% 7/. El hecho de que ese valor sea superior al costo de oportunidad del capital indica que ya hace tiempo que debería haberse ejecutado el proyecto, el cual debe, por lo tanto, llevarse inmediatamente a cabo.

Conclusiones

35. Los elementos fundamentales del estudio de este caso son, en primer lugar, la evaluación de los beneficios que se obtendrían con tal inversión portuaria y, en segundo término, la utilización funcional de un puerto como elemento de estrategia económica. El mercado del mineral de hierro procedente de Ferrolandia se vería considerablemente ampliado por la reducción del costo del transporte marítimo que permitiría la construcción en el puerto de instalaciones adecuadas para graneleros más grandes.

36. Al evaluar los beneficios, no sería correcto considerar la reducción del costo del transporte como un beneficio aparte del aumento de los beneficios procedentes de la venta de mineral de hierro. De ese modo, se contarían dos veces los beneficios. El aumento de la producción y/o la ampliación del mercado son consecuencia de la reducción del costo del transporte. La medida correcta del beneficio económico de la inversión portuaria es, pues, el valor neto de ese aumento de la producción.

37. En el caso que se considera, sólo se necesitan las inversiones en el puerto para lograr los resultados necesarios. Si se hubieran necesitado otras inversiones no portuarias, por ejemplo más conexiones ferroviarias entre el puerto de Nori y las minas de hierro, también ellas habrían venido a formar parte del costo total del proyecto, costo en el que igualmente habría habido que tener en cuenta el aumento de los gastos de producción del mineral a que eventualmente podría dar lugar el incremento de las cantidades extraídas.

38. Se ha supuesto también que, sin esta mejora del puerto, no se lograrían las consecuencias favorables que se deducen de este estudio, es decir, la reducción del costo del transporte marítimo y, gracias a ella, la ampliación del mercado.

39. El hecho de que, gracias a la inversión portuaria, Ferrolandia pueda ampliar los horizontes de su mercado para incluir al Japón es importante, fundamentalmente hace más flexible la posición del país, que sale de ese modo de su situación de única y exclusiva dependencia de las vicisitudes del mercado europeo.

7/ La tasa de rentabilidad del primer año es la relación entre los beneficios que se obtendrán ese año y el costo de capital actualizado al año (5), año en el que se terminaría el proyecto $(9,8/[(16)\ (1,15)^2 + (12)\ (1,15) + (10)] = (9,8/(45)) = 0,22$.

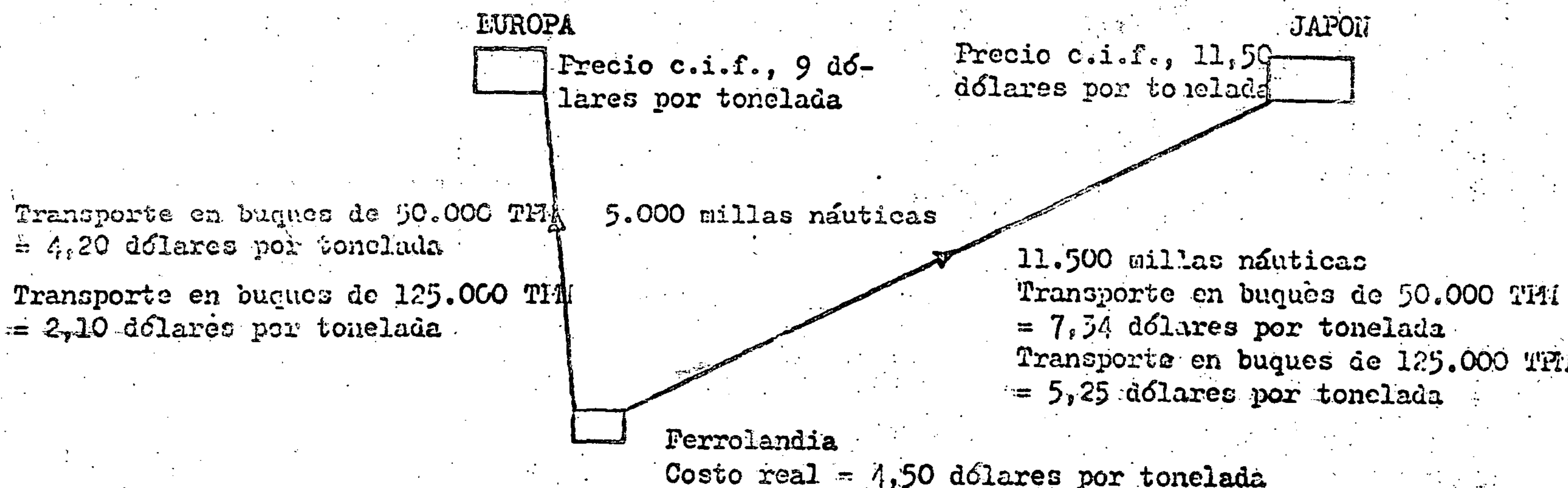
40. Es importante señalar que en lo que respecta a las exportaciones de mineral de hierro, Ferrolandia se ve obligada a aceptar los precios que le ofrecen. Cabría, naturalmente, con la reducción del costo del transporte por unidad, que Ferrolandia ofreciera su mineral a un precio c.i.f. o f.o.b. más bajo que el que ofrecen otras fuentes de suministro, disminuyendo su margen de beneficios por tonelada. Eso iría, sin embargo, en contra de sus intereses, ya que las fuentes más grandes y más cercanas al mercado de consumo tomarían represalias contra ella. Y lo que es más importante, el proyecto de inversión se evaluó basándose en las premisas de que Ferrolandia podría obtener el actual precio c.i.f. y de que los beneficios del proyecto consistían en el aumento de valor neto de las exportaciones.

41. En el caso de que las condiciones del mercado sean tales que, con el descubrimiento y la explotación de más mineral en fuentes cercanas a los mercados de consumo, se reduzca el precio c.i.f. que puede obtenerse del mercado de la CEE, Ferrolandia podría encontrarse con condiciones de mercado más adversas, sobre todo si no tiene ningún contrato a largo plazo con sus compradores.

42. Para ilustrar la importancia potencial de la ampliación del mercado, además de los beneficios directos de las ventas adicionales al mercado más distante del Japón, se ha previsto también el supuesto de que disminuyera efectivamente el precio c.i.f. obtenible en el mercado de la CEE. En la parte II se exponen los resultados de la evaluación del proyecto a la luz de ese cambio.

Apéndice I

POSICION RELATIVA DE FERROLANDIA FRENTE A EUROPA Y EL JAPON



Parte II: La inversión como factor de sustitución de mercados

43. La importancia del puerto como componente de la estrategia económica general del comercio exterior -en este caso de la exportación de mineral de hierro- aumenta cuando se saca partido de la flexibilidad que ofrece la ampliación del mercado.

44. Investiguemos y analicemos las consecuencias de una evolución concreta del comercio de mineral de hierro sobre la base de ciertos cálculos e hipótesis hechos por el equipo de expertos técnicos y económicos que están estudiando las exportaciones de mineral de hierro de Ferrolandia.

La nueva situación

45. Actualmente se están abriendo nuevas fuentes de mineral de hierro en la Europa continental, y se ha previsto que, al aumentar la oferta, disminuirá el precio c.i.f. del mineral. A ese cambio hay que sumar el hecho de que ha aumentado el número de puertos europeos que están tratando de mejorar sus instalaciones de descarga de mineral para poder recibir buques más grandes. En varios estudios se ha pronosticado que para 1984 el precio del mineral de hierro se habrá reducido a unos 7,50 dólares por tonelada en el mercado europeo.

46. Ante la perspectiva de que se haga realidad esa situación, Ferrolandia ha adquirido aún más conciencia de su precaria situación en el mercado del mineral de hierro. Si no se hace en el puerto la inversión necesaria para que puedan atracar en él buques más grandes (125.000 TPM), tarde o temprano Ferrolandia quedará excluida del mercado europeo de mineral de hierro, ya que el costo al que podrá suministrar ese mineral será, a causa del costo prohibitivo del transporte marítimo, superior al precio prevaleciente en dicho mercado.

47. Actualmente, es urgente que Ferrolandia planee instalaciones portuarias con capacidad para graneleros más grandes. Con el transporte de minerales en graneleros de 125.000 TPM y la consiguiente disminución del costo del transporte por tonelada, Ferrolandia podría vender más a los centros europeos utilizando esos buques más capaces y dirigiendo la carga hacia los puertos más grandes de recepción ya existentes o hacia aquellos en los que van a construirse instalaciones adecuadas. Al mismo tiempo se pondrá económicamente a su alcance el mercado japonés, pese a la disminución prevista del precio del mineral de hierro en aquel país, que descenderá a unos 10,75 dólares por tonelada a medianos del decenio de 1980.

48. La estrategia del mercado de Ferrolandia gira, pues, en torno al logro de ese objetivo, aprovechando la oportunidad de diversificar sus ventas que le ofrece la disminución del costo del transporte marítimo.

49. El cuadro 5 <u>infra</u> está basado en las conclusiones del equipo de expertos técnicos y económicos y en las proyecciones del Ministerio de Fomento del Comercio.

Cuadro 5

Exportaciones de mineral de hierro de Ferrolandia

	Sin inversión portuaria. A la CEE. En buques de 50.000 TPM. Flete por tonelada: 4,20 dólares					Con inversión portuaria. A la CEE. En buques de 50.000 TPM. Flete por tonelada: 4,20 dólares					En buques de 125.000 TPM. Flete por tonelada: 2,10 dólares				Al Japón. En buques de 125.000 TPM. Flete por tonelada: 5,25 dólares						
Año	c.i.f.	f.o.b.	Beneficio por tonelada	Cantidad vendida (en millones de toneladas)	Afluencia neta total de efectivo al año (en millones de dólares	c.i.f.	f.o.b.	Beneficio por tonelada	Cantidad vendida (en millones de toneladas)	Afluencia neta total de efectivo al año (en millones de dólares)	f.o.b.	Beneficio por tonelada	Cantidad vendida (en millones de toneladas)	Afluencia neta total de efectivo al año (en millones de dólares)	c.i.f.	f.o.b.	Beneficio por tonelada	Cantidad vendida (en millones de toneladas)	Afluencia neta total de efectivo por año (en millones de dólares)	Total combinado de la afluencia neta de efectivo a/	Aumento de la afluencia neta de efectivo b/
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)
1) 1976																					
2) 1977																					
3) 1978																					
4) 1979	9,00	4,80	0,30	8	2,4	9,00	4,80	0,30	5	1,5	6,90	2,40	5	7,2	11,50	6,25	1,75	2	3,5	12,20	9,8
5) 1980	↓	↓	↓	↓	↓	↓	↓	↓	5	1,5	↓	↓	5	7,2	↓		↓	2	3,5	12,20	9,8
6) 1981	↓	↓	↓	↓	↓	↓	↓	↓	3,5	1,05	↓	↓	3,5	8,4	↓		↓	3	5,25	14,70	12,5
7) 1982	↓	↓	↓	↓	↓	↓	↓	↓	3,0	0,9	↓	↓	3,5	8,4	↓		↓	3,5	6,15	15,4	13,0
8) 1983	↓	↓	↓	↓	↓	↓	↓	↓	2,0	0,6	↓	↓	4,0	9,6	↓		↓	4,0	7,0	17,2	14,8
9) 1984	9,00	4,80	0,30	8	2,4	9,00	4,80	0,30	1,5	0,45	6,90	2,40	4,0	9,6	11,50	6,25	1,75	4,5	7,00	17,9	15,5
10) 1985	7,50	5,30				7,50	5,30				5,40	0,90	4,0	5,6	10,75	5,50	1,0	6,0	6,0	9,6	9,6
↓	↓	↓				↓	↓				↓	↓	↓	↓	↓		↓	↓	↓	↓	↓
18) 1993	7,50	5,30				7,50	5,30				5,40	0,90	4,0	5,6	10,75	5,50	1,0	6,0	6,0	9,6	9,6

Nota: Todos los precios están expresados en dólares por tonelada. El coste medio de producción de la tonelada de mineral de hierro se mantiene a 4,50 dólares durante todo el período.

a/ Suma de las columnas 10), 14) y 19).

b/ Columna 20) menos columna 5).

Análisis

50. El proceso de evaluación es análogo al de la parte I 8/. El beneficio que aportaría el proyecto es la diferencia entre los beneficios que se obtendrían con y sin la inversión 9/. El costo del proyecto es el mismo que en la parte I.

51. El valor neto actualizado del proyecto en la nueva situación es el que se indica en el cuadro 6 infra, aplicando tasas de actualización del 12 al 21%.

52. El proyecto es viable, ya que la actualización a un costo de oportunidad del capital del 15% da un valor neto actualizado de 9,5 millones de dólares. El valor neto actualizado sólo se convierte en cero con una tasa de actualización del 20%, la llamada tasa interna de rentabilidad.

Conclusiones

53. Cuando el puerto de Nord invierta en instalaciones con capacidad para graneleros más grandes, podrá reducirse, gracias a la utilización de esos buques, el costo del transporte marítimo, lo que a su vez ampliará el ámbito en que, económicamente, puede venderse el mineral de hierro de Ferrolandia. A la luz de esta nueva situación, se acentúa aún más la importancia de hacer lo más flexible posible la ampliación de ese mercado.

54. La evolución consistente en transportar la carga en buques más grandes y a distintos mercados ha aumentado en realidad los beneficios netos del proyecto pese a la situación más desfavorable con que ha de enfrentarse Ferrolandia 10/. Significa esto que, si el precio no hubiera disminuido y se hubiera seguido una estrategia semejante, los beneficios netos que se habrían obtenido en la parte I habrían sido aún mayores.

8/ Véase el cuadro 4.

9/ Dicho de otro modo, la diferencia entre los beneficios que se obtendrían en uno y otro caso es el costo de no invertir en el proyecto. Al no invertir, Ferrolandia renuncia a los beneficios adicionales que le reportaría el proyecto del puerto, proyecto que debería, por lo tanto, llevar a cabo si su costo es inferior al de no invertir.

10/ Véanse los cuadros 4 y 6. En la nueva situación, el VNA en la parte II es de 9,5 millones, en vez de los 4,2 millones actualizados al 15%.

Cuadro 6

Valores actualizados de costos y beneficios (nueva situación)[a]

Año	Costo de capital	Costos de conservación y explotación	Costo total	Beneficio b/	Beneficio neto	Valor neto actualizado c/			
						12%	15%	18%	21%
1) 1976	16		16		-16	-14,3	-13,9	-13,6	-13,2
2) 1977	12		12		-12	-9,6	-9,1	-8,6	-8,2
3) 1978	10		10		-10	-7,1	-6,6	-6,1	-5,6
4) 1979		1	1	9,8	8,8	5,6	5,0	4,5	4,1
5) 1980		1	1	9,8	8,8	5,0	4,4	3,9	3,4
6) 1981		1	1	12,3	11,3	5,7	4,9	4,2	3,6
7) 1982				13,0	12,0	5,4	4,5	3,8	3,2
8) 1983				14,8	13,8	5,6	4,5	3,7	3,0
9) 1984				15,5	14,5	5,2	4,1	3,3	2,6
10) 1985 d/				9,6	8,6	16,5	11,7	8,5	6,0
11) 1986									
18) 1993		1	1	9,6	8,6				
Valor neto actualizado						18,0	9,5	3,4	-1,1 e/

a/ Todos los costos y beneficios se expresan en millones de dólares.

b/ De la columna 21) del cuadro 5.

c/ Actualizado al año 0 (1975) y redondeado a las décimas.

d/ Los valores de esta fila representan el valor actualizado de la corriente de beneficios netos de 8,6 millones de dólares desde el año 10 (1985) hasta el año 18 (1993).

e/ La tasa de actualización a la que el VNA = 0 (la llamada tasa interna de rentabilidad) se obtiene aproximadamente como sigue:

$$\frac{3,4}{(x - 18)} = \frac{-1,1}{(21 - x)}$$, siendo x (tasa de rentabilidad interna) = 20,5%.

CASO Nº 5: EL PUERTO DE MANA

Comparación entre la inversión en una terminal de contenedores especializados y en una terminal polivalente

1. El puerto de Mana, que es el único puerto al servicio de la economía de la República de Cali, podría considerarse como uno de los ejemplos más típicos de un puerto mediano de carga general en un país en desarrollo que tiene que hacer frente a un aumento moderado del tráfico y a las exigencias cada vez mayores de las compañías navieras en cuanto a la construcción de instalaciones más adecuadas que proporcionen un servicio más rápido y menos costoso.

2. El Gobierno central de Cali, bajo la presión de la industria nacional del transporte marítimo, decide examinar las futuras necesidades portuarias y analizar cuidadosamente las ventajas y los inconvenientes de las distintas soluciones posibles. Con ese objeto se crea una Comisión especial de Planificación y Desarrollo Portuarios, cuya misión es pronunciarse por el plan de desarrollo que más beneficios netos reportará a la economía de Cali durante los próximos 25 años.

3. La Comisión tiene a su disposición una gran cantidad de datos. La información que a continuación se facilita constituye sólo una selección de los elementos fundamentales.

4. El Ministerio de Planificación y Desarrollo Económicos ha proporcionado las previsiones del tráfico en el puerto de Mana hasta el año 1999. Es interesante observar que el aumento global previsto es moderado: un aumento del 2,5% entre 1975 y 1984; un aumento temporalmente más elevado, del 3,5%, hasta 1989, y nuevamente un aumento del 2,5% a partir de ese año. El tráfico total del puerto se espera que se eleve de la cifra actual de 1,2 millones de toneladas anuales a 2.275.000 toneladas anuales en 1999.

5. Muy importante a este respecto es la forma en que se espera que se produzca ese aumento; en el cuadro 1 figuran las previsiones del porcentaje correspondiente a cada una de las principales clases de productos, porcentaje que, como puede verse, aumenta por lo que se refiere a la mayoría de las cargas unitarizadas y especiales, en detrimento de la carga general. La proporción de los productos siderúrgicos en el total se mantiene a un nivel del 20%.

6. Es posible, por consiguiente, elaborar, como se hace en el cuadro 2, unas sencillas previsiones del tráfico para el período 1975-1999.

7. Las conclusiones que pueden sacarse del cuadro 2 son muy significativas. Entre los miembros de la Comisión hay acuerdo general, basado en datos anteriores, en que las instalaciones actuales del puerto de Mana, consistentes en diez atracadores de carga general de tipo corriente, tienen una capacidad de 1,2 millones de toneladas (a razón de 490 toneladas por cada 24 horas en el muelle y una tasa de ocupación del 67%). Significa esto que, si se quiere mantener el nivel actual de servicio, y dado que sólo se conseguirán probablemente pequeñas mejoras de la productividad, para 1980 el puerto de Mana tendrá que ser dotado de nuevas instalaciones las cuales tendrán que ser, además, de tipo distinto, para atender a las corrientes de tráfico que se prevén para el futuro, y especialmente para manipular el número cada vez mayor de unidades de carga. Dentro de la Comisión hay, sin embargo, serias diferencias de opinión acerca del plan de desarrollo que debe aceptarse y del tipo de instalación que se ha de elegir. Esencialmente, se manifiestan dos teorías diferentes.

Cuadro 1

Previsiones del porcentaje que corresponderá a las principales clases de carga en el total de la carga general, 1975-1999

	1975	1980	1984	1989	1994	1999
Cargas paletizadas	5,0	5,5	5,5	6,0	6,5	7,5
Cargas preeslingadas	5,0	5,5	6,0	6,5	7,0	7,5
Contenedores	1,0	4,0	7,0	12,0	18,0	25,0
Carga de transbordo por rodadura	-	2,0	3,0	4,0	4,0	5,0
Productos siderúrgicos y maquinaria	20,0	20,0	20,0	20,0	20,0	20,0
Productos forestales	10,0	10,0	11,0	11,0	12,0	12,5
Automóviles	1,0	2,0	2,0	2,5	2,5	2,5
Carga general	58,0	51,0	45,5	38,0	30,0	20,0
Total	100,0	100,0	100,0	100,0	100,0	100,0

Cuadro 2

Previsiones de tráfico, 1975-1999

(En miles de toneladas)

	1975	1980	1984	1989	1994	1999
Cargas paletizadas	60	75	85	105	130	170
Cargas preeslingadas	60	75	90	110	140	170
Contenedores	12	55	105	190	365	570
Carga de transbordo por rodadura	0	25	45	70	80	115
Productos siderúrgicos y maquinaria	240	270	300	345	405	455
Productos forestales	120	135	165	190	240	285
Automóviles	12	25	30	45	50	55
Otros tipos de carga general	696	685	680	670	605	455
Total	1 200	1 345	1 500	1 725	2 015	2 275

8. Según la primera, el tráfico en el puerto de Mana hasta 1999 es demasiado heterogéneo y demasiado reducido para justificar la inversión en uno o en varios muelles altamente especializados. Los partidarios de esta teoría propugnan resueltamente la idea de la terminal polivalente 1/, e insisten en que la pronta construcción de tal instalación beneficiará considerablemente al puerto de Mana, por lo que sugieren que se inicie ya en 1976, a fin de que pueda entrar en servicio en 1980.

9. Los componentes del segundo grupo consideran que aún no ha llegado el momento de construir instalaciones distintas de los atracaderos tradicionales de carga general, y que a partir de 1989 debe entrar en funcionamiento una terminal de contenedores que permita hacer frente al creciente tráfico de tales recipientes y al de transbordo de la carga por rodadura. Es evidente que antes, e incluso después de esa fecha, se necesitarán otras instalaciones adicionales, por lo que proponen la construcción de nuevos atracaderos de carga fraccionada: uno en 1980, otro en 1984 y un tercero en 1994. Habida cuenta de que las unidades de carga representarían una proporción considerable de la carga total manipulada en los puestos de atraque tradicionales, el movimiento anual ascendería a 150.000 toneladas (suponiendo una tasa de ocupación de los puestos de atraque del 67% y un rendimiento diario de 610 toneladas). Ambos grupos están de acuerdo en que, debido a la obsolescencia, para 1980 habrá habido que ir dando gradualmente de baja a dos de los atracaderos existentes. En los cuadros 3, 4 y 5 se resumen las ideas básicas de ambos grupos.

10. En relación con los cuadros 3, 4 y 5 es preciso formular algunas importantes observaciones.

a) Se necesitan cuatro años para construir una terminal polivalente y una terminal de contenedores, y tres para construir una terminal tradicional de carga fraccionada. Los costos de capital se distribuyen como sigue a lo largo del período de construcción:

Distribución porcentual de los costos de inversión

	Año de construcción			
	1º	2º	3º	4º
Atracaderos de carga fraccionada	55	35	10	
Atracaderos de contenedores	35	30	25	10
Atracaderos polivalentes	35	30	25	10

b) La terminal polivalente propuesta en la solución 1, permitirá manipular, por orden de prioridad, las cargas de alta y media productividad y, siempre que la capacidad lo permita, algunas de las cargas de baja productividad, como las paletas o las mercancías preeslingadas.

1/ Ese tipo de terminal se describe en el informe de la secretaría de la UNCTAD "Las innovaciones técnicas en la esfera del transporte marítimo y sus efectos en los puertos: Repercusiones de la unitarización en las operaciones portuarias" (TD/B/C.4/129/Supp.1 y Corr.1), sección B del capítulo IV.

Cuadro 3

Planes de desarrollo propuestos, 1975-1999

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Variante 1	comienzo / terminación de la construcción de dos atracaderos polivalentes									comienzo / terminación de la construcción de un atracadero polivalente					comienzo / terminación de la construcción de un atracadero polivalente									
Variante 2		comienzo / terminación de la construcción de un atracadero de carga general				comienzo / terminación de la construcción de un atracadero de carga general				comienzo / terminación de la construcción de una terminal de contenedores						comienzo / terminación de la construcción de un atracadero de carga general								

Cuadro 4

Variante de inversión 1: principales características

	1980	1984	1989	1994	1999
Número de atracaderos polivalentes en servicio	2	2	3	4	4
Combinación de cargas en los atracaderos polivalentes (toneladas)					
carga baja de productividad	150 000	85 000	215 000	270 000	[illegible]
carga mediana de productividad	430 000	495 000	580 000	695 000	795 000
carga alta de productividad	80 000	150 000	260 000	445 000	655 000
movimiento total	660 000	730 000	1 055 000	1 410 000	1 690 000
rendimiento medio de cada estancia de un buque	800	925	860	880	1 020
Capacidad media del atracadero polivalente al año (tasa de ocupación del 67% a un rendimiento medio por buque, en toneladas)	660 000	770 000	1 070 000	1 460 000	[illegible]
Tasa prevista de ocupación efectiva de los atracaderos polivalentes	67,0%	63,5%	66,1%	64,7%	65,4%
Número de atracaderos de tipo corriente en servicio	8	8	8	8	8
Carga que pasa por los atracaderos de tipo corriente (toneladas al año)	685 000	770 000	670 000	605 000	625 000
Capacidad de los atracaderos de tipo corriente (toneladas al año) (a una tasa de ocupación del 67%)	960 000	960 000	960 000	960 000	960 000
Tasa prevista de ocupación efectiva de los atracaderos de tipo corriente	47,8%	53,7%	46,8%	42,2%	43,6%

Cuadro 5

Variante de inversión 2: principales características

	1980	1984	1989	1994	1999
Número de atracaderos de contenedores	-	-	1	1	1
Movimiento total en el atracadero o los atracaderos de contenedores (toneladas al año)	-	-	260 000	445 000	685 000
Capacidad media del atracadero (o los atracaderos) de contenedores sobre la base de una tasa de ocupación del 50%, una manipulación de 400 contenedores cada 24 horas de permanencia en el muelle y 350 días de trabajo al año (toneladas)	-	-	840 000	840 000	840 000
Tasa prevista de ocupación efectiva del atracadero (o los atracaderos) de contenedores	-	-	15,5%	26,5%	40,8%
Número de atracaderos de tipo corriente en servicio	9	10	10	11	11
Carga que pasa por los atracaderos de tipo corriente (toneladas al año)	1 345 000	1 500 000	1 465 000	1 570 000	1 590 000
Capacidad de los atracaderos de tipo corriente (a una tasa de ocupación del 67% y un rendimiento diario de 610 toneladas) (en toneladas al año)	1 350 000	1 500 000	1 500 000	1 650 000	1 650 000
Tasa media prevista de ocupación efectiva de los atracaderos de tipo ordinario	66,8%	67,0%	65,4%	63,8%	64,6%

c) En el cuadro 6 se indican, respectivamente, los costos totales de inversión de los atracaderos de carga fraccionada, de contenedores y polivalentes. En él se indica asimismo, para cada una de las principales partidas de costos, el respectivo componente de divisas. Se parte del supuesto de que el terreno para los tres tipos de atracaderos habrá de ser adquirido a un costo de oportunidad de 5 dólares por m2, ya que también existe la posibilidad de dedicarlo a la construcción de un polígono industrial.

11. La Comisión decide llevar a cabo una evaluación económica nacional detallada procediendo a un análisis de costos y beneficios sociales a precios virtuales, con objeto de determinar determinar cuál de los dos planes posibles genera, durante un período de 25 años, los beneficios más elevados para la economía nacional.

12. Para efectuar esa evaluación económica nacional, la Comisión pide a la administración del puerto de Mana que calcule los costos de explotación de los tres tipos de atracaderos objeto de estudio. En los cuadros 7, 8 y 9 se resumen los resultados de las estimaciones realizadas por la administración del puerto. Cabe señalar que, en el caso de los atracaderos de carga fraccionada, tanto la mano de obra no calificada como la calificada se consideran como costos variables, ya que hay una reserva de mano de obra que no representa un contingente fijo, mientras que, en el caso de los atracaderos para contenedores y polivalentes, sólo se emplea mano de obra calificada, que se considera como costo fijo.

13. Un factor sumamente importante en la evaluación económica nacional es el relacionado con los costos de permanencia de los buques en el puerto, costos en los que cada una de las dos soluciones podría tener efectos bastante diferentes. Dentro del marco de una evaluación económica nacional, sin embargo, la principal cuestión que se plantea es la de si el ahorro de costos redunda realmente en beneficio del país. A este respecto se plantean otras cuestiones, como las relacionadas con la participación de las compañías navieras nacionales, el volumen de carga transportada en buques fletados por nacionales de Cali, la posibilidad de una reducción de los fletes como resultado de la disminución de los costos portuarios, etc. Para eludir esas complicaciones, per teniendo al mismo tiempo en cuenta en la evaluación económica nacional, los efectos del tiempo de permanencia del buque en el puerto, la Comisión decidió partir del supuesto de que toda reducción de ese tiempo en uno de los dos sistemas comparado con el otro se traduciría en un aumento correspondiente de los derechos portuarios, de modo que esos beneficios resultantes del plan de mejoras del puerto afluirían al propio país.

14. a) Para calcular los valores del tiempo respectivo de permanencia del buque en puerto en función de las dos soluciones, la Comisión utilizó los datos siguientes:

Costo diario de permanencia de los buques en el puerto:

Buque de carga fraccionada	4.000 dólares por día
Buque granelero de tonelaje medio	7.500 dólares por día
Buques portacontenedores y buques de transbordo por rodadura	13.500 dólares por día

Cuadro 6

Costos de inversión de los distintos tipos de atracaderos

(En miles de dólares de los EE.UU.)

	ATRACADEROS DE CARGA FRACCIONADA		ATRACADEROS DE CONTENEDORES		ATRACADEROS POLIVALENTES	
	Inversión inicial	Componente de divisas	Inversión inicial	Componente de divisas	Inversión inicial	Componente de divisas
		(porcentaje)		(porcentaje)		(porcentaje)
Muro del muelle	2 100	60	3 000	60	4 320	60
Afirmado y tinglados	1 695	25	4 200	25	5 100	25
Equipo de manipulación	1 296	75	7 234	90	5 750	90
Varios (vías férreas, alumbrado, etc.)	259	50	550	50	838	50
TOTAL	5 350		14 984		16 008	
Terreno (valorado a 5 dólares el m^2)	105	-	600	-	500	-
Estación de contenedores (tinglados)	-		800 a/	25	-	
TOTAL GENERAL	5 455		16 384		16 508	

a/ Para una estación de contenedores (EC) de 10.000 m^2.

Cuadro 7

Costos de explotación de un atracadero de tipo corriente de carga fraccionada

(Dólares por tonelada)

		Atracadero con una capacidad de manipulación de 120.000 toneladas a una tasa de ocupación del 67%	Atracadero con una capacidad de manipulación de 150.000 toneladas a una tasa de ocupación del 67%
Costos de personal y de mano de obra (incluido el personal de conservación)	Mano de obra calificada/personal administrativo	4,40	3,52
	Mano de obra no calificada	2,10	1,60
Costos de conservación y explotación	Materiales nacionales	0,80	0,64
	Materiales importados	1,20	0,96

Cuadro 8

Costos de explotación de una terminal de contenedores

		Atracadero con una capacidad de manipulación de 840.000 toneladas a una tasa de ocupación del 50%
Costos de personal y de mano de obra (incluido el personal de conservación)	Mano de obra calificada/ personal administrativo Mano de obra no calificada	871.000 dólares por año y muelle
Costos de conservación y explotación	Materiales nacionales	0,55 dólares por tonelada
	Materiales importados	0,84 dólares por tonelada

Cuadro 9

Costos de explotación de una terminal polivalente

		Costo por atracadero
Costos de personal y de mano de obra (incluido el personal de conservación	Mano de obra calificada/ personal administrativo Mano de obra no calificada	471.500 dólares al año
Costos de conservación y explotación	Materiales nacionales	0,54 dólares por tonelada
	Materiales importados	0,80 dólares por tonelada

b) La Comisión partió, por otra parte, de la hipótesis de que todos los contenedores y las cargas objeto de transbordo por rodadura son transportados en buques construidos con ese objeto, de que el buque granelero de tamaño manejable se destina exclusivamente al transporte de productos siderúrgicos, maquinaria, productos forestales y automóviles, que los demás productos se transportan en buques de carga fraccionada.

c) La relación entre los distintos tiempos de espera de los buques se basa en la "relación entre el tiempo de espera y el tiempo de servicio", publicada por la secretaría de la UNCTAD en su estudio sobre el movimiento de mercancías en los muelles 2/. En el caso de la terminal de contenedores, se parte del supuesto de que se dispone efectivamente de dos atracaderos, ya que la terminal está al lado de un muelle de tipo corriente en el que pueden emplazarse grúas pórtico para la carga y descarga de los buques. También se parte del supuesto de que los buques destinados a la terminal polivalente se dirigen exclusivamente a ese tipo de terminal, aunque en la práctica podrían cargarse y descargarse (a tasas de rendimiento más bajas) en las instalaciones de tipo corriente 3/. El volumen medio de la carga varía según el tipo de buque. Los valores que figuran a continuación son estimaciones realistas del futuro volumen de la carga:

- buques de carga fraccionada que atracan en un muelle ordinariamente dedicado a ese tipo de carga	980 toneladas
- buques de carga fraccionada que atracan en un muelle polivalente	900 "
- buques graneleros que atracan en un muelle ordinario de carga fraccionada o en un muelle polivalente	2 000 "
- buques portacontenedores y de transbordo por rodadura que atracan en un muelle ordinario de carga fraccionada, en un muelle polivalente o en una terminal de contenedores	3 000 "

d) Todo ahorro realizado en el costo de permanencia de los buques en puerto en función de las dos soluciones vendrá representado por una entrada neta de divisas. Por eso, en el análisis de costos y beneficios sociales deberá utilizarse el precio virtual de las divisas.

2/ Movimiento de mercancías en los muelles: Métodos sistemáticos para mejorar las operaciones de manipulación de carga general (TD/B/C.4/109 y Add.1), publicación de las Naciones Unidas, Nº de venta: S.74.II.D.1, Primera parte, cuadro del anexo (pág. 35).

3/ Como resultado de una serie de decisiones adoptadas por la administración del puerto y los sindicatos, el número de días de trabajo al año difiere según el tipo de muelle: 365 días en los muelles de carga fraccionada, 350 días en los muelles de contenedores, y 310 días en los muelles polivalentes.

e) Los tiempos de servicio de los buques en los puertos de atraque están basados en las siguientes estimaciones facilitadas por la administración del puerto de Mana:

- Instalaciones ordinarias de manipulación de carga fraccionada: todos los buques sin excepción, 610 toneladas por cada 24 horas de permanencia en el puerto de atraque, si no existe una terminal polivalente; 490 toneladas por cada 24 horas de permanencia en el puesto de atraque, si hay una terminal polivalente para las cargas de alta y media productividad.
- Terminal polivalente: buques de carga fraccionada, 900 toneladas por cada 24 horas de permanencia en el puesto de atraque; buques graneleros de tamaño mediano, 2.000 toneladas por cada 24 horas de permanencia en el puesto de atraque; y buques portacontenedores y de transbordo por rodadura, 3.000 toneladas por cada 24 horas de permanencia en el puesto de atraque.
- Terminal de contenedores: los buques portacontenedores y de transbordo por rodadura alcanzan un promedio de 4.800 toneladas por 24 horas de permanencia en el puesto de atraque.

15. Finalmente, la Comisión recibe del Centro de Planificación Económica del Gobierno, las siguientes estimaciones de los costos de oportunidad:

a) Costo de oportunidad de la mano de obra no calificada: 75% de su precio de mercado;

b) Costo de oportunidad de la mano de obra calificada: igual a su precio de mercado;

c) Prima sobre las divisas: 50% (lo que significa que el precio virtual de las divisas es 1,5 veces superior al tipo de cambio oficial).

La moneda nacional de la República de Cali es el liv, cuyo tipo de cambio oficial es actualmente de 1 liv = 1 dólar.

El análisis de costos y beneficios sociales efectuado por la Comisión de Planificación y Desarrollo Portuarios consta de las fases siguientes:

a) Cálculo de los precios virtuales de los costos de inversión de cada uno de los tres tipos de atracaderos que se están examinando y distribución por atracadero de la inversión total según se indica en el apartado a) del párrafo 10. Los resultados son los que se indican en el cuadro I del apéndice.

b) Cálculo de la diferencia de los costos de explotación entre las dos soluciones, en los años 1980, 1984, 1989, 1994 y 1999. (En 1975 las dos variantes utilizan las mismas instalaciones para el mismo tráfico.) Los resultados son los que se indican en el cuadro II del apéndice.

c) Cálculo de la diferencia del costo total del tiempo de permanencia de los buques en el puerto en los años 1980, 1984, 1989, 1994 y 1999. En el cuadro III del apéndice se expone detenidamente este cálculo, cuyos resultados finales se resumen en el cuadro IV del apéndice.

d) Cálculo del valor neto actualizado de la corriente de costos y beneficios adicionales a distintas tasas de actualización (8%, 10%, 12%, 14% y 20%). Los resultados son los que se indican en el cuadro V del apéndice.

Conclusiones

16. La aplicación del análisis de costos y beneficios sociales sobre la base de los distintos datos de que dispone la Comisión de Planificación y Desarrollo Portuarios demuestra que. si los beneficios y costos se evalúan correctamente a sus precios virtuales o costos de oportunidad, la aplicación de la solución 1 es mucho más eficaz que la de la solución 2 desde el punto de vista de la economía nacional. La pronta construcción de una terminal polivalente, sin más inversiones en muelles ordinarios de carga fraccionada, ofrece, pues, claramente un beneficio neto más elevado cuando se actualiza con arreglo a tasas comprendidas entre el 8 y el 20%. Si el costo de oportunidad del capital hubiera sido del 30%, el valor de las dos variantes desde un punto de vista puramente económico habría sido el mismo.

Cuadro I del apéndice

Costos de inversión, a precios virtuales, del componente de divisas y distribución del mismo por años de construcción

Partida	Atracadero de carga fraccionada		Atracadero de contenedores		Atracaderos polivalentes (2 atracaderos)	
	(Miles de dólares)	(Miles de LIV)	(Miles de dólares)	(Miles de LIV)	(Miles de dólares)	(Miles de LIV)
Muro del muelle	2 100	2 730	3 000	3 900	4 320	5 616
Afirmado	1 695	1 907	4 200	4 725	5 100	5 738
Equipo de manipulación	1 296	1 782	7 234	10 489	5 750	8 338
Varios	259	324	550	688	838	1 048
Terreno	105	105	600	600	500	500
Estación de contenedores	-		800	900	-	
Total	5 455	6 848	16 384	21 302	16 508	21 240
Año 1	55%	3 766	35%	7 456	35%	7 434
Año 2	35%	2 397	30%	6 390	30%	6 372
Año 3	10%	685	25%	5 326	25%	5 310
Año 4	-		10%	2 130	10%	2 124
TOTAL	100%	6 848	100%	21 302	100%	21 240

Cuadro II del apéndice

Cálculo de la diferencia entre los costos de explotación de la variante 1 y los de la variante 2

(Miles de dólares)

	1975		1980		1984		1989		1994		1999	
		A precios virtuales		A precios virtuales		A precios virtuales		A precios virtuales		A precios virtuales		A precios virtuales
Variante 1												
Mano de obra no calificada	2 520	1 764	1 439	1 007	1 617	1 132	1 407	985	1 271	890	1 315	919
Mano de obra calificada	5 280	5 280	3 957	3 957	4 331	4 331	4 363	4 363	4 548	4 548	4 636	[illegible]
Materiales nacionales	960	960	904	904	1 010	1 010	1 106	1 106	1 245	1 249	1 591	[illegible]
Materiales importados	1 440	2 160	1 350	2 025	1 580	2 370	1 648	2 472	1 854	2 731	2 070	[illegible]
TOTAL	10 200	10 164	7 650	7 893	8 466	8 843	6 524	8 926	8 918	[illegible]	9 410	[illegible]
Variante 2												
Mano de obra no calificada	2 520	1 764	2 260	1 582	2 520	1 764	2 461	1 723	2 638	1 847	2 671	[illegible]
Mano de obra calificada	5 280	5 280	4 734	4 734	5 280	5 280	6 028	6 028	6 397	6 397	6 458	[illegible]
Materiales nacionales	960	960	861	861	960	960	1 081	1 081	1 250	1 250	1 395	[illegible]
Materiales importados	1 440	2 160	1 291	1 937	1 440	2 160	[illegible]	2 436	1 881	2 822	2 101	3 152
TOTAL	10 200	10 164	9 146	9 114	10 200	10 164	11 194	11 268	12 166	12 316	12 635	[illegible]
Diferencia entre los totales correspondientes a las variantes 1 y 2				1 221		1 321		2 342		2 852		[illegible]

Cuadro 15

Cálculo de la diferencia del "costo total del tiempo de permanencia del buque en puerto" entre las variantes 1 y 2

Año	Tipo de buque	Tipo de terminal	Tonelaje total anual que ha de manipularse (toneladas)	Tasa de productividad por 24 horas en muelle (toneladas)	Permanencia de los buques en muelle (días)	Relación del tiempo de espera	Tiempo de espera (días)	Tiempo total de permanencia en puerto (días)	Costo de los buques por día en puerto (dólares)	Costo total de permanencia de los buques en puerto (miles de dólares)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1980	Variante 1									
	Buques de carga fraccionada	C.F.	685 000	490	1 398	0,015	21	1 419	4 000	5 676
	Buques de carga fraccionada	P.V.	150 000	900	167	0,837	140	307	4 000	1 228
	Buques graneleros de tamaño manejable	P.V.	430 000	2 000	215	0,837	180	395	7 500	2 963
	Buques portacontenedores y de transbordo por rodadura	P.V.	80 000	3 000	27	0,837	23	50	13 500	675
	TOTAL		1 345 000							10 542
	Variante 2									
	Buques de carga fraccionada	C.F.	835 000	610	1 369	0,071	97	1 466	4 000	5 864
	Buques graneleros de tamaño manejable	C.F.	430 000	610	705	0,071	50	755	7 500	5 563
	Buques portacontenedores y de transbordo por rodadura	C.F.	80 000	610	131	0,071	9	140	13 500	1 890
	TOTAL		1 345 000							13 417
1984	Variante 1									
	Buques de carga fraccionada	C.F.	770 000	490	1 571	0,026	41	1 612	4 000	6 448
	Buques de carga fraccionada	P.V.	85 000	900	94	0,732	69	163	4 000	652
	Buques graneleros de tamaño manejable	P.V.	495 000	2 000	248	0,732	182	430	7 500	3 225
	Buques portacontenedores y de transbordo por rodadura	P.V.	150 000	3 000	50	0,732	37	87	13 500	1 175
	TOTAL		1 500 000							11 500
	Variante 2									
	Buques de carga fraccionada	C.F.	855 000	610	1 402	0,057	80	1 482	4 000	5 928
	Buques graneleros de tamaño manejable	C.F.	495 000	610	811	0,057	46	857	7 500	6 428
	Buques portacontenedores y de transbordo por rodadura	C.F.	150 000	610	246	0,057	14	260	13 500	3 510
	TOTAL		1 500 000							15 866
1989	Variante 1									
	Buques de carga fraccionada	C.F.	670 000	490	1 367	0,008	11	1 378	4 000	5 512
	Buques de carga fraccionada	P.V.	215 000	900	239	0,401	96	335	4 000	1 340
	Buques graneleros de tamaño manejable	P.V.	560 000	2 000	[illegible]	0,401	116	406	7 500	3 045
	Buques portacontenedores y de transbordo por rodadura	P.V.	260 000	3 000	87	0,401	35	122	13 500	1 647
	TOTAL		1 725 000							11 544
	Variante 2									
	Buques de carga fraccionada	C.F.	885 000	610	1 451	0,044	64	1 515	4 000	6 060
	Buques graneleros de tamaño manejable	C.F.	580 000	610	951	0,044	42	993	7 500	7 448
	Buques portacontenedores y de transbordo por rodadura	T.C.	260 000	4 800	54	0,023	1	55	13 500	743
	TOTAL		1 725 000							14 251

(continúa)

Cuadro 15 (continuación)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
[illegible]	Variante 1									
	Buques de carga fraccionada	C.P.	605 000	490	1 235	0,004	5	1 240	4 000	4 960
	Buques de carga fraccionada	P.V.	270 000	900	300	0,253	76	376	4 000	1 504
	Buques graneleros de tamaño manejable	P.V.	695 000	2 000	348	0,253	88	436	7 500	3 270
	Buques portacontenedores y de transbordo por rodadura	P.T.	445 000	3 000	148	0,253	37	185	13 500	2 [illegible]
	TOTAL		2 015 000							12 [illegible]
	Variante 2									
	Buques de carga fraccionada	C.P.	875 000	610	1 434	0,035	50	1 484	4 000	5 [illegible]
	Buques graneleros de tamaño manejable	C.P.	695 000	610	1 139	0,035	40	1 179	7 500	8 [illegible]
	Buques portacontenedores y de transbordo por rodadura	T.C.	445 000	4 000	93	0,067	6	99	13 500	1 [illegible]
	TOTAL		2 015 000							16 [illegible]
[illegible]	Variante 1									
	Buques de carga fraccionada	C.P.	625 000	490	1 276	0,035	10	1 286	4 000	5 144
	Buques de carga fraccionada	P.V.	[illegible]	500	[illegible]	0,253	[illegible]	237	4 000	[illegible]
	Buques graneleros de tamaño manejable	P.V.	735 000	2 000	[illegible]	0,253	101	499	7 500	3 [illegible]
	Buques portacontenedores y de transbordo por rodadura	P.V.	645 000	3 000	228	0,253	58	286	13 500	3 [illegible]
	TOTAL		2 275 000							13 [illegible]
	Variante 2									
	Buques de carga fraccionada	C.P.	795 000	610	1 303	0,035	46	1 349	4 000	5 396
	Buques graneleros de tamaño manejable	C.P.	695 000	610	1 303	0,035	46	1 349	7 500	10 [illegible]
	Buques portacontenedores y de transbordo por rodadura	T.C.	685 000	4 200	163	0,190	27	170	13 500	2 295
	TOTAL		2 275 000							17 309

Cuadro IV del apéndice

Cálculo de la diferencia del costo total de "permanencia del buque en puerto" entre las variantes 1 y 2: resumen

Año	Costo total de la "permanencia de los buques en puerto" con la variante 1 (dólares)	Costo total de la "permanencia de los buques en puerto" con la variante 2 (dólares)	Diferencia de costo de la "permanencia de los buques en puerto" (ventaja de la variante 1 sobre la variante 2)	
			Al tipo de cambio oficial (LIV)	Al precio virtual de las divisas (LIV)
1980	10 542	13 417	2 875	4 313
1984	11 500	15 866	4 366	6 549
1989	11 544	14 251	2 707	4 061
1994	12 232	16 116	3 884	5 826
1999	13 696	17 809	4 113	6 170

Cuadro 15

Beneficios netos actualizados resultantes de la elección de la variante 1

(Miles de LIV)

	COSTOS		BENEFICIOS												
Año	Costo de capital de la variante 1	Costo de capital evitado de la variante 2	Diferencia de costo operacional entre las variantes 1 y 2	Diferencia de costo total de permanencia de los buques entre las variantes 1 y 2	Beneficio total	Costos (Factor de actualización: 8%)	Beneficios (Factor de actualización: 8%)	Costos (Factor de actualización: 10%)	Beneficios (Factor de actualización: 10%)	Costos (Factor de actualización: 12%)	Beneficios (Factor de actualización: 12%)	Costos (Factor de actualización: 16%)	Beneficios (Factor de actualización: 16%)	Costos (Factor de actualización: 20%)	Beneficios (Factor de actualización: 20%)
1975	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1976	7 434	-	-	-	-	6 373	-	6 144	-	5 926	-	5 525	-	5 163	-
1977	6 372	3 766	-	-	3 766	5 058	2 990	4 787	2 829	4 535	2 681	4 082	2 413	3 688	2 179
1978	5 310	2 397	-	-	2 397	3 903	1 762	3 627	1 637	3 375	1 523	2 933	1 324	2 561	1 156
1979	2 124	685	-	-	685	1 446	466	1 319	425	1 205	389	1 011	326	854	279
1980	-	-	1 221	4 313	5 534	-	3 487	-	3 124	-	2 804	-	2 271	-	1 853
1981	-	3 766	1 221	4 313	9 300	-	5 426	-	4 772	-	4 207	-	3 291	-	2 595
1982	-	2 397	1 221	4 313	7 931	-	4 205	-	3 700	-	3 203	-	2 419	-	1 843
1983	-	685	1 221	4 313	6 219	-	3 132	-	2 637	-	2 243	-	1 635	-	1 203
1984	-	-	1 321	6 549	7 870	-	3 645	-	3 054	-	2 534	-	1 784	-	1 271
1985	5 727	7 456	1 321	6 549	15 326	1 594	6 573	1 303	5 372	1 069	4 406	726	2 995	500	2 063
1986	[illegible]	6 390	1 321	6 549	14 260	1 265	5 667	1 015	4 544	818	3 660	537	2 402	357	1 599
1987	[illegible]	5 326	1 321	6 549	13 196	976	4 852	769	3 822	608	3 024	386	1 916	248	1 233
1988	2 662	2 130	1 321	6 549	10 000	362	3 404	280	2 633	217	2 046	133	1 252	83	779
1989	-	-	2 342	4 061	6 403	-	2 019	-	1 533	-	1 170	-	691	-	416
1990	2 727	-	2 342	4 061	6 403	1 085	1 869	809	1 394	606	1 044	346	596	201	346
1991	3 366	3 766	2 342	4 061	10 169	861	2 748	630	2 012	464	1 481	256	816	144	458
1992	2 455	2 397	2 342	4 061	8 800	664	2 202	478	1 583	345	1 144	184	608	100	332
1993	1 062	685	2 342	4 061	7 088	246	1 642	174	1 159	123	823	65	425	33	222
1994	-	-	2 852	5 826	8 678	-	1 862	-	1 290	-	900	-	446	-	226
1995	-	-	2 852	5 826	8 678	-	1 724	-	1 173	-	803	-	384	-	189
1996	-	-	2 852	5 826	8 678	-	1 596	-	1 066	-	717	-	331	-	157
1997	-	-	2 852	5 826	8 678	-	1 478	-	969	-	640	-	286	-	131
1998	-	-	2 852	5 826	8 678	-	1 369	-	881	-	572	-	246	-	109
1999	-	-	2 834	6 170	9 004	-	1 315	-	831	-	530	-	220	-	94
						23 854	65 489	21 534	52 621	19 293	42 544	16 181	29 076	13 930	20 734
				Beneficio neto actualizado		41 635		31 087		23 251		12 895		6 804	

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SISTEMAS MARITIMOS Y PORTUARIOS

EVALUACION DE PROYECTOS MARITIMOS. "LA INVERSION EN EL TRANSPORTE Y EL DESARROLLO ECONOMICO"

AUTOR: GARY FROMM

MARZO, 1979.

I

INTRODUCCION: ENFOQUE DE LAS DECISIONES SOBRE INVERSIONES

Gary Fromm *

Es un axioma que el desarrollo económico exige servicios de transporte adecuados y eficaces. Se acepta, en general, que para determinados países y en ciertas etapas de su evolución, existe en teoría una medida óptima de capacidad de transporte. No obstante, dista mucho de ser unánime el consenso en cuanto a la determinación de esa capacidad y de la correspondiente tasa de inversión. Probablemente ello se debe tanto al hecho de que los economistas no han estudiado el papel del transporte en el desarrollo económico contemporáneo, como a la fundamental disparidad de opiniones entre ellos. A través de la bibliografía selecta, preparada por Katherine Warden e incluida al final del texto de este libro, se advierte claramente que son pocos, o ningunos, los análisis completos de la teoría normativa del desarrollo de los transportes que se han hecho hasta ahora. El presente volumen intenta ofrecer una contribución introductoria a este tema.

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El contexto del desarrollo

Los países menos desarrollados presentan una amplia diversidad en cuanto al medio geográfico, demográfico, político, económico y social. No obstante, dentro de cada combinación de estas características pueden agruparse elementos comunes que originan efectos similares sobre los programas de desarrollo y de transporte. En primer lugar, estos países, salvo escasas excepciones, pueden clasificarse en cuatro categorías geográfico-demográficas: 1) tierras tropicales densamente pobladas; 2) tierras tropicales con escasas densidades de población; 3) tierras montañosas de las zonas templadas que poseen un altiplano o una llanura costera de alta densidad de población y otros lugares con bajas densidades; 4) tierras desiertas donde las densidades generales de población son bajas, pero que presentan concentraciones a lo largo de ríos o de zonas costeras. En general, los problemas de desarrollo y transporte son más graves en las zonas tropicales y donde las densidades de población son bajas. Por supuesto, las densidades desmedidamente altas (como en la India) plantean otras dificultades.

En segundo lugar, en el terreno político hay países cuyo desarrollo está limitado por factores técnicos, disponibilidad de recursos, inventiva, inclinaciones y pericia de los planificadores y de los gobiernos; hay otras naciones donde fuertes grupos que responden a intereses creados ejercen bastante poder como para retrasar significativamente el desarrollo alejándolo de los niveles que podría alcanzar en otras condiciones. Estos grupos no sólo pueden obstruir programas esenciales, sino también distraer recursos, derivándolos hacia inversiones que poco contribuyen al desarrollo.

En tercer lugar, en el ámbito socioeconómico, sobre las decisiones en materia de inversiones influyen numerosas carecterísticas, de las que sólo cabe citar algunas en este caso. Más importante es el hecho de que intervienen como factores predominantes el bajo ingreso *per cápita* y la muy desigual distribución del ingreso. Además, el sector agrícola sufre por lo común las consecuencias de una baja productividad total y sólo cuenta con reducidos sectores de plantaciones verdaderamente desarrolladas o de agricultura comercial que rinda cosechas exportables y rentables. Lo más probable es que los métodos agrícolas sean primitivos y que la producción de muchos agricultores alcance únicamente para la subsistencia de sus familias. Por otra parte, es escaso el incentivo para la producción de excedentes. Por desconocerse las posibilidades de comercialización y por no disponerse de transportes rápidos y seguros hasta los mercados internos, gran parte de cualquier excedente que pudiera producirse se echaría a perder antes de ser exportado o consumido en centros urbanos. A menudo la red disponible de transportes al interior del país fue planeada pensando en la exportación de minerales y cosechas rentables, y no para satisfacer las necesidades internas de transporte.

Una característica relacionada con esto es la desocupación generalizada o la subocupación de la mano de obra en las zonas rurales. Pese al empleo de técnicas agrícolas ineficaces, la reducida producción de comestibles no requiere más que una fracción de la mano de obra disponible, sobre todo donde la densidad de población es elevada. Debido a esta falta de oportunidades locales de empleo y a los bajos niveles de la vida rural, así como a los atractivos de la vida de ciudad y al desconocimiento de las verdaderas condiciones de las zonas urbanas, la gente emigra en gran número a los centros urbanos más importantes. En el mejor de los casos, esa urbanización es perjudicial para el bienestar tanto del individuo como de la nación. No sólo es sumamente limitada la demanda de mano de obra no especializada en las etapas tempranas de la industrialización, sino que las condiciones de vida en las ciudades populosas son a menudo menos satisfactorias que en las aldeas de donde provienen los inmigrantes. De todos modos, los inmigrantes desocupados tienen que comer y disponer de vivienda, por muy pobremente que esto se resuelva, pero ello origina un drenaje económico que se habría evitado si aquéllos hubieran permanecido en las zonas rurales. Si no se crean oportunidades de trabajo en el medio rural, el mejoramiento de los transportes entre las zonas urbanas y las rurales puede, lamentablemente, estimular una migración excesiva. El ensayo de Louis Lefeber (capítulo VI) desarrolla este punto con mayor detalle.

Los sectores industrial y comercial padecen también de un dualismo similar al del sector agrícola; algunas industrias operan en niveles de productividad internacionalmente competitivos, o cerca de ellos, mientras que otras están muy atrasadas.

Al igual que en la agricultura, muchos artículos no se fabrican en el país (o se fabrican sólo en cantidades limitadas), y es menester importarlos para satisfacer las necesidades de consumo y producción. Si hay gran necesidad de importaciones y si los ingresos de divisas se hallan restringidos mayormente a las que provienen de la exportación de materias primas o de artículos de primera necesidad, los déficit de la balanza de pagos se vuelven comunes y traban la expansión interna.

En todos los sectores de la economía, incluso el gubernamental, la productividad y el desarrollo deben ser estimulados mediante una mayor educación básica y profesional. Puesto que con toda seguridad la iniciativa privada en este campo habrá de resultar desastrosamente insuficiente, el gobierno debe asumir la responsabilidad principal en el aspecto formativo. Debe también cargar con gran parte de las nuevas inversiones en infraestructura (especialmente en instalaciones básicas de transporte), dado que en general el sector privado no está capacitado para hacerlo, salvo en condiciones políticamente insostenibles o económicamente inconvenientes (véase nota de pág. 127) [1].

La financiación de estas inversiones y otros gastos públicos es una de las principales dificultades con que tropieza el gobierno. Frente a una proporción inicialmente baja del producto nacional susceptible de ser destinada a objetivos del gobierno, a una larga tradición de evasión impositiva, a estructuras impositivas arcaicas y a una administración tributaria ineficaz (cuando no corrompida), casi todos los gobiernos de naciones menos desarrolladas se ven en serias dificultades para hacer frente a las cargas financieras de un crecimiento acelerado [2]. Claro que alguna ayuda se obtiene de la asistencia y préstamos extranjeros, pero lo normal es que esto sólo satisfaga una parte de las necesidades y a veces implique onerosas obligaciones políticas o económicas de reembolso. Es evidente

[1] La expansión de los sectores industrial y comercial puede en gran medida dejarse librada a la iniciativa privada dentro de ciertos amplios límites e incentivos fijados por el gobierno. (Sin embargo, hay excepciones en los casos en que intervienen grandes inversiones de capital, serios riesgos y nuevas tecnologías que hacen necesaria una directa intervención del gobierno.) También en el sector agrícola los empresarios privados deben estar en condiciones de elevar significativamente la productividad con la ayuda de servicios de extensión agrícola y de préstamos o créditos garantizados o provistos por el gobierno.

[2] Harry T. Oshima, "Shares of Government in Gross National Product for Various Countries", *American Economic Review*, junio 1957, pp. 381-90; también, Harley H. Hinrichs, "The Changing Level of Government Revenue Share During Economic Development", Universidad de Maryland, 1964 (mimeografiado).

que la reforma impositiva debe tener alta prioridad entre las medidas administrativas de desarrollo. (Otras reformas legales, especialmente las relativas a la legislación contractual, son de igual modo imperativas en muchas naciones.) Importa también sobremanera que los usuarios paguen los bienes y servicios públicos (excluidos los servicios de bienestar, tales como la educación primaria y la salud pública). (Véanse los capítulos X y XI, por James R. Nelson y por A. Robert Sadove y Gary Fromm respectivamente.)

Finalmente, en cuanto al transporte en sí, por lo general es dable encontrar una vasta gama de tecnologías, que van desde los senderos y caminos de tierra primitivos para transporte humano o animal, hasta las modernas supercarreteras, ferrocarriles y aviones de gran velocidad. Además, a menudo prevalece igual diversidad en la distribución e integración geográficas de las instalaciones y servicios de transporte; algunos (en parte debido a circunstancias históricas fortuitas) se hallan diseminados al azar, mientras que otros se hallan conectados entre sí integrando subsistemas eficaces.

Objetivos del desarrollo y papel del transporte

Las breves generalizaciones precedentes acerca del contexto del desarrollo no son aplicables en forma universal, especialmente en cada uno de los detalles, a todos los países menos desarrollados. No obstante, son útiles para formular los objetivos de muchos programas de desarrollo económico y para analizar las posibles concesiones de préstamos a esos países. En términos generales, aquellos objetivos podrían definirse como: 1) incremento del ingreso nacional total, acompañado de una distribución equitativa entre la población, el sector empresario y los grupos regionales, y dentro de ellos; 2) aumento de las clases y cantidades de bienes y servicios terminados disponibles para los consumidores, las industrias y el gobierno; 3) desarrollo de una estructura industrial nacional capaz de recibir divisas y abastecer mercados internos; 4) fijación y mantenimiento de un elevado nivel de ocupación. Por supuesto, casi todos estos objetivos están sujetos a desplazamientos alternativos en el tiempo, o sea que puede sacrificarse uno de ellos para el mejor logro de otro.

Para materializar estos objetivos, normalmente se necesita

(entre otros requisitos, muchos de ellos de índole no económica) que el sector de la agricultura se expanda y mejore; que crezca el sector industrial y se desarrollen mercados rurales y urbanos; que se entrene una fuerza laboral especializada; que se creen centros urbanos con todos sus servicios productivos, sociales y culturales diversificados; y que se provea un sistema de transportes económico y seguro, que resulte eficaz desde el punto de vista de la asignación de recursos.

Función del transporte

El transporte desempeña un papel de múltiples facetas en el logro de los objetivos del desarrollo. Salta a la vista su función como requisito del insumo de factores: permite que se trasladen mercaderías y pasajeros entre los centros de producción y los de consumo, y dentro de ellos. Como gran parte de este movimiento se realiza entre zonas urbanas y rurales, el transporte proporciona un ingrediente esencial para la extensión de la economía monetaria al sector agrícola y el aumento de su productividad. Si durante este proceso es posible acrecentar los ingresos rurales, ello tal vez ayude a retardar la urbanización patológica.

Algo menos evidente es el papel del transporte en la modificación funcional de las posibilidades de producción mediante la alternación de los costos de los factores relativos. El mejoramiento del transporte reduce el tiempo que se emplea en los viajes, resultando de ello economías en la cantidad de horas-hombre insumidas en el desplazamiento de mano de obra, y permite reducir los costos de existencias, de capital, de intereses y de obsolescencia. Por supuesto, también disminuyen los costos de expedición, determinando la posibilidad de producciones que de otro modo no serían factibles. Así, pues, el transporte origina economías internas en muchos sectores, con lo cual promueve economías externas en todos los sectores en general.

También el aumento de la velocidad y el mayor alcance de la red de transportes repercuten beneficiosamente en la movilidad de factores, haciendo más fácil el traslado de recursos humanos y materiales hasta los lugares donde se los pueda emplear más productivamente. Por tanto, el transporte ayuda a lograr distribuciones regionales preferenciales de población, industrias e ingresos.

(Por último, el transporte es además un bien de consumo privado y público. Como bien privado, permite a las personas viajar por razones particulares. Como bien público, sirve para acrecentar la capacidad de defensa nacional, la cohesión social y la estabilidad política.) Tal como observa Hans Heymann en su examen de los objetivos del transporte en orden al desarrollo económico (capítulo II), estos últimos efectos no económicos y redistributivos son en gran medida inconmensurables, cualitativos y tienen que ver con el bienestar de la sociedad. Modifican prioridades económicas y, por tanto, plantean intrincados problemas para la formulación y evaluación de programas de inversión en transportes. Puesto que los economistas no han sido elegidos por mandato popular para revelar las preferencias sociales, lo único que pueden hacer es indicar las consecuencias económicas de diferentes proposiciones, dejando librada a los políticos la selección definitiva [5].

Aun así, empero, la tarea de los economistas es importante, pues a ellos les toca idear programas de desarrollo alternativos que sean *eficaces*, partiendo de un conjunto casi infinito de posibilidades. Además, dado que la subestimación de un sector (como el del transporte), suponiendo condiciones *ceteris paribus* para los demás, puede significar costos en extremo elevados, esas ideas deben encuadrarse dentro de los límites de un marco de planificación integral. Por desgracia, esta clase de planificación resulta sumamente complicada.

Cómo se llega a un plan integral

El método para llegar a la planificación integral que a continuación se sugiere (y que, cabe admitirlo, es un tanto idealista) se vale de un proceso iterativo en seis etapas, que obliga a los planificadores del transporte y a otros planificadores a repetir una sucesión de análisis hasta dar con un

[5] En algunas ocasiones esto ha conducido a asignaciones que evidentemente no son óptimas desde un punto de vista económico. Sin embargo, es interesante advertir que aun en la sociedad soviética, tan estrictamente planificada, los costos económicos de oportunidad se subordinan a menudo a los objetivos políticos derivados de la planificación del transporte, cuando esos objetivos políticos entrañan grandes sacrificios económicos. (Véase la exposición de Holland Hunter sobre este fenómeno en el capítulo VII.)

conjunto de planes alternativos de acción a corto y a largo plazo que resulten satisfactorios. La opción entre estas alternativas se convierte entonces en una cuestión de criterio social y debe quedar en manos, por lo menos en las sociedades democráticas, de los representantes elegidos por el pueblo, con el asesoramiento de planificadores del desarrollo y otros expertos. Sin embargo, no estarán de más algunas observaciones preliminares antes de esbozar esta metodología.

Cabe reconocer desde el principio que un plan de desarrollo económico no debe ser otra cosa que un aspecto de un programa de gobierno encaminado a mejorar el bienestar nacional. Lo que este programa abarca es mucho más que la formulación y concreción de un plan de inversiones del sector público sobre la base de actividades del sector privado anticipadas y estimuladas. No basta con que el gobierno invierta en infraestructuras (viviendas, agua, energía, transporte, etc.) o para incrementar la capacidad de producción de artículos de primera necesidad. En general, el gobierno debe crear condiciones que favorezcan el desarrollo; debe despertar una conciencia de la potencialidad y ventajas del desarrollo, incitando al empleo eficaz de recursos y facilitando y estimulando las actividades económicas privadas. Además, aunque tal vez pueda resultar beneficioso un grado moderado de inflación, debe evitarse la inflación acelerada, que origina de por sí incertidumbre, distorsión en el empleo de recursos, especulación indebida, dificultades en la balanza de pagos y otros efectos que frenan el desarrollo. Por consiguiente, se recurrirá a una vasta gama de instrumentos normativos (financieros, monetarios, de importación, tarifas aduaneras, imposición directa e indirecta, transferencias, educación, etc.), aparte de las erogaciones, con el objeto de alcanzar un elevado coeficiente de crecimiento y la realización del potencial respectivo [6].

Aun disponiendo de todos estos medios, la formulación de normas *ideales* y su aplicación podrían resultar insuperablemente difíciles en muchos países, a causa de la escasez de información que sirva de base a las decisiones. Una de las primeras tareas de las naciones subdesarrolladas consiste en compilar estadísticas básicas nacionales (y regionales donde corresponda) sobre población, recursos, producción, precios, ingresos, distribución de la renta, ahorros, inversión, etc., de

[6] Las recomendaciones precedentes son comparables a las de Jan Tinbergen, *The Design of Development* (Johns Hopkins Press, 1958), pp. 3-8.

modo tal que puedan estimarse los cambios esperados y las mutuas relaciones estructurales entre estas variables. A falta de ello, no sólo resultará más incierto el trazado del desarrollo, sino que además será imposible evaluar los resultados de las medidas normativas. La simple determinación de que tal o cual efecto ha sido beneficioso no es prueba suficiente de que se hayan dado los pasos justificables o que por otro camino no se hubiesen logrado ventajas mayores. Es posible que el planificador o administrador que tiene un "complejo de avestruz" y basa sus conclusiones en conocimientos innecesariamente escasos haga más mal que bien a su país.

Esto es particularmente cierto en el primer paso del proceso de planificación, o sea la especificación de las metas. Las metas deben expresarse en términos de niveles mínimos y niveles deseados, y de coeficientes de crecimiento que han de lograrse en intervalos de cinco años a partir del momento actual hasta un horizonte de treinta o cuarenta años desde ahora. En parte, este largo plazo es necesario a fin de permitir la debida justificación de las principales inversiones en infraestructuras; y, lo que es aún más importante, es menester que así sea para que los cambios a largo plazo en cuanto a metas y a distribución regional de la población y de las actividades económicas puedan ser debidamente sopesados al formular programas de desarrollo a mediano plazo [5]. Las metas particulares que se deben especificar variarán de un país a otro. En general, abarcarán un diagrama cronológico para la realización de los objetivos vinculados con el producto nacional bruto, el ingreso *per cápita* y su distribución, la composición (y, en los casos de ciertos componentes, los valores mínimos) de la demanda y la producción finales, la distribución del ingreso y la producción por regiones, y algunos otros rubros de especial significado para una determinada nación.

Debe destacarse el carácter mínimo de estos deseos. El propósito de la planificación es maximizar el bienestar nacional, y se presume que esto equivale (o por lo menos se relaciona positivamente con ella) a la maximización del logro de

[5] Cuando cabe esperar que factores de plazo aún más largo que los incluidos en el horizonte de planificación (por ejemplo, necesidad de cuenca hidrográfica) puedan alterar apreciablemente los costos de oportunidad descontados, éstos, desde luego, también deben ser tomados en cuenta.

objetivos [6]. La función de las metas consiste en actuar como exigencias mínimas [7]. Independientemente del grado en que algunos objetivos sean trascendidos, todos ellos deben por lo menos ser alcanzados. En esencia, ello determina precios implícitos para ponderar las metas cuando algunas variables se vean forzadas a satisfacer aquellas exigencias. Por este motivo, las metas deben reflejar con precisión las preferencias sociales y ser fijadas en niveles alcanzables o por debajo de ellos. Las metas desconsideradamente altas, aunque pueden servir a un propósito de propaganda políticamente útil, perjudican la planificación, en vez de contribuir a su mayor eficacia. Si se trata de fijar metas razonables, deberá disponerse de abundante información acerca de las características y la capacidad de la economía [8].

Por supuesto, un conjunto de metas, si no se cuenta con medios que permitan materializarlas, es algo enteramente inútil. Por tanto, la segunda etapa del procedimiento de planificación consiste en integrar esos objetivos en un plan dinámico de desarrollo a largo plazo. Si bien es posible que existan algunas divergencias en los detalles, los conceptos que deberán aplicarse al formular este plan son en esencia idénticos a los utilizados por Lefeber en el capítulo VI. Aquí no hace falta modificarlos ni ampliarlos; el resultado final es el mismo: un vasto programa de utilización y asignación de recursos y producción entre las distintas industrias y entre las regiones a través del tiempo (hasta alcanzar el horizonte), capaz de rendir un conjunto óptimo de bienes y servicios utilizables en última instancia por la demanda [9].

[6] Metas destinadas a minimizar defectos indeseables pueden expresarse como problemas de maximización utilizando precios negativos; por ejemplo, asignando a los residuos industriales un precio negativo, un precio igual al de su eliminación.

[7] Dado que el bienestar puede declinar si se sobrepasan por un amplio margen determinadas metas, a veces pueden también especificarse restricciones máximas, es decir, el desiderátum debe hallarse dentro de una gama adecuada. Además, es posible que algunas metas sólo estén sujetas a una restricción máxima.

[8] Estas características e incapacidades entran en el proceso de planificación como restricciones adicionales. Aparte de los coeficientes técnicos, de producción, es posible que revistan especial importancia los factores de ahorros y financieros. (Véase capítulo XI, por Sadove y Fromm.)

Puesto que en las primeras etapas del desarrollo es probable que se importe un gran porcentaje de nuevas instalaciones para producción e insumos materiales, debe también prestarse mucha atención al sector extranjero, es decir, a las ganancias potenciales de divisas, contenido importado de la producción, balanza de pagos, préstamos y créditos a largo plazo, ayuda extranjera, etc.

[9] Como la incertidumbre y los requerimientos de datos son tan grandes al planificar para un período mayor de 40 años, el programa a largo plazo debe

Es evidente que los conjuntos de producción y de rendimiento de este programa deben satisfacer las exigencias de las metas y al mismo tiempo prever una maximización del producto económico. Por encima de esto, sin embargo, el plan dinámico de largo alcance debe cumplir también otras tres finalidades: 1) servir de norte para la fijación de otras pautas y políticas de desarrollo a largo plazo; 2) proveer el marco fundamental a largo plazo dentro del cual deben encuadrarse los planes a corto plazo, y 3) asegurar que estos últimos planes armonicen con los objetivos de desarrollo a largo plazo.

Los planes a mediano plazo representan el paso que sigue al proceso de planificación y constituyen el puente entre las acciones a corto plazo (por ejemplo, inversión en proyectos) y el programa a largo plazo. Si bien el plan de desarrollo a largo plazo determina en general las prescripciones para el mediano plazo, su alto grado de agregación lo hace insuficiente para orientar la política del período actual. Para la planificación a plazo mediano se requieren más detalles: el número de sectores industriales y sus correspondientes categorías de demanda final deben ampliarse a varios centenares; es posible también que se requiera un detalle mayor en lo regional. En segundo lugar, si bien el plan de largo alcance debe optimizar extensamente la utilización de recursos a largo plazo, no es suficientemente detallado ni preciso en lo que respecta al plazo corto. Por lo general, se hace caso omiso de los elementos transitorios, y ciertos efectos que se producen en los macrosectores no pueden ser tratados. Por consiguiente, se requiere un grado mayor de optimización. Por último, para maximizar el rendimiento y reducir las presiones inflacionarias, debe haber coherencia entre el empleo de recursos y la disponibilidad de éstos a corto plazo.

Aunque salta a la vista la necesidad de planificación a corto plazo para cumplir estos requisitos, la forma exacta que habrá de adoptar no es intuitivamente obvia. Teóricamente, debe utilizarse también el análisis de la actividad dinámica para la formulación de planes a mediano plazo; en la práctica, esto puede resultar difícil, siendo posible que baste como alter-

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ser bastante acumulativo y probablemente no debe contener más de 50 sectores y 6 regiones.

Cabe insistir en un punto: importa fundamentalmente que se tome en cuenta el impacto del cambio tecnológico continuado sobre las relaciones de la producción.

nativa una técnica aproximada. En vez de intentar la optimización de la función objetiva (es decir, la satisfacción de metas y la maximización del rendimiento) en un proceso de una sola etapa, tal vez sea más factible la planificación si se procede por pasos sucesivos. Ello podría hacerse mediante una serie de programas lineales de uno o dos años que abarcasen un lapso de cinco o seis años. El procedimiento consistiría entonces en imponer las condiciones iniciales y las especificaciones para el rendimiento del plan a largo plazo como exigencias del primer programa, dar entrada a toda la información adicional necesaria y tratar de buscar una solución eficaz [10]. Este mismo procedimiento puede luego repetirse para el próximo breve período, con las condiciones iniciales modificadas por la solución anterior. Cuando medie un conflicto entre las especificaciones para los planes a largo plazo y a corto plazo, deben predominar estas últimas [11].

Hay más problemas técnicos que deben resolverse al preparar la serie de programas lineales. Por ejemplo, el análisis de actividades tal como se formulan habitualmente no permite una aplicación alternativa a las distintas regiones. Sin embargo, dadas las variaciones geográficas y la dispersión de recursos, producción y mercados *dentro* de las regiones, es evidente que a ciertas regiones tal vez les convenga ser tanto importadoras como exportadoras de determinados artículos, especialmente en áreas cercanas a sus fronteras. En cierta medida, puede darse cabida a esto en el programa mediante la inclusión de subregiones en el conjunto regional y diferenciando arbitrariamente ciertos artículos que de lo contrario serían homogéneos [12]. Otra fuente de dificultades es la inestabilidad potencial de la programación de soluciones; pequeñas variacio-

[10] Salvo en lo que atañe a la interacción con el plan a largo plazo, en esta etapa el análisis es en esencia similar al de Mitchell Harwitz en el capítulo VIII. Para obtener los valores necesarios de años intermedios del plan de largo plazo que han de utilizarse en esta etapa se requiere algún tipo de interpolación; probablemente éste adoptará la forma de exponente.

[11] Después de sucesivas repeticiones de todo el procedimiento de planificación, no existirán discrepancias de esta clase, dado que se utilizan soluciones de corto plazo para reordenar el plan a plazo largo dentro del juego de metas establecido.

[12] Podría también señalarse que no toda la planificación regional debe forzosamente realizarse dentro de los límites de un grupo planificador central. La toma de decisiones por las personas de cargos más elevados, en los que se hacen las asignaciones básicas (a industrias y regiones) a nivel nacional, mientras que la planificación detallada se cumple en el nivel regional, es posible y resulta conveniente cuando las áreas geográficas regionales son extensas y existe pronunciada disparidad entre sus características. Sin embargo, es indispensable una realimentación entre los planes regional y nacional a fin de asegurar coherencia y optimización de objetivos generales.

nes en los precios o en las disponibilidades de recursos motivan grandes y rápidos cambios regionales y de composición en la producción. Estos hechos pueden impedirse introduciendo retrasos y frenos de reacción por inercia.

Aun con sus contramarchas, esta metodología de la programación presenta varias ventajas críticas en comparación con la técnica dinámica del insumo-producto de Leontief (caso simplificado y especial de programación lineal), utilizada normalmente en la planificación a mediano plazo. Pese a que ambas técnicas cumplen los requisitos de coherencia y verificación de recursos a que antes nos referíamos, el análisis de insumo-producto no optimiza la distribución de recursos porque no admite productos combinados ni procesos alternativos de producción con mezclas variables de insumos de mano de obra y de capital, ni una multiplicidad de tipos de recursos o exigencias de recursos diferenciales. Dadas sus mismas premisas muy restrictivas, el sistema de Leontief se "traba" en un punto estático eficaz o en una ruta dinámica, aun cuando otros programas eficientes sean posibles y más convenientes desde el punto de vista social [13]. Es obvio que la técnica más general, que da cabida tanto a la coherencia como a la posibilidad de opción, es la preferida a los fines de la planificación.

A esta altura, ya programados los planes a mediano plazo que determinan las capacidades de la industria y la producción por regiones, es menester complementarlos con los detalles relativos a aquellos sectores que han de estar sujetos a la intervención del gobierno. Es decir, el plan para cada industria se forja en términos generalizados de producción y capacidad, los cuales para que resulten útiles desde el punto de vista operativo, deben traducirse en productos separados y distintos, en tipos particulares de capacidades y en localizaciones precisas. En cuanto al transporte, esto exige que los tipos y volúmenes potenciales de tráfico sean trasladados de un punto a otro, y que se asegure la aptitud de las instalaciones (básicas y terminales) y del equipo operativo para el transporte de esas cargas. Entonces se podrán formular proyectos destinados a eliminar todas las deficiencias de capacidad. En estas especificaciones deberán tomarse en cuenta las características económicas de los diferentes tipos de transporte (descritos por

[13] Para una crítica excelente de la programación lineal contrastada con el análisis de insumo-producto, véase R. Dorfman, P. A. Samuelson, y R. M. Solow, *Linear Programming and Economic Analysis* (McGraw-Hill, 1958).

Richard Heflebower en el capítulo III), las posibilidades tecnológicas actuales y futuras (véase el capítulo IV, por Wilfred Owen), y una gran cantidad de consideraciones sobre el trazado del plan (véase Gary Fromm, capítulo V). También, por supuesto, esta planificación debe hacerse sobre la base de un sistema: ha de contemplarse todo el sector del transporte, no solamente determinados servicios o instalaciones.

La evaluación de costos-beneficios de estas inversiones potenciales y la determinación de si en verdad deben realizarse constituyen la cuarta etapa del proceso de planificación. Puesto que el tema ha sido desarrollado con mucho detalle en otros trabajos y expuesto por Hans Adler en el capítulo IX, es innecesario detenernos aquí más tiempo en él [14].

La quinta etapa del proceso de planificación tiene que ver con elementos que no pueden introducirse expresamente en estos análisis [15]. Se trata de efectos económicos indirectos que todavía no se han tomado en cuenta, y factores sociales y políticos que podrían limitar el grado de firmeza con que pueden utilizarse los análisis anteriores en la especificación de proyectos y trazado de planes de alcance nacional a largo y mediano plazo. Estos elementos deben ser identificados, medidos hasta donde sea posible dacerlo y puestos en lista como apéndice a los documentos de la planificación. Como consecuencia de la combinación de estos elementos con los datos del plan, se modificará el trazado para determinados sectores. También deberán hacerse las asignaciones por regiones, balanceando las demandas de "participación equitativa" en los recursos y producto del desarrollo, con el objetivo de maximizar el ingreso nacional dentro de un horizonte de tiempo determinado. Por participación equitativa se entiende en este caso no sólo la cantidad de bienes y servicios, sino también su calidad. Así, por ejemplo, deben tomarse en cuenta tanto las demandas políticas como económicas de transporte. Tal vez económicamente convenga mantener caminos llenos de baches y rodadas en una región, mientras en todas las demás se pavi-

[14] Un ejemplo de la aplicación de estas técnicas se puede encontrar en el análisis que hace Robert T. Brown de las decisiones tomadas en Chile en materia de ferrocarriles (capítulo XII).

[15] Esto vale particularmente para sectores tales como la salud y la educación, cuyas producciones no son en su mayor parte insumos directos para otros sectores y que sirven para modificar la distribución del bienestar entre sectores de la población. En estos casos la asignación de recursos a su respectiva producción es algo arbitraria y depende en grado considerable de la especificación de metas y del proceso político.

mentan supercarreteras, pero políticamente ésa puede ser una medida que no tiene en cuenta la realidad. Sin embargo, estas decisiones no deben ser tomadas por los planificadores, sino por los representantes elegidos por el pueblo.

Por otra parte, antes que el poder ejecutivo y la legislatura se vean abocados a una decisión de esta índole, será necesario haber completado el proceso de planificación. Tal es la función de la sexta y última etapa de la planificación. Dos son las tareas por cumplir: en primer lugar, deben armonizarse entre sí los diversos resultados de las etapas anteriores y los diversos planes sectoriales; en segundo lugar, se debe preparar un conjunto de programas alternativos de desarrollo. Ambas funciones pueden cumplirse repitiendo completamente las etapas anteriores de planificación, introduciendo ajustes marginales para asegurar cierta coherencia y las alternaciones necesarias en la combinación y especificación de metas y otras asignaciones que permitan contar con un espectro de diferentes planes óptimos y subconjuntos de planes entre los cuales puedan hacer su elección los políticos [16].

Es imposible precisar a priori el número de repeticiones que harán falta para lograr un conjunto razonable de alternativas importantes (cada una de las cuales debe ser coherente dentro del conjunto). Su magnitud dependerá del detalle y cuidado con que se haya emprendido la repetición inicial, la complejidad de la economía en cuanto a variabilidad de posibilidades de producción, disponibilidades de recursos y dispersión geográfica, y la importancia de las consideraciones sociales y políticas respecto de los factores económicos. De todos modos, es probable que el esfuerzo requerido sea considerable.

En sí y de por sí, ello podría provocar resistencia contra la adopción de un procedimiento de planificación tan vasto como él que acaba de esbozarse. Además, a menudo es cierto que nada suscita tan tenaz oposición como aquello que menos se entiende. No cabe duda de que el método propuesto de planificación resulta complejo, su utilización presupondría grandes esfuerzos para la compilación y análisis de datos, y su puesta en marcha requeriría economistas e ingenieros muy capacitados, de los cuales hay una extrema escasez. Otra imperfección del método se debe a que habrá lagunas e inexactitudes en los datos, problemas estadísticos en la formación de conjuntos, una multitud de premisas simplistas y un sinnúmero de otras dificultades. Con todo, los otros métodos a que puede recurrirse como alternativa (y que necesariamente utilizan los mismos datos) presentan un cuadro todavía menos alentador, no en la metodología misma, que es sencilla, sino en sus resultados.

[16] En términos técnicos, el objetivo de este proceso consiste en determinar el conjunto fronterizo de eficiencia y su trazado en el horizonte dentro del ámbito pertinente de la función de bienestar social.

La planificación, tal como se la practica hoy en la mayoría de las naciones subdesarrolladas, consiste casi por completo en el intento de adoptar medidas convenientes a corto plazo. En algunas ocasiones se proponen metas a plazo largo o mediano; éstas pueden incluso consistir en un "plan quinquenal", formulado sobre una base de insumo-producto. No obstante, rara vez se practica la optimización de objetivos a plazo mediano o largo, y sobre todo se hace hincapié en proyectos individuales destinados a satisfacer necesidades inmediatas. Tal como ya lo han demostrado numerosos ejemplos, esta suboptimización puede traducirse en enormes pérdidas de oportunidades de desarrollo. A decir verdad, el análisis de proyectos es una de las piedras angulares de la planificación eficaz, pero cuando se lo emplea solo, a menudo acarrea consecuencias poco satisfactorias. Por tanto, se lo debe complementar con informaciones adicionales y otras técnicas que proporcionen pautas de acción a largo plazo. Ésta es la función que se atribuye al procedimiento en seis etapas. No obstante los costos y las imperfecciones del procedimiento, éste debe contribuir a decisiones más inteligentes y a un bienestar nacional mayor que el que se logra con los métodos de planificación actuales, no sustituyendo al análisis de proyectos, sino complementándolo.

Es necesario responder a tres grupos de críticos potenciales: 1) los representantes elegidos y los jefes de gobierno que educen que la intervención de los planificadores conspira contra sus prerrogativas en materia de fijación de normas económicas; 2) los empresarios que creen que la planificación destruye la libre empresa al restringir sus actos y disminuir sus ganancias; 3) los economistas que piensan que, provocando escaseces o superabundancias mediante un crecimiento desequilibrado, se estimula una tasa máxima de aumento del producto nacional bruto. De estos recelos contra la planificación nos ocuparemos por orden.

Los temores de los políticos carecen de fundamento en absoluto, pues sólo a ellos, en casi todos los países, se les concede la facultad de legislar y aprobar (o rechazar) programas de acción y asignar fondos. Los planificadores se concretan a cumplir una función de cuerpo subordinado, toda vez que trabajan bajo la dirección de aquéllos, ayudándolos a tomar mejores decisiones.

Es vana también, en gran medida, la alarma de los empresarios. La planificación tiene por objeto lograr el máximo aumento del producto real *per cápita* a tono con otros objetivos de bienestar social. Salvo pocas excepciones, se estimula y se ayuda la iniciativa privada, la actividad productiva y la eficiencia, dado que las metas de los planificadores exigen una mayor producción y más elevadas ganancias absolutas en todos los sectores. Con miras a este fin, a menudo se provee una infraestructura bajo la forma de transportes, energía, viviendas, obras sanitarias, etc.; varios países han concedido asimismo exenciones impositivas a los nuevos establecimientos fabriles. Es verdad, sin embargo, que la planificación incluye una revisión cuidadora de la economía y, por tanto, tiende a concentrar la atención en ciertas aberraciones y desigualdades que de lo contrario pasarían inadvertidas y no se corregirían. Así, es posible limitar o impedir beneficios especulativos exorbitantes de la tenencia de tierras o de la explotación de minerales y otros recursos naturales, especialmente si pertenecen a propietarios extranjeros.

También se da el caso de que los planes y políticas de desarrollo de un país pueden resultar restrictivos para ciertas industrias, sobre todo en lo que se refiere a fijación de precios o decisiones relativas a la expansión de capacidad. En algunas ocasiones ciertas empresas se ven obligadas a hacer cosas que voluntariamente no hubiesen hecho. No obstante, debe recordarse que, en parte, los planes de desarrollo se estructuran a partir de actitudes adoptadas anticipadamente por el sector privado. Su objetivo no es centralizar la toma de decisiones ni el control de las actividades en cada microcosmos, sino más bien formular un conjunto de pautas de acción mediante las cuales se confía en que se maximizarán el ingreso y la producción, y se minimizarán las pérdidas económicas, por ejemplo un exceso indeseable de capacidad. A medida que estos esfuerzos en pro del desarrollo vayan surtiendo efecto, irán ampliándose los mercados internos y aumentará la demanda efectiva dentro del país, acrecentándose así las ventas y ganancias. En realidad, las empresas que hacen hincapié en el

desarrollo tienen poco que temer y mucho que ganar con la planificación; pero es posible que se vean en dificultades aquellas que esperan ganancias injustificadas e inesperadas, o beneficios monopolistas, a expensas del bienestar social.

Estas opiniones parecen todavía menos extremas si se tiene en cuenta que casi todos los países industrializados utilizan algún tipo de planificación (y limitan las prácticas abusivas) en la conducción de sus políticas económicas. Es interesante destacar que ninguno de esos países ha empleado intencionalmente la técnica del crecimiento desequilibrado (escasez-superabundancia) invocada por algunos economistas [17]. Este proceso lleva implícito el concepto del uso del desequilibrio como fuerza impulsora (por ejemplo, al provocar una superabundancia o al mantener una escasez de la capacidad del transporte), de acuerdo con las ganancias privadas y las presiones políticas oficiales (y también los efectos de demostración) provenientes de economías y complementaciones externas destinadas a estimular nuevas inversiones y una mayor producción. Se ignora si en realidad tales desequilibrios generan incentivos lo bastante poderosos como para originar un mayor incremento de ahorros, erogaciones de capital y producción dentro de este tipo de crecimiento desequilibrado. De todos modos, no resulta afectada la validez de la metodología de programación anteriormente descrita, puesto que se puede tomar en cuenta la secuencia de los efectos inducidos [18]. Sea como fuere, esto exige que los partidarios del crecimiento desequilibrado inducido cuantifiquen su técnica: sin parámetros, todas las consecuencias de las brechas y lagunas entre la producción deseada y la real son en gran medida problemáticas.

Planificación de las inversiones en transportes

La planificación de las inversiones en el transporte es tarea difícil, ya sea que se la encare como parte integrante de aná-

[17] Por ejemplo, A. O. Hirschman, *The Strategy of Economic Development* (Yale University Press, 1958). [hay trad.: *La estrategia del desarrollo económico*, México, Fondo de Cultura Económica, 2ª ed., 1964].

[18] La programación de la forma dinámica no presupone un grado especial de equilibrio o desequilibrio. No obstante, dada la mutabilidad de las metas, las restricciones por inercia o retrasos en el tiempo y las condiciones de desequilibrio inicial de las situaciones "del mundo real", es fácil que las soluciones en materia de planificación pertenezcan al tipo caracterizado por el desequilibrio.

lisis completos del tipo que acabamos de esbozar, o que se la sitúe en el medio más tradicional de la suboptimización de un sector determinado. Los trabajos a que se hace referencia a continuación describen algunos de los elementos y problemas que surgen cuando se trata de asignar idealmente al transporte una parte de los recursos destinados al desarrollo.

El ensayo de Hans Heymann se ocupa de los objetivos del transporte dentro del desarrollo económico y menciona en particular las dificultades que las metas y efectos no económicos plantean al elegir entre distintas inversiones. En el capítulo III, Richard B. Heflebower examina las características económicas de medios alternativos de transporte (economías de escala, intensidad de capital, flexibilidad, etc.), que tan marcadamente influyen en la elección entre distintas inversiones para el transporte. En el capítulo siguiente, Wilfred Owen señala el impacto de los cambios tecnológicos sobre los medios de transporte y describe algunas posibilidades futuras de reducir los costos de traslado y de incrementar la movilidad.

En el capítulo V se habla de la planificación del sector transporte en función de un plan de desarrollo económico y se exponen algunos de los problemas singulares con que se tropieza en la preparación de un programa de inversiones. La manera de alcanzar el desarrollo económico máximo y un crecimiento regional equilibrado es el tema del ensayo de Louis Lefeber, que esboza un modelo completo y dinámico de planificación y comenta sus derivaciones en materia de políticas de salarios, precios, regiones y transporte. La reseña que Holland Hunter hace a continuación del papel del transporte en el progreso de la Unión Soviética destaca la impracticabilidad de subestimar un eficiente desarrollo del transporte para dar prioridad a fines políticos. Este autor llega a la conclusión de que la aplicación de técnicas de programación lineal regional del tipo propuesto por Mitchell Harwitz en el capítulo VIII debe permitir que los países actualmente en evolución y la U.R.S.S. planifiquen y regulen el proceso de desarrollo en forma menos inhumana y con menos despilfarro de recursos que en el pasado.

Sin embargo, la programación no puede por sí sola dar la pauta de la conveniencia de tales o cuales inversiones consideradas individualmente. Así, pues, el capítulo de Hans Adler está dedicado a ofrecer una descripción del método de evaluación de costos-beneficios, como instrumento para fijar prioridades en favor de proyectos de transporte. La política de precios de los servicios de transporte que de allí resulte es un asunto que justifica cierta preocupación, puesto que no sólo afecta a la distribución de ventajas entre los diferentes usuarios, sino que puede también implicar subsidios extraídos de fuentes de rentas generales del gobierno. En el capítulo X James R. Nelson explora las consecuencias de diferentes esquemas de precios y propone un plan de débitos en partes múltiples para obtener una recuperación total de los costos. Por supuesto, entre la determinación de precios y la financiación del transporte existe una relación estrecha. Un estudio inadecuado de las necesidades de financiación puede acarrear graves consecuencias para la disponibilidad de fondos públicos de inversión y dar lugar a presiones inflacionarias, tema del cual se ocupan A. Robert Sadove y el presente autor en el capítulo XI. Por último, para ilustrar los principios utilizados en la evaluación de proyectos, determinación de precios y financiación de las erogaciones en transportes, el examen que Robert T. Brown hace de la "decisión sobre ferrocarriles" en Chile tiene el carácter de un estudio de casos. Sigue una bibliografía selecta preparada por la señora Warden.

Estas breves excursiones preliminares por los diversos aspectos de la inversión en transporte y del desarrollo económico ofrecen respuestas, que distan mucho de ser definitivas, a las múltiples cuestiones y problemas relacionados con la asignación ideal de recursos al sector transporte. Sin embargo, se confía en que el lector podrá formarse una apreciación de las cuestiones generales y de algunas cuestiones menudas, y se sentirá estimulado a acrecentar sus conocimientos en este campo.

V

PLANIFICACION DEL SECTOR TRANSPORTE

Gary Fromm *

Estimular el desarrollo económico sin planificación es como querer llegar a puerto con un barco que carece de timón. Si una nación recién formada debe incrementar la tasa de realización de su potencial humano y material, normalmente tendrá que establecer un marco óptimo para actividades económicas tanto privadas como públicas. Pese a las opiniones de Adam Smith y Thomas Jefferson, el apoyarse en el mercado, fuerzas políticas e intuición de los legisladores, rara vez garantizará un rápido crecimiento y prosperidad en economías inmaduras. Antes que sea posible materializar políticas económicas ideales, se requiere un plan de desarrollo. Este plan debe abarcar objetivos finales mínimos de demanda, capacidades de producción, requisitos de producción intermedia y otras limitaciones sobre la base de un sector dinámico nacional, regional e industrial. Desde luego, el desarrollo económico no depende *per se* de la planificación. Tampoco es ésta una panacea que cure todos los males económicos; a decir verdad, se la puede exagerar, impidiendo con ello un desarrollo alcanzable. No obstante, las consecuencias sociales y económicas del desarrollo se pueden mejorar en grado considerable con una planificación inteligente.

Un plan de desarrollo es la suma y el producto de sus

* The Brookings Institution.

partes; cada sector depende de todos los demás, y el conjunto de todos ellos depende de cada uno. No obstante, sobre cada sector influyen también factores singulares que no se relacionan con las fuerzas que chocan con los demás. Así, por ejemplo, el sector transporte debe ser planeado coincidentemente con otros sectores de desarrollo a los que el transporte tiene que ayudar y promover. Sin embargo, también se lo debe estructurar parcialmente partiendo de determinados hechos económicos, políticos y sociales, y tendencias de la economía nacional.

Esto implica que de una u otra manera deberá predeterminarse un esquema de distribución de recursos entre las diversas partes del sector transporte; que la relación entre inversiones en caminos, ferrocarriles, puertos o instalaciones para el transporte aéreo deberá tener en sí misma alguna validez o que en una determinada etapa del desarrollo se requerirá un plan de inversiones en ciertos tipos de elementos. A su vez, este plan surge de la necesidad de integración de las partes del sector transporte y las metas del plan general de desarrollo. Lamentablemente, salvo las características tecnológicas, los planes para inversiones en transportes de un país dado no pueden servir mayormente de guía para otros países. El hecho de que existan marcadas diferencias entre las extensiones y formaciones de los terrenos; diferencias de organización y distribución demográficas, sociales y económicas; distintas etapas de industrialización; inversiones previas y atención prestada anteriormente a la conservación; dependencia del comercio exterior, así como disparidad de metas nacionales; todo ello excluye la posibilidad de una norma universal para la asignación de recursos a las inversiones destinadas al transporte, y no debe hacerse nada por procurarla [1]. Por otra parte, dado que un plan de desarrollo es una combinación de sectores, mientras que un sector es una función de proyectos separados entre sí, desde el principio debe procederse a una atenta evaluación de

[1] Mucho es sin duda lo que se puede conocer a través de un examen rápido de las experiencias relativas a las inversiones en transportes y el crecimiento en países desarrollados y en países en proceso de desarrollo. No obstante, parece injustificada la conclusión a que llega Tinbergen de que las inversiones en transportes públicos y privados absorben constante y *adecuadamente* entre el 20 y el 25 por ciento del total de desembolsos brutos de capital. (Jan Tinbergen, *The Design of Development*, Johns Hopkins Press, 1958, p. 31.) No sólo estos límites de porcentajes carecen de toda significación normativa *per se*, sino que, además, las propias estadísticas de Tinbergen (*ibid.*, pp. 90-91) y las del Banco Internacional de Reconstrucción y Fomento ponen de manifiesto muchos casos que están fuera de tales límites.

los proyectos. El mérito de cualquier proyecto depende de una gran cantidad de factores complementarios y en conflicto. Todos ellos deben ser tomados en cuenta y contrapesados debidamente al asignar prioridades a los diversos proyectos [2].

Factores comunes en la planificación sectorial

El factor primordial común a todos los sectores en la planificación de desarrollo es la determinación del rendimiento económico (y otros efectos sociales) de los proyectos en términos de costos y beneficios. En otras palabras, los costos de inversión, conservación y explotación de los proyectos deben compararse con los beneficios computables de las inversiones. (Véanse los métodos propuestos por Hans A. Adler en el capítulo IX.) Sin embargo, subsiste una evidente perplejidad. Puesto que los beneficios provenientes de los transportes a menudo son más indirectos que directos, resulta sumamente difícil cuantificarlos. Sobre todo en el caso de los caminos, no es fácil computar los beneficios totales en términos de valor de los ingresos, valor agregado, o inclusive cantidad de productos, como en el caso de las decisiones relativas a inversiones industriales.

Política en materia de beneficios y precios

Además, la demanda que debe satisfacerse y los beneficios que han de derivarse de ello no son a menudo entidades fijas ni independientes entre sí, dado que la demanda dependerá en parte de una política de precios. La política de precios implantada por el gobierno, tal vez indeterminada durante el período de planificación, no sólo influye en la demanda total de instalaciones y servicios, sino que también puede originar beneficios indirectos diferentes para diversas industrias y ramas de comercio afectadas. Esto se traduce en nuevas dificultades para el cálculo de beneficios [3].

[2] Esto no implica desconocer que los proyectos deben examinarse a la luz de una red integral de transportes, ni subestimar la importancia de las reformas administrativas o las alternativas intersectoriales (por ejemplo, entre inversiones en transportes y comunicaciones, o entre transportes y bienes de inventario). Estas cuestiones serán tratadas más adelante.

[3] Esto presupone que actúan elementos oligopolistas en la economía y que el gobierno no impone (ni podría hacerlo aunque lo quisiera) relaciones de precio que tengan aplicabilidad en condiciones puramente competitivas (y, por lo tanto, susceptibles de determinación endógena).

Los problemas con que se tropieza al analizar el proyecto de un nuevo puerto en una zona aislada y subdesarrollada de una nación que empieza a surgir ejemplificarán algunas de las situaciones del caso. Los beneficios internos directos que habrán de obtenerse de la construcción del puerto y los costos portuarios más bajos se pueden calcular en términos de ingresos del puerto resultantes del tráfico actual, así como del que ha de desviarse desde otros medios de transporte. También es posible estimar ingresos internos adicionales de ese puerto (pero en forma mucho menos definitiva), a raíz del tráfico proveniente de nuevas industrias que los bajos costos de transporte harán factibles desde el punto de vista económico. Sin embargo, los beneficios económicos del puerto no se limitan a las economías reflejadas en esos flujos de rentas internas del puerto. Por ejemplo, si el nivel de los aranceles portuarios cobrados a una industria de exportación está por debajo de lo que esa industria pagaba anteriormente, habrá economías y beneficios portuarios externos bajo la forma de más elevadas utilidades para esa industria de exportación. Por supuesto, un aumento de los aranceles portuarios podría hacer que esos beneficios externos pasasen a formar parte de los beneficios portuarios internos; en tal caso se traducirían en mayores ingresos para el puerto. De igual manera, los beneficios externos obtenidos por las compañías navieras debido a mejores facilidades portuarias (menor tiempo empleado en maniobras, etc.) pueden o no reflejarse en tarifas más bajas y volúmenes mayores de fletes. Así, pues, la política de determinación de precios (oficial y privada) influye en la distribución de beneficios provenientes de la instalación, pero también afecta, a través de las elasticidades de la demanda, al tráfico total y a los beneficios totales a que dará origen la inversión.

Esto no es un problema de evaluación exclusivo del transporte, ni se lo puede eludir con sólo dar por sentado que la mera competencia, basada en los rendimientos constantes y decrecientes en escala, y la determinación de precios según costos marginales aparecen en todas partes en la economía. El mundo real es, de hecho, imperfecto. Las economías de escala, los elementos monopolistas de la empresa privada, la previsión insuficiente y otras aberraciones, todo ello motivará desviaciones de los precios de mercado que habrían prevalecido en un marco ideal. El uso de precios imaginarios (*shadow prices*) en lugar de precios de mercado (véase el capítulo escrito por Louis Lefeber) aliviará algunas de las dificultades de medición de beneficios originadas en las imperfecciones del mercado, pero no todas; su adopción contribuirá también a cuantificar los efectos externos sobre el desarrollo.

Efectos externos sobre el desarrollo

Las inversiones en transporte y en otros campos cumplen a menudo una función doble: desempeñan un papel pasivo y un papel dinámico en el proceso del desarrollo. El sector transporte es pasivo en cuanto a la satisfacción de las demandas previsibles actuales e inmediatas de la agricultura, industria y comercio. Es dinámico en cuanto altera las relaciones de precios relativos entre factores de producción (reduciendo los costos de distribución gracias a la instalación de puertos, construcción de carreteras, oleoductos, etc.), con lo cual facilita la explotación de recursos poco o nada utilizados. También el mejoramiento del transporte puede contribuir a una mayor expansión de la economía de mercado, del espíritu empresario y de los ahorros privados e inversiones en actividades productivas.

Sin embargo, es difícil, si no imposible, determinar el alcance de este estímulo dinámico a la producción. Asignar un valor a estos efectos externos sobre el desarrollo es aún más azaroso que adjudicarlos a proyectos o sectores determinados. No sólo es posible que una porción importante de tales beneficios se hubiera producido sin las nuevas instalaciones, sino que, cuando se utilizan los precios imaginarios y se admiten posibilidades de sustitución, puede a veces ocurrir que su beneficio neto sea pequeño, si no negativo. Esto no equivale a decir que los efectos beneficiosos sean imaginarios; en realidad, a menudo son tangibles y considerables. No obstante, en la mayoría de los casos, sobre todo cuando el estímulo del transporte al desarrollo parece insignificante y los efectos problemáticos, esos beneficios deben clasificarse junto con otros factores económicos no cuantificables, que han de ser identificados y evaluados hasta donde sea factible, incluyéndolos en la evaluación de costos y beneficios del proyecto como un agregado[4]. Cuando varios proyectos tienen efectos externos e interdependientes sobre los beneficios o los costos, se los debe evaluar, desde luego,

[4] Es evidente que también deben tomarse en cuenta los efectos endógenos sobre el aspecto costos. Por ejemplo, el uso oportuno de divisas escasas merece cuidadosa atención.

como grupo y también independientemente. Esto internalizará algunos de los efectos externos.

Planes sectoriales y bienestar nacional

Otro factor común en la formulación de planes sectoriales es su impacto sobre la distribución del ingreso entre grupos y renglones (incluso urbanos versus rurales) dentro del país. El emplazamiento y el tipo de inversión en instalaciones generales productivas y sociales, aunque hayan sido planificados con miras a que sean eficientes por razones económicas, es posible que provoquen un descenso relativo, si no absoluto, del bienestar de algunos sectores de la población. Estos cambios pueden ser o no convenientes desde el punto de vista del bienestar social. Podría suponerse que los planes económicos adoptados fuesen los más eficaces y que las injusticias en perjuicio de determinados grupos o regiones se corrigiesen fácilmente mediante una apropiada política de impuestos y transferencias. Empero, no ocurre necesariamente así en un país subdesarrollado, trabado por grupos que responden a fuertes intereses creados, por la falta de datos indispensables y de personal adiestrado, y por una administración impositiva deficiente. Tal vez haga falta introducir una que otra modificación en esos planes "eficientes", a fin de compensar posibles efectos indeseables sobre la distribución del ingreso.

Las desigualdades regionales en cuanto al ingreso afectan no sólo al bienestar, sino también a la unidad nacional. Aun sin esas desigualdades, la estabilidad política sufre cuando los lazos económicos, las comunicaciones y el transporte son limitados y cuando en la población hay sectores no cohesivos. Esta inestabilidad puede conducir a un desbarajuste o a un derrocamiento rápido de los gobiernos (a veces por medios revolucionarios) y retrasar la actividad económica. En consecuencia, tanto por razones económicas como políticas es posible que a ciertos proyectos de transporte se les asigne una alta prioridad en el presupuesto de inversiones, debido a que tienden a fortalecer los lazos nacionales al vincular regiones aisladas con el resto del país.

Ceteris paribus, puede ocurrir que algunas inversiones gocen también de preferencia en virtud de su contribución a la defensa y la seguridad nacionales. Por lo común, sin embargo, debe evitarse la justificación de desembolsos para elementos productivos y facilidades de transporte sobre la base de razones logísticas u otras de índole militar, a menos que satisfagan un requisito definido de la defensa. Lo contrario sería sacrificar eficiencia económica por motivos chauvinistas.

Por último, deben tomarse en cuenta otros factores sociales. La destrucción de vistas panorámicas o lugares históricos; la bastardización de la cultura y las costumbres locales; la sustitución de la serenidad de la naturaleza por el apresuramiento, el bullicio y la contaminación del aire y de los cursos de agua, todo ello es parte del precio que a menudo se paga por acelerar el ritmo del desarrollo y por "elevar" el nivel de vida. Según sean su densidad de población y sus características climáticas, geográficas y agrícolas, una nación puede no ser indiferente a la pérdida de activos naturales y valores sociales.

Los problemas que se han comentado son comunes a todos los sectores de la planificación del desarrollo. Sin embargo, en el planeamiento del sector transporte intervienen varias características propias. Estas características no se destacan tanto por su índole exclusiva, como por la singularidad de su alcance. Aunque también se las encuentra en otros sectores, plantean problemas particulares al planificador del transporte.

Rasgos distintivos de la planificación del transporte

No hay duda alguna de que la vigilancia pública es una de las dificultades que se presentan en los transportes. El sector transporte y las decisiones sobre su planificación son probablemente objeto de un escrutinio más atento por parte del público y los políticos que otros sectores. Además de exigir la parte del león en los recursos de inversión, los proyectos de instalaciones básicas del transporte son primordialmente inversiones públicas; por lo general el sector privado no puede o no quiere hacerlas, a pesar de que éstas afectan vitalmente las decisiones relativas a inversión privada así como los intereses regionales representados por los políticos [5]. Por otra

[5] La buena disposición del sector privado a emprender inversiones en infraestructuras, a falta de intervención del gobierno, depende de la renuencia de las empresas a correr riesgos y de los valores y variantes que se esperan en las tasas de rendimiento. En lugares donde los riesgos son grandes, debido a las in-

parte, estos proyectos son comúnmente visibles y afectan a grandes grupos que pueden fácilmente formular y expresar juicios sobre los servicios y su uso.

Carácter global de las inversiones en transportes

Otra fuente de dificultades es también el hecho de que las decisiones relativas a inversiones en este campo son globales, puesto que las funciones de la oferta en relación con la capacidad del transporte no son continuas. Si se trata de invertir para la expansión de un ferrocarril, esta expansión debe cumplirse en su totalidad a fin de que sea posible obtener beneficios importantes; es menester que un camino esté construido entre los dos puntos extremos para que su utilidad sea apreciable; un aeropuerto destinado a un importante tráfico internacional tiene que estar terminado para que se adapte a los grandes aviones de chorro.

Hay también requisitos de inversión suplementaria o complementaria que refuerzan este carácter de "globalidad" de muchos proyectos relativos a instalaciones para transportes. Es posible que un nuevo puerto de aguas profundas proyectado con un costo de 20 millones de dólares sólo pueda justificarse si simultáneamente se construye una red de caminos que unan el puerto con el interior del país y cuyo costo por lo menos sea igual al del puerto mismo. Por supuesto, este carácter global no es exclusivo del sector transportes; sobre otros sectores pesa también a veces la necesidad de llegar a una capacidad excesiva, si se quiere contar con una capacidad utilizable de algún modo. En las naciones nuevas más pequeñas, sin embargo, las grandes necesidades de capital que origina este ca-

gentes necesidades de capital y a la incertidumbre de la demanda, puede ocurrir que las compañías privadas inviertan únicamente si existe la posibilidad de ejercer un control monopolista, si es posible cobrar tarifas más elevadas que las competitivas y si pueden obtenerse beneficios extranormales. En el caso de proyectos de infraestructura, especialmente cuando intervienen intereses extranjeros, puede ocurrir que estos requisitos sean inaceptables por razones de índole política e inconvenientes en sentido económico, dando así lugar a la inversión gubernamental directa o a reglamentaciones que aseguren adecuadas condiciones del servicio, precios "razonables" y mínimo desperdicio de capacidad. Si se adopta el temperamento regulador, es posible que entonces se requieran garantías de ciertas tasas de rendimiento y seguridad contra la nacionalización a fin de fomentar inversiones privadas en infraestructuras.

rácter global de las inversiones en transportes pueden resultar especialmente gravosas.

Problemas de tiempo y espacio

Al asociarse el carácter global con otros dos problemas relacionados entre sí, las proyecciones a largo plazo y la necesidad de una especificidad regional causan dificultades nuevas. Probablemente la vida física o económica de los proyectos de transporte no sea superior a la de las inversiones realizadas en muchos otros sectores. Cabe esperar que los equipos rindan *económicamente* durante 10 a 20 años, mientras que las instalaciones básicas (vías férreas, asientos de los durmientes, pistas, puertos, aeropuertos, etc.), si se las conserva, no se conviertan en económicamente obsoletas debido a desplazamientos de la población o alteraciones de las características regionales de la producción durante 20 a 40 años, o aún más [6].

Esta vida larga no plantearía ningún problema, de no ser por el carácter global de la inversión. Dicho en otras palabras, la satisfacción de las demandas actuales de transporte crea automáticamente una capacidad excesiva aplicable a la satisfacción de necesidades futuras. Así, por ejemplo, los servicios provistos actualmente afectan a los costos futuros del transporte; una consideración insuficiente de las necesidades futuras y una equivocada especificación de las capacidades actuales pueden originar un derroche de recursos el día de mañana. Debe advertirse que estas capacidades no son rubros en abstracto; deben ser instalaciones concretas, en lugares específicos,

[6] Tal vez el progreso tecnológico futuro acorte apreciablemente este plazo al provocar una obsolescencia económica más rápida en los diversos medios de transporte. Los camiones más pesados y los motores diésel determinaron que resultasen anticuados los firmes de vías férreas y caminos; los buques de mayor tonelaje de peso muerto hacen que ciertos puertos resulten inadecuados; y las características más modernas y la mayor amplitud de los medios de transporte aéreo internacional, con sus nuevos patrones de seguridad, motivan que la previsión de ayer en materia de diseño de aeropuertos se convierta en falta de previsión adecuada. No obstante, aunque estos progresos determinen que sean deficientes o caigan en desuso construcciones de fecha anterior, lo común es que no motiven una pérdida de valor de las servidumbres.

Por supuesto, la vida física del equipo y las instalaciones fundamentales puede ser mucho más larga que su vida económica. Todavía en nuestros días es posible encontrar vagones de carga de 1910 que siguen en uso. Que desde el punto de vista de la eficiencia operativa se justifique utilizarlos, parece algo sumamente dudoso.

destinadas a atender niveles y tipos concretos de movimiento de cargas y pasajeros durante un mínimo de 10 a 20 años.

La planificación a largo plazo en la industria o la agricultura rara vez se traza de una manera que el economista especializado en transportes pueda utilizar en esa perspectiva de tiempo. En la planificación a largo plazo en el sector industrial puede muy bien anticiparse y especificarse una lista bastante detallada de industrias que deberán desarrollarse, pero por lo general sin indicar la naturaleza de las necesidades derivadas en materia de transporte. A menudo los planes formulados en el sector industrial, sobre todo en el campo de la empresa privada, hacen hincapié en la utilización de facilidades de crédito para estimular la iniciativa privada, contribuyendo así a la vaguedad en cuanto al diagrama cronológico y localización del nuevo desarrollo industrial.

Análogamente, la planificación a largo plazo en la agricultura se ha limitado por lo común a señalar metas de producción clasificadas por tipos de alimentos y formas de aumentar la producción con ayuda de programas de semillas, fertilizantes, mecanización, riego y crédito. Ni siquiera para corto plazo, y con mayor razón para largo plazo, es fácil traducir estos programas en necesidades de transporte.

Frente al problema de planificar geográficamente de una manera muy concreta y mucho más allá del plazo para el cual hacen sus planes la industria y la agricultura, y teniendo aun así que resolver sus necesidades futuras en gran medida implícitas, el economista del transporte debe desarrollar (si es posible conjuntamente con los planificadores de otros sectores) proyecciones explícitas del alcance, diagrama cronológico y localización de las demandas de transporte. Evidentemente, las demandas actuales y previstas de los diversos sectores se deben ampliar hasta donde lo permitan los datos y las ideas disponibles; pero, dado que el horizonte para estas cifras generalmente será corto, es indispensable otro nivel de abstracción. Para complicar aún más las cosas, al planificador del transporte no se le da, ni se le puede dar, una consideración especial del diagrama cronológico para la presentación del documento relativo al plan del sector transporte; éste debe integrarse y vincularse con el resto del plan. Se lo debe presentar simultáneamente, con especificaciones y estimaciones de costos para instalaciones de transporte destinadas a desarrollos aún parcialmente indeterminados de carácter industrial, agrícola, minero y otros.

Es posible deducir variaciones razonables de producción anticipada en otros sectores (y su diagrama cronológico y dispersión geográfica), partiendo de metas realistas y específicas de carácter nacional a plazo medio y largo; estudios de asentamiento y proyección demográficos; y análisis del probable desarrollo de recursos de tierra laborable, riego y mano de obra experta. Los costos y la determinación de precios de los componentes de esta actividad influyen realmente en su volumen total. Se da por sentado que los planificadores conocen la necesidad de formular sus proyecciones de tal manera que los sectores armonicen entre sí y se sitúen dentro de las diversas capacidades factibles y deseables de producción. (Adviértase que esto no presupone que el crecimiento deba ser equilibrado.) La tarea podría simplificarse pasando por alto la distribución regional del desarrollo futuro y planificando sobre la base de la actual estructura de actividad industrial. Sin embargo, la adopción de este procedimiento podría resultar costosísima (debido a que las inversiones en instalaciones básicas son grandes e irrecuperables) en el caso de existir divergencias entre la estructura regional actual y la futura.

También la dimensión geográfica del desarrollo de un país se halla configurada por los costos del transporte y la capacidad disponible. Por lo tanto, el transporte no debe acomodarse pasivamente a las demandas de otros sectores, sino que ha de esforzarse por lograr una distribución zonal preferencial de la producción. Esto es, con mucho, un asunto demasiado importante para dejarlo librado exclusivamente al sector transporte; el grupo planificador, en conjunto, debe cargar con la responsabilidad de decisiones básicas en materia de localización y llevar a cabo los estudios necesarios para avalarlas. Lamentablemente, si el grupo planificador falla a este respecto, esa responsabilidad recae exclusivamente sobre el planificador del transporte. Si éste tiene que preparar estimaciones razonablemente dignas de confianza y contribuir a guiar el desarrollo hacia sus propias ubicaciones regionales, debe realizar por sí mismo esos estudios.

Problemas de distribución

Es probable que la determinación de la *mejor* distribución regional de la producción sólo pueda hacerse mediante una u otra forma de procedimiento reiterativo. Partiendo de una especificación inicial, el análisis pasa a considerar sus derivaciones en términos de necesidades de transporte y de otra índole. Una vez conocidas éstas con certeza, hay que volver a examinar las distribuciones originarias para introducir mejoras, y así sucesivamente.

Dada una estructura de intercambio regional, si se relacionan las proyecciones de los requerimientos de transporte por unidad física de producción y entrega con el volumen esperado de demanda final, se logran estimaciones de necesidades futuras de transporte para el acarreo de productos [7]. El movimiento de los insumos de mano de obra (es decir, personas) a fin de satisfacer las necesidades de producción puede calcularse sobre una base similar. En su mayor parte, se tratará de demandas de viajes urbanos de ida y vuelta entre la casa y el trabajo. Suponiendo que la fuerza laboral y la ocupación aumenten proporcionalmente, estas demandas se correlacionarán con los aumentos de las poblaciones urbanas. En regiones agrarias, los viajes a y desde los establecimientos agrícolas determinan demandas urbanas y cuasi-urbanas (los viajes realizados con el fin de acarrear productos al mercado y llevar insumos al establecimiento agrícola se han incluido en las necesidades de producción y distribución de productos mencionadas más arriba). La última parte de los viajes comerciales, viajes entre ciudades, dependerá de las condiciones geográficas y de la estructura y extensión del comercio interregional e internacional.

Por último, aparte de las relativamente limitadas necesidades gubernativas y militares, resta únicamente la demanda de servicios de transporte por parte de los usuarios. (Sin embargo, al planificador del transporte debe informársele de todo

[7] Es indudable que una mayor investigación de las necesidades de transporte (factores de cubicaje y densidad del transporte por unidad de producto en los casos de artículos fundamentales) serviría a un fin útil. En este campo no rigen las restricciones mencionadas anteriormente sobre el uso de datos relativos a las naciones desarrolladas.

requerimiento especial de índole militar.) En general, las inversiones considerables destinadas a satisfacer deseos personales de viajar no pueden justificarse en las etapas tempranas del desarrollo, cuando tienen un valor tan elevado las utilizaciones alternativas de las escasas divisas disponibles del reducido capital nacional y de la poco abundante mano de obra especializada. De todas maneras, estas demandas pueden satisfacerse en parte andando "a dedo" o en vehículos comerciales privados (principalmente camiones), o aprovechando el exceso de capacidad que queda disponible en caminos, ferrocarriles públicos y servicios de ómnibus fuera de las temporadas de máxima movilidad. Empero, a medida que progresa el desarrollo, el aumento del ingreso y un intenso deseo de movilidad y viajes personales pueden crear una demanda de servicios de transporte, especialmente en automóviles, muy por encima de estas capacidades. En los países en que la mayoría de los automóviles son importados, es natural que la satisfacción de esta demanda esté sujeta a los controles que el gobierno impone a la importación. En otras naciones donde la producción y venta de automóviles están reguladas principalmente por las fuerzas del mercado, las compras potenciales de vehículos de esta clase y su utilización deben calcularse mediante un análisis convencional de la oferta y la demanda, es decir, relacionando el consumo con el ingreso, los precios y otras variables, y la producción con la disponibilidad y costos de los insumos. Luego, aplicando ponderaciones que señalen la probable distribución de la propiedad y pauta de uso de los vehículos por región, se podrán predecir los nuevos requerimientos esperados en materia de carreteras.

Cuando se llegue a este punto, se habrá logrado una información general sobre la economía futura, que permitirá formular estimaciones iniciales de nivel y diagrama cronológico de las demandas de transportes. El paso siguiente consistirá en un intento de esbozar la estructura básica y la evolución cronológica de la infraestructura del transporte, de manera que éste pueda desempeñar su papel en el desarrollo sin desviaciones ni desperdicio de cantidades importantes de recursos. Antes que se termine esta tarea de planificación surgirá una enorme cantidad de nuevos problemas, algunos de los cuales examinaremos a continuación.

Algunos problemas específicos de la planificación

En primer lugar y por sobre todo podemos citar la consideración de las redes de transporte terminadas. Muy a menudo los planificadores se dejan llevar por la tentación de resolver necesidades del transporte exclusivamente entre un punto y otro, pero sin pasar revista a las derivaciones generales de la red total en cuestión. No es forzosamente cierto que el plan de transportes más eficaz sea el que trata de llegar a los más bajos costos unitarios entre cada punto de origen y el punto de destino. Desde el punto de vista del costo total del transporte pueden ser convenientes determinadas economías de escala y costos de regreso, ordenamiento circular, concentración del tráfico en una determinada forma de transporte y empleo de vehículos de uso general —más bien que de uso para un solo fin— (y otros procedimientos aparentemente eficientes). En otras palabras, hay casos en que una "ineficiencia" planificada puede resultar eficiente.

Lógicamente, sin embargo, casi siempre habrá que eludir la ineficiencia. En los casos en que el volumen de tráfico es potencialmente elevado, las rutas con muchos rodeos y "resquebrajadas" pueden resultar elementos costosos de una planificación torpe [8]. Gran ineficiencia produce también el utilizar, por razones de ubicación y costos, diversos tipos de transporte para trasladar pasajeros y mercaderías desde determinados lugares de origen a determinados destinos. Por ejemplo, los artículos de exportación manufacturados podrían transportarse desde la fábrica por camión, tren, camión y barco antes de salir de las fronteras nacionales. Claro que tal vez haga falta una u otra combinación de diversos medios de transporte, pero el número de elementos utilizados y los traslados entre un

[8] En la planificación de transportes parece existir una tendencia a errar en uno u otro sentido en cuanto a los puntos de enlace para un determinado medio: o bien todos los puntos son servidos mediante ramales de empalme de distancia mínima, o bien el sistema intramodal es fragmentario o inadecuadamente incompleto. Los enlaces entre países en fronteras nacionales contiguas parecen adolecer singularmente de esta última condición, hecho que tiende a dilatar la integración económica en vastas zonas regionales. Debido a esto es probable que se haya retardado el comercio internacional dentro del Mercado Común Europeo y la Asociación Latinoamericana de Libre Comercio, por las deficientes conexiones físicas del transporte y las diferentes estructuras tarifarias y prácticas reguladoras.

medio y otro deben estudiarse de modo tal que la eficiencia general aumente, en vez de reducirse. El plan de transportes debe dar cabida a la integración de los distintos medios eligiendo ubicaciones óptimas para empalmes, a cuyo efecto se establecerán rutas secundarias y conexiones, y se estimularán los métodos de bajo costo (por ejemplo, transporte en recipientes cerrados [*containers*], descarga por acción de la gravedad, etc.) y estaciones terminales para transbordos de un medio a otro. La meta debe ser en todo momento llegar a disponer de una capacidad que, sea cual fuere el medio de transporte, reduzca al mínimo los costos totales de distribución y viaje. En este aspecto tanto los ahorros como las pérdidas suelen ser frecuentemente considerables.

Costos y especificaciones

El hecho de que modificaciones relativamente pequeñas de las especificaciones introduzcan una variabilidad de los costos también dificulta aún más la tarea de planificación. Si en vez de soportar las cargas sobre ruedas de un camión de 10 toneladas, se desea que un camino soporte las de un camión de 13 toneladas (diferencia que, en términos de volumen de los camiones, no debe advertirse a simple vista), es posible que los costos de construcción aumenten en un 40 por ciento; el dragado de un puerto hasta una profundidad de 10 metros, en lugar de 9, para permitir el movimiento de buques con cualquier marea, podría elevar el costo del puerto entre un 15 y un 20 por ciento [9]. A menudo los problemas relacionados con esas especificaciones se convierten en puntos cruciales para una decisión sobre política. Sin embargo, es frecuente que los beneficios previsibles no puedan ser, y no sean, definidos con precisión ni analizados cuantitativamente. Además, el factor

[9] Estos costos de instalaciones básicas aumentan rápidamente debido en parte a la imposibilidad de sustituir equipos mecánicos por mano de obra en algunas operaciones importantes de construcción (por ejemplo dragado), y al elevado costo del insumo de mano de obra especializada en otras. La falta de sustituibilidad económica de métodos de construcción determina una gama de costos bastante constante en proyectos de transporte (inclusive necesidades de divisas) una vez establecidas las especificaciones. No cabe duda de que éste es un campo en el cual deben colaborar el ingeniero y el economista para precisar los límites de una viable sustituibilidad, dada la tecnología corriente y la cantidad y costo de los recursos disponibles, y para idear métodos de construcción de más bajo costo y más flexibles.

crítico en el momento de tomar una determinación de esta clase puede muy bien ser de carácter político e imposible de prever con un grado apreciable de certidumbre: Por ejemplo, las especificaciones de pesos que habrán de soportar los caminos dependen con frecuencia de si el gobierno desea y puede imponer una limitación a los pesos y cuál ha de ser el nivel en que ésta pueda aplicarse.

Otro aspecto del problema de costos y especificaciones es la posibilidad de alternativas entre diversos componentes de costos: costos de capital de instalaciones básicas contra costos de mantenimiento de instalaciones básicas; costos de capital de instalaciones básicas contra costos de explotación de vehículos. Los costos de explotación, tal como se los considera aquí, incluyen los gastos de inversión en vehículos por unidad de tráfico (es decir, por tonelada-kilómetro o coche-kilómetro). Hay otras alternativas, además, entre inversión en vehículos y costos de stock. A medida que se mejora la calidad de una instalación básica, con el consiguiente aumento de su costo, tienden a disminuir los costos de explotación de los vehículos que la utilizan. Esto es más evidente en el caso de caminos y ferrocarriles, donde un firme mejorado permite desarrollar velocidades más altas, transportar cargas más pesadas y operar con menores costos de combustible, mano de obra y reparaciones. Algunas pruebas de este fenómeno pueden encontrarse en el capítulo III.

Mantenimiento versus construcción nueva

Según sean las condiciones geográficas, climáticas y del suelo, podrá haber variantes bastante grandes entre los costos de mantenimiento y los de modificaciones del trazado. Esto vale especialmente en los casos en que estacionalmente o diariamente se tienen registros extremos de temperatura o precipitación pluvial. Es enormemente escaso el número de análisis comparativos de costos de construcción original con respecto a costos de mantenimiento de medios de transporte (bajo diversas condiciones físicas, especificaciones y costos de insumo de materiales, maquinaria y mano de obra) que se efectúan actualmente al hacer estudios de inversiones en transportes. Muy a menudo tanto el ingeniero como el economista dan por sentado que los factores de insumo en los países en proceso de desarrollo tienen costos relativos comparables a los de mantenimiento y de construcción en países industriales adelantados.

Por supuesto, el mantenimiento no se encara por sí mismo, sino en virtud de su repercusión sobre los costos operativos de los vehículos. Dentro de una gama pertinente, a medida que suben los gastos de mantenimiento, bajan los costos operativos de vehículos. Por lo tanto, es posible que se dé la oportunidad de reducir los costos totales del transporte sustituyendo un tipo de costo por otro. A menudo debe asignarse preferencia en el empleo de recursos, *ceteris paribus*, a la conservación o reconstrucción incompleta de una instalación existente, antes de pensar en la ampliación de nuevas instalaciones. Como es lógico, la existencia de un camino que necesite mantenimiento no implica concederle automáticamente una prioridad para la utilización de recursos en ese mantenimiento sin previo análisis comparativo de los beneficios que podrían lograrse con la aplicación de los mismos recursos a otra inversión. Lamentablemente, en las naciones en desarrollo se registra una marcada inclinación a construir nuevas instalaciones para el transporte, en vez de mantener las existentes. Esta distorsión tiene su raíz en factores tales como: costo relativamente alto del mantenimiento; falta de mano de obra técnica experimentada; necesidad de previsión en materia de adquisición planificada de equipos, adiestramiento de personal y organización con miras a las tareas de mantenimiento; y desconocimiento de los costos reales (directos o indirectos) que representa el no tomar medidas de mantenimiento preventivo o restaurador. Además, con frecuencia el país en vías de desarrollo descubre que le es más fácil conseguir en el extranjero préstamos para nuevas construcciones que aumentar los impuestos con el fin de financiar el mantenimiento.

Mucho puede ganarse en el sentido de reducir los requerimientos de capital inicial (o descontado) mediante una adecuada combinación de mantenimiento y de construcción por etapas, posibilitando así que la demanda potencial sea satisfecha sin una excesiva inversión en una capacidad desmedida.

Esto vale de manera especial en el caso del trazado y construcción de caminos. A propósito del Cercano Oriente, se ha dicho que existe algún tipo de "camino" entre todos los lugares habitados y que el ingeniero fue el perezoso camello, en su afán por encontrar la ruta más segura y más corta. Siguiendo las huellas de esta "ingeniería" originaria, el tráfico ha contribuido

a estabilizar el terreno. Hay mucho de verdad en esta afirmación, tanto como para asegurar que la construcción de caminos muchas veces puede ser tan sólo un mejoramiento destinado a proporcionarles la capacidad y la resistencia necesarias para el tránsito previsto.

Proyectando el tipo y nivel de tráfico para los diversos tramos de camino, y comparando los costos y beneficios totales del mejoramiento vial con niveles alternativos más elevados de capacidad y especificaciones, puede lograrse que las decisiones sobre construcción por etapas armonicen con los planes futuros de desarrollo de caminos a largo plazo mediante un costo inicial mucho menor (en cada etapa), con lo cual se liberan fondos para otros fines. La ventaja en este caso reside en el uso productivo potencial de los ahorros de costos, que de otra manera se habrían destinado a dotar a determinados tramos de una calidad o capacidad más elevada que la realmente necesaria en un momento dado. Los desembolsos totales y absolutos de capital (en dólares constantes) para instalaciones construidas por etapas serán casi siempre más cuantiosos que si la construcción se hubiese hecho en una sola fecha. Sin embargo, si las fechas de etapas se han elegido debidamente y si se toman en cuenta los usos alternativos de los ahorros en el costo inicial de construcción, el valor actual descontado de los desembolsos para la construcción por etapas (incluido el mantenimiento adicional) será menor que si no se procediese por etapas.

En los casos en que se ha adoptado esta técnica para la planificación y trazado de caminos, ha sido posible mejorar caminos hasta un tercio del total de kilómetros, en un nivel de utilidad *indispensable*, con el mismo presupuesto de construcción. Si bien este método aumenta sin duda los costos de planificación, tales costos, que aparecen relativamente abultados en la etapa de planificación, están más que justificados en función de los usos de oportunidad de los ahorros en costos de construcción [10].

[10] Sin embargo, proceder por etapas no es una ventaja que carezca de inconvenientes; es necesario poner mucho cuidado en la formulación de estos programas, pues existe el peligro de incurrir en errores costosos. Los costos de mantenimiento pueden llegar a ser prohibitivos en caminos de calidad pobre, cabe la posibilidad de elegir rutas inadecuadas y puede ocurrir que los costos suban excesivamente, etc. No obstante, tal vez los errores en el caso del método de etapas no sean mayores que en los tipos tradicionales, y quizá sean menores.

Importancia de la administración

Aun cuando estas ventajas son considerables, la administración de las instalaciones de transporte es probablemente una cuestión tan crítica en el desarrollo del transporte como lo es la asignación de fondos de capital. Una mejor administración, que utilice con más efectividad las actuales capacidades físicas antes de hacer nuevas inversiones en instalaciones, sobre todo en el caso de los puertos y ferrocarriles, puede obviar la necesidad de desembolsos de capital adicionales para ampliar la capacidad. Esto se torna evidente cuando se calculan los costos de las alternativas.

La capacidad efectiva de un puerto no depende únicamente del equipo físico provisto, sino también de la coordinación de una serie de acciones y movimientos de equipos, carga y papeleo administrativo. Por ejemplo, por un puerto de un país en desarrollo pasaban no hace mucho entre 400 y 500 toneladas anuales por metro lineal de muelle; en un puerto de Europa Occidental, las mismas instalaciones, con los mismos medios de transporte e iguales afluencias de productos, atendían un promedio de 650 toneladas anuales por metro lineal de muelle. Puesto que el costo de construcción de un embarcadero adicional, depósitos de reserva e instalaciones del caso asciende más o menos a cuatro millones de dólares por 100 metros de muelle, podría evitarse una inversión de esta magnitud destinada a satisfacer las crecientes demandas de instalaciones portuarias, con sólo introducir mejoras del orden del 10 al 15 por ciento en la administración del puerto [11]. De igual manera, en materia de ferrocarriles, donde las necesidades de capital son elevadas, pequeñas mejoras de la eficacia pueden a menudo traducirse en importantes aumentos de capacidad, eludiendo inversiones innecesarias. Dado que el costo de las mejoras de la administración es generalmente muy inferior al costo de la nueva capacidad física, los ahorros de recursos de capital resultan considerables.

[11] John H. Kaufmann, "Planning for Transport Investment in the Development of Iran", *American Economic Review*, Proceedings (mayo de 1962), p. 402.

Determinación del plan óptimo

Tal como ya debe ser evidente a través de la explicación que antecede, la planificación es una tarea compleja que presupone utilizar un gran acopio de datos, los cuales van desde estimaciones precisas de ingeniería a reacciones económicas desconocidas frente a objetivos sociales vagamente delineados. ¿Cómo, pues, puede idearse un plan óptimo cuando se dan múltiples factores inconmensurables, cuando son tan grandes las incertidumbres y tantas las alternativas? El esbozo que sigue no es más que un intento, no una solución.

Lo ideal sería que la planificación, en cualquier sector, se trazara dentro del contexto de una estrategia total de planificación, que maximizase rigurosamente un conjunto de metas con miras a alcanzar un determinado horizonte. Sin embargo, aun cuando no pueda encararse un proceso iterativo de programación muy complicado, los acercamientos de sus etapas serán siempre componentes valiosos de una planificación eficaz. En primer lugar, se necesitará decididamente un conjunto de metas basadas en disponibilidades de recursos y en deseos nacionales, a modo de pautas para un plan sectorial. En segundo lugar, la consideración de las maneras de alcanzar esas metas a largo plazo (y sus derivaciones geográficas) puede ser útil para su cumplimiento. En tercer lugar, aun cuando se trate únicamente de un elemento *ad hoc*, convendrá siempre contar con una u otra forma de análisis a plazo cercano que examine las sustituciones y complementariedades de inversiones entre los distintos sectores y procure aumentar las utilidades. Esta etapa debe también tratar de asegurar coherencia general en la utilización y disponibilidad de recursos. En cuarto lugar, para la asignación racional de recursos es indispensable la determinación de los costos y beneficios de los proyectos de cada sector. En quinto lugar, también debe preverse la consideración de otros efectos económicos indirectos y factores sociales y políticos que puedan influir en las decisiones relativas a inversiones. Finalmente, debe existir la oportunidad de revisar los planes sectoriales para eliminar incoherencias; además, en virtud de que la maximización del bienestar nacional no consiste solamente en una maximización del producto económico, sino que presupone consideraciones de equidad y preferencias regionales, de grupos y temporales, debe prepararse un juego de alternativas de desarrollo susceptibles de elección política [12].

La responsabilidad general de este procedimiento debe correr por cuenta del grupo planificador considerado en su totalidad. En grados diversos, cada sector contribuirá a todos los pasos del proceso y se encargará primordialmente de evaluar sus propios proyectos.

Dado que en las etapas primeras e intermedias del desarrollo la división de la demanda de transporte entre necesidades de la producción y del consumo final se inclina casi por completo hacia las primeras, el sector transporte tiene escaso papel que representar en la fijación de metas. Sin embargo, le cabe una intervención destacada en la determinación de frenos a su realización. El transporte debe recibir del grupo planificador una indicación de la futura distribución regional del crecimiento y cualquier anticipación posible de necesidades en materia de transporte. Como reacción a esto, debe preparar estimaciones de las demandas de transporte implícitas en ese desarrollo y proveer un análisis del carácter espacial y económico a largo plazo de la red nacional de transportes que hará falta. Esto presupone una descripción completa de la red existente y propuestas detalladas para su expansión en el tiempo. Repitiendo este proceso en colaboración con los planificadores de otros sectores y la autoridad central de planificación, será posible formular programas factibles de desarrollo (abarcando diferentes intensidades y mezclas geográficas de producción de transportes, industrial, comercial y agrícola) que satisfagan metas alternativas.

De igual manera, para el análisis a corto plazo se entregará a los planificadores del transporte una relación de las demandas esperadas, y se recibirá en respuesta la información acerca de si la capacidad es o no adecuada [13]. Los proyectos de inversiones del sector pueden entonces trazarse con miras a satisfacer necesidades a largo plazo y aliviar congestiones a corto plazo. Su evaluación y la inclusión de factores no económicos en un agregado al plan sometido para aprobación política no requieren aquí mayor comentario.

[12] Aun cuando estas etapas se han presentado como pasos separados y consecutivos, en la práctica se las seguirá con diversos grados de simultaneidad. Además, los planes resultantes deben ser objeto de continuas revisiones y correcciones, y se los ha de someter a los poderes legislativo y ejecutivo para su selección y aprobación.

[13] Tanto en los casos de plazo largo como corto, la determinación de precios de la producción entra críticamente en todas las funciones de costo de la (oferta) y demanda (véase en el capítulo X un análisis de la determinación de precios de los servicios del transporte).

En algunos países, aun el análisis más bien informal precedentemente esbozado no puede emprenderse debido a la escasez de personal experimentado, a la falta de estadísticas adecuadas y de un mecanismo de recopilación y comunicación de datos, al hecho de no haberse organizado un grupo planificador completo y a otros motivos. En el grado en que le sea posible, el planificador del transporte deberá: obtener su propia información sobre el carácter actual y futuro de la economía, fijar metas aparentemente razonables y tratar de aproximarse a su realización mediante la suboptimización de su propio sector conforme a los lineamientos generales aquí propuestos. Cabe esperar que las especificaciones resultantes no estarán en franco desacuerdo con las que se lograrían en una planificación global formal o informal.

Conclusión

Las decisiones sobre inversiones que se toman actualmente influyen no sólo en el nivel de vida de la generación actual, sino también en los de las generaciones futuras. Por ser imperiosa la necesidad de elevar la tasa de desarrollo y el ingreso *per cápita* en las naciones menos desarrolladas, y dado que los rendimientos económicos y las consecuencias sociales de un método de simple *laissez faire* pueden acentuarse en forma tan significativa, ofrece positivas ventajas la intervención del gobierno con el fin de mejorar la asignación y la utilización de recursos. Esa intervención no necesita adoptar la forma de control directo de todas las actividades directamente productivas, y tal vez tampoco deba ocurrir así. Pero existe una evidente necesidad de establecer líneas y normas que sirvan de guía, de acuerdo con las cuales los sectores privados puedan operar más eficazmente, y de proveer instalaciones básicas necesarias, inclusive las del transporte. Para esto, lo mejor es realizar un intenso y completo esfuerzo de planificación. Cualesquiera que sean las limitaciones de este método, sus soluciones superan a las que se obtienen cuando las decisiones se optimizan simplemente para cada sector independientemente y cuando en gran medida se pasan por alto los efectos de realimentación e interdependencia a largo plazo. La planificación en todo el ámbito de la economía no debe ser implícita, sino explícita. No obstante, en algunos países esta técnica puede no resultar del todo funcional en el futuro próximo, debido a lagunas en los datos requeridos y escasez de personal adiestrado.

Si falta una planificación global, el planificador del transporte debe trabajar en condiciones decididamente desventajosas al diseñar la parte que le corresponde de un plan de desarrollo. Tiene que detallar las inversiones en instalaciones de transporte de manera de satisfacer los requerimientos de otros sectores de la economía todavía no definidos específicamente, y debe también trabajar con una perspectiva temporal apreciablemente mayor que el período habitual en la planificación de este sector. Esto lo obliga a encuadrar (con la debida consideración de modificaciones de la producción regional potencialmente conveniente y otras alternativas) los programas de infraestructura del transporte dentro del marco de recursos naturales básicos, así como de factores geográficos, demográficos, de intercambio y otros, no menos que de las necesidades del transporte derivadas de proyectos de desarrollo planeados para ese momento o para el futuro. Estos factores básicos pueden entonces interpretarse en términos de población anticipada, centros agrícolas e industriales, tipos de productos y circulación comercial; y, tomando después en cuenta las características tecnológicas y de costos de diferentes medios de transporte, se las podrá traducir en necesidades del transporte. Enfocadas las necesidades con esta perspectiva, podrán relacionarse entre sí los diversos medios alternativos de transporte, de manera tal que se logre una red integral de instalaciones.

Con demasiada frecuencia los planes del sector transporte consisten fundamentalmente en un conjunto de propuestas de proyectos sueltos sobre caminos, ferrocarriles, puertos y oleoductos. En muchas de esas propuestas, si no en todas, es posible que las razones costos-beneficios sean favorables, pero juntas no representan un sistema eficiente de facilidades que minimice los recursos con el fin de satisfacer el total estimado de necesidades de transporte. La planificación de una red integral de instalaciones para el transporte pone de relieve la secuencia temporal imperativa de la planificación y construcción de ingeniería en cuanto a instalaciones no sólo relacionadas entre sí (por ejemplo, caminos secundarios hasta estaciones ferroviarias terminales, caminos a nuevos puertos, etc.), sino también vinculadas a programas industriales y agrícolas proyectados. La larga demora de los proyectos de transporte, desde las propuestas iniciales hasta

la comprobación de factibilidad del uso de las instalaciones, hace también que deba ser mayor la atención prestada a este aspecto de la planificación del sector transporte.

Los análisis de proyectos del sector transporte, aunque no tienen que vérselas con factores imponderables tales como los beneficios derivados de posibles proyectos sanitarios o educacionales, tropiezan con obstáculos en la estimación de costos y beneficios indirectos (y a veces directos). Al avanzar de proyectos a programas y de las determinaciones subsectoriales a las sectoriales, los análisis convencionales de inversiones marginales se vuelven menos definitivos y menos precisos. Esto no significa que un enfoque acumulativo del sector transporte pueda remplazar a los análisis de costos-beneficios del proyecto. Sin embargo, si estas evaluaciones se realizan dentro del marco de un esquema nacional de transportes desarrollado tal como se indica, podrían al parecer tomarse decisiones sobre inversiones para mejoramiento del transporte a la luz de objetivos pertinentes de planes regionales o nacionales, y llevarse a cabo menos asignaciones equivocadas de recursos al sector transporte y dentro de éste.

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IX

EVALUACION ECONOMICA DE PROYECTOS DE TRANSPORTE

Hans A. Adler *

Dentro de la economía, el arte de evaluar proyectos de transportes en países menos desarrollados sigue en estado rudimentario; pero resulta difícil juzgar si la discrepancia entre teoría y práctica es mayor que, por ejemplo, en medicina. El presente artículo describe el estado en que este arte aparece generalmente entre quienes poseen tal vez la máxima experiencia en él, comenta algunos de los problemas más importantes y sugiere una cantidad de nuevas mejoras. Se insiste sobre todo en la evaluación de carreteras, porque por lo general éstas presentan dificultades más serias para la evaluación económica y porque es muy probable que en la mayoría de los países subdesarrollados su expansión en el futuro revista más importancia que la de otros medios de transporte. Sin embargo, los métodos y técnicas que aquí se comentan son susceptibles de aplicación general.

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La evaluación económica de proyectos de obras públicas se ha desarrollado en forma muy extensa en lo que se refiere a medidas sobre recursos acuáticos, tales como prevención de inundaciones, navegación y conservación del suelo. En Estados Unidos recibió su impulso inicial en la década del 1930, cuando la ley exigió a la Oficina de Recuperación de Tierras, al Cuerpo de Ingenieros del Ejército y a otros organismos que calculasen los costos y beneficios, y utilizasen esos cálculos en la selección de proyectos concretos. Se han realizado muchos estudios de esta clase en los últimos diez años, destacándose especialmente los relacionados con recursos acuáticos.

En el campo del transporte, la evaluación de proyectos ferroviarios, y en cierto grado también de proyectos de navegación y puertos, se circunscribió por lo común a un análisis financiero destinado a determinar si las rentas futuras podrían cubrir los costos. Recientemente algunos ferrocarriles han adoptado métodos más formales para la preparación de presupuestos de capital. Sin embargo, las evaluaciones económicas se han convertido en una necesidad en el caso de las carreteras, debido a éstas, por lo general, no producen rentas directas. Las primeras fueron hechas por ingenieros de los departamentos viales de cada Estado a fines de la década del 30. En naciones menos desarrolladas no se generalizó su empleo hasta hace unos años, bajo el impulso de diversos programas de ayuda extranjera.

No existe, por supuesto, relación causal entre el atraso de la economía de evaluación de transportes y el hecho de que hasta hace unos años esto era virtualmente dominio exclusivo de los ingenieros. Por lo contrario, esta condición se debe en gran medida a que los economistas no se interesaron por este campo; pese a ser en éste de importancia singular la colaboración estrecha entre economistas e ingenieros. A consecuencia de esto, algunos de los errores más comunes en la evaluación de proyectos provienen de no aplicar correctamente los criterios económicos o de no aplicarlos en absoluto; algunos de éstos, como el no distinguir entre costos y beneficios privados y públicos, y entre costos medios y marginales, se comentan más adelante.

Un problema muy particular de los países menos desarrollados consiste en la falta de estadísticas básicas; a menudo esto es decisivo para el grado de exactitud y refinamiento posible del análisis. Por ejemplo, la mayoría de esos países han iniciado apenas hace unos años la recopilación de datos sobre tráfico en las carreteras. Cuando hay estadísticas disponibles, éstas se limitan de ordinario a simples recuentos del tráfico; difícilmente se cuenta con información sobre el origen y destino de ese tráfico y los tipos de artículos transportados en las carreteras. Generalmente es poco lo que se sabe acerca de costos operativos de vehículos en diferentes tipos de caminos o sobre gastos de mantenimiento de caminos con diferentes clases de superficies. A consecuencia de esto, la mayoría de las nuevas inversiones y las asignaciones para gastos de mantenimiento se han hecho virtualmente sin ningún análisis económico detallado de prioridades. Sin duda es cierto que, dentro de sus límites, algunas de las inversiones más obvias se pueden hacer con sólo mirar sencillamente un mapa y fijarse en la ubicación de las industrias principales y los centros de población. Pero esto deja de ser cierto una vez que se han construido las carreteras más evidentemente necesarias, y tampoco un método tan sencillo permite formarse un juicio adecuado sobre prioridades a lo largo del tiempo entre medios de transporte, o entre inversiones en transportes o en otras actividades. La falta de datos estadísicos básicos, sin embargo, no sólo es causa del estado de atraso en que se encuentra en gran medida el análisis relativo a esta materia, sino también un efecto del mismo, pues hasta hace poco los economistas no concentraban sus esfuerzos en las condiciones que debían estudiarse, por ser escaso el incentivo para la compilación de estadísticas apropiadas.

Pasos preliminares

Antes que un determinado transporte pueda ser evaluado debidamente, dos pasos previos son muy convenientes y por lo general esenciales para abreviar gradualmente el estudio de alternativas del proyecto. El primero de estos pasos consiste en un estudio económico general del país. Tal estudio cumple dos finalidades principales. La primera es establecer las necesidades generales de la nación en materia de transportes mediante el estudio detenido, por ejemplo, de la tasa de desarrollo económico y la expansión del tráfico resultante. La segunda tiene por objeto proporcionar una base para la apreciación de las necesidades en el sector transportes, contrapuestas a las de otros sectores de la economía. Esto no es algo que pueda hacerse con mucha precisión, y depende en gran medida de juicios cualitativos. Importa señalar que varios de estos estudios han sugerido que era demasiado lo que se invertía en transportes. Un reciente

estudio llevado a cabo en Colombia, por ejemplo, demostró que las inversiones en educación, viviendas y sanidad merecían una prioridad mayor que las inversiones marginales en transportes[1]. Estos estudios hacen falta también como ayuda para decidir si es posible reducir la demanda total de transportes mediante cambios de ubicación de las industrias, y a qué costo. El hecho de no hacerlos ha conducido a inversiones en transportes, así como a recomendaciones de nuevas inversiones en algunos países, que están completamente en desacuerdo con los recursos totales disponibles en el país para inversiones y con las prioridades de otros sectores.

El segundo paso debe ser un estudio detallado de los transportes a fin de establecer las prioridades dentro de este sector. Ejemplos de ello son los estudios de los transportes hechos recientemente en la Argentina, Colombia, Ecuador y Taiwan bajo los auspicios del Banco Mundial. Si se trata de sacar la mayor utilidad de estos estudios, no sólo deberá trazarse en ellos el marco amplio de prioridades para cada tipo de transporte, por ejemplo una lista de los caminos por orden de importancia, sino que deben también indicarse la misión precisa de cada uno y las prioridades entre ellos. Un programa de esta clase será materia de posteriores revisiones cuando se analicen en detalle determinados programas. A menos que el proyecto vaya precedido de un estudio económico general y de un estudio de los transportes, se corre gran peligro de hacer una evaluación incompleta que pueda conducir a una distribución equivocada de los recursos.

Problemas de la evaluación de proyectos

El propósito fundamental de la evaluación económica de un proyecto es medir sus costos y beneficios económicos para determinar si los beneficios netos se equiparan por lo menos a los que pueden lograrse con otras oportunidades de inversión marginal en el país en cuestión. Por supuesto, existen otros costos y beneficios que no son económicos, como las oportunidades culturales derivadas de los viajes, y las ventajas militares y

[1] Los ejemplos del presente capítulo son producto de investigaciones realizadas por el Banco Mundial, en general inéditas. El material editado aparece mencionado en la Bibliografía.

administrativas, y a veces desventajas, provenientes de la mayor movilidad. Éstos no se toman aquí en cuenta, dado que se hallan excluidos por definición, y también porque, para bien o para mal, la mayoría de las fuentes de financiación exterior no los consideran importantes para la concesión de préstamos cuya finalidad primordial es la de estimular el desarrollo económico. No obstante, estos otros beneficios y costos son muy reales, y el país interesado debe tomarlos en cuenta.

A veces se afirma que el valor de un proyecto debe medirse por su contribución al crecimiento de la renta nacional según se la mide tradicionalmente. Esto no está en desacuerdo con lo expresado más arriba, pero no es un método práctico. En primer lugar, excluiría por completo ciertos beneficios, como el mayor confort derivado de una mejor carretera o las economías de tiempo, que podría así emplearse para un mayor esparcimiento o reposo, lo cual no se reflejaría en la renta nacional. Más importante es el hecho de que el método basado en la renta nacional resulta demasiado complicado e indirecto, y en países subdesarrollados es sencillamente imposible de aplicar. Por ejemplo, si los costos de los transportes se reducen, debería hacerse un análisis para saber en qué forma se utilizarán en el futuro los recursos liberados en otros sectores de la economía, a fin de determinar el aumento de renta nacional resultante. Sin embargo, el método basado en la renta nacional es útil para fijar la atención en costos y beneficios desde el punto de vista de la economía considerada en su conjunto y no tan sólo de las partes directamente afectadas. De este modo ayuda a elegir los beneficios que se deben incluir y los que deben omitirse, y a evitar que se cuente dos veces un mismo beneficio bajo diferentes formas, como cuando el mejoramiento de un camino reduce costos de transporte y aumenta valores de la tierra. Es útil para la identificación de costos y beneficios, aunque no para medirlos.

Al evaluar un proyecto que se compone de varios subproyectos separables e independientes, deberán hacerse análisis económicos por separado para cada subproyecto. De lo contrario, es muy posible que los beneficios extraordinariamente abultados de un subproyecto oculten los insuficientes beneficios de otro. Por ejemplo, en el caso de un proyecto de ampliación de un puerto en América Central, los ingenieros recomendaron la construcción de dos muelles nuevos. La justificación económica indicaba un coeficiente de rendimiento sobre la inversión de un 12 por ciento, más o menos, lo cual era un porcentaje satisfactorio en el citado país. Sin embargo, cuando se hicieron análisis

separados para uno y otro muelle, resultó que el coeficiente de rendimiento en uno de ellos era de casi un 20 por ciento, mientras que el del otro no era más que del 4 por ciento una vez tomados en cuenta los costos extraordinarios por el hecho de construirlos separadamente; por cierto, el segundo muelle no se justificaba. El mismo principio es aplicable en especial a diversos grados de mejoras de caminos y a menudo también a diferentes tramos de camino.

A fin de medir los beneficios y costos económicos y compararlos con otras oportunidades de inversión, se los debe expresar en términos de dinero, que es el único común denominador práctico. Esto plantea un problema, ya que los precios de mercado no reflejan los costos reales en la medida en que no prevalezca en los sectores principales de la economía una competencia viable. Aparte de cualquier limitación aplicable en general a la competencia en naciones menos desarrolladas, se presentan dos problemas especiales en el sector transportes. El primero surge del hecho de que algunos servicios de transporte, por su índole misma, son oligopolistas o incluso monopolistas, de suerte que los precios cobrados por esos servicios a menudo carecen de relación directa con los costos. El ejemplo más evidente es la histórica determinación de precios de servicios ferroviarios, según la cual las tarifas de fletes para determinados productos no están basadas en los costos del transporte de esos productos, sino en el valor de éstos. Un segundo problema relacionado surge de la concesión de subsidios directos e indirectos a muchos servicios de transporte por parte del gobierno. Un ejemplo de aplicación general es el de la provisión de caminos. En la mayoría de las naciones en desarrollo los impuestos a la nafta y otros gravámenes que se imponen a los usuarios no cubren los costos de los caminos (incluidos el mantenimiento, depreciación, intereses y administración); aun en los casos en que puedan cubrir los costos generales, por lo común no hay relación entre lo que se le cobra al usuario individual y los diferentes costos de los diversos servicios de transporte, por ejemplo camiones, ómnibus y autos para pasajeros.

A pesar de estas dificultades, los términos monetarios representan el único común denominador práctico, y se puede lograr que sean significativamente más útiles adoptando "precios imaginarios" que reflejen más de cerca los costos y beneficios económicos reales.

Medición de los costos económicos

La medición de los costos económicos de un proyecto es mucho más sencilla que la de sus beneficios económicos y, por lo general, se la puede limitar a ajustes de los gastos reales en la medida en que no reflejen adecuadamente los costos económicos reales. Las categorías de costos para las cuales suelen necesitarse esos ajustes, es decir, para las cuales deben determinarse precios "imaginarios", se comentan seguidamente.

Empleo de los precios imaginarios

El primer ejemplo lo constituyen los impuestos a las ventas y otros impuestos indirectos. El impuesto a la nafta, por ejemplo, es un costo para quienes pagan el impuesto, pero no refleja necesariamente costos económicos para el país en su totalidad, en el sentido de que un aumento del impuesto no significa que se requieran más recursos económicos para producir un volumen determinado de nafta. Merece destacarse que el famoso informe *Road User Benefit Analysis for Highway Improvements* (Análisis de los beneficios de los usuarios de caminos para mejoras viales), de la American Association of State Highway Officials (Asociación Norteamericana de Funcionarios Estaduales de Vialidad), incluye erróneamente los impuestos en la medición de costos de combustibles, no estableciéndose diferencia entre costos (y beneficios) privados y públicos[2]. De igual manera se deben excluir los derechos de licencia y los derechos de importación, y deben introducirse ajustes por los costos de las importaciones, a tipos artificiales de cambio, incluyendo un subsidio.

Un segundo ejemplo son los salarios. En casi todos los países las leyes de salarios mínimos y otras reglamentaciones e inflexibilidades determinan que algunos salarios efectivamente pagados no dan una medición correcta de los costos reales de la mano de obra. Cuando una economía se destaca por una gran

[2] Washington (D.C.) 1960. Reimpresión del informe de 1952 sin modificaciones de fondo, salvo la adopción de los costos unitarios de 1959.

desocupación o subocupación, los costos reales del tipo de los de mano de obra son muy inferiores a los salarios reales. Cuando esta condición prevalece ampliamente y es probable que perdure cierto tiempo, como ocurre en muchas naciones menos desarrolladas, el costo de la mano de obra, sobre todo tratándose de obreros no especializados, debe calcularse en una cifra sustancialmente inferior a los pagos reales de salarios. En cambio parecería también que los costos reales de la mano de obra calificada pueden ser superiores a salarios pagados. Las mismas consideraciones valen para las ganancias. Al medir los beneficios de un equipo que economiza mano de obra, el beneficio real es considerablemente menor si la mano de obra remplazada continúa desocupada durante un período importante de la vida económica del equipo.

Un ejemplo final es el interés. Lo que se paga por este concepto es el costo financiero del capital, que frecuentemente no guarda relación con su costo económico, es decir, el costo de oportunidad del capital. Los fondos de inversión suministrados por los gobiernos para el transporte se entregan a menudo a un interés que está por debajo de lo que le cuestan al gobierno; y aun cuando cubra los costos del gobierno, estos últimos no reflejarán los costos económicos si el gobierno ha obtenido tales fondos mediante compulsión directa o indirecta, por ejemplo recurriendo a impuestos o exigiendo a los bancos préstamos al gobierno a tasas inferiores a las del mercado. Muy frecuentemente los fondos obtenidos de fuentes extranjeras suponen tasas de interés marcadamente inferiores al costo de oportunidad del capital en naciones menos desarrolladas.

Es muy difícil determinar el costo económico del capital cuando no hay mercados libres, en especial dado que las tasas de interés prevalecientes reflejan también factores tales como la inflación y el riesgo. El Banco Mundial ha emprendido varios estudios tendientes a evaluar el costo de oportunidad del capital en determinados países. Aunque tales estudios no permiten juicios definitivos, revelan una gama que va del 6 al 12 por ciento respectivamente para los países elegidos, y hay motivos para creer que en la mayoría de las naciones subdesarrolladas la tasa es por lo menos del 8 por ciento y a menudo más del 10 por ciento. Que en el descuento de costos y beneficios se apliquen las tasas de interés del mercado o una tasa social más baja (o acaso más alta) es algo que no entra en los límites de este trabajo. Sin embargo, desde un punto de vista práctico, las inversiones en países menos desarrollados, donde las tasas de rendimiento son inferiores al 8 por ciento, deben ser objeto de un análisis muy minucioso.

Muchos son los proyectos en cuya evaluación el problema de la tasa apropiada de interés puede minimizarse expresando el resultado en función de una tasa interna de rendimiento de la inversión, más que en función de la razón beneficios-costos. De esto se habla más adelante, en la última sección.

Otros tipos de ajustes

Además del uso de precios imaginarios, hay otros tipos de ajustes que son a menudo necesarios para una evaluación económica. Los tres ejemplos que se dan a continuación han sido elegidos principalmente porque ejemplifican errores bastante comunes.

— Al calcular los costos de un proyecto, los ingenieros incluyen habitualmente un rubro de eventuales para gastos imprevistos. Éstos son de dos clases. En primer lugar, puede suceder que los costos sean más elevados que lo previsto porque el trabajo resulta más difícil o más largo; por ejemplo, es posible que haya que excavar más tierra o que las condiciones del suelo sean menos favorables que lo indicado por los datos de las muestras en que se basó el cálculo de costos. Cabe también la posibilidad de que los costos sean más altos porque las condiciones inflacionarias vigentes en general aumentan los salarios y los precios. A los fines del análisis económico, el segundo elemento del margen de eventuales no se debe incluir bajo el rubro costos, ni se debe tomar en cuenta una inflación general en los precios de los beneficios. Sin embargo, no debe descartarse la posibilidad de cambios de los precios relativos en la medida en que sean predecibles y puedan influir sobre los costos y beneficios de una manera diferente.

— Un segundo error común ocurre en la forma de tratar el interés correspondiente al período de la construcción. Es común incluir este interés en los costos de los proyectos financiados mediante préstamos, como por ejemplo nuevos equipos para un ferrocarril o construcción de una ruta de peaje; pero a menudo se lo excluye cuando el proyecto se financia con subsidios provenientes de rentas generales, como sucede con la mayoría de las carreteras. Esta importante distinción financiera carece de sentido en cuanto se refiere a los costos económicos del proyecto,

dado que los recursos reales empleados (mano de obra, materiales, equipos, etc.) son los mismos, independientemente de la fuente de financiación. El dinero es el medio con el cual se procuran estos recursos económicos reales, de modo que el interés no se debe incluir en los costos económicos del proyecto.

Sin embargo, el interés entra aquí en un sentido muy distinto. Dado que los beneficios de un proyecto no empiezan hasta un tiempo después que éste se ha iniciado y se han pagado costos, se impone necesariamente comparar los costos y beneficios que empiezan en años distintos y corresponden a diferentes períodos. Independientemente del método de financiación que se adopte, la distribución de los costos en el tiempo es un elemento importante, dado que un costo sufragado este año tiene un valor económico distinto que el mismo costo en el futuro. Para medir la diferencia, los costos futuros se pueden expresar en valores actuales introduciendo un descuento sobre la base de una tasa de interés adecuada. El método correcto de comparación de beneficios y costos correspondientes a períodos diferentes de tiempo consiste, por lo tanto, en descontar todos los costos *y beneficios* futuros a la fecha en que se afrontó el primer *costo*. Siguiendo este método, el interés (como también la depreciación) queda contemplado implícitamente, de manera que, si se agregase interés a los costos, se incurriría en una duplicación.

Una variante que a veces se utiliza incluye el interés durante la construcción y descuenta los beneficios a partir del primer año, en que éstos comienzan, fecha que corresponde en general al momento en que se afrontan los primeros costos. Esto tiende a confundir el análisis financiero con el económico, dado que generalmente el interés incluido en los costos es el que en realidad se paga. En la mayoría de los casos, esto no guarda relación directa con el costo de oportunidad del capital ni con la tasa interna de utilidad según la cual se deben descontar los beneficios, de manera que en realidad los costos se descuentan con una tasa diferente de la empleada para los beneficios. Debe también puntualizarse que de hecho este método sobreestima los costos cuando los beneficios empiezan antes que el proyecto esté terminado, lo cual ocurre muy a menudo en la construcción de carreteras. Parece que no existe una ventaja especial en descontar costos y beneficios en un año que no sea el mismo en que se inicia el proyecto, que es casi siempre el primer año en que empiezan a afrontarse los costos.

Un tercer error, que sólo merece mencionarse por lo frecuente, consiste en no definir debidamente el alcance del proyecto, de donde resulta que los costos del proyecto no incluyen todos los costos pertinentes. Por ejemplo, las autoridades de un país en desarrollo que tenían a su cargo la construcción de un camino de peaje sólo incluyeron en el rubro costos del nuevo camino los ocasionados directamente por el camino; sin embargo, ello no tomaba en cuenta la necesidad de mejorar los caminos de acceso. Dado que la mejora de estos últimos era indispensable para la utilización eficaz del camino de peaje, los costos respectivos debieron incluirse en los del proyecto a los fines de la evaluación económica, aun cuando hubiera sido lógico excluirlos en un análisis de la posición financiera del organismo responsable. En este caso era probable que los caminos de acceso hubiesen sido mejorados de todas maneras alguna vez. Por lo tanto, se impuso la necesidad de fijar los costos adicionales de las mejoras antes de lo que habría sido necesario en otras circunstancias, y de los estándares más elevados del trazado indispensables para absorber el mayor volumen de tráfico ocasionado por el camino de peaje.

Medición de los beneficios económicos

La medición de los beneficios económicos de proyectos de transporte es habitualmente mucho más difícil que la medición de sus costos económicos. Son varias las razones. En primer lugar, algunos beneficios, aun cuando completamente directos (como el mayor confort y la mayor comodidad, propios de un camino mejorado) son difíciles de expresar en dinero, porque para tales beneficios no existen precios de mercado. En segundo lugar, los beneficios monetarios, tales como la reducción de los costos del transporte, favorecen a un gran número de personas durante un largo período, exigiendo difíciles previsiones a largo plazo. En tercer lugar, muchos beneficios son indirectos, por ejemplo el estímulo a la economía determinado por la mejora de los transportes; y para que estos beneficios se materialicen, a menudo se requieren inversiones en campos de actividad ajenos al transporte.

Entre los beneficios más importantes provenientes de proyectos de transportes se cuentan: 1) reducción de gastos operativos inicialmente en favor de los usuarios del nuevo servicio y también generalmente de quienes sigan utilizando los servicios

existentes; 2) costos más bajos de mantenimiento; 3) menos accidentes; 4) economías de tiempo tanto para los pasajeros como para las cargas; 5) mayor comodidad y confort, y 6) estímulo al desarrollo económico. No todos estos beneficios se dan en todos los proyectos, y de un proyecto a otro varía la importancia relativa de los mismos. En el actual estado del arte de evaluación de proyectos, los que en la lista figuran más cerca del principio son más fáciles de expresar en dinero que los otros. Este trabajo no versará sobre la medición de costos de conservación, ni de confort y comodidad. Los primeros plantean probablemente los problemas conceptuales menos difíciles, y en los países en desarrollo parecería que los últimos poseyeran un valor social relativamente bajo, aunque, a juzgar por las diferencias entre el servicio ferroviario de primera y de segunda clase, tienen un considerable valor privado.

Antes de analizar los problemas que se refieren a la medición de los demás beneficios, tal vez sea útil que consideremos una cuestión rara vez tomada en cuenta en su evaluación, a saber, la distribución de beneficios entre los beneficiarios. Por ejemplo, si la mejora de un puerto reduce el tiempo de maniobras de los barcos, inicialmente gran parte de los beneficios podría ir a manos de los armadores extranjeros; la medida en la cual aquéllos pasan al país inversor depende en gran parte del grado de competencia existente en el comercio naviero. De igual modo, el mejoramiento de una carretera panorámica puede al principio beneficiar a turistas extranjeros o a los de otras regiones del país. Un gobierno, por supuesto, podría adoptar una política tendiente a recuperar algunos (o la mayoría) de esos beneficios mediante cobros razonables a los usuarios de la carretera. Por lo tanto, la cuestión de la distribución de beneficios es importante para la elección de una política de cobros al usuario que canalice los beneficios hacia los destinatarios que se desea.

Tal vez sea más importante aún el hecho de que la distribución de beneficios afecta a su volumen general. Por ejemplo, si un ferrocarril mantiene las tarifas de cargas que ya existían, a pesar de que los costos del transporte han disminuido a raíz de mejoras introducidas, los consumidores no se beneficiarían directamente, pero tal vez el ferrocarril obtenga mayores ganancias; una determinación de los beneficios netos para la economía dependería de que se comparase lo que haría el ferrocarril con sus mayores ganancias (o el gobierno con sus "ahorros" provenientes de la reducción de pérdidas) contra los beneficios derivados de más bajas tarifas de cargas. Una consideración importante es que, si las tarifas no se rebajasen, las mejoras del transporte difícilmente estimularían un nuevo tráfico. Cuando hay un motivo para creer que la posible distribución de beneficios reduce su volumen general o está en desacuerdo con otras medidas oficiales el problema merece más seria atención que la que actualmente se le presta, con especial insistencia en las correctas tarifas que se le cobran al usuario.

Reducción de gastos operativos

El beneficio más directo de un nuevo servicio o de un servicio mejorado de transporte, y a menudo también el más importante y el más fácilmente mensurable en términos monetarios, es la reducción de costos del transporte. Aunque en el primer momento este beneficio favorece a los usuarios del servicio, la competencia o el deseo de minimizar las ganancias los conduce a compartirla en grados diversos con otros grupos, tales como productores, fletadores y consumidores. Por tanto, la reducción de costos beneficia a la nación en general y no sólo a los usuarios del servicio.

Crecimiento del tráfico

El primer paso de la medición de beneficios derivados de una reducción de costos consiste en estimar el uso futuro del servicio, es decir, el tráfico futuro durante su vida útil[3]. Este tráfico puede descomponerse en tres tipos principales: el "normal", el "desviado" y el "generado". El crecimiento "normal" de tráfico es el que habría tenido lugar de todos modos con los servicios existentes, aun sin la nueva inversión. Este tipo de tráfico se beneficia con toda la reducción de costos operativos que permite el nuevo servicio, ya que, por definición, aquél de

[3] La vida útil de una instalación está limitada en primer término por el cambio económico y la obsolescencia técnica como en los casos de procesos nuevos o mejorados y cambios de los mercados. Estos factores son mucho menos previsibles que la vida física de la instalación. Aunque en cierta medida los pronósticos relativos a la vida en servicio son, por lo tanto, inevitablemente especulativos, el hecho de tener que prescindir de plazos lejanos hace que la importancia de tales predicciones sea relativamente escasa. En muchos casos, por ejemplo, importará poco que a una carretera se asigne una vida de 25 o de 30 años.

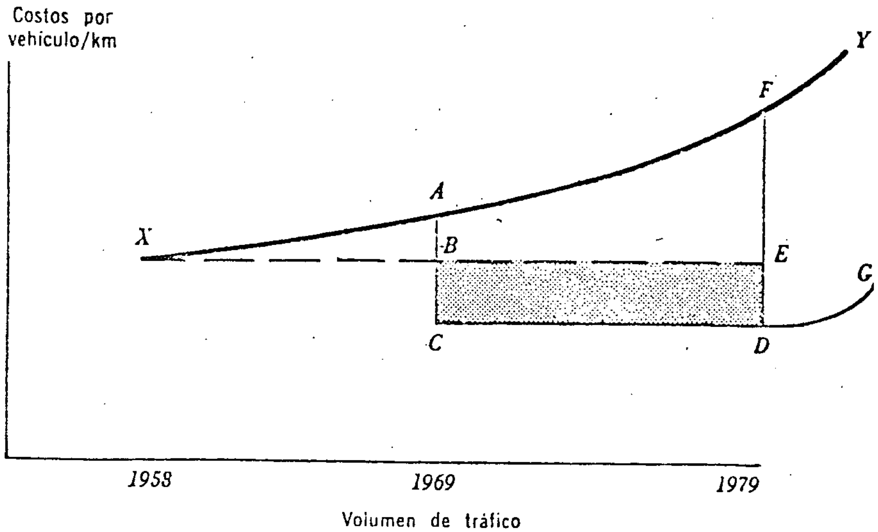
todos modos habría circulado aun a pesar de los costos más elevados (y acaso en constante crecimiento) del servicio existente.

El patrón apropiado para evaluar los ahorros en costos operativos de vehículos es el que proporciona la prueba de "con y sin": ¿a cuánto habrían ascendido los costos con el nuevo servicio, y a cuánto sin él? Sin embargo, en numerosas evaluaciones de proyectos se aplica equivocadamente un patrón muy distinto, la prueba de "antes y después": ¿a cuánto ascendían los costos antes que se instalase el nuevo servicio, y a cuánto ascenderán después? Tal como se verá más abajo, esta prueba suele conducir a una grave subestimación de los beneficios económicos.

Por ejemplo, a propósito de la evaluación de una nueva "autopista" en Japón, las autoridades competentes midieron los costos operativos de un camión en la carretera existente en 1958; eran más o menos el equivalente de 15 centavos de dólar por kilómetro, excluyendo los impuestos. Los costos en la nueva autopista, cuya inauguración había sido prevista para 1969, se estimaron en 11 centavos, o sea un ahorro de 4 centavos por camión/kilómetro. Este ahorro se aplicó luego al tráfico de camiones estimado para el período 1969-1979; se suponía que después de este período no se registraría ningún incremento del tráfico por haberse ya alcanzado la así llamada capacidad de trazado de la autopista, y porque de ahí en más los costos operativos de los vehículos empezarían a aumentar. Este método, que tiene por base la prueba "antes y después", ejemplifica una cantidad de errores comunes. El primero es el hecho de que en la comparación de costos en la carretera existente en 1958 con los de la nueva autopista de 1969 no se toma en cuenta el hecho importante de que la creciente congestión del tráfico en la carretera existente habrá elevado mucho los gastos operativos para 1969 respecto de los que regían en 1958. En segundo lugar, los costos operativos en la carretera existente habrían seguido aumentando después de 1969, mientras que los de la nueva autopista probablemente se mantendrían más o menos invariables durante 10 años y el aumento posterior sería probablemente menos pronunciado que en la carretera existente. Esta situación se ilustra en la figura IX-1.

XY representa los costos operativos de camiones en la carretera existente, suponiendo que la autopista no está construida. Asciende con el tiempo en razón de la congestión creciente. En 1969, en la época de inauguración de la nueva autopista, ya estaban algo por encima del nivel de 1958. La reducción de costos operativos por camión según la prueba "antes y después", es *BC*

FIGURA IX-1.



durante toda la vida de la nueva inversión, y los beneficios (hasta 1979) están representados por el área sombreada *BCDE*. En realidad, la reducción es *AC* cuando se inaugura el nuevo servicio en 1969 y *DF* en 1979; y los beneficios corresponden por lo menos a *ACDF*. Además, se presta a dudas el que no se presuponga ningún aumento de tráfico después de 1979. El concepto de capacidad de la carretera no podría en justicia considerarse científico, y el tráfico de la carretera existente es más que el doble de la capacidad de trazado. Lo que importa realmente es determinar en qué punto se justifica la nueva inversión con el objeto de aumentar la capacidad. Dado que tal vez esa inversión habrá de ser de carácter global, la decisión implica ponderar los costos de la congestión aumentada en la carretera existente, comparándolos con los beneficios netos de la capacidad adicional. A raíz del carácter global de la inversión, los aumentos de tráfico apreciablemente por encima de la capacidad de trazado pueden justificarse antes de ampliar más la capacidad.

A veces se dice que cuando se toman debidamente en cuenta los costos crecientes de una congestión en aumento, es decir, la diferencia entre las curvas *CG* y *AY*, el crecimiento de los ahorros operativos de vehículos tiende a ser dos veces más que

el del tráfico. Aunque estas generalizaciones deben tomarse con pinzas, algunos casos reales indican que a veces pueden servir a modo de relativa aproximación. Por ejemplo, el estudio de la mejora de un camino en Jamaica indicaba que los costos operativos se reducirían en unas £ 40.000 en 1963. Si este beneficio se incrementa con un aumento anual estimado del tráfico en un 12 por ciento, se llegaría a £ 70.000 en 1968 y a £ 120.000 en 1973. Sin embargo, tomando en consideración los costos crecientes de la mayor congestión, el beneficio ascendería a £ 90.000 en 1968 y a £ 250.000 en 1973. Esta diferencia se acentuaría más aún en los años siguientes.

La aplicación de la errónea prueba de "antes y después" puede llevar a resultados curiosos. A propósito de una mejora de una carretera, propuesta en Siria, las investigaciones realizadas demostraron que los costos operativos de vehículos en la carretera existente eran muy razonables; tenía una superficie bastante buena y un ancho satisfactorio. Lamentablemente, la carretera no se había construido para las pesadas cargas que soportaba y los ingenieros advirtieron que se deterioraría más o menos en dos años y que (aun con elevados gastos de mantenimiento) sería necesaria una reconstrucción total. No obstante, los costos operativos de vehículos no se reducirían apreciablemente en adelante. La prueba de "antes y después" indicaba que la reconstrucción produciría sólo modestos beneficios y no se justificaría, por lo menos en ese momento. Sin embargo, la prueba de "con y sin" demostró que, sin la nueva inversión, los costos operativos de vehículos aumentarían bruscamente, para no hablar de los gastos de mantenimiento, en este caso, eludir ese aumento sería la base adecuada para la evaluación económica de los beneficios.

Los ejemplos que anteceden se refieren exclusivamente a carreteras, pero en principio el análisis es idéntico para el caso de ferrocarriles y puertos. Por ejemplo, en 1963 el Ferrocarril Español elaboró un programa de modernización y expansión para 10 años, cuyo costo se calculó en el equivalente, más o menos, de mil millones de dólares. Además de evaluar los beneficios derivados de componentes del programa considerados aisladamente, se procuraba medir también el rendimiento del programa en conjunto. El análisis demostró que el programa rebajaría los costos operativos en un 25 por ciento aproximadamente entre 1963 y 1973. Cuando se confrontó este beneficio con los costos de inversión de la parte del programa relativa a modernización, la tasa interna de rendimiento resultó ser más o menos del 15 por ciento. Sin embargo, esta aplicación de métodos de "antes y después" subestimaba notablemente los beneficios, ya que, a falta de nuevas inversiones, los costos operativos no se hubieran quedado en el nivel de 1963, sino que habrían aumentado. Cuando se tomó en cuenta esta circunstancia, la tasa de rendimiento de la inversión pasó a ser más o menos del 18 por ciento.

El segundo tipo de tráfico es el que se desvía hacia el nuevo servicio, ya sea desde otros medios de transporte o desde otras rutas [4]. El beneficio producido por el tráfico desviado se calcula midiendo la diferencia entre los costos de transporte por la vieja ruta o el anterior medio de transporte y los de la nueva. Empero, se plantean dos problemas especiales que deben tenerse en cuenta al justipreciar ese beneficio. El primero es que los costos pertinentes y relacionados con nuestro caso no corresponden al promedio de costos del transporte en ambos medios, sino a los costos evitables, es decir, a las sumas que se habrían ahorrado. Por ejemplo, si el tráfico se desvía de un ferrocarril a una nueva carretera, los beneficios no pueden calcularse comparando los costos de transporte por la nueva carretera con lo que cobra el ferrocarril, ni siquiera con el promedio de los costos por ferrocarril, sino comparándolos con los costos maginales del acarreo del tráfico desviado por ferrocarril. Si, pongamos por caso, el tráfico desviado no es más que una pequeña parte del tráfico ferroviario total, y si el ferrocarril tiene exceso de capacidad, los ahorros marginales estarán muy por debajo de lo que surja de la comparación de promedio de costos; probablemente esto es lo que ocurre casi siempre. Si bien los datos disponibles en la mayoría de los países subdesarrollados no permiten estimaciones precisas de costos marginales, la comprensión de estos conceptos correctos es indispensable para hacer el mejor uso posible de los datos que puedan manejarse.

La comparación de los costos de distintos medios de transporte plantea otro problema práctico, por cuanto los servicios de transporte provistos por cada medio difieren de ordinario notablemente y, por lo tanto, deben ser reducidos a un común denominador. Los costos totales de distribución constituyen la preocupación primordial, no sólo el costo de embarque. Por ejemplo, la comparación de los costos del tráfico naviero de cabotaje derivado a una carretera debe tomar en cuenta no solamente los costos de embarque, sino también costos adicionales como carga y descarga, almacenaje, seguro, deterioros, demoras, etc. Es muy fácil que estos costos adicionales representen un 50 por ciento que se suma a los costos básicos de embarque. De igual manera, en la comparación de los costos de transporte por ferrocarril y por carretera debe tomarse debidamente en cuenta el hecho de que el acarreo en camión es un servicio de puerta a puerta, mientras que el servicio ferroviario por lo general requiere dos cargas y descargas, las cuales, además de los costos directos, a menudo implican demoras y deterioros.

Así como los beneficios para la economía se miden por la reducción de costos sociales (por ejemplo, excluyendo impuestos), no son los costos sociales sino los privados los que interesan al evaluar el volumen de tráfico desviado. En efecto, como muchas personas toman decisiones sobre la conducción de vehículos basándose particularmente en los gastos efectivos, la diferencia entre éstos y las tarifas ferroviarias que se cobran realmente (independientemente del costo) es lo que principalmente decidirá el volumen de tráfico de pasajeros que se desviará de un ferrocarril a una carretera.

El tercer tipo de tráfico es el generado recientemente por una rebaja de costos del transporte y que anteriormente no existía. Incluye tanto el tráfico que corresponde a aumentos de la producción industrial o agrícola estimulados por el menos costo del transporte, como el que no tiene nada que ver con aumentos de producción, por ejemplo el caso de artículos que antes se vendían en el lugar de su producción y que ahora se llevan a mercados en donde es posible obtener mejores precios.

En lo que toca a las reducciones de los costos del transporte, no se justificaría aplicar a este tráfico la reducción total de los costos unitarios operativos, ya que el mismo no habría tenido lugar sin la reducción. Si hay razones para creer que en una determinada situación se habría generado el tráfico con una reducción de los costos de transporte de sólo una cuarta parte de la reducción real, sería correcto aplicar al tráfico generado tres cuartas partes de la reduccin del costo unitario. En las múltiples situaciones en que los datos disponibles no permiten formular juicio sobre la relación entre el grado de reducción del costo de transporte y el volumen del tráfico generado, tal vez

[4] Otro tipo de tráfico desviado es el cambio de un tipo de vehículo a otro en la misma ruta, como los viajes de pasajeros que antes se hacían en ómnibus y ahora se hacen en auto particular. En este caso, es evidente que el mayor costo de operación de un automóvil particular está compensado por sus ventajas cualitativas, sobre todo el mayor confort y comodidad; de ordinario, no es posible medir estas diferencias en términos monetarios.

la hipótesis más razonable sea que este tráfico se habría desarrollado proporcionalmente a la reducción de los costos de transporte; de ser así, se justificaría aplicar a este tráfico la mitad, aproximadamente, de la reducción del costo unitario.

En el grado en que la finalidad principal de un nuevo servicio de transporte sea abrir nuevas tierras al cultivo y otra manera de posibilitar un nuevo desarrollo económico, las reducciones de los costos de transporte por tráfico generado no constituyen una medida significativa de los beneficios económicos del proyecto. En este caso, el beneficio está constituido por la nueva producción así posibilitada; de los problemas concernientes a la medición de este beneficio se habla más adelante.

Disminución de los accidentes

La disminución de los accidentes es sin duda alguna un beneficio económico, pero no toda mejora de los transportes los reduce; que ello ocurra o no, es cosa que debe investigarse en cada caso. Por ejemplo, es muy posible que un camino mejorado aumente al principio no sólo la cantidad de accidentes, sino —y esto es lo más importante— la tasa de accidentes por vehículo/kilómetro y la gravedad de los accidentes individualmente considerados. Esto podría suceder cuando la mayor velocidad no se halla contrapesada con nuevos factores de seguridad, sobre todo en un país donde la conducción de automóviles está todavía en sus etapas iniciales y donde la disciplina requerida para una conducción segura está igualmente subdesarrollada. Al parecer, la reducción de los accidentes es muy importante en autopistas que tienen carriles divididos y acceso controlado.

En la medición de beneficios económicos intervienen dos pasos principales. El primero consiste en estimar la disminución del número de accidentes, lo cual implica, por ejemplo, comparar la proporción de accidentes que se registrarían en la carretera actual si no se introdujeran mejoras, con la proporción registrada en carreteras de más alta calidad existentes en el país o, si fuere necesario, en otros países (pero tomando en cuenta las diferencias nacionales).

El segundo paso consiste en estimar el valor de la reducción de accidentes. A este fin es útil considerar tres tipos de daños. El que más fácilmente puede medirse en términos monetarios es el daño a la propiedad, por lo general a los automotores que

intervienen en el accidente. Las estadísticas policiales de Japón, por ejemplo, señalan que el promedio de daños a la propiedad por accidente equivale a 600 dólares; es posible que esta cifra no sea ilógica (aunque se la debería corregir teniendo en cuenta los impuestos internos, por ejemplo), dado que más o menos dos terceras partes del tráfico corresponden a camiones y ómnibus, cuyo promedio de edad es relativamente bajo. El costo atribuible a las lesiones es más difícil de justipreciar. En los estudios japoneses se lo calculó en unos 100 dólares por accidente, incluyendo en esta cifra un suplemento por pérdida de ganancias y otro por costo del tratamiento médico de los heridos cuya edad sobrepasaba los 14 años.

Finalmente, para justipreciar la reducción de accidentes fatales, el problema reside en la asignación de un valor a la vida. En el caso del Japón, ésta se calculó capitalizando el ingreso medio anual por trabajador a lo largo de un período de 30 años. Evidentemente, este criterio es muy discutible. Como mínimo deben deducirse del ingreso bruto los recursos necesarios para producir ese ingreso. Sería demasiado duro sugerir que, si un país está superpoblado, los valores sociales y privados de la reducción de muertes serían completamente distintos. En suma, parecería preferible no expresar en términos monetarios la reducción del número de accidentes fatales [5]. En muchos casos los accidentes fatales pueden no ser tenidos en cuenta, o bien se puede simplemente expresarlos por la cantidad de muertos en cuestión.

Ahorro de tiempo

Aun cuando la mayoría de las mejoras de los transportes reducen el tiempo que se tarda en los viajes, el valor del tiempo para pasajeros y cargas se omite a menudo en las evaluaciones de proyectos. Esto puede conducir a una grave subestimación de los beneficios, pues es posible que los ahorros de tiempo sean importantes.

En lo que concierne a las personas, el tiempo puede representar dinero, pero no es forzoso que ello ocurra. El que así sea

[5] Sin embargo, si el propósito de un proyecto es reducir el número de accidentes, como en el caso de medios de seguridad en un campo de aviación, resulta absolutamente indispensable expresar la disminución de casos fatales en términos monetarios.

depende en primer lugar de la forma en que se aprovechen las oportunidades permitidas por la mayor disponibilidad de tiempo, ya sea para una mayor producción o mayor ocio voluntario, por un lado, o para inactividad involuntaria, por otro. Lamentablemente, en muchas naciones subdesarrolladas existe una gran subocupación, de modo que los ahorros de tiempo pueden servir únicamente para empeorar la situación. Pero aun en estos casos, es posible que sean muy valiosos, por ejemplo, para los empresarios.

Como ejemplo de lo que puede hacerse para medir el valor del tiempo nos referiremos a un estudio recientemente hecho en Japón, donde se proyectó una nueva autopista con el fin de reducir considerablemente el tiempo empleado en los viajes. Los viajeros fueron divididos en dos grupos: los relativamente pocos que podían permitirse el lujo de viajar en autos particulares, y los muchos que viajaban en ómnibus. Como primer paso, se relacionó el valor medio del tiempo con el ingreso *per cápita* de ambas clases. Esto demostró que en una hora los viajeros de auto particular podían ganar por lo menos un dólar, mientras que los que se desplazaban en ómnibus podían ganar por lo menos 20 centavos. Dado que en Japón hay muchas oportunidades de empleo, este cálculo no era ilógico.

Sin embargo, para comprobar su validez estos valores medios se confrontaron con las sumas que la gente está realmente dispuesta a pagar por el tiempo. Con este objeto se hizo un estudio de las sobretarifas de los ferrocarriles para diferentes tipos de trenes que circulaban entre las mismas ciudades. En la línea Tokaido, por ejemplo, los viajeros tienen a su disposición una muy amplia variedad de trenes para elegir, que van desde los locales lentos hasta los expresos muy veloces. Si bien entre algunos de estos trenes la velocidad no es la única diferencia, pues también cuentan la comodidad y el confort, aquélla es la más importante y probablemente la única por lo menos entre dos de esos trenes. Un análisis de esas sobretarifas señala que los viajeros están conformes en pagar por lo menos el equivalente de 2 dólares en primera clase y 1 dólar en segunda por cada hora ahorrada. Estas comprobaciones y las que se basan en el método de las ganancias dieron un índice claro de la escala de valores que podría asignarse a los ahorros de tiempo de los pasajeros. Se sugiere allí que en Japón, por lo menos, muchas personas prefieren disfrutar de esos ahorros de tiempo bajo la forma de ocio aun pudiendo aprovecharlos en actividades productoras de ingresos. Es probable que esto no valga para la

mayoría de las naciones subdesarrolladas. De todos modos, dado que los ahorros de tiempo subsistirán presumiblemente durante la vida del proyecto, se debe tomar en cuenta el creciente valor del tiempo a medida que aumenta el ingreso *per cápita* [6].

El tiempo ahorrado en el envío de cargas puede perfectamente ser más valioso en las naciones menos desarrolladas que en las que ya se encuentran más adelantadas. Las cargas inmovilizadas durante el tránsito son en realidad capital y, por tanto, revisten importancia singular en los lugares donde la oferta de capital es escasa. Este ahorro puede medirse por el precio del capital, es decir, la tasa de interés. Además, la mayor rapidez de las entregas, que a su vez va habitualmente acompañada de una mayor seguridad, reduce los deterioros y permite un menor stock, lo cual a su vez es una nueva manera de ahorrar capital. Aparte de esto, en los casos en que no son posibles stocks más grandes, una demora puede inmovilizar otros recursos, como ocurre cuando la falta de un repuesto impide el funcionamiento de un equipo costoso.

Como en el caso de los ahorros de tiempo para los viajeros, se efectuó en Japón un estudio de los precios que los fletadores dispuestos a pagar por distintos tipos de servicios de transporte en casos en que el tiempo era por amplio margen la principal diferencia, y en otros en que tal vez fuese la única. El estudio abarcó una docena de productos importantes y reveló, por ejemplo, los siguientes precios pagados de hecho por el ahorro de una tonelada/hora (en centavos de dólar):

Productos lácteos	35
Pescado fresco	21
Verduras	20
Frutas	14
Minerales	1

Comparada con otros beneficios, la importancia relativa de los ahorros de tiempo depende, por supuesto, del carácter del proyecto en cuestión. El que pueda llegar a ser muy importante lo denota el proyecto para el cual se hicieron los estudios antes mencionados. En este caso el valor de los ahorros de tiempo fue casi la mitad del valor de los beneficios derivados de los más bajos costos operativos de los vehículos [7].

[6] Generalmente se deja un margen para ahorros de tiempo de los conductores de ómnibus y camiones dentro de los cálculos de ahorros en la explotación de vehículos.

[7] El ahorro de tiempo para los vehículos se cubre generalmente con el menor margen de depreciación que se incluye en los costos de explotación.

Desarrollo económico

Es común dar por sentado que todas las mejoras en los transportes estimulan el desarrollo económico. La triste verdad es que en algunos casos ocurre así y en otros no; e inclusive en algunos donde se da no se justifica económicamente, en el sentido de que puede haber mejores oportunidades de inversión. Por lo tanto, todos los proyectos deben estudiarse en forma individual y no aparecerá ninguna generalización útil hasta que una mayor investigación demuestre la existencia de ciertas correlaciones definidas.

Antes que pueda decirse que una determinada mejora de los transportes ha estimulado de algún modo el desarrollo económico, deben reunirse varias condiciones. La más importante es la que exige demostrar que el desarrollo económico no se habría producido en ningún caso, aun sin las mejoras de los transportes. La segunda es que los recursos empleados en el nuevo desarrollo, en otras condiciones habrían permanecido ociosos o se los habría utilizado menos productivamente. Por último, es esencial que la actividad económica estimulada no remplace a la actividad que hubiese tenido lugar en cualquier otro caso.

Tal vez estas condiciones sean evidentes, pero sorprende la frecuencia con que se las pasa por alto en la práctica. En los complicados estudios japoneses a que acaba de hacerse referencia, se emprendió una amplia investigación para medir el crecimiento de la producción industrial en el área de influencia de una nueva carretera, y hubo poderosas razones para creer que la carretera y la producción estaban en realidad vinculadas causalmente. Aunque esto resultó utilísimo desde el punto de vista local, fue mucho menor su importancia para el conjunto de la economía. Nuevos estudios señalaron que la mayoría de los recursos empleados en la nueva producción no habrían permanecido ociosos de todas maneras, y que las empresas que se encargaron de la nueva producción habían proyectado expandirse en cualquier caso y elegido un lugar cercano a la nueva carretera en virtud de sus ventajas. Por lo tanto, desde el punto de vista nacional no puede considerarse que la carretera haya contribuido significativamente al estímulo del nuevo desarrollo económico. Esto no implica que los desplazamientos de ubicación producidos por la carretera no comporten otros beneficios económicos aparte de los menores costos del transporte; tal vez hayan facilitado una producción más eficiente, pero este beneficio sólo puede representar una fracción de la producción neta total.

Cuando un servicio de transporte determina realmente una mayor producción y se cumplen las condiciones antes mencionadas, el valor neto de este aumento de producción da la medida apropiada del beneficio económico[8]. Sin embargo, en muchas situaciones el servicio de transporte en cuestión no es la única nueva inversión requerida para lograr la mayor producción. Esto trae consigo el problema de la distribución del beneficio, es decir, de la producción acrecentada, entre el transporte y las demás inversiones. Para esto no existe una solución teórica correcta, pero por lo menos existen tres métodos prácticos. Uno sería el no hacer ninguna distribución y relacionar los beneficios totales con el total de las inversiones. Un segundo método consistiría en anualizar los demás costos de inversión y deducirlos de los beneficios. Y el tercero sería distribuir los beneficios en la misma relación en que la inversión en transportes se halla con respecto a las otras inversiones necesarias.

Cada una de estas soluciones es apropiada para una situación distinta. Por ejemplo, en el caso real de la nueva minería del carbón en Sarawak, fue necesario construir un camino para transportar el carbón desde la mina a un puerto. Las estimaciones indicaban que el carbón representaría más del 90 por ciento del tráfico total, usando el nuevo camino. Éste fue una parte integrante del plan de extracción del carbón, exactamente tan integrante como los equipos usados para explotar las minas, y carecía virtualmente de todo otro uso. En este caso, la distribución de beneficios entre el camino y las inversiones hechas en la mina carecería de sentido. En cambio, cuando se construye un camino destinado a facilitar un nuevo desarrollo agrícola o industrial, que sin embargo requerirá también otras inversiones importantes, podría resultar más útil la distribución de beneficios.

Cuando el nuevo servicio de transporte amplía el mercado de bienes producidos anteriormente, el beneficio económico consiste en la diferencia de valor de ese bien en el mercado viejo y en el nuevo, menos los nuevos costos de transporte. Por ejemplo, supongamos que el precio en el mercado viejo haya sido de 10 centavos y en el segundo de 20 centavos; pero como

[8] Por supuesto, el valor neto de la producción y los ahorros en la explotación de vehículos para el tráfico generado no son acumulativos.

los costos del transporte son 12 centavos, el envío a este último mercado es antieconómico. Suponiendo una mejora del transporte que rebaje los costos respectivos a la mitad, o sea a 6 centavos, el artículo podrá entregarse en el segundo mercado a 16 centavos y venderse allí a 20. La ganancia producida por la nueva inversión (suponiendo un empleo total de los recursos antes y después del cambio) sería de 4 centavos. Debe tomarse en cuenta el hecho de que la mayor oferta puede repercutir sobre los precios en ambos mercados; si ello ocurre así, el beneficio se calcula habitualmente a los precios vigentes después de concluida la mejora del transporte [9].

Lo que en la práctica puede hacerse para calcular el valor neto del aumento de producción o de los mercados más amplios difiere entre uno y otro caso. En el ejemplo relativo a Sarawak que acaba de mencionarse, con intervención de diversos expertos se realizaron estudios detallados de la oferta de carbón, costos de producción y de transporte, y probables precios de mercado. Por lo general son mucho más difíciles los problemas que se relacionan con el desarrollo agrícola, debido a que su éxito depende de la buena voluntad y capacidad de un gran número de personas y del potencial de desarrollo de grandes zonas. En el caso de Sarawak, la probable producción agrícola resultante del nuevo camino se podía estimar con un margen aceptable de error, ya que sólo se trataba de dos productos y la experiencia de anteriores mejoras del transporte por tierra con un potencial agrícola similar podía servir de razonable guía en cuanto a la probable producción futura y a las demás inversiones requeridas para lograrla.

Este es un campo muy poco investigado hasta ahora. Pero es evidente que, si el propósito principal de un servicio de transporte es estimular el desarrollo económico, deben hacerse esfuerzos mayores por medir este beneficio (similares a los que hoy se hacen, por ejemplo, para un plan de riego). Y, si el desarrollo económico sólo puede conseguirse cuando la mejora del transporte va complementada con medidas tales como otras inversiones, servicio de extensión a los agricultores, reforma agraria, etc., estas medidas pasan entonces a ser condición esencial del proyecto. Esto también se ha reconocido en el ámbito del riego, pero lamentablemente no se lo reconoce del todo en el del transporte.

[9] Por lo general, para el tráfico de pasajeros este beneficio, es decir, la diferencia entre quedarse en casa y viajar, menos los costos de transporte, no puede medirse en dinero.

Comparación de costos y beneficios

Una vez evaluados los costos y beneficios en términos monetarios y en un grado plenamente significativo, los resultados pueden expresarse por lo menos en tres formas distintas: tasa de rendimiento de la inversión, razón beneficio-costo, o bien, período de reembolso. Mucho se ha escrito acerca de estas alternativas, por lo cual limitaremos la presente exposición a algunos puntos salientes.

Por desgracia, no hay uniformidad en la aplicación de estas formas. En algunas razones de beneficio-costo, por ejemplo, se comparan costos brutos con beneficios brutos, mientras que en otras primero se deducen de los beneficios algunos costos; esto puede afectar muy apreciablemente la proporción. A veces (lo que es más correcto) se utiliza la diferencia entre beneficios y costos. En el caso de cálculos de la tasa de rendimiento, los beneficios se miden a veces con relación a los costos de inversión (con margen para la depreciación o sin él), a veces según la tasa interna de rendimiento. Es indispensable saber exactamente qué fórmula se usa si el resultado final ha de ser interpretado debidamente.

Mientras que los ingredientes fundamentales (valor de los costos y beneficios) son los mismos independientemente de la forma definitiva en que se los exprese, la utilidad de las diversas formas varía según sea la finalidad. Un plazo corto de reembolso del dinero reviste importancia cuando el futuro es particularmente incierto, cuando es posible que pronto aparezcan mejores oportunidades de inversión, o cuando no hay disponibilidad de fondos para largo plazo. Estas consideraciones revisten mucha más importancia para las empresas privadas que para los gobiernos. Además, el hecho de que los beneficios de una inversión sean grandes al principio puede no dar indicación alguna de lo que haya de ocurrir durante la vida de la inversión, de manera que este método es singularmente pobre para comparar inversiones que tengan una diferente secuencia temporal de beneficios. Asimismo, existen técnicas superiores que permiten incorporar la incertidumbre al análisis de las inversiones.

El descuento de beneficios y costos mediante el costo de oportunidad del capital es teóricamente la mejor manera de comparar proyectos diferentes. La desventaja más importante de este método reside en el hecho de que para el descuento debe elegirse una determinada tasa de interés. En la práctica el interés se paga con una tasa frecuentemente mal elegida, que puede o no tener relación con el costo de oportunidad del capital en el país. Lamentablemente, el costo de oportunidad del capital con frecuencia es desconocido o sólo se lo puede calcular con un margen considerable de error. Esto es singularmente crítico, por cuanto la tasa de interés que se elija para el descuento es uno de los principales factores determinantes de la comparación beneficio-costo.

En cierta medida se puede minimizar la desventaja si se expresan los beneficios y los costos en función de la tasa interna de rendimiento de la inversión, es decir, la tasa que equipara los costos y beneficios descontados. En este caso el costo de oportunidad del capital se torna importante sólo en los casos marginales en que la tasa interna de rendimiento no está claramente por encima ni por debajo del área dentro de la cual cabe suponer que se encuentra el costo de oportunidad del capital. Por ejemplo, sería virtualmente cierto que una inversión hecha en Japón con una tasa de rendimiento del 12 por ciento se justifica, pues el costo de oportunidad del capital es menor, probablemente entre 6 y 10 por ciento. Pero aun cuando las dos tasas puedan aproximarse relativamente, la fórmula que utiliza la tasa interna de rendimiento presenta la ventaja de enfocar directamente la cuestión crucial: cómo comparar una determinada inversión con otras oportunidades de inversión. La razón beneficio-costo tiende a ocultar este punto capital, presuponiendo una determinada tasa de interés.

Por otra parte, la fórmula de la tasa interna de rendimiento tiene también sus desventajas. Si bien, desde el punto de vista práctico, por lo general conduce a una correcta elección de proyectos, a veces puede ser engañosa en la comparación de proyectos que tienen vidas distintas y cuyos beneficios se manifiestan en plazos diferentes. En la práctica, sin embargo, el transporte supone casi siempre inversiones a largo plazo, y los plazos de los beneficios no tienden a variar gran cosa. Aun cuando así ocurriese, es posible que el margen de error correspondiente a un cálculo basado en la tasa interna de rendimiento fuese menor que el descuento basado en el costo de oportunidad del capital, que generalmente se conoce sólo dentro de un amplio margen. Además, cuando un proyecto se compara no con una alternativa directa sino con las oportunidades de inversión

en general, la tasa interna constituye en general una fórmula perfectamente aceptable.

Otra desventaja de la tasa interna de rendimiento reside en que la solución puede ser ambigua en el sentido de que tal vez más de una tasa equipara costos y beneficios. En la práctica esto es raro en el caso de proyectos de transporte, dado que los costos se afrontan sobre todo en las etapas iniciales y los beneficios aparecen después; por lo tanto, en ese caso esta sería la única solución.

Por último, la fórmula de la tasa de rendimiento presenta la ventaja práctica de que los economistas, los expertos en finanzas y muchos empresarios poseen una cierta noción de lo que es una tasa interna, de manera que una tasa de rendimiento tiene probablemente más sentido para muchos públicos que una razón beneficio-costo. En resumidas cuentas, entonces, la tasa interna de rendimiento de la inversión suele ser, aunque no invariablemente, la forma más satisfactoria en que pueden expresarse los beneficios y los costos de proyectos de transporte en países menos desarrollados.

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SISTEMAS MARITIMOS Y PORTUARIOS

EVALUACION DE PROYECTOS MARITIMOS

"RECURSOS FINANCIEROS Y REALES PARA EL DESARROLLO"

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PLANES, PROYECTOS Y PRIORIDADES

1. Introducción

Dejando a un lado diferencias en cuanto a método y organización, puede decirse que en todo proceso de planificación han de concurrir dos elementos. Uno es la idea clara y completa de cuáles son los recursos reales y financieros de la economía, y el otro es aventurarse a proyectar hacia el futuro el empleo de esos recursos de modo tal que se obtenga el máximo desarrollo. Derívanse de esto dos cuestiones clave que pueden enunciarse así: ¿Dónde nos hallamos? y ¿Qué rumbo tomar? Desentrañar la primera es trabajo tedioso; enfrentarse a la segunda es un reto a la imaginación del experto y del arquitecto de la política.

No ha de sorprender, pues, que los planificadores de todas partes del mundo no presten suficiente atención a la primera cuestión, y en cambio se concentren en la segunda. De ahí que con frecuencia la planificación quede reducida a un mero ejercicio mecánico que consiste en exponer —con diversos grados de detalles y precisión, y sobre distintos supuestos, que pueden estar o no justificados— lo que se desea lograr en el futuro; en tanto los planes dejan de guardar relación con las condiciones prevalecientes que mediante ellos se pretende cambiar.

Desde luego, las circunstancias del momento no siempre pueden ofrecer una base firme para los planes, ni siquiera tratándose de proyecciones de tan corto plazo como son las del presupuesto anual de un gobierno. En la mayoría de los países los preparativos para formular el presupuesto de un año han de emprenderse en una época en que aún no se conocen cabalmente los resultados del año anterior, por lo cual las bases para el "plan" presupuestario no pueden fijarse con certeza. Mientras

más se adentre el plan en lo desconocido y mientras más quieran abarcar los planificadores en cuanto a métodos y sutilezas, mayor será el vacío entre las bases presupuestas del plan y sus bases reales asentadas en la economía cotidiana.

¿Dónde nos hallamos?

Este problema nunca podrá resolverse por completo. No obstante, existen sobradas razones para que el escrutinio del estado actual de las cosas sea más acucioso que el que los planificadores en muchos países acostumbran hacer. Son muy frecuentes las veces en que los planes de desarrollo han resultado obsoletos antes de llegar a completarse, por no estar al día en sus comienzos. La única manera de conjurar esto es mejorando la información actual que aportan a los planificadores los distintos sectores de la economía, y, en especial, los departamentos gubernamentales. Es sólo sobre la base de un cabal conocimiento de lo que está ocurriendo en el momento en que se formula el plan, como puede hacerse una provechosa determinación de lo que ha de ocurrir. Además, el incentivo que brinda la afluencia constante de datos ayudará a los planificadores a escoger con criterio nacional entre alternativas y a seleccionar metas asequibles. Y más útil aún les será evaluar la relación de los varios sectores de la economía ante las medidas ya implantadas.

En muchos países se ha intentado resolver el problema haciendo extenso uso del historial de los datos que arrojan las experiencias pasadas. Series de estas cronologías se compilan para indagar la trayectoria de la economía en el pasado, y de ellas se deducen las tendencias actuales y los valores promedios de las variables económicas pertinentes. Mucho hay que decir en favor de estas prácticas. Ver el futuro en la perspectiva del pasado y establecer el curso fundamental que ha seguido la economía nacional, es indispensable para apreciar adecuadamente las varias fuerzas que actúan en la economía así como conocer su intensidad relativa. Mas, infortunadamente, no siempre está lo bastante claro en la mente de los planificadores que ni aun la más cuidadosa y precisa evaluación de los derroteros *pasados*, puede sustituir a una evaluación igualmente cuidadosa y precisa en la que se determine la situación del panorama económico presente.

¿Qué rumbo tomar?

La utilidad de mirar hacia adelante —el aspecto seductor de la planificación— depende de la medida en que se cumplan dos condiciones. Una es la distinción que debe hacerse entre lo que es probable que ocurra "automáticamente", es decir, sin cambios en las políticas, y lo que habrá de ocurrir sólo si se hacen ciertos cambios. La segunda condición es que el plan sea considerado como una declaración de política sobre la cual puedan basarse con razonable seguridad las decisiones que adopten todas las unidades económicas. La distinción entre prever lo que ha de ocurrir "automáticamente", y lo que ha de suceder *sólo* en el caso de que el gobierno implante determinadas medidas, resulta importante porque permite a los planificadores, y mediante ellos a los forjadores de la política, concentrar su atención en el limitado número de cuestiones sobre las cuales *deben* recaer decisiones. En años recientes se ha puesto de moda expresar gran parte del análisis económico, y particularmente del análisis del desarrollo, en términos de la adopción de decisiones. Se ha aducido que la inhabilidad o la renuencia a adoptar decisiones de parte de los presuntos forjadores de la política, ya se encuentren en el sector del gobierno o en el privado, han detenido el desarrollo económico; de ahí que los economistas y otros científicos sociales hayan dedicado mucha atención a discurrir medios para facilitar la formulación de las decisiones. Tal vez el servicio más importante que la planificación aporta al proceso de adaptar decisiones es la distinción que hace entre cuestiones que requieren

inmediata resolución y aquellas cuya decisión puede aplazarse.

General o parcial

Una de las faltas en que comúnmente incurren los planificadores del desarrollo es su insistencia en que muchas decisiones deben tomarse a un mismo tiempo, y en que, a la inversa, no hay objeto en actuar sobre una recomendación de la política si al propio tiempo no se actúa sobre todos los demás problemas que son corolarios. En particular, algunos economistas latinoamericanos han argumentado que las medidas antiinflacionarias son inútiles si no van acompañadas de reformas fiscales, de una completa revisión de la propiedad de las tierras, de una reforma del sistema educativo, etc. Puesto que todo está entrelazado, todo debe hacerse a un mismo tiempo.

Este enfoque resulta erróneo en dos importantes aspectos. En primer lugar, deja de tomar en cuenta el mecanismo político que interviene en la adopción de las decisiones. Prescindiendo de las diferencias que puedan existir entre las instituciones políticas, las decisiones incumben a un gran número de personas que deben ser consultadas y convencidas, y de no lograr esto último, deben ser contradichas y aplacadas. En segundo lugar, insistir en que se dicten providencias generales es desconocer el hecho de que cualquier decisión fundamental de la política probablemente alterará un cúmulo de circunstancias que otras decisiones de toda suerte habrán de hacer cambiar.

De esta manera surge una importante asimetría conceptual. Por una parte existe la necesidad de una visión cabal de la economía, de saber el lugar dónde en el momento presente se encuentran todos sus componentes y en qué dirección tienden a moverse. En este aspecto, el plan debe ser general. Mas cuando se le mira en otro sentido —como la tarea de trazar una estrategia práctica—, el plan no puede ni debe ser general, sino por fases o fragmentado.

La idea de la planificación general conduce a otro aspecto del mismo proceso, que ha resultado tema de controversia en años recientes, es decir, la extensión y la profundidad de la planificación en los diversos sectores de la economía. La idea bastante común de que el planeamiento puede quedar limitado al sector público, lo cual a primera vista parece plausible, en la práctica no es realmente trascendente. En el sector público no pueden tomarse decisiones provechosas si no se tiene una noción bastante exacta de la dirección en que el sector privado se está moviendo, así como de cuál es probable que sea la composición de la inversión privada. Esto es igualmente cierto tocante a la magnitud y composición de las erogaciones públicas, de la selección de los proyectos para el desarrollo público; y de la decisión para aumentar o reducir los gastos corrientes para ciertos objetivos. Obviamente sería de poco sentido incluir, por ejemplo, en un plan para el desarrollo del sector público, el desembolso para una carretera, o un proyecto de energía eléctrica, sin determinar previamente cuál es la demanda probable de estas facilidades. Todo plan de desarrollo debe atender tanto al sector privado como al público.

La confusión que existe en la controversia relativa a la extensión de la planificación ha surgido por dos motivos conexos. Uno es el hecho de que al preparar las proyecciones los planificadores en muchos países han dejado de distinguir claramente entre decisiones gubernamentales y decisiones privadas —es decir, entre las decisiones referentes a la distribución de los recursos que el gobierno mismo puede y debe hacer, y aquellas decisiones que son el resultado de deliberaciones y acciones dentro del sector privado, las cuales sólo pueden ser influidas por las acciones del gobierno a través de un sistema de incentivos y de frenos.

El otro motivo es también resultado de no distinguir entre lo que el gobierno puede hacer y lo que "debiera

ser" hecho por el sector privado. Esta omisión lleva a los planificadores a la conclusión de que el gobierno debe *asegurarse* de que las proyecciones para el sector privado han de realizarse, y de que las "metas" serán alcanzadas —presumiblemente por la acción directa del gobierno en caso de que el sector privado no cumpliera su cometido en la medida a que aspiran los planificadores. Esta preocupación en cuanto a asegurarse de que los planes sean cumplidos es probable que conduzca a una prolongación de la acción del gobierno más allá de las intenciones originales de cualquier planificador, especialmente cuando la actuación del gobierno puede prolongarse fácilmente —como por ejemplo, en la industria. Semejante prolongación de las actividades del gobierno en campos donde el sector privado pueda actuar con eficiencia pareja y aun mayor que la del gobierno, es muy posible que se produzca a expensas de la atención que el gobierno debe prestar a las tareas que sólo él puede acometer. El resultado es un descenso en la eficiencia de la economía.

Existe un medio para contener estas tendencias. Si al preparar las proyecciones de las actividades del sector privado, los organismos encargados de la planificación confían en las consultas y en la cooperación de los representantes de ese sector, no sólo es probable que estas proyecciones sean más exactas, sino que, más aún, se aumentan las posibilidades de su efectiva realización. El secreto del éxito de la "planificación indicativa" en Francia y en algunos otros países no consiste en que estos planes fueron "técnicamente" mejores —sea cual fuere la significación de esto— sino en que fueron formulados en estrecha cooperación con las organizaciones que representaban las distintas industrias del sector privado. De este modo la "planificación indicativa" es una vía de dos direcciones. El tránsito en una dirección indica lo que los planificadores esperan que el sector privado ha de hacer; en la otra dirección dicho sector indica a los planificadores lo que se propone hacer.

2. IMPORTANCIA DE LOS PROYECTOS DE INVERSIÓN

La preocupación de los planificadores en la mayoría de los países en cuanto al conjunto total de la producción e insumo físico y financiero ha llevado a lo que hoy día es probablemente la deficiencia más generalizada de la planificación —la ausencia de preparación y evaluación de proyectos de inversión. Hace algunos años, cuando los métodos para la planificación eran motivo de mucha preocupación (y se tenía poca experiencia) se hacía la distinción entre "planificar desde arriba" y "planificar desde abajo". La primera expresión se empleó para representar un enfoque en el cual el conjunto de metas y proyecciones se trazan en primer término, determinándose a continuación los conjuntos por sectores, y así sucesivamente hasta llegar a las decisiones sobre cada inversión específica. "Planificar desde abajo" ha significado, por otra parte, agrupar los proyectos de inversión de todos los sectores de la economía dentro de metas de inversión, estableciéndose entonces la relación entre su gran total y el total de los recursos financieros y reales de que puede disponerse.

Cuando en varios países se hicieron los primeros intentos para formular planes de desarrollo, éstos eran frecuentemente poco más de una lista de proyectos en varias etapas de preparación —"listas de compras" como despectivamente se los llamaba por aquellos organismos nacionales e internacionales a los que eran sometidos. Era evidente que esta simplificada versión del "planificar desde abajo" resultaba de escaso valor, por dos razones: la primera, porque los proyectos no llegaban a integrar un total cuyas partes fuesen congruentes entre sí, y por eso excedían o quedaban por debajo de los recursos disponibles, dejando sin responder la cuestión de cómo habría de usarse el resto de los recursos, o si no de cuál era la prioridad de los distintos proyectos y cómo su secuencia en el tiempo habría de efectuarlos y modificarlos. La segunda razón, que en cierto modo resultaba una deficiencia más grave, era que todos los

proyectos, con excepción de unos pocos, eran sólo la expresión del convencimiento de que tal o cual inversión sería una "buena cosa", sin que se hubiera hecho intento alguno, siquiera en forma preliminar, para determinar sus costos y relacionar éstos con los beneficios esperados.

Fue en parte como consecuencia del creciente descontento provocado por este enfoque de "lista de compras" que a los defensores del "planificar desde arriba" les fue fácil tarea convencer a las autoridades gubernamentales y al público en general, y, sobre todo, convencerse unos a otros, de que era necesario prestar más atención a la determinación del *total* de las necesidades, del *conjunto* de las metas y de la *suma* de los recursos financieros y objetivos *globales*. El resultado de esta preocupación ha sido una relajación en las relaciones entre los organismos de planificación encargados de los totales por una parte, y las agencias gubernamentales y las unidades en el sector privado de la economía encargadas de los proyectos de inversión, de la otra. Con frecuencia cada vez mayor se oye la queja de que los planes eran excelentes, pero que su ejecución —que incumbía a otras personas— ha sido deficiente.

Ha habido, indudablemente, muchos planes y proyectos correctamente trazados pero que han sido mal ejecutados. Mas, a menudo, no ha sido la ejecución en sí la que ha fallado, sino que en realidad poco era lo que había que ejecutar; los planes no correspondían a proyectos específicos que hubieran sido preparados hasta el punto de que sus costos podían ser determinados con razonable precisión y ser comparados con los beneficios que habían de derivarse de los mismos. Argüir que son incompletos los planes que no están enteramente compuestos de una serie de sólidos proyectos de inversión, nos haría retroceder a la falacia y a las limitaciones del "planificar desde abajo". Como se ha dicho antes, todo plan debe necesariamente consistir de algunas partes "rígidas" y de otras "flexibles", a fin de permitir un margen a la formulación de las decisiones privadas dispersas, y a la incertidumbre. Sin embargo, obvio es que existe una alta correlación entre la utilidad de un plan y la medida en que está respaldado por proyectos específicos, cuyos costos y rendimiento social son conocidos con bastante precisión.

3. Los planes a largo plazo y los presupuestos anuales

Alguna confusión y controversias han surgido acerca de la duración de un plan y de la práctica comúnmente aceptada de llevarlo adelante mediante presupuestos anuales. En condiciones ideales el presupuesto anual no es otra cosa sino la ejecución de una parte del plan en ese año. Pero las condiciones con frecuencia distan de ser ideales, y en muchos países los presupuestos anuales se relacionan con el plan sólo del modo más vago. Hasta cierto punto los presupuestos anuales (y sus modificaciones ocasionales en el curso del año fiscal) reflejan los errores padecidos en las previsiones explícitas o implícitas contenidas en el plan. No obstante, muchos indicios sugieren que la divergencia entre las recomendaciones de un plan quinquenal y las decisiones subsecuentes adoptadas mediante el presupuesto anual y otras medidas, meramente reflejan las deficiencias inherentes en los tantos planes mencionados anteriormente —la falta de relacionar el conjunto del plan con los proyectos específicos en ejecución o que han de acometerse. Las razones de aquellos que opinan que la preparación de un plan quinquenal es una pérdida de tiempo (y, pudiera añadirse, un dispendio de conocimientos técnicos especializados que no abundan) y que todo lo que se necesita es una mejor preparación de los proyectos dentro del marco de los presupuestos anuales, se basan en un concepto erróneo de lo que el contenido de un plan debe ser. Si el plan no pasa de ser sino una proyección del conjunto de las necesidades, de los recursos, etc., y no contiene proyectos específicos, entonces tienen razón los que consideran inútiles los planes y la planificación. Pero la respuesta no consiste en eliminar los planes, sino

en hacer planes con un contenido que manifiestamente sea operante, es decir, planes que efectivamente puedan ejecutarse mediante una asignación anual de recursos.

Prioridades

Es probable que los economistas que están aferrados a la idea de que el desarrollo económico depende casi por completo de la efectividad de la planificación de conjunto, objeten la introducción de proyectos específicos dentro del proceso de planificación. Estos economistas habrán de indicar que los proyectos sólo pueden seleccionarse después que su prioridad haya sido determinada. Sin embargo, esto implica que las prioridades pueden ser determinadas en abstracto, sin relacionarlas a proyectos ni a la evaluación que a éstos corresponde.

Obviamente esto es un error. Sobre bases generales teóricas pudiera alegarse que no se requiere un esfuerzo especial para fijar las prioridades en el proceso de la planificación, dado que el rendimiento de cada proyecto determina su orden de prioridad. Mediante la selección de los proyectos que ofrezcan el rendimiento más alto en todos los sectores de la economía, puede asegurarse la mejor distribución posible de los recursos. La ventaja de contemplar el concepto de la prioridad desde este punto de vista consiste en que pone de manifiesto tanto la utilidad del concepto en sí, como sus limitaciones. La selección de los proyectos sin atender a ninguna prioridad sería adecuada si se cumplieran tres condiciones: *a)* que los precios del mercado reflejaran el costo real para la economía; *b)* que toda la producción fuera vendida en el mercado y *c)* que los planes de desarrollo, explícitamente o por derivación, fueran ajenos a la distribución efectiva de los ingresos y su distribución proyectada o prometida (según se explica más adelante). En caso de que no se cumpla cualquiera de estas condiciones, la prueba del rendimiento de los proyectos debe ser completada mediante alguna forma de determinación de prioridad.

El concepto de las prioridades adquiere vigencia en el caso de los servicios públicos que no se venden a precio de mercado, porque resulta imposible hacer el cálculo cuantitativo de sus beneficios. Se han hecho intentos para determinar los beneficios que pudieran derivarse de las erogaciones para servicios públicos tales como la educación, salud pública y asistencia médica; pero el cálculo económico evidentemente tiene aplicación limitada tratándose de erogaciones de esta índole, particularmente en la evaluación de proyectos específicos (¿cuál ha de ser el tamaño de una escuela, la capacidad de los hospitales, el número de la fuerza de policía?), si se lo compara con una evaluación de los desembolsos en conjunto. Por ello debe emplearse algún sistema de graduación de prioridades basado en reglas empíricas elementales, en consideraciones políticas y sociales, etc., en vez de la prueba del rendimiento.

Distribución del ingreso

Un último aspecto, y en la práctica el más importante, en que las consideraciones en cuanto a prioridad afectan las decisiones, es el de la distribución presente y futura del ingreso. Las inversiones en cabarets, cinematógrafos y fábricas de lápices de labios, pueden aparecer con el rendimiento más alto en un grupo de proyectos, pero ningún organismo de planificación se atrevería a recomendar la inversión de fondos públicos en tales empresas, o que se permitiera hacer inversiones para tales propósitos dentro de un sistema de inversiones autorizadas. El argumento que suele aducirse en el caso de artículos y servicios suntuarios es que habrían de servir a un reducido número de personas y no a la economía en total; y algunas veces los proyectos son rechazados por razones morales (como en el caso de casinos de juego y fábricas de bebidas alcohólicas). No parece sino que este modo de razonar sea un disfraz para pretender un objetivo que se halla implícito en todos los intentos de desarrollo: producir, en el curso y como consecuencia del desarrollo, una más equitativa distribución del ingreso; o para expresar esta misma proposición en su forma más moderada (y tímida), a fin de impedir, al menos, un creciente desequilibrio en la distribución del ingreso.

Empero, en las condiciones que frecuentemente prevalecen en los países subdesarrollados, una redistribución del ingreso que de otro modo fuera deseable, pudiera estar en conflicto con los objetivos del crecimiento. La venta de algunos bienes y servicios a precios de subsidio, "de modo que un mayor número de personas pueda disfrutar de ellos", podría conducir a un error de distribución de recursos escasos y a una reducción en la formación de capitales. Además, el resultado de tales políticas bien pudiera ser que la mayor parte del beneficio de los subsidios vaya a manos de personas que holgadamente pueden pagar el costo total de los artículos o servicios que son objeto de subsidio; y si esto es así, ni los objetivos de la distribución del ingreso, ni los objetivos del crecimiento pueden lograrse.

Todo esto no pretende sugerir que las prioridades basadas en la distribución del ingreso o, de modo más lato, en consideraciones de índole social, no tienen cabida en el proceso de planificación; siempre habrá algo de por sí objetable en el uso de los fondos públicos para construir hipódromos y clubes campestres. No hay duda que la distribución del ingreso es un problema primordial en el desarrollo. Mas, lo antes dicho sí sugiere que, salvo excepciones un tanto evidentes, la solución del problema de la distribución del ingreso no puede intentarse mediante la aplicación de algunas prioridades concebidas de antemano (provistas o despojadas de ribetes de consideraciones morales), en relación a la asignación de capital y de otros recursos escasos. La solución ha de buscarse, en parte, mediante erogaciones directamente encaminadas a aliviar las zozobras de las gentes que sufren aguda o crónica miseria; en parte, mediante la implantación de medidas fiscales, y en parte acelerando el proceso de crecimiento económico mediante la mejor distribución posible de los recursos con sujeción a un criterio económico.

Resulta en extremo difícil hacer un resumen de las ideas sobre la planificación y sobre el papel que corresponde a los proyectos y a las prioridades en el proceso de la planificación, dado que esas ideas abarcan un campo muy extenso. De estas ideas derívase una conclusión. La preparación de un plan que ha de servir a los encargados de dirigir y de orientar la economía es una difícil empresa que ofrece innumerables desafíos a la inteligencia y a la integridad de los planificadores. Elaborar un plan requiere competencia técnica, perspicacia e imaginación, y trazar un *buen* plan precisa todas esas condiciones, más valor y humildad suficientes para reconocer las limitaciones inherentes a la planificación.

centro de educación continua
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facultad de ingeniería, unam

SISTEMAS MARITIMOS Y PORTUARIOS

EMPRESAS DE MANIOBRAS EN LOS PUERTOS

INDICE

ING. ENRIQUE CARDENAS TRIGOS

MARZO, 1979.

I COMPAÑIAS QUE REALIZAN LAS MANIOBRAS PORTUARIAS

En algunos casos las Compañías Transportistas, ferrocarriles o de autotransportes, extienden por necesidad propia su actividad dentro del Puerto y son ellos los que se encargan de contratar a los trabajadores portuarios.

Por otra parte, las Compañías Navieras también extienden su actividad al Puerto y encontramos gran cantidad de ejemplos de Terminales Marítimas, que son operadas por las líneas de buques.

Existen Compañías con servicios de transportes multimodal y en estos casos estas mismas controlan sus propias Terminales Marítimas, como son las de SEA LAND ó SEA TRAIN.

Pero aunque hay gran catidad de estos ejemplos, por problemas de contratación de trabajadores, se han creado Compañías, que en los Puertos realizan en forma específica los servicios de maniobras portuarias y se denominan con diferentes nombres, pero podemos generalizarlas llamándolas Compañías de Servicios Portuarios.

Estas Compañías tienen como fin principal, prestar todo tipo de servicios de maniobras portuarias y conexas a éstas, tanto a línea de buques, como a usuarios, representados por Agentes Aduanales en el Puerto.

Para desarrollar su actividad cuentan con muelles, patios y almacenes, que son rentados ó contratados con las Autoridades Portuarias y equipos propios ó rentados, para la realización de las operaciones.

Pueden ser privadas ó de participación Estatal, Municipal ó Federal.

Y pueden operar en un muelle determinado ó pueden llegar a operar en todo un Puerto.

II EMPRESAS DE MANIOBRAS

Dependiendo de su formación mercantil, podemos establecer un organigrama general.

Consejo de Administración

Director Ejecutivo

Operación Control Administración Ingeniería

OPERACION

Tiene bajo su cargo la organización de las maniobras, así como el diseño de éstas, tanto en los buques, como en todas las áreas concesionadas a la Compañía.

Para esta programación, cuenta con la información que envían los Agentes Consignatarios de Buques, en la que incluyen horas de atraque de las embarcaciones, los planes de estiba, carnets y toda la información adicional sobre el tipo de carga, explosivos, corrosivos ó aquella que necesite de cuidado especial.

Por otra parte, los Agentes Aduanales, también proporcionan el programa de retiro de mercancías o la llegada de estas, con lo que pueden determinarse las cuadrillas y máquinas que deben de nombrarse para este fin.

Reporta al Area Administrativa, las operaciones realizadas para su cobro.

CONTROL

Las cargas que llegan a la terminal o salen de ella, - de pendiendo del esquema fiscal que se tenga, tienen - que ser contadas y apartadas para la revisión adecuada de la Aduana y para liquidar con el buque la operación de importación ó exportación.

Al igual que el Area de Operación, reporta al Area Administrativa cualquier servicio extra que se realice,- como pueden ser abriduras, marcaduras, pesaduras, etc.

También envía toda la información necesaria, para elaborar las estadísticas portuarias.

ADMINISTRACION

Esta área se encarga del control del personal, tanto de confianza, como los de Contrato Colectivo con Sindica - tos ó Uniones.

Quedan bajo su control, la contabilidad de la Compañía y vigila el cumplimiento de los compromisos fiscales - y otros derivados de prestaciones con trabajadores.

Bajo solicitud de las otras áreas, realiza las compras necesarias, para llenar las necesidades de estas.

Con la información que recibe de las diferentes fuentes de trabajo, hace la facturación de los servicios, estableciendo políticas de cobro.

En muchas ocasiones esta área se encarga de llevar el - control de las estadísticas en base a la información - que recibe del cobro para la facturación y puede contar con sistemas manuales de control ó servicio de computación.

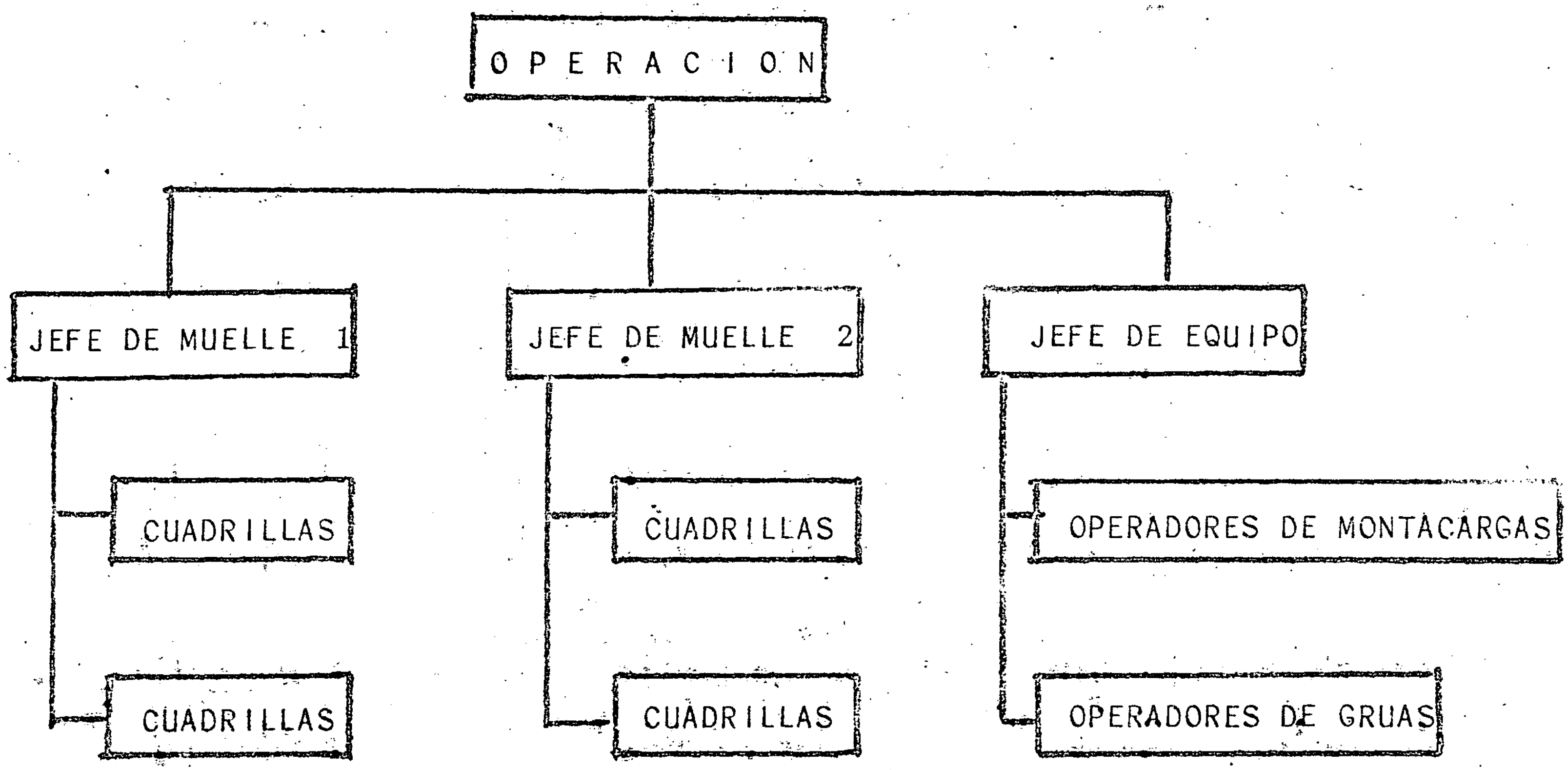
El análisis tarifario quedará también en esta área.

El Director ó Gerente de la Compañía, cuenta con el apoyo de la Auditoria Externa, para la buena vigilancia de las diferentes áreas de trabajo.

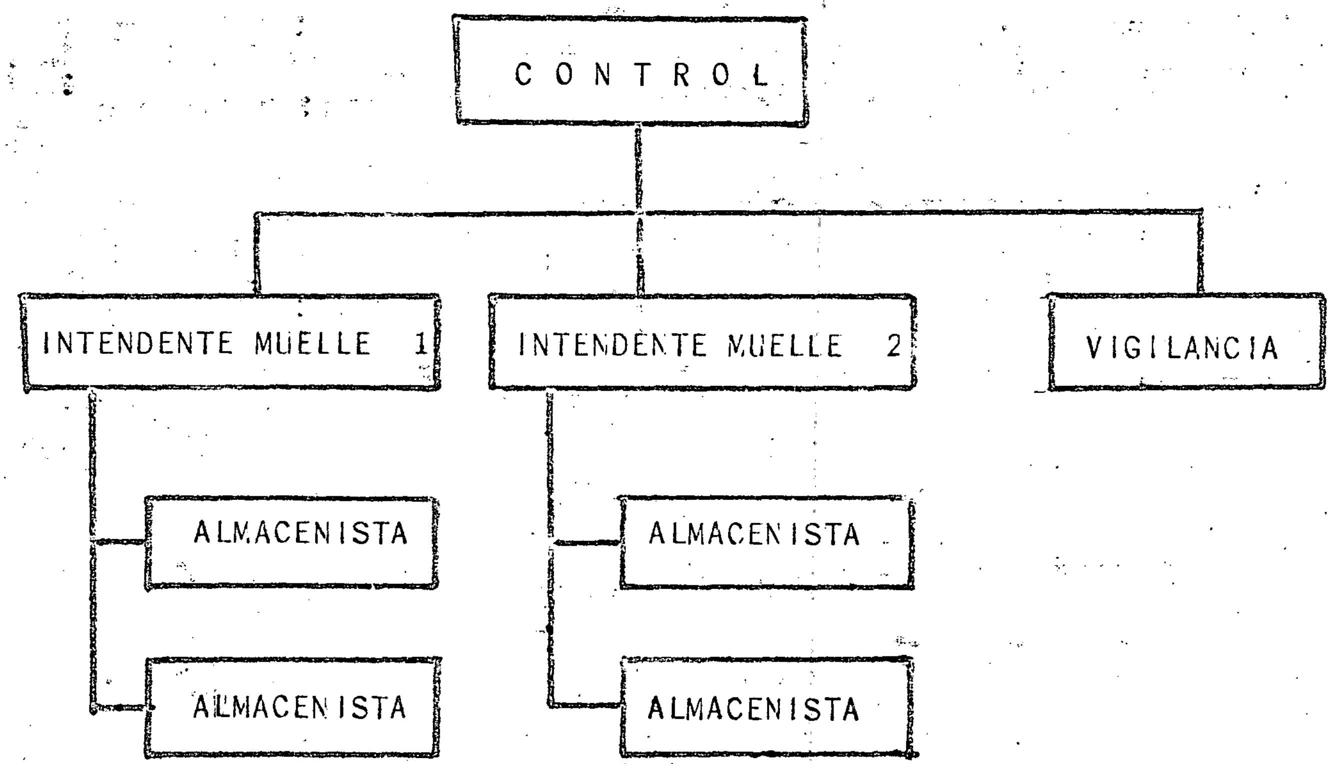
INGENIERIA

En términos generales esta área se encarga, además de dar mantenimiento a todos los equipos, realizar los trabajos electromecánicos y de ingeniería civil, para conservar en buen estado todas las instalaciones.

El algunos casos, pueden encargarse de servicios conexos como son: venta de agua, combustible, energía eléctrica y conexión teléfonica.



OPERACION
JEFE DE MUELLE 1
JEFE DE MUELLE 2
JEFE DE EQUIPO
CUADRILLAS
CUADRILLAS
CUADRILLAS
CUADRILLAS
OPERADORES DE MONTACARGAS
OPERADORES DE GRUAS


CONTROL
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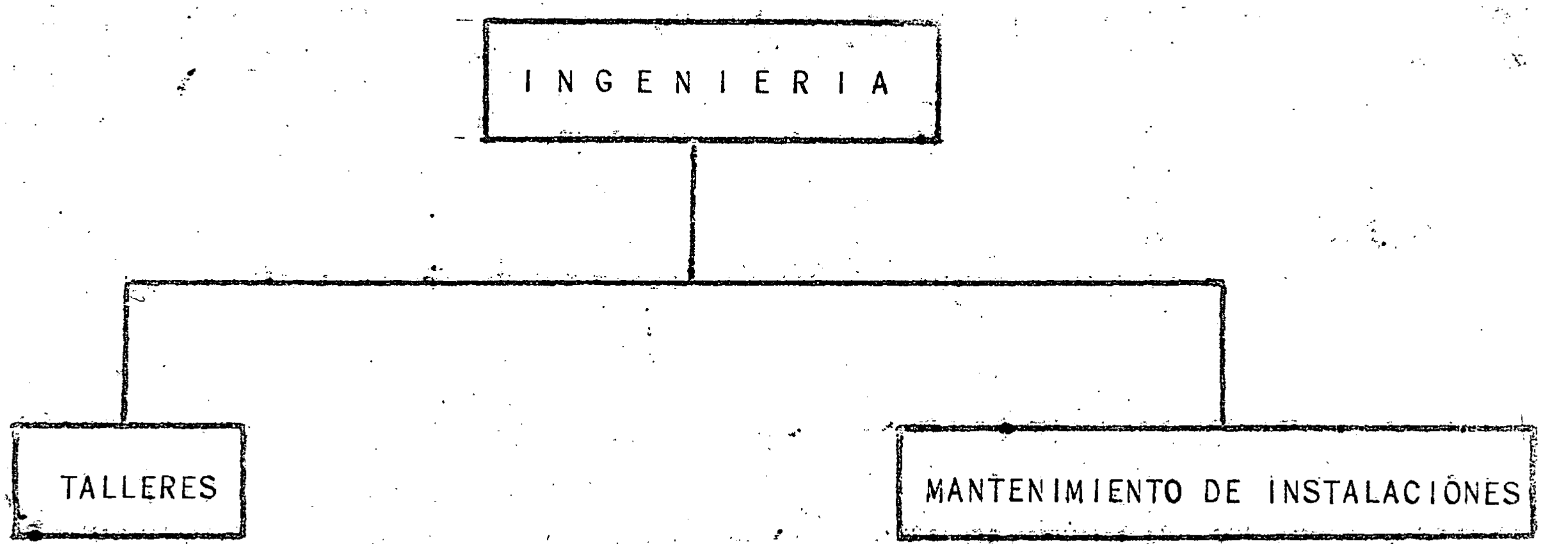
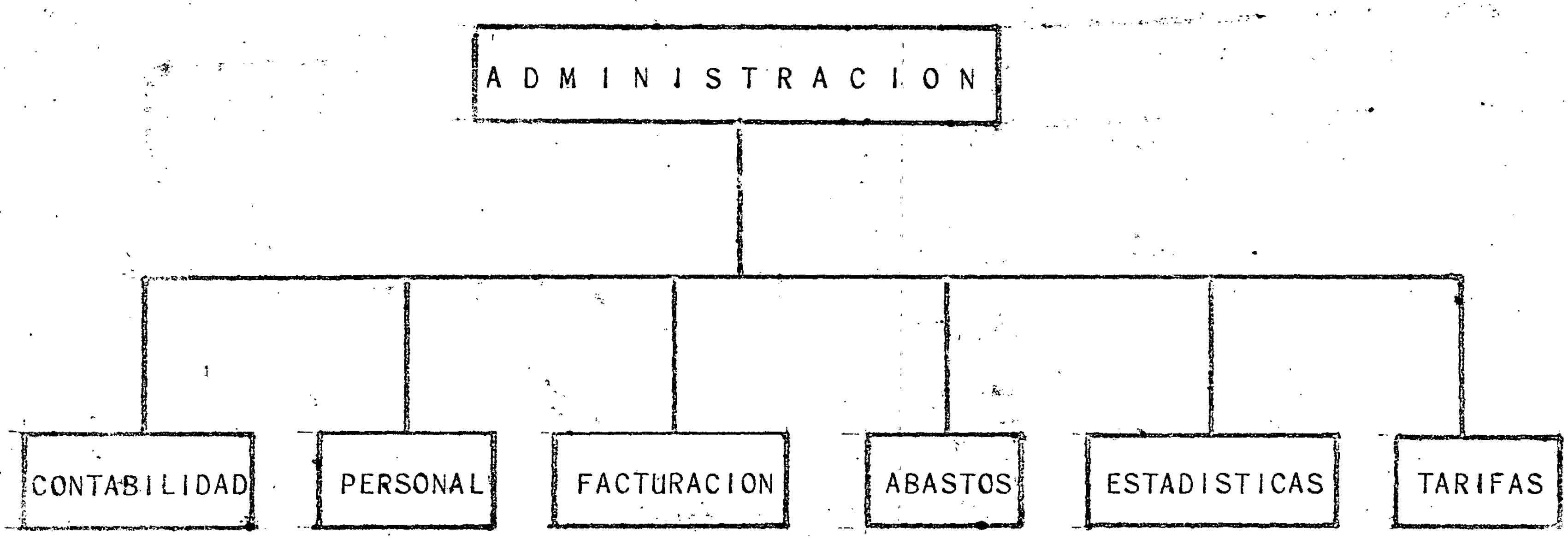

INGENIERIA
TALLERES
MANTENIMIENTO DE INSTALACIONES


A D M I N I S T R A C I O N
CONTABILIDAD
PERSONAL
FACTURACION
ABASTOS
ESTADISTICAS
TARIFAS

OPERACION

Normalmente estas Compañías estan formadas por accionistas y tienen por tanto, un Consejo de Administración que dicta las políticas que debe seguir la Compañía.

Este Consejo, nombra a un Director ó Gerente Ejecutivo, quien a nombre del Consejo de Administración, lleva a cabo el programa elaborado por ésta.

El objetivo principal será el de prestar los servicios de maniobras y conexos a estos, debiendo cimentar su estrategia en tres aspectos fundamentales:

Eficiencia

Seguridad

Costo.

De los estudios de estos tres elementos, saldrá la verdadera política a seguir de la Compañía y serán en todo caso las bases para lograr un organismo competitivo en esta rama de servicio.

La eficiencia de un Puerto, se mide por su productividad, reduciendo la estadía de los buques y se logra en base a una buena organización y vigilancia de las maniobras.

El operador de la Compañía, debe contar con trabajadores portuarios entrenados debidamente y con amplio espirtu de trabajo en grupo.

La selección de los equipos, será también factor importante, en la actualidad se cuenta con una gama muy amplia de estos equipos y puede adquirirse, el que se adapte más a las condiciones de los muelles, bodegas y patios.

Es recomendable que la maquinaria de trabajo se encu- entre dentro de la vida útil a fin de evitar, conti - núas descomposturas durante la ejecución de las mani- obras.

El uso de tarimas para unitizar la carga es totalmen- te indispensable, así como utilizar el sistema de pres lingado.

Por lo que se refiere a la seguridad, podemos definir- dos aspectos principales, las pérdidas y las averías.

Las pérdidas por robo, pueden ser reducidas, con vigi- lancia adecuada y con el control de las personas que - entran al Puerto.

Las averías, son causadas por una mala operación de - los equipos ó por defectos de pisos por donde transi - ten éstos.

Será indispensable que la productividad de la maniobra no vaya en contra del buen cuidado de la carga, debien do instruirse a los operadores el respeto.

El Area de Ingeniería, estará pendiente de mantener - los pisos por donde transiten las máquinas en óptimas condiciones.

El análisis del costo es fundamental en la vida de la- Compañía, por lo que es indispensable establecer una - política tarifaria competitiva.

A medida que el volumen de carga aumenta, los gastos - fijos por tonelada disminuyen y se está en posición de establecer tarifas convenientes.

El estudio de las tres premisas para lograr una buena Compañía, eficiencia, seguridad y costo es interesan- te, pues no será mejor la más eficiente, ni la más se gura, ni la más barata, será la que tenga un balanceo de estas tres características.

La eficiencia le interesa fundamentalmente a los buques, la seguridad de las mercancías a los usuarios, pues aunque el seguro cubra todos sus riesgos, las pérdidas de una carga no puede ser remplazada, en virtud de la oportunidad de usarla ó de venderla en un momento dado.

El costo, interesa a todos pero parece no ser tan fundamental, cuando se han satisfechos las dos primeras.

El esquema de la Compañía Mercantil, puede estar sustituida por otra en donde los gobiernos intervienen en la formación de estos organismos y tienen como finalidad dar el servicio de maniobras, sin fines de lucro, en provecho de un mejor Comercio Exterior.

Existen otras formas muy interesantes, en las que los trabajadores portuarios son los dueños de las Compañías ó formas Cooperativas.

III EJEMPLOS EN MEXICO

La primera Empresa.

Establecidas las características generales, la función como prestatario del servicio público de maniobras, las responsabilidades patronales y las obligaciones fiscales y económicas; era preciso a continuación decidir en qué puerto podría experimentarse la creación de la primera Empresa. Se hizo un examen detenido de los principales puertos mexicanos para encontrar el que ofreciera las condiciones más favorables, a saber:

a) Contar con una organización de trabajadores que ejecutará tanto las maniobras a bordo de los buques, como las que se realizan en los muelles, patios y almacenes.

b) Que la directiva de los trabajadores encontrara como solución adecuada y ventajosa a su situación, el establecimiento de la Empresa y la celebración del Contrato Colectivo.

c) Que hubiera usuarios dispuestos a participar dentro del capital social de una Empresa, de la que no obtendrían dividendos interesantes, sino que appoyando su funcionamiento e impulsando su desarrollo, obtendrían la consolidación de su fuente de trabajo.

d) Que el puerto tuviera un movimiento razonable de carga, preferentemente durante todo el año y que además tuviera una amplia perspectiva de desarrollo futuro.

e) Que se dispusiera de maquinaria y equipo mínimo, pero suficiente para iniciar operaciones.

Confrontado el cuadro anterior con diversos puertos solamente se encontró uno sólo capaz de cumplir con todos los requisitos de inmediato y éste fue el puerto de Manzanillo, Col., que ofreció las siguientes ventajas:

a) Contaba con la Unión de Estibadores y Jornaleros del Pacífico, C. R. O. M., agrupación con un gran sentido de la unidad y que controlaba tanto las maniobras a bordo como las de tierra.

b) La mayoría de los miembros de la unión y principalmente sus dirigentes locales estaban convencidos de las ventajas que les reportaría la constitución de la Empresa, porque consideraban que de esa manera lograrían transformar el puerto en la más importante terminal Marítima del Pacífico.

c) Se encontro que había varias personas entre los agentes de buques, aduanales y demás usuarios, dispuestos a participar adquiriendo acciones para integrar el capital social de la Empresa, además de estar dispuestos a apoyar ampliamente la operación, funcionamiento y desarrollo de las actividades de la institución, en beneficio del puerto.

d) Existía además, la perspectiva de la puesta en marcha del puerto de San Pedrito, cuyas instalaciones habían sido construidas y terminadas por la Secretaría de Marina, faltando únicamente el dragado de la dársena para iniciar las operaciones; además la localización geográfica de esta Terminal Marít ma compuesta de dos puertos prácticamente, le permitía dar servicio a una zona de influencia muy amplia que incluia el Valle de México, la Ciudad de Guadalajara y una amplia área industrial que se prolonga hasta San Luis Potosí.

e) La Unión de Estibadores y Jornaleros del Pacífico, contaba con una existencia mínima pero suficiente de maquinaria y equipo que bien podría ser la base inicial para que la empresa empezara sus operaciones.

f) El infatigable luchador de la causa obrera, Don Emilio Barragán con su larga experiencia en los problemas portuarios, había llegado a la convicción profunda de que los trabajadores deberías mejorar sus condiciones de vida a través de una Contrato Colectivo de Trabajo, por tal razón puso en juego su más denodado esfuerzo en ver cristalizado el tan añorado proyecto.

El día 16 de Junio de 1971 se constituyó la Empresa " Servicios Portuarios de Manzanillo, S. A. de C. V. ".

El objeto de la sociedad es prestar servicios públicos de maniobras en zonas bajo jurisdicción federal; servicios marítimos portuarios y servicios portuarios en general y actividades conexas de las vías generales de comunicación que les fueran autorizadas de acuerdo a las leyes y disposiciones respectivas. Adquirir, dar y tomar en arrendamiento y poseer por cualquier título los bienes, muebles e inmuebles para la realización del objeto social, aún cuando los inmuebles se encuentren ubicados en zona prohibida. En general celebrar contratos y realizar las actividades comerciales y mercantiles que se relacionen con el objeto de la sociedad.

El capital social constitutivo es variable, pero el mínimo sin derecho a retiro es de $ 7'000,000.00 (Siete Millones de Pesos 00/100 M. N.), dividido en 7,000 (siete mil acciones nominativas, con valor nominal de $ 1,000.00 (Un Mil Pesos). Integrado en dos series, correspondientes al Gobierno Federal 3,570 acciones de la serie " A " que representa el 51%; para los usuarios del puerto 3,430 acciones de la serie " B " suscritas por 12 empresas y 3 empresarios, relacionados con las - actividades Marítimas y Portuarias de Manzanillo.

La Asamblea General de Accionistas es el órgano supremo de la Sociedad y su funcionamiento se sujeta a las disposiciones relativas de la Ley General de Sociedades - Mercantiles, con las modalidades establecidas en los - estados sociales. El Consejo de Administración integrado por un número impar de trece, también se rige por lo dispuesto en los estatutos y la Ley General de Sociedades Mercantiles.

Los trabajadores al servicio de la Empresa, tienen derecho a designar con derecho a voz y voto un Consejero titular y su respectivo suplente, a efecto de que participen de los derechos y obligaciones que correspondan a - los responsables de la Administración.

TAMPICO

De 1922 a 1928, la administración de la Sociedad Cooperativa, estuvo a cargo de los Agentes Aduanales Rivas y Delfort, en tanto los obreros lograban la preparación - necesaria para hacerse cargo de esta. La gestión de los agentes se llevó a cabo con gran entusiasmo y buena voluntad de los mismos, destacándose también la actitud - de los Agentes Navieros, siendo uno de ellos, el señor- Pedro Assemat, el primero en contratar los servicios del Gremio para la estiba y maniobra de carga en el Puerto. El 1° de Mayo de 1922, el Gramio manejó su primera em - barcación, el vapor Missouri de matrícula francesa y - posteriormente, contrató sus servicios con las demás - firmas Navieras.

El Gremio no se concretó unicamente a las maniobras de- carga y descarga; ampliando sus perspectivas de trabajo para un mejor sostenimiento del mismo, contruyó obras - marítimas de importancia, tales como muelles, duques de alba, construcción de chalanes y otros tipos de embarcaciones.

En 1929 acaeció el asesinato de Isauro Alfaro, perpetrado por traidores infiltrados en las filas del Gremio. -

No por ello disminuyeron las actividades de la organización, que en ese mismo año, reunió el primer Congreso de Cooperativas del País en el Puerto de Tampico, para discutir los problemas del movimiento Cooperativo Nacional.

Dentro de la Reforma Portuaria, el Gobierno Federal, otorga al Gremio Unido de Alijadores de Tampico, el manejo de la Zona Franca, con lo que aparece en el marco de operación de los puertos una nueva estructura en base a una Cooperativa que ha mostrado a la fecha magníficos resultados.

VERACRUZ.

Uno de los problemas más antiguos, y que durante mucho tiempo fue considerado muy difícil solución en los Puertos, era la existencia de múltiples organismos sindicales que mantenían los servicios fraccionados, con sobreposiciones de radios de trabajo en algunos casos y conflictos y litigios interminables en otros, por diferencias entre los sindicatos de trabajadores portuarios.

En el Puerto de Veracruz, existía en 1971, cuatro diferentes organismos sindicales y una Cooperativa, que fragmentaban las maniobras. En 1972, se unificaron dos agrupaciones que prestaban servicios en tierra; en 1973, se retiró de ese Puerto aquella cooperativa que realizaba un trasbordo innecesario. Los sindicatos subsistentes que realizaban trabajos en tierra decidieron la constitución de la Empresa de Servicios Portuarios aportando ellos mismos la mayoría del capital social. En Agosto de 1975, decidieron fusionarse, de manera que ha quedado solamente un Sindicato para los trabajos en tierra, que agrupa el 80% del personal que labora en el Puerto.

La integración de las maniobras de tierra facilitó la implantación de una tarifa simplificada, el aumento de tiempo ordinario de servicios, la reduccipon de cuotas para el manejo de cargas unitarizadas y un incremento del 25 % en la capacidad de servicio del equipo del Puerto.

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SISTEMAS MARITIMOS Y PORTUARIOS

LAS INSTALACIONES Y LA OPERACION PORTUARIA

ING. JULIO PINDTER VEGA

MARZO 1979.

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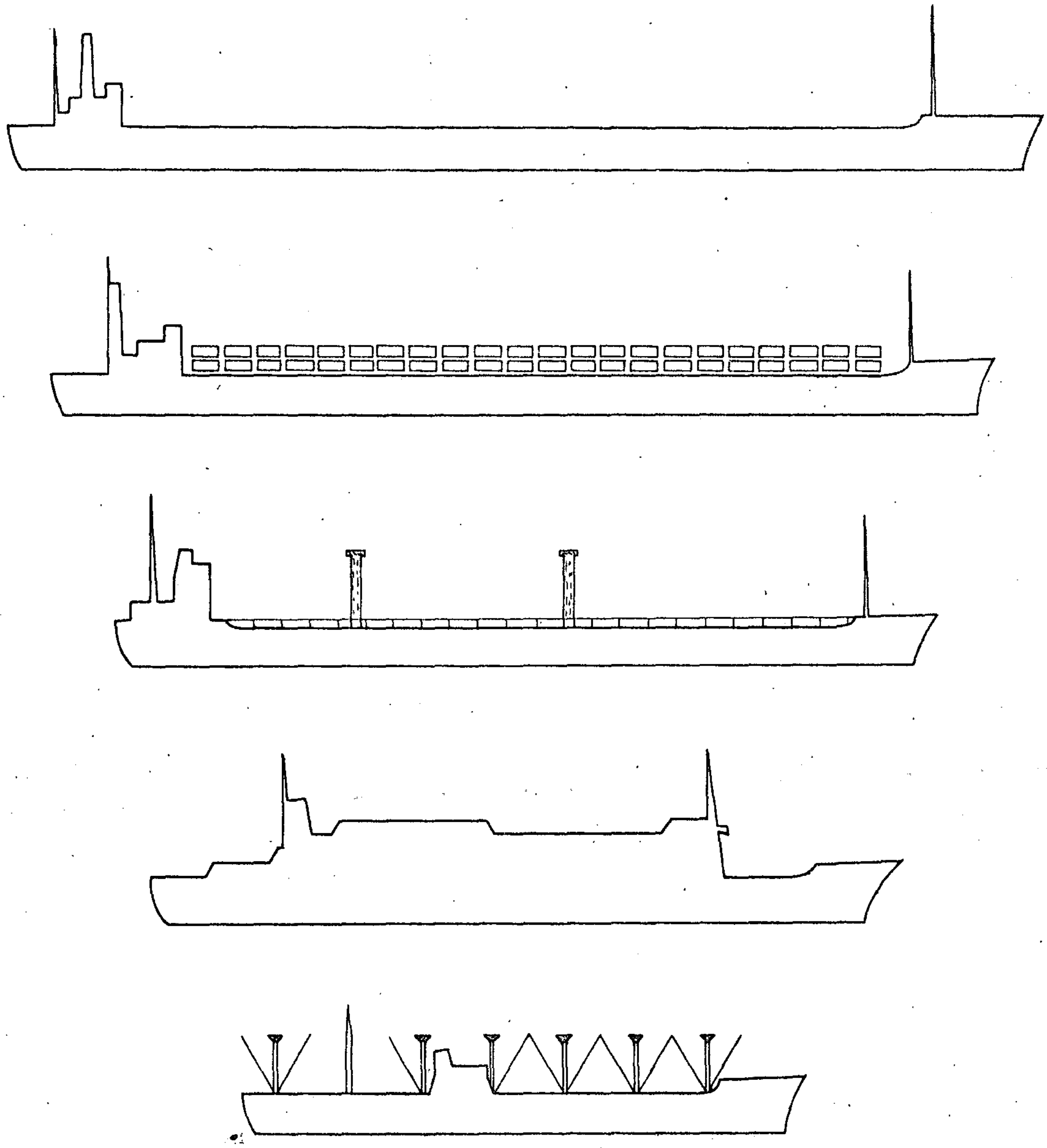

LAS INSTALACIONES Y LA OPERACION PORTUARIA

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MARZO DE 1979

I N D I C E

.- INTRODUCCION:

LA MUTUA DEPENDENCIA ECONOMICA DEL MUNDO ACTUAL, HA HECHO QUE LOS DIVERSOS PAISES INCLUYAN EN SUS PROGRAMAS DE ACCION LA MODERNIZACION DE SUS SISTEMAS DE TRANSPORTE. ESA INTERDEPENDENCIA QUE SE TRADUCE EN INTERCAMBIOS COMERCIALES ENTRE LAS NACIONES, SE REALIZAN CADA VEZ CON MAS ALTOS VOLUMENES DE MATERIAS PRIMAS Y PRODUCTOS TERMINADOS LO QUE HA MOTIVADO INOVACIONES TECNOLOGICAS EN LOS CONCEPTOS DEL TRANSPORTE Y SU DISTRIBUCION. EN ESTE INTERCAMBIO JUEGA UN PAPEL PREPONDERANTE EL TRANSPORTE MARITIMO, POR SUS VENTAJAS EN COSTO AL TRANSPORTAR GRANDES VOLUMENES DE CARGA A GRANDES DISTANCIAS; SI LA CARGA HA TRANSPORTAR ES DE BAJA DENSIDAD ECONOMICA; COMO SON LAS MATERIAS PRIMAS, EL EMPLEO DEL TRANSPORTE MARITIMO NOS PERMITIRA HACER MAS COMPETITIVO ESE INTERCAMBIO COMERCIAL DEL QUE HABLAMOS.

EL PLANTEAMIENTO DE NECESIDADES DE LOS ARMADORES A TRAVES DE SUS DEPARTAMENTOS TECNICOS HA LOS INGENIEROS PORTUARIOS HA PERMITIDO RESOLVER LAS INOVACIONES TECNOLOGICAS EXPERIMENTADAS EN LAS EMBARCACIONES AL DOTARLAS DE INSTALACIONES ADECUADAS PARA PERMITIR EL FLUJO EFICIENTE A TRAVES DEL PUERTO Y SU CONEXION CON EL TRANSPORTE TERRESTRE.

LA ORGANIZACION DE UNA MANERA APROPIADA Y EFICIENTE DEL TRAFICO QUE CONFLUYE A UN PUERTO, SEA TERRESTRE, FLUVIAL O MARITIMO ES LA FINALIDAD DE LA "ADMINISTRACION PORTUARIA". LA OPERACION PORTUARIA COMO PARTE DE LA "ADMINISTRACION" SE ENCARGA DE ADECUAR LAS MULTIPLES MANIOBRAS QUE SE REQUIEREN PARA PERMITIR LA MAXIMA EFICACIA EN EL TRANSBORDO DE MERCANCIAS Y PASAJEROS DEL TRANSPORTE MARITIMO AL TERRESTRE O VICEVERSA.

EN TEMAS SUBSECUENTES SE TRATARA LA ORGANIZACION DE LA ADMINISTRACION Y OPERACION PORTUARIA, EN ESTA PARTE NOS CONCENTRAREMOS A -- LAS INSTALACIONES PORTUARIAS Y SU OPERACION.

LAS MERCANCIAS QUE SON TRANSPORTADAS VIA MARITIMA POR SUS CARACTERISTICAS SE DIVIDEN EN:

CARGA GENERAL FRACCIONADA.- SACOS, CAJAS, MAQUINARIA DIVERSA, ETC.

CARGA GENERAL UNITIZADA.- AGRUPANDO LA CRRGA GENERAL SE FORMAN -- UNIDADES DE MAYOR PESO QUE PUEDEN SER TRANSPORTADAS EN TARIMAS ó PALLETS Y EN CONTENEDORES.

CARGA A GRANEL.- ESTA PUEDE SER LIQUIDA O SECA; LOS GRANELES LIQUIDOS, SON TALES COMO: HIDROCARBUROS, MIELES INCRISTALIZABLES, - JUGO DE FRUTAS, PRODUCTOS QUIMICOS, AZUFRE LIQUIDO, ETC.; EL GRANEL SECO SON LOS MINERALES SUELTOS, CEREALES, ETC.

EL COMERCIO EXTERIOR NACIONAL Y EL COMERCIO EXTERIOR MARITIMO SE PODRA OBSERVAR EN LA TABLA No. 1

COMERCIO EXTERIOR NACIONAL

1970 - 1977

(MILES DE TONELADAS)

A Ñ O	COMERCIO EXTERIOR NACIONAL			COMERCIO EXTERIOR MARITIMO			PORCENTAJE DEL COMERCIO MARITIMO AL NACIONAL		
	IMPORTACION	EXPORTACION	TOTAL	IMPORTACION	EXPORTACION	TOTAL	IMPORTACION	EXPORTACION	TOTAL
1970	8 865	14 183	23 048	3 376	9 705	13 081	38.1	68.7	56.8
1971	8 949	14 587	23 806	3 908	10 883	14 791	43.7	74.6	62.0
1972	11 565	15 874	27 439	5 635	11 314	16 949	48.7	71.2	61.7
1973	16 974	14 005	30 979	9 499	11 286	20 785	55.9	80.5	67.0
1974	16 907	16 501	33 408	8 247	12 767	21 014	48.7	77.3	62.9
1975	15 782	16 883	32 665	8 708	15 041	23 749	55.1	89.0	72.7
1976	11 353	17 604	28 957	7 158	15 110	22 268	63.5	85.8	76.9
* 1977	12 934	22 445	35 379	8 314	20 840	29 154	64.2	92.8	82.4

NOTA: (*).- COMERCIO EXTERIOR NACIONAL ESTIMADO.

J.P.V.

TABLA No. 1

2.- EL TRANSPORTE MARITIMO:

EL CRECIENTE VOLUMEN DE MERCANCIAS A TRANSPORTAR A OBLIGADO A LA ESPECIALIZACION DEL TRANSPORTE MARITIMO. EL BARCO DENOMINADO DE CARGA GENERAL ERA UTILIZADO PARA EL TRANSPORTE DE: CARGA GENE-- RAL FRACCIONADA, GRANELES EMBASADOS Y PASAJEROS, CON EL AUMENTO DE LOS VOLUMENES DE ESAS MERCANCIAS Y EL NUMERO DE PASAJEROS, SE PROPICIO LA ESPECIALIZACION PONIENDO EN SERVICIO: BARCOS PORTA - PALLETS, TRANSBORDADORES, DE CONTENEDORES, PARA TRANSPORTAR GRA- NELES, PERECEDEROS Y LOS DE PASAJEROS.

LAS CARACTERISTICAS GENERALES DE CADA TIPO DE EMBARCACION LAS -- TRATAREMOS A CONTINUACION.

2.1.- DIVERSOS TIPOS DE EMBARCACION.

2.1.1.- BARCOS DE CARGA GENERAL.

SE DESTINAN AL TRANSPORTE DE TODA CLASE DE MERCAN- CIAS. LAS PARTES PRINCIPALES DE UN BARCO DE ESTE TIPO SE PODRAN OBSERVAR EN LA FIG. # 1.

EN LA FIG. # 2 SE MUESTRA LA DIVISION DE UN BUQUE DE CUATRO ESCOTILLAS EN SECCION VERTICAL LONGITUDI NAL, EL CUAL SE DIVIDE EN CINCO ZONAS O SECCIONES VERTICALES, QUE SON:

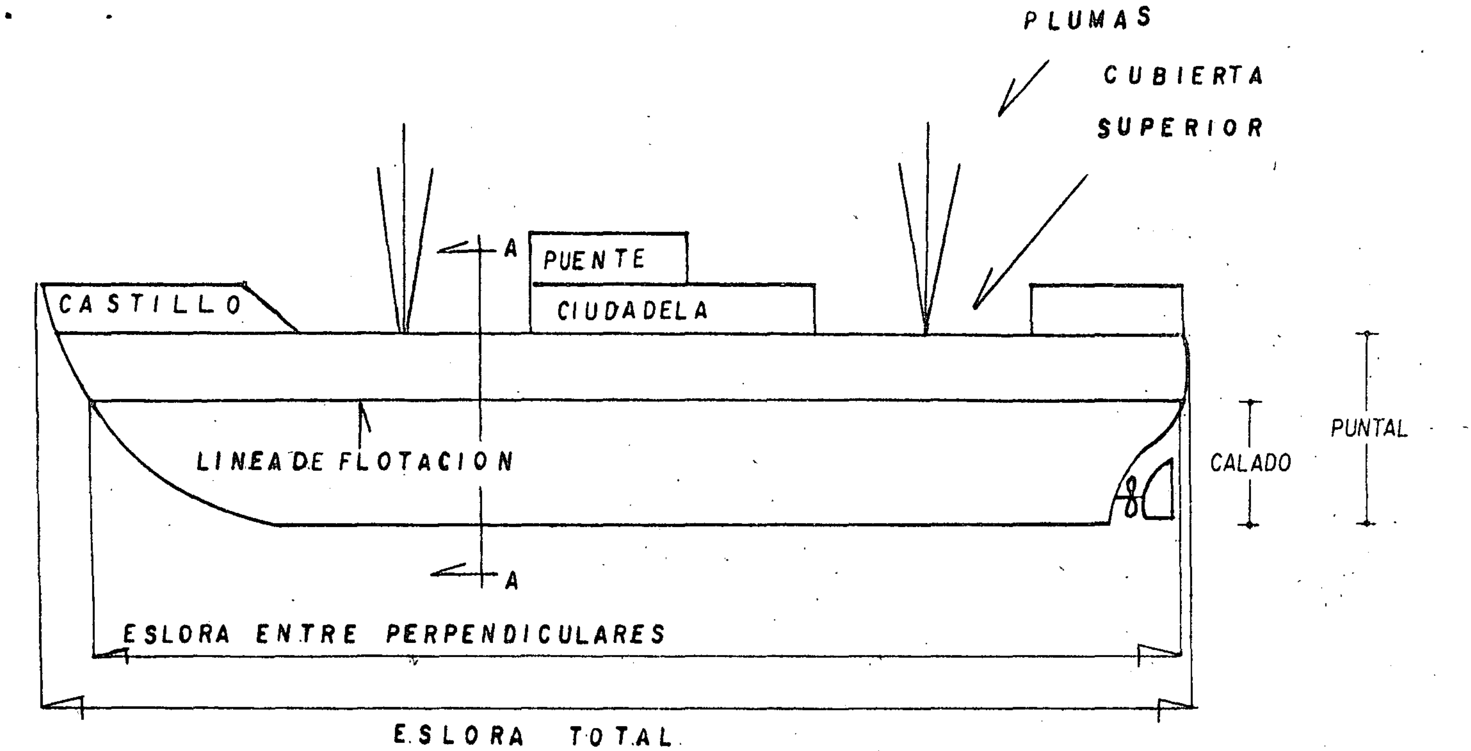
1a. SECCION DE PROA

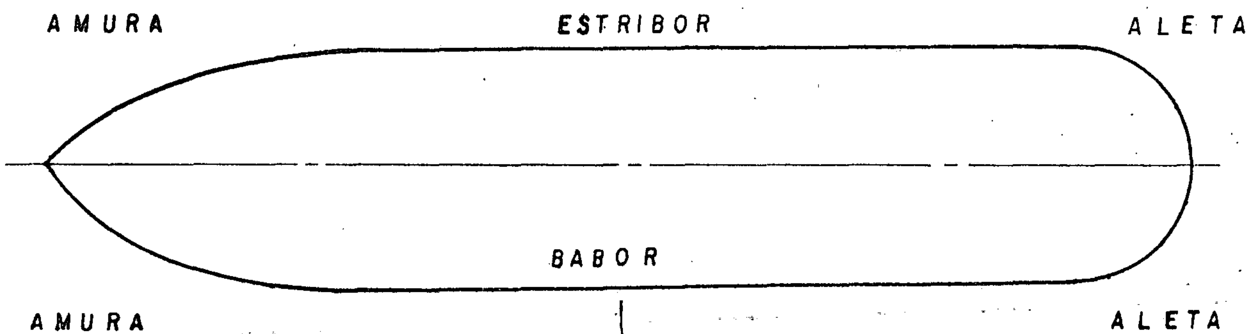
2a. SECCION DE BODEGAS DE PROA

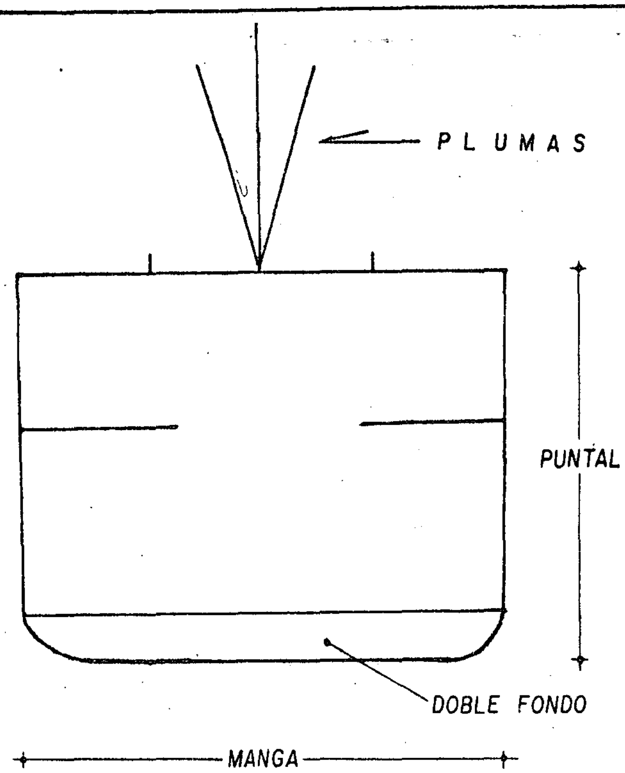
3a. SECCION DE MAQUINAS Y CALDERAS

4a. SECCION DE POPA

<u>SECCION DE PROA</u>.- ESTA ZONA COMPRENDE EL VOLUMEN - LIMITADO ENTRE LA RODA Y EL MAMPARO DE COLISION. - DESCRIBIENDO DE ARRIBA ABAJO, ENCONTRAMOS:







SECCION A-A
Fig. No.1

FIGURA No. 1

DIVISION DEL BUQUE EN SECCIONES VERTICALES

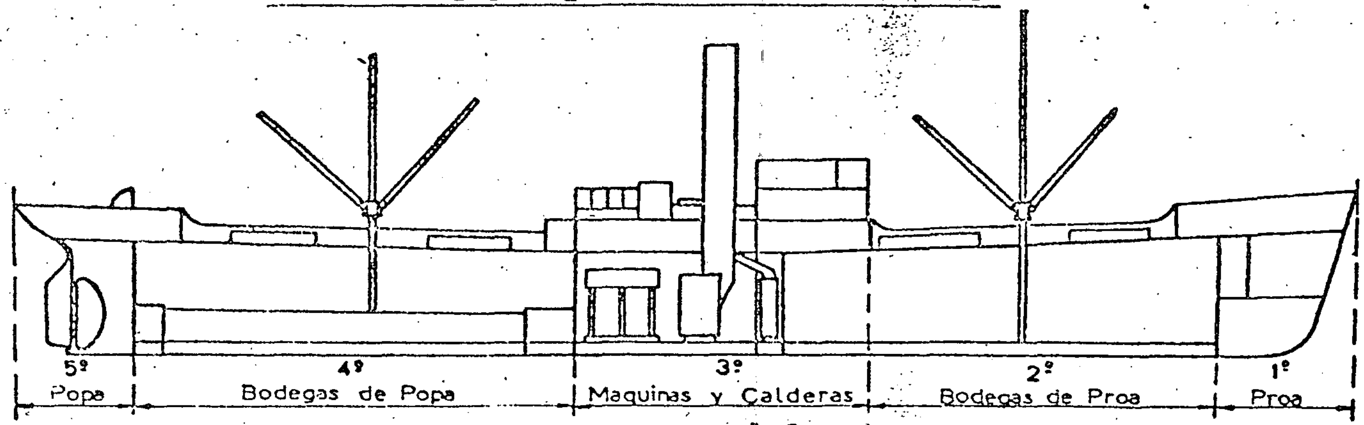


Figura # 2

LA CUBIERTA DONDE SE ENCUENTRAN INSTALADOS LOS MALACATES (DE VAPOR O ELECTRICOS) PARA ACCIONAR LOS CABOS, Y LAS CADENAS DE LAS ANCLAS.

PRIMER ENTREPUENTE.- DIVERSOS ALOJAMIENTOS

SEGUNDO ENTREPUENTE.- PAÑOLES Y CAJA DE CADENAS.

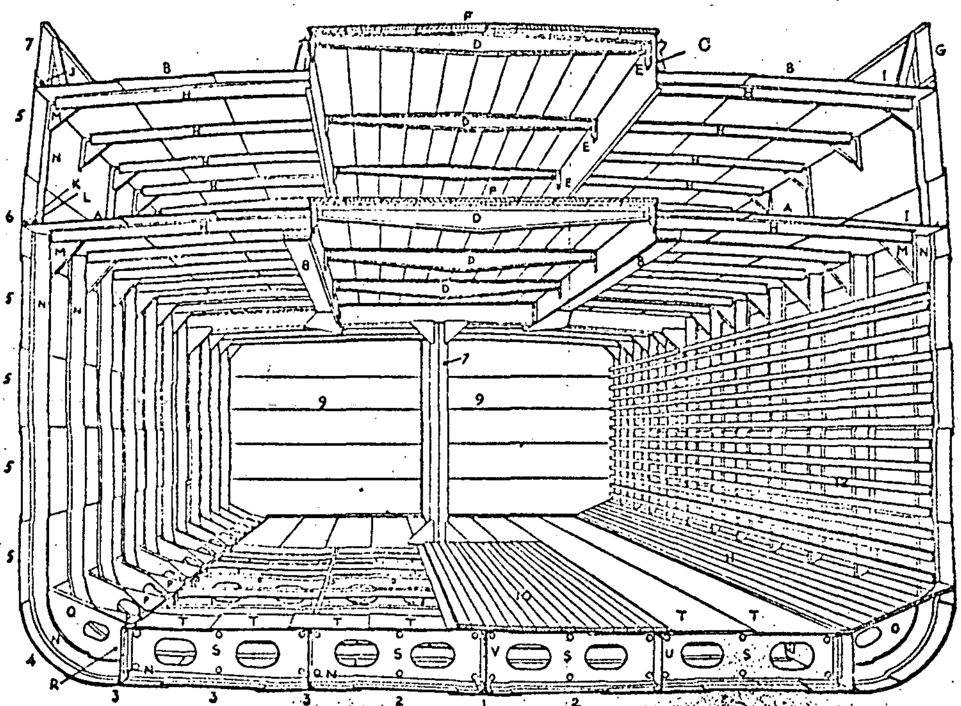
TANQUE DE ALMACENAMIENTO DE (COMBUSTIBLE .)

SECCION DE BODEGAS DE PROA.- COMPRENDE ESTA SECCION DESDE EL CASTILLO HASTA EL PUENTE . EN LA CUBIERTA SUPERIOR SE HALLAN LOS PALOS, PLUMAS DE CARGA, MALACATES Y ESCOTILLAS.

EN EL SENTIDO DE LA ALTURA, LAS BODEGAS, ESTAN DIVIDIDAS EN ENTREPUENTES, ENUMERANDO DE ARRIBA HACIA ABAJO SE TIENE PRIMER ENTRE PUENTE, SEGUNDO, ETC., HASTA EL ULTIMO QUE ES EL FONDO DEL BUQUE, LO QUE PERMITE LA SEPARACION DE LA CARGA DE LOS DIVERSOS PUERTOS, UNA DISPOSICION DE LAS BODEGAS PUEDE OBSERVARSE EN LA FIG. # 3 .

LAS ESCOTILLAS SON LAS ABERTURAS PRACTICADAS EN LAS CUBIERTAS Y SIRVENPARA COMUNICAR LAS BODEGAS Y LOCALES INTERIORES CON EL EXTERIOR. LAS DIMENSIONES Y FORMAS DE LAS ESCOTILLAS DEPENDEN DEL TIPO Y ESPECIALIDAD DEL BARCO.

LOS BUQUES SUELEN LLEVAR DOS PALOS: UNO A PROA LLAMADO TRINQUETE ENTRE LAS ESCOTILLAS UNO Y DOS Y OTRO A POPA LLAMADO MAYOR, ENTRE LAS ESCOTILLAS 3 Y 4 , SI ES UN BUQUE DE 4 BODEGAS COMO EL MOSTRADO EN LA FIG. # 2 .



Shelter Deck Vessel

A. Main Deck
B. Shelter Deck
C. Hatch Coaming
D. Hatch Beams
E. Hatch Carrier
F. Hatch Cover
G. Bulwarks
H. Half Beam
I. Stringer Plate

J. Gunwale Bar
K. Shell Bar
L. Stringer Bar
M. Beam Knee
N. Frame
O. Tankside Bracket
P. Gusset Plate
R. Margin Plate
S. Floor Plate

T. Tank Top Plating
U. Side Girder
V. Centre Girder
1. Keel Plate
2. Garboard Strake
3. Bottom Strake
4. Bilge Strake
5. Side Plating
6. Sheer Strake

7. Hold Pillar
8. Deck Girder
9. Bulkhead
10. Hold Ceiling
11. Bilge Ceiling
12. Spar Ceiling

FIGURA No. 3

SOBRE LOS PALOS VAN LOS ACCESORIOS PARA EL APAREJO DE LAS PLUMAS, ASI COMO TAMBIEN LOS SOPORTES PARA LAS LUCES DE SITUACION. LOS PALOS DE PROA Y POPA SE SUJETAN AL ENTREPUENTE O AL PLAN (FONDO DEL BUQUE).

LAS PLUMAS, SON SOPORTES GIRATORIOS DE METAL O MADERA QUE SOBRESALEN DEL COSTADO DEL BUQUE Y SIRVEN PARA ARREAR O IZAR CARGA EN PUERTO QUE NO CUENTAN CON GRUAS DE MUELLE, UNA DISPOSICION DE PLUMA PUEDE OBSERVARSE EN LA FIG. # 4. POR LO GENERAL LAS PLUMAS TIENEN UNA CAPACIDAD DE 3 A 5 TONELADAS. - EXISTEN BARCOS QUE CUENTAN CON PLUMA DE GRAN CAPACIDAD LLAMADA "PLUMA REAL" CON CAPACIDAD DEL ORDEN DE LAS 80 TONELADAS.

<u>SECCION DE MAQUINAS Y CALDERAS</u>.- APROXIMADAMENTE,- EL ESPACIO ENTRE LOS MAMPAROS DE PROA DE CALDERAS Y POPA DE MAQUINAS Y EN EL SENTIDO DE ARRIBA ABAJO, COMPRENDE LOS PUENTES ALTO Y DE GOBIERNO, LAS CHIMENEAS, ALOJAMIENTOS DE PERSONAL DE CUBIERTA Y MAQUINAS, LOS ESPACIOS DE MAQUINAS Y CALDERAS Y, POR ULTIMO, LOS TANQUES DEL DOBLE FONDO.

<u>SECCION DE BODEGAS DE POPA</u>.- ES SIMILAR A LAS BODEGAS ANTES DESCRITAS. LOS BARCOS DE CARGA GENERAL PUEDEN SER DE CUATRO O SEIS ESCOTILLAS, EN LA FIG. 5 Y 5A SE MUESTRA UN BARCO DE CARGA GENERAL DE 5 ESCOTILLAS. LAS DIMENSIONES GENERALES Y TENDENCIAS EN EL TAMAÑO DE LOS BARCOS DE CARGA GENERAL PODRAN OBSERVARSE EN EL ANEXO # 1, DEL APENDICE .

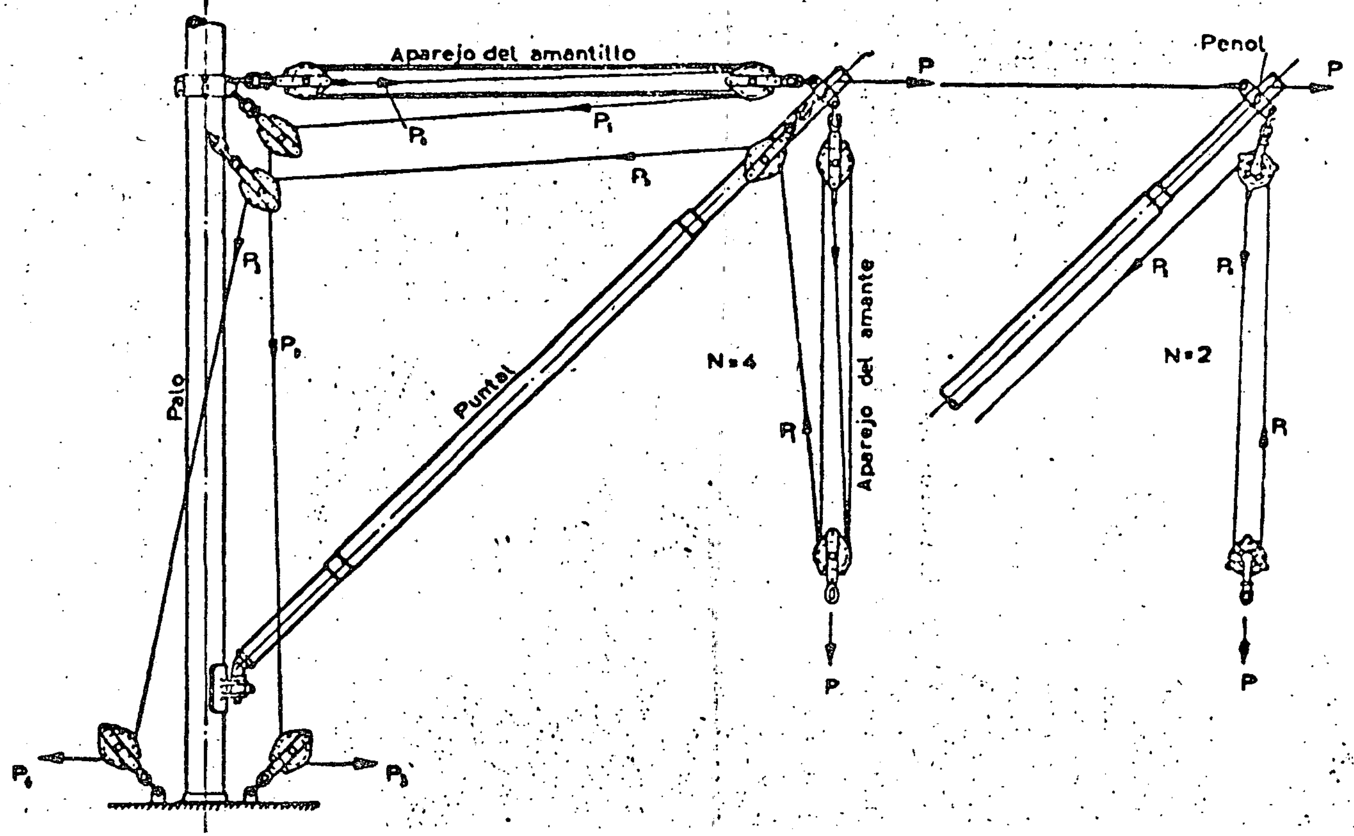
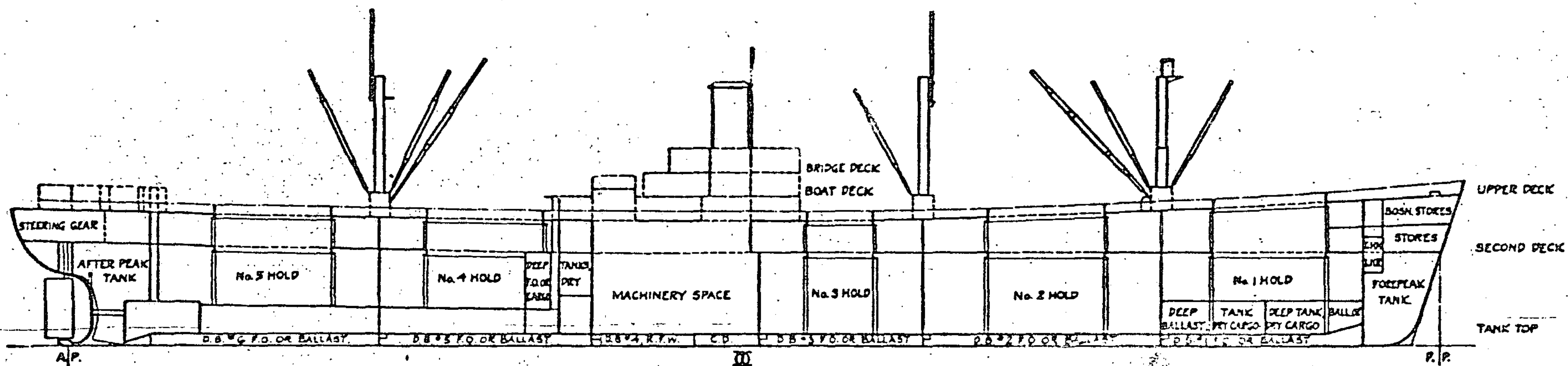


FIGURA No. 4

10 .

EC2 (LIBERTY) TYPE CARGO VESSEL



L.O.A.—441'-6": MOULDED DIMENSIONS—L.B.P.—417'-8¾", BEAM—56'-10¾", DEPTH ⨀-37'-4" TO UPPER DK

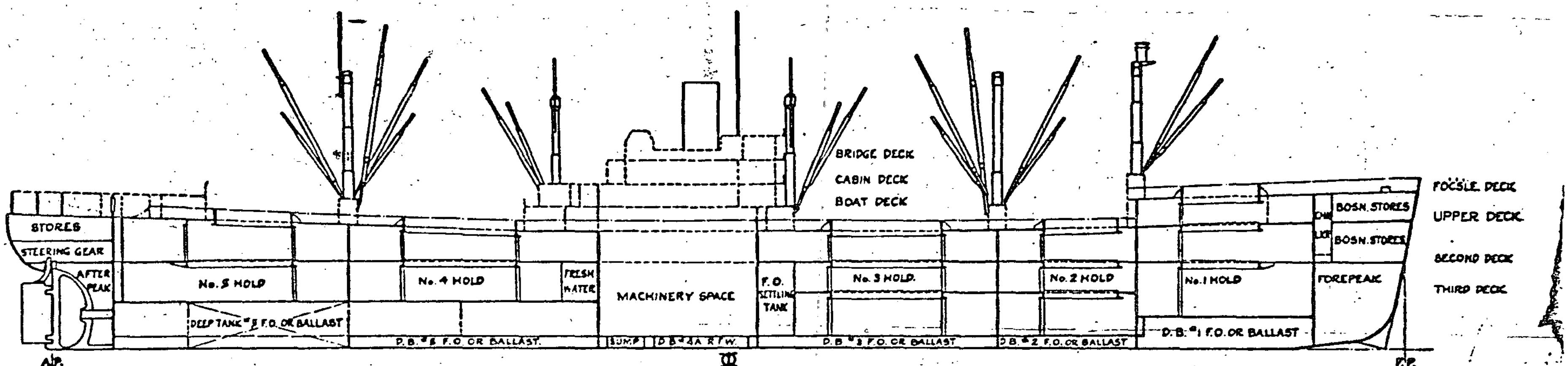
MEAN EXTREME SUMMER DRAFT—27'-8¾"
BETHLEHEM-FAIRFIELD SHIPS 27'-9¼"

GENERAL BASIC DESIGN: FLUSH DECK; FULL SCANTLING

Built By—BETHLEHEM FAIRFIELD SHIPYARDS INC.—WITH STEAM RECIPROCATING PROPELLING POWER
CALIFORNIA SHIPBUILDING CORP.—WITH STEAM RECIPROCATING PROPELLING POWER
DELTA SHIPBUILDING CO.—WITH STEAM RECIPROCATING PROPELLING POWER
J. A. JONES CONSTRUCTION CO., BRUNSWICK, GA.—WITH STEAM RECIPROCATING PROPELLING POWER
J. A. JONES CONSTRUCTION CO., PANAMA CITY, FLA.—WITH STEAM RECIPROCATING PROPELLING POWER
KAISER CO., VANCOUVER, WASH.—WITH STEAM RECIPROCATING PROPELLING POWER
MARINSHIP CORP.—WITH STEAM RECIPROCATING PROPELLING POWER
NEW ENGLAND S.B.CORP.—WITH STEAM RECIPROCATING PROPELLING POWER
NORTH CAROLINA S.B.CO.—WITH STEAM RECIPROCATING PROPELLING POWER
OREGON S.B.CORP.—WITH STEAM RECIPROCATING PROPELLING POWER
PERMANENTE METALS CORP. S.B.DIV. YARD No. 1—WITH STEAM RECIPROCATING PROPELLING POWER
PERMANENTE METALS CORP S.B.DIV. YARD No. 2—WITH STEAM RECIPROCATING PROPELLING POWER
ST. JOHNS RIVER S.B.CO.—WITH STEAM RECIPROCATING PROPELLING POWER
SOUTHEASTERN S.B.CORP.—WITH STEAM RECIPROCATING PROPELLING POWER
TODD-HOUSTON S.B.CORP.—WITH STEAM RECIPROCATING PROPELLING POWER
WALSH-KAISER CO.—WITH STEAM RECIPROCATING PROPELLING POWER

FIG. 5

VC2 (VICTORY) TYPE CARGO VESSEL



L.O.A.—455'3". MOULDED DIMENSIONS—L.B.P.—436'-6", BEAM—62'-0", DEPTH ℄-38'-0" TO UPPER DECK

MEAN EXTREME SUMMER DRAFT—28'-6⅝"

Built By—BETHLEHEM FAIRFIELD SHIPYARD INC.—WITH STEAM TURBINE PROPELLING POWER
(ONE BUILT WITH DIESEL PROPELLING POWER)
CALIFORNIA SHIPBUILDING CO.—WITH STEAM TURBINE PROPELLING POWER
KAISER CO. INC., VANCOUVER, WASH.—WITH STEAM TURBINE PROPELLING POWER
OREGON S.B.CORP.—WITH STEAM TURBINE PROPELLING POWER
PERMANENTE METALS CORP. S.B.DIV. YARD No. 1—WITH STEAM TURBINE PROPELLING POWER
PERMANENTE METALS CORP. S.B.DIV. YARD No. 2—WITH STEAM TURBINE PROPELLING POWER

GENERAL BASIC DESIGN: FORECASTLE; FULL SCANTLING

FIG. 5A

2.1.2.- BARCO PORTA TARIMAS (PALLETS).- PARA LA CARGA Y DESCARGA SE EMPLEA UN PORTALON QUE NO ES MAS QUE UNA ESCOTILLA EN LOS COSTADOS, QUE COMUNICA EL MUELLE CON EL ELEVADOR DE CARGA QUE UNEN LOS DIFERENTES ENTREPUENTES QUE TIENEN LAS BODEGAS.

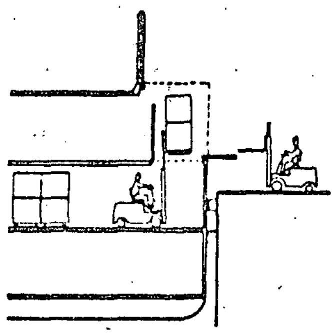
UNA DISTRIBUCION GENERAL DE ESTE TIPO DE BARCOS SE PODRA OBSERVAR EN LA FIG. # 6.

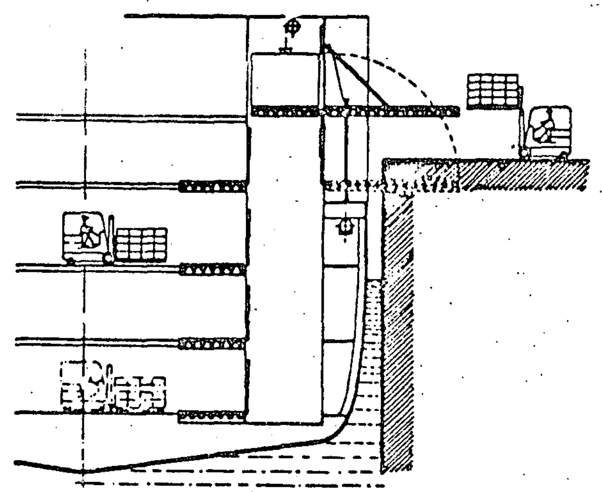
EL MANEJO DE LA CARGA EN PALLETS, PERMITE UNITARIZAR LA CARGA AL PERMITIRSE AGRUPAR A LA CARGA COLOCADA Y SUJETANDOLA SOBRE LAS TARIAMAS. EN GENERAL SON DE MADERA, Y YA EXISTEN DE MATERIAL AGLOMERADO DESECHABLES CON DIMENSIONES VARIAN, EN LA FIG. # 8 SE MUESTRAN SUS CARACTERISTICAS Y DIMENSIONES .

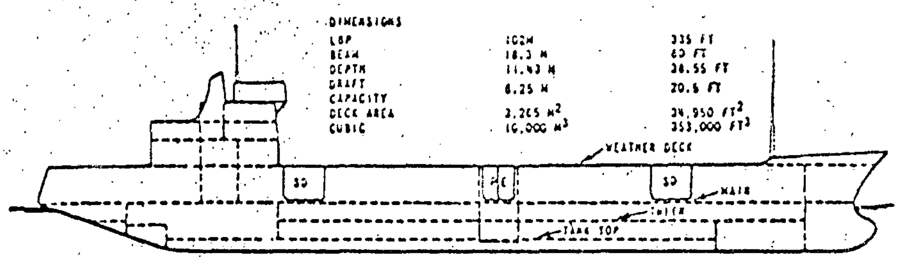
2.1.3.- TRANSBORDADORES.- SON BARCOS QUE PERMITEN EL TRANSBORDO POR RODADURA, POR MEDIO DE RAMPAS CON QUE CUENTAN LOS BARCOS, EN PROA, POPA O EN LOS COSTADOS, Y QUE POR MEDIO DE ELLAS APOYADAS EN EL PROPIO BARCO Y EN LOS ATRACADEROS PERMITEN LA CIRCULACION DE CAMIONES DEL MUELLE A LAS BODEGAS DEL BARCO O VICEVERSA.

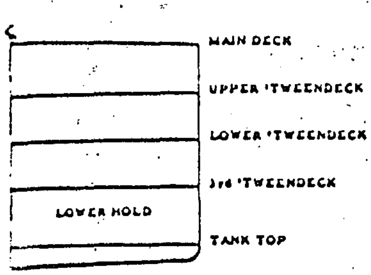
LAS BODEGAS CUENTAN CON VARIOS ENTREPUENTES PARA PERMITIR EL ACOMODO DE UN MAYOR NUMERO DE VEHICULOS, EN LA FIGURA NUMERO 7 SE MUESTRA UNA DISPOSICION EN LA PLANTA DE ESTE TIPO DE BARCO.

CUANDO LOS TRANSBORDADORES NO CUENTAN CON RAMPA, HAY QUE PROPORCIONARLA, ADOSANDOLA A UN MUELLE -









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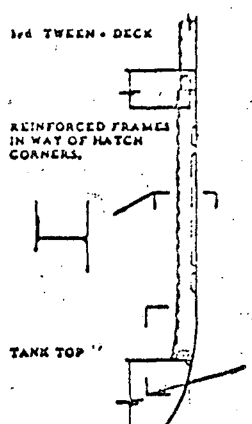


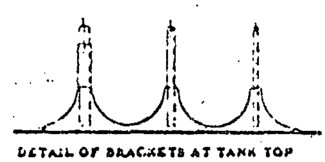
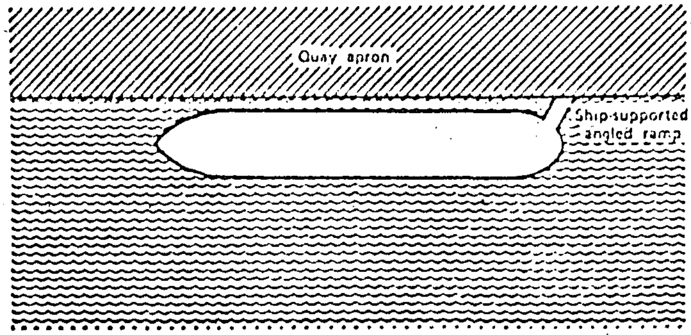


FIGURA No. 6

Roll-on/roll-off operation using a ship-supported angled ramp



Roll-on/roll-off operation using a stern ramp

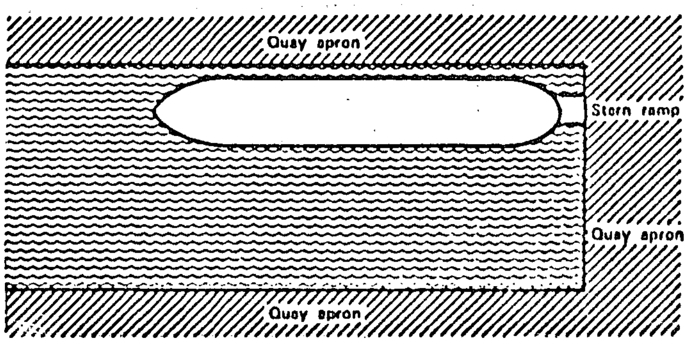


FIGURA No. 7

PALETA DE TRANSITO TIPO ESTANDARD.

1 y 2 Tons. de capacidad.

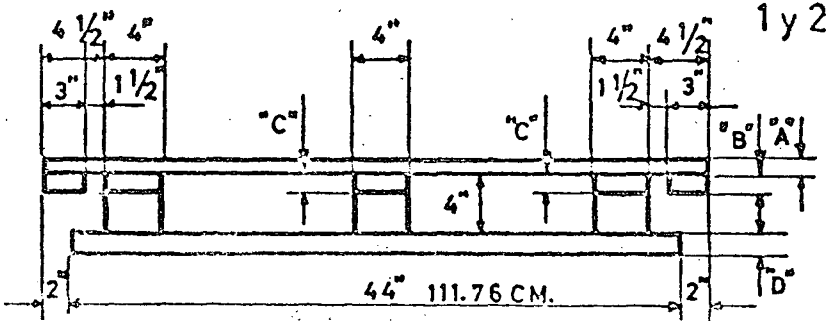


Fig. 20

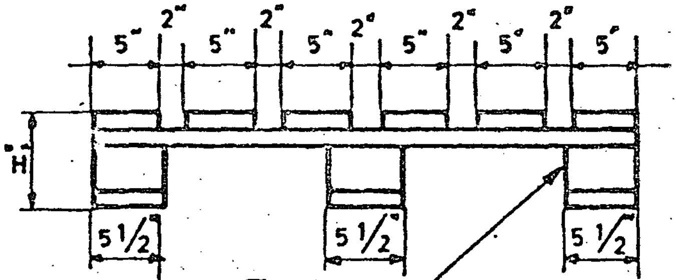


Fig. 21

BUENA MADERA SUAVE
O' PREFERIBLEMENTE
MADERA DURA.

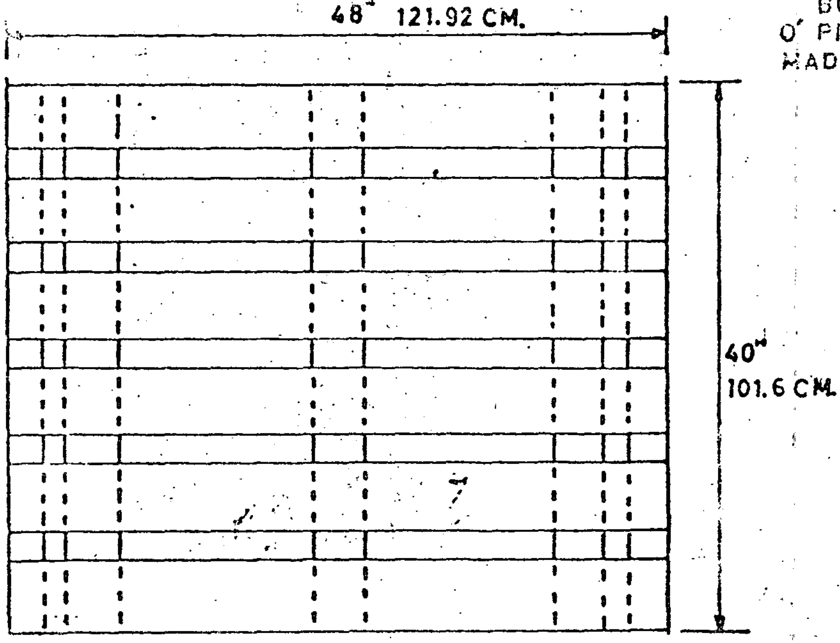


Fig. 22

	PALETA DE 1 TON		PALETA DE 2 TONS	
	MADERA SUAVE	MADERA DURA	MADERA SUAVE	MADERA DURA
"A"	1" X 6"	3/4" X 6"	1 1/4" X 6"	3/4" X 6"
"B"	1 1/4" X 3"	1" X 3"	1 1/2" X 3"	1" X 3"
"C"	1 1/4" X 4"	1" X 4"	1 1/2" X 4"	1" X 4"
"D"	1" X 5 1/2"	3/4" X 5 1/2"	1 1/4" X 5 1/2"	1" X 5 1/2"
"H"	6"	5 1/2"	6 1/2"	5 1/2"

Fig. 23

TABLA DE CONVERSIONES

PULG.	CM.
1/4"	0.635
1/2"	1.27
3/4"	1.905
1"	2.54
1 1/2"	3.81
2"	5.08

PULG.	CM.
3"	7.62
4"	10.16
4 1/2"	11.43
5"	12.70
5 1/2"	13.97
6"	15.24

FIGURA No. 8

ESPECIALIZADO COMO VEREMOS EN LA PARTE CORRESPONDIENTE A LAS INSTALACIONES. HAY TRANSBORDADORES MIXTOS, EN CUANTO PRESTAN SERVICIO DE CARGA Y PASAJE.

2.1.4.- BARCOS PORTA CONTENEDORES.- BARCOS ESPECIALIZADO PARA EL TRANSPORTE DE CONTENEDORES. EN ESTE CASO LOS CONTENEDORES SON MOVIDOS POR ELEVACION, POR - MEDIO DE GRUAS ESPECIALIZADAS DE MUELLE.

LOS BARCOS PORTACONTENEDORES INICIARON SUS OPERACIONES EN 1960 CUANDO LA COMPAÑIA MATSON COLOCO - SU PRIMER CONTENEDOR EN UN BARCO DE CARGA GENERAL TRANSFORMADO PARA ALOJAR CONTENEDORES EN SUS BODEGAS. ESTE TIPO DE BARCOS SE DIVIDEN POR SU CAPACIDAD EN BARCOS DE LA PRIMERA, SEGUNDA Y TERCERA GENERACION.

LA PRIMERA GENERACION SE INICIO CON LA TRANSFORMACION DE BARCOS DE CARGA GENERAL Y CARGAN DE 100 A 800 CONTENEDORES A UNA VELOCIDAD DE 15-20 NUDOS - CON PESO MUERTO DE 9-16 MIL TONELADAS, CUENTAN CON EQUIPO PROPIO PARA EL MANEJO DE CONTENEDORES Y CALADO DE 8 METROS. POR SU TAMAÑO Y ESCASA VELOCIDAD ESTAN DESTINADOS A ALIMENTAR PUERTOS DONDE ARRIBAN EMBARCACIONES DE MAYOR PORTE. LOS DE LA SEGUNDA GENERACION, DESARROLLAN VELOCIDADES DE 18 A 23 NUDOS CON CAPACIDAD DE 800 A 1500 CONTENEDORES Y DE 14 A 22 MIL TONELADAS D E PESO MUERTO Y 11.5 METROS DE CALADO.

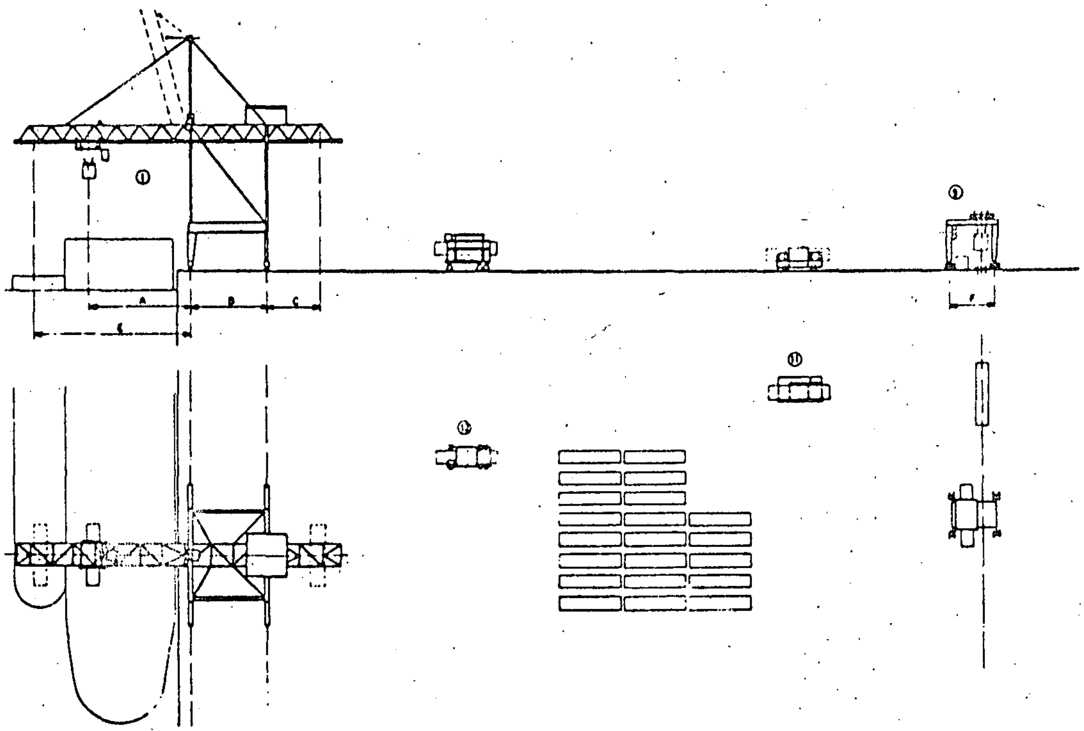
ALGUNOS DE ESTOS BARCOS ESTAN EQUIPADOS CON - GRUAS-PORTICO QUE SE MUEVEN A LO LARGO DE SUS COSTADOS, DESTINADOS A TOCAR PUERTOS QUE NO - CUENTAN CON EQUIPO DE MUELLE.

LA TERCERA GENERACION, DENOMINADOS "LOS BARCOS DE HOY Y MAÑANA" SON MAS GRANDES Y VELOCES, ES TAN ENTRE LAS 35 A 50 MIL TONELADAS DE PESO -- MUERTO , VELOCIDAD DE 25 A 33 NUDOS Y CARGAN - 1800 A 3000 CONTENEDORES Y CALADO DE 12.50 ME- TROS. ESTE TIPO DE BARCO ES COSTOSO EN SU - - CONSTRUCCION Y OPERACION, Y DEPENDEN DE LAS -- INSTALACIONES EN EL PUERTO YA QUE NO TIENEN SU PROPIO EQUIPO PARA CARGA Y DESCARGA. ALGUNOS ESTAN EQUIPADOS CON PROPULSORES A POPA Y PROA PARA AYUDAR EN EL ATRAQUE O EN LA SALIDA, HELI SES DE PASO VARIABLE PARA AYUDAR EN LAS MANIO- BRAS, CUARTOS DE MAQUINAS AUTOMATIZADOS, NAVE- GACION CONTROLADA POR COMPUTADORAS, ETC.

NOTA: LA CAPACIDAD E LOS BARCOS ES CON BASE A LAS UNIDADES (CONTENEDORES) DE 20 PIES DE -- LARGO.

LAS CARACTERISTICAS DE ESTE TIPO DE BARCOS SE PUEDEN VER EN LA FIG. # 9 Y EN EL ANEXO # 1.

LOS CONTENEDORES SON RECIPIENTES DE ACERO, ALU MINIO, PLASTICO O MADERA CONTRACHAPEADA CUBIER TA CON FIBRA DE VIDRIO QUE PERMITEN EL TRANSPOR TE DE CARGA, SELLANDO SUS PUERTAS PARA PERMITIR SU TRASLADO DEL ORIGEN EN EL LOCAL DEL USUARIO POR MEDIO DEL TRANSPORTE TERRESTRE HASTA EL - -



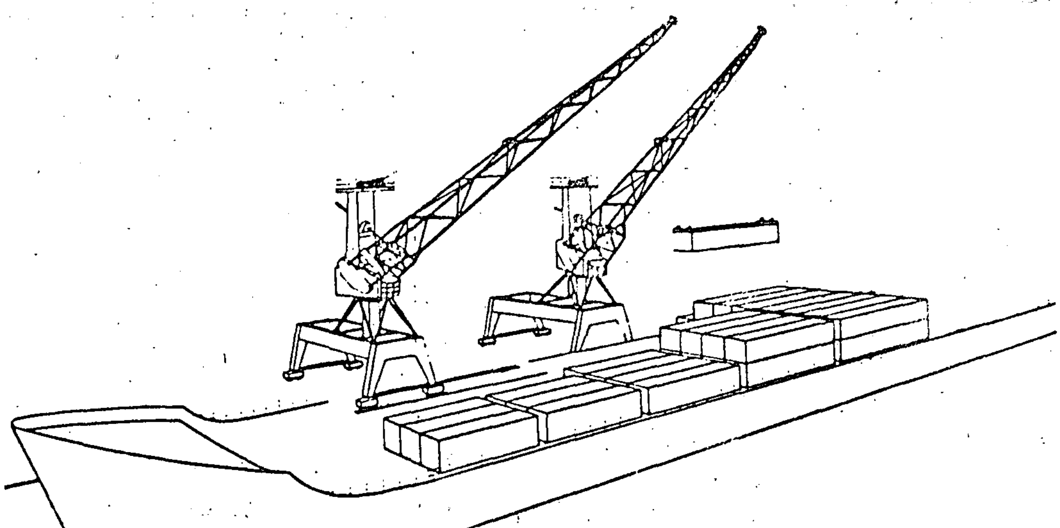


FIGURA No. 9

PUERTO DE EMBARQUE Y DEL MUELLE AL BARCO Y A LA INVERSA. LOS CONTENEDORES POR LO GENERAL SON DE 40,- 30 Y 20 PIES DE LARGO Y, 8 PIES DE ANCHO Y 8 PIES - DE ALTO. LOS MAS UTILIZADOS SON LOS DE ACERO DE 20 PIES. SU PESO VACIO ES DE 1900 KG. APROXIMADAMENTE Y SU CARGA UTIL DE 18 TONELADAS , SU CUBICAJE INTERNO ES DE 32 M3. EL PISO ES DE MADERA PARA DISTRIBUIR EL PESO SOBRE LAS VIGAS DE ACERO DEL PISO. EL PESO PERMISIBLE SOBRE EL PISO ES DE 980 Kg/M2. ESTOS -- CONTENEDORES SON A PRUEBA DE AGUA Y TIENEN UN SISTEMA PARA PROTEJERLOS DE LA HUMEDAD DE CONDENSACION. ESTAN DISEÑADOS PARA SER IZADOS POR LAS 4 ESQUINAS SUPERIORES.

EL CONTENEDOR DE 40 PIES ES EL PREFERIDO PARA LA MAYORIA DE LOS EMBARCADORES Y LOS OPERADORES DE LOS - BARCOS PORTACONTENDORES DE LA TERCERA GENERACION. PARA EL MANEJO EN CARRETERA EXISTE MENOS PESO EN UN CONTENEDOR DE 40 PIES QUE EN 2 DE 20. SU CAPACIDAD CUBICA ES DE 65 M3 Y EL PESO VACIO ES DE 3,400 Kg.- LA CARGA UTIL ES DE 27 TON.

LOS PRIMEROS CONTENEDORES ERAN BASICAMENTE PARA - - CARGA SECA, ACTUALMENTE SE HAN MODIFICADO, PONIENDOLES FORROS PARA MANEJAR CEREALES, GRANOS U OTRO PRODUCTO A GRANEL, A OTROS SE LES COLOCA MATERIAL AISLANTE PARA TRANSPORTAR CARGA CON TEMPERATURA CONTROLADA. PARA PIEZAS PESADAS, TUBERIA,ESTRUCTURAS, MAQUINARIA, ETC., SE UTILIZAN CONTENEDORES CON LA PARTE SUPERIOR DESCUBIERTA.

TAMBIEN EXISTEN CONTENEDORES-TANQUE PARA EL TRANSPORTE DE ACEITES COMESTIBLES Y ALGUNOS PRODUCTOS QUIMICOS, TAMBIEN EXISTE UN CONTENEDOR DE 8X4X20 PIES, -- USADO PARA PIEZAS QUE REQUIERAN ESTIBARSE DESDE LA - PARTE SUPERIOR, O MATERIALES DENSOS QUE CON POCA ALTURA ALCANZAN LA CAPACIDAD EN PESO DEL CONTENEDOR, - EN ESTE CASO Y EN EL ANTERIORMENTE DESCRITO PUEDEN - SER CARGADOS CON UNA GRUA DE PORTICO, Y POR ULTIMO - HAY CONTENEDORES PLEGABLES QUE CUANDO NO ES UTILIZADO SE ESTIBA OCUPANDO UN MINIMO DE ESPACIO.

2.1.5.- BARCOS PARA TRANSPORTE DE PERECEDEROS.- CUENTAN CON BODEGAS CON TEMPERATURA CONTROLADA Y LA CARGA Y DESCARGA DE LOS PROUDCTOS ES A TRAVES DE PUERTAS LOCALIZADAS EN LOS COSTADOS DEL BARCO, O CON ESCOTILLAS TIPO BARCO DE CARGA GENERAL.

2.1.6.- BARCOS PARA TRANSPORTES DE GRANELES.-

BUQUE TANQUES.- BARCO ESPECIALIZADO PARA EL TRANSPORTE DE GRANEL LIQUIDO, EN ESTE CASO HIDROCARBUROS. ESTE TIPO DE BARCO ES DE CONSTRUCCION MAS ROBUSTA QUE EL BARCO DE CARGA GENERAL YA QUE LA CARGA EN ESTOS - ULTIMOS GRAVITA SOBRE LAS CUBIERTAS, NO ASI EN LOS - BUQUE-TANQUES CUYA CARGA GRAVITA SOBRE EL FONDO, FORRO EXTERIOR MAMPAROS, ADEMAS DE QUE NAVEGANDO EN -- MAR AGITADO SE PRODUCEN FUERZAS DE INERCIA QUE ACTUAN SOBRE LOS COSTADOS Y MAMPAROS.

ESTE TIPO DE BARCO EFECTUA LA CARGA Y DESCARGA DEL - PRODUCTO POR MEDIO DE TOMAS DISPUESTAS SOBRE LA CUBIERTA A AMBOS COSTADOS Y APROXIMADAMENTE AL CENTRO DEL BARCO EN SENTIDO LONGITUDINAL, Y CUENTA CON SISTEMA DE BOMBEO INDEPENDIENTE A LAS MAQUINAS DE - -

PROPULSION.

EN ANEXOS NUMEROS 1 " 2 SE PODRAN VER LAS CARACTERISTICAS Y TENDENCIAS DE BARCOS PETROLEROS.

2.1.7.- BARCO DE PASAJEROS.- SON BARCOS ESPECIALIZADOS, CUYAS CARACTERISTICAS VARIAN, DEPENDIENDO DE LAS RUTAS Y LA DEMANDA DEL SERVICIO.

LOS BARCOS TIPO CRUCERO (TRASATLANTICOS) SON COMO LOS MOSTRADOS EN LA FIG. # 10 Y COMO PODRA OBSERVARSE EL ACCESO DE LOS PASAJEROS ES POR MEDIO DE PUERTAS DISPUESTAS EN LOS COSTADOS DE LA NAVE.

2.2.- DIFERENTES TIPOS DE TRAFICO MARITIMO.

EL TRAFICO MARITIMO LLAMADO DE "ALTURA" ES EL QUE SE EFECTUA DE UN PUERTO EXTRANJERO A UNO NACIONAL.

EL TRAFICO MARITIMO DE CABOTAJE ES EL QUE SE REALIZA ENTRE PUERTO NACIONAL .

3.- EL PUERTO.

3.1.- SERVICIOS AL BUQUE.

UNA VEZ QUE EL BARCO ANUNCIA SU ARRIBO A UN PUERTO DETERMINADO, A TRAVES DE LAS AGENCIAS CONSIGNATARIAS DEL BARCO A TRAVES DEL SERVICIO DE RADIO COSTERA, LA EMBARCACION SE SITUA EN LAS ZONAS DE FONDEO FUERA DEL PUERTO, EN DONDE ES ABORDADA POR LAS AUTORIDADES DE SANIDAD INTERNACIONAL, Y SI CUMPLE CON LOS REQUISITOS ESTABLECIDOS SE LE AUTORIZA

EL ATRAQUE, EL CUAL SERA REALIZADO POR UN PRACTICO (PILOTO DE PUERTO) AUXILIADO CON REMOLCADORES, LA AUTORIDAD MARITIMA FIJA EL MUELLE EN QUE OPERARA.

COSTOS DE TRANSPORTE.

LOS COSTOS PORTUARIOS HA QUE ESTARAN SUJETAS LAS - EMBARCACIONES COMERCIALES DE ALTURA QUE ATRAQUE EN MUELLES DE PROPIEDAD FEDERAL (CASO DE MEXICO) SE RAN LAS SIGUIENTES:

A.- REMOLCAJE.

EL SERVICIO DE REMOLCADOR SE COBRA DE ACUERDO CON EL TONELAJE BRUTO DEL BUQUE Y POR MANIOBRA DEL ATRAQUE O DESATRAQUE QUE PUEDE SER EN TIEM PO ORDINARIO O EXTRAORDINARIO.

B.- LANCHAJE.

ESTE SERVICIO SE COBRA DE ACUERDO A LA DISTAN- CIA Y MANIOBRA QUE SE REALIZE:

a) LLEVAR O TRAER AL PRACTICO A LA BOYA DE RE- CALADA.

b) LLEVAR O TRAER PERSONAL AL FONDEADERO DE EX PLOSIVOS.

c) LLEVAR O TRAER PERSONAL AL FONDEADERO DE -- CUARENTENA.

d) LLEVAR O TRAER PERSONAL AL FONDEADERO DE LA DARSENA.

e) LLEVAR PERSONAL Y CABOS A LOS DUQUES DE AL- BA Y/O BOYAS DE AMARRE EN LA MANIOBRA DE -- ATRAQUE.

f) SOLTAR CABOS AL DESATRAQUE, REVISAR CALADOS O ENMENDAR.

Disposición general de un trasatlántico español en proyecto para la Empresa Nacional "ELCANO"

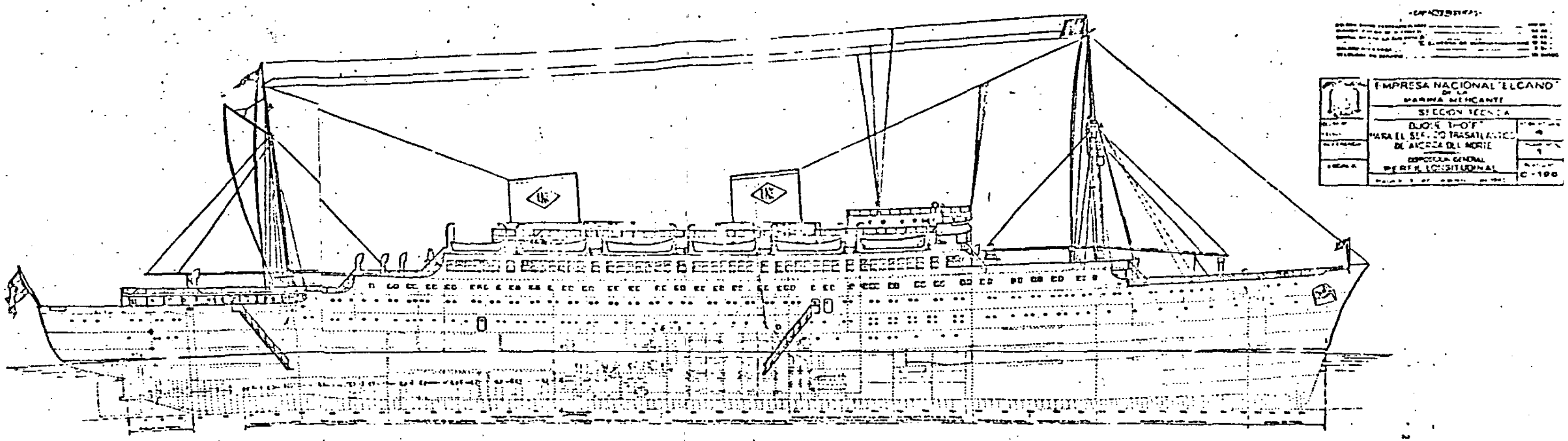


FIGURA No. 13

C.- PRACTICAJE:

EL PILOTAJE SE COBRA DE ACUERDO AL TONELAJE BRUTO DEL BUQUE Y EL CALADO MAXIMO DEL MISMO, POR MANIOBRA QUE SE EFECTUE:

a) DE BAHIA A ENTRADA A CANAL

b) ENTRADA CANAL

c) ATRAQUE

d) DESATRAQUE

e) SALIDA CANAL

D.- SANIDAD:

POR RECONOCIMIENTO DE EMBARCACION:

a) SANIDAD INTERNACIONAL

b) SANIDAD VEJETAL

E.- MIGRACION:

POR RECONOCIMIENTO DE EMBARCACION POR EL AGENTE DE MIGRACION.

(NO SE TOMA EN CUENTA LA ESTADIA, SE COBRA UNICAMENTE POR VISITA).

F.- ADUANA I:

SE COBRA POR EL PERSONAL DE RESGUARDO ADUANAL QUE INTERVIENE EN EL PUERTO (INTERVENTORES, ALMACENISTAS, VIGILANCIA Y DE SERVICIOS ADMINISTRATIVOS).

(SE COBRA UNICAMENTE EL TIEMPO EXTRAORDINARIO DADO QUE EL GOBIERNO CUBRE EL ORDINARIO).

G.- ADUANA II:

ESTE IMPUESTO SE PAGA CON RELACION AL PRODUCTO ESPECIFICO MOVIDO Y DE ACUERDO A LA TARIFA AUTORIZADA, LOS CONCEPTOS SON LOS SIGUIENTES:

a) ADVALOREM: PORCENTAJE QUE SE PAGA POR VALOR OFICIAL COMERCIAL DE LA MERCANCIA.

b) 3% ADICIONAL

c) 10% ADICIONAL (SOBRE DERECHOS DE MUELLAJE)

d) 1% FOMENTO EXPORTACION

H.- CAPITANIA DE PUERTO:

POR CONCEPTO DE VIGILANCIA SE COBRA LA CANTIDAD DE $ 120.00 POR TURNO DE 4 HRS. A PARTIR DE LAS 15.00 - - - - - HRS. HASTA LAS 08.00 HRS. DEL DIA SIGUIENTE.

I.- DERECHOS PORTUARIOS:

a) DERECHO DE PUERTO

b) DERECHO DE ATRAQUE

c) DERECHO DE MUELLAJE

LOS COBROS SE EFECTUAN DE ACUERDO AL DECRETO QUE - ESTABLECE LAS CUOTAS DE LOS DERECHOS POR LOS SERVICIOS PORTUARIOS Y MARITIMOS QUE PRESTA LA SECRETARIA DE MARINA (AHORA SECRETARIA DE COMUNICACIONES Y - TRANSPORTES). (13 DE AGOSTÓ DE 1976).

J .-AMARRADORES:

ESTE SERVICIO SE COBRA DE ACUERDO AL TONELAJE BRUTO DE LA EMBARCACION Y POR MANIOBRA, CONSIDERANDO, YA SEA TIEMPO ORDINARIO O EXTRAORDINARIO.

(ATRAQUE, DESATRAQUE).

K.- COSTOS CARGADURIA (ESTIBADORES)

SON LOS COBROS QUE HACEN POR EL MANEJO DE LA CARGA A BORDO O EN TIERRA

PARA LA COMUNICACION EN LOS PUERTOS NACIONALES ENTRE EL BARCO Y EL PERSONAL DEL PUERTO SE CUENTA CON EL - SISTEMA DE TELECOMUNICACION DENOMINADO RADIO COSTERA QUE A CONTINUACION SE DESCRIBE:

LA RED NACIONAL DE ESTACIONES COSTERAS, COMPUESTA -- POR CATORCE DE ESTAS, UBICADAS ESTRATEGICAMENTE EN LOS PRINCIPALES PUERTOS NACIONALES, Y ADMINISTRADA - DESDE 1971 POR LA DIRECCION GENERAL DE TELECOMUNICACIONES.

MEDIANTE ESTA RED SE BRINDA PROTECCION A LOS NAVEGANTES EN LOS LITORALES Y MAR PATRIMONIAL Y SE PRESTA - AYUDA PARA LA EXPLOTACION DE NUESTROS RECURSOS PESQUEROS.

LOS SERVICIOS DE RADIOTELEGRAFIA Y RADIOTELEFONIA PUEDEN ESTABLECERSE VIRTUALMENTE DESDE CUALQUIER LUGAR DEL MUNDO, DE TIERRA A BARCO Y VICEVERSA. LAS ESTACIONES COSTERAS, ESTAN UBICADAS EN LOS SIGUIENTES -- PUERTOS: ENSENADA, B.C.; GUAYMAS, SON.; LA PAZ, B.C.S.; MAZATLAN, SIN; MANZANILLO, COL.; ACAPULCO, GRO.; SALINA CRUZ, OAX.; CHETUMAL Y COZUMEL, Q.ROO.; PROGRESO, YUC.; CD. DEL CARMEN, CAMP; COATZACOALCOS Y VERACRUZ, VER.; Y TAMPICO, TAMPS.

SE DIVIDEN EN DOS GRUPOS, DE PRIMERA Y SEGUNDA CATEGORIAS, SEGUN SU CAPACIDAD DE SERVICIOS. ACTUALMENTE SE ENCUENTRAN EN OPERACION 2 ESTACIONES DE PRIMERA:- LA DE MAZATLAN, SIN., Y LA DE VERACRUZ, VER.; AMBAS PROPORCIONAN SERVICIOS DE RADIOTELEFONIA Y RADIOTELEGRAFIA. LAS RESTANTES SON DE SEGUNDA, PERO LA DE ENSENADA, B.C., QUE PRESTA SERVICIO RADIOTELEFONICO,

LAS DE MANZANILLO, COL., Y CHETUMAL, Q.ROO., QUE PRESTAN SERVICIO RADIOTELEGRAFICO JUNTO CON LAS DOS PRIMERAS EN TOTAL CINCO, SON LAS UNICAS CAPACITADAS PARA ESTABLECER ENLACES DE LARGO ALCANSE CON EMBARCACIONES DE ALTURA EN VIAJES INTERNACIONALES Y TIENEN UN HORARIO DE OPERACION, EXCEPTO LA DE CHETUMAL, Q.ROO., DE 24 HRS., TODOS LOS DIAS DE LA SEMANA.

ADEMAS DE LOS SERVICIOS DE RADIOTELEFONIA Y RADIOTELEGRAFIA, LAS ESTACIONES COSTERAS ESTAN CAPACITADAS PARA PRESTAR LOS SIGUIENTES: RADIOFAROS MARITIMOS, MUY IMPORTANTE, PORQUE SIRVE DE GUIA EN LA NAVEGACION DE EMBARCACIONES CON FALLAS O SIN EQUIPO DE RODAR, DURANTE TORMENTAS, BRUMAS O CON PILOTO MANUAL SOLAMENTE, CUANDO NO HAY VISIBILIDAD; BOLETINES METEOROLOGICOS, REFERENTES A LAS CONDICIONES DEL TIEMPO PREVALECIENTE EN LA ZONA DE INFLUENCIA DE DETERMINADA ESTACION COSTERA, PRESION ATMOSFERICA, VELOCIDAD DE LOS VIENTOS, PRECIPITACION PLUVIAL, ETCETERA, PERMITIENDO A LOS NAVEGANTES TOMAR LAS DEBIDAS PRECAUCIONES PARA NAVEGAR CON SEGURIDAD; AVISOS PARA LA SEGURIDAD DE LOS NAVEGANTES, UTILES PARA PREVENIRLOS DE OBSTACULOS EN SU RUTA, COMO RESTOS DE NAUFRAGIOS, MINAS EXPLOSIVAS O ALGUN OTRO OBJETO PELIGROSO; ASISTENCIA MEDICA EN ALTAMAR, CONSISTENTE EN DIAGNOSTICAR Y RESETAR, DESDE CUALQUIER ESTACION COSTERA, EN SU ZONA, AUN PACIENTE A BORDO DE UNA EMBARCACION EN ALTAMAR, RADIOTELEGRAFICA O RADIOTELEFONICAMENTE. ESTA COMUNICACION TIENE PRIORIDAD SOBRE LAS OTRAS, EXCEPTO LAS DE SOCORRO Y SEGURIDAD, Y HA DEMOSTRADO SU GRAN UTILIDAD, YA QUE POR MEDIO DE ESTE SERVICIO SE HAN SALVADO MUCHAS VIDAS; SERVICIO DE --

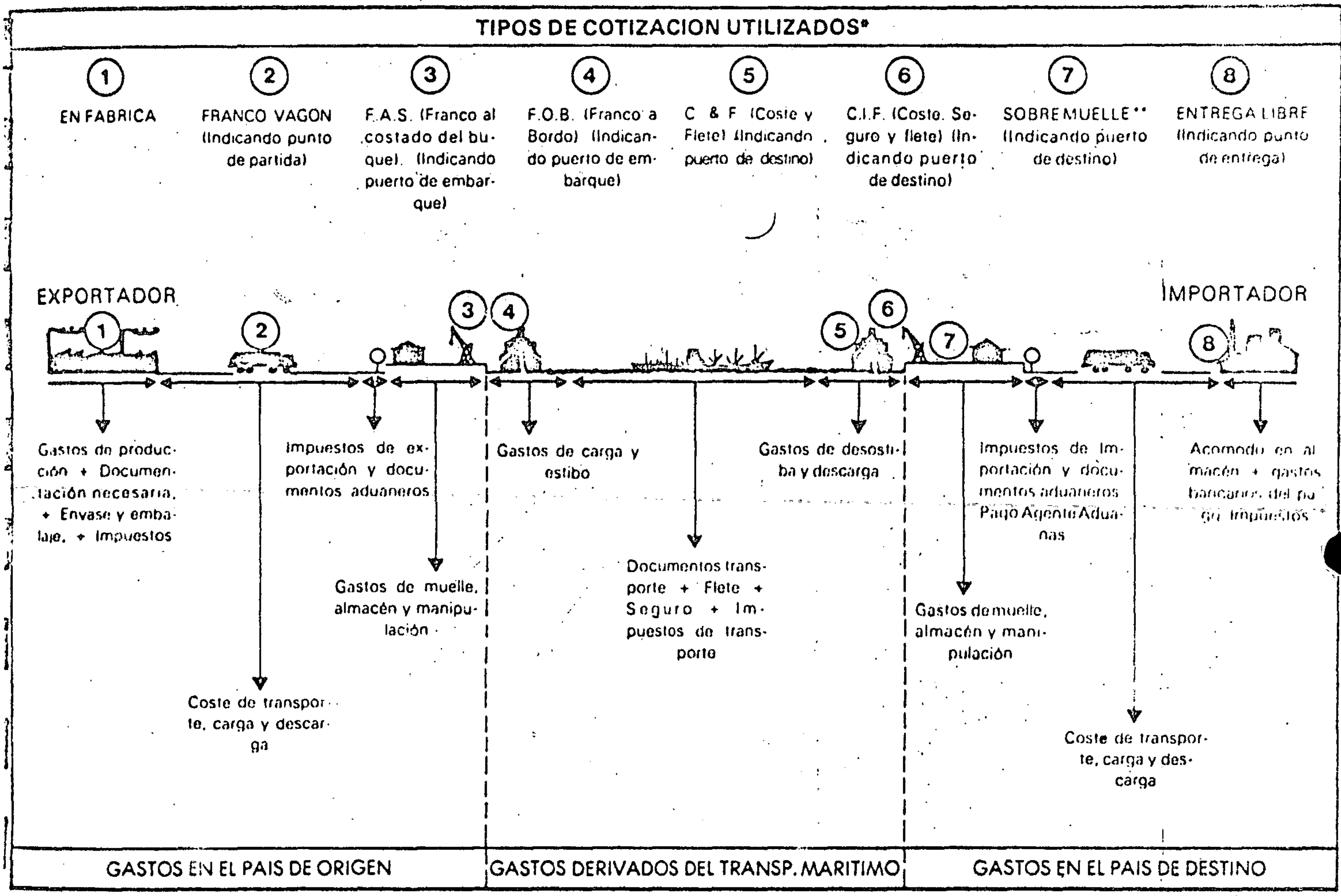
RADIODETERMINACION, MEDIANTE EL CUAL ES POSIBLE LOCALIZAR BANCOS DE PESCA PARA SU EXPLOTACION; OPERACIONES PORTUARIAS ES UN SERVICIO QUE SE PRESTA A LAS EMBARCACIONES SOLICITANTES DE PERMISO PARA EFECTUAR MOVIMIENTOS EN LOS PUERTOS, MEDIANTE COMUNICACION TELEFONICA ENTRE LOS CAPITANES DE PUERTO Y DE LAS EMBARCACIONES; LIBRE PLATICA POR RADIO CONSISTE EN RECIBIR; CON 8 HRS. DE ANTICIPACION AL ARRIBO DEL BARCO, INFORMACION DE ENFERMEDADES A BORDO, QUE SEAN OBJETO DE LEJISLACION, PARA QUE LAS AUTORIDADES DE SANIDAD INTERNACIONAL PUEDAN DETERMINAR SI ES PROCEDENTE O NO EL DESEMBARCO DE LOS PASAJEROS Y TRIPULACION, AHORRANDO ASI UN CONSIDERABLE TIEMPO EN TRAMITES; Y OTROS SERVICIOS IGUAL DE IMPORTANTES Y CON IMPLICACIONES SOCIALES Y ECONOMICAS.

RESUMIENDO, LAS ESTACIONES COSTERAS SON UM IMPORTANTE INSTRUMENTO PARA DAR CABAL CUMPLIMIENTO AL COMPROMISO CONTRAIDO POR NUESTRO PAIS EN EL CONVENIO INTERNACIONAL PARA LA SEGURIDAD DE LA VIDA HUMANA EN EL MAR (LONDRES, 1960); ADEMAS CONTRIBUYEN EN LA EFICIENTE VIGILANCIA DE NUESTRAS COSTAS Y MAR PATRIMONIAL; PRESTAN AYUDA A LAS EMBARCACIONES; ESTABLECEN CONTACTO DIRECTO E INMEDIATO, RADIOTELEGRAFICO Y RADIOTELEFONICO CON EMBARCACIONES NACIONALES Y EXTRANJERAS, EN VIAJES CORTOS Y LARGOS, DESDE CUALESQUIER PARTE DEL MUNDO Y DURANTE TODO EL AÑO, EXPIDEN RAPIDA Y EFECTIVAMENTE LOS SERVICIOS RADIOTELEFONICO Y RADIOTELEGRAFICO POR LA CORRESPONDENCIA PUBLICA; AUXILIAN EN LA EXPLOTACION PESQUERA Y EN LA INVESTIGACION OCEANOGRAFICA.

CON MIRAS HA SATISFACER LA FUTURA DEMANDA DE NUESTRO PUEBLO DE PRODUCTOS ALIMENTICIOS Y DE ENERGETICOS, Y DAN FACILIDADES A LAS ACTIVIDADES TURISTICAS Y A LA TRANSPORTACION DE PASAJEROS Y MERCANCIAS.

SERVICIOS MARITIMOS.- EL TRAFICO MARITIMO DE ALTURA Y CABOTAJE SE PRESTAN CON EMBARCACIONES DE ITINERARIO FIJO (ó REGULARES) Y TARIFA FIJA Y CON BARCOS "TRAMP" DENOMINADOS "TRAMPA", QUE SON BARCOS NO SUJETOS A ITINERARIO FIJO Y CON TARIFAS FLEXIBLES. EN EL CASO DE MEXICO, EL TRAFICO DE ALTURA SE REALIZA CON SERVICIOS DE ITINERARIO FIJO Y CON BARCOS TRAMPA NACIONALES Y EXTRANJEROS, NO ASI EL CABOTAJE QUE POR LEY EXCLUSIVAMENTE DEBERA EMPLEAR NAVES CON BANDERA NACIONAL.

GASTOS QUE SE PRODUCEN Y TIPOS DE COTIZACION UTILIZADOS EN LAS COMPRAVENTAS INTERNACIONALES



(*) La colocación de las siglas o expresiones correspondientes a cada tipo de cotización, antes o después del precio cotizado, significa que éste incluye el coste de fabricación de la mercancía más el monto de los gastos adicionales precisos para anotarla en las posiciones marcadas sobre el gráfico, con los números correspondientes a cada tipo de cotización. Estos tipos de Cotización responden a las definiciones de los INCOTERMS 1953. V/d. explicación en 8.4

(**) La cotización -SOBRE MUELLE- admite dos alternativas: en una los derechos y gastos son por cuenta del comprador y, en otra, los derechos y gastos son a cuenta del vendedor (incluso los derechos de Aduanas).

FIG. # 11

3.2.- CARACTERISTICAS GENERALES DE UNA EMBARCACION

PARTES PRINCIPALES DE UNA EMBARCACION.

PROA. ES LA PARTE DELANTERA DEL CASCO, DISPUESTA EN FORMA DE CUÑA PARA OFRECER EL MINIMO DE RESISTENCIA A EL AGUA MIENTRAS SE DESLIZA EL BARCO.

POPA. ES LA PARTE POSTERIOR DEL CASCO CON FORMA Y DEMENSIONES TALES QUE FACILITE EL PASO DEL AGUA QUE VA A LLENAR EL VACIO PROVOCADO POR EL AVANCE DEL BARCO Y PARA TENER ESPACIO SUFICIENTE PARA FACILITAR LA ACCION DE LOS ELEMENTOS DE GOBIERNO Y PROPULSION.

ESTRIBOR. ES EL COSTADO DERECHO DEL CASCO, CONSIDERANDO AL OBSERVADOR VIENDO DESDE POPA HACIA PROA.

BABOR. ES EL COSTADO IZQUIERDO CORRESPONDIENTE DE LA EMBARCACION.

AMURA. SON LAS PARTES CURVAS DEL CASCO PROXIMAS A LA PROA DEL BARCO Y SERAN DE BABOR O DE ESTRIBOR.

ALETA. SON LAS PARTES CURVAS DEL CASCO PROXIMAS A LA POPA Y PUEDEN SER TAMBIEN DE BABOR O DE ESTRIBOR.

QUILLA. ES LA PARTE PRINCIPAL DEL CASCO, FORMADA POR UNA PIEZA LARGA Y ROBUSTA QUE CORRE LONGITUDINALMENTE DE PROA A POPA Y SOBRE LA CUAL DESCANSA EL CONJUNTO DE TODAS LAS DEMAS PIEZAS. EN SUS EXTREMOS SE LEVANTAN: LA RODA QUE ES UNA PIEZA DE HIERRO O ACERO FUNDIDO QUE FORMA EL EXTREMO DE PROA Y EL CODASTE QUE FORMA EL EXTREMO DE POPA.

CUADERNAS. PIEZAS CURVAS, AFIRMADAS A LA QUILLA Y NORMALES A ELLA,

RODA Y EL CODASTE, O-SEA, ES LA MAXIMA LONGITUD DEL BARCO.

MANGA. ES LA MAXIMA DIMENSION TRANSVERSAL DEL BUQUE.

PUNTAL. ES LA DISTANCIA VERTICAL, MEDIDA EN LA SECCION MAESTRA, ENTRE LA CARA SUPERIOR DE LA QUILLA Y LA LINEA HORIZONTAL DE LA CUBIERTA DE CONSTRUCCION.

ALTURA. ES LA DISTANCIA VERTICAL, MEDIDA EN LA SECCION MAESTRA, ENTRE EL BORDE INFERIOR DE LA QUILLA Y LA LINEA HORIZONTAL DE BAO DE LA CUBIERTA DE CONSTRUCCION.

CALADO. ES LA DISTANCIA VERTICAL MEDIDA ENTRE EL NIVEL DEL AGUA Y EL BORDE INFERIOR DE LA QUILLA. GENERALMENTE EL CALADO EN LA POPA ES MAYOR QUE EN LA PROA. EL CALADO DE POPA ES EL QUE SE DEFINE COMO CALADO DE LA EMBARCACION. EL CALADO MAXIMO ESTA REFERIDO A LA LINEA DE FLOTACION A PLENA CARGA. EL CALADO MINIMO ES EL CORRESPONDIENTE A BARCO DESCARGADO O EN LASTRE.

FRANCO BORDO ES LA DISTANCIA VERTICAL, MEDIDA EN LA SECCION MAESTRA, ENTRE LA LINEA DE FLOTACION A PLENA CARGA Y LA INTERSECCION DE LA CUBIERTA ALTA CON EL COSTADO DEL BUQUE.

CARACTERISTICAS DE LAS EMBARCACIONES.

DESPLAZAMIENTO. ES EL PESO DEL BARCO, O SEA, ES EL PESO DEL VOLUMEN DEL AGUA DESALOJADO POR EL BARCO. SE MIDE EN TONELADAS METRICAS. ES UN VALOR VARIABLE DE ACUERDO CON LA CARGA TRANSPORTADA.

QUE DAN FORMA AL BUQUE Y SOSTIENEN EL FORRO O SEA LAS - QUE FORMAN EL COSTILLAJE DEL BARCO. SE LLAMA "CUADERNA MAESTRA" AQUELLA CUYO CONTORNO LIMITA LA MAYOR SUPERFI-CIE (COMUNMENTE ES LA DE MAYOR ABERTURA). LA SECCION CO RRESPONDIENTE DEL CASCO SE DENOMINA "SECCION MAESTRA".

CUBIERTAS. SON SUPERFICIES HORIZONTALES, QUE DIVIDEN EL INTERIOR - DEL BARCO EN VARIOS NIVELES O PISOS. LA SUPERIOR SE LLA MA CUBIERTA ALTA O DE CONSTRUCCION, Y SE ENCUENTRA TOTAL O PARCIALMENTE AL DESCUBIERTO. LA INMEDIATA INFERIOR SE LLAMA HABITABLE Y LA SIGUIENTE SE LLAMA PROTECTORA O SO-LLADO.

EN LOS BARCOS DE CARGA LAS AREAS ENTRE CUBIERTAS SE DES-TINAN A BODEGAS.

BAOS. SON PIEZAS HORIZONTALES TRANSVERSALES QUE COMPLEMENTAN EL MARCO FORMADO POR LAS CUADERNAS Y QUE SIRVEN PARA - - APOYO DE LAS CUBIERTAS.

LINEA Y SUPERFICIE DE FLOTACION. SE LLAMA LINEA DE FLOTACION A LA QUE SEPARA LA PARTE SE-CA DE LA MOJADA Y PLANO DE FLOTACION AL DEFINIDO POR DI-CHA LINEA. ESTA SE MARCA ESTANDO EL BARCO FLOTANDO EN - AGUAS TRANQUILAS. LA LINEA DE CARGA MAXIMA ES LA DE IN-MERSION MAXIMA ESTANDO EL BUQUE EN CONDICIONES NORMALES DE NAVEGABILIDAD.

DIMENSIONES DE UNA EMBARCACION

ESLORA. ES LA MAXIMA DISTANCIA ENTRE LAS CARAS EXTERNAS DE LA -

DESPLAZAMIENTO EN ROSCA. ES EL PESO DEL BUQUE AL SER BOTADO AL AGUA. INCLUYE EL PESO COMPLETO DEL CASCO CON -- SUS ACCESORIOS, INSTALACION COMPLETA DE MAQUINARIA, CALDERAS, ETC.

DESPLAZAMIENTO EN LASTRE. ES EL PESO DEL BUQUE LISTO PARA NAVEGAR CON DOTACION DE COMBUSTIBLE, AGUA, LASTRE, ETC., PERO SIN CARGA.

DESPLAZAMIENTO EN CARGA. ES EL PESO DEL BUQUE CON TODOS LOS PERTRECHOS Y CON LA MAXIMA CARGA QUE ES CAPAZ DE -- TRANSPORTAR.

N O T A : UN BUQUE QUE PASE DE AGUA DULCE A AGUA DE MAR DISMINUYE SU CALADO YA QUE AUMENTA LA DENSIDAD DE AGUA (1 M3 DE AGUA DE MAR = 1.026 TON.)

ARQUEO. ES LA MEDIDA CONVENCIONAL DE LA CAPACIDAD O VOLUMEN INTERNO DE UN BARCO. LA UNIDAD DE MEDIDA ES LA TONELADA DE -- ARQUEO (TONELADA MOORSON) EQUIVALENTE AL VOLUMEN DE 100 - PIES3 O SEA, 2.832 M3.

ARQUEO BRUTO. ES EL VOLUMEN DE TODOS LOS ESPACIOS INTERIORES DE A BORDO SIN DISTINCION DE CLASES. EN EL VALOR DEL ARQUEO BRUTO SE HALLAN BASADOS LOS PRECIOS DE LOS BUQUES, LAS PRIMAS DE NAVEGACION Y CONSTRUCCION Y LOS DERECHOS DE CARENA.

ARQUEO NETO. ES EL VOLUMEN DE LA PARTE DEL BUQUE DESTINADA A LA CARGA Y SE OBTIENE, DEDUCIENDO DEL ARQUEO BRUTO, EL VOLUMEN DE LOS ESPACIOS QUE, POR SU USO O MODO DE CONS

TRUCCION, NO PUEDEN DEDICARSE A LA ESTIBA DE CARGA.

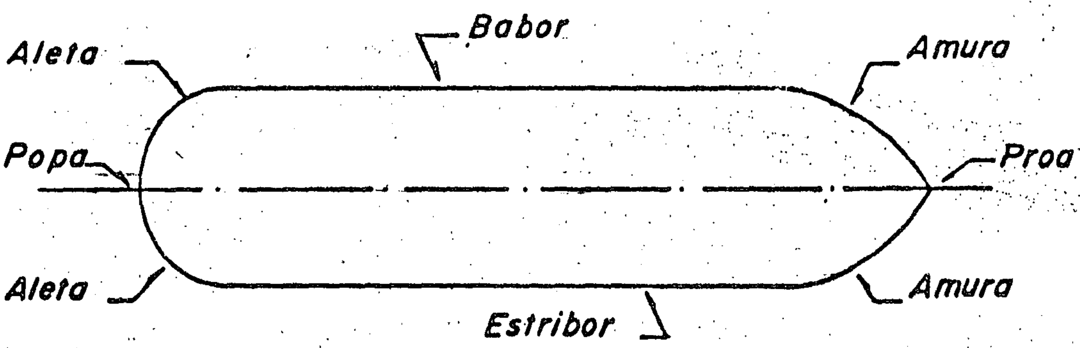
PORTE. ES EL PESO DE LA CARGA QUE TRANSPORTA EL BUQUE. LA UNIDAD DE MEDIDA ES LA TONELADA METRICA.

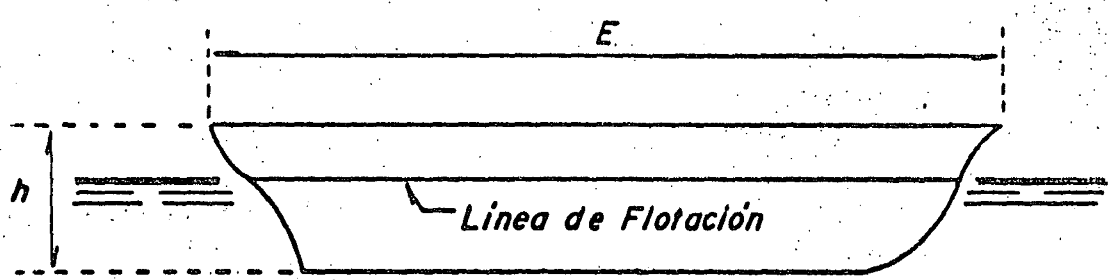
PORTE BRUTO. ES EL PESO DEL VOLUMEN DE AGUA DESPLAZADA AL PASAR EL BARCO, DE LAS CONDICIONES DE "BUQUE DESCARGADO" (DESPLAZAMIENTO EN ROSCA), A LAS DE "PLENA CARGA" (DESPLAZAMIENTO EN CARGA). ES DECIR, ES EL PESO QUE ES CAPAZ DE TRANSPORTAR EL BUQUE.

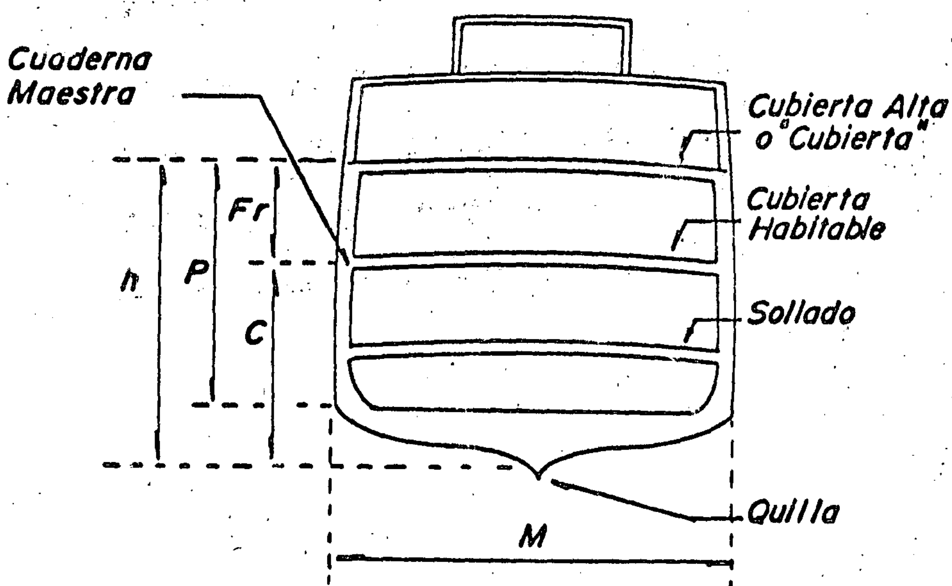
PORTE NETO. ES EL PESO DEL VOLUMEN DE AGUA DESPLAZADO, AL PASAR EL BARCO DE LAS CONDICIONES DE "BUQUE DESCARGADO" PERO CON DOTACION DE AGUA, COMBUSTIBLE, VIVERES, ETC. (DESPLAZAMIENTO EN LASTRE) A LAS DE PLENA CARGA (DESPLAZAMIENTO EN CARGA). ES DECIR, ES EL PESO DE LA "CARGA", PROPIAMENTE DICHA, QUE ES CAPAZ DE TRANSPORTAR EL BARCO.

TONELAJE. GENERALMENTE, EN CATALOGOS Y LISTAS OFICIALES, ENTRE LAS CARACTERISTICAS DE UN BARCO, SE DAN EL "TONELAJE BRUTO" Y EL "TONELAJE NETO". ESTOS VALORES SE REFIEREN AL "ARQUEO" POR LO QUE SU UNIDAD DE MEDIDA ES LA TONELADA "MOORSON" (DE 100 PIES^3).

PARTES PRINCIPALES Y DIMENSIONES DE UNA EMBARCACION







SECCION MAESTRA

NOMENCLATURA

E = Eslora
h = Altura
P = Puntal
Fr = Franco Bordo
C = Calado
M = Manga

RELACIONES ENTRE EL DESPLAZAMIENTO DE CARGA Y LAS DEMAS CARACTERISTICAS DE UNA EMBARCACION.

NOMENCLATURA Y UNIDADES:

D = DESPLAZAMIENTO EN CARGA, EN TONS. METRICAS

D_R = DESPLAZAMIENTO EN ROSCA, EN TONS. METRICAS

D_L = DESPLAZAMIENTO EN LASTRE, EN TONS. METRICAS

T_B = ARQUEO BRUTO, EN TONELADAS MOORSON.

T_N = ARQUEO NETO, EN TONELADAS MOORSON

P_B = PORTE BRUTO, EN TONELADAS METRICAS

P_N = PORTE NETO, EN TONELADAS METRICAS

RELACIONES:

ENTRE DESPLAZAMIENTO EN CARGA Y ARQUEO BRUTO

ESTA RELACION VARIA CON EL TIPO, DIMENSIONES Y CARACTERISTICAS DE LA EMBARCACION. EN GENERAL, PUEDE CONSIDERARSE PARA BARCOS DE 4.500 TONS. DE DESPLAZAMIENTO O MENOS, LA RELACION DE 2.26 Y, PARA BARCOS DE 20 000 TONS. DE DESPLAZAMIENTO, LA DE 1.97.

SE TOMARA UN VALOR INTERMEDIO PARA DICHA RELACION CUANDO EL DESPLAZAMIENTO ESTE COMPRENDIDO ENTRE LOS VALORES MENCIONADOS.

POR LO TANTO:

$$2.26\ T_B \quad D \quad 1.97\ T_B$$

ENTRE DESPLAZAMIENTO EN CARGA Y PORTE BRUTO

ESTA RELACION TAMBIEN ES VARIABLE Y LOS LIMITES DE VARIACION, EN ESTE CASO, SON 1.54 Y 1.43 PARA BARCOS DE 4500 Y 20 000 TONS. DE DESPLAZAMIENTO RESPECTIVAMENTE.

POR LO TANTO:

$$1.54\ P_B \quad D \quad 1.43\ P_B$$

ENTRE DESPLAZAMIENTO EN CARGA Y DESPLAZAMIENTO EN ROSCA.

EL DESPLAZAMIENTO EN ROSCA ES IGUAL AL DESPLAZAMIENTO EN CARGA MENOS EL PORTE BRUTO DE UNA EMBARCACION, POR LO QUE, DE LA RELACION D/P_B ANTERIOR, PUEDE DEDUCIRSE QUE EL DESPLAZAMIENTO EN ROSCA VARIARA, APROXIMADAMENTE, ENTRE 0.30 Y 0.35 DEL DESPLAZAMIENTO EN CARGA.

O SEA:

$$3.35\ D_R \quad D \quad 2.85\ D_R$$

ENTRE DESPLAZAMIENTO EN CARGA Y DESPLAZAMIENTO EN LASTRE.

EN GENERAL, PARA BARCOS CARGUEROS, EL DESPLAZAMIENTO EN LASTRE ES APROXIMADAMENTE IGUAL A 0.39 DEL DESPLAZAMIENTO EN CARGA.

O SEA:

$$D_L = 0.39\ D$$

ENTRE DESPLAZAMIENTO EN CARGA Y PORTE NETO.

EL PORTE NETO DE UNA EMBARCACION ES IGUAL A LA DIFERENCIA ENTRE EL DESPLAZAMIENTO EN CARGA, Y EL DESPLAZAMIENTO EN LASTRE POR LO QUE DE LA RELACION D/D_L ANTERIOR PUEDE DEDUCIRSE QUE EL PORTE NETO ES APROXIMADAMENTE IGUAL A 0.61 DEL DESPLAZAMIENTO EN CARGA.

$$P_N = 0.61\ D$$

OTRAS RELACIONES ENTRE LAS CARACTERISTICAS DE UNA EMBARCACION.

ENTRE EL PORTE BRUTO Y EL ARQUEO BRUTO.

ESTA RELACION ES VARIABLE SEGUN QUE EL BARCO SEA DE PASAJE O DE CARGA, ASI COMO DE SUS DIMENSIONES, ETC. GENERALMENTE VARIA ENTRE 1.40 Y 1.47

$$1.47\ T_B \quad P_B \quad 1.40\ T_B$$

ENTRE EL ARQUEO NETO Y ARQUEO BRUTO.

LOS VALORES ENTRE LOS CUALES OSCILA LA RELACION ENTRE EL ARQUEO NETO Y EL BRUTO SON: 0.6 Y 0.7

O SEA:

$$0.7\ T_B \quad T_N \quad 0.6\ T_B$$

APLICACIONES.

1.- CONOCIENDO CUALQUIERA DE LAS CARACTERISTICAS DE UNA EMBARCACION SE PODRAN CALCULAR LAS RESTANTES, YA QUE SE CONOCEN LAS DIFERENTES RELACIONES ENTRE ELLAS.

2.- CON EL DATO DEL "ARQUEO BRUTO" SE PODRAN TENER LOS VALORES MAXIMO, MINIMO Y PROMEDIO DE LAS DIMENSIONES DE LA EMBARCACION CON LA AYUDA DE LA TABLA "DIMENSIONES DE BARCOS MERCANTES DE EE.UU." QUE SE ANEXA, O BIEN CON LAS "LISTAS OFICIALES DE BARCOS MERCANTES" (CATALOGOS).

3.- GENERALMENTE EN CATALOGOS DE BARCOS, SE DA COMO DATO EL VALOR DEL PUNTAL "P" DE LA EMBARCACION. EN EL "ARTE NAVAL" DE A. BAISTROCCHI SE DAN VALORES DE LA RELACION "R" ENTRE LA ALTURA DE LA CONSTRUCCION "H" Y EL PUNTAL "P" DEDUCIDOS DEL LLOYD REGISTER" Y SE VE QUE:

PARA H 6.55 M. H/P ≐ 1.1

PARA H 6.55 M. H/P ≐ 1.15

CON LOS CUALES SE PODRA OBTENER EN FORMA BASTANTE APROXIMADA, EL VALOR DE "H" CORRESPONDIENTE.

SE ANEXA UNA GRAFICA, CONSTRUIDA CON DATOS DEL "ARTE NAVAL" QUE NOS PERMITE CONOCER EL VALOR DEL FRANCO BORDO (FR) Y DEL CALADO (C_M) PARA DIFERENTES VALORES DE LA ALTURA "H"

4.- CON EL VALOR DEL "PORTE NETO" (P_N) DE LA EMBARCACION SE PUEDE CALCULAR LA VARIACION DE CALADO AL PASAR EL BUQUE DE LAS CONDICIONES DE PLENA CARGA A LA DE EN LASTRE, APLICANDO LA FORMULA.

$P_N = E \times M \times 1.026 \times C \cdot (C_M - C_M)$ (ARTE NAVAL DE A. BAISTROCCHI).

EN LA QUE : P_N = PORTE NETO EN TONELADA METRICAS

E = ESLORA EN METROS

M = MANGA EN METROS

1.026 = PESO EN TONS. DE 1 M^3 DE AGUA DE MAR

C_M = CALADO MAXIMO O A PLENA CARGA EN METROS

C_M = CALADO EN LASTRE EN METROS

C_G = COEFICIENTE DE AFINAMIENTO QUE DEPENDE DEL DESPLAZAMIENTO Y DE LA VELOCIDAD DEL BARCO

EL VALOR DE C_G SE ENCUENTRA TABULADO EN LA PAG. 784 DEL ARTE NAVAL DE A. BAISTROCCHI PERO, EN GENERAL PUEDE DECIRSE QUE PARA EL TIPO DE BARCOS MERCANTE QUE ATRACAN EN PUERTOS MEXICANOS, C_G = 0.8, POR LO QUE:

$$C_M \doteq C_M - \frac{P_N}{0.81 \times E \times M}$$

RESTANDO EL VALOR DE "H" EL DE "CM" ASI CALCULADO SE PODRIA OBTENER LO QUE EL BARCO SOBRESALE DEL AGUA EN LAS CONDICIONES DE BARCO DESCARGADO.

5.- LOS RESULTADOS ANTERIORES PERMITIRAN CALCULAR APROXIMADAMENTE, ENTRE OTRAS COSAS:

A).- EL TIRANTE DE AGUA MINIMO NECESARIO EN LA BANDA DE ATRAQUE DE UN MUELLE.

B).- LA ELEVACION CORRESPONDIENTE DE LA RASANTE DE ACUERDO CON LA FLUCTUACION DE MAREAS.

C).- LA LONGITUD NECESARIA DE LA BANDA DE ATRAQUE

D).- LA FUERZA DE IMPACTO QUE SOBRE EL MUELLE Y SEGUN EL TIPO DE DEFENSA ELEGIDA, PRODUCIRA EL BARCO AL ATRACAR.

E).- LA TENSION EN LOS CABLES DE AMARRE PARA EL CALCULO DE LAS BITAS O EL EMPUJE SOBRE EL MUELLE, AL ESTAR OBRANDO EL VIENTO SOBRE EL CASCO DEL BARCO, SEGUN LAS CONDICIONES DEL PUERTO Y LA VELOCIDAD DEL VIENTO DOMINANTE.

F).- LAS DIMENSIONES NECESARIAS Y LA CARGA DE PROYECTO DE UNA GRADA DE CONSTRUCCION O DE UN VARADERO.

G).- EL DRAGADO MINIMO NECESARIO EN UN CANAL DE NAVEGACION, ETC.

EJEMPLO:

OBTENCION DE LAS CARACTERISTICAS Y DIMENSIONES DE UN BARCO DE - - - 2 000 TONS. DE ARQUEO BRUTO:

$$T_B = 2\ 000 \text{ TONS. MOORSON.}$$

DE LAS RELACIONES DADAS ENTRE LAS CARACTERISTICAS DE UNA EMBARCACION SE PUEDE DECIR QUE, PARA ESTE CASO:

D (DESPLAZAMIENTO EN CARGA) $\doteq 2.26 \times 2\ 000 \doteq 4500$ TONS.METRICAS

D_L (DESPLAZAMIENTO EN LASTRE) $\doteq 0.39 \times 4\ 500 \doteq 1750$ TONS. METRICAS

D_R (DESPLAZAMIENTO EN ROSCA) $\doteq 0.35 \times 4\ 500 \doteq 1580$ TONS. METRICAS

P_B (PORTE BRUTO) $\doteq \dfrac{4500}{1.54} \doteq 2920$ TONS. METRICAS

P_N (PORTE NETO) $\doteq 0.61 \times 4500 \doteq 2750$ TONS. METRICAS

T_N (ARQUEO NETO) $\doteq 0.70 \times 2000 \doteq 1400$ TONS. MOORSON

EN LA TABLA "DIMENSIONES APROXIMADA PARA DIFERENTES EMBARCACIONES" SE TIENEN LAS DIMENSIONES PRINCIPALES DE UNA EMBARCACION DE ACUERDO CON SU TONELAJE (ARQUEO BRUTO) OBTENIDAS DEL CATALOGO "MERCHAN VESSELS OF THE UNITED STATES".

PARA UN BARCO DE 2000 TONS. DE ARQUEO SE TIENE:

ESLORA MAXIMA = 105.46 M. M.MAX. = 23.70 M.

ESLORA MINIMA = 54.86 M. M.MIN. = 11.67 M.

ESLORA PROMEDIO = 81.00 M. M.PROM. = 15.14 M.

P.MAX. = 8.11 M.

P.MIN. = 3.23 M.

P.PROM. = 5.11 M. $\therefore$ H $\doteq 5.11 \times 1.15 \doteq 5.88$ M.

EN LA "LISTA OFICIAL DE BARCOS MERCANTES NACIONALES" SE TIENE QUE:

DRAGA CAMPECHE: T_B = 1832 TON. E = 80 M. CM = 4.45 M.

T_N = 700 TONS. M = 12.8 M.

DRAGA COATZACOALCOS: T_B = 2000 TONS. E. = 81.3 M. CM = 4.58 M.

TN = 1587 TONS. M = 12.8 M.

DRAGA EMANCIPACION: T_B = 2162 TON. E = 79.6 M. CM = 4.19

TN = 1304 TONS. M = 13.3 M. FR = 1.97

H = 6.16 M.

PARA LAS TRES EMBARCACIONES ANTERIORES SE TIENE:

E = 80.00 M.

M = 13.00 M.

H = 6.16 M

$$P = \frac{6.16}{1.15} = 5.35 \text{ M.}$$

LA GRAFICA NO. 1 ANEXA NO NOS PERMITE OBTENER LOS VALORES DE FR Y CM PARA H = 5.35 Y H = 5.88 (19.28') PORQUE HABRIA NECESIDAD DE EXTRAPOLAR DEL EXAMEN DE LOS DATOS DE LA "LISTA OFICIAL DE BARCOS MERCANTES NACIONALES" SE VE QUE EL CALADO MAXIMO QUEDA COMPRENDIDO ENTRE 4.19 Y 4.58

ASI PUES CM = 4.38 .°. FR = 6.16 - 4.38 = 1.78 M.

EL TIRANTE DE AGUA EN LA BANDA DE ATRAQUE DEBERA SER APROXIMADAMENTE:

4.38 + 0.30 = 4.68 ≙ 4.70

EL CALADO MINIMO O EN LASTRE SERA:

$$CM = CM - \frac{PN}{E \times M \times 0.81} = 4.38 - \frac{2750}{80 \times 13 \times 0.81} = 4.38 - 3.26 = 1.12$$

CON EL VALOR DEL CALADO MINIMO CONOCIDO SE PUEDE CALCULAR EL AREA MAXIMA EXPUESTA A LA ACCION DEL VIENTO.

ALTURA MAXIMA DEL BARCO SOBRE EL NIVEL DEL AGUA

6.16 - 1.12 = 5.04 M.

AREA MAXIMA EXPUESTA AL VIENTO: 80 x 5.04 = 403.2 M^2

RESUMEN:

D = 4500 TONS.

D_L = 1750 TONS.

D_R = 1580 TONS.

T_B = 2000 TONS. MOORSON

T_N = 1400 TONS. MOORSON

P_B = 2920 TONS.

P_N = 2750 TONS.

E = 81 M (CATLG.E.U.A.)

E = 80 M. (CATLG.NALES.)

M = 15.14 M. (CATLG.E.U.A.)

M = 13 M. (CATLG. NALES.)

H = 5.88 M. (CATLG.E.U.A.)

H = 6.16 M. (CATLG. NALES.)

P = 5.11 M. (CATLG.E.U.A.)

P = 5.35 M. (CATLG. NALES)

CM = 4.38 M.

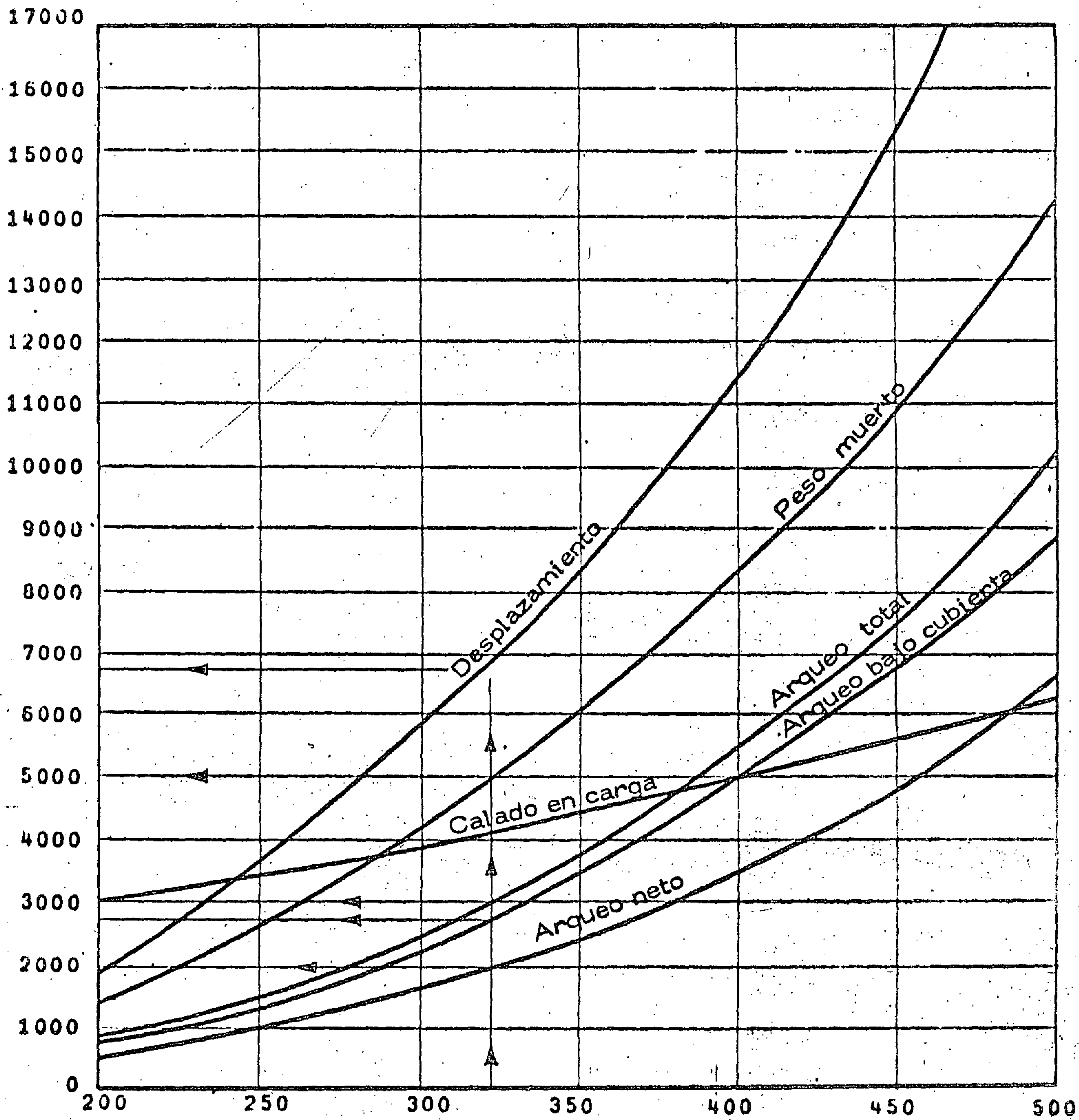
FR = 1.78 M.

TIRANTE DE AGUA EN EL ATRAQUE = 4.70 M.

CM = 1.12 M.

AREA MAXIMA EXP. AL VIENTO = 403.2 M^2

RELACION GRAFICA DE LA ESLORA CON EL CALADO Y LAS CARACTERISTICAS DE LA EMBARCACION



Eslora en pies

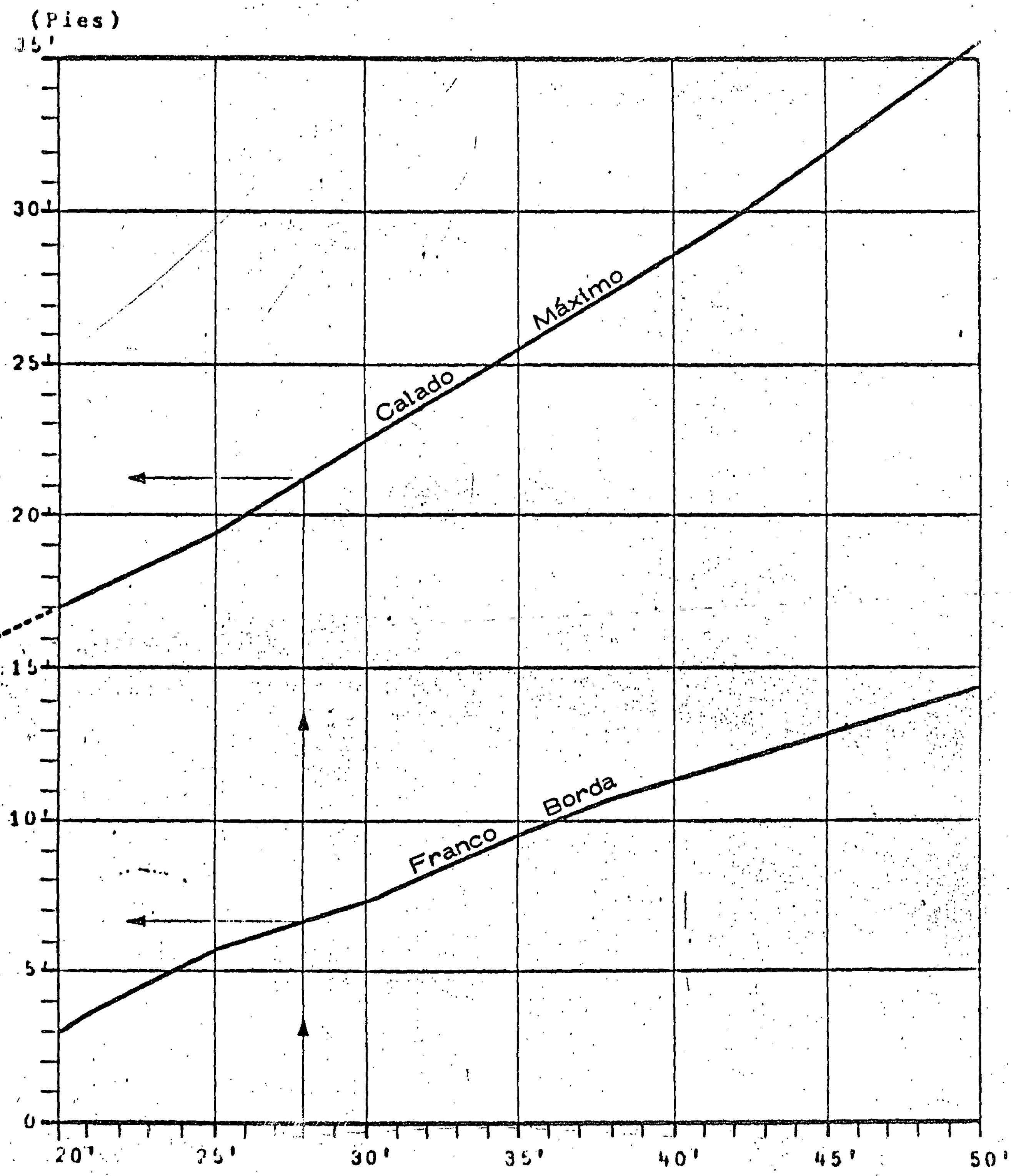
Para la ley de variación del calado con la eslora, la separación entre dos horizontales del diagrama, equivale a 5 pies.

Buques de 200 pies de eslora: $\frac{E}{P} = 12.5$, $\frac{M}{P} = 1.8$

Buques de 500 pies de eslora: $\frac{E}{P} = 13$, $\frac{M}{P} = 1.67$

E = Eslora
P = Puntal
M = Manga

RELACION GRAFICA ALTURA, CALADO
FRANCO BORDO



ALTURA DEL CASCO EN PIES

4.- LAS OPERACIONES EN EL PUERTO.

LAS OPERACIONES EN UN PUERTO SE REALIZARAN DE TAL MANERA - QUE EL FLUJO DE CARGA O PASAJEROS EN LA TRANSFERENCIA DEL SISTEMA DE TRANSPORTE MARITIMO AL TERRESTRE Y VICEVERSA -- SEA REGULAR, Y CON EFICIENCIA, ECONOMIA Y SEGURIDAD. EL - FLUJO A QUE NOS REFERIMOS PUEDE REPRESENTARSE ESQUEMATICA- MENTE DE LA SIGUIENTE MANERA:

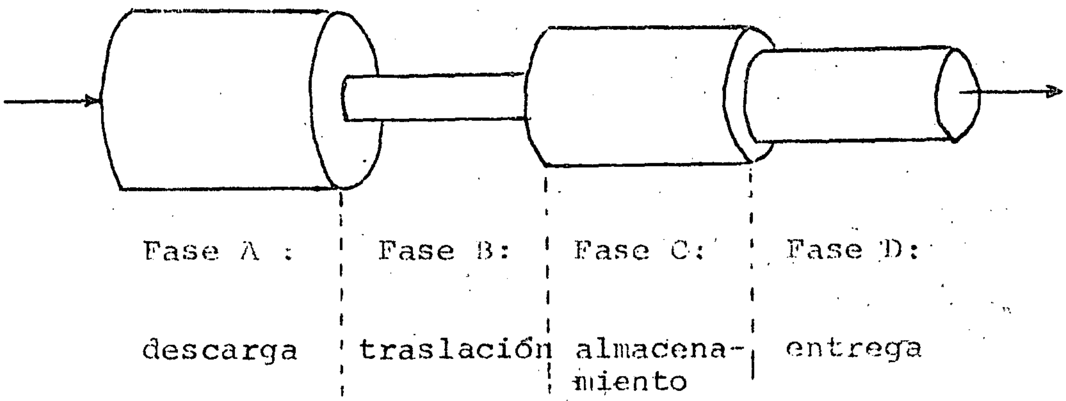


FIG. # 12

ASI SE REPRESENTA UNA DE LAS DISTINTAS VIAS QUE PUEDEN SE- GUIR LAS MERCANCIAS DE IMPORTACION AL PASAR POR UN PUESTO DE ATRAQUE. CADA UNA DE LAS CUATRO FASES TENDRA UNA DETER MINADA CAPACIDAD DE MANIPULACION QUE SERA DISTINTA DE LAS CAPACIDADES DE LAS DEMAS. LA SITUACION ES PARECIDA A LA -

DE UN LIQUIDO QUE CIRCULE POR EL INTERIOR DE UNA TUBERIA DE DIAMETRO VARIABLE O DESIGUAL, EN EL SENTIDO DE QUE EL RITMO DE MANIPULACION DE LAS MERCANCIAS EN EL PUESTO DE ATRAQUE - VENDRA DETERMINADO POR LA FASE QUE TENGA LA MENOR CAPACIDAD DE MANIPULACION. (EN LA FIG. 12SE TRATA DE LA FASE B: TRASLACION).

DE ESTA SEMEJANZA SE OBSERVA QUE NO SE CONSIGUE NADA CON -- TRATAR DE AUMENTAR LA CAPACIDAD DE AQUEL ELEMENTO DEL PUESTO DE ATRAQUE CUYA CAPACIDAD ES YA LA MAYOR (EN EL EJEMPLO ANTERIOR, LA FASE A: DESCARGA). EN REALIDAD SOLO SE PUEDE MEJORAR LA CAPACIDAD DEL CONJUNTO INCREMENTANDO LA CAPACIDAD DEL ELEMENTO MAS ESTRECHO O REDUCIDO, DE AHI LA UTILIZACION DEL TERMINO " ESTRANGULAMIENTO ". LA CAPACIDAD EL CONJUNTO IRA MEJORANDO A MEDIDA QUE SE INCREMENTA LA CAPACIDAD DE LA FASE B, HASTA QUE LLEGUE A IGUALAR LA DE LA FASE D: - ENTREGA. CUALQUIER MEJORA ADICIONAL DE LA CAPACIDAD TOTAL EXIJIRA UN AUMENTO SIMULTANEO DE LA CAPACIDAD DE LAS FASE - B Y D.

LA LINEA DE FLUJO DE CARGA SE PODRA OBSERVAR EN LA FIG. 13, EN LA CUAL SE MUESTRAN LAS INSTALACIONES EN SECCION TRANSVERSAL PARA CARGA GENERAL, MANEJO DE LIQUIDOS Y DE MINERALES.

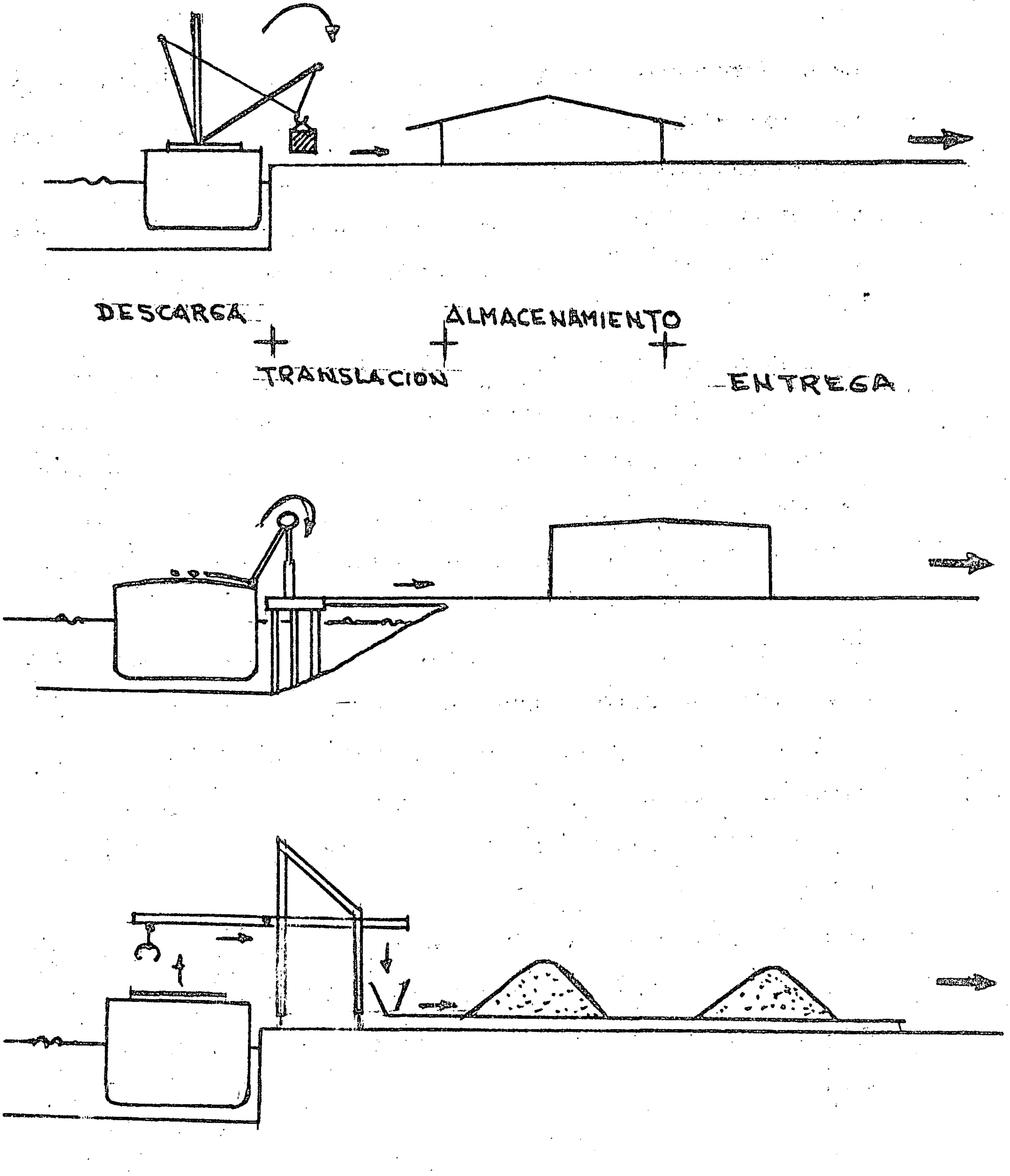


FIG. 13, FLUJO DE LA LINEA DE CARGA EN TERMINALES DE CARGA GENERAL, FLUIDOS Y MINERALES.

4.1.- TERMINALES DE CARGA GENERAL.

EN CASI TODO PUERTO LA CARGA GENERAL ES LA PARTE MAS IMPORTANTE DEL TRAFICO MARITIMO. EL VALOR DE LA CARGA GENERAL ES CONSIDERABLEMENTE MAYOR QUE EL VALOR PROMEDIO DE LAS MERCANCIAS DE GRANEL. EL MANEJO DE UNA GRAN VARIEDAD DE PEQUEÑAS CARGAS REQUIEREN DE MAS ESPACIO, MAS TRABAJO DE PERSONAL Y UN CUIDADO MAS METICULOSO. POR LO TANTO ES JUSTIFICADO EMPLEAR UN MAYOR DETALLE EN LA PLANEACION DE ESTE TIPO DE INSTALACIONES QUE PARA OTRAS PARTES DEL PUERTO.

DE ACUERDO CON EL DIAGRAMA DE FLUJO DE MERCANCIAS ANTERIORMENTE DESCRITO, LA FASE "A" DE DESCARGA O CARGA DE EMBARCACIONES, SE REALIZA POR MEDIO DE LAS GRUAS DEL BARCO O POR MEDIO DE LAS GRUAS DE MUELLE, QUE CORREN A LO LARGO DEL PUESTO DE ATRAQUE, EN MEXICO SE UTILIZA EL PRIMERO DE LOS DOS SISTEMAS. EN OTROS PAISES DE EUROPA, ASIA Y AMERICA DEL SUR, LA CARGA Y DESCARGA DE EMBARCACIONES SE REALIZA EMPLEANDO GRUAS DE MUELLE. LA EFICIENCIA DE AMBOS SISTEMAS ES APROXIMADAMENTE EL MISMO, SIEMPRE QUE SE CUENTE CON SUFICIENTE Y ADECUADO EQUIPO DE TRASLACION DE CARGA. EN LA FASE "B" DE TRANSLACION DE CARGA SE EFECTUA, ENTRE EL FRENTE DE AGUA Y LA BODEGA DE TRANSITO, A ESTE ESPACIO, SE LE DENOMINA PLATAFORMA DE TRABAJO, QUE DEBE TENER SUFICIENTE ANCHO PARA ALOJAR DOS VIAS DE FERROCARRIL Y ESPACIO PARA EL TRANSITO DE CAMIONES, DEBIDO AL GRAN PORCENTAJE DE CARGA QUE ES MANIPULADA EN MANIOBRA DIRECTA DE BARCO A TREN O CAMION O VICEVERSA, ESTE -

ESPACIO SE CONSIDERA CONVENIENTE NO SEA MENOR DE 20 MTS. Y 30 MTS. MAXIMO, YA QUE DE OTRA MANERA LA DISTANCIA A LA BODEGA DE TRANSITO SERIA DEMASIADO LARGA REQUIRIENDOSE UN - MAYOR NUMERO DE EQUIPO PORTUARIO DE TRANSLACION DE CARGA.

LA LONGITUD DEL MUELLE PARA CADA PUESTO DE ATRAQUE, ASI COMO LA PROFUNDIDAD DE AGUA SERA DETERMINADA POR EL TAMAÑO - Y CALADO DE LOS BUQUES QUE ARRIBEN AL PUERTO. LA TENDENCIA AL CRECIMIENTO EN TAMAÑO DE BARCOS DE CARGA GENERAL ES MENOR QUE LOS GRANELEROS Y LOS BUQUE-TANQUES, AL RESPECTO TAL PARECE QUE SE LLEGO AL BUQUE DE CARACTERISTICAS OPTIMAS, QUE REQUIERE UNA PROFUNDIDAD DE AGUA DEL ORDEN DE LOS 10 MTS; PREVINIENDO EN EL DISEÑO DE LOS MUELLES UNA POSIBLE PROFUNDIZACION A 12 MTS. PARA TOMAR EN CUENTA FUTURAS NECESIDADES. LA ESLORA MEDIA SE CONSIDERA DE 160 MTS. POR LO QUE LA LONGITUD DEL ATRACADERO SERIA DE 180 MTS. PERMITIENDO CON ESTO DEJAR 10 MTS. A CADA LADO DEL BARCO COMO MARGEN DE SEGURIDAD ENTRE NAVES Y PARA LA SUJECION DE LOS CABOS AL MUELLE.

LA PRODUCTIVIDAD POR ATRACADERO DEPENDE DEL TIPO Y VOLUMEN DE CARGA, PARA CARGA GENERAL FRACCIONADA SE CONCIDERA DEL ORDEN DE LAS 480 TON/DIA/BARCO. PARA GRANELES EN DESCARGA DIRECTA UN PROMEDIO DE 1000 TON/DIA/BARCO. SI EN UN MUELLE DETERMINADO SE HALLAN LOS DOS TIPOS DE CARGA ANTERIORMENTE MENCIONADOS, LA PRODUCTIVIDAD ESTARA EN FUNCION DE - LOS VOLUMENES DE CARGA DE CADA PRODUCTO, conciDERANDO UN - PROMEDIO APROXIMADAMENTE DE 280-300 DIAS DE TRABAJO AL AÑO, PARA TOMAR EN CUENTA DIAS FESTICOS DESCOMPOSTURA DE EQUIPO

DEL BARCO O DE TIERRA Y SUSPENCIONES CON FENOMENOS METEO-ROLOGICOS. EL RENDIMIENTO EN LAS OPERACIONES DE CARGA O DESCARGA SERA DEL ORDEN DE 130,000 A 200,000 TON/AÑO.

PARA PLANEAR NUEVAS INSTALACIONES DE ATRAQUE ES INSIPENSABLE EFECTUAR UN ESTUDIO DE LOS RENDIMIENTOS EN LA TERMINAL DE CARGA GENERAL, YA QUE ANTES DE PROGRAMAR AMPLIACIONES ES NECESARIO VERIFICAR QUE LOS RENDIMIENTOS EN LAS MANIOBRAS DE ALIJO SEAN LAS MAS CONVENIENTES, YA SEA AUMENTANDO LA PRODUCTIVIDAD, EL NUMERO DE DIAS LABORABLES Y LOS TURNOS DE TRABAJO. ESTE ASPECTO SE PODRA OBSERVAR EN LA FIG. # 14 QUE MUESTRA LA RELACION ENTRE LA PRODUCTIVIDAD EXPRESADA EN TONELADAS-HORA-GANCHO, EL NUMERO DE ATRACADEROS Y EL NUMERO DE DIAS DISPONIBLES DEL MUELLE, COMO EJEMPLO HEMOS CONSIDERADO LA COMPARACION DE DOS RENDIMIENTOS, UNO DE 12.5 TON/HORA/GANCHO Y EL OTRO DE 20.0 TON/HORA/GANCHO, OBTENIENDO PARA EL PRIMER CASO 6 ATRACADEROS PARA EL MANEJO DE 600000 TON/AÑO Y EN EL OTRO 4 ATRACADEROS.

LA GRAFICA MOSTRADA FUE TOMADA DE LA PUBLICACION "PORT DEVELOPMENT" DE UNCTAD PUBLICADO EN 1978 Y QUE FUE ELABORADA CONSIDERANDO CONDICIONES DE PIEZAS EN VIAS DE DESARROLLO.

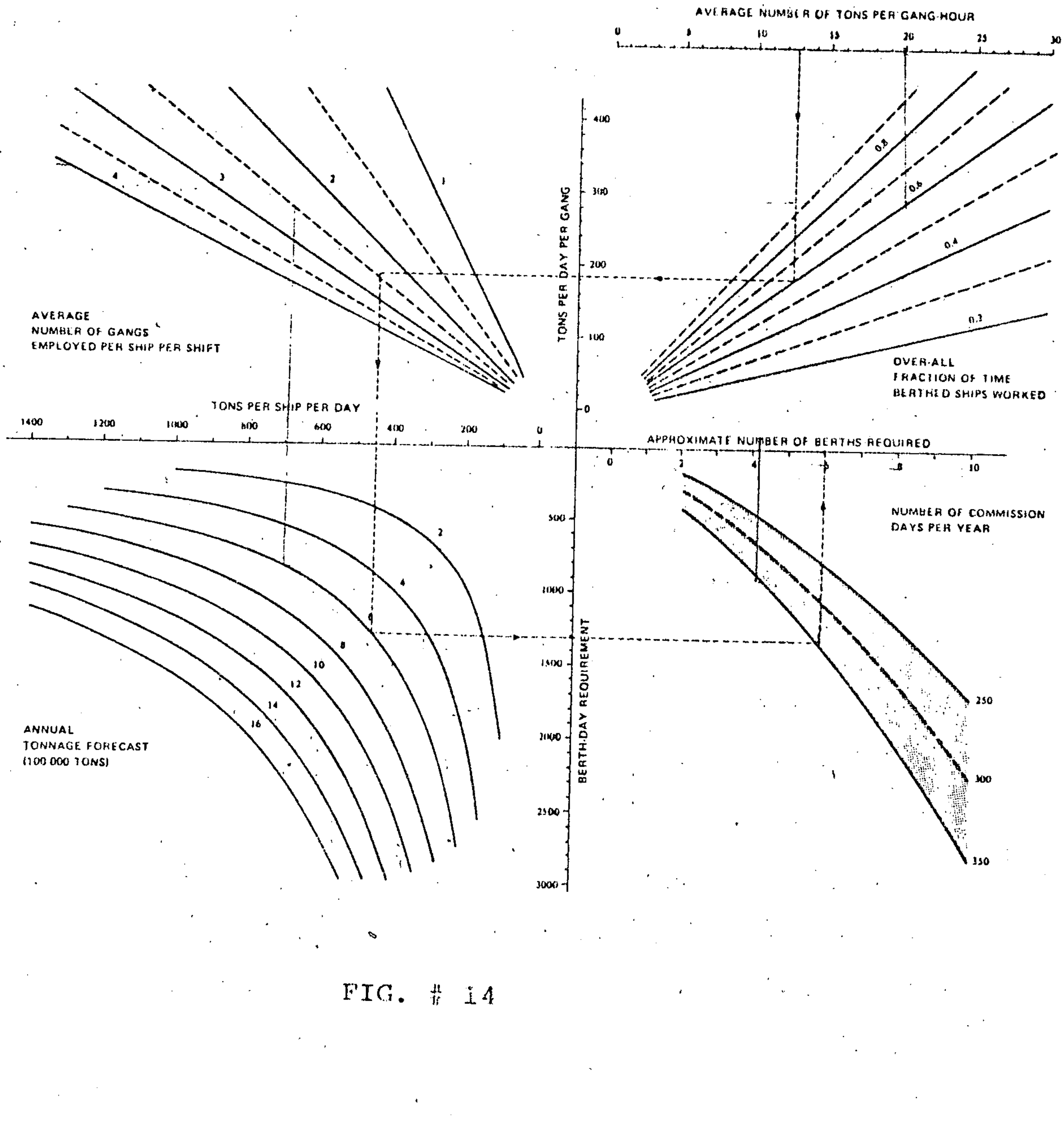

AVERAGE NUMBER OF TONS PER GANG-HOUR
TONS PER DAY PER GANG
AVERAGE NUMBER OF GANGS EMPLOYED PER SHIP PER SHIFT
TONS PER SHIP PER DAY
OVER-ALL FRACTION OF TIME BERTHED SHIPS WORKED
APPROXIMATE NUMBER OF BERTHS REQUIRED
NUMBER OF COMMISSION DAYS PER YEAR
BERTH-DAY REQUIREMENT
ANNUAL TONNAGE FORECAST (100 000 TONS)

FIG. # 14

LA FASE "C" DE ALMACENAMIENTO, COMPRENDE LA BODEGA DE TRANSITO DE MERCANCIAS, ES EL ELEMENTO MAS IMPORTANTE DE UN ATRACADERO DE CARGA GENERAL. TODAS LAS ACTIVIDADES ESTAN CONCENTRADAS DENTRO Y ALREDEDOR DE LA BODEGA, SU PROPOSITO ES PROTEJER LA CARGA DE LA LLUVIA, DEL POLVO Y EL VIENTO ASI COMO DE DAÑOS ACCIDENTALES Y ROBOS. ACTUA COMO BASE REGULADOR ENTRE LOS SISTEMAS DE TRANSPORTE MARITIMO Y TERRESTRE AL PERMITIR FORMAR BLOQUES DE CARGA PARA LA EXPORTACION E IMPORTACION. LAS CARGAS DE EXPORTACION DEBEN SER PREPARADAS EN LA BODEGA PARA SER CARGADAS DE ACUERDO CON EL PLAN DE ESTIBA DE LAS EMBARCACIONES.

EN NINGUN CASO LAS BODEGAS DE TRANSITO SERAN USADAS PARA ALMACENAMIENTO DE LARGA DURACION, LA CARGA NO DEBE PERMANECER UN MINIMO DE TIEMPO Y SER RETIRADA PARA EVITAR UN CUELLO DE BOTELLA EN EL FLUJO DE MERCANCIAS. PARA EL ALMACENAMIENTO DE LARGA DURACION, DEBEN PREVEERSE BODEGAS PARA ESTE FIN, DENOMINADAS BODEGAS ESTACIONARIAS QUE SE LOCALIZAN POR DETRAS DE LAS DE TRANSITO.

PARA EVITAR EL CONGESTIONAMIENTO Y DAR FACILIDADES A LOS EMBARCADORES, EN MEXICO SE PERMITE EL ALMACENAMIENTO SIN COBRO POR 15 DIAS, DESPUES DE ESE PERIODO SE INICIA EL COBRO DEL ALMACENAMIENTO DE CARGA. SI EL MUELLE ES DE 180 MTS., LA LONGITUD CONVENIENTE DE LA BODEGA ES DEL ORDEN DE LOS 120 MTS., LOCALIZADA AL CENTRO DEL MUELLE, QUEDANDO ESPACIO EN LAS CABECERAS PARA EL ESTACIONAMIENTO DE EQUIPO ALMACENAMIENTO DE MAQUINARIA, O CARGA Y DESCARGA DE CAMIONES.

EL ANCHO DE LA BODEGA CONVIENE TENGA UN MINIMO DE 40 MTS. Y DE SER POSIBLE SI EXISTE ESPACIO TENDER A 50 MTS. PARA DE ESA FORMA EXTENDER MAS UNIFORMEMENTE LA CARGA SIN NECESIDAD DE APILAR LOS DIFERENTES LOTES QUE SE AGRUPAN EN SU INTERIOR DE ESTA FORMA EL ACCESO A CADA LOTE ES MAS FACIL CON EL CONSIGUIENTE AHORRO EN TIEMPO Y AUMENTO DE EFICIENCIA.

LA RAZON PRINCIPAL PARA AUMENTAR LO MAS POSIBLE EL ANCHO DE LA BODEGA ES DEBIDO A QUE EL ESPACIO PROXIMO AL FRENTE DE AGUA ES MUCHO MAS VALIOSO QUE EN LA PARTE POSTERIOR YA QUE ES FACILMENTE ACCESIBLE EN LA LINEA DIRECTA DESDE LA BODEGA DE CADA BUQUE, SIN DOBLE MANEJO DE LA CARGA Y SIN LA NECESIDAD DE CRUZAR CALLES O RODEAR LA BODEGA DE TRANSITO.

LAS BODEGAS DE TRANSITO DEBERAN TENER PUERTAS CON DIMENSION MINIMA DE 4.50 MTS. DE ANCHO POR 5.00MTS. DE ALTURA A LO LARGO DE SUS COSTADOS Y EN LAS CABEZAS PARA FACILITAR LA MANIOBRA DE CARGA Y DESCARGA DE CAMIONES.

LAS PUERTAS DEL COSTADO O POSTERIOR DE LAS BODEGAS COMUNICAN AL TRANSPORTE TERRESTRE.

LA ILUMINACION DIURNA Y NOCTURNA ES IMPORTANTE PARA PERMITIR EL TRABAJO TODO EL DIA. PARA LA LUZ DIURNA SE RECOMIENDA COLOCAR LUCERNARIOS CUYA SUPERFICIE SEA UN MINIMO DEL 7% DEL AREA TOTAL.

PARA EL ALMACENAMIENTO DE CARGA EN TRANSITO A LA INTEMPERIE, DEBEN PREVEERSE PATIOS LOCALIZADOS EN ZONAS PROXIMAS A LAS BODEGAS DE TRANSITO CONVENIENTEMENTE DISEÑADOS DE ACUERDO CON EL TIPO DE CARGA QUE SE MANEJE POR EL PUERTO.

LA FASE "D", O SEA LA ENTREGA, SE RELACIONA CON LOS ACCESOS PARA EL TRANSPORTE TERRESTRE Y DEBEN SER PLANEADOS PARA UN MOVIMIENTO SIN OBSTRUCCION DE LOS VEHICULOS QUE LLEGAN Y SALEN, YA SEA VACIOS O CARGADOS, SIN INTERFERENCIA PARA LAS OPERACIONES DE MANEJO DE CARGA Y SIN INTERSECCIONES CON LOS PATIOS DE ALMACENAMIENTO AL DESCUBIERTO DEBIENDO EXISTIR ACCESO FACIL A LAS CARGAS ALMACENADAS A LA INTEMPERIE. LOS ACCESOS TERRESTRES DEL PUERTO ESTARAN CONECTADOS A LAS REDES DE CARRETERAS Y FERROCARRILES DE TAL MANERA QUE NO EXISTAN CONGESTIONAMIENTOS QUE NOS PROBOQUEN UN CUELLO DE BOTELLA EN EL FLUJO DE MERCANCIAS EN LA RECEPCION DE ENTREGA.

UNA DISPOSICION DE TERMINAL DE CARGA GENERAL PUEDE OBSERVARSE EN LAS FIGURAS 16 Y 17

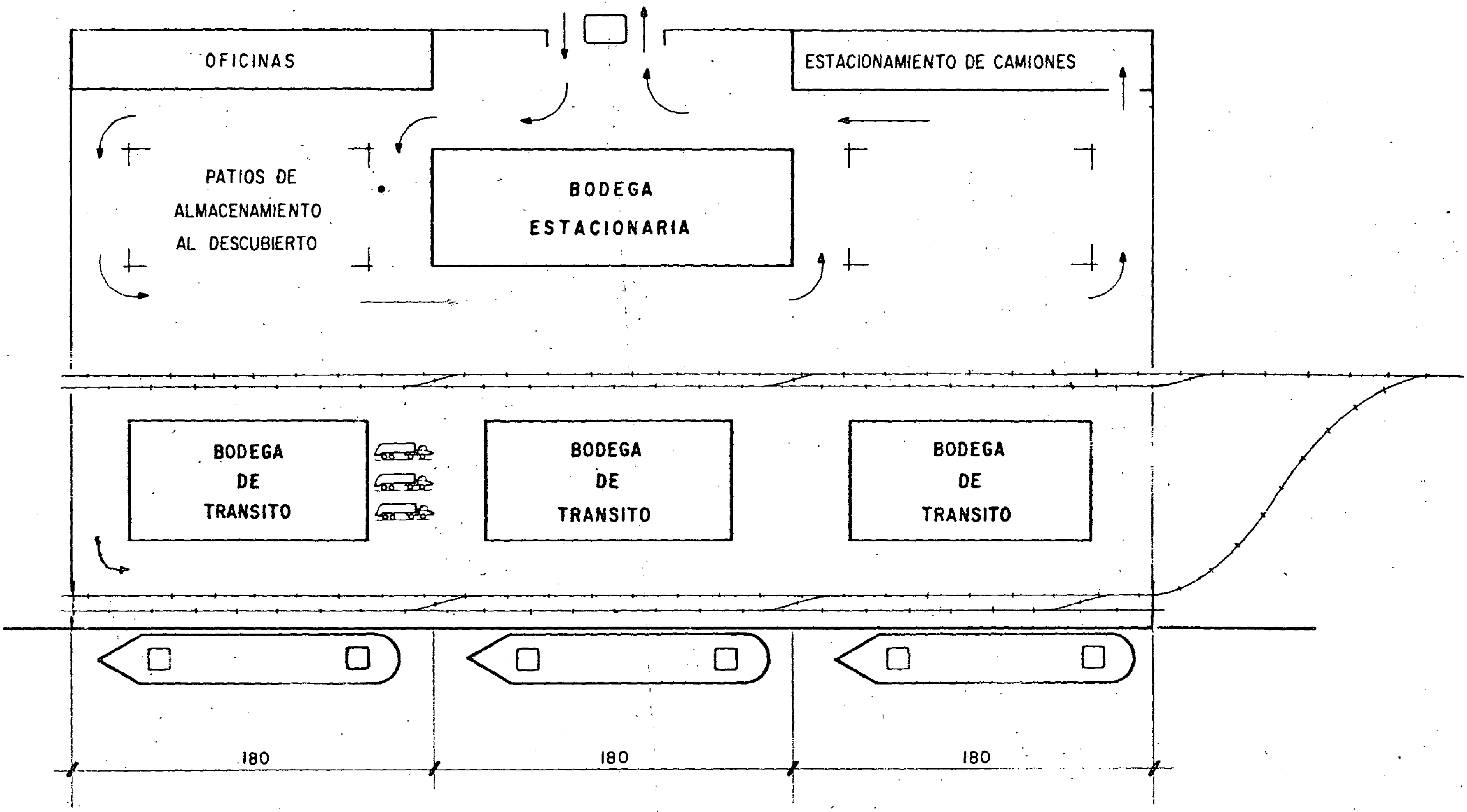


FIG. 16 TERMINAL TIPO, DE CARGA GENERAL MARGINAL.

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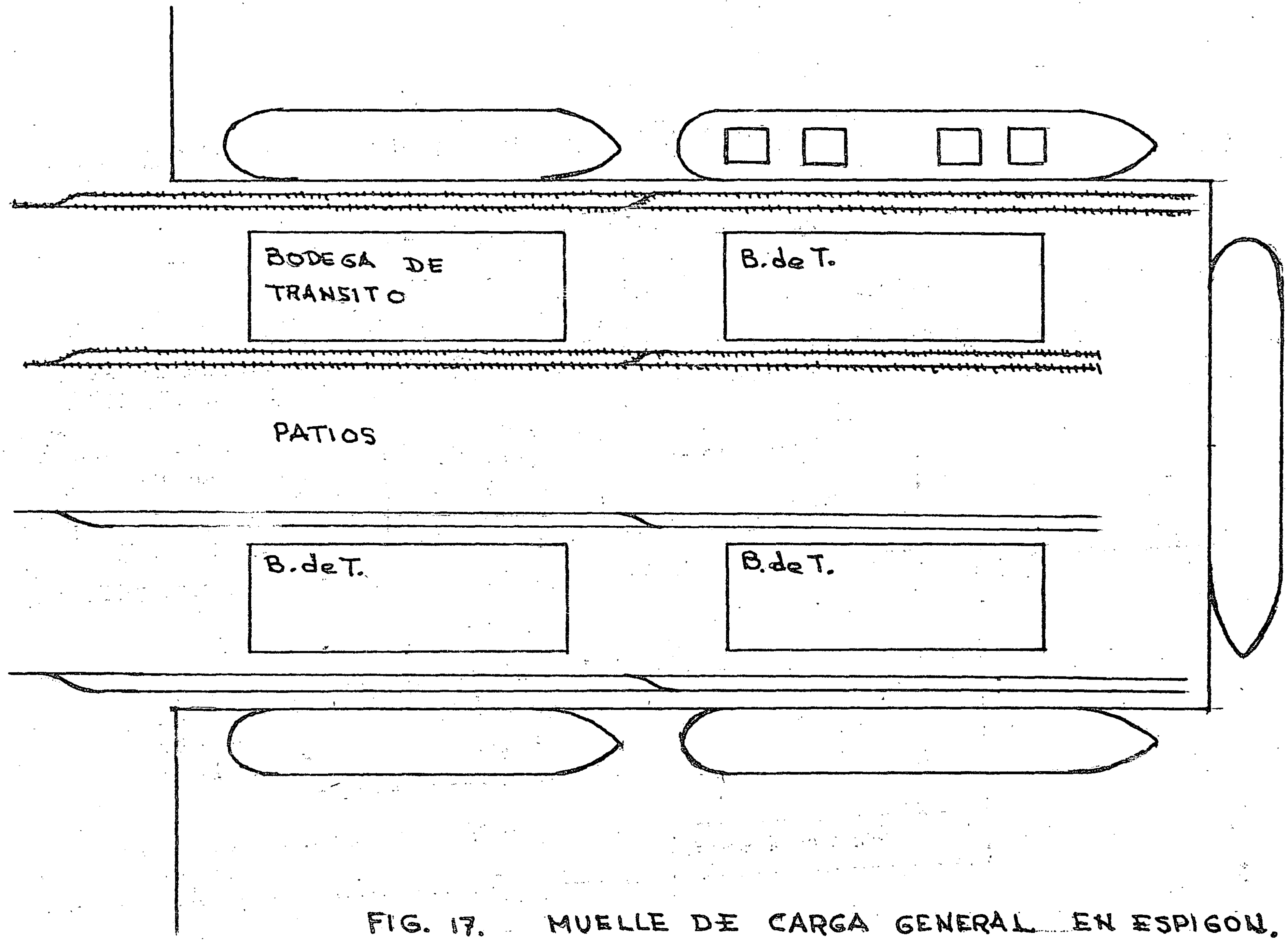


FIG. 17. MUELLE DE CARGA GENERAL EN ESPIGON.

4.2.- TERMINALES ESPECIALIZADAS.

4.2.1.- TERMINALES PARA EL TRANSBORDO POR RODADERA (TRANSBORDADORES).-

LAS INSTALACIONES PARA DAR SERVICIO A LOS TRANSBORDADORES, DEPENDEINDO DEL TIPO DE BARCO. EXISTEN EMBARCACIONES EXCLUSIVAS PARA EL TRANSPORTE DE CARGA, LA CUAL SE ENCUENTRA SOBRE EQUIPO RODANTE YA SEA EN TRAILERS CONVENCIONALES Y ESPECIALIZADOS PARA ESTE FIN CON RUEDAS PEQUEÑAS PARA UN MEJOR ACOMODO Y DE ESTA FORMA REDUCIR LOS ESPACIOS VACIOS DEL BARCO. OTRO TIPO DE BARCO ES EL MIXTO, QUE TRANSPORTA CARGA Y PASAJEROS. AMBOS TIPOS CUENTAN CON RAMPAS EN EL PROPIO BARCO PARA LA TRANSFERENCIA DE LA CARGA A LOS ATRACADEROS Y OTROS NO, POR LO QUE HAY QUE DISPONER EN LOS MUELLES RAMPAS PARA SU OPERACION.

UNA DISPOSICION GENERAL PARA ESTE TIPO DE INSTALACIONES SE MUESTRA EN LAS FIGURAS Nos. 18, 19 Y 20.

LA EFICIENCIA EN LA OPERACION DE UNA TERMINAL DE ESTE TIPO DEPENDERA DEL VOLUMEN DE CARGA Y PASAJEROS.

EN MEXICO SE CUENTA CON MAYOR NUMERO DE TRANSBORDADORES QUE TRANSPORTAN CARGA Y PASAJEROS Y NO CUENTAN CON RAMPAS LAS EMBARCACIONES. POR LO QUE EN LA DISPOSICION GENERAL DEBERA INCLUIRSE PATIOS PARA ESTACIONAMIENTO DE TRAILERS Y UNA TERMINAL DE PASAJEROS.

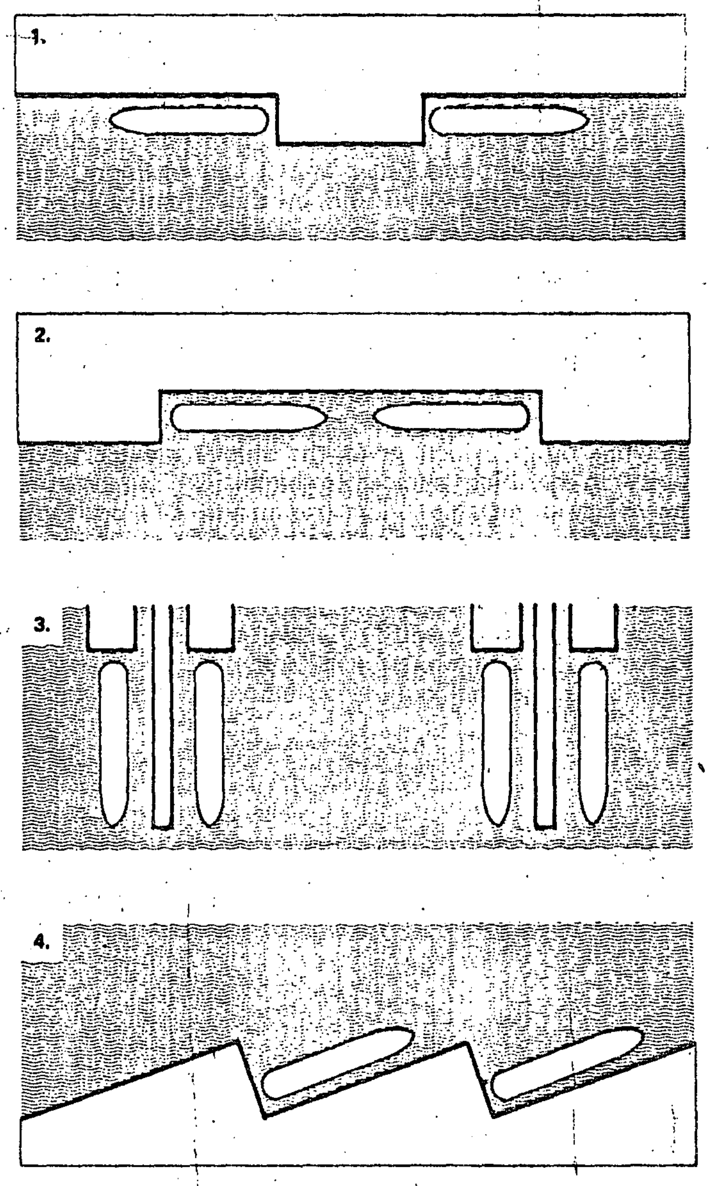


FIG. # 18 ATRACADEROS PARA BARCOS TIPO TRANSBORDADOR

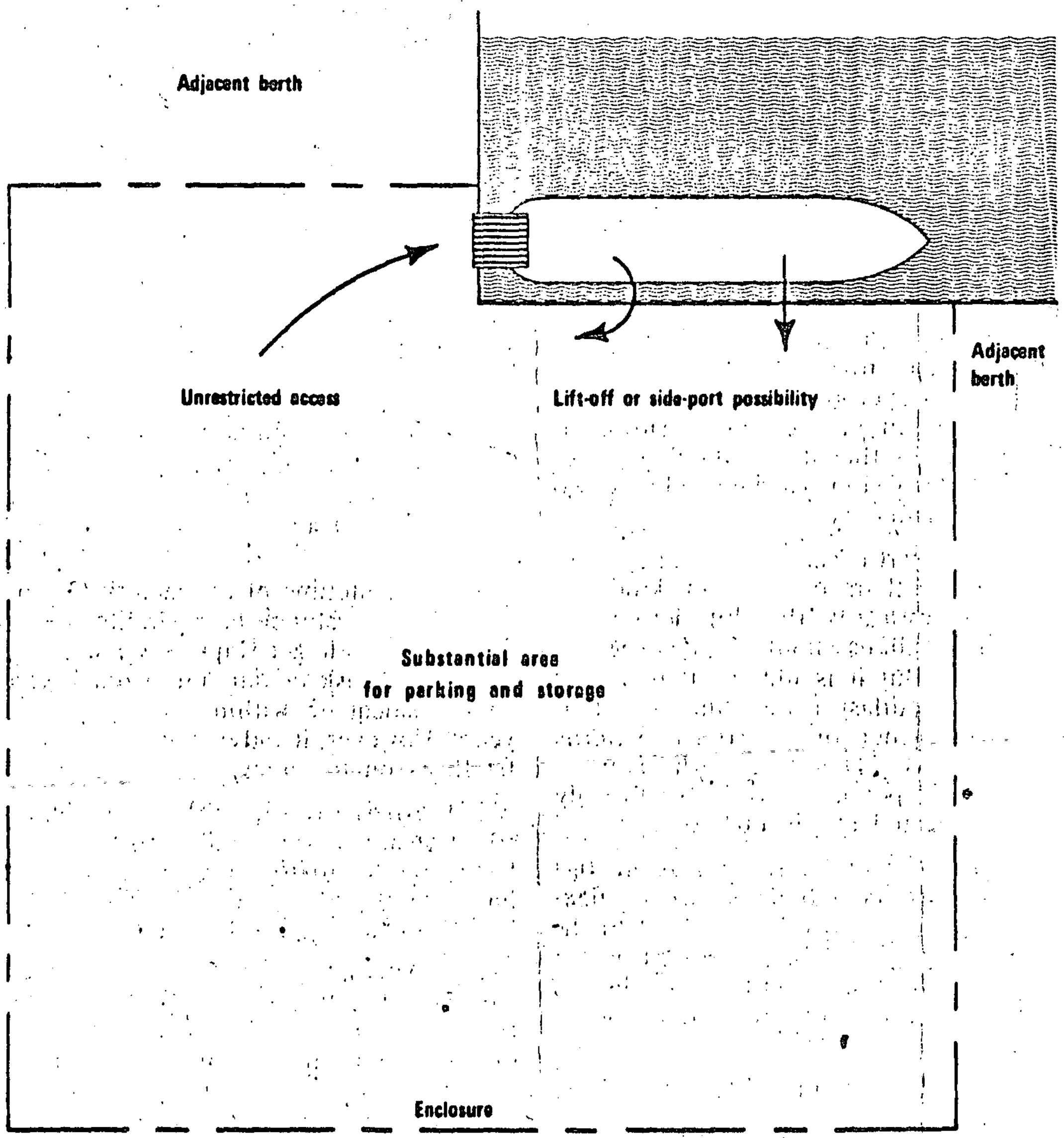
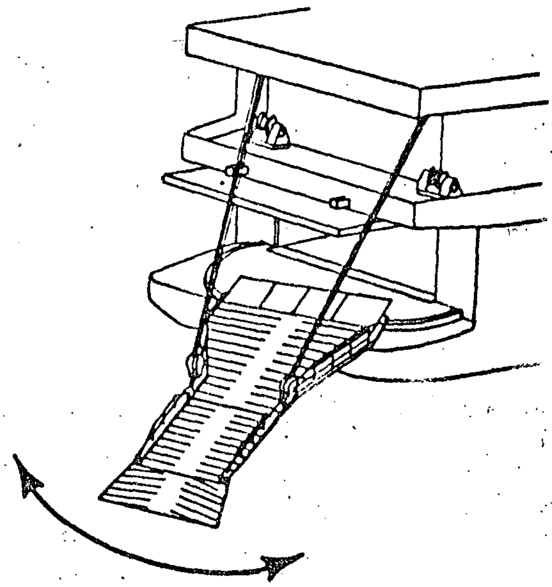


FIG. # 19 ATRACADERO PARA TRANSBORDADOR

Example of slewing ramp for ro/ro service



Example of adjustable bridge ramp for ro/ro service

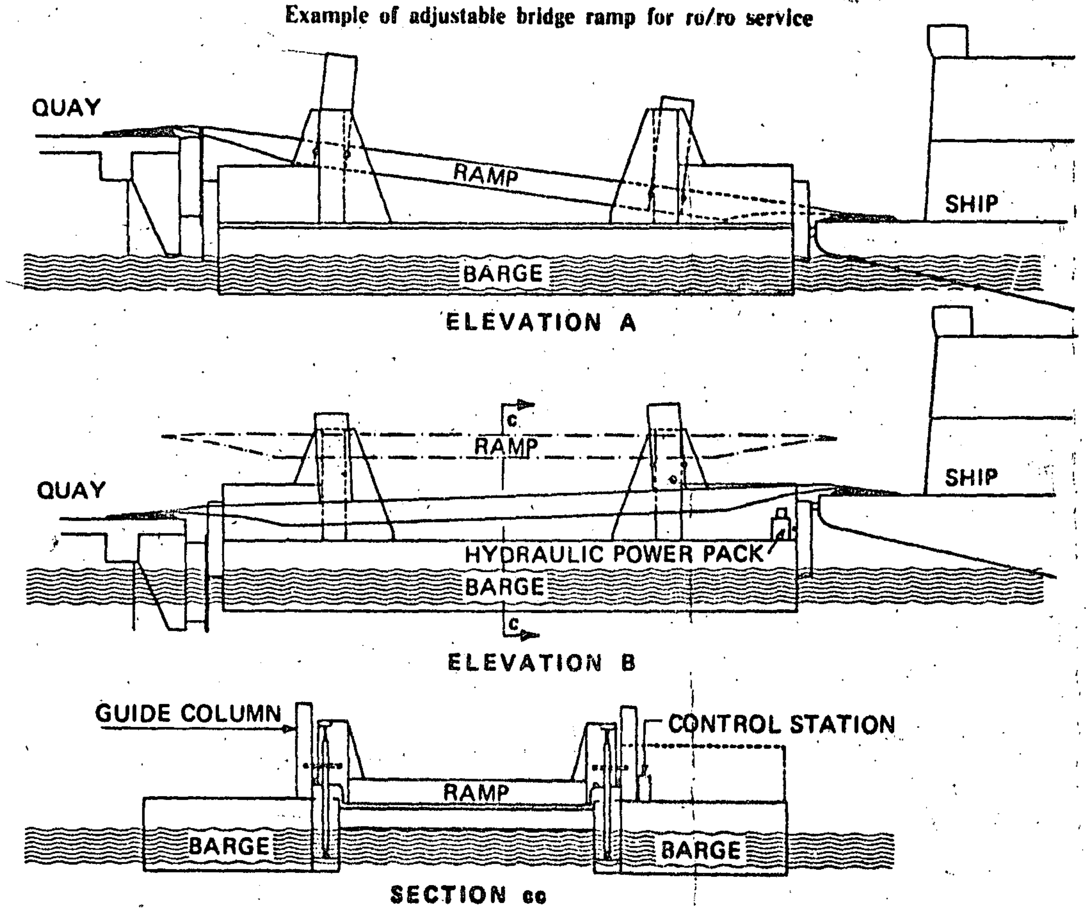


FIG. # 20 RAMPAS PARA LA MOVILIZACION DE LOS VEHICULOS QUE TRANSPORTAN CARGA EN TRANSBORDADORES.

4.2.2.- TERMINALES DE CONTENEDORES.

CUANDO EL MOVIMIENTO DE CARGA GENERAL FRACCIONADA EN UN PUERTO ES DE CONCIDERACION Y ESTA TIENE UN FLUJO DE IMPORTACION Y EXPORTACION DEL MISMO OR-- DEN SE RECOMIENDA LA CONSTRUCCION DE UNA TERMINAL PARA EL MANEJO DE CONTENEDORES. EN UNA TERMINAL DE ESTE TIPO CON UN PUESTO DE ATRAQUE SE MANEJA - APROXIMADAMENTE 5 VECES MAS CARGA QUE DE UN ATRA- QUE DE CARGA GENERAL CONVENCIONAL, DEPENDIENDO -- DEL GRADO DE MECANIZACION.

LA EFICIENCIA DE LA TERMINAL SE VERA AFECTADA POR EL NUMERO DE CONTENEDORES VACIOS QUE SERAN MOVI-- DOS POR FALTA DE CARGA YA SEA EN LA IMPORTACION O EN LA EXPORTACION.

UN A DISPOSICION DE UNA TERMINAL DE ESTE TIPO SE MUESTRA EN LA FIGURA No. 21 LA CUAL DEBERA CONTAR CON LAS SIGUIENTES AREAS E INSTALACIONES:

a).- MUELLE CON GRUAS PORTA CONTENEDORES.

b).- PLATAFORMA DE PREAPILAMIENTO

c).- AREA PARA CONTENEDORES DE EXPORTACION

d).- AREA PARA CONTENEDORES DE IMPORTACION

e).- AREA PARA CONTENDORES REFRIGERADOS

f).- AREA PARA CONTENEDOPES VACIOS.

g).- TALLER DE REPARACION DE CONTENEDORES

h).- BODEGA DE CONSOLIDACION DE CARGA

i).- OFICINAS

j).- TALLERES, PARA MANTENIMIENTO DE EQUIPO POR- TUARIO

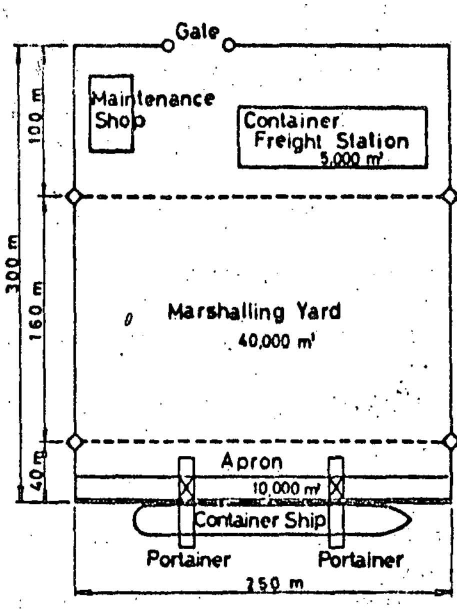


FIG. # 21 TERMINAL DE CONTENEDORES TIPO

4.2.3.- TERMINAL DE CARGA PARA USOS MULTIPLES.

TECNICOS DE LA SECRETARIA GENERAL DE UNCTAD DE NACIONES UNIDAS, RECOMIENDAN QUE LA TRANSICION ENTRE LAS TERMINALES DE CARGA GENERAL CONVENCIONAL Y LAS DE CONTENEDORES SEA CON UNA ETAPA INTERMEDIA, POR MEDIO DE UNA TERMINAL QUE DENOMINAN "TERMINAL DE CARGA GENERAL PARA USOS MULTIPLES". DICHA TERMINAL SE MUESTRA EN LAS FIGURAS Nos. 22, 23 Y 24 EN LAS CUALES SE INDICAN LAS DIFERENTES FASES DE QUE SE COMPONE LA TERMINAL.

DE ESTE TIPO DE TERMINALES ES CONVENIENTE ANALIZARLA PARA UN POSIBLE UTILIZACION EN NUESTRO PAIS POR LAS VENTAJAS ECONOMICAS QUE REPORTA; DADO QUE ES MAS ECONOMICA QUE UNA TERMINAL DE CONTENEDORES.

EN ESTA TERMINAL SE PRESTA SERVICIO A EMBARCACIONES DE CARGA GENERAL, DE TRANSBORDADORES Y DE CONTENEDORES.

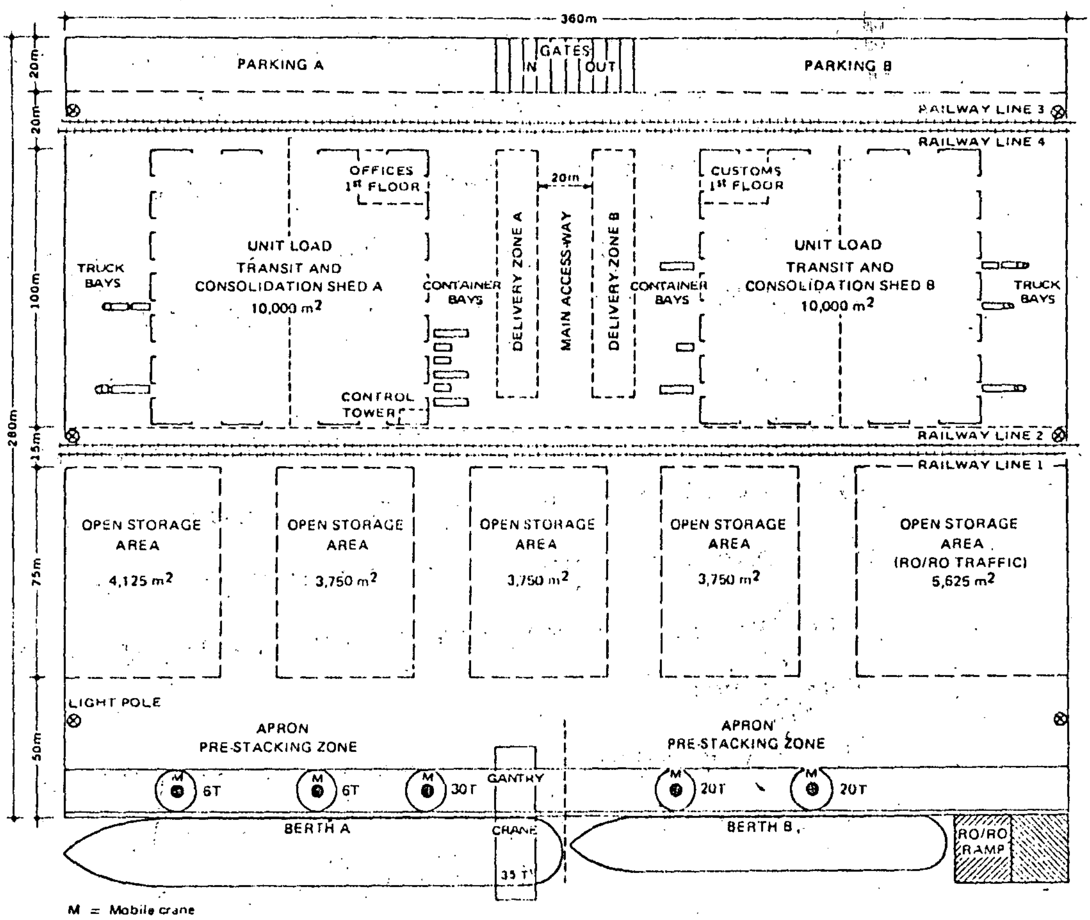


FIG. #22 TERMINAL PORTUARIA PARA USOS MULTIPLES

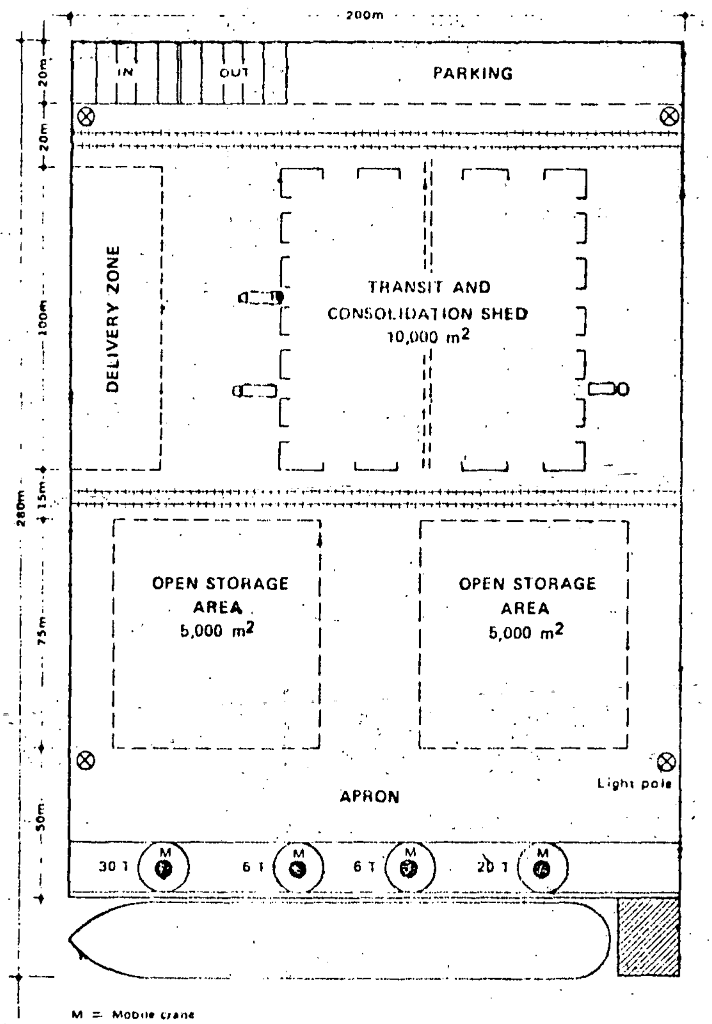


FIG.# 23,1a. ALTERNATIVA

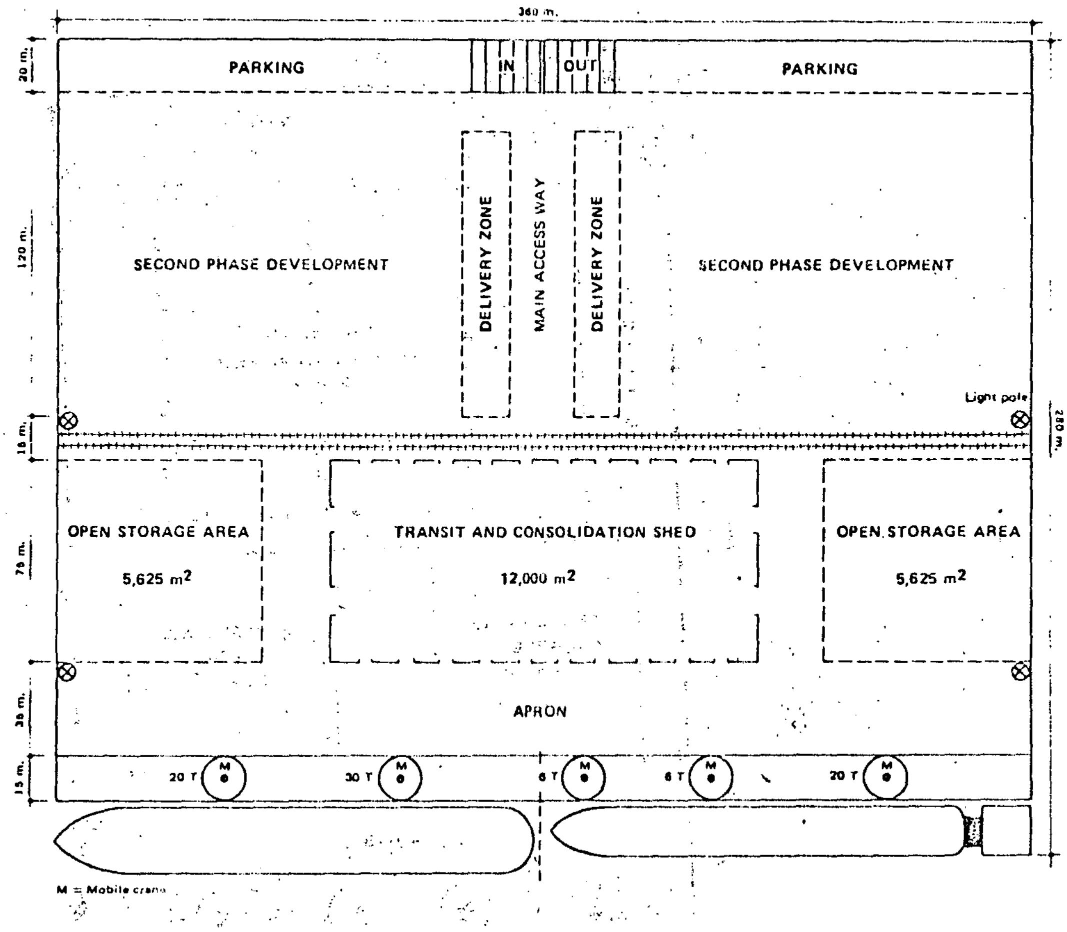


FIG. # 24 2a. ALTERNATIVA

4.2.4.- TERMINALES PARA MANEJO DE MINERALES A GRANEL.

LA MECANIZACION EN ESTE TIPO DE INSTALACIONES SE HACE NECESARIA SOBRE TODO SI LOS MINERALES A - - TRANSPORTAR SON DE BAJA LEY YA QUE PARA HACER -- COMPETITIVO SU COLOCACION EN EL MERCADO INTERNACIONAL POR VIA MARITIMA SE TIENE QUE RECURRIR A EMBARCACIONES DE GRAN PORTE CUYO VALOR Y COSTO - DE ESTADIA EN PUERTO ES ALTO, DEBIDO A LO ANTERIOR LA PRODUCTIVIDAD EN PUERTO DEBE SER TAL, -- QUE LA PERMANENCIA EN BARCO EN PUERTO SEA MINIMO EL VOLUMEN Y TIPO DE PRODUCTO NOS INDICA LAS CARACTERISTICAS Y TAMAÑO DEL EQUIPO DE CARGA Y DESCARGA, ASI COMO DE LA PROFUNDIDAD DE AGUA QUE SE REQUIERE PARA EL BARCO TIPO QUE SE ESPERA ARRIBARA AL PUERTO.

EL COSTO DEL TRANSPORTE MARITIMO SE REDUCIRA AL AUMENTAR EL TAMAÑO DEL BARCO. POR LO QUE SE DEBERA TENDER A LLEVAR A UN MINIMO LOS COSTOS DE - TERMINAL AL PROPICIAR LA MECANIZACION.

PARA PUERTOS CON AREAS ADECUADAMENTE DISPUESTAS PARA EL MANEJO DE MINERALES, EL ALMACENAMIENTO - AL DESCUBIERTO ES LO MAS INDICADO.

EN PUERTOS CON AREAS RESTRINGIDAS, CON FUERTE - PRECIPITACION PLUVIAL Y CON FRECUENTES RAFAGAS DE VIENTOS CONVIENE INSTALAR BODEGAS ESPECIALIZADAS PARA EL ALMACENAMIENTO DEL MINERAL, LA CUAL PROTEGERA AL MINERAL DE LA HUMEDAD Y A LAS ZONAS HABITADAS LAS PROTEJE DEL POLVO

VARIOS TIPOS DE CARGADORES Y DESCARGADORES DE BARCOS SE MUESTRAN EN LAS FIGURAS 25, 26 Y 27. LOS SISTEMAS DE ALMACENAMIENTO SE MUESTRAN EN FIG. No. 28. UNA DISPOSICION DE TERMINAL DE MINERALES ES LA MOSTRADA EN FIG. # 29.

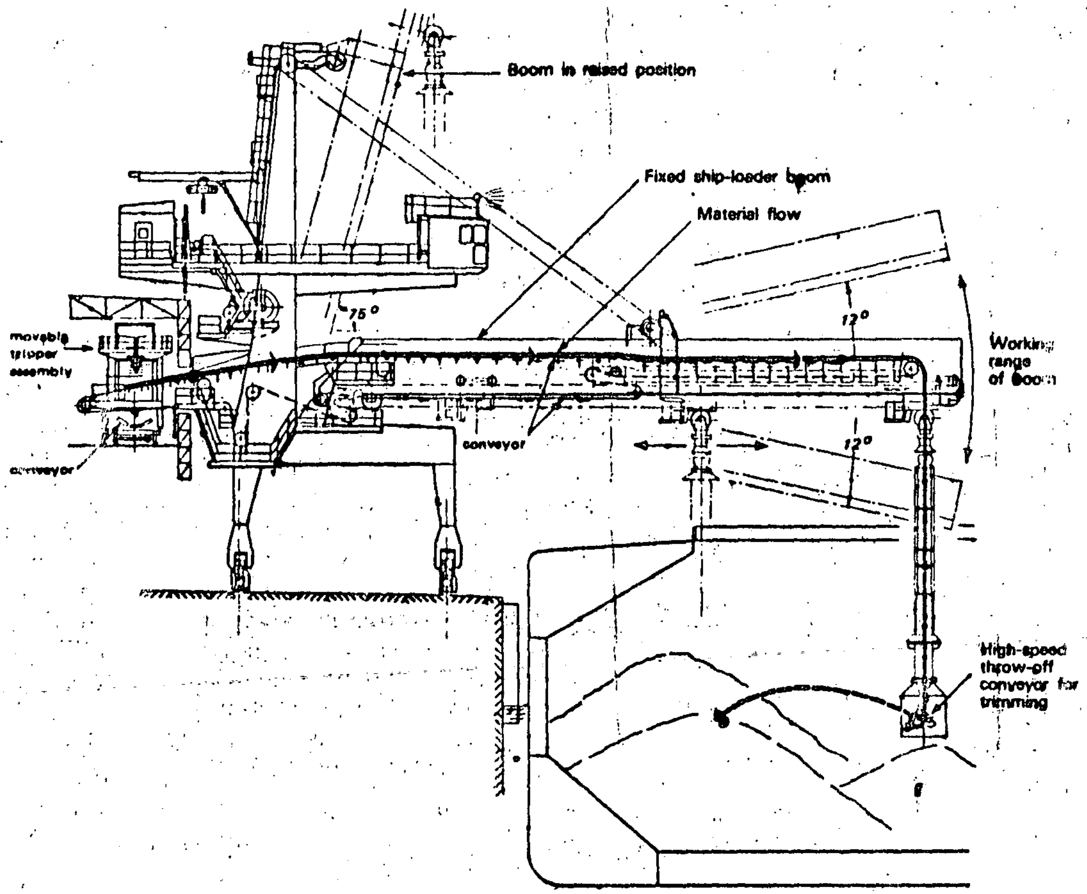


FIG.# 25, CARGADOR 1000-7000 TON/HORA

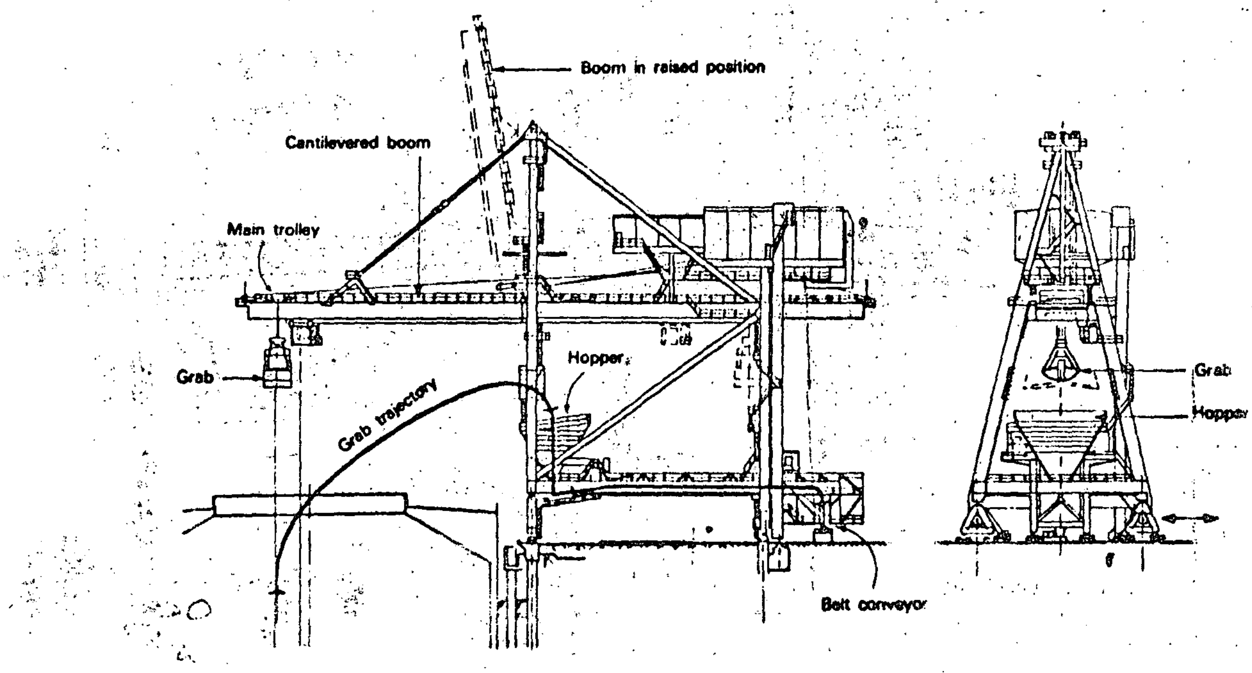
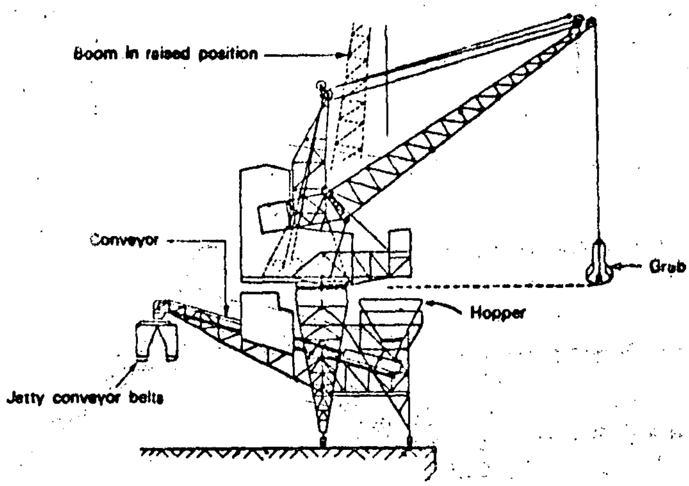
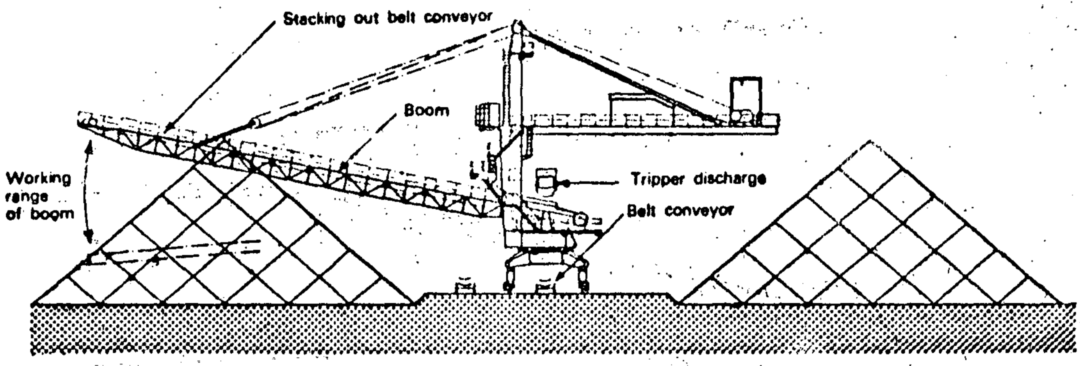


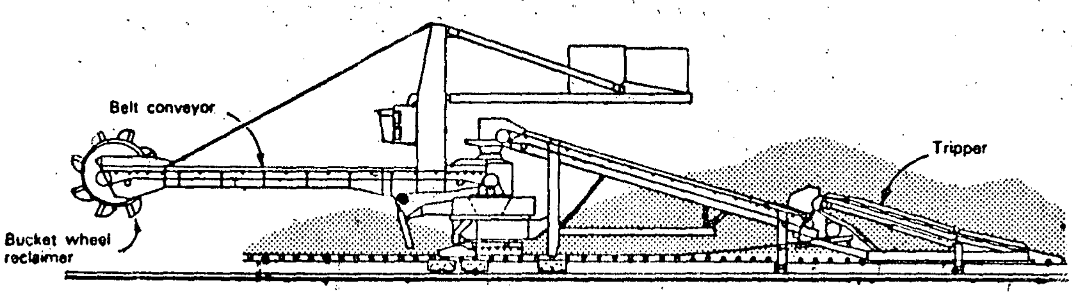
FIG. # 26, 500-2000 TON/HORA DESCARGADORES



500-700 TON/HORA DESCARGADOR



EQUIPO DE APILAMIENTO EN TIERRA



EQUIPO PARA DESAPILAR

FIG. 27

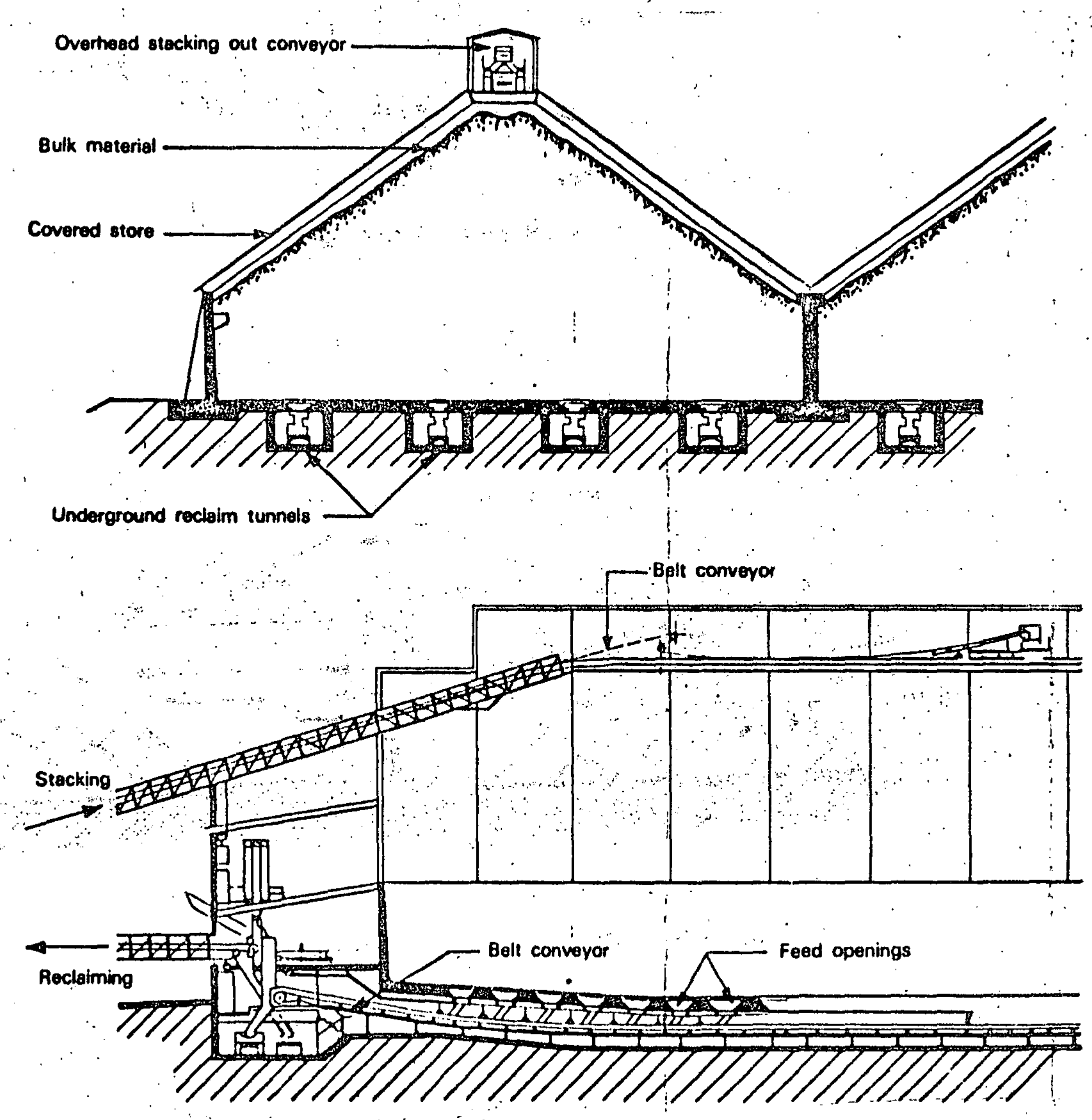


FIG. # 28 BODEGA MECANIZADA de MINERALES

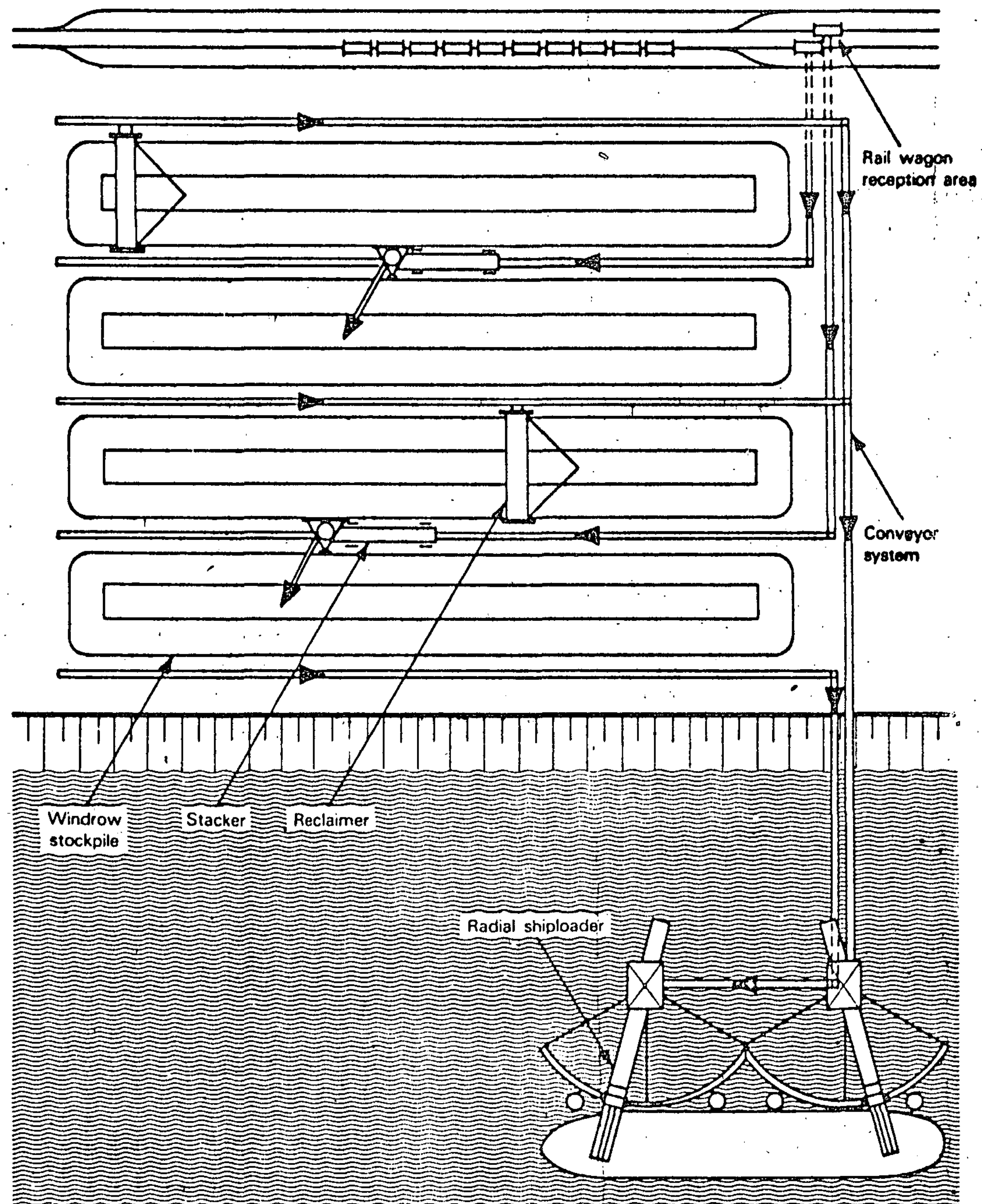


FIG. # 29 DISPOSICION GENERAL DE UNA TERMINAL DE MINERALES

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APENDICE

BARCOS DE CARGA GENERAL.

COMO YA SE MENCIONO, ESTE TIPO DE EMBARCACIONES NO REGISTRA UNA PRONUNCIADA TENDENCIA AL INCREMENTO, LO CUAL SE PUEDE OBSERVAR EN LA TABLA NO. 1 , TOMADA DEL LIBRO DE ALONZO D. QUINN. PARA OBTENER LAS CARACTERISTICAS TALES COMO: TONELAJE DE REGISTRO BRUTO (T. B. R.), TONELAJE NETO -- (T. R. N.) DESPLAZAMIENTO (D), PESO MUERTO (P. M.), SE PUEDE OBSERVAR LA - GRAFICA NO. 1 . DE LA TABLA Y DE LA GRAFICA SE OBTIENE QUE EN TERMINOS GENERALES EL CALADO MAXIMO NO SOBREPASA LOS 10.66 MTS., MANGA DE 25.00 MTS., Y QUE LA ESLORA ES DEL ORDEN DE LOS 160.00 MTS.

BARCOS PORTA CONTENEDORES.

ESTUDIOS DESARROLLADOS POR LA COMISION DEL TRANSPORTE MARITIMO - DE LA JUNTA DE COMERCIO Y DESARROLLO DE LAS NACIONES UNIDAS, CONCLUYEN -- QUE LAS CARACTERISTICAS DE ESTE TIPO DE BARCO SON LAS QUE SE MUESTRAN A - CONTINUACION:

	CAPACIDAD DE CONTENEDORES DE 20 PIES O SU EQUIVALENCIA.	T.P.M.	ESLORA TOTAL (M)	MANGA TOTAL (M)	CALADO (M)
BUQUES PORTA CONTENEDORES DE PRIMERA GENERACION	700-1000	11000	170	25	8.0
BUQUES PORTA CONTENEDORES DE SEGUNDA GENERACION	1500	30000	225	29	11.5
BUQUES PORTA CONTENEDORES DE TERCERA GENERACION	2500-3000	40000	275	32	12.5

BUQUES TANQUES.

LA FLOTA DE BUQUES TANQUES DE PETROLEOS MEXICANOS TIENEN LAS - --

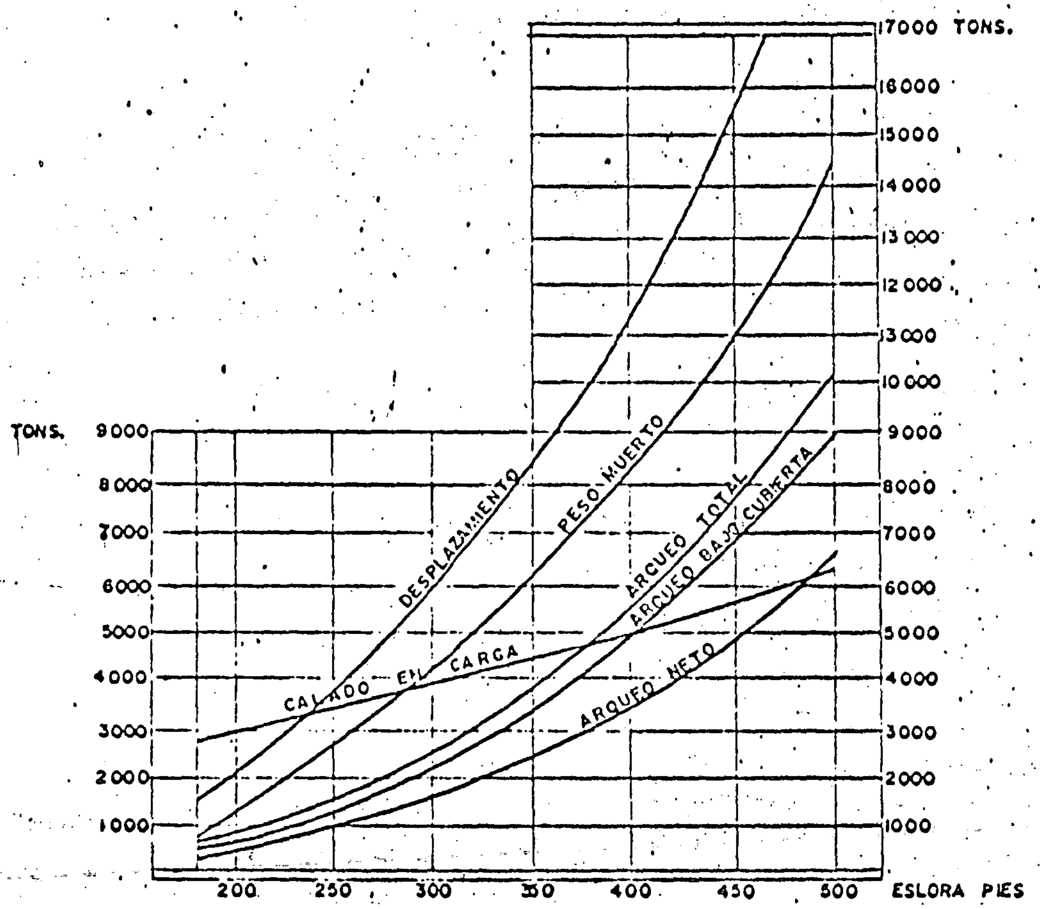
TABLA No 1

TABLE 3.3 Characteristics of General Cargo Ships

Year built	Name or class	Length: Over-all	Length: Bet. perp.	Breadth	Depth	Draft loaded (summer)	Tonnage, long tons: Dead-weight	Tonnage, long tons: Displacement
1899	*El Sud*	405'9"	390'11"	48'3"		22'0"	3,417	
1903	*Virginian*		490'0"	58'0"	35'6"	29'0"	11,200	18,425
1909	*Jean*	382'2"	311'0"	46'1"	24'2"	21'0"	4,600	
1910	*El Sol*	430'0"	405'7"	53'1"	23'8"	26'0"	6,850	
1912	*Dakotan*		416'2"	53'6"	31'6"	27'4"	8,950	13,250
1913	*Columbian*		404'0"	53'9"	28'10"	25'9"	7,900	12,000
1916	*Edgar F. Luckenbach*	442'0"	425'0"	57'3"	42'0"	29'5"	13,000	
1918	*Lagos Erie*		400'0"	52'0"	31'0"	25'2"	8,069	11,646
1918	*Invincible*		440'2"	56'0"	38'0"	28'9"	11,721	15,940
1919	*Mc Keesport*		395'6"	55'0"	34'11"	27'2"	9,808	13,150
1920	*Abercos*		402'0"	53'0"	34'6"	26'7"	9,414	12,760
1932	*Seatrain Havana*		460'0"	63'6"	38'3"	26'2"	10,900	16,460
1934	*Angelina*	410'11"	390'0"	55'0"	30'6"	25'0"	7,600	10,800
1939	C-2 class C2-S-AJ1	459'1"	435'0"	63'0"	31'6"	27'8"	10,775	13,869
1940	C-3 class C3-S-A2	492'0"	465'0"	69'6"	33'6"	28'7"	12,300	18,215
1942	Liberty ships EC2-S-C1	441'6"	417'9"	56'11"	37'4"	27'8"	10,800	14,100
1945	Victory ships VC2-S-AP2	455'3"	436'6"	62'0"	38'0"	28'7"	10,800	15,199
1946	C-4 class C4-S-B5	520'0"	496'8"	71'6"	43'6"	32'10"	15,036	22,094
1950	*Schuyler Otis Bland*	475'0"	450'11"	66'0"	41'6"	30'0"	10,516	15,910
1952–59	*Mariner* class	563'8"	528'6"	76'0"	35'6"	29'11"	12,910	21,093
1957	*Azalea City* (C-2 container-ship)	468'0"	442'2"	72'0"	40'2"	24'2"	7,891	13,125
1959	*Manila*	480'2"	449'6"	62'4"	38'9"	29'4"	11,374	16,207
1960	*Flora*	484'7"	447'0"	62'8"	39'1"	29'6"	12,417	17,088
1961	*Export Agent*	492'6"	470'0"	73'0"	42'2"	28'2"	11,089	17,570
1961	*Apollonia*	505'4"	475'11"	66'3"	41'4"	30'5"	14,974	20,274
1961	*Philippine President Roxas*	510'2"	475'9"	64'0"	40'4"	29'7"	12,156	17,379
1961	*Washington Mail*	563'8"	528'6"	76'0"	44'6"	31'7"	14,803	22,595
1962	*Vasilios R.*	526'0"	492'6"	67'3"	42'0"	31'3"	15,450	20,728
1962	*Pioneer Moon*	560'6"	530'0"	75'0"	42'9"	31'7"	13,583	21,053
1962	*African Meteor*	572'0"	541'0"	75'0"	42'10"	30'10"	12,728	20,110
[illegible]	*Ashley Lykes*	495'0"	470'0"	69'0"	41'6"	30'1"	11,336	17,210
..63	*C. E. Dant*	565'0"	528'6"	76'0"	44'6"	31'7"	14,376	22,629
1965	*Gulf Merchant*		470'0"	69'0"	41'6"	30'2"	11,368	17,2[illegible]
1968	*Alaskan Mail*	605'0"	582'6"	82'0"	46'6"	35'1"	22,208	31,5[illegible]
1968	*Genevieve Lykes*	540'0"	514'11"	76'0"	42'8"	31'8"	13,808	20,0[illegible]
1968	*Khaan Wave*	466'9"	410'0"	65'0"	40'6"	29'9"	14,924	18,825

CARACTERISTICAS DE BUQUES

REFERENCIA:
"Teoria del Buque"
del Ing. Naval Godino



PARA LA LEY DE VARIACION DEL CALADO CON LA ESLORA LA SEPARACION ENTRE DOS ORIZONTALES DEL DIAGRAMA — EQUIVALE A CINCO PIES.

1 PIE = 0.305 m

1 METRO = 3.28 pies

BUQUES DE 200 PIES DE ESLORA: $\frac{E}{P} = 12.6$; $\frac{M}{P} = 1.8$

BUQUES DE 500 PIES DE ESLORA: $\frac{E}{P} = 13$; $\frac{M}{P} = 1.63$

E = ESLORA
P = PUNTAL
M = MANGA

NOTA:
ESTA GRAFICA ESTA CALCADA DEL LIBRO "INGENIERIA MARITIMA" DEL ING. ROBERTO BUSTAMANTE Y OTROS AUTORES.

SIGUIENTES CARACTERISTICAS (TABLA 2). LAS CARACTERISTICAS DE LA FLOTA MUNDIAL SE PODRAN OBSERVAR EN LA TABLA NO.3 TOMADA DEL LIBRO DE ALONZO - - D. QUINN Y DE LA GRAFICA NO. 2

BARCOS PARA TRANSPORTE DE MINERAL.

LAS DIMENSIONES Y TENDENCIAS PODRAN OBSERVARSE EN LA TABLA NO. 4. DE LA CUAL SE OBTIENE QUE EN TERMINOS GENERALES SE PODRIA CONSIDERAR QUE LA EMBARCACION DE MAYOR TAMAÑO ES DEL ORDEN DE 12.80 MTS. DE CALADO,- - - 230.00 MTS. DE ESLORA TOTAL, MANGA DE 31.00 MTS., PUNTAL DE 19.00 MTS.

BARCOS ESPECIALIZADOS.

A).- BARCOS PARA TRANSPORTE DE GAS
B).- BARCOS TERMO
C).- TIPO LASH Y SEABEES
D).- DE PESCA.

LASH.- TIPO DE BARCO PORTA-BARCAZAS, SU CARACTERISTICA PRINCIPAL ES QUE DISPONE DE UNA GURA DE 500 TON. LAS BARCAZAS LASH TIENEN UNA - CAPACIDAD DE 350 TON., (18.74 M. X 9.50 M. X 2.74 M.) SIENDO 2.74 AL CALADO A PLENA CARGA, Y LOS BUQUES TRANSPORTAN DE 73 Y 89 BARCAZAS.

SEABEE.- TIPO DE BARCO PORTA-BARCAZAS, TIENEN TRES CUBIERTAS Y LAS BARCAZAS SE SUBEN A BORDO MEDIANTE UN MONTA-CARGAS. LAS BARCAZAS TIENEN UNA CAPACIDAD DE 850 TON., (29.70 M. X 10.67 M. X 3.25 M.) Y UN BUQUE DE ESTE TIPO PUEDE TRANSPORTAR 38 UNIDADES APROXIMADAMENTE.

DE PESCA.- EN ESTA ACTIVIDAD, EXISTEN EN MEXICO, UN SINNUMERO - DE EMBARCACIONES DE VARIOS TIPOS, DESDE EL CAYUCO, O PEQUEÑA EMBARCACION DE PESCA, HASTA LOS BARCOS ESPECIALIZADOS PARA LA CAPTURA DEL ATUN.

SE ANEXAN LAS CARACTERISTICAS DE LAS FLOTAS, ATUNERA, ANCHOVENTERA, SARDINERA, CAMARONERA Y DE ESCAMA.- CONSIDERAMOS SON LAS REPRESEN

TABLA [illegible]2 CARACTERISTICAS DE LA FLOTA DE BUQUES TANQUE DE PETROLEOS MEXICANOS.

NOMBRE DEL BARCO	AÑO DE CONST.	T. B. R.	T. N. R.	P. M. (TON)	D. MAX. (TON)	D. ROSCA
EMILIANO ZAPATA	1968	2,841.02	1,397.83	2,956	4,989	2,032
VICENTE GUERRERO	1967	5,772.81	3,052.62	8,893	12,478	3,548
MARIANO ESCOBEDO	1967	7,991.83	4,599.71	9,550	14,194	4,643
MIGUEL HIDALGO	1967	7,075.53	3,826.00	11,262	15,122	3,859
LAZARO CARDENAS	1955	11,065.49	6,225.13	16,566	22,352	5,669
CUAUHTEMOC	1967	10,085.72	5,724.97	17,473	22,128	4,686
PLAN DE SAN LUIS	1967	10,085.72	5,724.97	17,473	22,128	4,686
VENUSTIANO CARRANZA	1968	10,085.72	5,724.97	17,473	22,128	4,686
P. ELIAS CALLES	1968	10,085.72	5,724.97	17,473	22,128	4,686
ABELARDO L. RODRIGUEZ	1956	11,470.47	6,429.58	17,729	24,063	6,347
JUAN ALVAREZ	1955	12,447.04	7,157.36	19,405	25,875	6,469
GUADALUPE VICTORIA	1958	12,568.01	7,209.65	20,253	26,641	5,967
PLAN DE AYUTLA	1967	12,763.18	7,561.34	21,668	27,432	5,605
PLAN DE AYALA	1968	12,753.36	7,550.04	21,689	27,432	5,705
MARIANO MOCTEZUMA	1974	14,742.95	8,895.68	21,689	28,017	6,328
FRANCISCO J. MUJICA	1973	14,743.69	8,895.68	21,696	28,017	6,322
MANUEL AVILA CAMACHO	1973	14,743.69	8,895.68	21,704	28,017	6,313
INDEPENDENCIA	1974	14,742.95	8,895,68	21,704	28,017	6,314
REFORMA	1974	14,742.95	8,895.68	21,704	28,017	6,318
REVOLUCION	1975	14,743.69	8,895.68	21,704	28,017	6,313
MELCHOR OCAMPO	1968	12,753.36	7,550.04	21,727	27,432	5,692
PLAN DE GUADALUPE	1967	12,763.34	7,561.34	21,760	27,432	5,627
JOSE MA. MORELOS	1967	12,762.84	7,508.00	21,797	27,432	5,598
BENITO JUAREZ	1968	12,753.36	7,550.07	21,822	27,432	5,654
ALVARO OBREGON	1968	12,753.36	7,558.90	21,839	27,432	5,630
FRANCISCO I. MADERO	1968	12,758.65	7,562.50	21,889	27,432	5,593

(TON)	COEF. BLOCK	ES. T. (m)	ES.+P.P. (m)	MANGA (m)	PUNTAL (m)	CALADO (m)	F. BORDO (m)
	0.634	101.10	94.49	14.34	8.00	5.65	2.373
	0.693	135.06	128.32	18.01	9.93	7.62	2.362
	0.685	140.60	131.06	19.24	10.94	8.02	2.991
	0.8060	135.02	128.02	19.55	9.27	7.30	2.005
	0.744	165.20	155.46	20.73	11.58	9.09	2.549
	0.790	144.78	137.47	21.30	11.80	9.33	2.514
	0.790	144.78	137.17	21.30	11.80	9.33	2.514
	0.790	144.78	137.47	21.30	11.80	9.33	2.514
	0.790	144.78	137.47	21.30	11.80	9.33	2.514
	0.790	166.42	152.45	21.26	11.81	9.12	2.746
	0.772	173.00	161.54	21.31	12.09	9.34	2.738
	0.790	170.60	163.98	21.89	12.00	9.07	2.691
	0.780	170.75	163.86	22.05	12.17	9.45	2.691
	0.780	170.69	163.86	22.05	12.18	9.45	2.691
	0.795	170.61	164.00	22.05	12.95	9.47	3.016
	0.795	170.61	164.49	22.05	12.93	9.47	3.016
	0.795	170.61	164.00	22.05	12.95	9.47	3.016
	0.795	170.61	164.00	22.05	12.95	9.47	3.016
	0.795	170.61	164.00	22.05	12.95	9.47	3.016
	0.795	170.61	164.49	22.05	12.95	9.47	3.016
	0.780	170.69	163.86	22.05	12.17	9.45	2.703
	0.780	170.75	163.86	22.05	12.17	9.45	2.691
	0.780	170.69	163.86	22.05	12.17	9.45	2.691
	0.780	170.69	164.28	22.05	12.18	9.46	2.703
	0.780	170.75	163.86	22.05	12.18	9.45	2.691
	0.780	170.75	163.86	22.05	12.18	9.45	2.691

TABLA No. 3

Characteristics of Tankers

Year built	Name or class	Length		Breadth	Depth	Draft loaded (summer)	Tonnage, long tons	
		Over-all	Bet. perp.				Dead-weight	Displacement
1901	*Cowasee*	302'6"	287'0"	42'2"	23'2"	21'5"	3,960	5,000
1906	*W. S. Porter*	399'2"	385'0"	49'8"	28'11"	24'6"	6,560	
1908	*Texas*	412'3"	409'2"	52'8"	27'1"	24'0"	9,232	
1914	*John D. Archbold*	474'6"	458'3"	60'0"		26'1"	9,546	
1916	*Charles Pratt*	516'6"	500'0"	68'0"	38'4"	27'3"	14,990	
1921	*T. J. Williams*		465'0"	60'0"	36'3"	27'8"	11,590	17,875
1921	*Cacalilao*	435'0"	420'0"	56'0"	33'6"	27'2"	9,975	13,300
1930	*Brilliant*		481'4"	65'9"	37'0"	28'11"	14,565	20,200
1931	*Bridgewater*	467'0"	450'0"	62'0"	34'0"	27'8"	12,585	16,000
1941	T-2 class tankers	523'6"	503'0"	68'0"	39'3"	30'2"	16,350	21,880
1943	*Atlantic Sun*	547'3"	521'0"	70'0"	40'0"	30'5"	17,575	24,110
1948	Esso *Zurich*	628'0"	601'1"	82'6"	42'6"	32'5"	26,550	34,690
1950	*Atlantic Seaman*	659'6"	626'8"	85'0"	45'0"	34'3"	30,155	39,663
1953	*Tina Onassis*	775'7"	723'3"	95'2"	51'6"	37'10"	45,230	58,420
1953	*Petroking*	673'0"	645'0"	92'0"	46'0"	34'8"	38,045	48,016
1954	*W. Alton Jones*	707'0"	677'0"	93'0"	48'6"	36'8"	38,911	49,660
1954	*World Glory*	736'4"	705'0"	102'0"	50'0"	37'9"	45,509	58,625
1955	Sinclair *Petrolore*	789'0"	756'0"	106'0"	54'2"	40'7"	56,089	75,630
1956	Cities Service *Baltimore*	661'0"	630'0"	90'0"	45'3"	34'2"	32,710	42,751
1956	*Universe Leader*	854'9"	815'0"	125'0"	61'3"	46'2"	85,515	109,630
1957	Esso *Gettysburg*	715'0"	685'0"	93'0"	48'7"	36'9"	37,659	50,176
1957	*Tidewater*	785'10"	749'8"	102'0"	53'0"	39'3"	53,069	69,186
1958	*Sansinena*		810'0"	104'0"		41'9"	60,000	
1959	*National Defender*	810'0"	770'10"	104'0"	60'0"	44'9"	66,532	82,678
1959	*W. Alton Jones*	824'10"	782'0"	116'0"	56'0"	43'2"	68,840	89,200
1959	*Oriental Giant*	849'9"	803'10"	107'11"	60'8"	44'10"	70,365	91,516
1959	*Princess Sophie*	859'2"	820'0"	115'0"	60'0"	44'3"	71,282	91,511
1960	*J. Paul Getty*	844'4"	808'0"	110'0"	61'4"	46'4"	73,900	97,000
1960	*Universe Daphne*	949'9"	906'0"	155'0"	67'6"	50'11"	115,360	146,570
1961	*Olympus*	818'11"	784'1"	113'6"	61'6"	45'10"	75,145	94,260
1961	*Orion Hunter*	860'0"	820'0"	104'0"	60'0"	43'10"	67,208	86,800
1961	*Naess Sovereign*	874'10"	833'4"	122'1"	64'0"	48'2"	90,280	113,900
1962	Esso *Austria*	849'1"	809'6"	116'6"	60'4"	45'9"	78,566	99,676
1962	*Manhattan*	940'5"	892'0"	132'0"	67'6"	50'1"	108,400	138,700
1962	*Nissho Maru*	954'8"	905'6"	141'1"	72'10"	54'4"	130,217	160,673
1963	*William M. Allen*	824'8"	782'0"	116'0"	56'0"	43'8"	65,480	96,333
1963	*California Getty*	835'0"	794'0"	122'1"	65'4"	48'10"	90,321	110,145
1963	Esso *Deutschland*	855'11"	820'0"	125'0"	62'6"	47'5"	90,487	111,610
1964	Esso *Bayern*	869'6"	820'0"	125'0"	62'6"	47'11"	90,600	111,786
1965	*Ionian Commander*	775'0"	738'3"	104'4"	53'4"	40'8"	60,032	73,811
1966	*Ionic*	835'0"	784'5"	123'1"	57'5"	43'11"	84,227	100,587
1968	*Kaimon Maru*	984'3"	935'1"	158'2"	78'9"	59'2"	175,891	205,096
1968	*Universe Ireland*	1132'10"	1082'8"	175'0"	105'0"	81'5"	326,585	375,811
1969	*Universe Kuwait*	1134'10"	1082'3"	174'10"	105'0"	71'11"	276,000	
	Projected (long)	1348'0"		213'0"		89'0"	500,000	
	Projected (bulky)	1260'0"		216'6"		98'0"	500,000	
	Projected	1800'0"		283'0"		95'0"	1,000,000	

CARACTERISTICAS DE BUQUES TANQUE

FUENTE : U.S. DEPARTMENT OF COMMERCE
MARITIME ADMINISTRATION OFFICE
OF SHIP CONSTRUCTION AND
MARITIME REPORTER AND ENGINEERING NEWS.

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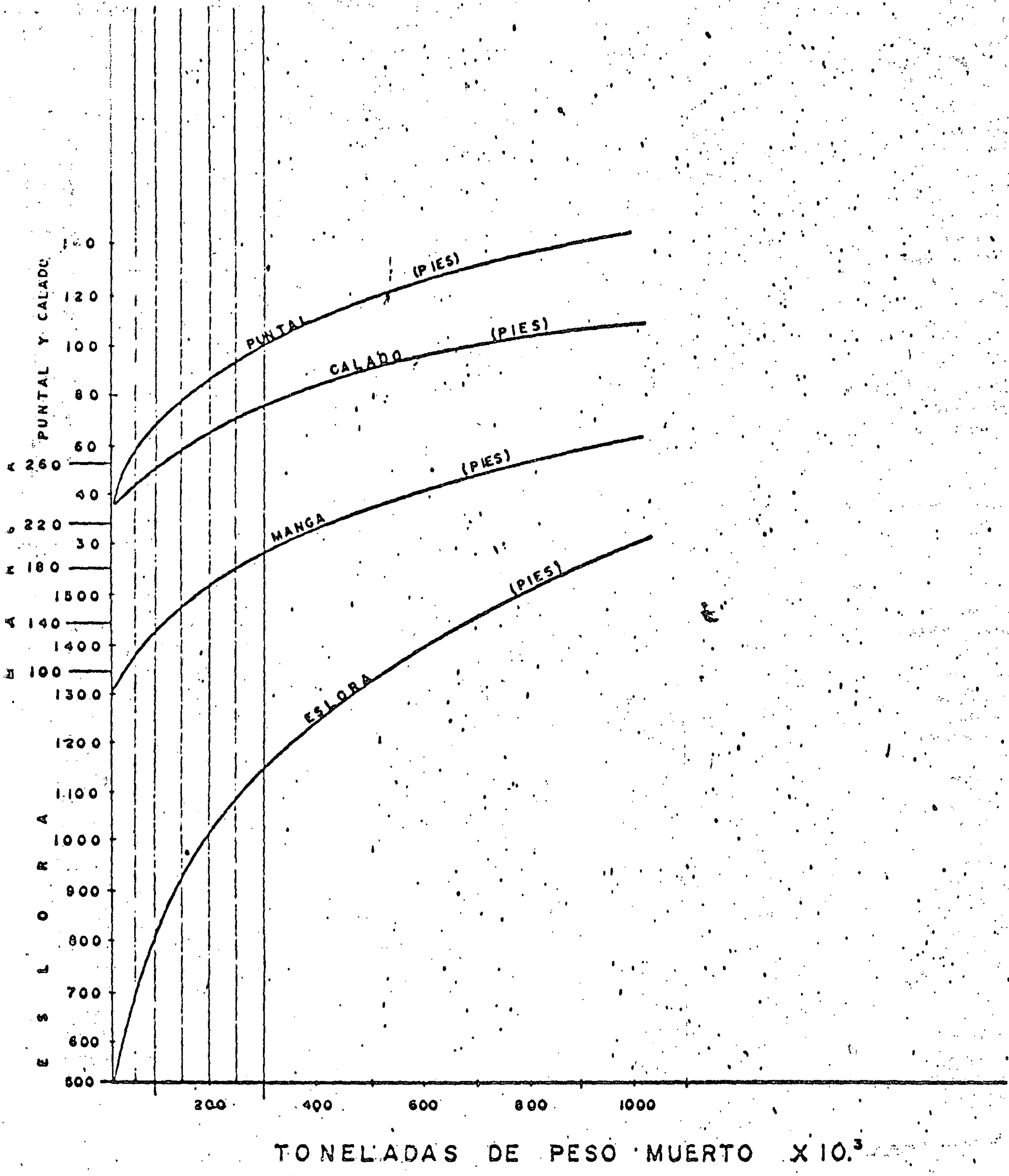

TABLA No 4

Characteristics of Bulk Carriers (Ore, Coal, etc.)

Year built	Name	Length		Breadth	Depth	Draft loaded (summer)	Tonnage, long tons	
		Over-all	Bet. perp.				Dead-weight	Displacement
1902	*Ben E. Tate*		563'8"	50'0"	28'0"	20'9"		
1907	*H. F. Jones*		527'10"	54'0"	31'2"	26'2" *		
1917	*Homer D. Williams*		580'0"	60'0"	32'0"			
1922	*Marore*	571'6"	550'1"	72'0"	44'0"	34'1"	22,980	31,000
1938	*John Hulst*		594'3"	60'0"	32'6"	22'3" *		19,000
1942	*Leon Fraser*		623'3"	67'0"	35'0"	24'0" *	18,160	23,900
1945	*Venore*	582'11"	560'0"	78'0"	43'9"	34'4"	24,251	32,449
1954	*Ore Chief*	794'0"	756'0"	116'0"	56'0"	38'9"	60,000	80,000
1955	*Leader*	680'0"	651'1"	88'0"	48'0"	34'7"	34,260	44,981
1957	*Cosmic*	744'1"	708'8"	100'5"	50'6"	37'3"	46,673	61,245
1958	*Consolidation Coal*	635'0"	610'0"	75'0"	47'3"	32'5"		
1958	*Baune*	657'4"	625'0"	87'0"	46'0"	35'2"	34,947	45,380
1959	*Revere*	604'8"	566'0"	80'0"	42'4"	25'1"	17,693	25,944
1960	*San Juan Exporter*	532'11"	498'9"	68'11"	44'8"	31'6"	18,308	23,955
1960	*Clyde Ore*	546'0"	516'9"	73'10"	40'2"	30'10"	20,075	26,240
1960	*Naess Jupiter*	681'0"	651'1"	88'0"	48'0"	34'7"	34,585	45,175
1960	*Edward L. Ryerson*	730'0"	712'0"	75'0"	39'0"	26'6" *	26,055	34,135
1961	*Timna*	550'2"	520'0"	74'0"	48'4"	34'7"	22,034	29,734
1961	*Argonaftis*	583'6"	545'0"	74'8"	44'0"	31'6"	20,990	28,058
1961	*Ore Venus*	751'0"	710'0"	102'0"	51'6"	38'0"	50,692	65,660
1962	*Corsair*	592'2"	565'0"	79'0"	46'8"	32'9"	24,911	32,370
1962	*Centauro*	679'0"	637'0"	91'10"	51'6"	36'1"	35,316	46,248
1962	*Sonic*	746'1"	708'8"	100'5"	55'7"	37'11"	48,976	62,551
1963	*Atlantic Eagle*	625'10"	589'6"	75'0"	46'4"	33'8"	23,670	31,947
1963	*Archangel*	628'2"	589'6"	75'0"	46'3"	33'8"	23,960	31,994
1963	*Aristeides*	735'1"	705'0"	100'8"	55'6"	38'0"	50,055	62,214
1963	*Amalfi*	753'0"	700'11"	98'5"	55'6"	39'6"	46,730	60,122
1964	*Dromon*	643'0"	600'0"	76'0"	45'6"	33'9"	27,480	35,883
1966	*Cedros*	995'9"	939'11"	142'1"	81'0"	62'3"	170,418	200,242
1967	*Alberto Lollighetti*	709'11"	656'2"	93'11"	57'6"	38'3"	44,477	55,309
1967	*Leonidas D.*	708'9"	672'7"	101'9"	59'1"	39'3"	52,458	63,208
1968	*Agamemnon*	734'9"	698'10"	105'10"	62'6"	40'2"	56,672	69,468
1968	*Grischuna*	742'10"	710'0"	102'0"	57'6"	42'5"	60,659	72,120

* Fresh-water draft—Great Lakes.

TATIVAS EN ESTA MATERIA Y DE LAS CUALES PODEMOS AFIRMAR QUE LAS PROFUNDIDADES REQUERIDAS SERAN:

FLOTA ATUNERA	7 MTS.
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Grupo Preparatorio Intergubernamental para un Convenio sobre el transporte intermodal internacional
Tercer período de sesiones
Ginebra, 16 de febrero de 1976
Tema 2 a) del programa provisional

ASPECTOS TECNICOS Y FINANCIEROS DE LAS TECNOLOGIAS MODERNAS DE TRANSPORTE UTILIZADAS EN LAS OPERACIONES DE TRANSPORTE MULTIMODAL

Informe de la secretaría de la UNCTAD

Corrección

Anexo

Página 5, pregunta 10, cuadro del texto (1972)

Donde dice "2 400 TEU" debe decir "3 000 TEU".

Página 10, pregunta 19, último párrafo

Donde dice "Deben manipularse" debe decir "Pueden manipularse".

Página 19, pregunta 44, línea 1

Donde dice "por metro cuadrado útil" debe decir "por metro útil".

Página 35, pregunta 68, línea 5

Suprímase "parcialmente".

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1. En los períodos de sesiones primero y segundo del Grupo Preparatorio Intergubernamental para un convenio sobre el transporte intermodal internacional se hizo patente que la falta de información y de datos adecuados sobre los aspectos técnicos y financieros de las tecnologías modernas de transporte utilizadas en las operaciones de transporte multimodal constituía para los países en desarrollo un problema de capital importancia. El presente informe ha sido preparado para ayudar a los países en desarrollo a tomar decisiones, en relación con los trabajos del Grupo y en el orden práctico, con respecto a la unitarización en sus puertos.

2. Para que la presentación de la información y los datos pertinentes fuera lo más clara y sucinta posible, la secretaría de la UNCTAD consideró que lo más apropiado sería presentar un texto redactado en forma de una serie de preguntas y respuestas. Por consiguiente, la secretaría encargó al Sr. A. Behnam, del Irak, que preparase las respuestas a una serie de preguntas relativas a los tipos principales y el costo del material utilizado en las técnicas modernas de transporte aplicadas en las operaciones de transporte multimodal.

3. La lista de preguntas y respuestas figura en el anexo al presente informe y abarca el transporte marítimo -incluidos los buques- y los puertos, así como el transporte por ferrocarril, por carretera, por vías de navegación interior y por vía aérea. Las preguntas giran en torno a los distintos métodos de unitarización de la carga que, si bien en principio no son necesarios para que pueda haber transporte multimodal, contribuyen a que se obtengan las máximas ventajas de esa forma de transporte.

Anexo I

PREGUNTAS Y RESPUESTAS SOBRE LOS ASPECTOS TECNICOS Y FINANCIEROS DE LAS TECNOLOGIAS MODERNAS DE TRANSPORTE UTILIZADAS EN LAS OPERACIONES DE TRANSPORTE MULTIMODAL

INDICE

A. TECNOLOGIAS MODERNAS DE TRANSPORTE Y OPERACIONES MULTIMODALES

1. ¿Qué es el transporte multimodal internacional?

El transporte multimodal internacional consiste en el porte de mercancías de un país a otro por dos o más modos de transporte en virtud de un contrato único -el documento o contrato de transporte multimodal (TM)- expedido por la persona o la empresa que organiza ese servicio -el operador de transporte multimodal (OTM)- y que asume además la responsabilidad de la ejecución de toda la operación. El sistema contrapuesto al transporte multimodal es el transporte fragmentado.

2. ¿Cuáles son las características principales del transporte multimodal?

Lo que caracteriza al transporte multimodal es la naturaleza de la relación contractual entre el OTM y el cargador. El OTM actúa como entidad con personalidad jurídica propia que ofrece a los cargadores un contrato único para el porte de mercancías por más de un modo de transporte.

3. ¿Qué se entiende por transporte de puerta a puerta?

El porte completo de la mercancía desde el local del expedidor hasta el local del destinatario.

4. ¿Ha de ser el transporte multimodal necesariamente de puerta a puerta?

No. Puede ser de muelle a puerta, de muelle a almacén en el interior, de puerta a muelle, de puerta a almacén en el interior y de almacén en el interior a almacén en el interior. Ahora bien, las ventajas pueden ser mayores si toda la operación de transporte se planea y realiza como una operación única de puerta a puerta.

5. ¿Qué modos de transporte pueden utilizarse en el transporte multimodal?

Todos los modos de transporte, es decir, por vía marítima, por carretera, por ferrocarril, por vía aérea o por vías de navegación interior, que sean compatibles con las unidades de mercancías acarreadas.

6. ¿El transporte multimodal, ¿supone automáticamente la unitarización de la carga?

No. En teoría, el transporte multimodal es compatible también con la carga fraccionada. Sin embargo, como el movimiento de carga fraccionada entraña operaciones de manipulación de la carga en cada punto de transbordo de la cadena de transporte, quizá sea difícil que un solo operador asuma la responsabilidad de toda la operación y emita un documento único de transporte directo. De ahí que el transporte multimodal internacional ofrezca su máxima utilidad en relación con el transporte unitarizado; de las diversas formas de unitarización, el sistema de contenedores es el que mejor se presta al transporte multimodal internacional, ya que permite la máxima protección contra daños y hurtos.

Buques celulares

Año de entrada en servicio	Capacidad de transporte de contenedores	Peso muerto	Eslora total	Manga total	Calado
Primera generación (1968)	750 TEU	12 000 T	175 m	25 m	8 m
Segunda generación (1970)	1 500 TEU	30 000 T	225 m	29 m	11 m
Tercera generación (1972)	2 400 TEU	35 000 T-50 000 T	275 m	32 m	12

Velocidad: 20-25 nudos (algunos alcanzan los 33 nudos)

Buques típicos de carga general y contenedores

Capacidad de transporte de contenedores	Eslora total	Manga total	Calado
792 TEU	202 m	23 m	10 m
233 TEU	171 m	23 m	9
247 TEU	150 m	22 m	8 m

Velocidad: 16-20 nudos

Buques LASH (buques portadores)a/
(Clase Delta Mar)

Capacidad de transporte de contenedores o gabarras	Peso muerto	Eslora total	Manga total	Calado
288 TEU y 74 gabarras LASH	41 000 T	272 m	30,5 m	11,62 m

Velocidad: 22,5 nudos

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a/ El buque portagabarras tipo LASH tiene una popa ancha en forma de U provista de unas estructuras que sobresalen del casco y sirven para las operaciones de carga y descarga. Para descargar las gabarras se utiliza una grúa-pórtico de 510 toneladas montada sobre railes. El buque es del tipo de cubierta única con la superestructura a proa.

11. ¿Cuáles son las instalaciones de manipulación a bordo de los buques portacontenedores?

Algunos buques portacontenedores no van provistos de aparejos de carga. En los demás, es posible cualquier combinación del siguiente material de manipulación:

Pescantes de carga giratorios de gran potencia: pescantes de carga moderno provisto de dos amantillos gemelos que permiten un movimiento giratorio y basculante sin tensiones excesivas.

Grúas de cubierta gemelas: grúas montadas sobre una plataforma giratoria común de tal manera que pueden funcionar juntas o independientemente.

Grúas-pórtico: aparato de elevación móvil cuyos pies se desplazan a lo largo de ambas bandas del buque. La viga entre ambos pies sostiene un carrillo que lleva el material de izada y que está dotado de un movimiento de traslación por el través del buque.

Montacargas (buques portagabarras): mecanismo de elevación hidráulico situado en la popa del buque que permite la carga o descarga de los contenedores (en gabarras).

Estiba mecanizada: dispositivos automatizados de las bodegas para facilitar el desplazamiento horizontal y la estiba de los contenedores.

Vehículos de plataforma baja: tipo de remolque que permite la máxima utilización del espacio en los buques Ro-Ro.

Instalaciones de acceso: tales como rampas en la popa o la aleta de los buques Ro-Ro que permiten el acceso del equipo de transbordo.

Carretillas-pórtico de silueta baja: equipo utilizado en los buques Ro-Ro para embarcar y desembarcar contenedores, grandes plataformas y otras grandes unidades.

12. ¿Cuál es el costo indicativo de algunos de esos buques? c/

Buque portacontenedor para el transporte de 800 contenedores de carga seca y 400 contenedores frigoríficos (25.000 TPM-22 nudos)	50,6 millones de dólares

c/ Datos obtenidos por cortesía de los editores del Fairplay Journal; nivel de precios a mediados de 1975 o según las cotizaciones publicadas en la sección "Ventas de buques" del Fairplay Journal, números de febrero a junio de 1975. Los precios de las gabarras LASH y Seabee han sido tomados de Containerization International Yearbook, 1974.

características, puede utilizarse repetidamente o ser desechable. El término paletas comprende las paletas planas, las paletas-caja y las paletas con montantes:

- La paleta plana es una simple base de uno o dos pisos sin ninguna superestructura;
- La paleta-caja es una paleta plana con una estructura en forma de caja, cuyos lados pueden ser de red o macizos y que puede tener o no una cubierta;
- La paleta con montantes es una paleta plana con montantes de esquina ajustables y largueros desmontables.

16. ¿Qué paletas normalizadas se utilizan en el transporte multimodal?

Las recomendaciones de la ISO d/ sobre las dimensiones normales de las paletas de doble piso para el transporte directo de mercancías y de paletas de mayor tamaño para los mismos fines, son las siguientes:

Pulgadas	Milímetros
32 x 48	800 x 1 200
40 x 48	1 000 x 1 200
32 x 40	800 x 1 000
48 x 69	1 200 x 1 600
48 x 72	1 200 x 1 800

17. ¿Qué es un contenedor?

Se ha dado del contenedor la siguiente definición internacional e/:

un elemento del equipo de transporte

a) de carácter permanente y por tanto suficientemente resistente para permitir su uso repetido;
b) especialmente ideado para facilitar el porte de mercancías por uno o varios modos de transporte, sin manipulación intermedia de la carga;
c) provisto de dispositivos que permitan su fácil manejo y, en particular, su transbordo de un modo de transporte a otro;
d) diseñado de manera que sea fácil de llenar y vaciar;
e) de un volumen interior de un metro cúbico (35,3 pies cúbicos), por lo menos.

El término contenedor no comprende los vehículos ni los embalajes de tipo corriente

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d/ ISO 198 1961 y R.329 1963.

e/ ISO 668.

20. ¿Cuál es el costo aproximado de los contenedores? f/

Contenedor de acero	20 pies	1 900 a 2 500 dólares
Contenedor de acero	40 pies	3 900 a 4 500 dólares
Contenedor refrigerado	20 pies	4 500 a 7 000 dólares
Contenedor refrigerado	40 pies	11 000 a 14 000 dólares

21. ¿Pueden transportarse los contenedores por todos los modos de transporte?

En general, sí. No obstante, los contenedores transportados por buques se ajustan generalmente a las normas de la ISO y no son compatibles con el transporte aéreo.

22. ¿Cuáles son los diversos sistemas de manipulación de los contenedores?

1. Sistema ordinario de manipulación
2. Sistema de transbordo por elevación (lift-on/lift off)
3. Sistema de transbordo por rodadura (roll-on/roll-off)
4. Sistema de transbordo por flotación (float-on/float-off)

23. ¿En qué consiste el sistema ordinario de manipulación de contenedores?

Este sistema se suele emplear cuando el movimiento de contenedores es limitado, especialmente cuando éstos son transportados en buques de línea corrientes. Los contenedores pueden cargarse en el buque empleando los aparejos propios de éste, y la descarga en el muelle se efectúa con estos aparejos o con grúas instaladas en tierra. Los contenedores pueden ser transbordados directamente del buque a vagones de ferrocarril o vehículos de carretera, o bien trasladados con camiones plataforma o remolques de muelle a una zona de almacenamiento cercana. La carga y descarga de los vagones de ferrocarril y vehículos de carretera puede efectuarse con grúas móviles, grúas pórtico, carretillas de horquilla elevadora y otro material análogo.

24. ¿Qué es un sistema de transbordo por elevación?

Se trata de un sistema usual cuando el tráfico de contenedores es regular y considerable. Los contenedores se descargan del buque utilizando los aparejos de éste o bien grúas de gran potencia instaladas en tierra; en la mayor parte de los casos los contenedores se colocan directamente en un camión plataforma, en un chasis semirremolque arrastrado por un tractor de carretera ordinario, o en un tren de chasis consistente en un tractor que arrastra cierto número de contenedores hasta la zona de

f/ Cotizaciones de fabricantes de la República Federal de Alemania, sujetas a fluctuaciones (febrero de 1975).

27. ¿Cuáles son los diferentes tipos de remolques que se emplean en la manipulación y el transporte de contenedores?

Remolque plataforma:	Un chasis con una plataforma de madera y generalmente con un tablero delantero.
Remolque de chasis sencillo:	Bastidor sobre ruedas en el que se colocan los contenedores para transportarlos por carretera.
Semirremolque:	Remolques sin ruedas delanteras. La parte delantera se apoya sobre la unidad de tracción o, cuando está separada de ésta, en patas de soporte.
Remolque con ejes en tándem:	Remolque o semirremolque dotado de ejes dobles.
Chasis plano:	Chasis remolque con superficie totalmente plana, sin los rebordes de los remolques corrientes.
Chasis de carretera:	El remolque especial en que se colocan los contenedores para ser transportados por un vehículo o una unidad de tracción de carretera.
Remolque bajo:	Remolque de silueta baja, empleado en los buques Ro-Ro.
Semirremolque de toldo:	Semirremolque de costados bajos y pared posterior abatible. Provisto de anillas metálicas y lona impermeabilizada.
Semirremolque extensible:	Semirremolque que puede extenderse, en general de 40 a 60 pies; tiene ranuras y clavijas de cierre simétricas.
Semirremolque de volquete:	Semirremolque con dispositivo neumático de descarga. Levantando un extremo del contenedor, permite volcar la carga a granel en silos, sin necesidad de emplear otro equipo de manipulación en los puntos de entrega.
Bogie:	Juego de ruedas especialmente destinadas a emplearse como ruedas traseras bajo los contenedores o chasis.
Tren delantero:	Juego de ruedas que puede colocarse en la parte delantera de un semirremolque para convertirlo en un remolque de cuatro ruedas.

Existen modelos adaptados a los diversos números y longitudes de contenedores del sistema modular de la ISO.

Los semirremolques especiales para el transporte de contenedores corresponden en general a una de dos categorías principales: los destinados a transportar contenedores dentro del perímetro de un terminal o en las operaciones de transbordo de un buque Ro-Ro, y los empleados para transportar contenedores por carretera.

32. ¿Debe el cargador o usuario pagar por una carga completa de contenedor aunque envíe sólo una carga parcial?

No, en tal caso el cargador paga un flete basado en un peso o volumen mínimo de utilización.

33. ¿Qué es una "carga completa de contenedor" (CCC)?

Es la enviada en un contenedor, generalmente cargado por un cargador o un agente de grupaje, a un destinatario, y por cuyo transporte se paga la tarifa de contenedor completo.

34. ¿Cómo se estiban los contenedores en los buques?

La estiba de los contenedores varía según el tipo de buque. En los buques corrientes de carga fraccionada, los contenedores se colocan unos junto a otros en sentido longitudinal, en la cubierta y sobre las tapas de las escotillas y se afianzan mediante dispositivos inmovilizadores. En los buques portacontenedores celulares, se apilan verticalmente en células con capacidad de hasta nueve contenedores. Las células están provistas de guías especiales que permiten el fácil deslizamiento de los contenedores. En la mayoría de los buques portacontenedores se apila del 25 al 35% de los contenedores sobre las tapas de las escotillas, que tienen dispositivos de anclaje adecuados. En los buques portacontenedores más pequeños que carecen de células, los contenedores se llevan en las bodegas sujetos con barras.

En los buques Ro-Ro, los contenedores se estiban sobre cubierta y se afianzan con dispositivos de amarre, o permanecen sobre remolques de diversos tipos durante el transporte.

Ante la perspectiva de una unitarización deben tenerse en cuenta los puntos de transbordo y la infraestructura que el puerto puede ofrecer. Hay que determinar, además, hasta qué punto los cargadores o usuarios se percatan de lo que es la unitarización y están en condiciones de organizar sus operaciones a base de unidades de carga. La elección del método de unitarización, que influirá en definitiva en las inversiones destinadas a los servicios portuarios, dependerá también del tipo de mercancías que han de pasar por el puerto.

Debe dotarse al puerto de equipo adecuado para la manipulación o modificar el equipo existente. También deben efectuarse en la disposición material del puerto los cambios que sean necesarios para el movimiento de las unidades de carga que, según se prevé, han de pasar por el puerto. Por ejemplo, habilitar lugares para estacionamiento, preparar una zona de almacenamiento de contenedores o construir muelles adecuados.

38. ¿El hecho de que el movimiento de mercancías se haga por métodos multimodales supone un cambio en las operaciones del puerto?

Sí. Cuando el movimiento de mercancías se hace por procedimientos multimodales, las operaciones del puerto son principalmente de tránsito. La manipulación de la carga y la estiba se reducen al mínimo. Sin embargo, en un puerto de tipo corriente se plantearán diversos problemas nuevos, sobre todo en el caso de la entrega directa. Habrá que proceder a una vasta reorganización del puerto de modo que se reúnan las condiciones necesarias para las operaciones de entrega directa a vehículos de carretera, trenes o gabarras. Por ejemplo, la maniobra de los vagones de ferrocarril constituirá un problema importante a menos que se creen las instalaciones necesarias. La regulación del tráfico por carretera es otro ejemplo de ello; la planificación de ese tráfico y la medida en que pueda satisfacer las exigencias del transporte multimodal influirá en las operaciones del puerto. Las operaciones requerirán menor densidad de mano de obra y exigirán más espacio abierto del que se dispone en la mayoría de los puertos de tipo corriente. Habrá que mejorar los métodos en materia de documentación y de información. El movimiento multimodal de las mercancías supone una comunicación más activa con los clientes y los destinatarios.

39. ¿Harán falta en los puertos muelles especiales para manipular la carga unitarizada?

Esto dependerá de la escala utilizada y del sistema de unitarización. Cuando el movimiento de contenedores no es grande la manipulación puede hacerse en los muelles corrientes de carga fraccionada, que suelen consistir en un espacio o andén angostos

D. TERMINALES DE CONTENEDORES, DEPOSITOS E INSTALACIONES CONEXAS

42. ¿Cuál es la diferencia entre un muelle de contenedores y un terminal de contenedores?

Las expresiones "muelle" y "terminal" pueden denotar idénticas instalaciones. Ahora bien, desde un punto de vista técnico el muelle es un andén donde atracan los buques y donde los contenedores son cargados a los buques o descargados de ellos, mientras que la palabra "terminal" puede denotar el muelle y la zona, por lo general contigua al muelle, donde los contenedores son almacenados, llenados, vaciados y trasladados a trenes o vehículos de carretera. Pueden establecerse también terminales de contenedores en puntos situados en el interior.

43. ¿En qué consiste la explanada en un terminal para contenedores?

Por lo general el término "explanada" se refiere al andén paralelo al muro del muelle y adyacente a éste donde se clasifican los contenedores para proceder a su carga o descarga con grúas.

44. ¿Cuáles son los costos aproximados de construcción del muro del muelle y de la explanada? 1/

a) Muro del muelle: por metro cuadrado útil para grúa de contenedores — 4.000 a 20.000 dólares EE.UU.
Relleno de explanada por metro cuadrado — 28 a 42 dólares EE.UU
Pavimento de hormigón o esfalto, por metro cuadrado — 7 dólares EE.UU.

45. ¿Cuáles son las partes integrantes de una terminal de contenedores?

a) La zona de clasificación que va del muro del muelle a la zona de apilamiento.
b) Las zonas de apilamiento y el espacio reservado para contenedores vacíos y averiados.
c) Los parques de remolques.

1/ Las cifras están basadas en datos publicados en "Aspectos tecnicos de los sistemas de transporte de grandes contenedores" (ST/ECA/170) Nueva York 1970, págs. 106 y 112, y reajustados con arreglo a los precios registrados en junio de 1975 en el Reino Unido, conforme a un índice proporcionado por una firma de consultores en ingeniería de ese país.

contenedores ofrecen una fórmula eficaz, en sustitución del movimiento de contenedores de puerta a puerta, para los cargadores o usuarios que tienen cargas parciales o cargas completas de contenedores pero no cuentan con medios apropiados para efectuar ellos la carga.

49. ¿Quién puede organizar una estación de carga de contenedores?

Las estaciones de carga de contenedores pueden ser organizados por las empresas navieras, los transportistas por carretera, los comerciantes al por menor que operan con mercancías homogéneas o bien por el Estado en forma de una red nacional de estaciones de carga auspiciadas por él, fórmula ésta que puede ser más ventajosa que la de un gran número de centros de grupaje administrados por entidades particulares.

50. ¿Son necesarias las estaciones de carga de contenedores en un puerto donde sólo se mueve un pequeño número de contenedores?

No. Sobre todo si los contenedores pueden trasladarse directamente afuera del puerto o a un tinglado corriente de carga fraccionada donde sea posible efectuar su llenado y vaciado, siempre que las dimensiones materiales de los tinglados permitan la maniobra sin obstáculos del equipo de traslación.

51. ¿Es posible instalar los servicios conexos, es decir, el tinglado de agrupación de la carga, la zona de almacenamiento y apilamiento, las zonas de entrega y conservación de contenedores en un lugar que no sea contiguo al muelle?

Aunque es posible contestar afirmativamente a esta pregunta, debe señalarse que, en caso de que el tráfico aumente considerablemente, esta solución impondrá ciertas limitaciones a las operaciones de manipulación de contenedores. Asimismo, al establecer los servicios conexos lejos de los servicios de grúas aumentarán los gastos de capital en equipo de traslación, disminuirá el ritmo de manipulación de la carga y se perderá flexibilidad, sobre todo en lo que se refiere a la elección del equipo de traslación. Por ejemplo las carreterillas-pórtico no son apropiadas para la traslación a distancia.

52. ¿Cómo pueden utilizarse los tinglados de carga fraccionada en muelles comunes para contenedores y carga fraccionada en caso de que aumente el tráfico de contenedores?

Si se transforma el muelle para destinarlo exclusivamente al movimiento de contenedores, los tinglados pueden utilizarse para el llenado y vaciado de contenedores siempre que esos tinglados, por su anchura y altura, permitan la maniobra del equipo de

E. UNITARIZACION Y MATERIAL DE MANIPULACION DE LA CARGA

53. ¿Cuál es el material necesario para manipular la carga unitarizada en el puerto? i/

El material diferirá de un puerto a otro según las distintas variedades de unidades de carga acarreadas a través del puerto y según la configuración física de éste. Sería imposible hacer una lista completa de todo el equipo de manipulación para todas las formas de unitarización. Ahora bien, el equipo para manipular la carga unitarizada en los puertos puede consistir en cualquier combinación de los elementos siguientes:

a) Grúas martillo, grúas de torre, grúas para la manipulación de contenedores, grúas-puente, grúas móviles, material para transporte sobre vagones plataforma (sistema "canguro"), etc.

b) Carretillas de carga lateral, dispositivos de elevación lateral y unidades de transbordo lateral.

c) Carretillas elevadoras provistas de una variedad de dispositivos: mecanismo de desplazamiento lateral, horquillas extensibles, soportes con vástago, dispositivo portabarriles, brazo con gancho, dispositivo portabidones, prensores, etc. k/.

d) Gatos rodantes, gatos accionados mecánicamente.

e) Material de acceso para los contenedores: rampas de andén de carga, rampas móviles, rampas levadizas, plataformas elevadoras, etc.

f) Carretillas-pórtico.

g) Material de tracción: remolques, chasis, tractores, sistemas rodantes neumáticos o hidráulicos portátiles, "multifits", etc.

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i/ El sistema de transbordo por rodadura y, hasta cierto punto, el sistema de transbordo por flotación, no necesita el mismo material de elevación de gran potencia que el sistema de contenedores. Sin embargo, el material utilizado para el transbordo y la traslación de las unidades de carga en todos los sistemas no es físicamente diferente. Aunque esta pregunta ha sido formulada con respecto a los puertos, parte del material enumerado es necesario para manipular cargas unitarizadas en cualquier punto de transbordo y en los terminales de contenedores.

k/ Los soportes con vástago se utilizan para izar alfombras, tubos, etc.

El dispositivo portabarriles consiste en dos pares de brazos superpuestos que ciñen el barril.

El brazo con gancho es un accesorio que habilita la carretilla elevadora para funcionar como grúa móvil.

El dispositivo portabidones es un aparato de elevación con movimiento vertical y un gancho para izar y manipular uno o dos bidones simultáneamente a modo de una eslinga.

Los prensores son un dispositivo consistente en dos brazos colocados en lugar de las horquillas que permiten asir, sujetándola por los lados, una unidad de carga o un solo artículo sin ayuda de paletas.

El costo aproximado de una grúa-pórtico es el siguiente:

Grúa-pórtico económica para la manipulación de contenedores, 30 toneladas, contenedor ISO 20'/30'/40', utilizado en barcos destinados a travesías cortas	500.000 dólares EE.UU.
Grúa-pórtico de 40 toneladas para la manipulación de contenedores, de un alcance útil de 115 pies con bastidor de suspensión, según el grado de automatización	2 a 3 millones de dólares EE.UU.

55. ¿Qué es una grúa móvil y cuál es su costo aproximado?

Una grúa móvil es una grúa automotriz destinada a funcionar sobre una superficie vial. Tiene múltiples aplicaciones y suele estar provista de eslingas y brazos de suspensión. Las grúas móviles pueden utilizarse para la manipulación de contenedores cuando el número de éstos es pequeño.

El costo de las grúas móviles, según su capacidad, que oscila entre 11 y 60 toneladas, y la longitud del aguilón, se sitúa entre 43.000 y 215.000 dólares.

56. ¿Qué es una carretilla de toma lateral y cuál es su costo aproximado?

Una carretilla de toma lateral es una carretilla elevadora cuyo mecanismo de izada está situado en un lado del vehículo para la manipulación de contenedores. Las carretillas de toma lateral provistas de bastidores de suspensión y horquillas se utilizan también para la carga y descarga de buques Ro-Ro y para el transbordo de contenedores desde las zonas de almacenamiento y hasta ellas. El mástil de elevación puede desplazarse de modo que el contenedor descanse sobre el chasis de la carretilla durante el transporte. Sus especificaciones técnicas son las siguientes:

Capacidad de elevación: 20 a 35 toneladas.

Apilamiento: 2 a 3 alturas de contenedores de 20 x 8 x 8 ó 40 x 8 x 8.

Velocidad de izada: 12 m/minuto a 15 m/minuto, cargada.

Una carretilla de carga lateral con una capacidad de elevación de 35 toneladas permite manipular por término medio de 12 a 15 contenedores por hora, en la carga o descarga de vagones de ferrocarril o camiones.

58. <u>¿Qué es un dispositivo de elevación lateral y cuál es su costo aproximado?</u>

Los dispositivos de elevación lateral son mecanismos de manipulación de contenedores montados en camiones, remolques y ~~semirremolques~~ de transporte por carretera y consisten en dos brazos elevadores accionados hidráulicamente con eslingas o bastidores de suspensión montados en cada extremo de un chasis. Estos elevadores laterales pueden alzar un contenedor del suelo y depositarlo sobre su propio chasis o sobre el de un camión o un vagón de ferrocarril. La capacidad y las especificaciones técnicas de los dispositivos de elevación lateral son las siguientes:

Un elemento de izada lateral de 20/40 pies montado sobre un semiremolque extensible equipado para contenedores ISO de 20/40 pies permite el transbordo de contenedores desde el suelo, un vagón de ferrocarril o un remolque sólo por un lado y apilar dos contenedores de 8' 6". Un elevador lateral, con una capacidad de elevación de 30 toneladas, permite manipular por término medio de 6 a 7 contenedores por hora, en la carga o descarga de vehículos de carretera o vagones de ferrocarril.

El costo aproximado de un dispositivo de elevación lateral es de 80.000 dólares.

59. <u>¿Qué son las unidades de transbordo lateral y cuál es su costo aproximado?</u>

Las unidades de transbordo lateral consisten en brazos accionados hidráulicamente que desplazan lateralmente los contenedores empujándolos o arrastrándolos. Están provistas además de gatos niveladores hidráulicos, dos en cada extremo de chasis, lo que permite el transbordo intermodal en superficies a diferente nivel. Este sistema se utiliza para el transbordo de contenedores entre camiones de carretera y vagones de ferrocarril y para el almacenamiento intermedio sobre patas o soportes. El costo aproximado del material de transbordo lateral es de 60.000 dólares por unidad.

60. <u>¿Qué es un gato rodante y cuál es su costo aproximado?</u>

Los gatos rodantes se componen de dos ejes independientes provistos de sendos mecanismos hidráulicos de elevación y bastidores. Los dos bastidores tienen a su vez dispositivos de cierre para su acoplamiento a las cantoneras de los contenedores de tipo corriente. La elevación se efectúa con una bomba de mano. Una vez izado el contenedor, se remolca toda la unidad desde el costado del buque hasta la zona de almacenamiento con un tractor ordinario. Las especificaciones técnicas de un gato rodante son las siguientes:

carretilla-pórtico recoge los contenedores y los transporta a la zona de almacenamiento y puede incluso cargarlos en camiones de carretera. Las especificaciones técnicas de las carretillas-pórtico son las siguientes:

Las destinadas a la manipulación de contenedores de dimensiones normalizadas (20, 30 y 40 pies) tienen una velocidad de traslación de 28 km/hora y una capacidad de elevación de 30 toneladas. Pueden subir pendientes de un desnivel máximo del 3%. Su altura de izada es superior a los 5 metros y pueden apilar hasta tres alturas de con contenedores.

La carretilla-pórtico puede maniobrar hacia adelante, hacia atrás y de lado. Su velocidad de traslación con una capacidad de carga de 30 toneladas es de 400 m/minuto.

El costo aproximado de una carretilla-pórtico es el siguiente:

Carretilla-pórtico capaz de apilar tres contenedores ISO de 20'/30'/40'	180.000 a 200.000 dólares EE.UU.
Tractor "Tugmaster" para contenedores ISO 20'/30'/40' sobre remolque, utilizado principalmente en el sistema de transbordo por rodadura	17.000 dólares 37.000 dólares

El costo de los bastidores de suspensión es el siguiente:

Grúa de 40 toneladas para la manipulación de contenedores	60.000 dólares
Grúa de 40 toneladas de desplazamiento horizontal de la carga	57.000 dólares.

Estas cifras se basan en un diseño que permite una velocidad de 30 km por hora. Por otra parte, en muchos países, debido a las limitaciones del sistema de carreteras, la anchura máxima autorizada es de 2,40 m y la altura máxima de 1,80 m.

Las carreteras deben construirse con capacidad suficiente para soportar cargas por eje hasta de 13 toneladas si se prevé un tráfico de todos los tipos de contenedores ISO.

El número de carriles depende de la intensidad del tráfico. En zonas de poco tráfico, pueden bastar las carreteras de un solo carril, siempre que estén bien trazadas y se construyan zonas de cruce. Hay que determinar además la resistencia de los puentes de carretera. Si la resistencia del puente sólo permite que pase un vehículo con contenedor cada vez, habrá que regular el tráfico en consecuencia. Si el puente no tiene resistencia bastante para soportar el peso de un contenedor, habrá que hacer una desviación, a menos que se pueda reforzar el puente o construir uno nuevo.

65. ¿Cuáles son los costos de construcción y mejora de las carreteras y de la infraestructura de carreteras?

a) Carreteras n/

Pavimentación de una carretera de grava. Ensanchamiento de la plataforma de 8 a 11 metros. Mejoras secundarias del trazado. Costo total unos 138.000 dólares por km.

Construcción de una carretera principal de dos carriles para velocidades de 100 km/hora. Anchura del pavimento, 8 metros. Costo total, unos 340.500 dólares por km.

Construcción de una carretera con fines de desarrollo, incluidos varios puentes pequeños. Terreno quebrado. Ancho del pavimento, 6 metros. Costo total unos 48.000 dólares por km.

Al construir carreteras nuevas, el costo suplementario de aumentar la carga por eje será relativamente reducido.

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n/ Los costos se refieren al Pakistán y se basan en cifras publicadas en "Aspectos técnicos de los sistemas de transporte de grandes contenedores" (ST/ECA/170), página 117, ajustadas a los precios de 1975 aplicando un índice basado en estimaciones de una empresa de consultores de ingeniería del Reino Unido. Las cifras de costos sólo indican órdenes de magnitud aproximados.

Costo de construcción de puentes

Tipo de puente	Costo (en dólares por m^2)
Puente colgante	450 - 900
Puente de celosía	300 - 375
Otros tipos	150 - 375

Costo de construcción de túneles por kilómetro cuadrado para una carretera de dos carriles: 750.000 - 1.500.000 dólares.

67. ¿Cuáles son las normas en cuanto a las características materiales y técnicas de una red ferroviaria utilizada en el transporte multimodal?

Más del 60% de las líneas ferroviarias de todo el mundo tienen un ancho de vía de 1,435 mm. Otros anchos de vías son 1,675 mm y 1,524 mm para dos tipos de vía ancha, 1.067 mm para las vías de El Cabo y 1,000 mm para la vía estrecha. En las curvas de pequeño radio se necesita un cierto ensanchamiento de la vía para que puedan pasar los vagones de más de dos ejes. Para una velocidad máxima de 70 km/h, el radio mínimo de la curvatura debe ser de 5.000 m y para velocidades máximas del orden de 75 a 100 km/h, el radio de curvatura mínimo debe ser de 10.000 m. Debe tenerse en cuenta los movimientos laterales y el hecho de que el peralte de los carriles y la fuerza centrífuga harán que los vagones sobresalgan más de los carriles cuando el tren está en movimiento. Por consiguiente, el espacio libre deberá ser mayor que la sección transversal máxima de los vagones junto con sus cargas. Los perfiles de carga deben diseñarse teniendo en cuenta las dimensiones del espacio libre, los movimientos laterales del tren sobre los carriles, las posiciones extremas de los vagones en las curvas y los márgenes de seguridad necesarios para túneles. Los ferrocarriles con perfiles de carga de la UIC pueden transportar asimismo todos los contenedores ISO de la serie 1. En los ferrocarriles de menor perfil de carga, el problema de la altura podrá resolverse utilizando vagones especiales con plataforma baja o bien vagones con ruedas de pequeño diámetro.

68. ¿Cuáles son las normas en cuanto a las características materiales y técnicas de los vagones de ferrocarril utilizados en el transporte multimodal?

Hay muchos tipos de vagones plataforma para el transporte de contenedores ISO. En los vagones plataforma ordinarios puede instalarse un dispositivo de sujeción que permita transportar dos contenedores de 20 pies en cada vagón. Puede ser necesario hacer ciertas modificaciones en los vagones plataforma de uso general, de manera que los contenedores queden parcialmente sujetos. Los vagones portacontenedores especiales tienen simples bastidores de hierro en vez de plataformas de tipo corriente; esto permite economías importantes en la tara, y por tanto, una mayor carga útil. Algunos vagones especiales están provistos de dispositivos de sujeción de contenedores que se accionan pulsando un botón y de señales luminosas que indican si los contenedores están firmemente sujetos a los vagones. Algunos están provistos de placas de guarda retráctiles. En un vagón equipado con 12 de estas placas, que permiten un desplazamiento

H. OPERACIONES MULTIMODALES Y VIAS DE NAVEGACION INTERIOR

70. ¿Qué condiciones deben reunir las vías de navegación interior para las operaciones de transporte multimodal?

Las vías de navegación interior deben estar coordinadas con los otros modos de transporte. Esto puede exigir inversiones en diversos programas relativos a las embarcaciones y el equipo. Tal vez sea necesario un servicio constante para mantener el calado de las vías de navegación de modo que éstas puedan ser utilizadas todo el año. En algunos países en desarrollo las vías de navegación interior pueden habilitarse para el movimiento de gabarras LASH y Seabee. Es indispensable, pues, que las vías de navegación interior tengan ciertas dimensiones mínimas que permitan el paso de gabarras LASH y de otro tipo que puedan transportar unidades de carga. En vías poco profundas dotadas de un canal de navegación cuya anchura y radio de curvatura sean suficientes, el transporte se puede efectuar eficazmente en grupos y "trenes" de gabarras. El "remolque de empuje" ofrece ventajas sobre los métodos tradicionales de desplazar las gabarras sin propulsión propia. Los remolcadores de empuje dirigen mejor las gabarras, sobre todo en los canales estrechos y sinuosos de poca profundidad. Las esclusas deben tener la suficiente profundidad, anchura y longitud para que quepa todo el tren de gabarras en el cuenco. En los puntos de distribución del interior debe instalarse equipo de manipulación de carga, tales como grúas de tierra firme, junto a los ríos o canales. En algunos casos pueden utilizarse pontones grúa. Puede ser necesario además techar ciertas zonas para proteger de la intemperie las operaciones de carga y descarga de las gabarras.

72. ¿Cuáles son los procedimientos de manipulación en el transporte de un contenedor por vía aérea?

En un viaje normal habrán las operaciones siguientes:

a) Carga de la mercancía por el cargador;

b) Traslado al almacén provisional;

c) Traslado del almacén al camión;

d) Traslado del camión al transportador de rodillos de la línea aérea;

e) Traslado del transportador de rodillos al almacén provisional del terminal;

f) Traslado del almacén del terminal a la paleta de avión;

g) Traslado al avión;

h) Estiba a bordo del avión;

Estas operaciones se harán a la inversa cuando el avión llegue a su destino.

J. LAS OPERACIONES MULTIMODALES Y LOS PAISES SIN LITORAL

73. ¿Es la unitarización de la carga beneficiosa para los países sin litoral?

Sí. Sobre todo porque la unitarización supone una mayor rapidez del tránsito, la simplificación de los trámites de aduanas, la reducción de la documentación, y la disminución de los hurtos y averías.

74. ¿Es posible el transporte multimodal para los países sin litoral?

Depende de la infraestructura que comunica al país sin litoral con los puertos de otros países. Puesto que el denominador común en los principales servicios de transporte multimodal es el uso de contenedores, el transporte multimodal será posible principalmente si los contenedores pueden transportarse por una red de ferrocarriles, carreteras y vías de navegación interior que comunique a los países sin litoral con los puertos.

I. OPERACIONES MULTIMODALES Y TRANSPORTE AEREO

71. ¿Qué condiciones debe reunir el transporte aéreo para las operaciones del transporte multimodal?

Los contenedores para el transporte aéreo difieren en tamaño, construcción y capacidad de los utilizados en otros modos de transporte. Los contenedores aéreos y los dispositivos de unidad de carga DUC, contenedores iglú o contenedores de cubierta inferior aprobados por la IATA, son mucho más ligeros que los contenedores ISO, pues responden a la preocupación principal de los portadores aéreos que es evitar todo daño al avión y aligerar el peso del contenedor. Los contenedores aéreos no tienen cantoneras ni montantes pesados ni están provistos de una estructura que permita el transporte integrado por mar y no podrían resistir el transporte marítimo ni la manipulación que éste entraña. Además la forma de iglú no es compatible con las características que exigen los materiales de manipulación de contenedores ISO tales como las grúas pórtico o grúas de contenedores y sus bastidores de suspensión. Los dispositivos de unidad de carga DUC son compatibles con las operaciones de transporte por carretera. Pero todavía hace falta diseñar un contenedor intermodal que sea apropiado tanto para el transporte aéreo como para los demás modos de transporte. Los aviones de gran fuselaje de la nueva generación (B-747, DC-10, L-1011), que pueden transportar contenedores intermodales aire/carretera de 20 pies, tienen un servicio de transporte bimodal y hasta cierto punto hacen innecesaria la maniobra suplementaria en terminales aéreos. Se trata, sin embargo, de aviones que suponen cuantiosas inversiones de capital. Tal vez sea posible en el futuro que los contenedores utilizados por las líneas aéreas en el transporte multimodal tengan las dimensiones señaladas por la ISO y vayan provistos de cantoneras normalizadas. Esos contenedores habrían de tener resistencia suficiente para soportar el transporte por aire y por tierra. Es indispensable, sin embargo, que su peso sea mucho menor que el de los usados en el transporte de superficie. Mientras tanto, a fin de lograr un transporte más integrado, hay que usar los contenedores prescritos por la IATA, útiles para cien viajes por lo menos, que están construidos con paneles formados por un alma de madera de balsa en sección transversal recubierta por ambos lados con láminas de una aleación de aluminio. Hay que contar con materiales especiales de manipulación tales como tractores, pinzas de izada, aparatos de elevación, dispositivos transportadores, etc.

de 14 pulgadas en cada dirección, el contenedor queda afianzado y protegido contra los movimientos violentos. Los vagones deben estar dotados de dispositivos amortiguadores especiales para evitar los daños durante las maniobras.

69. <u>¿Es posible el transporte multimodal en redes ferroviarias con distintos anchos de vía?</u>

Sí, en la medida en que este problema pueda superarse de modo que se evite el transbordo a base de cambiar los ejes en los puntos de empalme de vías de distinto ancho. Se considera que el nuevo tipo de vagones de ajuste automático suprimirá en breve los problemas que plantean los diferentes anchos de vía.

G. OPERACIONES MULTIMODALES Y TRANSPORTE FERROVIARIO

6. ¿Qué condiciones deben reunir los servicios ferroviarios para el transporte multimodal?

La adaptación del equipo existente o la adquisición de material móvil nuevo para que las unidades sean intercambiables, ya se trate de contenedores o paletas, de modo que se cuente con la capacidad de acarreo y la capacidad cúbica que requiera el transporte de unidades de carga. Es indispensable contar con terminales provistos de equipo de transbordo suficiente y situados en las inmediaciones de los terminales de contenedores. Al planificar redes nuevas o la ampliación de las ya existentes debe tenerse en cuenta la posibilidad de agrupar los envíos de mercancía en contenedores o paletas. Las reformas no tienen por qué ser muy ambiciosas ni llevarse a efecto con demasiado apresuramiento. Procediendo a una adaptación por etapas se podrán allanar obstáculos. Tal vez sea necesario adoptar un sistema de trenes-bloque. Un tren-bloque se compone de una serie de vagones y locomotoras permanentemente enganchados que funcionan formando una unidad en una determinada ruta, que el tren recorre en ambos sentidos con breves paradas en los puntos de transbordo. De esta manera es posible reducir al mínimo el tiempo de espera en los terminales, sobre todo si se trata de trayectos cortos o medianos. También es aconsejable adoptar el sistema de transporte "canguro"[p/] Este sistema permite trasladar rápidamente los remolques por ferrocarril de un terminal a otro y combina la flexibilidad de los camiones remolques para las operaciones de recogida y entrega con el transporte en masa que es la ventaja de los ferrocarriles. Puede ser necesario disponer de vagones plataforma provistos de bogies para gran velocidad que permitan transportar los contenedores ISO más grandes. Es recomendable el uso de vagones con bastidor de acero que no llevan la plataforma corriente y son más ligeros. Los contenedores se transportan directamente sobre el bastidor de acero. El peso que se ahorra con un vagón bastidor, en comparación con los vagones corrientes, es de 2.000 a 3.000 kg. Tal vez sea necesario revisar la organización, la política de precios y la infraestructura de la red ferroviaria con objeto de responder a las nuevas necesidades.

p/ El sistema "canguro" consiste en el transporte de camiones-remolque, cargados o vacíos, sobre vagones plataforma. Una designación más oficial es la de transporte de remolque sobre vagón plataforma (TOFC). No es sino una modalidad de transporte por contenedores, que se convierten en remolques cuando se les acopla un juego de ruedas traseras (bogies).

Costos marginales de construcción al aumentarse la carga total

Carga por eje autorizada	8 toneladas	10 toneladas	13 toneladas
Costo marginal de una carretera de dos carriles (en dólares por km)	0	5 400	10 800
Costo de obras de refuerzo (en dólares por km)			
Carga por eje actualmente autorizada	Refuerzo hasta 10 toneladas de carga por eje		Refuerzo hasta 13 toneladas de carga por eje
10 toneladas 8 toneladas menos de 8 toneladas	 10 500 18 000		12 000 16 500 28 500

b) Puentes o/

Sería conveniente que los puentes de nueva construcción fueran calculados para resistir una carga por eje de por lo menos 13 toneladas, o el correspondiente peso por bogie y peso total. El costo marginal para aumentar la carga por eje de 8 a 10 ó 13 toneladas suele ser módico. En algunos casos hay la posibilidad de reforzar los puentes existentes en vez de recurrir a nuevas construcciones.

Ejemplo de mejoras en puentes para aumentar a 13 toneladas la carga por eje autorizada

Tipo de puente	Mejora	Costo (en dólares por unidad)
Tablero de madera	Viga de acero suplementaria	300 - 450 por tonelada
Viga de acero y tablero de hormigón	Tablero nuevo	45 - 75 por m^2
Armazón de riostras	Refuerzo del armazón	2 250 - 22 500 por puente

o/ Los costos para Europa se basan en las cifras publicadas en "Aspectos técnicos de los sistemas de transporte de grandes contenedores" (ST/ECA/170) ajustadas a los precios de 1975 aplicando un índice basado en estimaciones de una empresa de consultores de ingeniería del Reino Unido. Las cifras de costos sólo indican órdenes de magnitud aproximados.

F. OPERACIONES MULTIMODALES Y TRANSPORTE POR CARRETERA

63. ¿Qué condiciones debe reunir el transporte por carretera para las operaciones de transporte multimodal?

La mayoría de las carreteras se han construido para responder a las necesidades locales y atendiendo a las características geográficas de la región. Puede ser que tales carreteras no satisfagan las exigencias del transporte multimodal y en particular del transporte de contenedores y otras grandes unidades de carga. Por este motivo es posible que sea necesario examinar las exigencias materiales del transporte por vehículos de carretera y la reglamentación aplicable, en lo que respecta a la idoneidad de las carreteras, así como al peso, la carga y las dimensiones de los vehículos que transportan las unidades de carga. Por ejemplo, para los efectos del transporte de los contenedores de mayor tamaño, bastarán cargas por eje sencillo de 10 toneladas y cargas por ejes en tándem de 16 toneladas como máximo. A fin de aumentar al máximo las cargas por eje autorizadas, es posible utilizar remolques de plataforma baja que puedan transportar contenedores apilados, siempre que no existan limitaciones en cuanto a la altura. Los transportistas por carretera tendrán que reorganizar sus servicios e instalar depósitos. La red de carreteras debe proporcionar un acceso adecuado a los puertos, los terminales de contenedores y las estaciones de carga de contenedores. Ahora bien, a fin de sacar el máximo provecho de las ventajas del transporte multimodal, la infraestructura de carreteras debería desarrollarse de tal manera que, a la larga, permita efectuar entregas puerta a puerta.

64. ¿Cuáles son las características físicas y técnicas que deben reunir las carreteras para el transporte multimodal?

Un requisito mínimo de la infraestructura vial es que la capacidad de carga de la red de carreteras sea por lo menos igual a las cargas por eje sencillo y por ejes en tándem y al peso bruto de los vehículos de carretera que transportan un contenedor cargado al máximo. Para el transporte de contenedores de 20, 30 y 40 pies, las carreteras deben reunir los requisitos siguientes:

Anchura del carril:	3 metros
Curva horizontal mínima:	30 metros
Pendiente máxima:	10%
Visibilidad mínima de parada:	25 metros
Altura libre mínima:	4 metros

Capacidad de elevación: 20 a 25 toneladas.

Altura de izada: 1,70 m (66,9 pulgadas).

El costo de un gato rodante oscila entre 5.600 y 6.300 dólares.

61. ¿Qué es una rampa y cuál es su costo aproximado?

Las rampas son una clase de material que se utiliza para salvar un espacio horizontal y/o vertical entre el piso de un andén de carga y el piso de un contenedor o de un camión o vagón de ferrocarril. Las rampas son de diversos tipos y tamaños. Las rampas móviles para la manipulación de contenedores permiten que las carretillas elevadoras introduzcan directamente las cargas en los contenedores, los camiones o los vagones de ferrocarril de puerta ancha.

Rampas de maniobra móviles

Capacidad: 7,26 a 11,34 toneladas.

Longitud: 9,15 a 10,97 m.

Anchura: 1,77 m.

Peso estimado: 1,6 a 1,96 toneladas.

Rampas de maniobra pequeñas:

Capacidad: 7,26 a 9,10 toneladas.

Longitud: 6,10 a 7,93 m.

Anchura: 1,77 m.

Peso estimado: 1,19 a 1,52 toneladas.

Hay dos tipos de rampas de esta clase:

La rampa de carga de paletas para la entrada horizontal en el contenedor que se está llenando y la rampa de carga directa que permite llegar sin interrupción hasta la cola del vehículo en que descansa el contenedor.

El costo de una rampa oscila entre 4.300 y 7.000 dólares. El de una rampa de paletas para salvar desniveles oscila entre 750 y 1.100 dólares.

62. ¿Qué es una carretilla-pórtico y cuál es su costo aproximado?

Las carretillas-pórtico son máquinas automotoras consistentes en un pórtico con patas que enmarca el contenedor. El pórtico lleva un dispositivo de elevación que suele ser un bastidor de suspensión; en algunos casos la carretilla está también provista de brazos elevadores que izan los contenedores por su parte inferior. La

El costo aproximado de una carretilla de carga lateral es el siguiente:

Con una capacidad de 20 y 25 toneladas para contenedores 20'/30'/40'	100.000 a 140.000 dólares EE.UU.
Con una capacidad de 35 toneladas para manipular contenedores de 20'/30'/40' por medio de un bastidor de suspensión hidráulico	221.000 dólares EE.UU.

57. ¿Qué es una carretilla elevadora y cuál es su costo aproximado?

La carretilla elevadora es el más versátil de todos los materiales de manipulación y consiste en un vehículo automotor provisto de horquillas de acero afiladas para manipular cargas paletizadas sobre patines y de horquillas de gran potencia para manipular contenedores. La carretilla elevadora puede estar provista de una serie de accesorios diversos para operaciones especializadas. Puede ir equipado con llantas de caucho de tipo macizo o neumático. Con una carretilla elevadora de gran potencia es posible manipular los contenedores al costado del buque y transportarlos a la zona de almacenamiento o cargarlos en camiones de carretera o en vagones de ferrocarril. Las especificaciones técnicas de las carretillas elevadoras son las siguientes:

La capacidad de elevación oscila entre 0,5 y 50 toneladas. La altura de izada normal oscila entre 2 y más de 5 metros. Una carretilla elevadora con una capacidad de elevación de 25 toneladas permite manipular por término medio de 15 a 20 contenedores por hora, en la carga y descarga de camiones y vagones de ferrocarril. Una carretilla elevadora de gran potencia dotada de un bastidor de elevación de contenedores intercambiable de 20 a 30 pies permite apilar tres contenedores.

Una carretilla elevadora con una capacidad de carga de 25 toneladas puede recoger o descargar un contenedor en un tiempo de 1 a 2 minutos. La velocidad de traslación es de 360 m/minuto.

El costo aproximado de una carretilla elevadora es el siguientes

3 a 5 toneladas	25.000 dólares
7 a 12 toneladas	50.000 a 70.000 dólares
20 a 25 toneladas	120.000 a 160.000 dólares

h) Accesorios de manipulación de la carga: bastidores de suspensión, aparejo de estabilización automática de la carga, dispositivos de rotación de la carga, pulpos, dispositivos de vástago y sujetador[1/].

i) Eslingas y estrobos.

j) Transpaletas, eléctricas o manuales.

54. ¿Qué es una grúa-pórtico y cuál es su costo aproximado?[m/]

La grúa-pórtico es una grúa para la manipulación de contenedores y carga fraccionada. Cuando está instalada a bordo, abarca toda la anchura del buque. Existen también muchos tipos de grúas-pórtico de muelle para la manipulación de contenedores. Las grúas-pórtico para el transbordo ferrocarril/carretera, por ejemplo, pueden ser automotoras y desplazarse con ruedas que corren sobre rieles o con ruedas de caucho.

Las dimensiones de una grúa-pórtico varían según su diseño y capacidad. Una grúa típica de 20 a 30 toneladas con un mecanismo de izada auxiliar de 10 toneladas puede manipular contenedores de 20 a 40 pies. La velocidad de izada es de 45 m/minuto y 30 m/minuto, respectivamente.

Una grúa pórtico de terminal típica para la manipulación de contenedores tiene una capacidad de elevación en bastidor de suspensión de 30 toneladas. La altura de izada es de 10,1 m y la velocidad de izada de 9 m/minuto. La velocidad de traslación de la grúa es de 120 m/minuto.

La luz de las grúas-pórtico de mayor tamaño puede variar entre 10 y 25 a 30 m. La capacidad de carga oscila entre 30 y 40 toneladas.

1/ El dispositivo de rotación de la carga es un aparato que permite hacer girar la carga, una vez izada por la grúa, 360° en ambas direcciones por medio de un motor eléctrico conectado con una transmisión hidráulica situada dentro del soporte giratorio.

El pulpo es un dispositivo adaptado a las eslingas de la grúa y destinado a la carga y descarga de balas de pasta de madera. Se compone de varios elementos prensores de sección rectangular y brazos ajustables.

El dispositivo de vástago y sujetador es un accesorio especial para la manipulación del papel en bobinas. El vástago se inserta en el alma de la bobina y unos sujetadores se cierran mecánicamente para la izada.

m/ Los precios indicados en las respuestas a las preguntas 54 a 62 son precios en fábrica aproximados, suministrados por varios fabricantes del Reino Unido, la República Federal de Alemania y el Canadá, y están sujetos a variaciones.

traslación. La zona de tinglados habrá de tener mayor o menor amplitud según las necesidades del tráfico. Su extensión puede determinarse atendiendo al número de toneladas que han de manipularse en el tinglado al año.

Si los tinglados de carga fraccionada no son adecuados para las operaciones de llenado y vaciado, habrá que desmontarlos y utilizar el espacio para almacenar contenedores, sobre todo en reserva.

Si en algunos países en desarrollo se construyen terminales que estén expresamente destinadas a atender a la vez el tráfico de contenedores y el de carga fraccionada, los tinglados que se instalen no deben ser edificios de carácter permanente, sino estructuras desmontables constituidas de preferencia por elementos prefabricados.

d) Los andenes de recepción y entrega.

e) El tinglado de agrupación de la carga (que no se encuentra necesariamente en el terminal).

f) El taller de conservación y reparaciones.

g) Espacio para oficinas.

h) Otras instalaciones tales como la torre de control de operaciones, el puente-báscula, enchufes para contenedores refrigerados, las instalaciones de lavado de contenedores, etc.

46. ¿Cuáles son las funciones de un terminal de contenedores?

Las operaciones que se realizan en un terminal de contenedores son la carga y descarga de contenedores, su almacenamiento y agrupación y su traslado a vehículos de carretera y trenes. El terminal de contenedores puede dividirse en los elementos siguientes:

a) Zona de maniobra y embalaje para recepción de la carga y servicios de transportes.

b) Zona de maniobra y clasificación para la manipulación del equipo.

c) Zona de almacenamiento para contenedores cargados.

d) Zona de almacenamiento para contenedores vacíos.

e) Zona para llenar y vaciar contenedores.

f) Sector destinado a servicios de conservación del equipo y a administración.

g) Zonas de estacionamiento para remolques de chasis bastidor vacíos, vagones de ferrocarril, vagones plataforma y camiones de carretera.

47. ¿A qué nivel de tráfico se hace económicamente viable un terminal de contenedores?

Basándose en las prácticas actuales en materia de precios, se calcula que dada una inversión de 18 millones de dólares en un terminal de contenedores para grandes buques tendría que haber un movimiento de 30.000 a 35.000 cajones por año, para que los ingresos compensaran los gastos.

48. ¿Qué son las estaciones de carga de contenedores?

En estas estaciones de carga, llamadas también "centros de grupaje" o "centros de agrupación" de la carga se reciben los bultos o mercancías, que son agrupados y cargados en contenedores o descargados de ellos y distribuidos. Los depósitos de que sólo son apropiados para los buques portacontenedores más pequeños o para los buques corrientes de carga fraccionada que transportan contenedores. Debe disponerse de espacio suficiente para almacenamiento detrás del muelle; de otro modo, los contenedores han de ser trasladados directamente de los buques a vagones de ferrocarril o a vehículos de carretera. En todo caso, los patios de los muelles corrientes de carga fraccionada no suelen ser apropiados para la buena marcha de las operaciones.

Así, pues, para poder implantar en gran escala el método del transbordo de contenedores por elevación, los muelles tendrán que ser más reforzados y las aguas junto a ellos más profundas que cuando sólo han de prestar servicios a los buques corrientes de carga fraccionada, y sus servicios de manipulación habrán de ser más complejos.

40. ¿Requiere un muelle para contenedores mayor espacio que un muelle para carga fraccionada?

Sí. En vista del mayor movimiento de mercancías que la contenerización lleva consigo así como del ritmo más acelerado de las operaciones de manipulación, del uso de equipo de manipulación de contenedores suplementario o especializado, y de las mayores dimensiones de los buques portacontenedores de tercera generación en comparación con los buques corrientes de carga fraccionada, es evidente que los puestos de atraque habrán de tener mayor amplitud.

41. ¿Será necesario que en un muelle de contenedores la zona de descarga y almacenamiento tenga una pavimentación especial? ¿Cuáles serían los costos? h/

Sí. Los costos dependerán del tipo de pavimentación, que a su vez dependerán del volumen y la densidad del tráfico. De todos modos, como cifras indicativas, puede calcularse 35 dólares de los EE.UU. por metro cuadrado de pavimentación de la zona del muelle destinada a las operaciones de carretillas-pórtico, y 30 dólares por metro cuadrado para la pavimentación de los tinglados, a base de los precios registrados en junio de 1975 al Reino Unido. El costo de construcción de los tinglados será de unos 80 dólares por metro cuadrado, a base de los precios registrados en junio de 1975 en Reino Unido.

h/ Las cotizaciones fueron comunicadas por una empresa de consultores de ingeniería del Reino Unido y deben considerarse únicamente como órdenes de magnitud.

C. LAS OPERACIONES MULTIMODALES Y LOS PUERTOS

35. ¿Qué supone para los puertos el transporte multimodal?

Un movimiento más rápido de las mercancías gracias a la unitarización. Ahora bien, el transporte multimodal exige inversiones suplementarias en las instalaciones que se necesitan para manipular la carga unitarizada y una reorganización de la estructura y las operaciones del puerto, sobre todo en lo que respecta a la mano de obra.

36. ¿Qué se necesita en los puertos para manipular carga unitarizada?

Las necesidades de los puertos en este aspecto, difieren mucho según el tipo de unitarización que se adopte y según las instalaciones de manipulación y control que en ellos existan ya. Entre las diversas formas de unitarización, la más compatible con las instalaciones portuarias tradicionales es la paletización, siempre que se disponga de un número suficiente de carretillas elevadoras, que éstas tengan vía libre para maniobrar y que se cuente en el terminal con una explanada provista de un número suficiente de pistas.

El sistema de gabarras tampoco exige muchos cambios en la disposición del puerto, siempre que el muelle tenga profundidad suficiente para gabarras de escaso calado y que se disponga de una zona para maniobra. Los buques portagabarras requieren asimismo un fondeadero de amplitud suficiente que tenga de uno a cuatro puntos de amarre.

El movimiento de contenedores, si el tráfico es reducido, puede hacerse también en un muelle de tipo corriente siempre que se disponga de ciertos elementos materiales tales como grúas y remolques para manipular la carga fraccionada ordinaria de los contenedores. Ahora bien, contrariamente a lo que ocurre en el caso de los muelles para paletas, el terminal especialmente construido para contenedores es muy distinto de un muelle para carga fraccionada en cuanto a las condiciones materiales que debe reunir y a la organización interna. Es preciso contar con equipo de muelle idóneo para la manipulación, como, por ejemplo, grúas-pórtico y carretillas-pórtico, así como una zona extensa de muelles reforzados para clasificar y estacionar los contenedores. El terminal debe estar dotado además de tinglados, servicios de conservación, talleres de reparación y parques de remolques.

37. ¿Cómo adaptar un puerto a la manipulación del tráfico unitarizado?

La mayoría de los puertos están en condiciones de manipular las unidades de carga de tipo más sencillo, pero la manipulación de unidades más complejas y voluminosas exige muchos cambios.

28. ¿Cuáles son las características materiales de los chasis portacontenedores y de los chasis remolque portacontenedores para transbordo por rodadura?

Chasis portacontenedores

Tamaño	Altura (milímetros)	Peso bruto (milímetros)	Peso muerto (toneladas)	Carga útil (toneladas)	Carga por eje (toneladas)
Contenedor de 20 pies	1 350	24,3	3,75	20 551	16
Contenedor de 40 pies	1 360	31	4,63	26 371	20

Chasis remolque portacontenedores para transbordo por rodadura

Longitud	Ancho	Altura de la plataforma	Capacidad
6,055 a 12,19 m	2,435 m	0,515 a 0,826 m	20/39/48/55 T

29. ¿Cuál es el costo aproximado de esos remolques?g/

Chasis portacontenedores	20 pies	9.500 dólares aproximadamente
Chasis portacontenedores	40 pies	10.000 dólares aproximadamente
Remolque para transbordo por rodadura	20 a 25 pies	3.000 dólares aproximadamente
Remolque para transbordo por rodadura	40 a 60 pies	5.500 dólares aproximadamente

¿Qué es la agrupación de la carga?

Es un servicio que permite reunir en un solo contenedor, para su transporte, envíos pequeños o diferentes que separadamente no alcanzan a llenar un contenedor. Así, pues, las cargas que se agrupan son "cargas parciales de contenedor" (CPC).

31. ¿Qué son las "cargas parciales de contenedor" (CPC)?

Son los envíos de carga expedida a más de un destinatario o por más de un cargador o usuario que se transportan en un mismo contenedor. El contenedor puede llenarse con CPC en una estación de carga de contenedores para que sea entregada como carga completa de contenedor (CCC) a un destinatario. Es posible también que un cargador empaque la mercancía como CCC para ser entregada como CPC, o que la empaque como CPC para que sea entregada como CPC.

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g/ Precios basados en cotizaciones solicitadas a fabricantes de la República Federal de Alemania, febrero de 1975. Las cotizaciones sólo indican un orden de magnitud y están sujetas a fluctuaciones.

almacenamiento. Una vez en ella los contenedores se dejan sobre los chasis y pueden ser retirados directamente por los tractores de carretera para su remolque hasta el punto de destino definitivo; también pueden ser trasladados a una zona de maniobra donde, por medio de una grúa móvil, sea posible despacharlos en vagones de ferrocarril, gabarras o servicio de enlace de cabotaje.

Con este sistema también se pueden descargar los contenedores directamente sobre el muelle, donde una carretilla-pórtico los recoge uno por uno y los transporta a la zona de almacenamiento, desde dondo son trasladados luego, por medio de carretillas-pórtico o de una grúa-pórtico, a camiones o vagones de ferrocarril. Para la manipulación en el muelle cabe emplear carretillas-pórtico, carretillas de elevación lateral, carretillas de horquilla elevadora o carretillas en U (la carretilla en U se emplea para levantar y transportar contenedores: éstos quedan sujetos a los brazos en forma de U de la carretilla por medio de un sistema de enganche especialmente adaptado a las piezas de esquina ordinarias de los contenedores).

25. <u>¿Qué es el sistema de transbordo por rodadura?</u>

En este sistema se emplean buques especialmente diseñados que permiten efectuar las operaciones de carga y descarga conduciendo directamente a bordo o a tierra, a través de portalones laterales, de proa o de popa, y de las rampas del buque, el equipo de tracción o equipo de manipulación de poca altura, como por ejemplo carretillas de horquilla elevadora, Para el transbordo de la carga (contenedores) del buque al muelle, es posible utilizar también todos los sistemas de manipulación empleados en el transbordo por elevación. Los contenedores montados en semirremolques pueden conducirse directamente a bordo del buque o a tierra. Para el transbordo de contenedores con este sistema cabe emplear también carretillas de elevación lateral provistas de bastidores de suspensión u horquillas. El material de manipulación suele ser de silueta baja debido a las limitaciones de altura en los buques.

(El bastidor de suspensión está suspendido de una grúa. El bastidor se apoya en la parte superior de un contenedor y por medio de un sistema de cerrojos giratorios sujeta al contenedor para izarlo.)

26. <u>¿Qué es el sistema de transbordo por flotación?</u>

En este sistema un buque portagabarras transporta gabarras de 100 a 500 TPM. El buque puede izar las gabarras a bordo o descenderlas con una grúa o una plataforma elevadora. Las gabarras descendidas desde el buque pueden ser arrastradas por remolcadores. Los contenedores transportados en gabarras se transbordan de éstas al muelle con grúas; su acarreo en el terminal suele hacerse con el mismo equipo que se utiliza para la manipulación de contenedores en el sistema de carga fraccionada.

18. ¿Cuáles son las características materiales de los contenedores?

Si bien los contenedores deben ser de construcción rígida, algunos son plegables, o pueden ser desmontados y luego ser montados nuevamente, en tanto que otros están montados de modo permanente. Pueden ser de acero, aluminio, madera contrachapada o fibra de vidrio o de una combinación de esos materiales. El contenedor puede tener una puerta en un extremo o en una pared lateral o aberturas en su parte superior para su llenado y vaciado. Los principales tipos de contenedores que se emplean actualmente son los de 20 pies, con un peso bruto máximo de 20 toneladas y los de 40 pies, con un peso bruto máximo de 40 toneladas. Debido a su estanqueidad, los contenedores protegen la carga de la intemperie.

19. ¿Cuáles son los diferentes tipos de contenedores?

Los contenedores pueden clasificarse en seis tipos principales:

Contenedores de carga general	- comprenden los contenedores cerrados con puertas en un extremo y en las paredes laterales; los de techo abierto; los de paredes laterales abiertas; los de paredes laterales y techo abiertos; los de paredes laterales, techo y extremo abiertos; los de media altura y los ventilados (no isotermos);
Isotermos	- contenedores aislantes, refrigerados o con calefacción;
Contenedores cisterna	- para el transporte de líquidos a granel y de gas comprimido;
Contenedores para carga seca a granel	- de descarga por gravedad o descarga a presión;
Contenedores plataforma	- esencialmente contenedores planos sin superestructura que no forman parte de los sistemas plenamente automatizados de transporte en contenedores ya que carecen de parte superior por donde puedan ser izados con su carga;
Contenedores especiales	- contenedores para ganado y contenedores plegables;
Contenedores planos	- los contenedores planos son en realidad grandes paletas, con paredes o sin ellas. Deben manipularse con garfios y están dotados de bordes especiales para tal fin. Los contenedores planos con paredes plegables pueden estibarse cuando son devueltos sin carga.

Buque de carga general polivalente con una capacidad de transporte de contenedores de 300 TEU (14.000 a 15.000 TPM-16 nudos)	14,4 millones de dólares
Buque de línea regular de segunda mano apto para su transformación y cuyo año de construcción se sitúa entre fines del decenio de 1950 y fines del decenio de 1960 (13.000 a 20.000 TPM)	4 a 9 "
Buque LASH	50 millones de dólares, aproximadamente
Gabarras (LASH)	75.000 dólares por unidad
Buque Seabee	53,1 millones de dólares
(Astilleros Vallmet Helsinki) contratado a principios de 1975	
Gabarras Seabee	100.000 dólares, aproximadamente, por unidad

13. ¿Es posible transformar los buques de carga general corrientes para el transporte de carga unitarizada?

Sí. Los buques de carga general corrientes pueden ser adaptados para el transporte de contenedores, paletas y unidades preeslingadas o convertidos en buques Ro-Ro. Para estas transformaciones, los buques más adecuados son quizás los buques de línea de 10.000 a 13.000 TPM construidos a mediados del decenio de 1960.

14. ¿Cuál es el costo de una transformación de este tipo?

El costo de la transformación depende de múltiples factores, entre otros de la clase de buque, su edad y estado, el lugar en que se efectúe la transformación, el momento en que se lleve a cabo y las modificaciones accesorias realizadas.

15. ¿Qué es una paleta?

Una paleta es una tarima o plataforma de alrededor de 32 x 48 ó 40 x 48 pulgadas, generalmente de madera, en la que se puede colocar cierto número de bultos para formar una unidad de carga con objeto de proceder a su transporte, manipulación o apilamiento por medios mecánicos. La paleta puede tener o no una superestructura y, según sus

Buques Seabee b/

Nº de gabarras	Peso muerto	Eslora total	Manga	Calado máximo
38	39 000 T	267 m	32,36 m	11,90 m

Velocidad: 20 nudos

Ro-Ro (pequeño)

Capacidad de transporte	Eslora	Manga	Calado (cargado)	Toneladas de registro neto
5 TEU cubierta de vehículos 24 TEU cubierta superior	110 m	17 m	4 m	1 072

Ro-Ro con rampa en la popa

Capacidad de transporte de contenedores	Peso muerto	Eslora	Manga	Calado
1 200 TEU	20 650 T	199 m	287 m	9,6 m

Velocidad: 22 nudos

Buque celular Ro-Ro
(Clase Atlantic Champagne)

Capacidad de transporte	Eslora	Manga	Calado	Peso muerto
845 TEU y 990 vehículos	212 m	28 m	9,3 m	18 850 T

Velocidad: 24 nudos

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b/ El buque portagabarras tipo Seabee tiene tres cubiertas de carga continuas. Para izar las gabarras se utiliza una plataforma sumergible, con una capacidad de 2.000 toneladas, que se hace descender dentro del agua. Pueden estibarse 12 gabarras en la cubierta inferior, otras 12 en la cubierta principal y 14 en la cubierta superior.

B. OPERACIONES MULTIMODALES Y TRANSPORTE MARITIMO

7. ¿Qué tipos de buques se utilizan en el transporte multimodal?

Como el transporte multimodal es compatible, al menos en principio, con todas las tecnologías de transporte, se pueden utilizar buques de tipo tradicional o buques para carga unitarizada. De estos últimos, los tipos principales son los siguientes:

1. Buques portacontenedores:
   a) exclusivamente celulares
   b) parcialmente celulares
   c) Ro-Ro celulares
   d) portagabarras con bodegas celulares
   e) celulares frigoríficos
2. Buques de transbordo por rodadura (buques Ro-Ro)
3. Buques portagabarras
4. Buques portapaletas
5. Buques de carga fraccionada transformados
6. Buques graneleros
7. Buques de carga general polivalentes

8. ¿Qué son los buques celulares?

Buques especialmente destinados al transporte de contenedores y cuyas bodegas están provistas de células permanentes dotadas de guías verticales por las que pueden deslizarse los contenedores de modo que éstos queden firmemente apilados y se encuentren sujetos en todas las esquinas.

9. ¿Qué es el buque de transbordo por rodadura?

Es un tipo de buque en el que la mercancía se traslada por rodadura y no por elevación. La carga puede estibarse en las cubiertas del buque o permanecer sobre material rodante durante la travesía.

10. ¿Cuáles son las principales dimensiones de algunos buques portacontenedores?

Las principales dimensiones de los buques portacontenedores han variado con el tiempo conforme ha ido evolucionando la tecnología. Hay, pues, varias "generaciones" de buques portacontenedores:

SIGLAS Y ABREVIATURAS

ANSI	American National Standards Institute
CCC	carga completa de contenedor
CPC	carga parcial de contenedor
DUC	dispositivo de unidad de carga
ECC	Estación de carga de contenedores
FAK	flete uniforme para toda clase de mercancías
ISO	Organización Internacional de Normalización
LASH	buque portagabarras del tipo LASH
OTM	operador de transporte multimodal
Ro-Ro	buque de transbordo por rodadura
Seabee	buque portagabarras de tipo Seabee
T	toneladas
TM	transporte multimodal
TPM	toneladas de peso muerto
TEU	unidad equivalente a 20 pies (medida uniforme para expresar la cantidad de contenedores de diferentes tamaños)
UIC	Unión Internacional de Ferrocarriles (código)

4. Gran parte de la información suministrada en el anexo tiene un carácter puramente técnico y en rigor quizás no sea pertinente para los trabajos del Grupo Preparatorio Intergubernamental. Se incluye porque puede ser útil para los servicios técnicos de las entidades y organizaciones que se ocupan del transporte de los países en desarrollo cuando, en la práctica, tomen decisiones sobre unitarización.

5. Los datos de orden financiero proporcionados en el anexo al presente informe se refieren al costo por unidad de los principales tipos de materiales necesarios para la explotación de un servicio multimodal y no al costo global de todo el equipo. Este último variará según el número de unidades que se precisen, el cual, a su vez, dependerá de la escala de operaciones en cada país. Tampoco se facilita en el anexo información acerca del costo total de la nueva infraestructura o de las mejoras de la infraestructura existente que requieren los puertos y los sistemas de transporte interior, costo que también variará según los países, pero se proporciona información acerca de los niveles mínimos que es menester establecer.

6. De todos modos, la información que figura en el anexo pone claramente de manifiesto que la introducción de sistemas de unidad de carga, especialmente la contenedorización en un sistema de puerta a puerta, requiere cuantiosas inversiones de capital[1/]. Unas inversiones de tal magnitud tendrían que ser costeadas en divisas y, sin duda, plantearían graves problemas financieros a la mayoría de los países en desarrollo. Además, tendrían que competir con las inversiones en los sectores agrícola e industrial y en otros sectores prioritarios de la economía de esos países.

7. Las observaciones que anteceden ponen de manifiesto la necesidad de que los países en desarrollo procedan con cautela al tomar una decisión acerca de la introducción de esos sistemas de unidad de carga más complejos que permiten llevar a cabo operaciones multimodales. De estas observaciones se desprende además la necesidad de que los gobiernos y las instituciones financieras de los países desarrollados, así como los organismos financieros internacionales, incluidos el Banco Mundial y los bancos regionales de desarrollo, faciliten a los países en desarrollo ayuda o créditos en condiciones preferenciales en todos aquellos casos en que se considere que en un país es oportuno implantar operaciones multimodales que ofrecerán ventajas económicas generales a todos los países participantes en una corriente de tráfico determinada.

1/ A este respecto, conviene señalar que a esos desembolsos de capital hay que agregar los gastos de explotación y, en especial, los desembolsos por concepto de conservación, repuestos y reparaciones, que, habida cuenta de la fragilidad de la mayor parte del material descrito en el anexo, es probable que asciendan a sumas considerables.

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SISTEMAS MARITIMOS Y PORTUARIOS

CONSIDERACIONES ECONOMICAS DEL TRANSPORTE MARITIMO

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I.- EL ESTUDIO ECONOMICO DE LOS TRANSPORTES.

La economía del transporte constituye una derivación reciente de la teoría económica general. Pertenece a las disciplinas académicas - que en la práctica consideran un enfoque sectorial de la economía y su mayor desarrollo se ha venido desprendiendo de las conclusiones de la Economía del Desarrollo Regional y, particularmente de aquellos relacionados con la economía del bienestar, cuya mayor contribución ha sido la técnica de análisis de costo-beneficio.

Sin embargo en el estudio de la economía del transportes es oportuno aclarar que el enfoque sectorial comúnmente adoptado en la práctica, es el resultado de que en la mayoría de los países, gran parte de los sistemas de transporte, en sus diferentes modos, son controlados y regulados por el sector público.

Los gobiernos como los responsables directos por la provisión mayor de la infraestructura,(puertos, aeropuertos, ferrocarriles y carreteras) han requerido de un instrumental de análisis para establecer normas de acción para promover su expansión y desarrollo en función de las necesidades de transporte de bienes y personas en la economía, reflejo de su grado de desarrollo.

Los problemas que en la actualidad enfrentan los especialistas del estudio de Economía del Transporte son resultado de las condiciones y características del funcionamiento de los sistemas de transporte en la mayoría de los países.

No es difícil, de esta manera percatarse de los graves problemas de congestionamiento o subutilización de los sistemas de transporte urbano, carretero, portuario, aeroportuario, las difíciles condiciones financieras de los ferrocarriles, las fluctuaciones en el mercado de fletes y, la estacionalidad en los flujos de tráfico nacional e internacional.

Finalmente, el dinamismo de los cambios en las estructuras de organización de los transportes, es otro aspecto de la problemática que requiere de mayores esfuerzos a los análisis para adecuar los sistemas al desarrollo de un país determinado.

De esta manera se puede decir que los principales objetivos en el estudio económico de los transportes son:

a) Que la asignación de recursos destinados a la satisfacción de necesidades de transporte se traduzca en la mayor contribución al desarrollo nacional. Es decir, que el costo de oportunidad de dichas asignaciones en sector sea mínimo en relación a las oportunidades en otros sectores.

b) Desde el punto de vista de las facilidades existentes, que se procure su máxima utilización y brinde el mayor beneficio posible.

c) Que la canalización de las inversiones y costos de operación estén orientados hacia el mejoramiento de las estructuras de organización y para el desarrollo tecnológico en el sector.

Sin entrar en la polémica de los académicos en el sentido de considerar a los transportes como causa o efecto del desarrollo, baste por el momento aclarar que en cualquier sistema económico, los sistemas de transporte son el factor condicionante, aunque no suficiente en el desarrollo socioeconómico de un país.

II.- LA MECANICA DEL COMERCIO INTERNACIONAL Y SU RELACION -- CON EL TRANSPORTE MARITIMO.

Generalidades.

De acuerdo con la explicación de la teoría clásica del comercio - internacional, los países comercian entre sí debido fundamental - mente a tres razones:

a) País A comprará al país B los productos que no puede producir por razones climáticas y, venderá a otros países artículos que por la misma razón puede producir y otros no.

b) País A comprará a otro, artículos que aunque pudiendo producirlos, existan otros países que los ofrezcan a un costo menor. En estas condiciones, venderá aquellos artículos que los compradores puedan producir en su territorio pero a costos mayores.

c) Existirán casos en los que el país A compre a otro, artículos - que pueda producir a un costo menor que el vendedor pero, que sin embargo, le convenga más asignar los recursos a la producción de aquellos en los cuales tenga una ventaja todavía mayor.

Sin embargo, hay que tomar en cuenta que en la realidad la especialización no es absoluta. En muchas ocasiones en la expan - sión de las industrias se observa el fenómeno de costos crecientes, en donde, a pesar de que el país tenga ventajas comparativas en la producción de un artículo, la demanda de insumos para producirlos (mano de obra) provocará una alza en el costo de ésta ante limitaciones en la oferta regional del insumo bajo cuestión.

Otro aspecto que impide la absoluta especialización en la producción de artículos con evidentes ventajas comparativas, es el marco legal que regula el crecimiento, fomento y expansión de las industrias ya sea en términos de la política interna de un país o en función del panorama internacional.

II.- La Reglamentación Internacional del Comercio

Como resultado de los intentos para reglamentar por parte de los gobiernos el flujo de las importaciones, ha surgido un complicado esquema reglamentario para controlar el flujo internacional de los intercambios comerciales a través de la imposición de tarifas o cuotas.

Entre las principales consideraciones que se han utilizado para argumentar en favor de las tarifas o cuotas están:

a) Protección de industrias nacientes.- Generalmente dichos derechos de importación recaen sólo en los productos que son producidos actualmente o para los cuales existen planes de producir.

La justificación de esta medida tiene como objetivo principal - promover el desarrollo y competitividad de los productos nacionales relativa a la de los extranjeros, en donde su aplicación se extenderá por un tiempo predeterminado. Si la empresa o industria productora nacional no alcanza el grado de eficiencia y competitividad se correrá el riesgo de obligar a el consumo nacional a comprar productos más caros cuando existen mejores condiciones y oportunidades en el exterior. Asimismo los costos de ---- transporte serán otra razón que actúa sobre las ventajas y competitividad de la producción de un país en relación a otros. Si - por ejemplo el costo por tonelada del transporte de algodón de - Australia a Inglaterra (incluyendo seguros y todos los costos del manejo) es igual a 30 dólares, seguramente Inglaterra sólo estará interesada en comprar algodón australiano si la producción del mismo en Inglaterra, necesaria para satisfacer la demanda interna, resulta más barata que esos 30 dólares. Con este ejemplo podemos observar que los costos del transporte pueden actuar como un obstáculo a la especialización si es que sobrepasan un límite.

Aunque la teoría del comercio internacional, explicada en términos de las ventajas comparativas, es válida en un nivel amplio de generalización como el expuesto con anterioridad, es importante recordar que los razonamientos y conclusiones de dicha teoría son -

aplicables en circunstancias en donde las funciones de costo son constantes o crecientes en el largo plazo. En la mayoría de las industrias los costos son crecientes debido fundamentalmente a la escasez de algún(os) de los factor(es) de la producción.

b) Recolección de más ingresos por la vía fiscal.- Particularmente aplicable en el ámbito de los países subdesarrollados, ya que éstos se caracterizan por tener una población con bajos ingresos y por lo tanto la fuente de recaudación fiscal del gobierno difícilmente provendrá de esta fuente, que es el caso de los países desarrollados en donde el impuesto sobre la renta (progresiva) es la más importante fuente de ingresos del gobierno.

c) Como una medida para corregir desequilibrios en la balanza de pagos.- En este caso vale la pena destacar que dichas medidas correctivas han brindado los beneficios esperados sólo que en corto plazo, ya que al desviarse la demanda del consumo de las importaciones hacia los productos nacionales a largo plazo ocasione que el ingreso nacional se incremente y provoque al mismo tiempo que la tendencia hacia la importación se manifieste aun con mayor fuerza, invalidando el propósito inicial de la tarifa o cuota aplicada.

A pesar de los razonamientos antes expuestos, la polémica sobre la validez o inoperancia de las barreras a las importaciones entre países tiene una connotación especial cuando nos referimos a las condiciones y perspectivas de los países en desarrollo en el plano internacional. Esto significa que a pesar de que la corriente de opiniones se manifiesta en contra de este tipo de medidas -- restrictivas, ya que crea "ventajas artificiales" a la producción de un país en relación a la de productores en el extranjero, habrá que considerar que la liberación del comercio internacional tendería a favorecer la concentración industrial y el desarrollo tecnológico que generalmente se localiza en los países desarrollados. De esta forma en el largo plazo, comercio y desarrollo habrá que crecer en tanto ingresos y poder de compra entre -- las naciones presente un panorama más equilibrado y esto sólo podría llevarse a cabo a través de cierto grado de proteccionismo a - las industrias en formación de los países en vías de desarrollo.

La Tasa de Intercambio y su Importancia con el Comercio Marítimo .-

Al valor de una moneda en términos de otra se le denomina la tasa de intercambio. Dicha relación de intercambio entre las monedas, estará sujeta a fluctuaciones dependiendo de la oferta o demanda en la circulación de las monedas como consecuencia del volumen de operaciones de intercambio de productos en el mercado internacional, en el cual se utilizaron dichas monedas.

Bajo el sistema del patrón oro, esta situación no surgía debido a que tanto los sistemas monetarios interno e internacional estaban integrados. Es decir, la cantidad de monedas en circulación en una economía estaba sujeta y en relación a la cantidad de reservas de oro de su país. Sin embargo, era evidente que en el proceso de ajuste y equilibrio en las condiciones de intercambio de los países, éstos tenían que sufrir períodos de inestabilidad y desempleo.

En la actualidad los países, en su mayoría, reconocen que es indeseable permitir la libre fluctuación de los tipos de cambio como reflejo de las condiciones del mercado. Para ello han adoptado convenios para "estabilizar" dichas fluctuaciones a través de el Fondo Monetario Internacional que actúa como el organismo regulador del sistema monetario mundial.

Siendo la explotación naviera un giro empresarial eminentemente internacional, es evidente que cualquier variación en los tipos de cambio de las monedas, representa un asunto de vital interés, ya que un importante grupo de costos (combustibles, mantenimiento y reparaciones, etc.) tienen el "carácter internacional" a excepción de aquellos casos en donde existan marcadas restricciones gubernamentales.

Cuando por ejemplo un país determina devaluar su moneda, esto significa que en términos del resto de las monedas, los servicios ofrecidos por los navieros de ese país han mejorado su posición competitiva. Sin embargo esto no significa que inmediatamente va-yan a incrementarse sus ingresos. Por el contrario seguramente que requerirá de ajustar sus fletes ya que todos los servicios -- comprados a lo largo de su ruta internacional serán más caros (en relación al % de devaluación). Por otro lado, la devaluación asistirá a el naviero del país (que ha devaluado su moneda), siempre y cuando al tiempo de la devaluación pueda ofrecer el tonelaje extra que le pueda ser demandado para explotar en forma inmediata sus ventajas competitivas.

III.- LA DEMANDA DEL TRANSPORTE MARITIMO.

La demanda del transporte de carga o pasaje constituye por definición una demanda derivada. Esto es, los usuarios del transporte - marítimo, requieren en primer lugar de los productos y, posteriormente seleccionan al transporte más adecuado como el medio para obtener bienes. Existen sin embargo excepciones a este razonamiento; y, se refiere en particular al transporte marítimo de pasajeros, en donde los usuarios demandan al transporte como un - bien final, (viajes de recreo en yates o cruceros).

Ahondando un poco más en la definición del transporte como una - demanda derivada diremos que la necesidad del transporte surge - cuando se requiere de la asociación, de los parámetros, producción y consumo de un determinado producto. Dicha asociación se llevará a cabo en un "mercado" establecido y después de haber salvado la - separación geográfica de los puntos de origen (producción) y destino (consumo).

Resulta evidente que para cualquier situación que tenga por objeto - el análisis de la estructura y evolución de la demanda de un servicio de transporte, será indispensable en primer lugar, el conocimiento de las condiciones de producción y del consumo de los --- artículos que habrán de transportarse como resultado de la realización de las operaciones de intercambio comercial.

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En el caso del transporte marítimo, el análisis de la demanda ha reflejado que existe un considerable grado de correlación con las fluctuaciones del comercio entre los diferentes países del mundo. A nivel de las regiones de un país el conocimiento de las condi-- ciones del comercio marítimo interegional será pues el factor -- determinante para calcular los niveles de demanda del transporte de cabotaje.

Por lo que toca al análisis de este "deseo de movimiento" de -- bienes que da como resultado la necesidad (demanda) de transporte, es claro que a fin de precisar en forma cuantitativa o cualitativa los volúmenes de demanda será indispensable referirse a el - análisis de las causas que la originaron.

Las variaciones en la cantidad y dirección de los flujos de trans-- porte se dan dentro de una dimensión temporal, por lo que dependerán de cambios tanto a corto como a largo plazo. A corto plazo los cambios en las políticas de países pueden originar variaciones sustanciales en el volumen a consecuencia de variaciones climatológicas y dirección del transporte (sequías, guerras, independen-- cia de países, revoluciones, etc.). A largo plazo, cambios en la - estructura y localización de la población, variaciones en el valor de la producción nacional, cambios en los estandares de vida, etc., sin embargo, hay que dejar claramente establecido que la demanda de transporte marítimo no varía únicamente en función del volumen de las cargas a transportarse sino que estará también en función - de las distancias de los recorridos. Es, por lo tanto, explicable que en diseño de las rutas el factor distancia representa uno de - los más importantes en la decisión del naviero con respecto a la selección del tipo de embarcación a utilizar. A manera de generalización podemos decir que así como un aumento de las toneladas milla, produce un incremento en la demanda de transporte, - una disminución en la distancia producirá una disminución en la - demanda.*

De acuerdo con los informes publicados por la Organización de -- las Naciones Unidas en 1975 el valor total del comercio internacional ascendió a 982 500 millones de dólares. De esta cifra el - 60% correspondió al valor del comercio internacional por la vía - marítima.

Respecto al volumen del movimiento de la carga, el mismo informe señala que la carga mundial transportada ascendió a 35.73 millones de toneladas métricas, de los cuales 18.86 (50%) fueron transportadas por la vía marítima.

* La disminución en las exportaciones de carbón de hulla de Inglaterra a Canadá y Sudamérica, fué el factor determinante en la depresión de la flota mercante británica, asimismo, el cierre del Canal de Suez, contribuyó definitivamente en el incremento - de la demanda de barcos (bodegas) al aumentarse las distancias en aproximadamente 4 500 millas náuticas.

Claramente el transporte marítimo representa uno de los más - importantes instrumentos de interrelación en la compleja economía mundial.

La magnitud de la demanda ha sufrido cambios de consideración en los últimos 5 años.

Por ejemplo en 1970, el nivel de la demanda de transporte marítimo de cargas secas y líquidas, eran comparativamente iguales.

Con motivo del constante incremento en la demanda de hidrocarguros a nivel mundial y en forma importante debido a los problemas de orden político que han modificado la política de producción y abastecimiento del petróleo, el volumen de la carga líquida transportada por la vía marítima superó en un 35% a la carga seca para 1975.

De esta forma, la demanda de transporte de petróleo pasó de -- 540 a 1945 millones de toneladas métricas en el período 1970-- 1975, por lo que su tasa promedio anual de crecimiento fué de aproximadamente el 8%, razón por la cual la participación del - petróleo en el total del transporte marítimo mundial, se incrementó del 8% al 15% en el mismo período.

Factores de orden internacional como los desequilibrios en el - sistema monetario internacional motivados por una persistente inflación, han ocasionado por su parte, que el volumen del intercambio comercial entre países, haya perdido dinamismo al -

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mermarse el nivel de competividad de los productores y de la - capacidad de compra de los países importadores.

Asimismo, cambios tecnológicos en el terreno del transporte - marítimo, combinando con una mayor diversificación en las -- mercancías, así como los acontecidos en las condiciones de operación de los puertos y su estructura de costos, han tenido una - repercusión notable en la política de operación naviera, influyendo en forma negativa en el desarrollo de la flota mercante mundial.

Entre 1970 y 1975 se dieron importantes cambios en los porcentajes relativos en la participación de los grupos de países en el -- comercio mundial por vía marítima. En lo que se refiere a cargas embarcadas, los países desarrollados de economía de mercado aumentaron su participación del 28.4% en 1970 a 31.2% en -- 1975, mientras que la participación del grupo de los países en --- vías de desarrollo disminuyó del 64.1% en 1970 al 60.8% en 1975.

Dentro del grupo de países en vías de desarrollo, se dieron cambios más notables: la participación de Africa descendió del 16.9% en 1970 al 11.3% en 1975, mientras que en América Latina y el - Caribe aumentó su participación en el comercio mundial por vía marítima del 16.8% al 17.5% en 1975, un aumento más notable se dió en Asis, que pasó del 30.5% en 1970 a 32.8% en 1975.

Sin embargo, a largo plazo, tomando un período de diez años -- (1965-1975) podemos observar que hay una marcada disminución en la participación de América Latina ya que del 21.6% en 1965, se pasó al 17.7% en 1968 y al 16.8% en 1970 y al 17.5% en 1975, ésto nos indica que algunas de las exportaciones que tradicionalmente - efectuaban los países latinoamericanos a Europa, Japón y Estados Unidos, como el algodón, el henequén, el café, el cacao y otros -- productos tropicales de importancia, actualmente están siendo embarcados a los mercados de países desarrollados desde puertos localizados en Asia y en menor proporción en Africa.

De igual forma, es importante señalar la fuerte participación de - los países en vías de desarrollo en el embarque del petróleo crudo, que en el período de 1970 a 1975 fué mayor del 90%, situación que refleja el considerable incremento en el consumo mundial de energéticos.

Por otra parte tenemos que la participación de los países en vías - de desarrollo en el embarque de los derivados del petróleo ha disminuído del 65.4% en 1970 al 60.2% en 1975, descenso que se debió entre otras causas a la tendencia cada vez más acentuada de instalar las refinerías cerca de los mercados de consumo y no de los - centros de producción.

Por lo que se refiere a cargas desembarcadas, los países desarrollados de economía de mercado, poseen la más alta participación - a nivel internacional. De acuerdo al informe de la O.C.D.E., --- "Les Transporte Maritimes 1970", los países que agrupan esta -- organiza (Alemania, Canadá, E.U., Finlandia, Francia, Italia, -

Japón, Noruega, Países Bajos y Suecia), recibieron entre 1970 más del 70% de la carga sujeta al transporte marítimo internacional, sin incluír a la Gran Bretaña, que recibió en este período aproximadamente el 8% del conjunto de cargas internacionalmente desembarcadas.

Así, tenemos que considerar solamente once de los veinticuatro -- países miembros de la O.C.D.E., tenemos que el 78% de las cargas desembarcadas están destinadas a los países desarrollados de economía de mercado.

Este elevado porcentaje de concentración de actividad económica - constituye un elemento muy importante que condiciona a la demanda de especio de las bodegas de los buques mercantes y explica el predominio que tienen unos cuantos países en la participación de la flota mercante mundial, siendo los países compradores de las - materias primas los que al mismo tiempo controlan dichos mercados, por el volumen de las transacciones, están en mejores condiciones del transporte a través de sus buques.

El Concepto de la Elasticidad en la Demanda del Transporte de Carga.

Para evaluar y determinar el impacto de los cambios en el dinamismo de la economía sobre los flujos de transportes de mercancías, es necesario realizar cálculos que tienen por objeto determinar lo que ha llamado el grado de elasticidad.

Si se dice que la demanda del transporte es elástica con respecto a una variable determinada, entonces esta demanda será altamente sensitiva a cambios con respecto a dicha variable. Por ejemplo: si un incremento en la producción industrial de la región centro del país del 3% dá como resultado un incremento en la cantidad de energéticos y productos de acero básicos, por decir, del 6%, la elasticidad de la demandada del transporte de productos será del 6% aproximadamente.

Por otro lado, si la demanda de productos a transportarse es considerada como inelástica a cambios con respecto a una variable determinada, el volumen a transportarse permanecerá inalterado o tendrá cambios insignificantes. En este caso, si un 20% de un incremento en el consumo per capita en comida en Guadalajara le acompaña uno del 0.2% en la demanda de transporte de trigo, a esa ciudad, la demanda se considerará por lo tanto inelástica.

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En general se dice que cuando las elasticidades son altas con relación al ingreso, la producción o el consumo, los cambios en esas variables tendrán un efecto considerable y medible en la demanda por transporte.

Cuando por el contrario se ha detectado que la elasticidad es baja con respecto a las mismas variables, la respuesta será de menor consideración dentro de los planes en relación al nivel de capacidad que deba tener el sistema de transportes estudiado.

Sin embargo, otras variables, además de los cambios en las variables, producción, ingreso y consumo son de considerable importancia en el análisis de la configuración de la demanda del transporte, y se refieren a aquellos cambios que se manifiestan tanto en el costo del servicio de transporte estudiado como de los costos los servicios alternativos.

Es evidente con este último razonamiento, que es importante el estudio de la elasticidad en términos del probable impacto en los ingresos y costos de modos de transporte alternativos, ya que cualquier cambio en el nivel de precios de los servicios de un modo en particular afectará el nivel de competencia de los modos que representan una alternativa viable. A este nivel de interrelación se denomina como un fenómeno de elasticidad cruzada.

Ejemplificando esta argumentación, si entre el nivel de cargos a los usuarios del autotransporte y la demanda del transporte de pasajeros por ferrocarril, existe un considerable grado de interrelación, entonces un aumento por ejemplo del 15% de los fletes del primero dará como resultado un aumento en la demanda en el segundo del 25% .

<u>Demanda de Transporte de Carga como una Demanda Derivada.</u>

a) <u>Concepto</u>.- En cualquier situación, el concepto de elasticidad surge cuando tenemos una variable en función de otra y por lo tanto, cambios en una variable (y) responden a cambios acontecidos en otra (X) :

Y = f (x,r,s,t.....)

Si Ey = elasticidad de Y

Entonces:

De esta manera el análisis de la elasticidad se puede referir a variables tales como el precio de otros substitutos o complementarios de y. Así también en el nivel macro económico, el análisis de la elasticidad puede referirse a variables tales como la oferta monetaria, al producto interno bruto (PIB), el volumen de la producción, las demandas o ingresos regionales, etc.

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b) Demanda Derivada y su Relación con Otros Conceptos de Elasticidad.

Rara vez, el transporte en si, es demandado como un bien o servicio final. El transporte surge por lo tanto, porque se requiere de la asociación de los parámetros producción y el consumo de un determinado producto en un mercado y estos parámetros se encuentran separados geográficamente.

Si bien es cierto que la demanda de un producto (s) depende en forma directa del ingreso de los consumidores finales, también es cierto que la demanda de transporte de los productos responde en forma indirecta al nivel de ingreso de - los consumidores finales. Es por eso que la elasticidad ingreso de la demanda de transporte es también un concepto indirecto.

En el caso de "elasticidad-precio" de la demanda de transportes se mantiene la misma argumentación. Como hemos mencionado, la elasticidad de la demanda por un producto - está en función de los ingresos de los consumidores finales.

Sin embargo, el precio pagado por el consumidor del producto transportado en el punto de consumo será función también del nivel del precio del transporte que lo trasladó. En este caso el precio cargado a los productos transportados afecta al nivel de la demanda de los productos transportables en el punto de destino y por lo tanto, afecta el nivel de demanda de ese transporte. Por consiguiente, el camino a seguir para medir esta relación indirecta (demanda derivada), se puede lograr únicamente si investigamos el efecto o los efectos en los cambios en los niveles de precios del transporte en la cantidad consumida de los productos transportados.

Pero no solamente el precio del transporte influye en el nivel de consumo de los productos. También afecta en forma importante a la escala de operaciones de producción del producto en cuestión. Así, podremos medir esta relación también indirecta entre precio de transporte, producción del producto y la demanda del transporte por medio de análisis en el nivel de respuesta.

Finalmente, es importante señalar que las tareas que se emprendan para detectar las relaciones y grado de respuesta entre las variables precio y demanda de transporte se refieren a un proceso de ajuste en el largo plazo. A corto plazo la configuración, características y evoluación tanto de producción y consumo difícilmente se alteran o su cambio es poco significativo como para derivar conclusiones válidas para un programa sectorial o inclusive subsectorial.

IV.- LA OFERTA DEL TRANSPORTE MARITIMO.

Lo que trataremos en este capítulo merece una pequeña introducción con el fin de establecer el alcance de los planteamientos teóricos y principalmente para comprender la naturaleza de esta industria. Comercialmente el negocio naviero es una actividad que tiene una estrecha relación con el comportamiento y condiciones de la situación económica del mundo civilizado. Históricamente el desarrollo técnico y práctico de la administración de las empresas navieras son el resultado de la maduración entre una y otra generación. Pocos son los libros o artículos escritos con un sentido formal con el fin de establecer generalizaciónesEn la actualidad mas de 20,000 barcos navegan en una increible estructura de rutas oceánicas. Sin embargo en esta tarea, infinidad de aspectos se presentan a propietarios, administradores y agentes. La necesidad de captar cargas, de proveer de muelles para la carga y descarga, de racionalizar rutas y abastecimientos, de agua, combustibles, avituallamiento, de cumplir con los programas de mantenimiento y reparación a lo largo de las rutas son entre otros algunos de los aspectos que ocupan día a día a las organizaciones navieras, cualquiera que sea su tipo.

Las Rutas.

La contínua realización de viajes entre centros geográficos de importancia comercial dá como resultado el establecimiento de una ruta. La naturaleza del tráfico transportes, determinará básicamente el tipo de embarcación. Otras razones además de la de convergencia, explican el establecimiento de las rutas: la necesidad de abastecerse de combustible en estaciones comunmente utilizadas (Trinidad, Gibraltar, etc.) -

o en puntos de transbordo de cargas (Baltimore, New Orleans, Rotterdam) o en la entrada de canales o estrechos (Panama y Suez).

Sin embargo de los aspectos mencionados el que influye en forma importante en el establecimiento de las rutas, es sin duda el factor de carga de los viajes que no es otra cosa que el balance de la carga o la disponibilidad de esta en las rutas. Este balance, deberá garantizar la estabilidad deseada en el empleo del barco.

Actualmente podemos identificar grandes rutas comerciales :

1.- Ruta del Atlántico Norte

2.- Ruta Mediterráneo - Asia - Australia (Canal de Suez)

3.- Ruta Sudamericana (incluye comercio de las costas de EUA., Canada hacia ambas costas de Sudamérica)

4.- Ruta del Caribe.

5.- Ruta del Pacífico Sur .

6.- Ruta del Pacífico Norte

7.- Ruta Europa - Costa Este de Sudamérica.

8.- Ruta del Sur de Africa.

En todas ellas la posibilidad y "disponibilidad" de los canales de Suez y Panamá son de vital importancia para llevarse a cabo.

Como una industria de servicio el transporte marítimo ~~es uno de los~~ más importantes medios para realizar el intercambio comercial. Embarcadores manifiestan sus necesidades con relación a un determinado tipo de barco para operar en ciertas rutas, en donde incluyen frecuencia y regularidad. El armador por su parte actuará dentro de los límites establecidos para el servicio, a fin de satisfacer esas demandas, procurando que la "calidad" del servicio (en su concepción más -

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general) produzcan un balance optimo de beneficios entre los participantes del comercio marítimo. El funcionamiento de este mecanismo de intercambio de información se lleva a cabo a través de los mercados de cada "categoría de servicio"

Cada usuario del transporte, sin embargo encontrará en el mercado - una variedad de alternativas de transporte substitutas en cierto grado unas de otras.

En algunos casos será importante lograr el máximo de ahorros en -- tiempo, mientras que en otros serán importantes las características de diseño y equipos del barco que hagan posible el manejo de los embarques con mayor rapidez y menores riesgos. Asimismo, la regularidad y frecuencia en el servicio mejorará la calidad en el servicio y será elemento competitivo.

Sin embargo los armadores para ofrecer un servicio tomarán en consideración fundamentalmente como hemos mencionado el factor de carga, y será en el mercado de fletes donde analicen las condiciones tanto de la oferta de bodega como de los tráficos.

Un aumento de fletes por ejemplo, será indicativo que en el mercado - la demanda de transporte excede a la oferta de barcos disponible en -- ese momento. Asimismo, el nivel de fletes alcanzado será al mismo - tiempo la manifestación del valor que en ese momento tiene el factor - escaso : espacio de bodegas.

El proceso de ajuste en las condiciones de la oferta y demanda, dependerá de consideraciones de tipo técnico y económico, lo cual implica - que la situación de equilibrio no es instantánea y que por lo tanto toma algún tiempo.

Si por ejemplo la demanda se incrementa repentinamente a muy corto plazo el ofrecimiento de más bodegas se dará en forma gradual.

En primer lugar, los incrementos en la oferta provendrán de la entrada en servicio de los barcos que se encuentren la vecindad inmediata a la zona económica en donde tuvo lugar ese incremento. Posteriormente nuevos barcos serán atraidos siempre y cuando el nivel de fletes sea lo suficientemente atractivo para garantizar su desplazamiento y empleo. Si la demanda continúa en exceso de la nueva oferta, los armadores -- entonces estudiarán la conveniencia de recomisionar los barcos fuera de servicio. En este caso los ingresos esperados tendrán que compensar los costos que implica la recomisión de los barcos. Por último, los armadores estudiarán la alternativa de adquirir barcos para este servicio.

Es evidente por lo tanto que a corto plazo la oferta de tonelajes será - más inelástica ante incrementos en el precio de los servicios a ofrecer que a largo plazo. En el caso de la oferta, el análisis de la elasticidad la determinan una serie de factores, además del referente al precio, los de carácter técnicos.

A nivel de generalización diremos por lo tanto que en virtud de los largos períodos de gestación que implica la construcción de un barco, la - elasticidad de la oferta de tonelaje será menor entre más corto sea el período que transcurra entre un aumento en los fletes y la puesta en operación de barcos adicionales.

Por otra parte, debido a las particulares formas de contratación de los servicios de los barcos, los cuales varían en función de la categoría de servicio (línea o trampa) y del tipo de tráfico, la cantidad del tonelaje -

que esté en condiciones de entrar en una región o ruta ante un intempestivo incremento en la demanda será de poca consideración en términos del tonelaje total mundial.

Algunos barcos estarán comisionados para rutas específicas (graneles o petróleo) bajo contratos a largo plazo, otros estarán sujetos a líneas e itinerarios preestablecidos, aún cuando el tonelaje que estén moviendo sea reducido; habrá también casos en los cuales por las características especiales de diseño y construcción no puedan participar en el transporte de determinados productos y finalmente existirán barcos que por sus características tecnicas estén limitados únicamente a tráficos costeros.

El fenómeno observado en el mecanismo de ajuste entre oferta y demanda de tonelaje, situación que como ya dijimos tiene su efecto inmediato en el nivel de fletes, merece una explicación adicional en relación al régimen de explotación y rentabilidad de los armadores.

El nivel de fletes, tendrá un comportamiento determinado en función del grado de escasez de tonelajes. Es decir, mientras exista tonelaje disponible para el transporte de un determinado tráfico, el nivel de los fletes mantendrá su tendencia en forma regular.

Una vez agotadas las alternativas de uso de barcos para la creciente demanda (nuestro caso en consideración) es probable que se produzcan alzas de consideración en los fletes, lo cual en términos generales será indicativo de los ingresos que como mínimo requerirán los armadores para compensar el costo que implica recomisionar sus barcos que hayan tenido fuera de servicio. En este estado de cosas, los armadores estarán ganando utilidades más por arriba de lo que -

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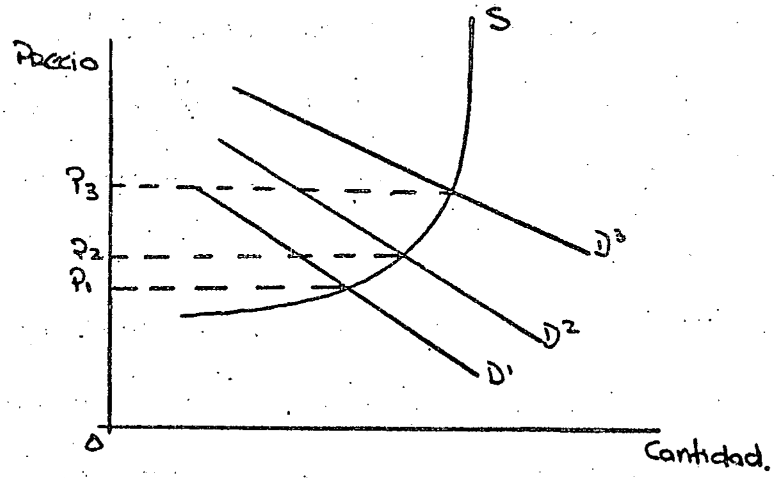
pueda considerarse normal (quasi-rentas).

El período durante el cual, los armadores estarán disfrutando de este nivel de fletes estará obviamente delimitado por el período de tiempo mínimo que tome la construcción de nuevo tonelaje.

La oferta bajo estas circunstancias se considera que es altamante inelástica. Gráficamente el proceso se describe de la siguiente manera :



En el círculo internacional del negocio naviero este fenómeno no se considera fuera de lo normal ya que existen períodos durante los cuales estarán ganando utilidades abajo de las mínimas requeridas para asegurar la renovación y expansión de las flotas.

Es por ello que en forma muy particular en este giro comercial serán las utilidades promedio a largo plazo las que determinan la permanencia de los armadores en el mercado naviero.

Factores Limitantes .

Con el fin de ampliar nuestro conocimiento en relación a las condiciones de explotación naviera, será necesario introducirnos en aspectos de orden técnico que son de gran importancia en la explotación comercial de los buques.

En primer lugar dado que los buques representan un modo de transporte que por las dimensiones y rango de operaciones ofrecen ventajas aparentes en cuanto al costo/ton/milla, en relación al resto de los modos, por otro lado, la productividad en el uso de las embarcaciones se ven limitadas en primer lugar por la relación de la capacidad en términos de peso y volumen de los artículos a transportar (factor de estiba).

En cuanto al factor de peso, las reglamentaciones oficiales a nivel internacional conocidas con el nombre de marcas de flotación, imponen un límite en la cantidad de carga que pueden transportar los barcos en determinadas épocas del año y en ciertas regiones oceánicas. Con frecuencia sucede que armadores tienen que rechazar carga aún cuando todavía existe espacio en las bodegas porque los límites o marcas se habrán alcanzado. Por el contrario, el volumen actúa como factor limitante cuando los embarques por su volumen utilizan la capacidad de carga de los embarques en términos de peso. Como resultado de esta situación, se ha desarrollado en el aspecto tarifario de los servicios del transporte marítimo una práctica de aplicación generalizada, que compensa al naviero en sus ingresos

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cuando el peso o volumen de las cargas actúan como una limitante en la explotación comercial de sus unidades. Si el embarque a transportar tiene un alto factor de estiba (una tonelada de peso ocupa más de 40 pies cúbicos de bodegas) la tarifa se aplicará con relación al volumen que ocupa el embarque o viceversa. De esta manera los embarques pagarán el transporte conforme a la mayor demanda y esta puede presentarse ya sea en volumen o en peso.

Estos factores serán de extrema importancia por lo que se refiere a la evaluación del sistema de transporte marítimo a nivel global. Las comparaciones de las estadísticas del tonelaje mundial y el volumen internacional del comercio marítimo reportarían que por ejemplo, solamente un 30% del tonelaje de los buques se utilizó en el transporte de la totalidad del comercio marítimo.

Por otro lado, debido a los imbalances en los volumenes de tráfico marítimo, producto de las especializaciones de los países ya sea como productores o consumidores de artículos de diferente densidad y volumen y estacionalidad, los armadores de buques tienen ante si el problema de cuantificar la cantidad de tonelaje a ofrecer.

En el caso particular, un armador que tiene que transportar productos que requieran de buques especializados (petroleros, graneleros, refrigerados) se enfrentará al problema de maximizar la utilización de su oferta de tonelaje a lo largo de una ruta en la que un tramo del viaje posiblemente no tenga embarques que transportar. En estas condiciones tendrá que programar la utilización de sus barcos con respecto al tramo de la ruta que le ofrezca la mayor demanda y considerar a los tra-

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mos de baja densidad de tráfico como un subproducto innecesario que logicamente no tendrá ningún valor de mercado. Obviamente la magnitud del problema dependerá del tipo de servicio bajo consideración. De esta forma tendrán mayores problemas aquellos armadores que estén operando bajo el régimen de línea que aquellos que actuen en el servicio trampa. Si las cargas son de caracter estacional, el problema se agudiza y entonces la cantidad de tonelaje a emplear tendrá que basarse en el cálculo del pico de la demanda estacional de tráfico -- pero en el trámo de la ruta de mayor demanda de barcos.

Del conocimiento y mayor profundidad en los análisis de estos fenómenos propios de este modo de transporte se habrán de derivar conclusiones más apropiadas con relación a los programas de desarrollo mercante de los paises, en particular aquellos elaborados a fin de encontrar el esquema legislativo, tarifario y de incentivos más apropiados para lograr que la prestación de los servicios de transporte marítimo sea lo más adecuada y eficiente a las necesidades del desarrollo de las naciones que hacen un uso importante de este modo de transporte.

Categorías de la Oferta .

Para un adecuado análisis de la oferta de transporte marítimo de -- carga, es necesario en primer lugar, precisar las diferentes categorías de servicio que ofrecen los armadores.

Comunmente las flotas mercantes se clasifican en categorías en donde los barcos representan las unidades de explotación del transporte. -- Por tanto, habrá barcos trampas, tanqueros, graneleros, remolcadores, pesqueros, costeros, de pasaje, etc., Desde el punto de vista - analítico es imprescindible establecer tales categorías aún cuando -- existan el fenómeno de substitución entre los servicios de cada categoría de servicio las cuales por su parte se enfrentan a mercados de diferente naturaleza.

El alcance de operación de cada categoría de servicio se puede resumir de la siguiente manera:

	Características del servicio demandado.	Categoría de servicio comunmente - utilizada.	Tipo de mercado
1.-	Demanda estacional para mercancías en grandes volúmenes	Barco trampa	Mercado trampa
2.-	Demanda para tránsitos regulares.	Barco de línea	Mercado línea
3.-	Demanda para tráficos regulares de gran volúmen	Barcos graneleros	Mercado de barcos graneleros.
4.-	Demanda para el transporte de petróleo derivados en ruta regular y tráfico controlado.	Buque tanque	Mercado de tanquero

El Fenómeno de Substitución .

En la explotación naviera se observa un considerable grado de interelación entre las funciones de los diferentes tipos de barcos. Comunmente los propietarios de barcos de línea rentan barcos trampa en epocas en las que les resulta más económico incrementar su capacidad por medio de la renta que a través de la compra.

Asimismo, es común observar que una misma compañía naviera se dedique a la explotación de diferentes tipos de barcos, o que pertenezca a varias conferencias, rente barcos trampa, opere tanqueros, graneleros o de turismo, etc...

Con relación a la industria de los tanqueros, este sector satisface en forma importante la demanda del transporte de petróleo crudo, además de otras cargas líquidas tales como, molazas, agua, productos químicos y creosota.

Técnicamente, diferencias en la construcción de buques tanque y de barcos trampa graneleros son el resultado directo de las funciones productivas que desempeñan. Obviamente los sistemas de carga y descarga y el tamaño del buque saltan a la vista.

Sin embargo, aún cuando las economias por tonelada-milla del buque tanque son considerablemente mayores que las ofrecidas por el buque trampa en razón de tamaño, éste último ha competido con éxito en el transporte de graneles , antiguo tráfico cautivo, ocasionando que se diera un cambio drástico en la especialización de los barcos .

Al crearse un "nuevo segmento de mercado" para los buques tanque en el tráfico de granos, armadores y constructores navales desarrollaron

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la idea del moderno barco granelero, el cual garantiza el empleo total del barco, con mayor flexibilidad en cuanto a los puertos de carga o descarga.

Aún cuando los servicios que ofrezca un barco trampa en el tráfico de graneles pueden substituirse por los que ofrezcan barcos de línea, -- graneleros especializados, combinados o tanqueros, dicha substitución se presenta sólo en forma marginal existiendo otras razones de costo, precio y demanda que influyen en el proceso de substitución. - Por lo que puede decirse que la substitución no se presenta en forma absoluta.

Por ejemplo, cuando la demanda de trampas en el tráfico de granos, sea de consideración y al mismo tiempo de poca importancia para el mercado del buque tanque, será común observar la entrada gradual - de éstos últimos en el tráfico de granos, sobre todo tanqueros viejos. Con la entrada de tanqueros al tráfico de graneles, la oferta de transporte para el tráfico de graneles se incrementará produciendo una -- baja en el mercado de fletes.

Si la entrada de buques tanque continúa incrementándose, ésta situación ocasionará por su parte que disminuya la oferta de barcos para el transporte de fluídos y por consiguiente los fletes en este mercado se eleven. Aunque simplificado el razonamiento, el mecanismo descrito nos permite conocer otros aspectos de la operación naviera, -- particularmente aquellos relacionados con la toma de decisiones de - parte de los armadores en relación a las condiciones del mercado.

V.- ESTRUCTURA DE LOS MERCADOS.

BARCOS DE LINEA.- Se refiere a un segmento del mercado del transporte marítimo que se caracteriza por tener un alto grado de especialización y en donde la regularidad y la frecuencia de los servicios son elementos de gran importancia para los usuarios. Con estas características, el mercado de línea se compone de un pequeño número de firmas que son propietarios de la mayoría de los buques, los cuales están organizadas por lo general dentro de agrupaciones internacionales llamadas conferencias.

En cuanto al rango de operación, las conferencias de armadores de línea realizan en determinadas rutas, previamente establecidas en el seno de las conferencias.

Sin embargo uno de los aspectos que destaca por su importancia en la configuración del mercado de buques de línea es el que se refiere a la restricción casi absoluta de las practicas competitivas entre los miembros de las conferencias, por lo que puede hablarse de un mercado que actua bajo reglas claramente demarcadas. Los niveles tarifarios serán por lo tanto de aplicación común y de conformidad entre los miembros, con lo que las practicas competitivas se reducen al ofrecimiento de ciertas condiciones del servicio, como son descuentos, rebates, acuerdos de lealtad, condiciones que desde luego están oficialmente aceptadas.

Las características expuestas con anterioridad no implican sin embargo que la estructura de las conferencias permanezca estática.

El otorgamiento de descuentos mayores a los oficialmente establecidos, la introducción de innovaciones tecnológicas son entre otros los más im-

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portantes razones que han ocasionado ajustes o modificaciones substanciales en la estructura de las conferencias.

En el plano internacional son muchos los criticismos expresados en contra de las conferencias de fletes, sin embargo hasta el momento no ha surgido otro esquema de operación que lo substituya definitivamente.

A largo plazo la permanencia del sistema parece depender de los avances que se puedan lograr a fin de que la negociación entre transportistas y usuarios se realice sobre consideraciones de costos más realistas. Sin embargo la actual tendencia hacia la unitarización de los transportes de pequeños embarques de alta densidad económica representa su mayor amenaza con relación a su permanencia en el mercado naviero internacional. Es de esperarse desde luego que el transporte convencional con buques de línea continua prestando una valiosa ayuda en los países que por innumerables razones de orden social y económico, así como de carácter técnico, no puedan sino en forma gradual introducirse en el sistema de unitarización.

Por cuanto se refiere al tamaño de los buques convencionales de línea, este fenómeno no se presentó principalmente debido a la configuración misma de sus mercados. La necesidad de cargar y descargar una tremenda diversidad de embarques, tanto en su valor como en su empaque representaron el principal obstáculo para el naviero en cuanto a los tiempos de estadía que se presentarían en el caso de usar barcos más grandes.

En sintesis, el tamaño de los buques de línea estuvo dictada por las condiciones mismas de su mercado en el cual los factores más importantes fueron: Las practicas comerciales de los productos transportados que por lo general las operaciones de compra y venta se refieren a embarques pequeños y de alta densidad económica. El otro aspecto de importancia es el que se refiere a los equipos para el manejo de los embarques y las condiciones operativas de los distintos puertos de carga y descarga, los que definitivamente son de carácter sumamente heterogéneo.

BUQUES GRANELEROS Y COMBINADOS.

Las principales características del servicio de transporte de graneles es su estacionalidad, además de su fuerte dependencia de transportes de grandes volumenes. Como resultado de la interrelación comercial entre los tráficos petrolero y de graneles, se ha desarrollado un tipo de barco, el cual es apto para ambos tráficos con igual eficiencia y economía siendo su mayor atractivo su versatilidad para operarlo en rutas de características diferentes.

Es interesante que a raíz de estos desarrollos en este segmento del mercado naviero la flota que se encuentra en operación es relativamente jóven. Conforme a un diagnóstico reciente de las condiciones de operación de la flota mundial granelera se estimó que el 72% de las embarcaciones de había construído en el curso de los años ---

sesentas . * Desde luego que en estas estadísticas están contabilizadas las embarcaciones petroleras que se convirtieron en -- graneleros a principios de esa década.

Por otro lado, en cuanto a la evolución en el tamaño de los graneleros destaca la influencia que ha recibido por parte del tráfico petrolero al desarrollarse el granelero combinado los cuales están adaptados técnicamente para el transporte ya sea de crudo, graneles o minerales. Sin embargo, existen también en el mercado - graneleros que están diseñados para el transporte de maderas, -- bauxitas, aluminio, cobre, productos forestales, etc.

En cuanto a los origenes de la demanda de buques graneleros, -- ésta se deriva principalmente de la localización y tamaño de los - grandes centros comerciales e industriales, así como de la localización y tamaño de las fuentes de producción o explotación de estos productos. **

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* World Bulk Carrier. Fearney and Eagers. Chartering Co. LTD.

** Se ha alegado continuamente que las decisiones sobre la localización de industrias que requieren de insumos a grandes volumenes, se ha visto influenciadas por las economías /ton/milla que se -- logran .

Establecido el tráfico, en cuanto a su dirección y volumen, es común, que por lo que toca a grandes graneleros especializados, -- que entre los usuarios y navieros se concerten contrataciones o - convenios de transporte aún cuando todavía el barco ni siquiera - se haya construído. Cuando los tonelajes a transportar son por -- millones de toneladas, entonces el transporte se contratará sobre de la base de varios graneleros en la misma ruta.

Típicamente un buque granelero consiste en una unidad sigle --- decked de tonelaje superior a las 18 000 TPM. En esta categoría desde luego que estarían incluídos los barcos trampa. Solamente en el caso de los grandes buques graneleros, estaríamos hablando de tonelajes muy superiores (En 1971 del total de la flota mundial granelera de 419 buques, de los cuales 369 erán de tonelaje - superior a las 18 000 TPM) .* Aún cuando los graneleros combinados hayan sido empleados con cierta frecuencia el el tráfico -- petrolero en estos ultimos años, en el mercado de los petroleros - ha ocasionado un considerable exceso de la capacidad en ese mercado lo que ha inducido gradualmente a la retirada de los graneleros combinados.

En cuanto a la especialización de los graneleros para explotar el - mercado se considera que serán los combinados los que serán más aptos para el transporte de grandes volumenes de productos de baja

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* The Geography of the Sea Transport, A.D. Cooper., Hutchinson University Library, London 1972 ppl 32.

densidad económica. Los puramente graneleros serán aquellos - que transporten volumenes más pequeños, pero de productos de alta densidad.

Finalmente diremos que la tendencia en la construcción de barcos graneleros ha sido estimulada por la introducción de equipos mecánicos para el manejo de los productos en los puertos tanto de - carga como de descarga. Sin embargo en muchos casos las limitaciones en su crecimiento están fijadas por el tránsito a través -- del Canal de Panamá. *

* Todos los graneleros en el rango de las 45-80 mil toneladas son diseñados de acuerdo con el Panamax (105 pies y 6 pulgadas de manga). Port System Studyfor the Public Ports of Washington - and Portland, Oregon. Vol. 11, Techn Suppl., Part 5, appl-19 By Washington Ports Association, Port of Portland, U.S. Administration . March 1975.

BARCOS TRAMPA.

Han sido numerosos los intentos por establecer una definición del caracter de los servicios que presta este peculiar sistema de transporte marítimo, pero en todos los casos las definiciones son únicamente referencias sobre las distintas funciones.

Aparece en la escena del transporte marítimo internacional en la segunda mitad del siglo XIX en donde la mayoría de los barcos trampas de aquellos años seran embarcaciones de entre 2 y 3 mil toneladas.

En la actualidad puede por lo tanto decirse que un barco trampa es aquel que se dedica al transporte de carga seca con rango mundial de operación en donde sus servicios se formalizan a travès de los conocidos contratos o polizas de fletamiento. Es asimismo una embarcación que por lo general tiene tonelaje superior a las 4000 TPM el cual a largo plazo puede considerarse sin itinerario fijo y que cubre distancias relativamente largas.

Si operación en el mercado es de suma versatilidad. A corto plazo puede estar rentado por una compañía de línea un gobierno o una industria para realizar el transporte en forma regular con lo cual no se diferencia con un barco de línea.

Si consideramos que en el mercado internacional naviero existe un considerable fenómeno de substitución, competencia y complementaridad entre las diferentes categorías de servicios, llegaríamos a la conclusión de que es extremadamente dificil establecer límites que nos sirvieran para medir con exactitud los rangos de operación de tales categorías. Sin embargo, tomando en cuenta que - alrededor de las 36 000 TPM dependiendo de las circunstancias, tanto tanqueros como graneleros combinados compiten efectiva-- mente en el mercado trampa, podemos intuír que el rango de ---- acción de el barco trampa queda establecido para transportes en - donde al menos en teoría es económicamente ventajoso el empleo de barcos entre las 4000 y 35000 TPM.

A nivel internacional el mercado trampa funciona en forma muy similar al modelo teórico de competencia perfecta. Existe por lo -- tanto libre acceso al mercado. Son numerosas las firmas que -- siendo dueñas de buques trampa son capaces de prestar servi-- cios además de que por lo general serán de naturaleza similar a los que están prestando las firmas establecidas.

Por otro lado, la entrada de una unidad mas en el mercado es imperceptible y por lo general sin ninguna consecuencia, aunque debido a su caracter internacional de sus operaciones comerciales - es posible que en una ruta, dada la proximidad geográfica y la disponibilidad de tonelaje de un trampa, únicamente pueda alterar -- las condiciones de los fletes en forma significativa. Estos casos - son por lo general de naturaleza excepcional.

BUQUES TANQUE.

Pertenece al segmento del mercado naviero que ha desplegado un marcado dinamismo, en términos de su desarrollo tecnológico así como en las estrategias de su explotación comercial. Además todo este dinamismo ha influído en forma importante el desarrollo del mercado de los -- buques graneleros como resultado del contínuo mecanismo de substitución y complementaridad que entre ambos se lleva a cabo que a su vez es reflejo de los cambios en el comercio y la política marítima del petroleo y los graneles.

El mercado de los buques tanques por otra parte se caracteriza por la concentración de los servicios en pocos vendedores y compradores del petróleo a nivel mundial. La demanda del transporte del petróleo se - deriva principalmente de las políticas adoptadas con relación a la explotación y comercialización del producto de las grandes compañías - petroleras y sus subsidiarias en el mundo, las cuales son propietarias de una tercera parte del tonelaje de la flota mundial de buques tanque.

Las firmas petroleras independientes por su parte son propietarios - de un 40% del tonelaje mundial el cual por lo general se encuentra -- rentado en su mayor parte por gobiernos con industria petrolera nacionalizada y por las mismas grandes compañías petroleras. El resto del tonelaje, pertenece a navieros independientes los que operan - en forma marginal.

Es interesante hacer notar que a raíz del notable crecimiento en el - tamaño de los buques petroleros, las estadísticas sobre la propiedad del tonelaje han permanecido relativamente estáticas desde antes de la Segunda Guerra Mundial.* Este razonamiento desde luego no obedece únicamente a consideraciones de órden técnico.

El argumento de las economías de escala, ha servido de base para la explicación del crecimiento en el tamaño de los buques tanque tiene a su vez una estrecha relación con el desarrollo tecnológico alcanzado en la industria naval y de las condiciones político-económicas que conllevan a la producción y distribución de los energéticos a nivel mundial.** Sin embargo, cualquier cambio en la relación entre los costos de combustibles, mano de obra y materiales de construcción naval tenderá también a alterar las consideraciones con respecto a las economías de escala.

Se ha comprobado que técnicamente aún cuando sea posible la construcción de un petrolero de un millón de toneladas, las diseconomías de escala empiezan a partir de las 800 000 toneladas.** Por otro lado, las limitaciones físicas que presentan los puertos y otras terminales es nivel mundial, así como aquellas que se refieren al paso entre canales estrechos de las principales rutas han representado los principales obstáculos al desarrollo del tamaño de los buques.

* En el período transcurrido entre los 40s y 70s, la participación en la flota petrolera mundial de las grandes compañías, pasó del 36% al 37.5%.

** El cambio en la localización de las refinerías en los países importadores industrializados, liberó a una gran cantidad de pequeños tanqueros antes ocupados para el transporte de refinados, y de esta manera se pudieron construír barcos más grandes para cubrir distancias ahora mayores.

La naturaleza especializada de la industria del transporte de petróleo, la marcada concentración en las operaciones de distribución y explotación, así como la existencia de marcadas fluctuaciones en los volúmenes y las rutas a consecuencia de innumerables factores --- políticos y económicos, hacen de esta industria una de las que operan con mayores riesgos en el transporte marítimo. Por estas razones - resulta explicable la política comunmente adoptada por las compañías petroleras de rentar tonelaje casi en la misma proporción al de su propiedad, ya que de esta forma se reduce el riesgo de mantener cuantiosas inversiones de capital.

Por su parte y con el mismo fin, firmas petroleras independientes han adoptado la practica de tener rentada una gran proporción de su flota sobre la base de tiempo o viajes consecutivos. El resto de su tonelaje estará operando típicamente sobre rentas por viajes al nivel de fletes que en ese momento opere en el mercado. Finalmente y en con-- traste con el mercado de línea no existen restricciones en la entrada de nuevos operadores.

VI.- LA ESTRUCTURA DE LOS COSTOS.

La dificultad actual de establecer conclusiones válidas para generalizar sobre los costos de la explotación naviera, se enfrentan al grave problema estadístico de la información que sobre la materia se - dispone además de la dificultad que implicaría la captación y proceso de información que es por excelencia de caracter privado en el mundo naviero internacional.

Sin embargo es posible ejemplificar en forma aproximada la realidad de la estructura de costos para derivar algunas conclusiones -- sobre la problemática de los empresarios navieros con relación a la política de explotación comercial de los buques.

Las conclusiones aquí presentadas se derivan del análisis de varios cièntos de buques en diferentes partes del mundo, a travês de publicaciones especializadas en el perído 1956 - 1966.*

Dentro de los principales rubros de costos destacan:

1.- Administración. Gastos de Venta. Para un naviero tipo, estos - costos varían entre el 8 y el 15% de los costos totales por barco. - Esta proporción variará dependiendo del tamaño de la flota que po-- sea. Por lo general dicha proporción variará en forma inversa al -- número de barcos y asimismo entre mayores sean las unidades. Es obvia la posición al respecto de los propietarios de barcos línea que rentan una parte considerable de su tonelaje en operación por medio de trampas.

* The Economics of the sea Transport. Carleen O'Laoughlin. Pergamon Press. 1967 - pp107.

2.- Depreciación.- En general representa del 15 al 25 por ciento del total de costos/barco. Varía lógicamente en función directa al costo - de capital de las embarcaciones y con relación al método utilizado para depreciar a las unidades.

3.- Mano de Obra.- Representan la parte más importante del conjunto de costos de explotación de los armadores y sobre del cual la discusión ha tomado rastos internacionalistas.

En consecuencia, la magnitud de los costos puede variar entre el 18 al 35 porciento, dependiendo básicamente de la bandera de registro de los barcos examinados. Asimismo, se ven influídos por las diferentes esquemas regulatorios de los países sobre la materia, así como de las condiciones técnicas de operación de los diferentes barcos.

Algunas unidades requerirán más mantenimiento y operaciones del manejo de los embarques que otros, por ejemplo.

En cuanto a las economías de escala, con referencia al costo - de la mano de obra, se obtuvo que el costo por tonelada de un barco de 1000 TBR es cuatro veces mayor que el correspondiente a un barco de 10 000; Sin embargo, al examinar un barco de 15 000 el costo por tonelada es aproximadamente el 70% de éste último.

De esta forma, queda implícito que las ventajas competitivas de los diferentes armadores tendrán una relación estrecha dependiendo de la mano de obra que hayan contratado y en particular de la nacionalidad de la misma.

4.- Reparaciones y Mantenimiento.- En general representa aproximadamente entre el 10 y el 15% si el mantenimiento es de naturaleza --

rutinaria, pero en general éste varía dependiendo en primer lugar del tamaño del barco y de sus características de diseño. --- Asimismo, la edad del barco es un factor de gran importancia en la magnitud de los costos. Obviamente, un barco viejo tendrá necesariamente que ser más costoso que uno de reciente construcción.

Finalmente, los costos de mantenimiento varían en función de los estandares de trabajo y eficiencia de los astilleros en donde se realicen dichos trabajos.

5.- Seguros .- Factor de costo que varía al igual que la depreciación en función del valor de la unidad. La reputación del armador así como los riesgos serán aspectos que influyan en forma importante.

6.- Combustibles y Derechos Portuarios.- Son componentes del - costo de operación que actuan en forma directa dependiendo de las características de la ruta , la distancia y de los puertos que comprenda dicha ruta.

De esta forma una ruta con tiempos de navegación y estadísticas menores será más barata su operación que una con situación inversa. Enmedio de esta situación habrá compensaciones entre -- estos costos cuando se trate de una ruta en donde el tiempo de navegación sea prolongado, pero con estadías cortas. Por otro lado aspectos de caracter técnico, tales como la potencia de las máquinas, la edad de las mismas, los lugares de aprovisionamiento en ruta y la velocidad también serán de gran importancia analizar para establecer generalizaciones más apropiadas con respecto a estos costos. Del estudio de referencia se estableció que estos costos representan en promedio un 24% de los costos totales de operación.

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SISTEMAS MARITIMOS Y PORTUARIOS

PUERTOS INDUSTRIALES

ING. JUAN F. VALERA ADAM

26 MARZO, 1979.

CENTRO DE EDUCACION CONTINUA
FACULTAD DE INGENIERIA
U.N.A.M.

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ING. JUAN F. VALERA

Marzo de 1979.

PUERTOS INDUSTRIALES

I. ORIGEN DEL PUERTO INDUSTRIAL

La situación económica del mundo se transformó radicalmente al término de la II Guerra Mundial. Las nuevas condiciones propiciaron la aparición de sistemas industriales, de comercio y de transporte que han tenido evoluciones espectacularmente rápidas.

Los sistemas de producción y comerciales tienden a aprovechar las economías de escala en todos los renglones posibles y la transportación marítima ofrece una posibilidad excelente. En la década de los sesenta se inicia una presión cada vez mayor de la competencia que hace crecer el tamaño de las embarcaciones e impone su especialización; este fenómeno se refleja a su vez, en los puertos obligándolos a efectuar grandes inversiones en instalaciones y equipo para poder recibir los nuevos barcos.

Las embarcaciones de mayor tamaño y por consiguiente de mayor precio, deben buscar su economía aumentando la velocidad de desplazamiento y en la reducción máxima en los tiempos muertos; buscan hacer el mínimo de escalas y exigen la mayor rapidez en las maniobras de carga y descarga.

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Paralelamente, los sistemas de transferencia de la carga de y a los transportes terrestres y éstos mismos, buscan su propia competitividad optimizando la eficiencia. Al aparecer el contenedor, surge el transporte multimodal.

El sistema portuario vá transformándose; los puertos de gran fuerza económica y de mejor posición geográfica, capaces de servir a los barcos con mayor eficiencia, se transforman en concentradores de la carga que reciben de otros puertos, los alimentadores.

En los puertos concentradores surgen las terminales de contenedores mas sofisticadas, es a donde llegan los barcos portacontenedores especializados ahora en su tercera generación y que transportan de 1 000 a 1 200 TFE (twenty feet equivalent) a velocidades que fluctúan entre 21 y 25 nudos.

El sistema roll on-roll off es un esfuerzo para reducir los tiempos de transferencia entre barcos y transporte terrestre y los barcos lash y sea bee logran evitar la dependencia del puerto al servir a los usuarios que tierra adentro pueden disfrutar de las economías del transporte fluvial y por canales.

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Además, en la búsqueda de cómo aumentar los volúmenes manejados, los puertos procuran atraer industrias a sus propias áreas, con la tendencia a reducir aún más los costos de transporte que logran las industrias al estar próximas al puerto y algunas al tener frente de agua propio.

En muchos países los centros industriales se desarrollaron junto a los ríos o las costas y el puerto surgió como un servicio indispensable. Después el puerto promueve el asentamiento de industrias en su propio recinto, ofreciendo grandes ventajas. Las limitadas áreas disponibles resultan pronto insuficientes ante la demanda.

El éxito que se obtiene presenta posibilidades para resolver problemas económicos nacionales y surgen así los puertos industriales con ese destino específico y en donde los criterios de diseño portuario cambian radicalmente obedeciendo medularmente al objetivo del aprovechamiento máximo de las economías de escala.

Los puertos industriales son factores del desarrollo económico y no pocas veces sirven también para buscar un mejor ordenamiento demográfico, como en el caso de Japón, en don

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de han contribuido a frenar la tendencia al hacinamiento - de las grandes ciudades al crear oportunidades de empleo en sitios de la costa poco pobladas y de reducida posibilidad de aprovechamiento agrícola.

A diferencia de los puertos comerciales que tienen una función clara y muy importante en el transporte de mercancías, los puertos industriales se orientan a promover la producción y a resolver problemas de ordenamiento demográfico, de desarrollo económico o de empleo.

Los avances en los procedimientos de construcción con equipos de capacidades y rendimientos cada vez mayores, hicieron posible diseñar los grandes puertos industriales adentrándose en el mar y aprovechando las tierras de poco valor en las costas y alejándose de ríos o lagunas con lo - que se evitan los altos costos de mantenimiento de profundidades al evitar las aportaciones de azolve de ríos y lagunas.

Los puertos industriales han sido un notable éxito en el - mundo; solo los graves problemas que han padecido algunos países como consecuencia de los fenómenos económicos mun-

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diales, han podido frenar el rápido desarrollo que experimentaron desde su puesta en marcha.

Existen entonces dos tipos de puertos industriales en el mundo: los que pudieran llamarse inducidos, que surgieron promovidos por un puerto comercial como una forma de aumentar su volumen de operaciones y los puertos industriales - creados específicamente como tales y como instrumentos económicos de interés generalmente nacional.

Las diferencias entre un puerto industrial y uno comercial, son profundas. Comienzan en la función que han de cumplir.

El puerto comercial es fundamentalmente el punto donde las mercancías cambian de modo de transporte, es la liga entre el transporte terrestre y el transporte marítimo. Su fuente de ingresos se centra fundamentalmente en los servicios que en cualquier forma se relacionan con el barco, la carga y el transporte terrestre.

El puerto industrial dirige sus funciones a la producción precisamente. Sus objetivos caen siempre en procurar todo tipo de facilidades al establecimiento y operación de in-

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dustrias. Hace posible para ellas, el aprovechamiento de economías de escala.

Dentro de un sistema portuario, los puertos industriales son receptores de materias primas y emisores de productos intermedios y productos terminados. Los productos intermedios, frecuentemente se mueven dentro del puerto industrial por agua o por tierra, y los productos terminados se envían a los puertos concentradores, a las grandes terminales también por vía terrestre o marítima.

II. ANTECEDENTES EN EL MUNDO

El puerto de Marsella, ya cercado e imposibilitado para captar industrias, creó el puerto industrial de Fos. Cinco años después de iniciada su construcción, un 75% de las 4 500 Ha que inicialmente ofreció a los empresarios e inversionistas, ya habían sido contratadas y un año después, en 1975, 9 500 personas trabajaban ya en las industrias allí establecidas; el total de empleos generados incluyendo el efecto multiplicador, se estimaba en 25 000. Se piensa que hacia 1985 esta última cifra podrá llegar a 100 000 empleos y que las ciudades cercanas tendrán unos 400 000 habitantes adicionales.

Japón, que cuenta con cerca de 1 000 puertos comerciales; (de entre los de primer orden, dedican 17 especialmente a promover comercio exterior), decidió enfrentarse al problema de las altas concentraciones demográficas en sus principales ciudades, todas ellas costeras, creando centros de desarrollo económico tanto tierra adentro como nuevas áreas no desarrolladas de la costa. Se han construido así, once grandes puertos industriales, entre ellos Kasima el que podría servir como ejemplo para esta presentación. Inicial-

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mente se constituyó Kasima como un desarrollo sobre tierra y con áreas ganadas al mar con productos de dragado de las dársenas y canal de acceso. Ahora ya se proyectan nuevas áreas construidas totalmente en el mar; las autoridades locales desarrollaron el proyecto en alrededor de 7 500 Ha, que comprenden áreas urbanas, reservas ecológicas y una primera etapa de zona industrial de 2 400 Ha. La prosecución de las obras del puerto se realizó con los recursos generados por la venta de los terrenos que fueron abriéndose para las industrias, que como en el caso de Marsella-Fos habían ocupado ya casi todas las áreas, a los 14 años de iniciadas las obras.

Las obras, adecuadas a la magnitud de las características del oleaje en esas costas, son notables: el rompeolas sur, el principal, se llevó hasta la cota -21 m. con una longitud del orden de los 3 Km; el canal de acceso y sus dársenas principales, dotadas para un tráfico del orden de 10 000 barcos anuales, tienen 540 y 600 metros de ancho de plantilla respectivamente, y 22 a 24 metros de profundidad.

En 1968 Singapur decidió la construcción del puerto industrial Jurong, en un esfuerzo por sacar al país del estanca

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miento económico. El resultado ha sido asombroso, pues entre 1974 y 1977, en sólo cuatro años, logró hacer crecer a la economía del país 28%. Los informes citan diferentes datos en cuanto al número de empresas instaladas en las 2 200 Ha que tiene destinadas el puerto a la industria; el dato menor es de 700 y el mas alto 1 200.

Durante la II Guerra Mundial, el puerto de El Havre fué destruido casi totalmente; su reconstrucción se inició inmediatamente al término de la guerra y al poco tiempo, en 1950, manejó casi diez millones de toneladas que aumentaron a 16.6 para 1960; en la siguiente década el tonelaje anual creció rápidamente y llegó a casi 60 millones en 1970. Puede señalarse 1974 como el año en que el puerto industrial se inició al ampliar de 280 Ha a 5 200 Ha las tierras principalmente para industrias, dotadas con instalaciones capaces de recibir buques de 250 000 TPM. Se señalaba una meta de unas 10 000 Ha para 1985; el 80% de ellas constituirían el puerto industrial. Aunque El Havre está en la desembocadura del río Sena, no por ello se contrapone el criterio expresado en páginas anteriores: una gran esclusa señalada como la mayor que se ha construido, prácticamente lo aisla del río sin cerrar el acceso a esa

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vía navegable de gran importancia en Francia.

En lugar aparte de la costa, la autoridad portuaria del Havre construyó adicionalmente el puerto petrolero de Antifer sobre los 35 metros de profundidad, en donde puede recibir buques-tanque de 500 000 TPM.

Corea brinda otro ejemplo interesante. Siendo un país de solo 100 000 Km^2, tiene 43 puertos de los cuales 21 se califican de primer orden. Diez de estos últimos a su vez, son puertos industriales a los que este país debe el que en 20 años se multiplicaran por 10 los principales indicadores económicos. El ingreso anual per cápita era de 87 dolares al término de la guerra (1953), y asciende actualmente a 1 100 dólares.

III. CARACTERISTICAS PRINCIPALES

CRITERIO BASICO.

Del objetivo que se persigue al establecer un puerto industrial: crear las condiciones y conveniencias que posibilitan la viabilidad económica del establecimiento de industrias, se desprende el criterio general básico para su planificación. La inversión mas cuantiosa es la de la propia industria; la inversión en infraestructura, particularmente la portuaria, resulta comparativamente de poco peso.

Por tanto, los criterios de diseño deben ser los que mejor satisfagan las necesidades de las industrias; de ello se derivarán la preferencia de los inversionistas; la posibilidad de recuperación de la inversión, la generación de utilidades y, finalmente, la consecución de los fines últimos que se persiguen en cuanto a creación de empleos.

AREAS NECESARIAS

El criterio para decidir sobre las proporciones que se

deben dar a las áreas que ocupará el puerto es de suma importancia. Abundan los ejemplos en que a la vuelta del tiempo, el puerto queda imposibilitado para expandirse al quedar limitado por la población; recíprocamente ésta pierde valiosas áreas que le permitirían solucionar los problemas del crecimiento urbano.

El puerto industrial es especialmente dinámico; su propia producción genera su crecimiento. En la generalidad de los casos ocurre un crecimiento espectacular durante los primeros años, después continúa en forma sostenida el desarrollo pero a un paso menos rápido; el puerto se afirma definitivamente con resultados evidentes en un plazo de 10 a 15 años. El desarrollo prosigue durante generaciones. Un ejemplo de ello es lo que se consideró como una gran fortuna del puerto de Londres, en donde pudieron aprovechar las últimas tierras de las que se le dotó hace sesenta años para crear su ampliación: el puerto de Tilbury.

El país que emprenda el establecimiento de un puerto industrial debe reservar y adquirir tierras suficientes no solo para permitir el crecimiento irrestricto

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de las propias industrias, sino también para propósitos habitacionales, urbanos, de reservas ecológicas y zonas verdes.

Resulta harto difícil poder llegar a dimensionar las necesidades de superficie de terrenos, por los procedimientos convencionales. El camino de estudiar el mercado, para tratar de definir la demanda de tierras, no parece ser el indicado.

Es conveniente más bien, trazar el posible perfil industrial del puerto que se proyecta. El tipo de industria que puede esperarse está definido por la base industrial existente; los recursos naturales que se disponen en la zona, o que son accesibles con facilidad; y por los productos con demanda interna o externa que puede aprovecharse. Una vez definidos los tipos de industrias más viables cabe hacer un estimado de las áreas industriales y habitacionales.

Los resultados de la exploración así realizada, pueden enriquecerse con la experiencia de los puertos industriales ya existentes, a fin de indicar las superficies

rio, debe dársele una gran consideración a los costos de operación y mantenimiento, los cuales serán una carga constante durante la vida del puerto, que no podrá escatimarse so pena de perder las ventajas logradas en la construcción y de quedar en posición competitiva desventajosa frente a otros puertos industriales.

Dado que la industria es el centro de atención al diseñar un puerto industrial, al definir los tipos de embarcaciones a las que se darán los servicios, la primera consideración evidente es que solo los barcos de gran porte serán capaces de rendir las necesarias economías de escala en el transporte de insumos y de productos.

Por ahora, los barcos mayores son los que se utilizan en el transporte del petróleo y sus productos de refinación. Los barcos tanque petroleros crecieron rápidamente en gran parte debido al cierre del Canal de Suez. Cuando éste se abrió nuevamente al tráfico se detuvo la carrera, llegándose a un máximo de 500 000 TPM, dimensión que en este momento no parece conveniente sobre

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pasar. De hecho, algunas unidades de esta magnitud quedaron sin terminarse y el mayor número en uso está en el rango de 200-250 000 TPM.

Las grandes profundidades que requieren estos barcos llevan generalmente a soluciones desarrolladas mar dentro, tan lejos de la costa como sea necesario para alcanzar las batimétricas de 30 a 40 metros o bien el uso de las monoboyas.

Además de esa especialidad, el diseño del puerto deberá tener en cuenta que las industrias primarias, como las petroquímicas y la siderurgia son las que se sirven de los mayores barcos especializados para el transporte de graneles secos y líquidos.

Se prevé que en 1980 el 42% del movimiento mundial de cereales se haga en barcos graneleros de 20 a 35 000 TPM y el 24% en unidades de 35 a 55 000 TPM; el 34% restante, en barcos mayores, hasta de 85 000 TPM.

Los graneleros para mineral de hierro que se pronostican para puertos de los EUA en el futuro más próximo,

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estarán principalmente en el rango de 50 y 75 000 TPM, aunque el mayor barco de este tipo en servicio es de 160 000 TPM y desde 1973 hay buques OBO (ore-bulk-oil) de 250 000 TPM. Las limitantes de tamaño para estos barcos son principalmente: el monto económico de las existencias (stock) de la industria y la desproporción entre las velocidades de manejo del mineral en la carga y descarga del barco. En la primera se llega a 16 000 ton/hora mientras que la mejor descarga está en el nivel de 6 000 ton/hora, lo que prolonga la estadía hasta el grado de hacer incosteables los barcos mayores.

A excepción de los buques-tanque, el pronóstico mundial es que en los próximos 30 años los graneleros estarán en los 250 000 TPM.

El servicio de contenedores resulta indispensable para las industrias de todos los tipos, sin embargo, no siempre un puerto industrial tendrá una terminal concentradora. Deberá tenerse en consideración el papel que en este tráfico jugará en el sistema de puertos de la que formará parte, para definir las instalaciones adecuadas.

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Los puertos alimentadores manejarán portacontenedores hasta de la segunda generación, mientras que la terminal concentradora manejará por ahora los de la tercera generación capaces de llevar de 1 000 a 1 200 TFE a velocidades de 21 a 25 nudos. Aunque hay cierta incertidumbre, se considera posible esperar que se llegue a capacidades del orden de 3 000 a 3 500 TFE (twenty feet equivalent), que calarán unos 11 metros y tendrán esloras de unos 300 metros.

El servicio roll on-roll off se hará en naves cuyas características quedan envueltas en las de los contenedores.

Los barcos lash y sea bee caracterizados por no requerir atraque, deben operarse no solo en los puertos costeros ligados a otros tierra dentro por canales o ríos, sino en donde las industrias con frente de agua sean númerosas y hayan llegado a altos volumenes de producción y hagan envíos a otros puertos con cualquiera de las características citadas.

Las áreas de agua del puerto, comprendiendo el canal de

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acceso, las dársenas de maniobras y las de operación, deberán ser diseñadas siempre teniendo presente, además de las dimensiones de los barcos, el mayor volumen de tráfico que pueda pronosticarse. La experiencia mundial enseña en efecto, que cualquier pronóstico de volúmen de operaciones queda sobrepasado en plazos increíblemente cortos. Y solo los costos de dragado, y en mucho menor proporción el costo de la tierra, que ciertamente no son los mayores, son los afectados al optarse por mayores anchos en canales y dársenas.

Es evidente que las necesidades de las industrias con frente de agua en cuanto a profundidades variarán en función del tipo de graneles y, por consecuencia, del tamaño de barcos que les dará servicio. En general puede hablarse de frentes de agua profunda y de frentes de agua con profundidad normal.

En tanto que algunas industrias requieren muelles y equipamiento privados y en ocasiones muy especializados para carga y/o descarga de buques y para las cuales esas instalaciones son el elemento extremo de su línea de producción, otras pueden servirse de muelles

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en donde sólo tendrán el principio o el fin, según el caso, de su propio sistema de conducción, (por ejemplo: bandas transportadoras o tuberías).

Las primeras están obligadas a tener frente de agua propio, las segundas pueden estar en lotes de terreno a distancia del frente de agua que va desde el espacio para la instalación de los ductos y sus controles de operación, hasta no más allá de 1 500 metros.

Para otras industrias, generalmente las secundarias y eventualmente las terciarias, el puerto deberá contar con muelles y equipo mecanizado "de uso común"; entre ellos se contarían las instalaciones para contenedores, bodegas de tránsito, consolidadoras, instalaciones para el manejo y almacenaje de líquidos a granel y también graneles secos (silos y áreas descubiertas).

Las áreas e instalaciones para la atención y operación de los transportes terrestres en el área portuaria son naturalmente de gran importancia, y es indispensable un diseño en que se les dé amplitud suficiente y les permi

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ta crecer en forma acorde con el crecimiento del puerto industrial. Sería inadmisible limitar el desarrollo industrial por un apoyo insuficiente del transporte terrestre originado en la falta de áreas para su operación adecuada.

Dentro de la planificación de las áreas portuarias, deben figurar las necesarias para los servicios a los barcos, tales como avituallamiento, talleres, etc.: servicios a los consignatarios y a los propios usuarios del puerto industrial, como pueden ser los bancarios, de comercio, etc., y los necesarios para las oficinas gubernamentales.

El gran volumen de tráfico marítimo que se genera en un puerto industrial, obliga a dar especial atención a los sistemas de señalamiento y a los de control de la navegación en canales y dársenas.

DE ORDEN ECONOMICO.

En páginas anteriores se señala que los puertos industriales se crean actualmente buscando resolver proble-

mas nacionales de orden demográfico, de desarrollo -- económico o de empleo.

Los aspectos económicos que justifican su creación van más allá de la viabilidad económica. El beneficio nacional que estos puertos entrañan al resolver problemas sociales o de desarrollo, inclinan sin duda la decisión a favor de ellos.

Un puerto industrial planeado correctamente en todos - sus aspectos requiere del apoyo económico del gobierno en su creación y arranque; superada esta fase, se vuelve autosuficiente y es capaz de generar dividendos a la inversión, además de los grandes beneficios sociales.

En ninguna parte del mundo pudo detectarse interés en establecer industrias y ni siquiera se auguraba posibilidad de que ese interés pudiera despertarse, cuando Singapur decidió salir de su grave situación económica creando el puerto de Jurong. Lo que produjo el éxito fué la presencia del puerto industrial y una promoción perseverante y prolongada entre los grandes industria-

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les e inversionistas.

Este ejemplo ilustra cómo la investigación de mercado debe dirigirse, no sobre encuestas, sino sobre el análisis de las posibilidades de los recursos naturales; de la disponibilidad de otras materias primas de procedencia interna y externa, y de las tendencias y pronósticos de la demanda de bienes y productos en la nación y en el exterior. También ilustra cómo el resultado del estudio de viabilidad podrá quedar corto, pues no es posible detectar la reacción del inversionista ante las nuevas posibilidades que le brinda el puerto industrial, y tener ante sí un nuevo panorama dentro del que resultan factibles inversiones que no hubiera podido siquiera vislumbrar.

El proyecto inicial del puerto industrial, producto de una planificación cuidadosa sobre las condiciones en el momento de su creación, deberá ser un instrumento flexible y dinámico que, a lo largo de los años vaya ajustándose a los cambios en las premisas. Un proyecto de esta naturaleza, que se desarrolla en el plazo largo, debe tener esta característica para ser verdade

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ramente útil.

Es imprescindible que la ejecución del proyecto se programe por etapas, y evitar tener inversiones muertas con el riesgo de perderse por cambios en el proyecto - oligados por el cambio natural de las condiciones que existan.

Se puede ver con claridad que hay un grupo de obras que deben realizarse para poder iniciar la marcha del puerto industrial, y hay otras obras que deberán ir realizándose a medida que se hagan necesarias.

En términos generales, deben realizarse en una primera etapa las obras que permitan el establecimiento de las primeras industrias y las que permitan operarlas.

Siguiendo ese criterio, las obras marítimo-portuarias de la primera etapa serían: los reompeolas; el canal - de acceso; los dragados hasta la profundidad que requerirán los barcos que darán servicio a las primeras fases de la producción industrial; la primera dársena de maniobras y la dársena donde estarán los muelles de las

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primeras industrias, y las primeras longitudes de atraque de las instalaciones de uso común indispensables para el apoyo de la construcción de las insdustrias que no requieren frente de agua propio.

En tierra, las obras de la primera etapa deberán ser la habilitación de los terrenos para las primeras industrias y para las que razonablemente puedan esperarse en el plazo corto; si se trata de terrenos obtenidos con productos del dragado, pudiera ser aconsejable su preparación al tiempo de su depósito. Igualmente será necesaria la construcción de las instalaciones en tierra para uso común: patios de maniobras, bodega de tránsito y en forma imprescindible las líneas troncales hasta el frente de agua y los ramales para servir a las primeras industrias, de vialidad terrestre, ferrocarril y autotransporte, y el abastecimiento de electricidad, agua y drenaje.

Otras inversiones aconsejables al arrancar el proyecto son las necesarias para la adquisición de tierras que garanticen la vida del puerto industrial. Se registran casos en el mundo en que ha sido imposible la --

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cración de un puerto industrial ya proyectado, debido al encarecimiento de la tierra, creado por la especulación.

Los apoyos al desarrollo regional en el aspecto de habitación, comunicaciones, ecología, etc., deben atacarse a medida que el puerto industrial vaya generando el desarrollo. Sin embargo los centros urbanos deben quedar debidamente planificados y controlados para encauzar su evolución correctamente. En algunos casos será necesario crear los primeros centros de población para evitar asentamientos sin orden, que conducen después a problemas de muy difícil solución.

IV. EL PROBLEMA MEXICANO

La consideración de los puertos industriales, de los que hemos tratado de presentar una imagen general, y el indiscutible éxito que han constituido en el mundo, lleva a conclusiones importantes de aplicación para nuestro país.

Es bien sabido que México dentro de 20 o 25 años, estará ante graves problemas como consecuencia de su crecimiento demográfico y del rápido desarrollo económico que está teniendo lugar, y que se robustecerá con los frutos de las políticas que ahora se trazan para el aprovechamiento planeado de los beneficios de que se derivan de la explotación de los recursos petroleros.

Como en el resto del mundo, existe en el país la corriente poblacional del medio rural hacia las zonas urbanas, lo que es un factor de concentración que se suma al crecimiento demográfico esperado en lo que resta de este siglo, para dar por resultado que, de no tomarse acciones que corrijan la tendencia, las grandes concentraciones en las áreas de las ciudades de México, Monterrey y Guadalajara aumentarían hasta llegar a niveles que provocaría problemas de -

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muy difícil solución.

El desarrollo industrial seguiría el paralelismo que hoy tiene con el urbano: actualmente las tres zonas de concentración aportan el 63% de la producción nacional y en ellas vive un porcentaje semejante de la población del país.

Los costos nacionales de esta aglomeración ya ahora representan graves deseconomías al país: los servicios urbanos aumentan su costo no en proporción lineal con el crecimiento de las urbes sino a ritmo mucho mayor.

Los sistemas de transporte y de distribución se distorsionarán cada vez más, acentuando los costos innecesarios en los bienes y servicios.

La tendencia actual de la concentración industrial se acentúa en virtud de las ventajas de mejor infraestructura y mejores servicios, y también en virtud de la proximidad a los mayores centros de consumo y de la presencia de subsidios y trato preferencial que cancelan así, artificialmente, las ventajas económicas y físicas que otros sitios del país ofrecen a la industria.

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La población marginal crece, pues la inmigración continuada y creciente supera la capacidad de generación de empleos de estas ciudades.

La concentración de la actividad industrial, el crecimiento de la población redundante, el aumento acelerado de los costos y la ineficiencia industrial, junto con el bajo nivel de competitividad internacional de la rama manufacturera, explican, en buena medida, la pérdida de dinamismo de la industria cuyo ritmo de crecimiento ha descendido de un 9% como promedio para la década de los sesenta a un 4% en los últimos tres años.

El desarrollo industrial en las zonas costeras permitiría superar las deseconomías que se observan en el altiplano. Establecer puertos industriales en sitios donde son abundantes las materias primas básicas; se tiene agua en cantidades suficientes para abastecer el desarrollo de industrias y poblaciones, y hay un costo relativamente inferior de la tierra y del suministro de energéticos, junto con las ventajas en materia de costo de transporte, tanto para recibir materias primas, bienes intermedios y de capital como para exportar productos, representan posibilidades -

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efectivas para propiciar la desconcentración de la industria y procurar un desarrollo mas equilibrado.

La demanda interna habrá mas que duplicarse en los próximos 21 años. El país deberá estar preparado para satisfacerla, pues de otra suerte deberá seguir dependiendo en proporción cada vez mayor de la producción extranjera.

La posibilidad de reducir costos, que brindan los puertos industriales, será una ventaja no sólo para la producción destinada al mercado interno, sino para alcanzar mayor competitividad en el mercado internacional, de modo que se logre que la industria nacional esté capacitada para la generación de empleos en cantidad suficiente y en los lugares hacia donde es racionalmente deseable encauzar el crecimiento demográfico.

Un primer examen de la necesidad de empleos del país aconsejaría promover en las costas las industrias intensivas de fuerza laboral y, intensivas de energéticos, de tal modo de crear más empleos con la misma inversión, evitándose así el costo de las obras portuarias indispensables para el desarrollo de las industrias primarias, intensivas de -

capital, es decir, las que proveen menos empleos por el dinero invertido.

Esta política llevaría irremediablemente a la dependencia externa para proveer a las industrias secundaria y terciaria de las materias primas industriales, en la medida que lo requeriesen para hacer frente a una demanda continaumente creciente. Por otra parte se caería en la necesidad de exportar recursos naturales para cuyo procesamiento no habría suficiente capacidad.

Si se adoptara este criterio, deberían considerarse los puertos con que actualmente cuenta el país, como los sitios disponibles apropiados para que se establezcan las industrias secundarias que se benefician de la cercanía del puerto; sin embargo, todos son puertos comerciales, y casi todos carecen de áreas para la ampliación aún de sus operaciones normales.

El Gobierno Mexicano está tomando ya las primeras acciones para la creación de puertos industriales.

Entre las zonas costeras donde sería aconsejable desarro-

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llar estos proyectos, tienen condiciones que pueden garantizar el éxito de la empresa: desarrollo industrial de importancia, vocación industrial, apoyo urbano, vías férreas caminos y aeropuertos existentes, en construcción o ya planeados para construcción a corto plazo, disponibilidad de energéticos y de materias primas en la propia zona.

Se ha recomendado, iniciar de inmediato esos tres puertos industriales en las siguientes zonas: Lázaro Cárdenas, - Tampico e Istmo de Tehuantepec en la que el desarrollo principal por ahora sería la región de Coatzacoalcos y la de - apoyo para aprovechar la salida natural al Pacífico, la región de Salina Cruz.

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SISTEMAS MARITIMOS Y PORTUARIOS

LA INDUSTRIA NAVAL

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LA INDUSTRIA NAVAL

SEMBLANZA HISTORICA

SABEMOS QUE LA PRIMERA INDUSTRIA DEL MEXICO-HISPANO, FUE LA DE LA CONSTRUCCION NAVAL.

EN OCTUBRE DE 1520, EN TLAXCALA SE CONSTRUYEN 13 BERGANTINES QUE SON BOTADOS AL AGUA EN EL LAGO DE TEXCOCO CON LOS QUE -- HERNAN CORTES SITIA Y CONQUISTA LA CAPITAL AZTECA.

YA DESDE EL AÑO DE 1532 EXISTIAN ASTILLEROS EN CAMPECHE, ACAPULCO, ZIHUATANEJO Y MANZANILLO, DONDE SE CONSTRUYERON EMBARCACIONES QUE EFECTUARON LARGOS VIAJES COOPERANDO AL DESCUBRIMIENTO Y COMUNICACION DE NUEVAS TIERRAS PARA EL IMPERIO HISPANO.

DURANTE 3 SIGLOS SE CONSTRUYERON EN LA NUEVA ESPAÑA MAGNIFICOS BARCOS PARA LA EPOCA.

AL INTRODUCIRSE EL ACERO Y LAS MAQUINAS DE VAPOR EN LA - CONSTRUCCION DE BUQUES, LA REPUBLICA NO SE ENCUENTRA INDUSTRIAL Y- TECNOLOGICAMENTE PREPARADA Y VE DECLINAR SU INDUSTRIA NAVAL, LA - CUAL QUEDA LIMITADA A LA CONSTRUCCION DE EMBARCACIONES MENORES DE- MADERA DESTINADAS PRINCIPALMENTE A CABOTAJE Y PESCA.

LA DECLINACION DE LA INDUSTRIA NAVAL,AUNADA A LA GEOGRAFIA DEL PAIS QUE SI POR UN LADO POSEE EXTENSAS COSTAS,POR OTRO, - LOS NUCLEOS DE POBLACION SE CONCENTRAN EN LA ALTIPLANICIE Y LA INDUSTRIALIZACION DEL PAIS VECINO DEL NORTE DA ORIGEN A QUE UN GRAN- PORCENTAJE DEL COMERCIO SE EFECTUE POR TIERRA, TODOS ESTOS FACTORES

IMPIDEN O AL MENOS NO ALIENTAN EL DESAROLLO DE LA MARINA MERCANTE.

MIENTRAS TANTO EL RESTO DEL MUDNO, LOS PAISES INDUSTRIALIZADOS, A MEDIADOS DEL SIGLO PASADO COMIENZAN A TRANSFORMAR SUS FLOTAS MERCANTES DE MADERA Y DE PROPULSION A VELA, A BUQUES DE ACERO CON MAQUINAS DE VAPOR.

LA TRANSICION EN UN PRINCIPIO, FUE CON PASOS INSEGUROS, EXPERIMENTANDO DIVERSOS MEDIOS DE PROPULSION, EL PRIMERO FUE LA RUEDA DE PALETAS INSTALADA EN 1801 EN EL BUQUE CHARLOTTE DUNDAS, PARA EL SERVICIO DE REMOLQUE EN EL CANAL DE FORTH-CLYDE, SEGUIDO DEL CLERMONT DE FULTON EN 1807, UTILIZADO PARA EL SERVICIO DE PASAJEROS EN EL RIO HUDSON. A PARTIR DE ESTE MOMENTO LA RUEDA DE PALETAS ALCANZA EL MAXIMO DE PERFECCIONAMIENTO Y DE APLICACION, SUBSTITUYENDO PAULATINA Y PROGRESIVAMENTE A LA VELA, SIENDO EL MAS COMUN EL BUQUE MIXTO DE VELA A VAPOR, PERO A PARTIR DE LA MITAD DEL SIGLO XIX, DECLINA SU EMPLEO SIENDO EL BUQUE SCOTIA DE LA COMPAÑIA CUNARD, EL ULTIMO BUQUE TRANSOCEANICO CONSTRUIDO CON RUEDAS DE PALETAS EN 1861.

LAS CAUSAS DE SU RAPIDO OCASO, TAN PRONTO SE PERFECCIONO LA HELICE, FUE DEBIDA A SU POCA APTITUD PARA VIAJES CON MAL TIEMPO, SALIENDOSE DEL AGUA EN LOS BALANCES, HACIENDO DIFICIL EL MANTENIMIENTO DE LA DERROTA Y ESTANDO ADEMAS PROPENSA A ROMPERSE POR LOS GOLPES DE MAR.

POR SU PARTE LA HELICE, AUNQUE LOS PRIMEROS INTENTOS DE APLICACION A LA PROPULSION DE LOS BUQUES DISTAN DE 1680, NO TUVO UNA UTILIZACION VERDADERAMENTE PRACTICA, HASTA EL SIGLO XIX EN

QUE DESPUES DE ENSAYOS REALIZADOS EN NUEVA YORK (1804) Y TRIESTE (1829) SIN MUCHO EXITO POR STEVENS Y RESSEL, RESPECTIVAMENTE, FRANCIS PETTIT SMITH, PATENTA EN 1836 UNA HELICE DE DOS ESPIRAS COMPLETAS, CON LA QUE EFECTUA CON EXITO SUCESIVAS PRUEBAS, EN UNA DE LAS CUALES PERDIO CASI MEDIA ESPIRA, LO CUAL ORIGINO UN AUMENTO EN LA VELOCIDAD DE LA EMBARCACION Y UNA RECTIFICACION DE LA PATENTE DE SMITH.

CASI SIMULTANEAMENTE CON SMITH, EL INGENIERO SUECO JOHN ERICCSON IDEA UN PROPULSOR HELICOIDAL QUE PATENTA Y PRUEBA, PRIMERAMENTE EN EUROPA Y LUEGO EN AMERICA, CON TAN BUEN EXITO, QUE LA ARMADA NORTEAMERICANA LE ENCARGO LA MAQUINARIA PROPULSORA DEL PRINCETON, AL QUE COLOCO UN HELICE DE BRONCE DE SEIS PALAS EN 1839. ASI LA HELICE FUE SUBSTITUYENDO A LA RUEDA DE PALETAS EN SU PAPEL SECUNDARIO DE AYUDAR A LAS VELAS EN LA PROPULSION, HASTA QUE LA EVOLUCION DE LAS MAQUINAS DE VAPOR DIO LA SUFICIENTE SEGURIDAD EN LAS LARGAS TRAVESIAS Y PERMITIO LA DESAPRICION DE LA VELA, IMPONIENDOSE LA HELICE EN LA PROPULSION MARINA Y CONSERVANDO SU PREDOMINIO HASTA LA FECHA.

PARALELAMENTE, LAS MAQUINAS PROPULSORAS SE FUERON DESARROLLANDO.

ES EN EL AÑO DE 1707 QUE DENIS PAPIN PRUEBA SU MAQUINA DE EMBOLO EN UNA EMBARCACION POR MEDIO DE RUEDAS DE PALETA EN EL RIO FULDA (ALEMANIA), EL RESULTADO NO ES SATISFACTORIO. POSTERIORMENTE SE HACEN EXPERIMENTOS CON LA MAQUINA ATMOSFERICA DE NEWCOMEN * EN 1736 SIN EXITO. EN 1774 EN FRANCIA SE PRUEBA UN BUQUE CONSTRUIDO EN EL SENA Y DOTADO DE UNA MAQUINA DE DOS CILINDROS. MESES DESPUES

SE DESPRENDE EL CONTRAPESO DEL BALANCIN Y AL CAER SOBRE EL FONDO LE HACE UNA VIA DE AGUA LLENDOSE A PIQUE. CONTINUAN NUMEROSOS EXPERIMENTOS EN INGLATERRA, FRANCIA, ALEMANIA Y E.U.A., PRINCIPALMENTE.

ES JAMES WATT EL QUE IDEA LA PRIMERA MAQUINA REALMENTE MARINA, ADAPTADA AL MOVIMIENTO GIRATORIO, AUNQUE CONSERVANDO SIEMPRE EL BALANCIN; DE ESTE TIPO ERA LA MONTADA EN EL REMOLCADOR CHARLOTTE DUNDAS, Y QUE PUEDE RESUMIRSE ASI: LA CRUCETA DEL EMBOLO VA ARTICULADA POR MEDIO DE BIELAS A UNA DE LAS EXTREMIDADES DEL BALANCIN MIENTRAS QUE LA OTRA EXTREMIDAD DE ESTE PONE EN MOVIMIENTO LOS CIGUEÑALES DE UNA RUEDA DE PALETAS, LA MAQUINA DE BALANCIN LATERAL ES SEGURA Y CASI NO TIENE PUNTO MUERTO. FUE UTILIZADA EN LOS BUQUES HSTA 1860.

EN 1871 SE INTRODUCE LA MAQUINA DE TRIPLE EXPANSION. EL PASO SIGUIENTE ES LA TURBINA DE VAPOR DESARROLLADA PRINCIPALMENTE POR CHARLES A. PARSON Y GUSTAVO PATRICIO DE LAVAL.

EL PRIMER BUQUE CON TURBINAS DE VAPOR ES EL INGLES "TURBINIA", CONSTRUIDO EN 1894 DE 44.5 TONELADAS DE DESPLAZAMIENTO Y 1500 C.V., DANDO 18 NUDOS; DOS AÑOS DESPUES SE LE SUBSTITUYO POR OTROS TRES DE PRESION COMBINADA ALTA, MEDIA Y BAJA PARA ACCIONAR DOS HELICES Y PUDO OBTENERSE LA INCREIBLE VELOCIDAD DE 34.5 NUDOS.

A PARTIR DE ESTA FECHA, POR EL EXITO OBTENIDO, FUERON INSTALADAS PRINCIPALMENTE EN BUQUES DE GUERRA Y DE PASAJEROS Y SU CAMPO DE APLICACION SE AMPLIA MUCHISIMO, CUANDO HACIA EL AÑO DE 1910 SE INTRODUCEN LOS ENGRANAJES REDUCTORES.

LOS CAMBIOS RADICALES EN EL CONCEPTO DEL BUQUE TANTO EN LOS MATERIALES TRADICIONALES DE CONSTRUCCION COMO EN LOS MEDIOS - DE PROPULSION ORIGINARON UNA COMPLETA TRANSFORMACION EN LOS SISTEMAS QUE FUERON TRADICIONALES POR DECENAS DE SIGLOS EN LA CONSTRUCCION NAVAL.

ALGUNOS ASTILLEROS PRINCIPALMENTE POR SU SITUACION GEOGRAFICA CERCA DE LAS FUNDICIONES Y ACERIAS EFECTUARON LA TRANSFORMACION CON MAYOR O MENOR DIFICULTAD, SIN EMBARGO UN GRAN NUMERO - FUE DESAPARECIENDO AL DECAER LA DEMANDA DEL BUQUE DE MADERA Y MUCHOS OTROS APARECIERON PRINCIPALMENTE EN LAS REGIONES DE PRODUCCION METALURGICA NOTABLE, (CUENCA DEL RHIN), CURSO BAJO DEL CLYDE, DEL FORTH, ESTUARIOS DE LOS RIOS WESER Y ELBA, REGION FRANCESA - DEL NOROESTE, RIO DE BILBAO, ETC.)

LAS TECNICAS DE LA CONSTRUCCION NAVAL CAMBIARON RADICALMENTE, LAS VENTAJAS DE LOS NUEVOS MATERIALES INFLUYERON INMEDIATAMENTE EN LOS DISEÑOS Y DIMENSIONES DE LOS BUQUES, LA INTRODUCCION DE LOS NUEVOS MEDIOS PROPULSORES LOS LIBERARON DE SU DEPENDENCIA- DE LOS ELEMENTOS Y EN TODOS LOS CONCEPTOS PODEMOS ASEGURAR QUE NACIO UNA NUEVA INDUSTRIA.

EL ACERO SE CONVIRTIO EN LA MATERIA PRIMA POR EXCELENCIA PARA LA CONSTRUCCION NAVAL. POR SUS PROPIEDADES PERMITIO UN- DRAMATICO AUMENTO EN LAS DIMENSIONES DE LOS BUQUES.

LA FILOSOFIA TRADICIONAL DEL TRANSPORTE DE LA CARGA TAMBIEN SUFRIO CAMBIOS; EL SISTEMA ORIGINAL DE IDEAR LOS TIPOS DE EM

BALAJES Y RECIPIENTES MAS ADECUADOS PARA LOS DIFERENTES PRODUCTOS A TRANSPORTAR, PRINCIPALMENTE CARGA GENERAL, CARGA A GRANEL Y LIQUIDOS PARA LOS CUALES NO EXISTIAN BARCOS ESPECIALES, CAMBIO AL INTRODUCIRSE EL BUQUE ESPECIALIZADO.

LOS BIDONES DE ACEITE Y VINO CAYERON EN DESUSO Y APARECIO EL BUQUE TANQUE DISEÑADO ESPECIFICAMENTE PARA EL TRANSPORTE DE LIQUIDOS, ASI MISMO APARECIO EL BUQUE GRANELERO Y MINERALERO PARA CARGAS A GRANEL JUNTO CON LOS BUQUES DE CARGA GENERAL Y EL DE PASAJEROS, QUE, HASTA LA TERMINACION DE LA SEGUNDA GUERRA MUNDIAL, FUE EL PRINCIPAL MEDIO DE TRANSPORTE DE PERSONAS ENTRE LOS CONTINENTES, DISMINUYENDO SU PARTICIPACION, AL AUMENTAR LA CAPACIDAD Y CONFIABILIDAD DE LA AVIACION.

EL BUQUE SE CONVIRTIO EN UNA CIUDAD MOVIL, AUTOSUFICIENTE, DONDE SE GENERA LA ENERGIA ELECTRICA, SE PRODUCE AGUA POTABLE AIRE COMPRIMIDO, CALEFACCION, REFRIGERACION, POSEE SUS PROPIAS PLANTAS PROPULSORAS, ETC. EN UNA IDEA, ES LA CONSTRUCCION MOVIL MAS GRANDE QUE EL INGENIO HUMANO HA CREADO.

ESTA INDUSTRIA TUVO REPERCUSIONES INSOSPECHADAS AL UTILIZAR MATERIALES Y PRODUCTOS, DE INDUSTRIAS TAN DISPARES COMO LA SIDERURGICA, LA TEXTIL, LA ELECTRICA, LA DE DECORACION, Y MUCHAS OTRAS. A LA INDUSTRIA NAVAL SE LE HA DEFINIDO COMO LA INDUSTRIA MULTIPLICADORA DE INDUSTRIAS POR EXCELENCIA. DONDE ESTA SE ASENTO, PROPICIO LA INDUSTRIALIZACION MASIVA DE LAS REGIONES, CON REPERCUSIONES ECONOMICAS NOTABLES, QUE CASI DE INMEDIATO ORIGINARON-

LOS AUMENTOS DE NIVELES DE VIDA, DE EDUCACION Y ESPECIALIZACION DE LOS OBREROS, CON TODAS SUS VENTAJAS INHERENTES.

EL NUEVO ASTILLERO, NACIO A PARTIR DE LA SEGUNDA MITAD DEL SIGLO PASADO Y POR CASI UN SIGLO, LOS SISTEMAS DE CONSTRUCCION ASI COMO LOS PROPIOS BUQUES, NO SUFRIERON CAMBIOS RADICALES, EL PERFECCIONAMIENTO, SE EFECTUO PROGRESIVA Y LENTAMENTE.

LA UNIDAD BASICA DE LA CAPACIDAD DE LOS ASTILLEROS HASTA FECHAS RECIENTES ERA LA GRADA DE CONSTRUCCION.

EL NUMERO DE GRADAS Y SUS DIMENSIONES DETERMINAN LA CAPACIDAD DEL ASTILLERO. TRADICIONALMENTE EL ASTILLERO CUENTA CON UN GRAN NUMERO DE TALLERES DE DIFERENTES ESPECIALIDADES, LO QUE HACE QUE EL GRADO DE INTEGRACION O VALOR AÑADIDO DEL BUQUE, EN LA PROPIA PLANTA, SEA RELATIVAMENTE ALTO.

ERA PRACTICA NORMAL EN LOS ASTILLEROS MAS IMPORTANTES TENER LOS TALLERES SUFICIENTES PARA EFECTUAR LAS FUNDICIONES, FORJAS FABRICACION DE APARATOS AUXILIARES, CARPINTERIA E INCLUSIVE FABRICA DE LOS MOTORES PROPULSORES.

PANORAMA ACTUAL DE LA INDUSTRIA NAVAL EN MEXICO

LA MULTITUD DE PROBLEMAS SOCIO-ECONOMICOS DEL PAIS, INHIBIERON DURANTE MUCHO TIEMPO AL GOBIERNO FEDERAL, A PRESTARLE SU COMPLETA ATENCION AL DESARROLLO EFECTIVO DEL SECTOR MARITIMO INDUSTRIAL DEL PAIS, E IMPLEMENTAR UNA POLITICA INTEGRAL EN LA QUE LOS ASTILLEROS PARTICIPEN Y EVOLUCIONEN DENTRO DE DICHO SECTOR DE LA ECONOMIA NACIONAL, COMO UN FACTOR COMPLEMENTARIO DEL MISMO, SIENDO SUS DOS FACTORES BASICOS, LOS PUERTOS Y LAS FLOTAS DE TRANSPORTE MARITIMO COMERCIAL, Y DE EXPLOTACION DE LOS RECURSOS MARINOS NACIONALES. ACTUALMENTE NUESTRO DESARROLLO PORTUARIO ES SUSTANCIAL, Y EL CRECIMIENTO DE NUESTRA MARINA NACIONAL YA ES NOTORIO, Y AMBOS FACTORES, CONTINUAN EVOLUCIONANDO COMO POTENCIAL, QUE REPRESENTAN EN LA ECONOMIA NACIONAL.

LA IMPORTANCIA DE LO ANTERIOR, RESIDE EN EL HECHO DE QUE, A PESAR DE LOS ESFUERZOS INVERTIDOS EN LA EVOLUCION DE LA INDUSTRIA NAVAL, LAS NECESIDADES DE CONSTRUCCION, E INCLUSO DE REPARACION DE LAS EMBARCACIONES DE NUESTRA MARINA NACIONAL, TANTO PUBLICAS COMO PRIVADAS, HAN SIDO EN SU MAYORIA SATISFECHAS EN EL EXTRANJERO, POR NO CONTAR EL PAIS, CON ASTILLEROS CAPACITADOS PARA EL EFECTO. POR OTRA PARTE, A MANERA DE CIRCULO VICIOSO, DICHOS ASTILLEROS, NO HAN PODIDO SATISFACER APROPIADAMENTE TALES NECESIDADES, YA QUE NO HAN CONTADO CON UNA LEGITIMA Y RACIONAL OPORTUNIDAD PARA PODERSE CAPACITAR Y SER COMPETITIVOS EN EL MERCADO.

NO OBSTANTE, EL RAZONABLE GRADO DE CAPACITACION ADQUIRIDO A LA FECHA POR EL PERSONAL TECNICO Y OBRERO DE LOS ASTILLEROS A TRA

VES DE LOS TRABAJOS DE CONSTRUCCION Y REPARACION NAVAL YA EFECTUADOS, LA FALTA DE TRABAJO CONTINUO DE LOS MISMOS, HA PROVOCADO INESTABILIDAD Y EN CONSECUENCIA RESULTADOS NEGATIVOS EN SU OPERACION. TAMBIEN HA DADO LUGAR A QUE GRAN PARTE DE LAS INVERSIONES DE DIVERSO TIPO, EFECTUADAS EN LOS MISMOS A LO LARGO DEL TIEMPO, CON EL OBJETO DE MEJORAR SUS CONDICIONES Y RESULTADOS DE OPERACION, NO HAYAN ENCONTRADO EL APOYO ADECUADO Y OPORTUNO PARA MATERIALIZAR SUS BENEFICIOS PREVISTOS, REDUNDANDO EN RESULTADOS INFERIORES A LOS ESPERADOS. IGUALMENTE, HA ORIGINADO QUE LAS INSTALACIONES Y LOS RECURSOS FISICOS PRODUCTIVOS CON QUE CUENTAN LOS ASTILLEROS NACIONALES EN GENERAL, SEAN INCOMPLETOS E INADECUADOS, Y ALGUNOS SEAN OBSOLETOS, OCASIONANDO DEFICIENCIAS POR SUS ALTOS COSTOS Y/O TIEMPOS DE PRODUCCION. TODO ELLO ORIGINANDO SU IMPOSIBILIDAD DE COMPETIR EN EL MERCADO INTERNACIONAL.

EL EXITO EN EL MANEJO Y EVOLUCION DE LA INDUSTRIA NAVAL, COMO CUALQUIER OTRA EN EL MUNDO, HA DEPENDIDO DE CUATRO GRANDES FACTORES:

1.- EL MERCADO DEFINIDO AL CUAL DIRIGIR LOS PRODUCTOS Y/O SERVICIOS DEL ASTILLERO.

2.- EL CONOCIMIENTO TECNICO DE LA INGENIERA DE DISEÑO Y CONSTRUCCION DE LAS EMBARCACIONES Y LA ADMINISTRACION DE LA EMPRESA INDUSTRIAL QUE EMPAPA A TODAS LAS AREAS FUNCIONALES Y NIVELES DE SU ESTRUCTURA ORGANIZACIONAL.

3.- LA DISPONIBILIDAD DE LAS FACILIDADES Y LOS RECURSOS PRODUCTIVOS (MANO DE OBRA, MAQUINARIA, EQUIPO, E - INSTALACIONES), FINANCIEROS.

4.- Y POR ULTIMO CONTAR CON UNA INDUSTRIA AUXILIAR A LA OPERACION DE LOS ASTILLERO.

EL ADECUADO BALANCE EN LA CONJUGACION DE LOS FACTORES - MENCIONADOS, TRAE COMO RESULTADO,EL QUE UN ASTILLERO PUEDA OFRE- CER LOS APROPIADOS PRODUCTOS Y/O SERVICIOS, CON LA OPORTUNIDAD - DEBIDA Y A UN PRECIO ADECUADO. LO ANTERIOR HA LLEVADO A LOS AS- TILLEROS MAS EVOLUCIONADOS DEL MUNDO A ELEGIR UNA GAMA LIMITADA- DE BUQUES A CONSTRUIR, SELECCIONADOS DE PROFUNDOS ESTUDIOS DEL - MERCADO, YA QUE SUS REQUERIMIENTOS DE INVERSION SE REDUCEN, AL - LIMITAR Y APROVECHAR AL MAXIMO LOS RECURSOS PRODUCTIVOS NECESA-- RIOS Y AL MEJORAR SU PRODUCTIVIDAD Y SUS COSTOS DE PRODUCCION.LO ANTERIOR INCREMENTA NOTORIAMENTE SUS POSIBILIDADES DE OPERAR ECO NOMICAMENTE, YA QUE LA FLEXIBILIDAD QUE A OTROS LES HA PERMITIDO CONSTRUIR UNA AMPLIA GAMA DE BUQUES, HA REDUNDADO EN REQUERIMIEN TO DE UNA GRAN INVERSION, LAS MAS DE LAS VECES IRRECUPERABLE,QUE LOS HACE NO COMPETITIVOS AL NO SER SU OPERACION RENTABLE.

LA INVESTIGACION DEL MERCADO,Y LA COMERCIALIZACION DE - LOS PRODUCTOS Y/O SERVICIOS QUE SE OFREZCAN, LA PLANEACION Y LA- COTIZACION PARA LA OFERTA,Y LA PROGRAMACION Y EL PRESUPUESTO PA- RA LA PRODUCCION, ASI COMO EL CONTROL DE ESTA ULTIMA DE SUS COS- TOS, SON LAS ACTIVIDADES MAS IMPORTANTES EN EL FUNCIONAMIENTO DE LOS ASTILLEROS, YA QUE EN ELLAS RESIDEN LOS ASPECTOS CRITICOS DE SU OPERACION Y SU ADMINISTRACION Y CON CONSECUENCIA DE LOS RESUL

TADOS QUE SE OBTENGAN DE ELLAS.

LO ANTERIOR DEBIDO A UNA SERIE DE CIRCUNSTANCIAS EXTERNAS QUE ENTRE OTRAS A CONTINUACION SE SEÑALAN:

I.- EL MERCADO EN EL QUE SE OPERA ES NETAMENTE DE COMPRADORES, MUY DIVERSIFICADO EN CUANTO A LAS ESPECIFICAS DEMANDAS, E IMPLICA LA SATISFACCION DE DIFERENTES NECESIDADES EN CADA CASO.

II.- LA GRAN DIFICULTAD, Y SUSTANCIALES GASTOS INVOLUCRADOS EN SELECCIONAR Y PROMOVER UN PRODUCTO Y/O SERVICIO, QUE TENGA UNA RAZONABLE, Y POSIBLEMENTE EXITOSA ACEPTACION EN EL MERCADO.

III.-LOS IMPREVISIBLES EFECTOS QUE LA INFLACION PUEDE TENER EN LOS COSTOS DE PRODUCCION, YA QUE ENTRE LA FIRMA DE UN CONTRATO Y LA ENTREGA DE LA EMBARCACION PUEDE TRANSCURRIR UN LARGO PERIODO.

IV.- LA OFERTA INTERNACIONAL ES ALTAMENTE COMPETITIVA, EN PARTICULAR POR LAS MEDIDAS PROTECCIONISTAS DE LOS GOBIERNOS DE OTROS PAISES, A MANERA DE SUBSIDIOS GUBERNAMENTALES DIVERSOS, SOBRE EL PRECIO DE VENTA Y AUN DE EXENCIONES FISCALES Y DE FONDOS DE FINANCIAMIENTO PARA LAS VENTAS TANTO AL EXTERIOR COMO INTERNAMENTE EN EL PAIS.

V.- LOS REQUERIMIENTOS DE SUBSIDIOS PARA LA OPERACION Y FINANCIAMIENTO PARA LAS VENTAS AL INTERIOR, QUE SON -

NECESARIOS CUANDO LAS CONDICIONES DEL MERCADO LO DEMANDAN.

VI.- LA DISPONIBILIDAD, O FALTA DE ELLA, DE UNA INFRAESTRUCTURA ADECUADA QUE SOPORTE O AUXILIE LA EFECTIVA, EFICIENTE, Y COMPETITIVA OPERACION DEL ASTILLERO.

POR OTRA PARTE, DEBIDO TAMBIEN A UNA SERIE DE CIRCUNTANCIAS INTERNAS DE LOS PROPIOS ASTILLEROS, ENTRE LAS CUALES A CONTINUACION SE ENUMERAN LAS PRINCIPALES:

I.- LAS LIMITADAS CONDICIONES Y TIEMPO DISPONIBLE PARA DEFINIR UNA OFERTA Y ESTABLECER UN COMPROMISO CONTRACTUAL.

LA INCONFIABLE DURACION DE ENTREGA Y EN NO POCOS CASOS, CALIDAD DE LOS MATERIALES Y PARTES COMPONENTES A UTILIZARSE, DIFICULTAN E IMPOSIBILITAN EL AVANCE PROGRAMADO DE LA CONSTRUCCION Y/O REPARACION, LO QUE REDUNDA EN CICLOS REPETITIVOS DE INCUMPLIMIENTO TANTO DE LOS COMPROMISOS CONTRACTUALES DE TERMINACION, PRUEBAS Y ENTREGA DE LAS EMBARCACIONES, COMO DE LAS ETAPAS TAMBIEN CONTRACTUALES DE COBRO PARCIAL DE LAS MISMAS.

II.- LA GRAN DIVERSIDAD Y COMPLEJIDAD DE ACTIVIDADES QUE IMPLICA EL PROCESO PRODUCTIVO EN LA OPERACION DEL ASTILLERO Y LA GRAN DIFICULTAD QUE REPRESENTA EL OPTIMIZAR LA UTILIZACION DE LOS RECURSOS DISPONIBLES, AL ATENDER ; EN PARTICULAR, UNA AMPLIA GAMA DE EMBARCACIONES A CONSTRUIR Y REPARAR QUE, POR LA INDOLE DEL

MERCADO, ES CONDICION NORMAL EN UN ASTILLERO.

IV.- EL EXTRICTO CONTROL DE DISPONIBILIDAD OPORTUNA DE LA INFORMACION TECNICA Y DE UN GRAN NUMERO Y VARIEDAD - DE MATERIALES Y PARTES COMPONENTES DE ORIGEN DIVERSO QUE SE INVOLUCRA EN LA CONSTRUCCION Y REPARACION NAVAL EN UN PERIODO LIMITADO.

V.- UN TIEMPO DE ENTREGA CONTRACTUAL, SUJETO A PENALIZACION POR EXTEMPORANEIDAD.

VI.- LA SUSTANCIAL CARGA FIJA QUE IMPLICA LA DISPONIBILIDAD DE COSTOSAS INVERSIONES EN RECURSOS PRODUCTIVOS- ESPECIALIZADOS (INCLUYENDO PLANILLA BASE DE PERSONAL) PARA ATENDER, DENTRO DE UNA OFERTA MUY COMPETIDA Y - MUY DIFICIL DE SATISFACER.

VII.- UN LIMITADO MARGEN DE UTILIDAD BRUTA Y NETA, DEBIDO- POR UNA PARTE, A QUE LOS CONTRATOS DE CONSTRUCCION SE OBTIENEN POR LO REGULAR, COMO RESULTADO DE GANAR CONCURSOS DE LICITACION INTERNACIONAL, Y POR OTRA A LA - GRAN COMPETENCIA EXISTENTE ENTRE LAS OFERTAS CONCURSANTES.

RAZONES COMO LAS ANTERIORMENTE EXPUESTAS, PERMITEN SEÑALAR LAS IMPORTANTES DIFERENCIAS QUE HAY ENTRE LA OPERACION DE UN - ASTILLERO Y LA DE CUALQUIER OTRA EMPRESA INDUSTRIAL, CUYOS PROCESOS SON LIMITADOS, FIJOS Y CONTINUADOS Y CUYO MERCADO Y CONDICIONES COMERCIALES PUEDEN SER Y DE HECHO, SON CONTROLADAS POR LAS MISMAS.

EL CONCEPTO DEL ASTILLERO MODERNO, LO SEÑALA COMO UNA IN

CONEXAS Y AFINES A LA NAVAL QUE CONTRIBUYEN AL DESARROLLO SOCIO-ECONOMICO DEL PAIS.

ES DE MONIO PUBLICO, DENTRO DEL AMBITO DE LA ECONOMIA INTERNACIONAL, EL HECHO DE QUE LA EVOLUCION DE LOS PAISES ALTAMENTE DESARROLLADOS Y LOS EN VIAS DE DESARROLLO, HA ESTADO INTIMAMENTE LIGADA A SUS CRECIENTES CAPACIDADES PARA ATENDER Y SATISFACER, CON UN GRADO SUSTANCIAL DE AUTOSUFICIENCIA, SUS NECESIDADES DE COMERCIO MARITIMO Y DE EXPLOTACION Y VIGILANCIA DE SUS RECURSOS MARINOS, Y CONSECUENTEMENTE DE LA CONSTRUCCION Y/O REPARACION DE SUS FLOTAS REQUERIDAS PARA LOS VARIOS EFECTOS, HABIENDO REPORTADO LOS SIGUIENTES BENEFICIOS:

A) LA CREACION DE MAS Y/O MEJORES INDUSTRIAS, CON INCREMENTO DE LA CAPACIDAD Y LA DIVERSIFICACION PRODUCTIVA DE LAS MISMAS.

B) LA REDUCCION DEL DESEMPLEO, AL MULTIPLICARSE LAS FUENTES DE TRABAJO Y CON MOTIVO DEL USO INTENSIVO DE MANO DE OBRA CARACTERISTICO DE LA INDUSTRIA EN GENERAL.

C) LA ELEVACION DEL NIVEL TECNOLOGICO INDUSTRIAL, Y EL MEJORAMIENTO SOCIO-ECONOMICO DEL PAIS, AL REQUERIRSE, POR UNA PARTE, PERSONAL TECNICO Y PROFESIONAL Y MANO DE OBRA ALTAMENTE CALIFICADOS, Y POR OTRA PARTE, A LAS DERRAMAS MONETARIAS A NIVELES LOCAL, REGIONAL Y NACIONAL, POR CONCEPTOS DE SUELDOS Y SALARIOS Y DE EROGACIONES PARA ADQUISICIONES DE MATERIALES, Y PRODUCTOS SEMIACABADOS O ACABADOS, RESPECTIVAMENTE.

D) EL MEJORAMIENTO DE LA BALANZA GENERAL Y DE PAGOS, DEBIDO AL AHORRO Y A LA CAPTACION DE DIVISAS AL SUSTITUIR IMPORTACIONES Y PODER EXPORTAR PRODUCTOS Y/O SERVICIOS NACIONALES, RESPECTIVAMENTE.

ACTUALMENTE EXISTEN EN EL PAIS CIENTO CUARENTA Y CINCO ASTILLEROS, DE LOS CUALES SESENTA, SE ENCUENTRAN EN EL LITORAL DEL PACIFICO, Y OCHENTA, EN EL GOLFO PUEDEN CONSIDERARSE REALMENTE ASTILLEROS. LO ANTERIOR, POR CONTAR CON LOS RECURSOS SUFICIENTES,O AL MENOS BASICOS, Y ATENDER, AUNQUE EN DIVERSA PROPORCION, TANTO A LA CONSTRUCCION COMO A LA REPARACION DE EMBARCACIONES. EL RESTO (125) LO CONSTITUYEN TALLERES QUE PRESTAN SERVICIOS DE REPARACION Y MANTENIMIENTO A LAS FLOTAS PESQUERAS Y DEPORTIVAS, Y NO CUENTAN SIQUIERA, CON RECURSOS ADECUADOS NI SUFICIENTES PARA EL EFECTO.

LA MAYOR ACTIVIDAD DE LOS VEINTE ASTILLEROS PRINCIPALES DEL PAIS HA SIDO FUNDAMENTALMENTE LA DE REPARACION, POR UNA PARTE DE LAS FLOTAS MAYORES Y MEDIANAS NACIONALES Y DE ALGUNAS EMBARCACIONES EXTRANJERAS, Y POR OTRA PARTE, DE NUESTRA FLOTA PESQUERA EN GENERAL.

LA ACTIVIDAD DE CONSTRUCCION NAVAL DE DICHOS ASTILLEROS, AUNQUE INTENSA EN ALGUNAS OCASIONES, HA SIDO NORMALMENTE ERRATICA, HABIENDO TENIDO LOS ASTILLEROS MAYORES, LAS MAS DE LAS VECES, QUE DIVERSIFICAR SU PRODUCCION A OTRAS LINEAS METAL-MECANICAS NO ESPECIFICAMENTE NAVALES, POR CARENCIA DE DEMANDA EN EL MERCADO DEL RAMO.

NO FUE, SINO HASTA PRINCIPIOS DE LA DECADA EN CURSO QUE LA ACTIVIDAD DE CONSTRUCCION NAVAL EN MEXICO RECIBIO EL IMPULSO MAS EFECTIVO EN SU HISTORIA, CON MOTIVO DEL DECRETO PRESIDENCIAL QUE DISPUSO LA CONSTRUCCION DE 500 EMBARCACIONES PESQUERAS QUE PROPORCIONARON 5 AÑOS CONTINUOS DE INTENSO TRABAJO SIN PARALELO, Y QUE AUNADAS A OTROS TRABAJOS DIVERSOS DE CONSTRUCCION NAVAL, EXISTENTES EN EL PERIODO ALUDIDO, LA SACARON DEL LETARGO EN QUE SE ENCONTRABA, PERMITIENDO QUE LOS DEDICADOS A CONSTRUIR EMBARCACIONES PEQUEÑAS, SE REACONDICIONARAN Y EVOLUCIONARAN. LOS ASTILLEROS MAYORES SIN EMBARGO NO PUDIERON CAPITALIZAR LA EXPERIENCIA EN TODA SU MAGNITUD, DEBIDO, A QUE EN CIERTO MODO, DESVIRTUARON SU EVOLUCION AL SUBUTILIZAR LAS FACILIDADES Y LOS RECURSOS PRODUCTIVOS CON QUE CONTABAN, PARA LA CONSTRUCCION DE EMBARCACIONES MEDIANAS, EN OTRAS MAS BIEN PEQUEÑAS.

A LA FECHA, LA ACTIVIDAD NAVAL INDUSTRIAL EN EL PAIS, CONSISTE EN LA CONSTRUCCION DE ALREDEDOR DE 80 EMBARCACIONES DE DIVERSO TAMAÑO Y TIPO (CAMARONEROS, SARDINEROS, ATUNEROS, ETC.) EN SU MAYORIA DE CASCO DE ACERO DESTINADAS PARA ARMADORES COOPERATIVIZADOS Y ALGUNOS PARTICULARES, ADEMAS DE 3 REMOLCADORES PARA PEMEX Y DIEZ BUQUES PATRULLA DE FIBRA DE VIDRIO PARA LA ARMADA DE MEXICO. LO ANTERIOR REPRESENTA UNA UTILIZACION DE LA CAPACIDAD PRODUCTIVA ANUAL DE LOS PRINCIPALES ASTILLEROS EN CONJUNTO DE UN 30 A UN 35%.

ES ASI, QUE A LA FECHA, LOS PRINCIPALES ASTILLEROS NACIONALES REPETIDAMENTE ALUDIDOS SE ENCUENTRAN COMO SIGUE:

A) 8 (ASTILLEROS FEDERALES MANEJADOS POR LA SECRETARIA

DE MARINA DISTRIBUIDOS ESTRATEGICAMENTE A LO LARGO DE AMBOS LITORALES. ASTILLEROS QUE CUENTAN CON FACILIDADES Y RECURSOS PRODUCTIVOS ADECUADOS PARA CONSTRUIR Y REPARAR (EN CARENA Y/O A FLOTE) EMBARCACIONES DE DIVERSOS TIPOS DE HASTA DE 3500 TPM. EN EL LITORAL DEL GOLFO Y DE HASTA 2500 TPM. EN EL DEL PACIFICO, DANDOLES SERVICIOS DE REPARACION ANUALMENTE, A 100 UNIDADES DE LA ARMADA DE MEXICO, Y HA 337 UNIDADES DE LA MARINA MERCANTE, TRANSPORTES MARITIMOS NACIONALES Y EXTRANJEROS, EMBARCACIONES PESQUERAS, TANTO DEL SECTOR PUBLICO COMO EL PRIVADO CON UN VOLUMEN DURANTE EL AÑO PROXIMO PASADO DE 409,071 TBR. EN REPARACIONES, ADEMAS DE EFECTUAR TRABAJOS METAL-MECANICOS HA DIVERSOS ORGANISMOS Y ENTIDADES DEL GOBIERNO FEDERAL, DEL ORDEN DE LAS 1000 TONS. ANUALES. LO ANTERIOR CON UNA FUERZA TOTAL DE TRABAJO DE 3165 HOMBRES, ENTRE PERSONAL ADMINISTRATIVO Y DE OPERACION.

B) NUEVE ASTILLEROS ENTRE PARAESTATALES Y DESCENTRALIZADOS MANEJADOS EN LA FORMA SIGUIENTE:

POR AUSA (2), BANFOCO (2), PROPE-MEX (4) Y EL SINDICATO DE PEMEX (1).

ASTILLEROS DEDICADOS TANTO A LA CONSTRUCCION COMO A LA REPARACION DE EMBARCACIONES BASICAS PESQUERAS DE DIVERSOS TAMAÑOS Y TIPOS AUNQUE ALGUNOS SE DEDICAN EXCLUSIVAMENTE A ESTA ULTIMA, Y QUE CUENTAN CON FACILIDADES Y RECURSOS PRODUCTIVOS SUFICIENTES, CON CAPACIDAD PARA EMBARCACIONES HASTA DE 750 TBR. LOS DEL PACIFI-

CO Y HASTA DE 55,000 TBR. EN EL GOLFO, AUNQUE, EN UN FUTURO SE EXTENDERA HASTA 80,000 TBR. EN EL DE VERACRUZ, QUE SE PROYECTA PARA ATENDER A LA FLOTA MAYOR DE PEMEX. DE DICHOS ASTILLEROS LOS MENORES DAN ANUALMENTE SERVICIOS DE REPARACION Y MANTENIMIENTO AL 20% DE LAS FLOTAS NACIONALES TANTO DEL SECTOR PUBLICO COMO DEL PRIVADO, Y OCACIONALMENTE A UNAS CUANTAS EXTRANJERAS DE PASO POR EL PUERTO DE VERACRUZ, LO ANTERIOR CON UNA FUERZA DE TRABAJO DEL ORDEN DE LOS 4400 HOMBRES APROXIMADAMENTE.

c) OCHO ASTILLEROS PRIVADOS, CUATRO DE ELLOS UBICADOS EN EL NORESTE DEL PAIS Y LOS RESTANTES A LO LARGO DEL GOLFO DE MEXICO, ASTILLEROS DEDICADOS TANTO A LA CONSTRUCCION COMO A LA REPARACION DE EMBARCACIONES PESQUERAS CON CASCO DE ACERO Y MADERA, QUE CUENTAN CON LAS FACILIDADES Y LOS RECURSOS PRODUCTIVOS BASICOS PARA EMBARCACIONES DE HASTA 80 TONS. DE DESPLAZAMIENTO Y PROPORCIONAN LOS SERVICIOS DE REPARACION Y MANTENIMIENTO AL 30% DE LAS FLOTAS PESQUERAS DE AMBOS LITORALES.

D) POR LO QUE SE REFIERE A LA ACTIVIDAD DE CONSTRUCCION NAVAL, LA CAPACIDAD ANUAL DE LOS SECTORES DE LA INDUSTRIA, ARRIBA SEÑALADOS, CONSISTE EN LA DE 56 EMBARCACIONES DE 80 T. DE DESPLAZAMIENTO POR EL FEDERAL, A CARGO DE LA SECRETARIA DE MARINA, DE 150 DE EMBARCACIONES DE 80 TONS. POR EL PARAESTATAL, A CARGO DE AUSA Y BANFOCO. Y DE 220 EMBARCACIONES DE 80 TONS. DE DESP. POR EL PRIVADO.

CABE HACER NOTAR QUE LA CAPACIDAD DE LOS ASTILLEROS DE QUE SE TRATA,

EXPRESADA EN TERMINOS PRODUCTIVOS Y TECNOLOGICOS, SE HALLA FINCADA EN EL NIVEL DE SUS FACILIDADES Y RECURSOS PRODUCTIVOS, PERO SOBRE-TODO EN EL NIVEL DE LOS CONOCIMIENTOS Y DE LA EXPERIENCIA LOGRADOS CON GRAN DEDICACION Y DENODADOS ESFUERZOS A TRAVEZ DE LOS ULTIMOS-TREINTA AÑOS POR SUS PARTICIPANTES Y QUE LO QUE A LA FECHA EXISTE, ES EL RESULTADO DE UN PROCESO EVOLUTIVO DE PRUEBA Y ERROR QUE NECESARIAMENTE, TENIA QUE SER ASI. LO ANTERIOR, DEBIDO A QUE NUNCA HA-EXISTIDO UN CONTINUADI Y DECISIVO RESPALDO PARA LA INDUSTRIA, EN - FUNCION DE UN OBJETIVO SOCIO-ECONOMICO A ALCANZAR A NIVEL NACIONAL, SINO A INQUIETUDES DE GRUPOS AISLADOS CUYA VIDA Y META SON LAS ACTIVIDADES PARA SATISFACER LAS NECESIDADES MARITIMAS DEL PAIS, QUE-TRADICIONAL Y FUNDAMENTALMENTE HAN SIDO IMPULSADAS Y MANEJADAS POR PROFESIONALES DE ESTE CAMPO NO SOLO EN MEXICO, SINO EN EL MUNDO ENTERO.

POR ULTIMO, LOS TERMINOS PRODUCTIVOS Y TECNOLOGICOS QUE - CONDICIONAN LA CAPACIDAD REAL ACTUAL DE LA INDUSTRIA NAVAL NACIONAL, SE REFIEREN A LAS CIRCUNSTANCIAS EXTERNAS E INTERNAS SEÑALADAS EN EL APARTADO ANTERIOR Y DETERMINAN LOS RESULTADOS QUE SE OBTIENEN EN LA OPERACION Y ADMINISTRACION DE LOS ASTILLEROS. EN ESTE CONTEXTO SE PUEDE ASEVERAR QUE LOS RESULTADOS SECTORIALES DE LA INDUSTRIA NAVAL EN EL PAIS EVIDENCIAN POR SI SOLOS LA TRAYECTORIA - QUE HA TENIDO LA MISMA A LA FECHA Y LA ORRIENTACION QUE NECESITA - PARA NO DEFERIR MAS SU EVOLUCION.

EN PARTICULAR, ES IMPORTANTE EL HECHO DE QUE EXISTE EN EL PAIS UNA INFRAESTRUCTURA DE LA INDUSTRIA NAVAL QUE, AUNQUE INCIPIENTEMENTE, SI LA COMPARAMOS CON LOS PAISES DESARROLLADOS O EN ETAPAS

MAS AVANZADAS QUE LA NUESTRA DE LOS EN VIAS DE DESARROLLO, SE CONSIDERA RAZONABLE, PARA SUSTENTAR UNA ETAPA MAS DE EVOLUCION HACIA NUESTRA INDEPENDENCIA TECNOLOGICA E INTEGRACION NACIONAL EN EL CAMPO NAVAL. LO QUE ES NECESARIO LLEVAR A CABO, ES CAPITALIZAR LOS CONOCIMIENTOS Y LA EXPERIENCIA CON QUE LOS VARIOS SECTORES DEL PAIS CUENTAN EN EL RAMO, PRIORIZANDO LA INGERIENCIA DE CADA SECTOR, DE ACUERDO A SU GRADO DE PREPARACION PARA EL EFECTO.

HIPOTESIS DE DESARROLLO

LA INFRAESTRUCTURA QUE ES PRECISO ESTABLECER PARA EL DESARROLLO DE LA INDUSTRIA NAVAL SE PUEDE, SIMPLIFICANDO, CIRCUNSCRIBIR EN CUATRO GRANDES RUBROS:

A) DESARROLLO DE LA MARINA NACIONAL

B) ADECUACION DE INSTALACIONES EXISTENTES

C) CAPACITACION Y DESARROLLO DE RECURSOS HUMANOS

D) FOMENTO DE LA INDUSTRIA NAVAL AUXILIAR

TODO LO ANTERIOR RESPALDADO POR UNA SERIE DE POLITICAS NACIONALES QUE LE DEN COHERENCIA DENTRO DEL AMBITO SOCIO-ECONOMICO DEL PAIS.

A) <u>DESARROLLO DE MARINA NACIONAL</u>

MEXICO ES UN PAIS CON CRECIENTES NECESIDADES DE DESARROLLO DE SU MARINA NACIONAL, EN TODOS LOS ORDENES. LA MARINA MERCANTE EN-ESPECIAL, DEBE ATENDER EL RETO QUE SIGNIFICA EL INCREMENTO DE NUESTRAS POSIBILIDADES DE EXPORTACION, DE NUESTRA POLITICA DE DIVERSIFICACION DE MERCADOS, CAPTACION DE DIVISAS, E INDEPENDENCIA DECISORIA DENTRO DEL AREA ECONOMICA.

LAS RAZONES HISTORICAS POR LAS CUALES NO SE HAN DESARROLLADO LAS FLOTAS TRASATLANTICAS QUE DE NUESTRA VARIEDAD DE RECURSOS Y EXTENCION DE LITORALES PODRIA ESPERARSE, SON MUCHAS Y DIVERSAS, SIN EMBARGO, COMO MAS SIGNIFICATIVAS SE CONSIDERAN LAS SIGUIENTES:

1.- LA DISPOSICION DEL GOBIERNO DEL REY CARLOS II DE ESPAÑA A MEDIADOS DEL SIGLO 18 DE QUE TODO EL COMERCIO ENTRE ESA NACION Y LA NUEVA ESPAÑA SE HICIESE EN BUQUES ESPAÑOLES.

2.- LA POBREZA DE NUESTRO COMERCIO EXTERIOR POR VIA MARITIMA DURANTE EL PRIMER SIGLO DE VIDA INDEPENDIENTE DEL PAIS.

3.- LA IMPORTANCIA GEOECONOMICA DE NUESTRA VECINDAD CON LOS ESTADOS UNIDOS DE NORTEAMERICA.

EN LA ACTUALIDAD NUESTRO PAIS HA LOGRADO EL DESARROLLO DE UNA FLOTA MERCANTE DE CIERTA IMPORTANCIA DESTACANDO DESDE LUEGO DE ENTRE ELLAS LA DE PEMEX, LA DE LA INDUSTRIA PESQUERA EN GENERAL, LAS DE TRANSPORTACION MARITIMA Y NAVIMEX, EN SU MAYOR PARTE LAS CUALES EN TERMINOS GENERALES TIENEN SOLO, MEDIA VIDA UTIL.

ASI MISMO SE DEBE MENCIONAR DENTRO DEL CONTEXTO "DESARROLLO DE LA MARINA NACIONAL" LO CORRESPONDIENTE A LAS FLOTAS DE DRAGADO, TRANSBORDADORES Y LAS DE LA MARINA DE GUERRA. ESTA ULTIMA EN ESPECIAL EN CONDICIONES TALES, QUE REQUIEREN PRACTICAMENTE DE UNA RENOVACION MAYOR.

LA PROBLEMATICA ACTUAL DE LA MARINA NACIONAL, PUEDE CONCRETARSE COMO SIGUE:

1.- FALTA DE UNA POLITICA REGULADORA QUE COORDINE LOS DIFERENTES SECTORES DE ESTA ACTIVIDAD.

2.- FALTA DE PROMOCION PARA EL INCREMENTO DE LA VOCACION MARITIMA.

3.- RECURSOS ECONOMICOS INSUFICIENTES ASIGNADOS A LA MARINA NACIONAL EN GENERAL.

B) ADECUACION DE LAS INSTALACIONES EXISTENTES

EN MEXICO EXISTE ACTUALMENTE UNA DEMANDA REAL Y NUMEROSA DE EMBARCACIONES DE MUY DIFERENTES CARACTERISTICAS QUE SON DESDE EL BUQUE PESQUERO EN SUS DIFERENTES ESPECIALIDADES, (CAMARONERO, HUACHINANGERO, ATUNERO, ETC.) HASTA EL SUPER TANQUE, ENTRE ESTOS DOS GRANDES EXTREMOS EXISTE UNA ENORME VARIEDAD DE BUQUES QUE SE ENCUENTRAN DENTRO DE LAS POSIBILIDADES ACTUALES DE LOS ASTILLEROS NACIONALES PARA CONSTRUIRLOS, HACIENDOLES LAS ADECUACIONES NECESARIAS A SUS INSTALACIONES, DENTRO DE ESTAS CARACTERISTICAS, SE ENCUENTRAN LOS TRANSBORDADORES, REMOLCADORES, DRAGAS, BUQUES ABASTECEDORES, BARCAZAS DE PERFORACION DE PETROLEO, CHALANES, BUQUES FRIGORIFICOS, BUQUES DE GUERRA ETC. EL ENTRAR DE LLENO A LA SATISFACCION DE ESTAS NECESIDADES PERMITIRIA.

1.- UN MEJOR Y MAS RACIONAL APROVECHAMIENTO DE LA CAPACIDAD INSTALADA DE LA INDUSTRIA NAVAL NACIONAL.

2.- CREACION DE POLOS DE DESARROLLO EN LAS COSTAS QUE ALIVIARAN EN ALGO LA PRESION DEMOGRAFICA EN LOS GRANDES ASENTAMIENTOS HUMANOS DEL PAIS, YA QUE ESTA INDUSTRIA Y SU AUXILIAR DEMANDAN GRANDES CANTIDADES DE MANO DE OBRA.

3.- DESARROLLO DE LA INDUSTRIA NAVAL AUXILIAR.

4.- OBTENCION DE LA EXPERIENCIA TECNOLOGICA NECESARIA -

QUE NOS PERMITA ABORDAR PROYECTOS DE MAYOR EMBERGADURA. -

C) CAPACITACION Y DESARROLLO DE RECURSOS HUMANOS

LA FALTA DE UN DIAGNOSTICO VERAZ DE LA SITUACION EN QUE QUE SE ENCUENTRA LA POBLACION DEDICADA A LABORAR EN LA INDUSTRIA NAVAL,- A OCACIONADO QUE LOS ESFUERZOS QUE SEHAN HECHO POR CAPACITAR Y DESARROLLAR ESTE RECURSO HAN SIDO TRADICIONALMENTE, AISLADOS, AJENOS A - LAS VERDADERAS NECESIDADES Y CON RESULTADOS GENERALMENTE DESALENTADORES.

ACTUALMENTE LA FUERZA, COMPUESTA, DE OBREROS, TECNICOS ESPECIALISTAS E INGENIEROS ES FORMADA BAJO DIFERENTES CRITERIOS, EN DIFERENTES INSTITUCIONES EDUCATIVAS, RECLUTADA, GENERALMENTE EN CIERTO - MODO, EN FORMA ANARQUICA.

LA INFRAESTRUCTURA EDUCATIVA AL PRESENTE ESTA FORMADA, PARA EL NIVEL OBRERO POR LOS DIFERENTES CENTRO DE FORMACION TECNOLOGICA - COMO LOS C.E.C.A.T.IS. Y E.T.I.S. PARA EL NIVEL MEDIO SUPERIOR LOS - C.E.C.E.T. Y S. Y EL SISTEMA DE ESCUELAS TECNOLOGICAS, ADEMAS SE - - CUENTAN CON EL APORTE MUY IMPORTANTE DE LAS ESCUELAS NAVAL Y NAUTICAS Y EN MENOR NUMERO PERO NO MENOS IMPORTANTE EL DE LAS UNIVERSIDADES,- NACIONAL Y ESTATALES, E INSTITUTO POLITECNICO NACIONAL, Y EN ESPECIAL SE DEBE MENCIONAR A LA UNIVERSIDAD VERACRUZANA, QUE DENTRO DE LA FACULTAD DE INGENIERIA TIENE LA CARRERA DE INGENIERO NAVAL, ESPECIALIDAD QUE NECESARIAMENTE TENIA QUE OBTENERSE EN EL EXTRANJERO.

LA SECRETARIA DE MARINA, DENTRO DE SU PLAN DE EDUCACION NAVAL, ESTA IMPLEMENTANDO UN SISTEMA DE CAPACITACION Y DESARROLLO DE - RECURSOS HUMANOS PARA LA INDUSTRIA NAVAL, PARA LA ATENCION DE TRES -

NIVELES BASICOS, 1º OBRERO CALIFICADO, 2º SUPERVISOR DE CAMPO, Y 3º INGENIERO DE CAMPO, ACTUALMENTE EL PRIMER NIVEL SE ENCUENTRA YA EN SU FASE OPERATIVA, HABIENDO EGRESADO EN EL PASADO MES DE DICIEMBRE 50 ELEMENTOS OBREROS EN DIFERENTES ESPECIALIDADES DEL CENTRO DE CAPACITACION TECNICA PARA LA INDUSTRIA NAVAL " CONTRALMIRANTE ING. NAV. FELIX ARRUTI ITURRIOTZ ".

COMO SE PODRA OBSERVAR POR LO ANTERIOR, EXISTEN LAS CONDICIONES BASICAS PARA QUE EN ESTA AREA NUESTRO PAIS, SEA AUTOSUFICIENTE TECNOLOGICAMENTE DENTRO DE LA ESPECIALIDAD, SIMPLEMENTE SE CONSIDERA QUE DEBERA SER ESTABLECIDO LO SIGUIENTE:

1.- UN CENTRO DE ENTRENAMIENTO PARA LA INDUSTRIA NAVAL.

2.- UN LABORATORIO EXPERIMENTAL DE MODELOS, SISTEMAS PROPULSORES, Y METALURICA, QUE FORMARIA PARTE DEL CENTRO DE ENTRENAMIENTO.

1.1.- EL CENTRO DE ENTRENAMIENTO PARA LA INDUSTRIA NAVAL CONTEMPLARIA LA PREPARACION EN EL NIVEL OBRERO DE INSTRUCTORES EN LAS SIGUIENTES ESPECIALIDADES:

a) FRESA

b) TORNO

c) AJUSTE EN BLANCO

d) ERECCION DE MAQUINAS

e) REFRIGERACION

f) MOLDEO Y FUNDICION

g) FORJA

h) TUBERIAS

i) EBANISTERIA

j) CARPINTERIA DE MODELOS

k) MAQUINAS ELECTRICAS

l) INSTRUMENTACION Y CONTROLES

m) DISTRIBUCION ELECTRICA

n) CARPINTERIA DE RIVERA

ñ) CARPINTERIA DE GALIBOS

o) DIBUJO INDUSTRIAL Y NAVAL

p) SOLDADURA Y PAILERIA

q) ELECTRONICA

1.2.- ADEMAS DE ESTAS ESPECIALIDADES DEL CURSO BASICO, SE IMPARTIRAN- TECNICAS DE SUPERVISION PARA LAS CORRESPONDIENTES AREAS.

1.3.- EL CURSO SUPERIOR CONTEMPLARIA BASICAMENTE, LO REFERENTE A LAS- DIFERENTES TECNICAS DE CONTROL ADMINISTRATIVO DE LOS DIFERENTES RECURSOS E INSUMOS UTILIZADOS POR LA INDUSTRIA.

2.- EL LABORATORIO EXPERIMENTAL PERMITIRIA A LOS DIFERENTES ESPECIALISTAS DEL AREA DESARROLLAR MODELOS HASTA LOGRAR PROTOTIPOS QUE DESDE EL PUNTO DE VISTA TECNOLOGICO SERIAN TOTALMENTE NUESTROS, CON EL CONSIGUIENTE BENEFICIO DE LOGRAR NUESTRA INDEPENDENCIA EN ESTA AREA DEL- EXTRANJERO.

ESTAS DOS CONSIDERACIONES QUE REQUIEREN SER IMPLEMENTADAS PARA LOGRAR LA INFRAESTRUCTURA, EN CUANTO A RECURSOS HUMANOS SE REFIERE PARA LA INDUSTRIA NAVAL, ESTAN EN LA ACTUALIDAD EN SUS INICIOS YA ESTABLECIDAS, PUESTO QUE LA SECRETARIA DE MARINA CUENTA CON LOS PROGRAMAS HE INSTALACIONES NECESARIAS, COMO ES EL CENTRO DE CAPACITACION - TECNICA PARA LA INDUSTRIA NAVAL YA MENCIONADO Y LA UNIVERSIDAD VERA--

CRUZANA CON LA MAQUINARIA Y EQUIPO PARA EL LABORATORIO HIDRO-DINAMICO (TANQUE DE PRUEBAS) PREREQUISITOS PARA ESTABLECER EL "PLAN NACIONAL DE EDUCACION TECNOLOGICA PARA LA INDUSTRIA NAVAL".

D) FOMENTO DE LA INDUSTRIA NAVAL AUXILIAR

SE RECONOCE CON EL NOMBRE GENERICO DE INDUSTRIA NAVAL AUXILIAR AQUELLA DEDICADA A LA PRODUCCION DE PARTES Y SERVICIOS QUE SERAN DEDICADOS A LA CONSTRUCCION Y REPARACION NAVAL Y QUE EN SU ORIGEN, NO ES ESPECIFICAMENTE, PARA LA INDUSTRIA NAVAL.

DURANTE LA DECADA PASADA Y LO QUE VA DE LA EN CURSO CONSECUENCIA AL GRAN IMPULSO DADO A LA INDUSTRIA NAVAL, CON EL FOMENTO A LA PESCA QUE ORIGINO ORDENES DE CONSTRUCCION DE BUQUES PESQUEROS POR MAS DE QUINIENTOS, SE PROPICIO EL NACIMIENTO DE UNA INDUSTRIA AUXILIAR A LA NAVAL, FORMANDOSE ALGUNAS EMPRESAS PRIVADAS QUE ACTUALMENTE FABRICAN DIVERSOS COMPONENTES Y PROPORCIONAN SERVICIOS VARIOS A LOS DIFERENTES ASTILLEROS DEL PAIS COMO SUBCONTRATISTAS, ASI MISMO SE DIO A QUE CIERTAS INDUSTRIAS CONEXAS Y AFINES EXISTENTES, DIVERSIFICARAN SU PRODUCCION FABRICANDO TAMBIEN MATERIALES, MAQUINARIA Y EQUIPO, Y PARTES COMPONENTES PARA EL EFECTO.

POR LO ANTERIOR SE PUEDE OBSERVAR QUE YA EXISTE UNA INFRAESTRUCTURA BASICA EN ESTE CAMPO, PERO TAMBIEN SE DEBE RECONOCER QUE ESTA ES BASTANTE LIMITADA E INSUFICIENTE EN RECURSOS HUMANOS, TECNOLOGICOS Y FINANCIEROS, ADEMAS DE QUE SU PRODUCCION ES ERRATICA DEBIDO PRINCIPALMENTE A LA CARACTERISTICA DE LA DEMANDA Y A LA DIFICULTAD PARA OBTENER LOS INSUMOS NECESARIOS EN FORMA PROGRAMADA.

PARA CONSOLIDAR PUES ESTA INDUSTRIA SE HACE NECESARIO LA TOMA DE CIERTAS MEDIDAS BASICAS.

a) DIFUSION A NIVEL NACIONAL DE LOS PROGRAMAS A CORTO MEDIANO Y LARGO PLAZO PARA LA INDUSTRIA DE CONSTRUCCION Y REPARACION NAVAL.

b) DIFUSION NACIONAL DE LAS PARTES, COMPONENTES Y SERVICIOS QUE PUEDEN Y DEBEN SER SUMINISTRADOS POR LA INDUSTRIA NAVAL AUXILIAR.

c) PROGRAMA DE ESTIMULOS FISCALES, LEGISLACION Y FINANCIAMIENTO PARA LA INDUSTRIA NAVAL AUXILIAR.

d) PUBLICACION Y DIFUSION DE UN CATALOGO DE SUMINISTRADORES DE BIENES Y SERVICIOS A LA INDUSTRIA NAVAL.

LA CONSTRUCCION NAVAL - PROCESO TRADICIONAL

LA PRIMERA PARTE A CONSIDERAR ES EL DISEÑO NAVAL, ESTE ES EL PRODUCTO DE PLATICAS, A VECES INFINITAS, DEL ARMADOR CON LOS INGENIEROS PROYECTISTAS, EN DONDE SE ESTABLECEN LOS CRITERIOS A SEGUIR PARA EL TIPO DE NAVE A CONSTRUIR, QUE EN EL CASO DE LAS DE GUERRA POR TENER QUE REUNIR DETERMINADOS REQUISITOS, LA SOLUCION DE DISEÑO ES UNICA, EN CAMBIO EL PROYECTO DE UNA EMBARCACION CIVIL O MERCANTE DA UNA SOLUCION DE COMPROMISO, ME EXPLICARE:

EL ARMADOR, AL PEDIR UNA NAVE, GENERALMENTE DA LOS SIGUIENTES DATOS:

1.- DEBE TENER UNA CAPACIDAD DE X TONELADAS DE CARGA UTIL QUE GENERALMENTE ES MUY GRANDE, PUES A MAYOR NUMERO DE TONELADAS DE CARGA TRANSPORTADAS MAYOR ES EL FLETE A COBRAR.

2.- DEBE TENER UNA ALTA VELOCIDAD, CON EL OBJETO DE QUE A IGUALDAD DE TIEMPO EFECTUE MAS VIAJES Y POR CONSIGUIENTE, MAS FLETES.

3.- DEBE TENER UN PROPULSOR DEL MENOR CABALLAJE POSIBLE, - PARA QUE LOS CONSUMOS DE COMBUSTIBLE Y LUBRICANTE ASI- COMO SU COSTO DE MANTENIMIENTO SEAN BAJOS.

ESTO COMO SE VE SE CONTRAPONE CON EL PUNTO ANTERIOR YA QUE PARA MAYOR VELOCIDAD SE NECESITA MAS POTENCIA.

4.- EL BARCO DEBE SER " COMPACTO " PARA QUE PUEDA ENTRAR A CUALQUIER PUERTO POR PEQUEÑO QUE ESTE SEA.

ESTO SE CONTRAPONE CON LA SOLICITUD PRIMERA DE CAPACIDAD - DE CARGA ABUNDANTE.

5.- TODOS LOS EQUIPOS A BORDO DEBERAN SER LOS MAS ELEMENTALES QUE EXISTAN, PARA MANTENER EL PRECIO DE LA EMBARCACION BAJO.

ESTE PUNTO, SE CONTRAPONE TAMBIEN, CON EL REQUERIMIENTO DE QUE LA OPERACION DEL BARCO SE LLEVE A CABO CON EL MENOR NUMERO DE - TRIPULANTES POSIBLE, ES DECIR AUTOMATIZARLA AL MAXIMO. Y ASI PODRIAMOS SEGUIR ENUMERANDO LOS " REQUERIMIENTOS " DEL ARMADOR QUE NORMALMENTE SON DIAMETRALMENTE OPUESTOS DESDE LOS PUNTOS DE VISTA TECNICO Y ECONOMICO.

AL FINAL SE LLEGA A UNA SOLUCION QUE LLAMAMOS DE " COMPROMISO " QUE SATISFACE A MEDIAS " AL ARMADOR Y CON ESTA SE PROCEDE A- LA ELABORACION DE ESPECIFICACIONES Y PLANOS, Y YA CON ESTOS AL PROCESO EN SI DE LA CONSTRUCCION NAVAL.

EL PROCESO TRADICIONAL ES EL SIGUIENTE:

DE LOS PLANOS, SE PASA A LA SALA DE GALIBOS, DONDE A ESCALA REAL SE TRAZAN LAS LINEAS, PARA PRODUCIR LAS PLANTILLAS DE MADERA - QUE SE ENVIAN A LOS DIFERENTES TALLERES PARA FABRICAR LOS NUMEROSOS COMPONENTES ESTRUCTURALES DEL BUQUE. MIENTRAS TANTO, EN LAS CARPINTERIAS SE CONSTRUYEN MUEBLES, FORROS INTERIORES, ETC. LOS CONTRAMAESTRES, ELABORAN LAS JARCIAS DE MASTILES Y PLUMAS.

LAS GRANDES PIEZAS DE FORJA COMO CODASTE, BANCADAS, POLINES, CIGUEÑALES, SON FABRICADAS, Y ASI, UN GRAN PORCENTAJE DE LAS - PARTES DEL BUQUE ES HECHO EN LA PROPIA PLANTA. ESTAS PIEZAS SE - - TRANSPORTAN A LA GRADA PARA SU MONTAJE, PIEZA POR PIEZA, UNA VEZ - TERMINADA LA ESTRUCTURA QUE ES FORMADA PRINCIPALMENTE POR: LA QUILLA, CUADERNAS, MAMPAROS, VAGRAS, ESLORAS Y LONGITUDINALES, SE PROCEDE AL FORRADO DEL BUQUE. COMPLETADO EL FORRO Y AL SER CUERPO ESTANCO QUE LE PERMITE FLOTAR, DESPUES DE LA TRADICIONAL CEREMONIA, DONDE SE LE BAUTIZA ROMPIENDOSE EN LA RODA ENGALANADA UNA BOTELLA DE - CHAMPAÑA, ES BOTADO, DESLIZANDOSE SOBRE LA GRADA HACIA EL MAR, DE - DONDE SE LE REMOLCA AL MUELLE DE ARMAMENTO. DURANTE ESTE PERIODO - SE PROCEDE A INSTALAR LA MAQUINARIA PRINCIPAL Y AUXILIAR, DIFERENTES SISTEMAS DE TUBERIAS, SISTEMAS ELECTRICOS, CENTRALES, TABLEROS, MAQUINARIA DE CUBIERTA, ACABADOS INTERIORES, ETC., HASTA QUE FINALMENTE ESTA LISTO PARA EFECTUAR SUS PRUEBAS.

COMO ES FACIL DE COMPRENDER EL FACTOR LIMITANTE EN ESTE - ASTILLERO - ES EL PERIODO DE OCUPACION DE LA GRADA DE CONSTRUCCION.

HASTA LA TERMINACION Y BOTADURA DE UN CASCO NO PODRIA INICIARSE EL SIGUIENTE.

NORMALMENTE LOS ASTILLEROS CUENTAN CON GRADAS DE DIFERENTES LONGITUDES PARA CONSTRUIR DIFERENTES TIPOS Y TAMAÑOS D E BUQUES, SIMULTANEAMENTE.

NO ES SINO, HASTA LA INTRODUCCION DE LA SOLDADURA ELECTRICA, DURANTE LA SEGUNDA GUERRA MUNDIAL, QUE HAY UN NUEVO ELEMENTO SIGNIFICATIVO EN LA INDUSTRIA, ESTA, SUBSTITUYE AL REMACHE, PERMITIENDO DISMINUIR SUBSTANCIALMENTE EL NUMERO DE HORAS-HOMBRE EMPLEADOS EN LA CONSTRUCCION DEL CASCO.

ES EN ESTE PERIODO, EN EL QUE TAMBIEN SE INTRODUCE EL CONCEPTO DE LA FABRICACION EN SERIE DE BUQUES, PRE-FABRICANDO, NUMEROSOS COMPONENTES FUERA DEL ASTILLERO.

ESTO ES DEBIDO A LA GRAN IEMANDA DE BUQUES QUE ORIGINAN LOS NUMEROS HUNDIMIENTOS Y AL DISEÑO DE UN PROTOTIPO QUE ES CONSTRUIDO EN UNA GRAN NUMERO DE ASTILLEROS; EL EJEMPLO CLASICO DE ESTE BUQUE ES EL "LIBERTY" DEL CUAL FUERON CONSTRUIDOS MAS DE TRES MIM. SIN EMBARGO EL CONCEPTO DE LA CONSTRUCCION EN SERIE NO PUEDE SER APLICADO EN LA POST-GUERRA DEBIDO A QUE EL ARMADOR EXIGE LA CONSTRUCCION DE SUS BUQUES DE ACUERDO CON SUS ESPECIFICACIONES Y NECESIDADES, POR LO QUE CADA UNO ES UN PROYECTO DIFERENTE QUE OBLIGA A HACER PLANOS DE CONSTRUCCION Y DETALLE, LISTA DE MATERIALES Y PROGRAMA DE CONSTRUCCION.

OTRO EJEMPLO DE PROTO-TIPO CONSTRUIDO DURANTE LA II GUERRA ES EL BUQUE TANQUE T-2 QUE TIENE UN PESO MUERTO DE 16,000 TONELADAS SIENDO EL TIPO DE BUQUES DE MAYOR CAPACIDAD DE CARGA EN LA EPOCA.

ES EN LA DECADA DE LOS CINCUENTAS CUANDO VERDADERAMENTE CAMBIAN LOS CONCEPTOS TRADICIONALES DE LA CONSTRUCCION Y DISEÑO DE

LOS BUQUES. SON VARIOS LOS ELEMENTOS QUE CONTRIBUYEN Y DIFERENTES LOS LUGARES.

EN EUROPA SE DESARROLLAN LAS TORRES DE TRAZADO OPTICO - QUE PROYECTAN UN PLANO DE ESCALA 1 A 10 DIRECTAMENTE SOBRE LAS - - PLANCHAS DONDE HABILES TRAZADORES PINTAN RAPIDAMENTE LAS LINEAS PARA POSTERIORMENTE PROCEDER A SU CORTE, ESTO ELIMINA EN GRAN PARTE- EL TRABAJO DE LAS TRADICIONALES SALAS DE GALIBOS Y LA CONSTRUCCION DE LAS COSTOSAS PLANTILLAS.

PERO ES EN JAPON, EN CONJUNTO CON ARMADORES AMERICANOS,- DONDE SE ORIGINAN LOS CONCEPTOS MAS TRASCENDENTALES. SE INICIA LA CONSTRUCCION DE LOS SUPER-TANQUES DE 80,000 TONELADAS DE PESO MUERTO, (ACTUALMENTE HAY EN CONSTRUCCION BUQUES DE MAS DE 500,000 TONELADAS Y PROYECTOS PARA DE 1,000.000 TONELADAS) CAMBIAN LA FILOSOFIA DEL DISEÑO HACIENDO ESPECIAL ENFASIS EN DETERMINAR LOS SISTEMAS DE PRODUCCION Y FACILITAR AL MINIMO ESTA ASI COMO HACER EL PROYECTO ESPECIFICO PARA LAS FACILIDADES Y HERRAMIENTAS CON QUE CUENTA EL ASTILLERO. INTRODUCEN EL CONCEPTO DE MODULOS Y BLOQUES DE -- GRANDES DIMENSIONES, DONDE INCORPORAN LOS ELEMENTOS, COMO SISTEMAS - DE TUBERIAS, ELECTRICOS Y TERMINADOS INTERIORES, QUE ANTERIORMENTE SE HACIAN EN EL PERIODO DE ARMAMENTO Y QUE SON CONSTRUIDOS FUERA - DE LAS GRADAS DE CONSTRUCCION, AL TERMINAR TODOS LOS BLOQUES DE - QUE CONSTA EL BUQUES CON GRANDES MEDIOS DE IZAJE (GRUAS CON CAPACIDAD DE 800 TONELADAS Y MAS) SON MONTADOS SOBRE LA GRADA, LO - QUE PERMITE DISMINUIR RADICALMENTE EL PERIODO DE UTILIZACION DE - LA GRADA POR BUQUES, Y ASI, DE UN GOLPE, MULTIPLICAN LA CAPACIDAD- DEL ASTILLERO POR 5 O 6 VECES.

POSTERIORMENTE NACE EL ASTILLERO EXCLUSIVO PARA CONSTRUCCION NUEVA, DESLIGANDOLO DE LA REPARACION NAVAL Y LA FABRICACION DE PRODUCTOS INDUSTRIALES QUE SIEMPRE HABIAN ESTADO LIGADOS ESTRECHAMENTE, CON OBJETO DE UTILIZAR AL MAXIMO EL EQUIPO INSTALADO.

LAS TECNICAS SIGUEN MODIFICANDOSE RAPIDAMENTE, SE ESTANDARISAN GRAN PARTE DE LOS COMPONENTES DEL BUQUE COMO PUERTAS, ESTANCAS, REGISTROS, VENTANAS, VENTILAS, ESCALAS, Y ESCALERAS, ETC.

LA TORRE OPTICA ES SUBSTITUIDA PRIMERO POR LA MAQUINA AUTOMATICA DE OXICORTE QUE CON UNA CELDA FOTO ELECTRICA SIGUE LAS LINEAS DE PLANOS A ESCALA 1 A 10 Y POCO DESPUES SE INTRODUCE EL CONTROL NUMERICO, DONDE LOS DIBUJOS SE PROGRAMAN SIGUIENDO UN SISTEMA DE COORDENADAS QUE SE TRANSFORMAN EN UNA CINTA PERFORADA LA CUAL ALIMENTA LA MAQUINA DE CORTE.

LAS COMPUTADORAS SE UTILIZAN EXHAUSTIVAMENTE EN EL DISEÑO, PROGRAMACION Y OPERACION DE LOS ASTILLEROS.

ANTE LA GRAN DEMANDA DE TONELAJE LOS ASTILLEROS TIENDEN A ESPECIALIZARSE POR TIPO Y TAMAÑO DE BUQUES.

PARALELAMENTE APARECEN UNA SERIE DE BUQUES ALTAMENTE ESPECIALIZADOS Y AUTOMATIZADOS COMO PORTA-CONTAINERS, LASH, BUQUES TANQUES PARA TRANSPORTES LICUADOS A PRESION ATMOSFERICA, ETC.

DESPUES DE ESTA BREVE EXPLICACION DE LA EVOLUCION DE LA INDUSTRIA NAVAL, TRATAREMOS DE DESCRIBIR LOS CONCEPTOS BASICOS INTRODUCIDOS EN LA PLANEACION Y ORGANIZACION DE UN ASTILLERO DONDE SE INTRODUCEN LAS TECNICAS ACTUALES.

FILOSOFIA BASICA

LA INDUSTRIA DE LA CONSTRUCCION NAVAL COMO YA SE DIJO, ES

UNA INDUSTRIA DE SINTESIS.

LA PLANTA INDUSTRIAL DEBERA SER CONCEBIDA DESDE EL PUNTO DE VISTA DE SU ACTIVIDAD FUNDAMENTAL: EL MONTAJE O ENSAMBLE DE BARCOS.

COMO POLITICA INDUSTRIAL BASICA SE PUEDE DECIR QUE EL ASTILLERO DEBE HACER SOLAMENTE LO QUE NO PUEDA COMPRAR O SUB-CONTRATAR EN LAS DEBIDAS CONDICIONES DE CALIDAD, PRECIO Y PLAZO DE ENTREGA.

ES IMPORTANTE, EN ESTE PUNTO, LA IDEA CLARA DE UN ASTILLERO EXCLUSIVO PARA CONSTRUCCION, Y UNA EMPRESA, QUE PUEDA PRODUCIR FABRICACIONES AUXILIARES DE LA INDUSTRIA NAVAL, REPARACION, PRODUCTOS INDUSTRIALES, ETC., A LA CUAL PUEDE PERTENECER O NO EL ASTILLERO.

LA EXPERIENCIA ES DEFINITIVA Y EN LA ACTUALIDAD UN ASTILLERO MODERNO SOLO SE PUEDE CONCEBIR COMO UNA INDUSTRIA EXCLUSIVA PARA CONSTRUCCION, ALIMENTANDA POR PRODUCTOS DE INDUSTRIAS AUXILIARES QUE PUEDEN O NO PERTENECER A LA MISMA EMPRESA, PERO QUE SERAN INDEPENDIENTES EN CUANTO A ADMINISTRACION Y OPERACION, O SEA QUE SERAN UN NEGOCIO SEPARADO.

EL RENDIMIENTO DE CADA LINEA DE FABRICACION DEBE SER CONSIDERADO SEPARADAMENTE.

ES IMPORTANTE SEÑALAR, DESDE EL PUNTO DE VISTA DE NEGOCIO, QUE NORMALMENTE UN SOLO ASTILLERO, NO ES CLIENTE LO SUFICIENTEMENTE IMPORTANTE, COMO PARA QUE UNA LINEA DE FABRICACION DE PARTES DE LA INDUSTRIA AUXILIAR A LA NAVAL, QUE LE VENDA SOLO A EL, PUEDA PASAR EL UMBRAL DE LA RENTABILIDAD.

POR LO QUE, SI UNA LINEA DE PRODUCCION NO OPERA CON UTILIDADES, NO DEBE QUEDAR ENMASCARADA, EN EL CONJUNTO DE LA OPERACION DE LA CONSTRUCCION DE BUQUES.

EN CONSECUENCIA, EN EL PLANEAMIENTO DEL ASTILLERO SE PARTE DEL SUPUESTO QUE EXISTE LA INDÙSTRIA AUXILIAR NECESARIA.

POSTERIORMENTE SE DETERMINARA LAS NECESIDADES DE LA INDUSTRIA AUXILIAR, Y SI SE LLEGARA A LA CONCLUSION DE QUE ES CONVENIENTE INSTALARLA EN EL MISMO RECINTO DEL ASTILLERO, DEBERA OPERAR INDEPENDIENTE Y COMO NEGOCIO SEPARADO.

UN ASTILLERO COMPARADO CON OTRAS INDUSTRIAS Y DESDE EL PUNTO DE VISTA DE SU OPERACION, PRESENTA LAS SIGUIENTES PECULIARIDADES.

1.- NECESITA DE MEDIOS DE PRODUCCION COSTOSOS Y DE POCA VERSATILIDAD, QUE EN GRAN MEDIDA, DEFINEN AL TIPO DE PRODUCTO, LA CANTIDAD DE PRODUCCION, Y EL PRECIO RESULTANTE.

2.- PRODUCTOS, CUYA UNIDAD ES DE GRAN PRECIO, Y NECESITA PERIODOS LARGOS DE PREPARACION, CONSTRUCCION Y EXPERIMENTACION EN SERVICIO.

3.- EN MUCHOS CASOS, FALTA DE DEFINICION DEL PRODUCTO, AL CONTRATAR Y ALGUNAS VECES AL EMPEZAR LA CONSTRUCCION.

4.- VALOR AGREGADO MUY BAJO EN EL CASO DEL ASTILLERO EXCLUSIVO, EXIGIENDO LA COOPERACION DE OTRAS INDUSTRIAS ALGUNAS DE LAS CUALES TRABAJAN 100% PARA CONSTRUCCION NAVAL Y OTRAS NO MENOS IMPORTANTES PARA EL ASTILLERO QUE TIENEN UN MERCADO DE VENTAS MUCHO MAYOR QUE EL DE

LA CONSTRUCCION NAVAL.

EN OTRAS PALABRAS, SE PUEDE DECIR QUE LA OPERACION RACIONAL DE UN ASTILLERO DEPENDE EN GRAN MEDIDA DE LA ADECUACION DE LA PLANTA INDUSTRIAL AL TIPO DE BARCOS A CONSTRUIR, ASI COMO LA DE ADAPTACION DE LOS PLANOS DE DETALLES DE CADA BARCO A LA CAPACIDAD Y CARACTERISTICAS DE LA PLANTA.

DESDE EL PUNTO DE VISTA DE RENTABILIDAD DEL ASTILLERO, ES PRECISO PENSAR EN TERMINOS DEL CONJUNTO Y NO POR SUMA DE RESULTADOS PARCIALES DE CADA CONTRATO.

PUEDE SUCEDER Y SUCEDE EN LA PRACTICA QUE UN CONJUNTO DE CONTRATOS, CADA UNO DE LOS CUALES ES INDIVIDUALMENTE FAVORABLE, PUEDE CONDUCIR A UN RESULTADO NEGATIVO EN LA OPERACION TOTAL.

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