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FOREIGN DEEP WATER PORT DEVELOPMENTS

A Selective Overview of Economics, Engineering, and Environmental Factors

IWR

INSTITUTE FOR WATER RESOURCES

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS

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INSTITUTE FOR WATER RESOURCES

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Brigadier General, USA
Director

FOREIGN DEEP WATER PORT DEVELOPMENTS

A Selective Overview of Economics, Engineering and Environmental Factors

A Report Submitted to the

U.S. Army Engineer Institute for Water Resources
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FOREWORD

Background

The development during the middle-1960's of the supertanker for the world-wide movement of crude oil and the subsequent development of very large ore carriers has focused attention on the port development plans of the principal trading nations. Only a few nations have well located, natural harbors capable of accommodating super-size ships requiring 70 to 100 feet of water. Most nations have had to assess the value of deep-water ports in terms of the cost of development compared to the gains in transportation savings, and to the local and regional economic and social expansion often associated with large-scale port improvements. Broad considerations of national interest and security also frequently affect decisions on major port developments.

The trading nations of Europe, the Middle East and Asia have made a wide variety of approaches to the accommodation of deep-draft shipping, as have Canada and the West Indies. The U.S. has not generally developed deep-water ports or off-shore facilities for loading and unloading very large vessels, although several ports, particularly on the West coast, are now preparing to receive vessels requiring 60 or more feet of water. For the most part, supertankers enter U.S. port areas only after stopping in the West Indies or Canada to lighten their load or after part of the load has been lightered to U.S. ports.

The economic advantages of scale resulting from the use of very large vessels are becoming apparent and require that the development of U.S. ports and facilities be carefully appraised in light of the future transport needs, particularly of crude oil and in terms of the engineering, economic, and the environmental characteristics associated with deep-water port development.

The Corps of Engineers has the responsibility for the improvement of the navigable rivers and harbors of the U.S. and for maintaining authorized harbor depths. The Corps also issues permits where alterations or new structures are proposed in the public waterways and harbors of the nation.

Purpose

The objective of this study was to analyze selected foreign harbors (and off-shore loading and unloading facilities) where the experience was judged to be relevant to the U.S. situation. Specifically, the study seeks to explain (for the nations studied) how the decision to deepen or enlarge ports was arrived at; the approaches considered and the actual adjustments made to accommodate deep-draft ships, including the difficulties met and solved in construction and operation, and the character of future plans. Assessment of the social disruptions and environmental impact of port development was an additional important objective of the investigation.

Findings

A summary of the findings and conclusions is contained in the Main Report, as Part 2. The Appendices, A through I, contain detailed findings and conclusions for each of the ports and countries studied.

Shipment of crude oil constitutes the major portion of the world's ocean-transported cargo. Savings possible in this trade (approaching 50 percent) are unquestionably the most dramatic effect of the use of very large crude carriers (VLCC's). Important savings are also possible in the movement of iron ore and other bulk commodities by very large ships.

The study amply demonstrates the close relationship between deep-water port development plans and national economic development goals and objectives of the nations studied. While all nations are keenly aware of the direct savings in transport cost, these are by no means the only, or even the controlling, reason for building deep water ports. Regional development through the growth of coastal industrial complexes has been a major element in the decisions. The role of new large ports in helping to effect better population and industrial distribution was also considered and is sometimes a deciding element.

While Japan has pioneered in the development of super-size vessels, the European nations and the international oil companies have taken the lead in the development of the port-side technology, including port and channel deepening plans, development of deep-water piers and off-shore platforms, single-point moorings, and various combinations of these approaches.

The environmental aspect of deep water ports have not been given a prominent place in most deep water port developments studied. The care exercised in the development of Bantry Bay in Ireland by Gulf Oil is exceptional. However, most nations are now keenly aware of the environmental hazards of large industrial and residential developments, and are beginning to consider the potential effects of deep harbors and the associated industry. The report indicates environmental problems which have arisen and plans which have been developed to solve them.

Assessment

This report fulfills the contract objectives of bringing into summary form relevant experience with selected foreign deep-water ports. The advantages and disadvantages of the principal approaches to port development for deep-draft ships are clearly presented. The impact of port developments on the local and regional economics concerned is amply explored. The reader is cautioned, however, that the foreign experience with deep-draft ports may not be completely applicable to the U.S. needs. For example, trade plays a much greater role in the total economy of all of the countries studied than it does in the economy of the United States. The foreign experience, however, holds many lessons in engineering, economics, and environmental protection which are worth critical examination in full light of U.S. needs and interests.

Status

This study of foreign experience with deep-water ports and off-shore facilities is to be supplemented in the near future by a report of a Corps of Engineers task force which visited selected petroleum loading and unloading ports in Europe and the Middle East as the guests of the Standard Oil Company of New Jersey and the Gulf Oil Company. Additional information on Japanese ports and port plans will be contained in an Institute study now in preparation in the South Pacific Division of the Corps.

This study of foreign ports by Arthur D. Little, Inc. and the work supplementing it by the Corps staff will be utilized in a second Institute study now being conducted by Robert R. Nathan Associates which assesses U.S. deep-water port needs.

This report is not to be construed as necessarily representing the views of the Federal Government nor the Corps of Engineers.

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1 INTRODUCTION

1.1 PURPOSE AND SCOPE

Under Contract No. DACW 31-71-C-0044, issued by the U.S. Army Corps of Engineers, Baltimore District, on 8 December 1970, the Institute of Water Resources, Alexandria, Virginia, commissioned Arthur D. Little, Inc. (ADL) to conduct an interpretive study of the development and operation experience of selected foreign deep water ports.

The objectives of this study, covered in the following report and appendices, are:

- <u>General</u>
  - examine the interrelationships among engineering, environmental, socio-economic, and political aspects of port development,
  - identify socio-economic and environmental consequences of port deepening, and
  - present the positive and negative aspects of each approach;
- <u>Specific</u>
  - for each approach considered and selected, present the lessons learned and future plans, and further outline:
  - rationale of decision to develop a deep water port,
  - port management structure and funding,
  - socio-economic impact,
  - environmental appraisal, prevention and correction, and
  - engineering solutions
- <u>Subjects</u>
  - Area screening of the United Kingdom, Japan (receiving ports), Australia and the Persian Gulf (loading ports); and
  - Individual ports at Le Havre and Dunkirk, France; Antwerp, Belgium; Amsterdam and Rotterdam, the Netherlands; Bantry Bay, Ireland; and Port Cartier, Canada.

1.2 APPROACH

A case team of Economics, Environment and Engineering personnel from ADL's home office was formed to study major areas. The help of four ADL field offices (London, Paris, Brussels, and Teheran) was also enlisted. Alcan Shipping Services, Ltd., Montreal, Canada, was retained as a subcontractor to do research on Canada and Australia.

First, a literature search and a survey of in-house data were made to determine the problems which might be relevant to deep water port planning in the United States. Then a few selected interviews were held to prepare a field itinerary for March, 1971. All subject ports and areas except those of Japan and Australia were visited by the team members. In Europe, three case team members of ADL's home office and an ADL field office representative in each country took part in the inspection visits. Because of the time constraints, however, and the Corps' desire to have ADL interpret readily available data rather than accumulate new data, only government, port or city officials and citizens who appeared most concerned with deep ports (and who were in a position to provide insights on past overall experience as well as future plans) were interviewed.

The analysis of document and notes gathered during the trip took place during the months of April, May, June and July and an interim presentation of the study results was made to the IWR in May. A final oral presentation was made to an audience of Federal agency representatives on August 18, 1971, at which time a draft report was submitted to the IWR.

2. CONCLUSIONS

The situation and experiences reviewed in the course of this study constituted local solutions to site, country and time-oriented problems. Only general conclusions and recommendations are drawn from foreign port development experience and presented in the following paragraphs. Readers with interest in a specific area, who have a knowledge of the local port site conditions and the problems prevailing at the present time, may be able to draw more direct inferences for deep water port development possibilities from the material presented in this report and its appendices. However, the reader should be aware that foreign experience may not be completely applicable in the U.S. setting.

2.1 PORT MANAGEMENT AND GOVERNMENT INTERVENTION

In foreign countries, ports are managed by a wide variety of bodies, ranging from national and state authorities, to provincial and municipal bodies; they include company terminals and autonomous ports that cross municipal boundaries. Overall supervision of public ports is generally exercised by one or more ministries (eg., Transport or Equipment) which exert varying degrees of control on coordination, finances and development planning. This is because foreign governments (particularly in Japan and France) have come to recognize the important role that efficient, modern ports play in furthering national, regional, economic development. However, as long as the coordination and planning functions are fulfilled, no particular management structure seems to show a clear superiority.

In foreign port development, a wide range of subsidies, both direct and indirect, are used to support infrastructure development; they may range from constructing and maintaining ship channels to acquiring land and reclaiming areas. As the development of expensive deep water terminals for use by a limited number of bulk-importing companies becomes more common, the ratio of government subsidies to total cost generally declined--the latter is the ratio commonly used in the United Kingdom.

Subsidy policies are also used selectively to encourage international trade or regional development. The concentrated monoport policy--used by the Netherlands to rebuild Rotterdam into its current world preeminence--is slowly being replaced by a multiport policy. More recently, environmental considerations, such as coastal and urban saturation, have begun to play a role in this process--more in Belgium, the Netherlands, the United Kingdom, and Japan than in France or Canada.

The interrelationships between individual ports, cities, and governments take several forms. We encountered a very flexible and effective structure in the North Sea countries, where formal and informal working groups bring together the various individuals and organizations concerned with long-range planning and development. The United Kingdom approach may be more thorough and comprehensive, but it has also led to more projects being abandoned rather than completed.

2.2 ECONOMIC CONSIDERATIONS

The primary reason for deep water port development is, of course, the movement of crude oil. Shipping costs are slashed about 50% when Very Large Crude Carriers (VLCC's) of 250,000 dwt or more are used to move oil, as against 65,000-to-80,000 dwt tankers (currently the maximum contemplated for most U.S. receiving ports). Major European and Japanese ports are geared for VLCC's. In some cases, iron ore and bauxite have also justified the development of deep water ports, but such ports are in the minority. More often they have become associated with crude oil terminals or are actively seeking such an association (Dunkirk is one example of this).

The broader and more important economic reason for development has usually been the growth of efficient coastal and industrial complexes: 1) to compete in the world and domestic markets (Belgium, Holland); 2) to promote regional development (France or Japan); or, 3) to decongest an existing saturated urban-industrial complex (like in Japan).

The relationship between port development and national economic development has been amply substantiated and continuously gauged by authorities by use of economic models of various types; such models range from the simple port traffic vs. GNP type correlations used in Japan, to elaborate macro-econometric analysis used in the Netherlands. Some of the latter employ a cost-benefit approach and input-output matrices involving social option matrices, eg., economic, social or environmental development choices.

Typically, the life cycle of an integrated industrial port complex involves two stages. First, heavy initial investments, accompanied by rapid growth of a basic industry complex (petroleum and/or metallurgy) which reaches a "critical mass" , second a self-sustaining growth, at which point development policy usually becomes more selective (as in Rotterdam and Le Havre). Eventually, a large port must integrate its growth with the needs of the surrounding community. Antwerp, because of its land and channel-depth limitations, is already being forced to plan on how best to cope with such a process. In Rotterdam, congestion and a failing environment will slow the phenomenal growth of the past 20

While industrialization was originally a primary goal for most deep port development in the countries visited, port and channel congestion has now resulted in an increased awareness of the importance of the transfer functions ports. Even though the value-added of such activity is much lower, it can provide sustained activity for secondary ports. For instance, the people of Antwerp consider their port's reputation for efficient cargo handling as a primary asset for maintaining its competitive position among northwest European ports. Japan is even designing distribution ports just to supply the "backyard" of overly industrialized areas with manufactured products from the new, distant, industrial ports emerging in less developed areas. For such transfer ports, bulk transport to the interior--via pipelines, water, and rail--must be efficient, while road and air transport need to cater to the movement of manufactured products with high value-to-weight ratios. Commodity specialization between ports, and of berths in a given port is increasing.

2.3 ENGINEERING FACTORS

Post-war tanker deadweight has increased by a factor of 10 every 20 years, while draft has doubled in the same period. The development of dry bulk carriers has lagged somewhat, but large, multi-purpose ore/oil ships and (still smaller) coal/oil and ore/bulk/oil carriers are being developed. Slurry ore carriers are likely to be developed actively during the coming decade and the 200,000 dwt to 350,000 dwt ships are likely to become the backbone of long-haul of dry and liquid bulk shipments in the 1970's. Some large containerships are being built with draft exceeding 40 feet.

A wide range of engineering solutions to accommodate these deep draft vessels in overseas deep water terminals have been implemented or porposed. The key ones are:

- Deepening existing harbors by dredging and sometimes blasting; extending estuary facilities toward the sea, and increasing outer harbor depth and both land and water acreage;

- Excavating new harbors when necessary, despite the high cost and inflexibility;

- Seeking virgin natural sites in underdeveloped areas; or

- Developing offshore mooring berths, single-point buoys, or sea islands.

Revised channel and basin-design principles stress the importance of water current effects (vs. wave and wind effects) on loaded superships, and of wind on light ships, in terms of reduced maneuverability (stopping distance and turning radius). Whenever possible, blasting is avoided (for economic rather than ecological reasons) but dredging is used intensively despite the high cost of continuous maintenance dredging. Extensive hydraulic-model studies of channel deepening have been used to minimize maintenance dredging, and to study the influence on inner-harbor swells, down-stream erosion, and upstream salt intrusion. Dredging spoils are used for land reclamation and construction whenever possible, or are disposed of in selected troughs. However, dredging of polluted silt has proven detrimental to marine life in Japan, and is believed to have promoted salt intrusion into some Dutch polder land.

Port congestion is another problem in most large ports, and interaction with small ship traffic (50% of new ships built still being 4000 dwt or smaller) will require new traffic control aids and procedures.

Some of the basic principles that have been suggested by port engineers include:

- Because port infrastructure is generally rigid long range, good forecasts and prospective flexible design are basic necessities (eg., tidal basins are preferable to locked docks);

- Making thorough geological surveys of bedrock and soft-sediment location;

- Taking into account current conditions in designing of approach and docking facilities;

- Selecting virgin natural sites with ample depth and land acreage to ensure future flexibility (Thus far, the Bantry Bay transfer terminal in Ireland is an example of successful environmental and engineering planning in a recreation area.) ;

- Choosing simple, straight-forward, and rugged design in pier construction and cargo handling seems to be less costly in the long run than choosing sophisticated designs; and

- Commodity concentration and specialization are the trend for ports, berths in a given port, and ship design.

2.4 ENVIRONMENTAL IMPACT

Historically, with the exception of the United Kingdom, concern over environmental management was not too apparent in the countries studied.

Land-use planning has mainly served to meet economic ends. Recently, to prevent costly mistakes or the shelving of otherwise beneficial projects, increased awareness of urban-industrial decay in major ports has brought to light the need for improved planning and increased communication between concerned organizations and individuals. Leasing (rather than selling) waterside land to users under a concession system--such as used in northwest European ports seems to ensure generally better control of environmental performance and future flexibility of usage. This become more important as handling terminals require more and more frontage and inland depth (containers in particular).

Although no evidence of direct salt damage to aquifers or agricultural land was reported, there is concern over the impact of planned dredging and industrial development in Le Havre and in Rotterdam. Industrial, municipal, and shipping pollution of fresh and salt water do exist, and the Effluent Fee system introduced recently in France is not yet strict enough in scope and enforcement to bring much improvement. Only the Thames River Authority seems to have been able to reverse the process of deterioration in water quality.

Air pollution control - backed by precise legislation and monitoring control - and sewage or solid-waste treatment activities are just beginning despite much social pressure. Baseline studies are still practically non-existent, even though some attempts are being started.

Chemical dispersal is sometimes used to prevent oil from reaching the beaches in spite of its possible toxic effects on sea life. Through serious initial planning, Bantry Bay, Ireland, stands out as proof that salmon and trout fishing, and summer residency are not incompatible with a transshipment terminal.

Finally, a major lesson may be gained from the various degrees of participation shown in planning efforts by the various groups: national, regional, and municipal authorities; industry (management and labor); and environmental experts (mostly architects, urbanists, and sociologists). The planning horizon generally covers a 5, 10 and 20 to 30 year period. National (industrial competition with neighbors) and regional (depressed-area development or revival) considerations are still major decision factors. But the needs of local communities are also increasingly being recognized.

2.5 INTERRELATIONSHIPS AND POLICY IMPLICATIONS

All the countries visited consider the development of deep-water ports as a vital tool in their national economic policy (and, for the oil-importing countries, their energy policy) with far-reaching significance for formulating national and regional development strategies and bringing important industrial, political and, more recently, socio-environmental forces into play.

One must first recognize that a major bulk port needs:

- a deep access for 250,000 dwt ships (from 65 foot to as much as 100 to 120 feet draft for major oil ports in the 1980's.)
- efficient ship and cargo-handling capability for short turn-around time and low accident risk;
- good links with major interior zones by pipeline, rail, and water for bulk shipment, and road and air for other cargo movement and secondary industry development; and
- large industrial land acreage with good load-bearing properties, for storage and transfer; such space requirements may cover anywhere from 20 to 50,000 acres for an integrated, urban-industrial complex.

The required investment and social impact are such that both government and private participation appear necessary, particularly since coastal land area is limited, and industrial, residential, and recreational activities tend to migrate to the seaside in most developed countries.

Accordingly, by and large, major port development policy decisions should be based on:

- good, long-range forecasts;

- clear national strategies;
- consideration of all possible location alternatives and natural sites;
- a flexible, but definite regional master plan;
- planning an overall transportation system integration;
- compensation or reorientation of existing ports; and
- implementation of mechanisms ensuring participation of, and communications between, all parties concerned.

Figure 2-1 illustrates a hypothetical spectrum of advantages and disadvantages of alternatives available to a country whose trade in oil and dry bulk warrants consideration of deep water ports. Discussed in detail in Chapter 3, this framework can be used by decision-makers to rank alternative options. By weighting the various factors (eg., economic versus ecological) and focusing on specific sites and technical alternatives suitable for each option, it should be possible to establish a rational ranking scheme to narrow the range of desirable options. An unweighted use of the matrix of Figure 2-1 resulted in the following hypothetical ranking:

1st	:	New coastal transshipment terminal, New deep integrated port, with industrial complex;
2nd	:	New offshore transshipment terminal, Foreign transshipment terminal, Do nothing;
3rd	:	Shallow-draft supercarriers, Lighten super tankers;
4th	:	Deepen and expand existing ports.

FIGURE 2-1 ADVANTAGES AND ISADVANTAGES OF VARIOUS PORT DEVELOPMENT ALTERNATIVES

Development Alternatives (Il trative Examples)	Evaluation
I. Do Nothi	Fair
II. Lighten S er Carriers (Upper M ord Haven, U.K.; Lower D ware Bay, U.S.A.)	Poor
III. Use Fore Transshipment Terminal (Freeport ahamas; Pt. Tupper, Canada)	Fair to Good
IV. Use Shall Draft Super Carriers (Under St y by Netherlands)	Poor
V. Deepen, pand, Existing Port-Industrial Complex (Long Be h, U.S.A.; Dunkirk; Rotterdam)	Least Attractive
VI. Use New astal Transshipment Terminal (Bantry B , Ireland)	Most Attractive
VII. Use New fshore Transshipment Terminal (Island) (LeHavre/ ntifer, France; Dita, Japan)	Fair to Good
VIII. Use New ep Port-Industrial Complex (Kashima, apan; France)	Good

Major Disadvantages — Environmental

Alternative	Exposed New Coastal Area	Feeder Traffic Congestion	Complex Regional Planning	Disrupts Social and Cultural Traditions	Spill Potential	Less Control Over Port Activities	Increased Urban/Industrial Congestion	Dredging Required	Reduced Terminal Accessibility
I.			✱		▲	✱	■		
II.		■	✱		■	✱	■	✱	
III.		■	✱		▲	■	✱	✱	▲
IV.			✱		▲		■	✱	
V.		✱	▲		▲		■	■	
VI.	▲	■	✱	✱	▲		✱	✱	
VII.		■	✱		▲		▲	✱	▲
VIII.	▲	▲	■	▲	▲				

Major Disadvantages — Economic

Alternative	High Initial Investment	Possible Labor Shortage	Long Lead Time	Transshipment Costs	National Security Problems	Economic Loss	Industrial Relocation Outside U.S.	High Maintenance Costs	Land Shortage	Limited Expansion Potential	Limited to Liquid Bulk
I.					▲	■	■			▲	
II.				■	✱	▲	✱				▲
III.				■	▲	■	▲			✱	
IV.	▲		■			✱		▲			
V.	■							▲	▲		
VI.	▲		✱	▲		✱					
VII.	■		▲	▲	✱	✱		✱	▲	✱	
VIII.	■	▲	▲	✱							

Major Advantages — Economic

Alternative	New Growth Center	Less Costly Land	Minimum Land Constraint	Present Ports as Is (Status Quo)	Minimum Investment	Quickly Available	Uses Present Infrastructure	Labor Pool Available	Existing Local Industrial Market	Improves U.S. Trade Position
I.				■	■	■	■		▲	
II.			✱	▲	■	■	■		▲	✱
III.		▲	▲	▲	▲	▲	▲		▲	▲
IV.				✱			■		▲	▲
V.							■	▲	■	■
VI.	✱	▲	▲	▲	✱	✱	▲			▲
VII.				▲			▲		▲	▲
VIII.	■	▲	▲	✱						■

Major Advantages — Environmental

Alternative	Best Site Option	Planning Flexibility	Baseline Studies	Balanced Growth Potential	Decentralization	Reduced Major Spill Potential	Reduces Coastal Environmental Problems	Retains Virgin U.S. Coastal Areas	Dredging Reduced	Upgrade Present Port System
I.								■	■	
II.							✱	■	▲	✱
III.		✱		✱	✱	▲	▲	■	▲	✱
IV.							✱	■	▲	▲
V.						✱	✱	■		■
VI.	■	▲	■	▲	▲	✱	✱		▲	✱
VII.	■	■	▲	▲	✱	▲	▲	▲	▲	✱
VIII.	▲	▲	■	▲	■	✱	✱		▲	▲

Note: All advantages and disadvantages as applicable to alternatives assumed to have equal importance when compared to each other.

Legend:
- ■ Particularly Applicable to Alternative
- ▲ Applicable to Alternative
- ✱ Somewhat Relevant to Alternatives

3. ISSUES RELEVANT TO DEEP WATER PORTS

3.1 FOREIGN PORT MANAGEMENT, FUNDING, AND PLANNING

The countries surveyed in this study have a wide range of port management bodies. Major public ports may be municipal ports, operated by city-or province-appointed managers or boards (North Sea ports), or autonomous ports operated under a ministry (France). Some major ports are grouped under a national or state authority (British Commonwealth). Private-industry ports are represented by Port Cartier, Canada and Bantry Bay, Ireland.

Port management patterns are also subject to change. For example, in 1950 Japan disbanded its National Port Authority and created "Port Management Bodies" which are provincial or municipal authorities. Britain, which offers a wide range of management practices, recently shelved a plan to assemble its major ports under a National Port Authority and is considering returning port administration powers to municipalities.

Whatever administrative practices may exist, foreign governments have recognized (to varying degrees) the national importance of operating efficient ports. This is particularly true in the highly competitive environment of northwest Europe. As a consequence, 100% national subsidies in channel maintenance, for example, are not uncommon, while infrastructure (channels and seawalls, basins, and raw land) developments often warrants 60% to 100% rates. The subsidy percentage tends to decrease as one follows the coast from France to the Netherlands. By contrast, United Kingdom ports must pay for their own maintenance, and receive only 20% national grants on infrastructure expenses.

The huge expenditures involved in developing ports for handling superships however, has given rise to second thoughts and foreign governments are becoming increasingly aware that while cheaper bulk raw materials benefit the nation's economy in the long run, it also primarily benefits the oil-refining and ore-processing companies. In Japan, therefore, a compromise has recently been reached between government and private companies, so that subsidies decrease progressively as channels are dredged to depths increasing from 40 to 53 feet. At 53 feet, for example, the cost is shared 10% by the national government, 10% by the (municipal or provincial) port management body, and 80% by industry. Port user charges have also risen in recent years, but the financial situation of almost all public ports remains generally tight. More generally, foreign governments have recognized the need for selectivity, and are using the subsidy to either encourage those ports which are a major factor in spurring foreign trade or in developing a depressed area. Japan and France thus employ well-graduated systems geared to meet these objectives.

Of course, such government intervention makes it more difficult to achieve better international cooperation, as seen in the competitive rivalry between Antwerp and Rotterdam -- a situation which may be slowly moving toward a resolution. Government subsidy is not the only factor in maintaining a competitive posture. Quality of service remains a strong factor in international competition, as proven by Antwerp -- which considers service a major asset in its competition with Rotterdam and Dunkirk.

In this context, the large expenses involved and their socio-economic impact have long made port planning a matter of government intervention. Again, Japan and France are foremost in this field: Japan sees a direct correlation between port traffic and GNP, and France believes that major integrated ports are the key to improve its development posture vis-a-vis its more concentrated industrial partners in the Common Market. But in all European countries surveyed, national and regional planning authorities are called upon to coordinate individual port planning. The individual authority has to fit its ambitions within the wider framework, but may influence decisions to a degree directly related to the port's economic importance. Rotterdam and Antwerp, for example, can summon powerful political pressure; in the case of Rotterdam, however, state and regional bodies have been increasingly reevaluating the past "monoport" policy concept. Although it played a substantial role in Rotterdam's reconstruction and emergence as the world's first port, saturation and polarization are introducing diseconomies. Also, there is a need to spread industrialization into depressed areas. (This also began to be recognized by Japan in the early 1960's).

In analyzing economic incentive and benefits of deep water ports, we have drawn heavily upon the development experience in northwest Europe, because countries in this region have mostly developed strategies of port development based on determining national economic returns. Japan is another outstanding example of a country with a well designed strategy, but its great many distinct geographical and economic features made it less suitable to be compared with the United States and to be studied in detail at this stage. Australia, Canada, and the ports of Bantry Bay and the Persian Gulf do offer rather specific lessons in the technical, environmental, and economic aspects of deep water port development, and these are detailed in the Appendices. But in the broader socio-political sense, the European nations' development more nearly parallels our own. At the same time, the European experience provides examples ranging from mature,heavily industrialized ports to new ports which are tied into regional development plans.

3.2 ECONOMICS

3.2.1 Economic Rationale for Deep Water Port Development in Europe

In Europe, deep water port development is closely tied to the increasing need for imported energy and fuel,essentially crude oil. The need for oil to fuel an industrial economy has fostered the development of large oil tankers known more commonly as supertankers. The supertanker technology lessens the cost of transporting oil. Thus, there has been a rapid building of supertankers of ever larger sizes.* This, in turn, has stimulated the need for deep water port facilities to accommodate large tankers having deep draft requirements.

This trend is likely to continue and even accelerate. Supertankers of 326,000 dwt are now in service, a 477,000 dwt vessel is entering production, and 800,000 dwt vessels are in the research design stage. Nearly 300 ships over 100,000 dwt are in service, and by 1974 this number will more than double.

Further port expansion is being undertaken or planned in each of the ports we studied to increase port channel depths. It is of interest to note, for example, that Le Havre, which is on the threshold of converting itself to a major international deep water port facility, is planning facilities for ships of up to 500,000 dwt by 1975 and for tankers of up to 1,000,000 dwt by 1980. Not all ports we examined can expand to this degree. Table 3-1 shows the current, planned, and potential deep water access for selected ports in France, Belgium, and the Netherlands.

Although the short-and-medium-term economic rationale is the requirement for petroleum, the broader and more important economic rationale is the

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* Approval has been given by the Transport Ministry of Japan for construction of a 477,000 dwt (deadweight tons) tanker, more than 150,000 dwt larger than the largest presently in serviee. It would be 1,243 feet in length, 203 in width, and 92 in draught. It has been chartered for 20 years at $1 per dwt per month, which converts to about Worldscale 33, compared to rates for 80,000 dwt tankers of approximately 100 Worldscale--dramatic evidence of how the cost disadvantage of distance from market can be offset by transport technology. The popular 250,000 dwt vessel is generally chartered at or below Worldscale 60 today.

TABLE 3-1

DEEP WATER ACCESS
MAXIMUM SHIP SIZE
NW EUROPE

Port	Approximate Maximum Ship Size in dwt		
	Current	Planned	Potential
Amsterdam, Netherlands	90,000	150,000	150,000
Antwerp, Belgium	80,000	125,000	125,000
Dunkirk, France	125,000	300,000	750,000
Le Havre, France	250,000	500,000	1,000,000
Rotterdam Europort, Netherlands	250,000	300,000	350,000
Rotterdam Botlek, Netherlands	80,000	80,000	80,000

Source: Arthur D. Little, Inc.

development of efficient coastal industrial complexes to compete in world and domestic markets, and to maintain national economic growth.

In Europe, deep water port facilities are also used for movement of other bulk cargo (such as iron and aluminum ore, coal, grain, salt, fertilizers, etc.) and general cargo. Many officials of European port administrations and companies located at port facilities commented on the visible trend of movement of heavy manufacturing facilities to deep water coastal industrial zones, versus estuary, inlet, river and inland locations. While this trend is probably due in part to the favorable terms and inducements offered by port facilities to companies that locate operations at port sites, it is also widely realized that the most important means by which industrial production costs can be reduced in the future and efficient industrial complexes can be developed is through lowering transportation and distribution costs. This, of course, is particularly important to industries importing bulk raw materials and exporting processed products.
There was, however, particularly among Dutch or Belgian officials who do not endorse Rotterdam's latest channel deepening plans, some concern that ore and oil exporting countries will tend to manufacture more semi-finished and finished products rather than sell their raw materials. While this should not overly affect crude oil shipment, it can be expected to reduce shipment of ores, as they are displaced by alumina and steel movements increase. Because these latter commodities are less sensitive to ship size economies, the preeminence of crude oil over ores as a rationale for deep water ports should not be challenged in the future.

3.2.2 Port Development Strategy

It seems that a new stage in the development of port strategy is emerging in each of the countries considered. This is because port development has had such a pervasive influence on such things as plant location, urban concentration, and socio-environmental issues, particularly in the United Kingdom, the Netherlands, and Japan. Serious arguments are thus being raised about the feasibility and desirability of allowing ports to continue to expand and operate in the same way as in the past. This trend, of course, is accentuated by the increasing costliness of continued dredging, its environmental impact, and diversion of recreational coastal land and nearby urban centers to port development and industrial sprawl. Complete answers have not been found to these problems, but some general observations and lessons can be derived.

The French port development policy can still proceed without being unduly hampered by the constraints that face the already industrialized port complexes located in Belgium and the Netherlands. France is the only country in Europe which still has relatively large reserves of coastal lands with low population density. Therefore, the lessons the U.S. can derive from French port development experience are of a technical nature rather than of a socio-economic and environmental nature. Of course, if the U.S. chooses to closely examine the feasibility of creating a new port-industrial complex in a low-density urban and industrial area, the French experience would be very relevant.

The port-industrial complexes in Belgium and the Netherlands are more analogous to the present U.S. port situation. It is of interest to note that each of these countries is embroiled in raising comprehensive questions about the multitude and complexity of inter-relationships between port development and general economic, social and environmental development.

Japan ports,which are in a more advanced stage of saturation than European ports, provide important environmental lessons; they also illustrate to the utmost the importance of port development in an open, dynamic economy.

Specific lessons to be learned from European experience are:

1) The central government plays a leading role in planning and in subsidizing port development. The approach is a long-term one (10-30 years) and involves regional planning that cuts across sub-regional boundaries.

2) Planning for industry, especially land-usage in and around port facilities, is determined along with basic port policy. In fact, one of the most notable successes of the European port policy has been the parallel development of industry at port sites.

3) Organizational coordination among local, regional, and national governments is provided by regional planning authorities.

4) Semi-autonomous port administrations cross municipal boundaries for some large ports.

5) The short-and-medium-term economic rationale is initially or ultimately the requirement for petroleum. The broader and more important economic rationale is the development of efficient coastal industrial complexes to compete in world and domestic markets.

6) The Europeans have been, up to now, only slightly concerned with environmental management in its broadest sense, and more specifically, air, water, and solid waste pollution problems. But concern is growing in all areas.

3.2.3 Potential Models for Deep Water Port Development

The European ports chosen for analysis in this study were selected, in part, to provide a cross-section of port development experience. After appraisal of the past, present, and future directions of their development, some important lessons may be applicable to any national port policy.

Several alternative approaches for deep water port development based on European experience suggested themselves in the course of our analyses. They are briefly listed below, with their major economic advantages and disadvantages.

The approaches are based on whether the deep water facility is located at a major existing port center, whether a new port center is created, or whether off-shore facilities are built.

First Alternative: Do Nothing

Major Advantages

- Release of limited government funds for alternative uses

Major Disadvantages

- Increased ocean transport costs to and from the Country.
- Possible offshore movement of some processing industries:
- Negative balance of payments impact;
- Possible loss of taxes and jobs;
- Possible erosion in country's competitive trade posture.

Second Alternative: Lighten Supercarriers

This approach is used by many ports around the world. Milford Haven in England is an example of a relatively deep water port which, before recent dredging, used to lighten 250,000 dwt tankers before entrance to the port (and still does so for up-river terminals). Lightening also occurs at certain U.S. ports, for example, Delaware Bay.

Major Advantages

- Eliminates investment requirement for deep water port(s);
- Can be immediately implemented;
- Might provide a stopgap measure

Major Disadvantages

- Transport less economical because of increased ship turnaround time;
- Reinforces urban concentration and growth of port/industrial congestion;
- May require additional channel dredging;
- Adds costs and problems in lightening dry bulks.

Third Alternative : External Transshipment Terminal

European deep water ports, especially Bantry Bay and Rotterdam, serve in part as transshipment ports; i.e., goods moving through Rotterdam and Bantry Bay are shipped by pipeline, rail, road and/or vessel to a hinterland destination which in many cases includes other European countries.

Certain ports outside the U.S. coastal zone serve the U.S. in the same way: for example, Point Tupper - Canada; Freeport - Bahamas; St. Croix - The Virgin Islands. These types of transshipment ports could be expanded and relied upon further.

Major Advantages

- Relatively lower investment costs at transshipment port;
- Little or no modification of domestic ports required;
- Relatively short-time requirement for construction (no dredging or artificial island required);
- Port location avoids high density urban areas;
- Relatively inexpensive land for port industrialization (i.e., Canada);
- Might provide a stopgap measure.

Major Disadvantages

- Additional transport and handling costs over direct shipment;
- Involves national security risks;
- Balance of payments effects less favorable than for direct shipment to deep water terminal;
- Loss to domestic economy of industry and jobs which could locate at transshipment port;
- May not be possible to obtain throughput capacity at desired location--therefore expansion potential may be limited.

Fourth Alternative: Subsidize Shallow-Draft Supercarrier Fleet

We understand the shallow-draft concept is being evaluated in the Netherlands because of depth constraints posed in the English Channel and the North Sea. There are serious engineering and construction problems involved in the traditional designing approach to shallow-draft super-tankers. However, the 50,000 dwt tankers was, at one time, thought to be impossible to build; the talents of industry might be able to generate a novel and practical approach to building a shallow-draft super-tanker.

Major Advantages

- Eliminates investment requirement for deep water port(s);
- Success would yield a valuable export product (i.e., vessels could be sold or more probably licensed abroad);
- Positive impact on the balance of payments;
- Success could help a basic industry;
- Has potential for achieving economics in importing and exporting bulk materials.

Major Disadvantages

- Increases R & D expenses;
- Additional vessel construction costs incurred to compensate for:
  - (a) reduction in optimum speed and power;
  - (b) reduction in structural strength of vessel shape;
- Reinforces urban concentration and growth of port industrial congestion;
- Requires relatively long time for construction of vessel (depending on R&D breakthrough).

Fifth Alternative: Deepening and Expanding of Existing Port-Industrial Complex

Up to the last five years, this development pattern has been most typical of European ports. Harbors have been dredged, where necessary, to deepen channels to accommodate the increasing size of ships. However, the limit of this dredging technology is being reached in many major European ports because of the high costs of additional dredging. Rotterdam offers the best example of a major North Sea port which continued its dredging at a heavy financial and environmental cost, and now provides harbor access to vessels of 250,000 dwt. Antwerp is planning to be able to serve large tankers and ore carriers of 125,000 dwt. After extensive and costly dredging and excavating, Antwerp decided it could not go further. Each of the European ports studied is concerned with the relative merits of dredging harbor access versus creation of offshore terminal points.

Major Advantages

- Ties in more readily to existing port infrastructure and inland transportation and communication links;
- Provides opportunity to improve port operations;
- Provides port industry superstructure on or near site already existing;
- Taps already existing labor market.

Major Disadvantages

- High investment dredging costs;
- Land requirements for industrial expansion;
- Reinforces urban concentration and industrial congestion.

Sixth Alternative: New Coastal Transshipment Terminal

In Europe, no port now exists of this sort except Bantry Bay's sea island and terminal on Whiddy Island (which is not associated with an industrial complex or older harbor). A terminal close to shore and acting only as a transshipment point may be applicable for some countries.

Major Advantages

- Flexibility of industrial location because pipelines and other transportation links could connect offshore terminal to industrially zoned areas moving progressively inland (possibly towards and into economically depressed regions);
- Industrial zone could be placed well inland (creating extensive buffer zone between port and industrial zone);
- Uses relatively inexpensive hinterland land (when connected by transport links) for industrialization and community development as compared to coastal land;

Major Disadvantages

- Large investment costs for coastal terminal;
- High investment and operation costs for improved inland transport and communication links;
- Long lead time for site selection, construction and connections with shoreline;
- Terminal land constraint;
- High cost terminal expansion;
- Transshipment costs from island to mainland.

Major Advantages (con.)

- Should be able to use present infrastructure on mainland;
- Labor pool available;
- Improves country's trade position by lowering shipping costs;
- Requires minimum industrial land constraint --location flexibility;
- Requires little or no modification of existing ports;
- Could avoid present high density urban areas;
- Provides structure for develop ment of new industrial growth strip;
- Uses a minimum of coastal land.

Major Disadvantages (con.)

Seventh Alternative : New Offshore Transshipment Terminal (Island)

As limits to on-shore expansion are being reached and offshore terminal construction technology advanced, placement of offshore deep water terminals serving existing harbors is being considered. Some European ports have made plans to move into this category (Le Havre, Dunkirk, Zeebrugge). One of several plans for Le Havre incorporates an artificial, hook-shaped island of about 2 miles in diameter some 10 miles offshore to serve supertankers of 500,000 dwt. Dunkirk has medium-range plans to build a similar island. Both Belgium and the Netherlands are debating the merits of creating similar offshore facilities.

Major Advantages

- Flexibility of industrial location because pipelines and other transportation links could connect offshore terminal to industrially zoned areas moving progressively inland (possibly towards and into economically depressed regions);

Major Disadvantages

- Large investment costs of offshore island;
- High investment and operation costs for improved inland transport and communication links;

Major Advantages

- Industrial zone could be placed well inland (creating extensive buffer zone between port and industrial zone);
- Uses relatively inexpensive hinterland land (when connected by transport links) for industrialization and community development as compared to coastal land;
- Requires minimum industrial land constraint -- location flexibility;
- Requires little or no modification of existing ports;
- Could avoid present high density urban areas;
- Provides structure for developing new industrial growth strip;
- Uses a minimum of coastal land;
- Multiple economic uses (power plants, airports, etc.);
- Presumably can locate island at best site relative to mainland needs;
- Should be able to use present infrastructure on mainland;
- Labor pool available;
- Improve country's trade position by lowering shipping costs.

Major Disadvantages

- Requires complex regional planning;
- Poses vessel and personnel accessibility problems to offshore island during adverse weather;
- Long lead time for site selection, construction and connections with shoreline;
- Transshipment costs from island to mainland;
- Terminal island land constraint;
- Terminal island expansion at high cost.

Eighth Alternative--A New Deep Water Port Industrial Complex

Since trade has traditionally been of major significance to most European nations, most suitable port areas have long been used in Europe and have long been commercial and industrial centers. Most European ports fall into this category. However, one can classify the French port of Fos near

Marseilles as one which does not fit this pattern, since it is located on a virgin site some 30 miles from Marseilles. To a lesser extent, some other of the French ports (Dunkirk in particular) fall into this category. Much of the rationale for the recently publicized comprehensive port policy of France is based on the proposition that infusion of capital into selected port areas and development of these areas as deep water ports will ultimately lead to the development of new industrial-urban poles. This proposition was also the very basis of Japan's New Port Policy in the 1960's.

We believe a development strategy that provides national infrastructure in a regional development context also has relevance for other countries. Thus, a strategically placed port facility could become the catalyst for developing less industrialized areas of the country. However, careful attention must be paid not only to the economic factors but also to all the non-economic factors that come to play in locating a new port and developing an industrial-urban pole.

Major Advantages

- Develop new regional growth centers;
- Provides opportunity for balanced, controlled, and integrated growth;
- Could avoid present high density urban port areas;
- Provides option to select overall best available virgin port site;
- Requires little or no modification of existing ports;
- Relatively inexpensive land for port industrial and community development;
- Existing ports could be upgraded on planned basis;
- Minimum urban and industrial land constraint;
- Industrial decentralization;
- Positive influence on U.S. trade position.

Major Disadvantages

- High initial investment in port infrastructure and inland transportation and communication links;
- Complex regional planning requirement;
- Possibility of inadequate initial specialized labor market;
- Relatively long time requirement for construction;
- Transshipment costs to other ports.

3.2.4 Economic Justification of Port Development (Cost-Benefit)

In the countries of Belgium, the Netherlands, and Japan, port development is both (1) integrally tied to industrial development and (2) a major factor in the countries' overall national economic and employment picture. Almost by definition, industrial complexes are close or relatively near to important port facilities. Japan, Belgium and the Netherlands firmly regard the port not only as a transport and warehouse nucleus, but as the center around which major industries cluster. This results in an attitude of "what's good for the ports is good for the country." In many ways this attitude is so commonly held that it doesn't have to be proven or measured. Because of this, only a few actual economic impact or cost-benefit studies have been undertaken and only then with a limited scope. (However, the economic impact has been measured on a gross basis in Japan, Belgium and the Netherlands on a macro-economic level.)

a. Netherlands

A number of financial cost-benefit analyses relating to aspects of port development have been prepared for Rotterdam. However, these studies have not incorporated the more intangible social cost elements about which environmentalists are concerned. In general, the Europeans view cost-benefit analysis (no matter how wide the scope) as a static analytical tool. The Rijnmond Planning Group and the Central Economic Planning Bureau of the Netherlands believe that Input/Output analysis is the only tool presently available which can realistically evaluate the multi-faceted economic impact of port development. These agencies are in the process of developing a family of Input/Output forecasting and impact models -- port, regional, and national (similar to those being developed by Belgium and Japan).

The Netherlands Central Planning Bureau indicated that a new study is about to be completed by the National Planning Committee (an advisory body, on which various Ministries are represented) which will introduce a new analysis approach. This approach looks at the development of Southwest Holland from the point of view of three major conceptual choices that can be made -- a choice about economic development, a choice about social development, and a choice about environmental development. The choices are not formalized in mathematical models but represented in terms of development schemes and tradeoffs. Apparently, this is the first time that such a study approach has been attempted by the Dutch, and it is felt that it would be the first step in pointing toward the direction in which the Netherlands might move in evaluating future port development plans.

b. Belgium

Antwerp has taken a path similar to that of Rotterdam in constructing a series of Input/Output models to evaluate the economic impact of the port on the region and the nation. A sample of the type of answers which their port and regional Input/Output model provides are: If the production of a given branch of industry increases by x, what is the total production and employment increase for the economy of the region? What total income do the various sectors generate (directly and indirectly) per unit of production of a sector? What are the direct and indirect exports of the sectors of the regional economy? These dynamic Input/Output models are supplemented by environmental and engineering studies, and regional land planning studies. Antwerp port authorities are somewhat suspicious and even hostile toward the use of cost-benefit studies. This attitude stems from the use of a cost-benefit approach by Zeebrugge (Antwerp's major national competitor) in justifying its proposal for a new deep water port. Antwerp authorities believe that the quantification of the indirect and intangible benefits were highly unrealistic, and in overall terms, the study was misleading.

c. France

France has conducted no formal cost-benefit studies. This is surprising in view of the French passion for national and regional planning and given the fact that cost-benefit analysis started in France in 1844 with Dupuit's classic paper on public works. French authorities in Paris pointed out that they do not need to conduct time-consuming cost-benefit studies because they have already developed a port policy plan. At the time this policy was formulated, a simple direct cost-benefit analysis was used for internal descriptions, but it is now obsolete. The substantial amounts of government money being allocated to port development is based primarily upon a more general policy of promoting greater and more efficient heavy industrialization to a level comparable to other European nations, and is coupled with a broad industrial decentralization scheme aimed at inducing industry to move from Paris to the more outlying regions of the country including the coastal zones. It is in line with the centralized planning approach generally associated with planning in France.

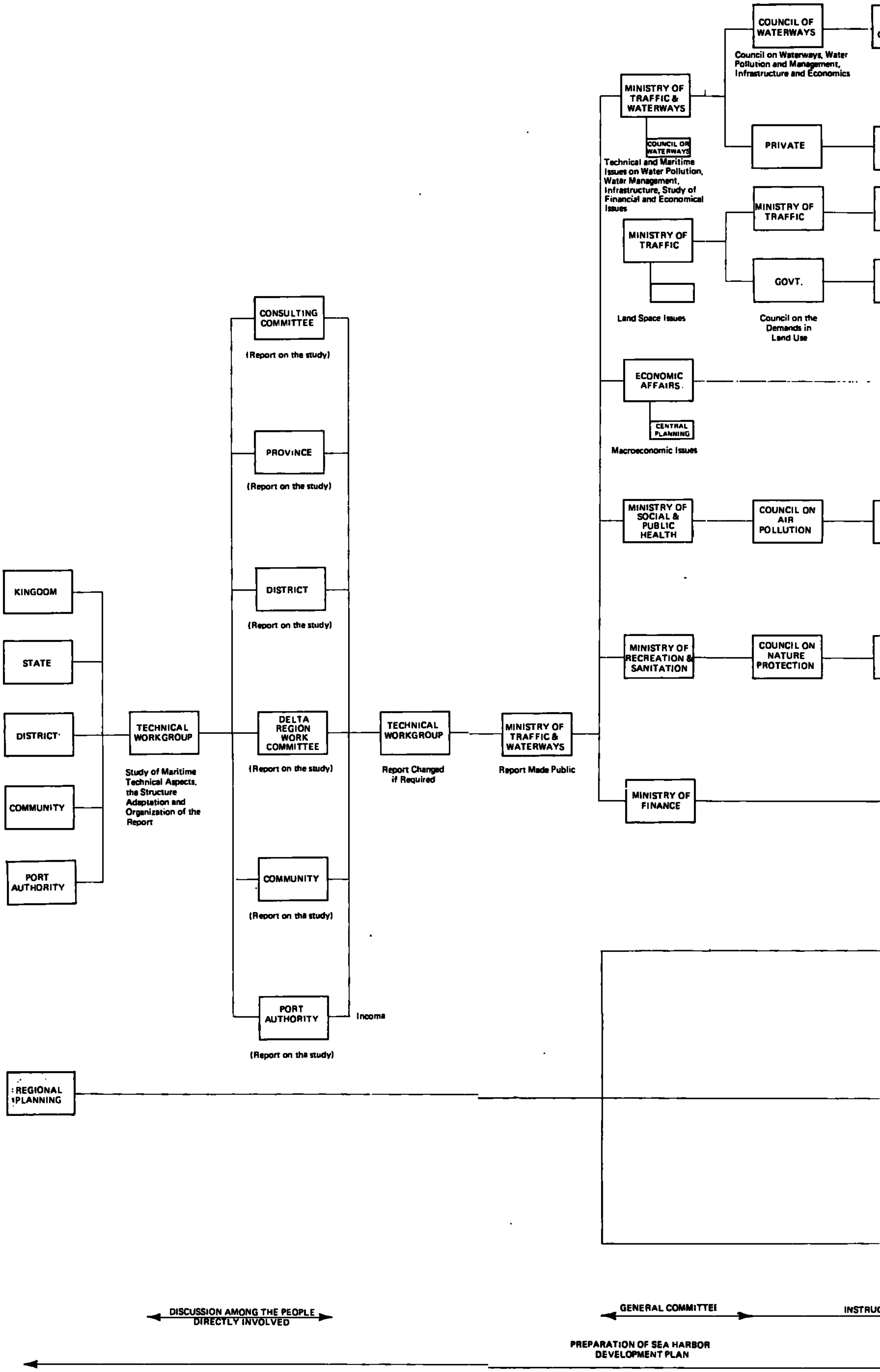
3.2.5 National Port Decision-Making Organization

The Netherlands provides a model for decision-making that could perhaps guide the U.S. in organizing to cope with the port question. The attached chart (Figure 3-1) portrays what might be called a government decision-making organization scheme which has been operating since 1968 in the Netherlands in matters dealing with port and canal development. The chart shows how the national government, the provinces, regional government, the community and the port authority first form a working group to provide a report to a subcommittee of the National Physical Planning Service. This report contains a description of physical planning requirements and cost estimates. A copy of the report is then provided to representatives of the National, Provincial, Regional, Community, and Harbor Authorities.

After all the various issues have been studied by these bodies, they report for review by other individual Ministries, such as the Ministry of Recreation and Sanitation, the Ministry of Public Health, Economics, National Planning and Finance. Subcommittees in these particular Ministries then examine the various issues as they relate particularly to their areas of interest, and submit recommendations and comments independently via the Cabinet. The Cabinet then gets together and discusses the matter, and finally submit a Cabinet report to the legislature concerning the finances of the development plan.

The objective of this planning approach is to provide as rational a decision-making process as is possible. Nevertheless, support for various plans requires considerable legislative backing and in this matter, politics, of course, also wields its influence. The deliberative process includes inputs from all groups at interest, so that by the time a "solution" emerges in the form of a particular development plan, it already enjoys broad support.

FIGURE 3-1 NETHERLANDS DECISION MAKING O
PORT AND CHANNEL DEVELOPMENT



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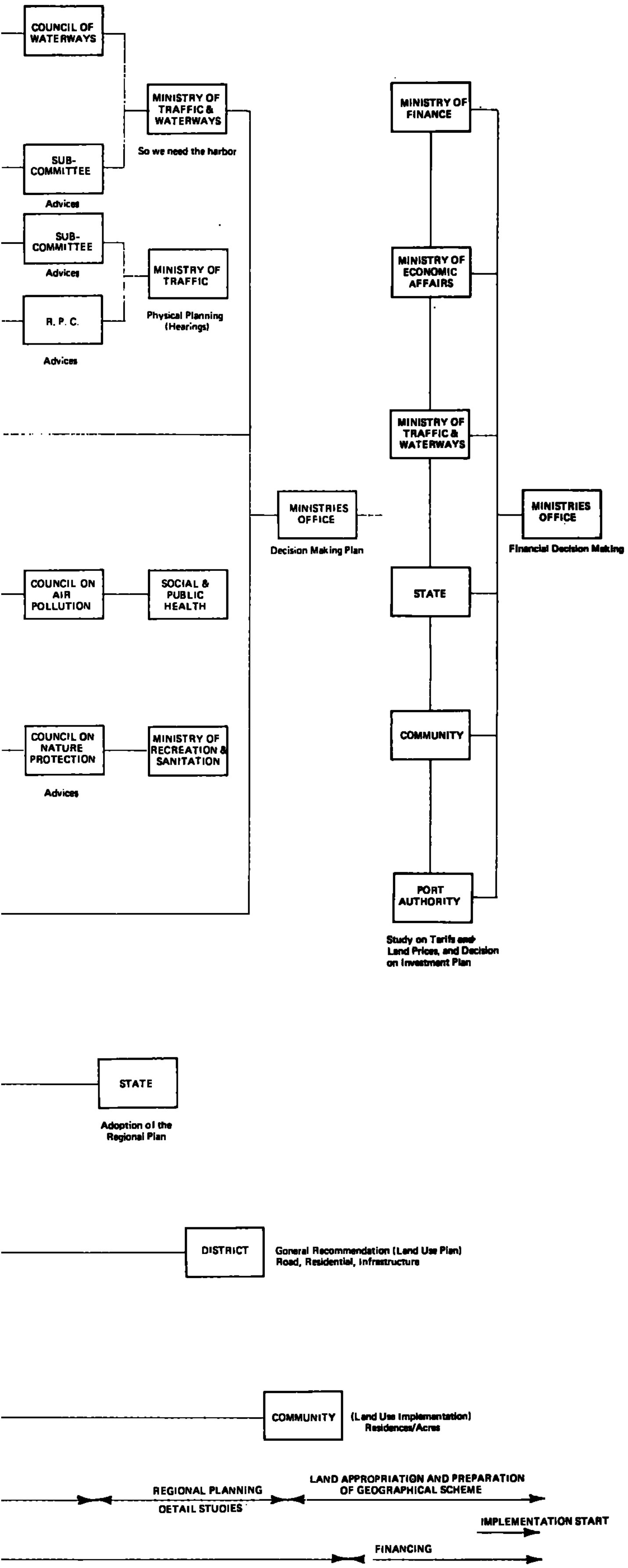

COUNCIL OF WATERWAYS
MINISTRY OF TRAFFIC & WATERWAYS
So we need the harbor
SUB-COMMITTEE
Advices
SUB-COMMITTEE
Advices
MINISTRY OF TRAFFIC
R. P. C.
Physical Planning (Hearings)
Advices
MINISTRY OF FINANCE
MINISTRY OF ECONOMIC AFFAIRS
MINISTRY OF TRAFFIC & WATERWAYS
MINISTRIES OFFICE
Decision Making Plan
MINISTRIES OFFICE
Financial Decision Making
COUNCIL ON AIR POLLUTION
SOCIAL & PUBLIC HEALTH
STATE
COMMUNITY
COUNCIL ON NATURE PROTECTION
MINISTRY OF RECREATION & SANITATION
Advices
PORT AUTHORITY
Study on Tarifs and Land Prices, and Decision on Investment Plan
STATE
Adoption of the Regional Plan
DISTRICT
General Recommendation (Land Use Plan) Road, Residential, Infrastructure
COMMUNITY
(Land Use Implementation) Residences/Acres
REGIONAL PLANNING
DETAIL STUDIES
LAND APPROPRIATION AND PREPARATION OF GEOGRAPHICAL SCHEME
IMPLEMENTATION START
FINANCING

3.2.6 Transfer Function vs. Industrialization

It is our observation that in non-remote areas, efficient heavy industrialization is a major factor in the economic rationale for a deep water port development. Whether intentional (as in the case of Le Havre and Dunkirk) or not, heavy industry that relies on imported raw materials tends to spring up around deep water ports that offer ready access to markets. Antwerp, Rotterdam, and Tokyo illustrate this phenomenon.

Historically, European ports have provided a transfer function by dispatching and receiving commodities originating between the hinterland and foreland areas. After World War II, world trade expanded dramatically under free trade policies fostered by the West. With the increasing importance of world trade and the decline in the availability of indigenous sources of raw materials, heavy industry began to settle in port areas to achieve maximum economies in transportation. At this point in time many of these port areas have reached a "critical mass" for industrialization. That is, they have reached a stage in the industrial development process where growth feeds upon itself based upon the attraction of component supplier and user industries. Ports such as Marseilles/Fos, Le Havre, Dunkirk, and Amsterdam have not yet -- for a variety of reasons -- reached this critical mass stage, although Le Havre is close and Fos' development plans aim at an early arrival at this level. In order to more rapidly reach this growth phase, the national governments underwrite and subsidize not only basic port infrastructure, but also the establishment of such basic ocean-linked, stimulative industries, such as steel, oil refining, and alumina production.

Rotterdam and Antwerp are examples of ports which have passed through the critical mass stage and have experienced explosive growth. A large and well-linked hinterland, strong national base, export position for backhaul, good land, labor availability, and a good image were factors in this success. However, in the case of Rotterdam, a higher-order growth barrier seems to have been reached. This barrier is the limited availability of land and public opposition to further areal expansion by industry.

Thus, the increasing influx of heavy manufacturing facilities to the port area has resulted in industrialization requirements (land, labor, infrastructure, etc.) of a higher priority than those of the traditional transfer function provided for the hinterland.

Our analysis of industries locating in port areas shows that a combination of factors, rather than a single factor, work in attracting industries to a coastal port zone. Many of the industries that enjoy a locational advantage by being part of a port complex may be classified in one or more of the following groups:

- Those that draw their resources from the water;
- Those that realize a transportation cost advantage more important generally for raw materials than for finished products;
- Those that engage in the transfer and storage of goods;
- Those that require large amounts of cooling and process water or which discharge large quantities of effluents;
- Those that locate in the port for non-economic reasons. For example, in some cases, factors such as zoning, cheap land, or noxious odors associated with the industrial process may have influenced location; in others technological innovations may have eliminated the advantages that a port location formerly offered.

Table 3-2 lists heavy manufacturing sectors and their industry characteristics. The industry characteristics describe usage of labor, utilities (electricity, gas, water and effluent disposal), and investment relative to land usage. Other important measures of industrialization such as value added and output tonnages are presented also in relation to land usage.

Some observers believe that a number of major European ports have allowed their inland transportation links and services to be eroded -- by concentrating on port industrialization. However, many port officials expect such transfer functions to decrease in importance as a revenue earner because containerization will displace many of such collection and distribution functions.

For planning purposes, existing port areas that have less than 25,000+ acres of industrially zoned land available and at least twice that land available

TABLF 3-2

INDUSTRIAL CHARACTERISTICS BY MANUFACTURING CATEGORY

Manufacturing Category	Labour Requirement Per Acre	Utility Requirement Per Acre	Investment Requirement Per Acre	Added Value Per Acre	Transport Tonnage Per Acre	Added Value Per Employee	Industrial Effect On The Environment	
							Air	Water
1. Electrical Equipment	High	Very High	High	Very High	Very Low	Average	*	*
2. Glass and Ceramics	Low	Low	Very Low	Very Low	Low	Low	-	-
3. Machinery	Average	Average	Low	Average	Very Low	Average	*	*
4. Metals -- Iron and Steel	Average	Very Low	High	High	High	Average	**	**
5. Metals -- Non Ferrous	Average	Variable	High	High	Average	Average	**	**
6. Oil Refining	Very Low	Very Low	High	Very Low	Very High	Very High	**	*
7. Petrochemicals	Very Low	Average	Average	Low	Average	Very High	**	-
8. Other Chemicals	Low	Low	Average	Low	Average	High	-	-
9. Pulp and Paper	Low	High	High	Low	High	Average	*	**
10. Transport Equipment	Average	Average	Low	Average	Low	Average	*	*
11. Wood, Lumber and Cork	Average	Low	Low	Average	Average	Low	*	*
12. Other Industries	Variable	Variable	Variable	Variable	Variable	Variable	-	-

- highly variable within category

* less effect on environment than **

Source: Amsterdam Port Municipality/Inbucon.

for other support purposes, should not be developed as integrated deep water ports but should concentrate and specialize in offering transfer services. A general saying of port officials in both Rotterdam and Antwerp is that "in developing a port you always need twice the land acreage you originally planned."

Land adjacent to deep water is a highly valuable asset. Some of the major European ports have leased land to industry for 50 years at a very low cost in order to attract industry. Port officials at these ports now realize that in the heat of the nationalistic competitive port battle, they made a major mistake. In most cases they would have attracted a sufficient number of industries anyway. Consequently, industry has been a major beneficiary of European port investment and municipal port authorities are burdened with heavy financial debts. Finally, in the major ports which are facing environmental saturation, the value of certain types of industrialization is being openly questioned. For example, one question currently posed is: "Why invest in a steel mill when the developing country which sells the ore needs a steel mill more than we do to create employment and income, and does not mind incurring the pollution, and some day may insist that we take so much steel for a given amount of ore?"* It is our observation that careful industrial zone planning must parallel deep water port planning. In addition, industrial zones at a deep water port should be reserved and restricted to only those basic heavy industries which require and can achieve major productivity gains by having direct access to deep water ocean transport.

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* A Belgian

3.3 ENGINEERING CONSIDERATIONS

3.3.1 Introduction

Except for those countries with self-sufficient economies (eg., USSR) or with small industrial bases well served by feeders (eg., Denmark), every country consuming or producing bulk raw materials (oil and ores particularly) has developed or is in the process of developing port access for ships exceeding 80,000 dwt. Each of the countries which has initiated action to increase its capabilities to accommodate deep-draft vessels has developed specific engineering and construction skills to deal with the particular bathymetric, tidal, geological or geographic anomalies inherent in building specific port facilities.

The ports in Belgium and on the west coast of France, which are exposed to quite severe tidal ranges, have developed particular engineering technologies to design, construct, amintain and operate locks and dikes (the latter to protect the low-lying shoreline from being inundated). Estuarine ports have frequently used hydraulic models to reduce channel maintenance by enhancing natural scouring. Such models were later also used to investigate wave and silting problems inside the harbor and shoreline modification outside of new outer harbors. But recent advances in tanker and bulk carrier sizes have rendered much of the past structures obsolescent because of congestion and high operation costs. Established ports such as Rotterdam and Amsterdam have moved seaward by opening new outer harbors, reclaiming needed industrial land, and increasing their tidal basin acreage. All the while, they continued to deepen their wetdocks.

Urban-industrial congestion and environmental disruptions all too often followed these developments. Spurred by the imperative of further regional development, virgin sites were thus actively sought (eg., Hunterston, Fos-Marseilles). Scarcity of such sites often led to the development of man-made, excavated harbors (Port Cartier, part of Dunkirk, Japan). These, however, were costly and inflexible. Moreover, in the Persian Gulf and in Europe and Japan, relatively cheap pipeline transportation for the handling of oil fostered the establishment of offshore terminals with multiple or single mooring points. Later, these developed into "sea islands" or platforms (Kuwait), and soon into offshore islands, fully protected by seawalls (Le Havre). In the meantime, the same pipelines and transshipment systems gave renewed development opportunities to virgin natural sites (Finnart, Bantry Bay).

3.3.2 Vessel Designs

a. Tankers

Because the Persian Gulf contains about two-thirds of the free world crude oil reserves and produces one-third of the crude oil -- most of which must be hauled some 7,000 to 12,000 miles to Europe and Japan -- there has been a tremendous incentive to increase tanker size and reduce transport costs. Since the end of World War II, the deadweight of the largest tanker afloat has increased tenfold every 20 years and its draft has about doubled in the process:

INCREASE IN TANKER SIZE AND CAPACITY
1945-1971

	1945	1950	1955	1960	1965	1970	1971
Size, 000 dwt	21	30	47	104	130	326	477
Draft, ft.	30	34	38	49	54	82	92.5
Freight Index	100	85	72	54	52	44	36

It is most certain that several 500,000 dwt tankers will be operating in the mid-70's, and that million dwt tankers will join the world's tanker fleet before 1980.

b. Dry Bulk Carriers

Dry bulk carriers, which are subject to more constraints in cargo handling and storage than tankers,have historically had a 10-year delay in size development, and their size may remain below 200,000 dwt during the 1970's. But the 1960's saw the development of the combined carriers, ore-oil, coal-oil, ore-bulk-oil multi-purpose ships, which have increased flexibility for backhaul or trade switch, and which cost only 5 to 12% more than the same size tanker. They will make up about one-third of the bulk carrier tonnage in January, 1975. The largest ore/oil carrier on order is a 277,000 dwt. This compares to an order for 150,000-160,000 dwt for ore or OBO. One may thus expect 300,000 dwt vessels to carry iron ore and bauxite in quantities by the mid-seventies. Such ships may also carry coal or grain. Finally, recent developments have made it possible to slurry coal or ore for transport by pipeline or ships. The current success of the Marcona operation between Peru and the U.S. west coast leads us to believe that slurry ore carriers, up to at least 200,000 dwt, will also be in operation before 1980.

c. Containers

Although it was commonly thought that a 35-foot draft would be a limit for containerships, several such ships of draft between 40 and 46 feet are on order in Japan.

d. Design Vessel Characteristics

Port design characteristics are changing in response to growth in ship size. Some of the design characteristics currently used by the port of Le Havre in planning its projects are as follows:

Tonnage	Length	LBP	Beam	Depth	Draft
500,000 dwt	1370 ft.	1325 ft.	211 ft.	104 ft.	92.5 ft.

3.3.3 Channel and Basin

a. Channel Orientation

Currents are of greater concern than wind or waves in loaded superships, but wind is important in light or insufficiently ballasted vessels. In Bantry Bay, draft is continuously maintained at a 40-foot minimum, even when the ship is tied along the dock. Deep channels should be parallel to the current for route stability (and also to reduce silting). Special ballasting rules are observed for strong cross-winds. Waves, which used to be another controlling factor (channel perpendicular to swell) seem now less critical.

b. Channel Dimensions

Straight channels are desirable for radio navigation, but not always possible. Channel curves should have a diameter of 20 times the ship's length (ten times length is normally acceptable for smaller vessels). Channel widths of three times or five times the beam appear sufficient unless severe cross-currents and winds call for extra width (up to one time the length in Rotterdam). Having ships drag an anchor has been considered to increase route stability.

In curves, the channel width should be equal to at least the length of the vessel. In the entrance basin, stopping distance and maneuvers, commented upon in Appendix A.2 (Le Havre), requires three to four vessel lengths in diameter. A 200,000 dwt requires ten lengths to stop from 15 knots, and three lengths from 4.2 knots. Shallow depth increases the stopping distance and turning radius by 30-40 percent, if the ratio of depth to draft is 1.15.

The "pilot's margin"--i.e., the minimum allowable distance between the bottom of the ship and the channel bed--depends on wave height motions and squatting (linked to speed and depth-to-draft ratio or wetted surface ratio). Although hydraulic testing and experience is the ultimate criterion, some useful numbers are used by French engineers.

For example:

- For maximum waves of 10 feet in channel, the depth margin should be 6 feet minimum;
- For maximum waves of 6.5 feet in basins, the margin should be 4 feet minimum;
- For maximum waves of 4-5 feet at dockside, the margin should be 2 feet minimum;
- In open sea, a margin of 15 percent or even 20 percent is sought, although Rotterdam's channel is said to have a theoretical margin of 7 percent.

Turning basins, which used to be about 3 x L in diameter, have sometimes been reduced by necessity to 2 x L. But this is usually considered overly restrictive; a diameter of 2.5 times the design vessel length is preferable.

c. Dredging

With the exception of Gulf Oil's deep water port in Bantry Bay, Ireland, extensive dredging is usually required to increase the channel and dock depths in N.W. European ports. Fortunately, because the overburden is generally loose unconsolidated material dredging operations have been greatly facilitated and bedrock has never been contacted. In Holland, where the entrance channel into Rotterdam has been increased from 32 feet to 62 feet, seismic readings never located bedrock. In effect, additional depths are possible if the up river effects of channel deepening can be effectively controlled for natural scouring (Rouen-Le Havre).

Wherever possible, in French, Belgian, and Dutch ports, wrecks were bypassed if they did not actually prevent channel deepening and prevent entrance to a harbor. Many hulks lay for 20 years or more, until expanding world commerce developed a demand for deep water port facilities. The Dutch have used dredges to drag sand from beneath the wrecks, sinking them to a depth where even their top hamper was at least ten fathoms below the water surface. This work was completed in less than one year.

New channel construction and maintenance dredging in all European countries visited, with the exception of Ireland, has been extensive. The work has resulted in new dredge developments and techniques. Probably the most advanced development involves the design and use of the trailing suction-hopper dredge which is extensively employed for channel maintenance in Holland. Such dredges have been developed with a capacity of 18,000 tons per hour in 72-foot water depth.

On the other hand, deep channel dredging has changed the inner harbor wave pattern, accelerated down-stream erosion, caused salt seepage into polder lands, and changed the tidal influence so as to permit salt water to travel further up river than before and to degrade the upstream water quality.

Each country visited also seems to be satisfied with its way of disposing dredging spoil. Normally, the spoil is used either for construction purposes or for land reclamation. There are a few instances where the spoil has been returned directly to the sea; this happened when the material had no construction value.

d. Channel Congestion

One of the major problems affecting European (exclusive of Bantry Bay) deep water port development is chronic traffic congestion affecting port approaches, the out harbor, or the confines of inner harbors; accidents are not infrequent.

The Dover Strait providing access to the deep water ports in France, Belgium, and Holland is 20-miles wide and the usable navigational width is made narrower by sands and shoals. The meeting of flood tides, coupled with frequent dense fogs in the area, increases the navigational hazards. At times as many as 1,000 vessels pass through the narrow Strait per day. Also there are regular daily sailings of the ferry boats that cross the channel traveling back and forth between the Continent and England. Despite rules directing northbound shipping along the French side of the channel and outward bound traffic along the English side, deep draft ships are often forced into midchannel by lack of depth. Oddly enough, the various port authorities on the Continent do not display, or express, great concern over the traffic congestion, even though the increased port facilities will undoubtedly result in a further increase in maritime traffic.

One deep water port (Rotterdam) currently has 73,000 ship movements a year within the inner harbor channel. This figure includes 30,000* sea-going vessels entering and leaving the port annually. Total ship movements are, of course, expected to increase in proportion to the industrial development in the newly extended Europort facility.

Access to the main Belgium port (Antwerp) is gained through the Scheldt River which passes through Dutch territory. The Belgium port officials state that the Dutch authorities must approve all navigational devices used in their section of the river. The Dutch have delayed their consent on electronic navigational aids until the impact on the Dutch national defense has been fully investigated.

3.3.4 Harbor Configurations

a. Tidal Basins vs. Locked Basins

The inflexibility of locks to adapt to continuing increases in the size of carriers, and the loss of time which they inflict on smaller "quick transit" vessels (container and roll-on/off), has led tidal ports to develop--except in river ports like Antwerp--tidal basins rather than new wet docks. The inconvenience of vertical movement during cargo handling is reduced by the increase in size of modern vessels. An in-depth comparison of the two systems is underway in Great Britain for the National Port Council.

b. Excavated Harbors

Port Cartier, in the St. Lawrence estuary, is the only true excavated port included in our surveys. Japan also has recently built a large number of such ports. Because of the relative inflexibility of excavated harbors to accommodate future changes, accurate long-range forecasting of the facility's purpose and capacity is a necessity. The dim future of Port Cartier, in its competition with the nearby port of Seven-Islands, substantiates this point.

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* "Rotterdam Europort" Information, Department of the Ministry of Transport, Hydraulics and Public Works, The Hague, Netherlands.

When compared to natural and reclaimed sites, excavated harbors have the additional disadvantage of requiring at the outset a substantial investment in breakwaters. The breakwaters generally disturb the ecological balance, causing coastal erosion and sand transport, and the limited flushing requires special attention to effluents and basin cleaning.

On the plus side, such man-made harbors may help develop an otherwise unproductive or economically depressed area which lacks estuaries or natural bays. The waterfront is small and basins are well protected, with reduced maintenance and dredging.

c. River Ports

Although the huge dimensions of new tankers and bulk carriers seem to compromise the commercial future of estuary ports, these retain many advantages; in particular, they enable maritime traffic to move far into the hinterland. Bordeaux, Nantes, and Rouen are 60, 40, and 80 miles, respectively, from the sea. Bringing the cargo closer to consuming centers results in substantial transportation cost savings. It is not, then, surprising that some of the most important world ports—Rotterdam, London, Antwerp, and Hamburg--are all estuarine harbors. However, they are all moving out to sea, except Antwerp, which cannot.

d. Offshore Terminals

Offshore terminals have been developed for crude oil loading or unloading because pipelines are often cheaper than dredging close to the shore. They are useful also in reducing congestion in harbors and industrial bays (Japan).

The comparison between various solutions is shown in Table 3.3. This comparison has been derived from the experience in the Persian Gulf. In addition to single mooring buoys, sea platforms and jetties, larger islands (Le Havre) in unprotected waters are also being considered. Large islands, for dry bulk storage and other terminals are now under construction in Japan (e.g., container terminal in Kobe and the iron ore terminal

TABLE 3-3

PROS AND CONS OF SUPERTANKER BERTHS

	SINGLE-POINT MOORING (SPM)	SEA ISLAND	JETTY AND PIERS
ADVANTAGES	Suited to higher sea state 10-12 feet to berth 25 feet once moored	Can be designed for waves 10 feet longitudinal 5 foot beam, while moored	Same as sea islands
	Flexible on siting, orientation (ship swings with wind, current)	Orientation conditioned by wind and wave directions	Same as sea island
	Less damage prone in poor approach (can be ducked easily and tried again)	Damage to dolphins and platform are costly in time and dollars	Damage at T-pier connections endangers pipelines
	Less costly for one berth	Less costly than SPM for several berths	Less costly for high loading rates rates and short offshore distances
DISADVANTAGES	Access is difficult to crews and supplies	Access somewhat easier than SPM	No access problems
	Flexible and floating hose, risers are liable to damage (mechanical, fatigue, corrosion) and pollution (drainage difficult)	Steel chicksan arm better than aluminum or flexibles	Same as sea island
	Loading rate generally lower	Higher loading rates than SPM	No limits on loading rate

in western Honshu) but no actual experience has yet been acquired.

3.3.5. Miscellaneous

a. Breakwaters

In Rotterdam, unique construction techniques were used to build deep water entrance breakwaters. In fact, special block laying vessels were developed as part of the job. Basically, the stone dams were constructed in water 26-62 feet deep. In the deepest parts of the construction site trailing dredges dumped fine sea gravel and rough sand to heighten the sea floor. The filler material was then covered with gravel and rip rap of up to one ton in weight. This was then covered by rock of up to six-ton weight and two layers of 43-ton concrete blocks. The construction principle produced a filter system with each layer, entrapping the previous layer to prevent it from being washed away.

The positioning of the breakwater blocks was greatly assisted by using a Decca Navigation System, now used as navigational aid for vessel entry.

In Japan, tetrapods (also much used in France), hollow triangles and six-legged blocks are most popular for wave breakers. Huge caissons are used for the seawall, and perforated walls are designed to limit waves and currents to design specifications.

b. Dikes

Although the Dutch are generally credited with being the world's authorities on dike building, the newly constructed French dike protecting Dunkirk's Bassin Maritime from the North Sea has innovative engineering designs which, according to the French engineers, reduce the initial construction cost by some 15 percent below the cost of dikes of conventional design. (The detailed characteristics of construction are outlined in the appendix describing the Dunkirk port.)

c. Locks

The principal dimensions of France and Belgium's newest and largest locks are presented below. (Dimensions are in feet.)

	Dunkirk	Le Havre	Antwerp (Zandvliet)
Yr. Constructed	1966-71	1967-71	1961-67
Chamber			
Length	1200	1320	1560
Width	166	192	188
Depth	75.7	78.5	60.3
Cost $ million	27	36	41
Type of Gate	Rolling Caisson	Rolling Caisson	Rolling Caisson
Cost per Unit Vol.	$58/cu.yd.	$52/cu.yd.	$41/cu.yd.

European engineers are of the opinion that hydraulic model studies of lock sluicing should be taken for various heads to find the optimum economic solution for effective sluicing procedures. Such studies should take into account capital, operating and ship costs. Possible systems may include:

- Longitudinal culvert-side port system
- Loop culvert system
- End filling system--between and around sector gates.

The actual location of the lock is normally a compromise between various factors, navigational and structural strength requirements having the greatest design impact. Additional design criteria should, if possible, involve positioning the lock to minimize maintenance dredging at its approaches.

The hydraulic system adopted for filling and emptying the lock chamber also has great importance in the basic design of the structure. With an in-port operational cost of $20 per minute for a mammoth tanker, locking time must be minimized to avoid ship delays. Meanwhile, controlled sluicing to reduce turbulence and to avoid excessive hawser forces on vessels in the lock is of equal importance. The Zandvliet Lock, Antwerp, is the largest lock in the world having a capability to accommodate four 30,000 dwt vessels or one 100,000 dwt vessel although the larger vessels are not yet able to reach the port because of the restricted depth of the approach river.

Since lock gate damage can restrict entry and exit and can close the port until repairs are completed, the European trend is to construct the lock with floatable double caisson gates at each end to permit complete removal of one, or even two, caisson gates for overhaul and/or repair with only a minimum operational interruption.

The utilization of four gates within a lock may increase the initial construction cost, but the ultimate advantages will warrant the expense. If any gate is damaged, a replacement is immediately available. This avoids delays which would result while a damaged gate is removed and a spare one substituted. The extra gates therefore provide the fullest insurance against gate damage including the risk of water being lost from the dock to beach vessels within the dock area. The additional safety is sufficient to permit the design and construction of seawalls within the dock to be such that allowances are no longer needed for drawdown of water level due to lock gate failure. We are not aware of a comprehensive endeavor to accumulate past history on lock gates and to analyze the frequency, cause, and extent of damage.

There is little to no water change or flushing within the lock enclosures. Since the entry of industrial and domestic effluents is constant, cumulative and aggravated by surface water evaporation, acute pollution problems can be anticipated in the future. At least a 24-hour port shut down would be warranted to permit tidal flushing of most shipping basins. The floating trash and debris problem, however, appears to be more effectively controlled in the European ports than in U.S. ports.

d. Mooring Points

A major problem with superships is their huge mass which, even at very low speed, engenders extreme stress in the docking structure as well as in the particularly vulnerable hull of the ships. In shallow water (15 percent margin) the virtual mass can be twice the ship mass. Hulls are marked at the main bulkheads and stiffeners to make sure that main docking and tug pressure is applied at the best possible location.

Horizontal stress and shock become the major problems. The docking position must be perpendicular to wave directions (except in single point mooring buoys) and waves limited to four feet (for periods larger than 9 seconds) and five feet (for shorter wave periods).

Breasting dolphins, which may be protected by two larger, flexible, dolphins, should have large fenders with 150 square feet shields to spread the stress, reaching 2,000 tons. Mooring lines may be tied to 400-ton hooks on rigid mooring dolphins, spread on a line about 35 to 40 feet behind the breasting line.

Single point mooring needs 3300 to 3500 feet turning diameter for a 500,000 dwt vessel. Depth-over-draft ratios lower than 1.25 may bring a 30 percent increase in pulling stress if there are high waves. Six-hundred-ton pulling stress, possible in 11 foot waves, would require several mooring lines.

e. Fendering Systems

Large truck tires or heavy hard timber fendering systems are currently used in Continental ports, while Japan favors the Yokohama rubber fender. The most effective system was viewed in Bantry Bay, Ireland, where the Andre "R" type fender K60 and G40 are used. These fenders consist of a series of sandwiches of rubber bonded beween steel plates, assembled between prefabricated steel abutments and a central wedge. The resulting assembly is varied by both the size and number of sandwiches employed to produce a comprehensive range of performance while retaining the basic force deflection characteristic. This characteristic is one of decreasing stiffness with increasing deflection. It produces a terminal reaction which is lower than can be obtained from elastic springs of the same energy capacity and deflection which have the characteristic of increasing stiffness with deflection.

All movement is accommodated within the rubber and there are no mechanical parts subject to abrasion and wear or requiring lubrication. The bonded sandwiches have their steel plates encased in rubber in all areas which are exposed to sea water.

The rated or "normal" deflection can occasionally be exceeded without destroying the fender spring. The maximum possible deflection is 50 percent greater than the rated deflection and is accompanied by less than 50 percent rise in reaction, producing approximately 100 percent additional capacity. The capacity is available to deal with accidental overloads and up to 25 percent over rated deflection may be allowed.

3.2.6 A French Deep Port Design Philosophy

The French deep port design philosophy assumes as a first principle that the port is a rigid structure like a ship hull and the growth of a shell of a snail provides an anology of the way in which a rigid structure can grow and expand. This leads to a funnel concept for port planning where the dynamic development can freely move towards offshore deep water rather than the reverse. Lavera, an oil terminal between Marseilles and Fos, is a good example of the wrong way: at the end of a 2.5 mile long canal to the Etang de Berre, dredged at 30 feet, piers were built not from the bottom of the harbor towards the entrance, but on the contrary from the entrance of the harbor down and the first piers thus preempt future turning basins for larger vessels. The same thing happened in Le Havre, fortunately in much larger basins, but the most recent berth for 250,000 dwt tankers is more than 3,000 feet from the turning basin. In a typical coastal Mediterranean port, the dike should not be parallel to the coast but at an angle with the first pier being put in the narrow port, the development moving towards the wider, deeper part of the harbor.

Similarly, wet docks are much more rigid than tidal basins, although the latter have some size limitations introduced by the current in the narrow entrance which should not be higher than two knots.

A second principle is the importance of geology in site selection. Bedrock incidents in particular play a major role in basin and channel design. It is important to make preliminary surveys by first doing some drilling, then conducting a seismic survey to look for bedrock. This should then be followed by more systematic drilling programs. Sparkers are good, but limited in depth, and electric sounding has problems in salty soils.

The third principle is that current is more important and critical for big ships than swells or wind. The importance of swells becomes marginal for very big vessels, although tests like those conducted for Gulf's Kuwait terminal may still be necessary. Wind also becomes marginal for large tankers and bulkers, but is still important for the fast disappearing Atlantic liners. In Le Havre, use was made of warehouses and sheds to protect them from the wind effect. This might also be useful for container ships.

On the other hand, a current of two knots may apply a lateral force of several hundred tons to a vessel approaching a quay at a slight angle with the current parallel to the quay. A one-knot current could give a 500,000 dwt tanker a push of 200 tons. A transverse current of 1.7 knots will exert a push of 1100 tons on the same loaded 500,000 dwt. In a hook-shaped artificial island which has been proposed, a compromise would have to be reached not only to limit the current inside the protected area, but also to prevent large eddies from occuring at the tip of the island opposite the hook. The design of a perforated dike at the hook side extremity of the quay has to be carefully optimized for both purposes.

A fourth principle is that the future is paramount and that a new harbor should not be an annex of an old established smaller harbor. Thus, the basin of La Chaudiere in Marseilles is not built as an annex of the old port and Fos is not built as an annex to Lavera or even Marseiller--despite the fact that local municipalities wanted it that way. Similarly, deserted virgin sites are preferable to existing harbors, not only because of the flexibility they provide for the planner but because they entail fewer environmental problems. Whether this agreement is valid remains to be seen. Environmental problems are among the forces that are leading to the development of offshore port facilities at all continental port locations.

Gulf's isolated transshipment oil port facility on Whiddy Island in Bantry Bay, Ireland, was selected with great care and planning, and to date has not created any environmental unbalance. The naturally deep, maintenance-and-congestion-free channel has reduced navigational hazards and operational and maintenance costs. There is ample space for port expansion, and thus far, good rapport exists between town residents and the port operators. The pier and fendering system has proven to be a well-engineered installation, and the environmental control features incorporated into the design of the port are worthy of reproduction in continental ports, even though some improvements appear desirable. For example, doppler docking systems could be installed on the sea island for the final approach under tow; earthen dikes, used for spill retention around the oil tanks, could be reinforced because, in other terminals (Antwerp), they have not withstood the shock of major spills.

3.4 ENVIRONMENT ISSUES

3.4.1 Introduction

The rationale for deep water port development in Europe has generally been rooted in an economic viewpoint. Indeed, the same rationale is used in other areas in the world, notably Japan -- a nation which is also heavily dependent upon internationally produced raw material.

Understandably, however, with the increased awareness of the fragile nature of the physical environment in general, and the coastal and estuarine environments (upon which some countries depend so heavily for recreation and food) specifically, opposition has arisen to the idea of constructing ports. The threat of massive oil spills, of increased chances of vessel collisions, of uncontrolled industrial development near such harbors, of overcrowding, of land abuse, and of air, water and solid waste pollution, all have been raised as reasons not to "follow the crowd".

With this thought in mind, two issues become paramount: the first issue involves the proposition that concern over the physical and social environment as it is directly affected by the operation of a deep water port must be given consideration equal to that pertaining to economic, engineering and political questions. The second issue, involves the conclusion that comprehensive and thorough regional planning is required over both the short and long term to effectively cope with the needs of varying and usually disparate interest groups that become involved.

a. The Increasing Importance of Environmental Management

In general, environmental management might be defined as the establishment and maintenance of aesthetically and socially acceptable, productive and healthy surroundings for people. Within this definition may be included water and waste water treatment, air pollution abatement, solid waste management, noise pollution abatement, land use management, and, within the context of a deep water port, accident prevention.

Among the major factors traditionally and even currently considered in European port development -- i.e., economics, employment, engineering, and environment -- environmental matters occupy a position of relatively low priority -- particularly insofar as pollution abatement and the effects of rapidly expanding industrialization are concerned.

With the possible exception of the United Kingdom, we found relatively little indication of past concern over environmental matters -- although land use, and even this primarily in an economic sense, is a major issue. The matter is perhaps best illustrated by the following representative comments of the European officials we interviewed:

- "Effective concern regarding environmental quality can occur only in a rich and polluted society; we haven't been rich quite long enough." (Belgian official)
- "Awareness of our environment and its degradation is only a comparatively recent phenomenon, initiated primarily by the Torrey Canyon spill. Getting people to accept the costs of pollution control will be a long and arduous task." (French official)
- "What is environmental quality, and even if you could define it, what is its maintenance worth compared to economic progress?" (Dutch official)

These comments suggest a traditional emphasis on short-range, materialistic goals which historically could be achieved without much regard for their effects upon the physical environment and upon the people who live in that environment.

Clearly, however, "the winds of change" are blowing, and in some cases reaching nearly hurricane velocity. The activities of the Kabouter Organization in Amsterdam, take frequent calls (up to 55 a day) to the Rijnmond authority from aroused Rotterdam citizens concerning environmental pollution, indicate that environment may soon take precedence over or at least assume equality with economic considerations in Europe. The development and operation of adequate environmental safeguards, combined with a credible commitment to use such safeguards and an effective "selling" campaign, are likely to be necessary in the future to convince the public of the need for and benefits to be derived from any proposed deep water port facilities.

b. The Importance of Planning and Communications

A deep water port cannot be planned and built in a vacuum. To be effective, the planning effort must get representatives of many and disparate interest groups involved at an early stage. Antwerp (Antwerp District) and Rotterdam (Rijnmond) provide excellent examples of how local planning authorities have involved various interest groups -- labor, management, conservation, municipal authorities, and state authorities (representing various points of view) in their planning efforts.

While it is recognized that the fulcrum of activity and the catalyst to that activity is the port itself, a comprehensive planning effort must include, on both a short and long term basis, consideration of those areas which are either affected by or in themselves, directly affect the overall viability of the port. Such activities include:

- pollution abatement and control
- local and regional infrastructure
- port construction and maintenance
- type, density and location of industry
- type, density and location of housing and commercial areas
- recreational and cultural facilities

Beyond the region itself, consideration must also be given to the effect such a port will have on other communities, states or provinces outside the region and in an economic sense, even neighboring countries. Its fit with national policy considerations on matters such as energy, defense, regional economic development, and international trade must also be weighed.

Built into the development of a regional planning effort must be not only the aim of arriving at the best possible decision regarding a port project, but also the "selling" of the project before the decision can be achieved. The process of properly defining a question, and during that process arriving at a mutually agreeable decision by all parties concerned, is perhaps best exemplified in Japanese management practices. The following excerpts describing this process are from an article by Peter F. Drucker in the March-April 1971 issue of the Harvard Business Review ("What we Can Learn from Japanese Management").

> ...The Westerner and the Japanese mean something different when they talk of "making a decision." With us in the west, all the emphasis is on the answer to the question. Indeed, our books on decision making try to develop systematic approaches to giving an answer. To the Japanese, however, the important element in decision making is defining the question. The important and crucial steps are to decide whether there is a need for a decision and what the decision is about. And it is in this step that the Japanese aim at attaining "consensus". Indeed, it is this step that, to the Japanese, is the essence of the decision. The answer to the question (what the west considers the decision) follows its definition.
>
> ... Thus the whole process is focused on finding out what the decision is really about, not what the decision should be. Its result is a meeting of the minds that there is (or is not) a need for a change in behavior.
>
> ... [The advantage of such a process] is that it makes for very effective decisions. While it takes much longer in Japan to reach a decision than it takes in the west, from that point on they do better than we do. After making a decision, we in the west must spend much time "selling" it and getting people to act on it... The Japanese by contrast spend absolutely no time on "selling" the decision. Everybody has been pre-sold [or is reasonably comfortable with the decision and that their interests will be considered]. Also, the process makes it clear where in the organization the answer to a question will be welcomed and where it will be resisted.
>
> ... To the Japanese, the most important step is understanding the alternatives available. They discipline themselves not to commit themselves to a recommendation until they have fully defined the question and use the process of obtaining consensus to bring out the full range of alternatives. As a result, they are far less likely to become prisoners of their preconceived answers than we are.

A specific example of what should be done to improve on past experience pertains to relocation of small communities surrounded by industrially zoned acreages. The counsel of Berendrecht and Zandvliet, near Antwerp, would now prefer to relocate its clients in an area similar to their original environment. Prototype housing should be built there and presented to the menaced community, and assistance lent in managing compensation monies.

3.4.2 Environmental Topics

Within the framework of the two basic issues outlined above, a number of closely related topics were identified during our review of the five major West European ports and of other ports in the U.K., Japan and Canada.

a. Baseline Studies

Before construction of a major shoreside facility, we feel it is important that some form of environmental survey and inventory be taken. Such a study would include, but not necessarily be limited to, a "resource survey" covering such marine resources as commercial finned and shellfish, worms, seaweed, and recreational value. The reaction to pollution by certain forms of marine life, such as lobster larvae, should be studied, and certain organisms evaluated for use as indicators of pollution. The nearby waters as well as their tributaries should be surveyed to determine such points as density, salinity, turbidity, temperature, circulation and flushing, and water chemistry. Present sources of pollution should be identified and their importance noted.

One of the principal objectives of such a study would be to establish the "baselines" beyond which pollution should not be allowed to continue until appropriate measures are taken to protect the environment. Such a program would be particularly important in coping with low-level pollution; it would, however, be of little value in dealing with the prevention of large-scale oil spills. Certainly the program would serve as a valuable source of information and experience upon which other organizations could draw in carrying out similar projects.

In addition to a marine survey, serious consideration should also be given to inventorying and assessing the land and atmospheric environment around the proposed port site. The objectives of such a survey would be the same as those aimed for with respect to the marine-oriented study. With information of this type in hand, the effects of port development and use can be more accurately assessed and, over the long term, used in evaluating future plans.

As far as we were able to determine, no such baseline studies have been carried out or are currently planned in any of the five European ports we visited. This is perhaps understandable, since with the exception of Dunkirk, Bantry Bay, and Port Cartier, the major ports surveyed (Le Havre, Antwerp, Amsterdam and Rotterdam) have been in existence for hundreds of years and received renewed stimulus for growth immediately following World War II before there was any widespread concern over environmental quality.

There is a chance, however, that most new construction of deep water ports may in the future have to be carried out in a relatively new and unspoiled area. In such a situation, a baseline study would not only be important, but save the advantage of containing information obtained from a relatively stable virgin condition. It would thereby render analysis and results more credible.

Baseline studies of the type described above have never been carried out before on a large scale. We estimate that at a minimum it would require two or three years to do them. In fact, a longer time -- say, five years -- might be desirable. Obviously, such a time constraint works against any goals for rapid construction of a deep port facility. Consequently, planning efforts would have to be initiated considerably in advance of the making of any policy decisions. One approach would be to identify several possible alternative locations for deep water ports (without commitment to any of them), and study all of them simultaneously. This type of approach, though costly, would have several advantages: flexibility regarding final site selection, comparison of results from several different locations, and evaluation of various approaches to the problem.

b. Planning

The need for comprehensive and long-range planning has already been pointed out. Several specifics, however, should be mentioned, the first of which relates to the type of deep water port that will be built. Basically, there are two types, either an integrated industrial port containing both dock facilities and industrial sites, or a terminal type of operation such as presently exists at Bantry Bay, Ireland, and which serves only as a transshipment point. (Another example of the latter would be an artificially constructed island well offshore from the mainland--see, "Potential Models for Deep Water Port Development," Sections 3.2.3 and 3.4.3.)

Obviously, land use planning is of primary concern when dealing with industrially integrated types of port. Planning studies of those ports should include our assessment of: the ultimate industrial capacity of the area being investigated (beyond which additional capacity would have to be located elsewhere); the extent to which shoreline areas will be adversely affected; the growth of secondary and tertiary industries (i.e., those which may directly depend upon primary industries located close to the docking sites, such as steel and petroleum refining); aesthetic considerations such as greenbelt areas; recreational facilities, adequate space for housing and commercial developments; and the necessary infrastructure.

Among the environmental factors which should to some extent control the location of various types of activities are climate, meteorological conditions (i.e., wind velocity and direction), water quality and supply, topographical and geological conditions, and already existing infrastructure, housing and commercial facilities.

c. Land Concessions

In major European ports, the development of land areas directly related to port facilities are not owned outright by users but are rented under concession agreements. Such agreements offer two major advantages: 1) an income source to the developer (i.e., the government), and 2) a means to review and control within reasonable limits (through refusing to grant a concession initially or subsequently canceling it) the activities of the tenant.

d. Water Management

Extreme care must be taken to assure that extensive deepening of existing harbors or channels does not result in salt water contamination of fresh water aquifers which may underlie the waterways. Channel deepening may also permit salt water to encroach further upstream. This can cause excess salinity in fresh water supplies or, through lateral migration, land fertility damage. There appears to be some evidence that aquifer damage has occurred in the Le Havre area, but whether this is directly attributable to channel deepening is not known for certain. In Dunkirk, Antwerp, Amsterdam and Rotterdam, however, soil damage from lateral migration of salt water is of real concern. Questions such as these suggest that, aside from economic considerations, deep water ports should either be constructed in naturally deep harbors requiring little dredging or they should be placed as far from productive land as is practical.

With special reference to new port construction, adequate safeguards for waste-water treatment must be provided from the beginning, and in such a way as to permit upgrading when it is necessary. Oxygen-consuming wastes, suspended solids, dissolved solids, thermal discharges, and toxic materials should be properly treated from inception so as to reduce any possibility of damage to the receiving aquatic environment. Such provisions are not yet an integral part of world port planning. We believe that such precautions should be taken as a matter of course, along with the installation of the necessary instrumentation and monitoring equipment to assure proper operation of waste treatment facilities.

Because the principal rationale behind the development of deep water ports is oil transportation, a major concern regarding the construction of such facilities is the threat of oil spills--either minor and chronic or major and episodic. Prevention and cleanup techniques have not yet been fully developed. However, a complete system should include: shore-to-ship vessel traffic control methods, vessel inspectors, the use of experienced pilots on all arriving and departing ships; detailed and approved procedures for loading and unloading vessels (chartered as well as owned or operated by oil companies); the surrounding of all loading or unloading vessels with booms and/or bubble curtains; maintenance of a sufficient oil spill cleanup capability at the harbor; frequent inspection and maintenance of all petroleum and petroleum product handling equipment; adequate protection from accidental spills from storage facilities; active surveillance of operations; and pre-established legal procedures for dealing with offenders.

e. Air Pollution Control

The principal lesson to be learned from our review of European ports with respect to air pollution control is that in the absence of specific effluent standards and legislation or treatment methods, the "discussion" approach used by Dutch authorities appears to be reasonably effective in moderating pollution, especially when backed up by the land concession system. In addition, the air-monitoring system in Rotterdam -- primarily for sulfur dioxide and particulate matter -- has been well received and is expected to be duplicated elsewhere. Such a system, perhaps even more comprehensive in design so that it includes the monitoring of such contaminants as carbon monoxide and unburned hydrocarbons, should be included in the development of any integrated port complex. In any case, whether the port is to be located directly on the coastline or at an offshore site, current air pollution control regulations should apply with the caveat that more stringent controls might be required in virgin areas.

f. Solid Waste Management

Proper handling of municipal and industrial solid wastes is really only beginning in the ports we visited. Open burning, open dumps, and deep sea disposal are common practices and contribute directly to environmental degradation. Depending upon the extent of the area involved and its location, proper solid waste disposal practices should be followed, including consideration of high-temperature incineration (with possible recovery of waste heat and other by-products), recycling, and sanitary land fill.

Where dredging is required either for initial construction or maintenance purposes, careful attention must be paid to the disposal of spoil; spoil areas would presumably be determined in part by the baseline studies carried out prior to construction.

3.4.3 Potential Models for Deep Water Port Development

Shown below are the several alternative models for deep water port development suggested in Section 3.2.3 above, along with the major advantages and disadvantages to each alternative from an environmental standpoint.

a. Do Nothing

As might be expected, an explicit decision not to improve the economics of marine transportation capabilities would have approximately a "neutral" effect on the environment; appreciable changes related to new port development would not occur, and existing port complexes would continue on more or less present courses with increased congestion.

Such a decision, however, might materially worsen a country's trade position, and at some later point in time could precipitate a sudden reversal in policy which would permit more rapid but perhaps less thoroughly considered deep water port development activity.

Major Advantages

- Deep ports "not needed", therefore new dredging not needed;
- Retains virgin coastal sites.

Major Disadvantages

- Spill potential still exists;
- Congestion and industrial concentration remains a problem in existing ports.

b. Lighten Super Carriers

Aside from the alternative of "Do Nothing", this choice would probably be the least expensive in terms of investment. However, freight rates would be higher than for large tankers directly unloaded.

On the other hand, the potential of spills connected with offloading procedures would be increased, as would feeder traffic problems. Further, since deep draft dry bulk carriers probably could not be economically lightened, the pressure for deep water facilities for these vessels would still exist.

Major Advantages

- Reduces need for deep water--less dredging required;

Major Disadvantages

- Increases overall spill potential;
- Continues growth and con gestion of existing port;
- Feeder (lighter) traffic increases.

c. External Transshipment Terminal

Obviously, the principal environmental reason for favoring this alternative is that pollution problems are at least partially shifted outside the country's coasts. Closer examination, however, suggests that this may not be entirely true, and further that the economic costs may not be worth the marginal environmental gain. Costs depend on the amount, character, ownership, registry, and costs of feeder service.

The new Point Tupper terminal in Nova Scotia, built by the Bantry Bay operator, is an example. Sufficiently deep water is available to handle the largest tankers now plying the seas; vessel handling techniques are modern and presumably adequate; and environmental protection methods are in force. Finally, in the unhappy event of a small or moderate spill, damage would presumably affect only the immediate surroundings.

On the other hand, a major spill on the coast of the Maritime Provinces could well affect the U.S. east coast; if the Point Tupper terminal were used for transshipment purposes, feeder traffic would certainly increase.

Major Advantages

- Presumably a natural deep water site;
- Partial shifting of environmental problems outside the country;
- Diminished pressure for densification of urban areas;

Major Disadvantages

- Feeder vessel traffic will increase, thereby increasing chances of accidents;
- Probably offers less control over port operations from environmental standpoint;

Major Advantages

- Possibly less major spill threat to the coast, depending on location.

Major Disadvantages

- Probably offers less control over type and condition of super ships;
- Reduces access to the terminal.

d. Subsidize Shallow Draft Super Carrier Fleet

As was previously mentioned, this possibility is currently under study by the Netherlands government, and a New York firm. Aside from serious technical and eocnomic problems, the construction of a shallow-draft super carrier fleet would do little to improve the quality of the environment or to encourage planning for such improvement.

Major Advantages

- Dredging unnecessary -- existing ports can be used;
- Retains virgin coastal areas;
- Encourages at least some upgrading of existing ports.

Major Disadvantages

- Spill potential still exists;
- Continues growth and congestion of existing ports.

e. Deepening and Expanding Existing Port-Industrial Complexes

This type of activity is proceeding in many areas of the world; Le Havre and Rotterdam are two European examples. The Long Beach, California, project is perhaps the closest to such an approach that the United States has taken.

In addition to the tremendous costs involved however, extensive deepening of any of the major ports to accommodate vessels having drafts of roughly 80 feet would entail significant environmental hazards in the forms of spoil disposal, upstream salt water encroachment, and possible aquifer contamination. The problems of existing industrial congestion would be magnified. Finally, there is the distinct possibility that the channel would never be quite "deep enough," thereby causing a continuing spiral of dredging as in Rotterdam and Milford Haven.

Major Advantages

- Avoids industrialization of an "unspoiled" new area;
- Affords opportunity to improve existing environment.

Major Disadvantages

- Possibility of salt water contamination of fresh water, land, due to channel deepening;
- Increase congestion and urbanization;
- Spill potential remains, along with feeder traffic to other shallow ports;
- Complex regional planning involved in expansion program.

f. New Coastal Transshipment Terminals

Perhaps the best known deep water transshipment terminal in operation in the world today is Gulf Oil's facility in Bantry Bay, Ireland. Japan is also building several such terminals.

A well-designed,new coastal transshipment terminal would not bring long-term industrialization and environmental decay to a previously undeveloped area, unless it were permitted to develop into an integrated port complex. Environmental baseline studies could -- and should -- be carried out prior to construction, and regional planning requirements should be severe. As with every alternative, the potential threat of an oil spill would exist, but properly conceived and enforced traffic control and cargo handling regulations could materially reduce the likelihood of such an event; furthermore, institution of such procedures should be easier to accomplish in a new facility than in an older one where already established patterns are more difficult to change.

Major Advantages

- Reduces dredging requirements in existing ports;
- Reduces congestion pressure on existing ports;
- Baseline studies can be made;
- Better opportunity for balanced future growth if desirable;
- Option to select best physical site;
- Offers greater flexibility in planning port operations.

Major Disadvantages

- Increased feeder traffic;
- Exposes a new area;
- Partial disruption of previously established cultural and economic patterns;
- Overall spill potential remains.

g. New Offshore Transshipment Terminal (Island)

Because of depth limitations at coastal locations, man-made offshore islands are becoming an increasingly attractive alternative. Such facilities are being planned for Oita, Japan, and Le Havre/Antifer, France.

On balance, the environmental arguments are quite attractive: except for the land needs of pipeline and other conveying systems, virgin coastal sites can be preserved, planning flexibility is reasonably good, and coastal dredging would not be required. Feeder traffic would continue to be a problem, however, and subsequent expansion of the facility -- if built in deep water to start with -- would be an expensive proposition.

Industrialization resulting from such a terminal could be located along the coast and served by feeders, or well inland served by pipeline and rail. The latter case would allow development to bypass sensitive or congested areas. Careful regional planning, covering an extensive hinterland, is thus required.

Major Advantages

- Offers greater flexibility in developing port regulations;
- Provides opportunity to select "best site";
- Allows for more balanced growth on shore and reduces industrial congestion;
- Avoids "virgin" coastal site development except possibly at shore connections;
- Baseline studies can be made if desired;
- Reduces direct threat to coasts from major spills;
- Reduces dredging requirements in existing ports.

Major Disadvantages

- Increased feeder traffic
- Reduces accessibility in event of accident;
- Overall spill potential remains;
- Congestion at existing ports may remain a problem.

h. A New Deep Water Port Industrial Complex

This alternative might be typified by the projects now underway at Fos, France; Kashima, Japan; and to a lesser extent, Dunkirk, France. Perhaps the most intriguing possibility regarding this alternative is the opportunity of planning a complete integrated port facility "the way it should be," plus the incentive of developing a new efficient industrial center (possibly export oriented) in an area that needs a large economic stimulant. Conceivably, such a port could serve as a model for other areas throughout the world. Vessel traffic control, cargo handling procedures, pollution control, land-use planning, and industrial growth could be handled on a more comprehensive scale than in possible with any of the other alternatives. Despite its attractiveness, however, this alternative has the major drawback that final selection of the site would be an extremely difficult and time-consuming task. Economic and social dislocation under this alternative would be considerable and land areas set aside for the purpose would in all probability be much larger than in several of the other possibilities. Further, from a purely environmental standpoint, there may be merit in the position that intensive industrial congestion of the type spawned by deep water ports should be avoided altogether, and industry should be more widely dispersed despite the economic benefits of agglomeration.

Major Advantages

- Option to select best physical site;
- Greater flexibility for planning and controlling legislation regarding traffic control and pollution control;
- Avoids impingement on existing high-density urban areas;
- Baseline studies more practical;
- Better opportunity for balanced growth.

Major Disadvantages

- Exposes a new coastal area to industrial activity;
- Complex regional planning required;
- Disruption of social and cultural traditions in new areas;
- Feeder vessel traffic will probably increase;
- Spill potential.

TABLE 3-4

COMPARATIVE ENVIRONMENTAL MANAGEMENT PERFORMANCE
MAJOR EUROPEAN DEEP WATER PORTS

	France		Belgium	Netherlands	
	Le Havre	Dunkirk	Antwerp	Amsterdam	Rotterdam
Pollution Abatement — Existing					
Municipal	Nil	Nil	Nil	Nil	Nil
Industrial	Low	Nil	Low	Low	Low
Legislation	Low	Low	Low	Low	Low
Enforcement	Nil	Nil	Moderate	Low	Moderate
Pollution Prevention — New					
Municipal	Low	Nil	Nil	Nil	Low
Industrial	Low	Low	Moderate	Low	Moderate
Oil Spill Prevention/Cleanup	Low	Low	Low	Nil	Moderate
Evaluation of Marine Effects	Nil	Nil	Nil	Nil	Nil
Aquifer Damage	?	N.A.	N.A.	N.A.	N.A.
Salt Water Intrusion	N.A.	Poss.	Poss.	Poss.	Poss.
Areal Land Use					
Green Belt, Recreational, Housing	Low	Low	Good	Low	Moderate
Regional Planning	Good	Good	Good	Moderate	Good
Local Planning	Moderate	Moderate	Good	Moderate	Good
Current Overall Environmental Course	Low	Low	Moderate	Moderate	Moderate
Air	Low	Low	Low	Low	Moderate
Water	Low	Nil	Nil	Nil	Nil
Solids	Nil	Nil	Nil	Nil	Low
Sociological	Nil	Nil	Moderate	Moderate	Moderate

Legend: Nil; Low; Moderate; Good. N.A. Not Applicable

3.5 INTERRELATIONSHIPS AND POLICY IMPLICATIONS

As the world moves into the final quarter of the twentieth century, it has become increasingly apparent that large projects of almost any type cannot be based solely on simple expediency or the perceived need to meet short-term goals. We have become aware that any major program, regardless of its basic purpose, may have significant if not massive long-range effects on other portions of society at large, upon the economy, and upon our physical environment.

The interrelationship of these factors as they impinge upon major policy decisions pertaining to such subjects as national defense, energy policy, transportation, environmental quality, urban-industrial congestion, and economic development cannot be ignored.

An illustration of the degree to which such factors come into play, and the relative importance of each of them to a specific project, can be seen in the fold-out on pg. 2-9 of this report which summarizes the various advantages and disadvantages of the eight alternatives to the question of deep water port development.

A brief explanation of the table itself is perhaps in order before discussing its implication. For each alternative, major advantages and disadvantages are identified in the preceding sections on economic and environmental lessons learned from foreign port experience. Each alternative was reviewed separately by members of the ADL core team in terms of these advantages and disadvantages, with a subjective decision being made as to the degree to which they were applicable or not at all. The general degree of applicability was indicated, with each advantage and disadvantage being given equal weighting. Admittedly, such a weighting procedure avoids the valid observation that, depending on one's viewpoint, some factors may be more important than others. However, resolution of this problem was not within the scope of the effort involved, and, accordingly, it seemed more appropriate to leave the question open rather than try to resolve it.

Each alternative was then independently assessed relative to applicable advantages and disadvantages with the final results being discussed by the team members. In this way an aggregate opinion was obtained regarding the relevant merits of each alternative. (The evaluation procedure also allowed an implicit recognition by each reviewer of the relative importance of the various factors involved, i.e., an intuitive weighting.) The results of this tentative evaluation are shown in the center table. The most attractive alternative appears to be the development of a new coastal transshipment terminal,* and the least attractive alternative is the deepening and expansion of an already existing port-industrial complex. Other alternatives fell between these two extremes in the following order: (1) new deep integrated port complex; (2) offshore transshipment island, external transshipment terminal and "Do nothing;" (3) develop shallow superships, lighten superships.

The principal purpose of this exercise was to show that the situation becomes much more complicated when social and environmental impacts are explicitly considered in addition to the economic rationale for deep port development. For example, it would appear that from an economic standpoint there is relatively little to choose between the lightening of super carriers and the development of a new coastal transshipment terminal. When environmental factors are considered, however, the alternative of lightening super carriers suffers in the comparison.

Obviously, at some point in the consideration of various alternatives, trade-offs will have to be made. At that point various factors become either implicitly or explicitly more important than others. For example, how important will it be to a country if substantial segments of primary industry (e.g., petroleum processing and primary metals) are obliged for economic reasons to locate new facilities outside of the country because of the savings that can be achieved elsewhere? How important will such a decision be not only to the economic security of the country but to its military security as well? Is such a consideration, in the long run, more

* As this report is going to press Le Havre announced its decision to build a coastal terminal at Antifer rather than an offshore island(Petrole Information, 26.Nov.1971).

or less important than the environmental changes which would be caused by developing some form of new deep port? Will the development of a new deep port-industrial complex ease the pressure on existing urban-industrial complexes, and would the overall change be a desirable one? Which alternative affords the greatest chance of success in dealing with the questions pertaining to oil spill prevention and clean-up? What price is the Government prepared to pay to maintain or improve the country's current posture in world trade, and, conversely, what price is it willing to pay to maintain the status quo?

Specific questions can be asked with respect to each of the alternatives.

Would "Do Nothing" be merely putting off a positive deep port decision until a later time when the pressure for more rapid--and less thoroughly considered--action will be greater than it is now? In fact, it is already leading to external transshipments.

With respect to the lightening of supercarriers, can this solution be practically applied to other than liquid bulk vessels?

Concerning an external terminal, is the country in effect willing to reduce the amount of control exerted in the operation of the port and--as in the case of certain east coast Canadian or Bahamian operations--continue to expose portions of coastlines to the threat of major spills resulting from increased feeder traffic?

Can shallow draft super carriers operate economically in competition with conventional vessels of the same deadweight tonnage, and, if not, what would be the advantage over, perhaps, doing nothing?

With respect to all of the last four alternatives, how many such projects can be economically or environmentally undertaken, and what will be the impact upon older ports which are not deepened?

What compensations can then be planned to allay this impact?

It is our impression that all of these and other questions as well, in addition to those shown on the fold-out, were not explicitly considered by the planners of major foreign deep water harbors. Economic factors and questions of national prestige were undoubtedly considered very carefully, although not, generally, in a thoroughly quantitative manner. Environmental and social questions, though recognized, were often not "plugged in" to the decision-making process except more recently in the United Kingdom. Because of this, European, Japanese, and some United Kingdom and Commonwealth ports are under enormous social and environmental pressures, and because of already committed investment and in some cases the limited amount of coastline available for further development, significant changes in the situation will be difficult to accomplish. Deep port development has been stalled in the U.K. by environmental concern.

Though time is growing short, the United States is still in a position to be able to carefully assess the alternatives open to it, to discuss them openly, and to develop a comprehensive long-range plan for maintaining or improving its world position in marine transportation, taking into account not only the economic factors involved, but social, environmental, and security considerations as well.

4. EUROPEAN PORT DEVELOPMENT STRATEGIES

4.1 OVERVIEW

4.1.1 The Importance of Ports to National Economies

Europe has a historically limited and rapidly diminishing raw material resource base, a constraint on industrial growth that has been overcome by importing large quantities of raw materials and commodities and exporting processed materials and merchandise. Such an approach to industrialization has resulted in foreign trade becoming a significant component of the national economic activity of European countries. Figure 4-1, for example, compares the value of commodity exports as a percent of Gross Domestic Product (GDP) for selected European countries with that of the United States. Clearly, these European countries depend to a much higher degree on international trade for their total economic activity than does the United States. Although in 1970, the international export trade of the United States represented $43.2 billion or 4.5% of Gross Domestic Product and is an important element in the American economy and a very important factor in world trade, it is not in overall terms as vital a consideration to the survival of our national economy as it is, for example, in Belgium, whose exports of $11.6 billion represent 46.5% of the Gross Domestic Product and are a vital factor affecting national survival.

During the past five hundred years, European ports along the English Channel and the North Sea Coast have been the hub of world maritime activity. This relatively small land/sea area is the location where the greatest quantity of world cargo changes its mode of transportation (see Figure 4-2). For example, in 1969, the export and import tonnage moving through these ports was more than twice the volume of United States' ports. Major development projects which tend to lower transport costs and/or increase transport conveniences in this European zone will have an important impact on world trade flows and growth, with resulting repercussions on the industrial and economic structures of almost all nations engaged in international trade. However, the impact on European nations bounding this area is even more pronounced.

FIGURE 4–1 MERCHANDISE EXPORTS AS A PERCENT OF GROSS DOMESTIC PRODUCT, 1970

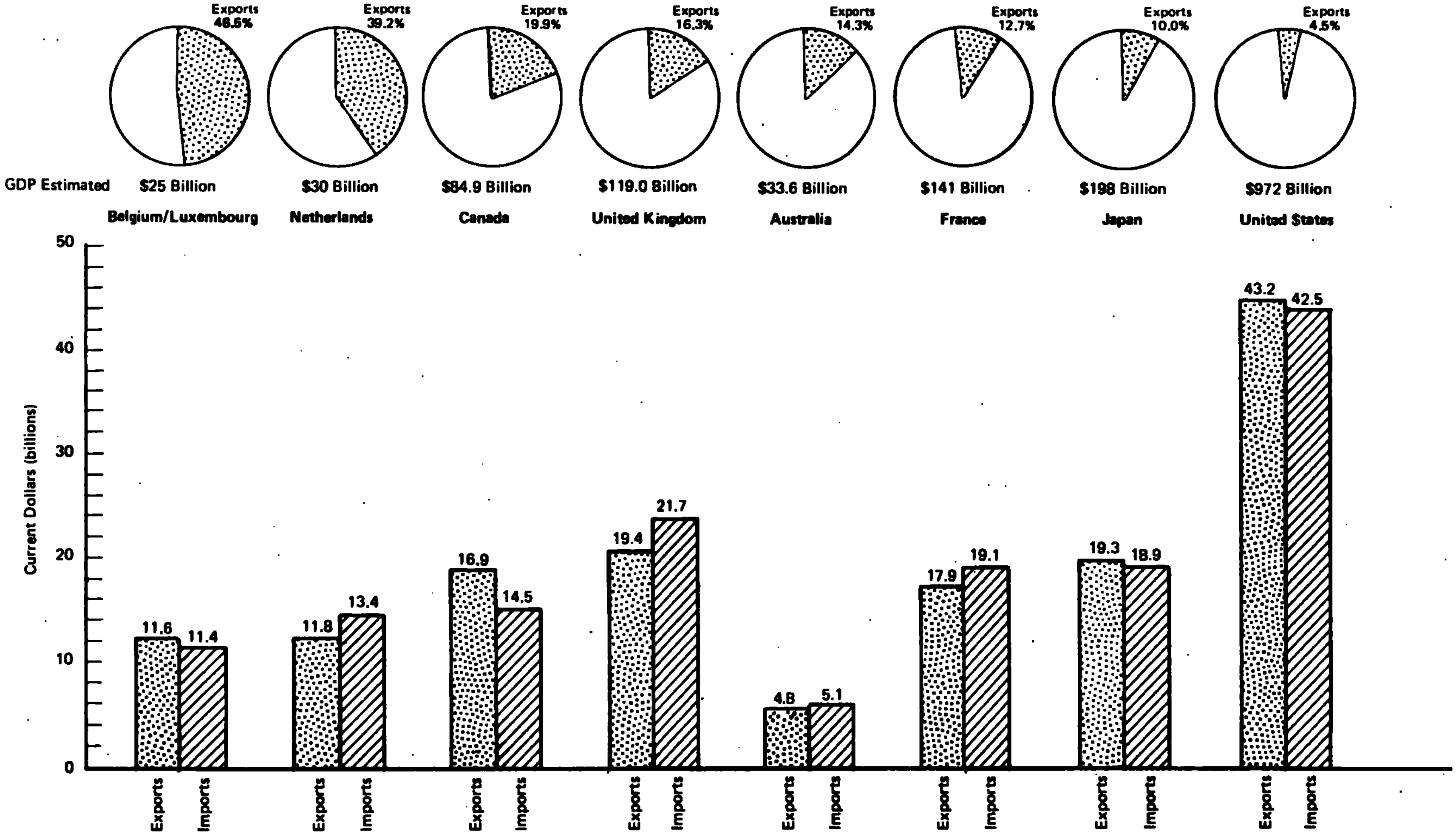


TABLE 4-2

PRESENT AND PROPOSED EXPANSION PLANS

Port	Quay Length	Present Maximum Tonnage	Major Port Features	Regional Infrastructure	Present Maximum Tonnage	Major Port Features	Infrastructure	Facilities	Industry
Le Havre	1.2 miles	69' or 250,000 dwt	Rapid process of expansion, 160 regular shipping lines. Eight large refineries, three pipelines to the Paris region. Important petrochemical complex. Phase of autonomous growth nearly reached. Second largest French port.		69' or 250,000 dwt	Rapid process of expansion, 160 regular lines. Eight large refineries, three pipelines to the Paris region. Important petrochemical complex. Phase of autonomous growth nearly reached. Second largest French port.	Deeping of the port approach and the tidal dock. Construction of a new tidal dock (300,000 dwt). Construction of 2 locks (200,000 dwt). Plans for an artificial island (1,000,000 dwt).	Creation of new supertanker-bulk carrier and container facilities. Extension of industrial areas. Construction of a container terminal (1971/1972). Construction of 2 new tanker-berths (300,000 dwt). Construction of oil storage reservoirs.	Development of 2,470 acres of industrial land. Plans for the construction of a steel mill and 2 new petrochemical works.
Dunkirk	9 miles	125,000 dwt	Third largest French port. Important ro/ro traffic; considerable railway traffic. 150 regular lines.	Several road construction and improvement plans.	125,000 dwt	Third largest French port. Important ro/ro traffic; considerable railway traffic. 150 regular lines.	Construction of an outer-harbor (300,000 dwt, 1974). Improvement of the port approach (1971). Plans for an artificial island (750,000 dwt).	Development of industrial areas. Increase of supertanker, bulkcarrier, and container facilities. Creation of a bulk storage area (1972). Enlargening of the existing general Cargo-Quay.	Development of 7,410 acres of industrial land. Construction of an aluminum plant. Expansion of the steelworks.
Antwerp	59 miles	43' or 80,000 dwt	300 regular shipping lines. Important General Cargoport. Selective Industrial policy. High investments in the chemical sector. Creation of very good Hinterland connections. Pipeline connection with Rotterdam.	Construction of the Scheldt-Rhone Canal. Several road construction and improvement plans. Adaptation of a number of canals to push barge convoys. Construction of nuclear power station.	43' or 80,000 dwt	300 regular shipping lines. Important General Cargoport. Selective industrial policy. High investments in the chemical sector. Creation of very good Hinterland connections. Pipeline connection with Rotterdam.	Improvement of the Sea Access way. Construction of two new harbor docks. Plans for a supertanker-terminal at Zeebrugge (200,000 dwt).	Development of new industrial areas. Plans for a World Trade Center.	Further development of industrial land, new refinery, petrochemical and chemical industry. 7,410 acres available on the left bank of the Scheldt.
Rotterdam	20 miles	62' or 250,000 dwt	Important bulk transit oil and containerport. Important petrochemical complex. Pipelines to the Ruhr, Amsterdam and Antwerp. Extremely good Hinterland connections. Lash ships have already arrived. Probably the Rijnpoortproject will be located at the Maasvlakte and the steel mill will not be allowed to settle.	Construction of Scheldt-Rhine Canal. Several road construction and improvement plans. Plans for extension of the airport.	62' or 250,000 dwt	Important bulk transit oil and containerport. Important petrochemical complex. Pipelines to the Ruhr, Amsterdam and Antwerp. Extremely good Hinterland connections. Lash ships have already arrived. Probably the Rijnpoortproject will be located at the Maasvlakte and the steel mill will not be allowed to settle.	Further reclamation of the Maasvlakte (1974). Construction of a new harbor entrance (1971). Construction of a new harbor complex ('Rijnpoort') for containers (1974).	Plans for a World Trade Center. Increase of supertanker and bulk-carrier facilities ('Maasvlakte'). New containerport ('Rijnpoort'). Development of industrial areas.	Further reclamation of 4,940 acres of Maasvlakte (1974). Other industrial and port areas planned. Extension of refining petrochemicals and chemicals.
Amsterdam	14 miles	Amsterdam: 45' or 90,000 dwt – Ijmulden: 100,000 dwt	No decision yet on the container port project. Slight over-capacity in equipment. Pipeline connection with Rotterdam. Industrial development has lagged behind. Phase of autonomous growth not yet reached.	Adaption of Amsterdam-Rhine Canal to push barge convoys. Widening of North Sea Canal. Several road improvement and construction plans. Plans for a new railway for freight center. Plans for extension of Schiphol Airport.	Amsterdam: 45' or 90,000 dwt – Ijmulden: 100,000 dwt	No decision yet on the container port project. Slight over-capacity in equipment. Pipeline connection with Rotterdam. Industrial development has lagged behind. Phase of autonomous growth not yet reached.	Widening of the Sea Access Canal (1972). Proposal for an outerport (150,000 dwt)	Plans for a World Trade Center. Reconstruction of the older parts of the port. Development of industrial areas.	Development of 7,163 acres of industrial land of which 4,446 acres before 1980. Expansion of refining capacity.

Source: European Port Authorities.

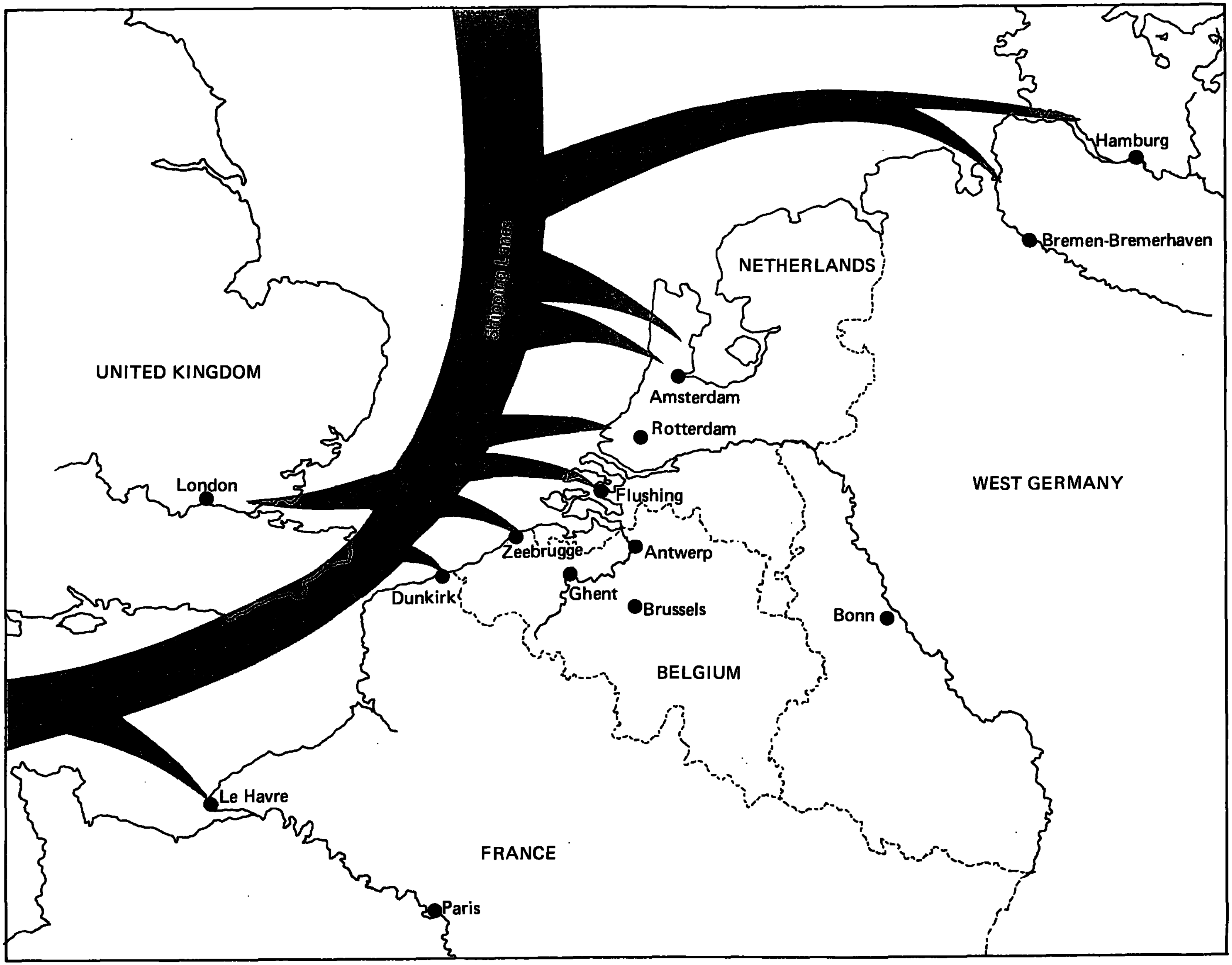


FIGURE 4–2 MAJOR NORTH SEA PORTS

A multi-faceted technological revolution recently emerged on the European maritime transportation scene with the development of massive supertankers or, as they are sometimes called, very large cargo carriers (VLCC's), large ore/bulk/oil carriers (OBO's), containerships, and LASH and See Bee systems. Taking into consideration these technological breakthroughs, European economists are projecting that the volume of world ocean-borne trade will more than double in the next fifteen years. Trade in bulk commodities is expected to grow at an ever faster rate. Since 1960, costs of the transfer function provided by carriers and European ports have decreased. Commodities which at one time could not economically enter European international trade in volume, because of their high transport costs, are now doing so (e.g., iron ore). In Europe, the maritime revolution will result in lower transport costs, increased competition in home markets, expanded world markets, and increased industrialization. European ports are at the nucleus of this ferment and have aggressively responded with major development projects (see Tables 4-1 and 4-2) to attract new port industries and hinterland and cargo in order to increase their revenues.

4.1.2 Forces of Change on European Ports

The main factors determining the future pattern of European maritime commodity traffic are also the basic determinants of the relative position and importance of European ports. The Scottish Council in Europe has identified the following factors as the most important:

a) Changes in the quantity and composition mix of maritime commodity flows;

b) The development of larger maritime transport vessels;

c) Developments in pipeline networks and other hinterland transport links;and

d) Present port facilities and the expansion plans developed by the port authorities to cope with the trends.

TABLE 4-1

GENERAL DATA ON SELECTED PORTS, 1970

	Le Havre	Dunkirk	Antwerp	Rotterdam	Amsterdam
Port Traffic (million tons)					
1969 Actual	51	21	73	183	21
1980 Forecast	100/125	75	175	430/450	NA
1990 Forecast	NA	NA	NA	614/666	79
2000 Forecast	NA	100/200	NA	828	NA
Vessel Size (thousands dwt)					
Current	250	125	80	250	90
Planned	500	300	125	300	150
Potential	1,000	750	125/135	?	150
Port Industrial Zone (acres leased)	2,865	2,932	6,175	12,000	1,500
Port Industrial Zone (acres reserve)	16,719	50,000	17,500	215	4,406
Present Concentration	Medium	Medium	High	Very High	Low
Estimated Port Investment (1970–1975)	$700M	$500M	$150M	$300M	$100M
Regional Planning Mechanisms	Yes	Yes	Yes	Yes	Yes
Channel and Sea Wall Expenditure					
State	100%	100%	75%	67%	67%
Port Authority			25%	33%	33%
Land, Basins and Infrastructure Expenditure					
State	80%	80%	60%	30%	30%
Port Authority	20%	20%	40%	70%	70%
Super-Structure Expenditure					
State	60%	60%			
Port Authority	40%	40%			
Enterprise			100%	100%	100%
Maintenance Expenditure					
State	100%	100%			
Port Authority			100%	100%	100%

Source: Various European National Planning Agencies

a. Changes in the Quantity and Composition of Maritime Commodity Flows

The volume of world maritime trade increased at an annual compounded rate of about 8 percent from 1960 to 1967 (Table 4-3). The maritime trade of the EEC countries increased at about the same rate as did the world's and at a slightly higher rate than Europe's. This can be explained by the higher economic growth rate of the EEC countries and more specifically by the EEC energy policy and the resulting rapid increase in the imports of crude petroleum. World maritime trade is expected to grow at an annual rate between 6.5 and 7.5 percent for the 1970-1990 period; for the EEC countries a slightly lower and gradually decreasing growth rate is expected (Table 4-4).

Important change is expected in the composition of European maritime trade. It is anticipated that the European trade in consumption goods and capital goods will show the highest growth rates, whereas the flow of raw materials (excluding crude petroleum) from the developing countries will be of decreasing relative importance (although huge quantities of raw materials will be imported).

Europe's historical composition of trade flows is shown in Table 4-5. Forecasts for the EEC regarding the trade in different commodities are compared in Table 4-6. The following conclusions may be drawn from these tables:

- Oil will remain the most important single trade commodity; and
- Chemical products and manufactured products are the two commodities of relatively growing importance in European trade.

b. The Development of Larger Maritime Transport Vessels

There are two basic trends in maritime transport:

1) Vessels are becoming much larger in size;

TABLE 4-3

DEVELOPMENT OF MARITIME TRADE OF WORLD, EUROPE, AND EEC, 1950-1967

(Million Tons)

	1950	1955	1960	1967	1968	Annual Growth Rate 1960-1967
World total	550	820	1,110	1,900	2,090	8.0
European total	382	598	725	1,170	1,278	7.2
imports	234	394	513	878	963	8.0
exports	148	204	212	292	325	4.7
EEC total			360	639		8.6
imports	—	—	273	511		9.4
exports	—	—	87	128		5.7

Source: U.N. Monthly Bulletin, January 1970.

TABLE 4-4

PROJECTED MARITIME TRADE OF THE EEC

1967-1990

(Million Tons)

	Period	Annual Growth %	1960	1967	1980	1990
Exports	1960-1967	5.7				
	1967-1980	6.0	87	128	280	506
	1980-1990	5.6				
Imports	1960-1967	9.4				
	1967-1980	6.1	273	511	990	1,650
	1980-1990	4.2				

Source: Future Developments of Maritime Transports and its Implication on Harbour Facilities in Western Europe, College of Europe, Bruges, Belgium.

TABLE 4-5

EUROPEAN SEABORNE TRAFFIC

(Million Tons)

	1965	1969	Percent Growth 1965-1969
CHEMICALS	18.8	36.1	91.9%
PETROLEUM	337.8	469.1	38.9
ORES AND SCRAP	58.7	77.9	32.7
FERTILIZERS	7.6	9.9	25.5
IRON AND STEEL	18.1	20.2	11.5
METALWARE	1.6	1.8	10.6
NONFERROUS METALS	3.7	6.1	8.8
TRANSPORT EQUIPMENT	3.4	4.0	2.6

Source: Scottish Council/'EMPEO'

TABLE 4-6

EEC FOREIGN TRADE IN MAJOR COMMODITIES
1967/1968, 1980, AND 1990
(Million Tons)

	Imports Exports	1967/1968	1980	1990	Annual Growth Percent 1980 Annual %	Annual Growth Percent 1990 Annual %
Petroleum	imports	342.0	770.0	1183.0	6.4	5.5
	exports	57.5	128.0	199.0	6.9	5.8
Chemical products	imports	8.81	23.4	50.1	7.8	7.9
	exports	6.9	23.8	56.3	10.9	10.0
Ore	imports	66.6	131.0	171.0	5.3	4.2
Metallurgical products	imports	5.37	11.5	24.0	6.0	6.3
	exports	16.53	32.9	63.0	5.9	6.3
Fertilizers	imports	10.79	19.0	28.0	4.4	4.2
Manufactured products	imports	23.12	57.0	98.0	7.2	6.5
	exports	28.19	70.0	146.0	7.9	7.8

Source: Scottish Council/N. V. Maatschappij voor Projektontwikkeling 'EMPEO'.

2) Vessels are becoming more specialized.

The use of larger vessels applies to nearly all types of ships, but is most evident for tankers and bulkcarriers. The tendency of increasing ship capacities is closely related to the increasing specialization of ships. The trend for specialized ships is a result of the efforts made to increase the speed of the turnaround time of the ship and thereby to decrease the cost of operation and increase the amount of time the ship is working.

The first generation of true supertankers consists of 100,000 to 200,000 dwt vessels. This phase is already well underway with nearly 300 ships over 100,000 dwt in service, and by 1974 this number will more than double. Of the 555 tankers under construction and on order in January 1971, two-thirds were 175,000 dwt and over.

The second generation of supertankers will consist of 200,000 to 500,000 dwt vessels. Six Gulf Oil vessels of 326,000 dwt are in operation at the present, while one supertanker of 477,000 dwt has been ordered. It is probable that future tankers of this generation will employ a broader type of construction configuration, with relatively lesser drafts.

Shipbuilders are even designing for a third generation of 500,000 to 1,000,000 dwt tankers. However, the major oil companies point out that because of the relatively decreasing cost-savings, the enormous capital requirement, the costly terminal facilities on land and the growing risks, a limit in the development of bigger ships will soon be reached.

Uncertain factors in the future development of supertankers include the possible reopening of the Suez Canal, the possible adaption of the Canal to 250,000 dwt vessels and the current addition to the Suez Canal of pipelines along its banks. Egyptian canal authorities insist that Suez can be deepened and widened. Should this expectation be realized, the transport pressure on the oil companies would be measurably eased. However, the political intangibles in the Middle East are always present.

The development of bulk carriers for dry bulk cargo has been less spectacular. Some European investigators have come to the conclusion that transport costs begin to climb with dry bulk ship sizes of over 140,000/160,000 dwt. Another limit on the development of larger bulk-carriers is the draught of these vessels, which exceeds the draft of crude tankers of comparable size. Although dry bulk carriers may remain below 200,000 dwt in the 1970's, multipurpose vessels (ore/oil) will go to 300,000 dwt.

c. Developments in Hinterland Transport Links

One of the key factors that contributes to the attraction power of individual European seaports and determines their part in Europe's maritime foreign trade, is the connections the port has with the European hinterland. Pipeline networks are of growing importance.

The introduction of very large crude oil supertankers and the unsuitability of some European ports to receive these vessels is inducing an extension of the European pipeline network and an increasing use of unit oil trains.

The increasing import volumes of crude oil by larger vessels, the low cost economics of these larger vessels, and the unsuitability of some European ports to receive these larger vessels has led to the creation and expansion of an important pipeline network in Western Europe. Pipelines are an economic form of transport when high volume throughputs are required. The ton-mile costs of high volume throughput crude pipelines are considerably below those of rail transport and the larger the throughput of the pipelines, the lower the costs can be.

Pipelines are used for the transport of not only crude oil but also chemicals, refined oils, gases, and solids in slurry forms.

For extensive distribution of refined products, the introduction of bulk product trains may prove preferable to the construction of product pipelines. Slurry pipelines have been used to a limited extent for the carriage of coal. Although transport costs are low, terminal costs for processing the material and maintenance are high; hence the rate of application of slurry pipelines in Europe is likely to be limited in the future.

The growing size of dry bulk carriers emphasized the importance of the availability and extension of a well adapted inland waterways network and stimulated railway bulk traffic as well. The introduction of containers, however, has led to a switch from a cost-oriented inland water transport system to a more quality-oriented one in which speed, frequency and adaptability are the crucial elements. Road and rail traffic have been influenced positively by these developments.

4.1.3 Effects of Change Forces

Ports require a great adaptability to change because their position as an interface between inland and maritime transport systems makes them highly vulnerable to external changing influences. The future development of individual ports, therefore, depends on their capability to adapt themselves to changing circumstances and increasing competition. Under the combined influence of changes in the quantity and the composition mix of maritime commodity flows, the development of larger maritime transport vessels and the influence of pipelines, several major trends are emerging. The major ones are:

a) The upgrading of ports and terminal facilities;
b) The development of deepwater ports;
c) Industrial migration to coastal zones; and
d) The development of central distribution terminals.

a. Upgrading of Port and Terminal Facilities

The increasing volumes of trade and the mounting size of supertankers have forced the ports to adapt their harbor approaches and harbor basins. These developments have led to several forms of adaption:

- Dredging projects for the deepening of approaches and basins;
- The construction of outer harbors;
- The construction of discharging piers; and
- Plans for the construction of artificial offshore islands.

The introduction of larger dry bulk carriers has had about the same effect, although the size of this type of vessel has been more limited.

Although container traffic influenced these forms of adaption as well, the emphasis here was much more on the requirements for rapid turnaround, which necessitated the location of specialized harbor basins and terminal facilities.

The same influences that have led to the adaption of port approaches and basins have also influenced the expansion and specialized redivision of storage capacity in the port. Increasing volumes of trade, especially in bulk supplied by ever larger vessels, made an expansion of storage capacity necessary.

The increasing size of supertankers and bulk carriers necessitates a comparable increase in the capacity of handling equipment in order to avoid longer waiting times in the port.

b. Development of Deepwater Ports

The single most important national economic rationale underpinning national investment in deepwater ports rests upon the facts that foreign trade movements are vital to the national economies and that there will be increasing future requirements for hydrocarbons and raw material commodities. However, the special inducement to construct deepwater as against regular ports has been the development of supertankers, increasingly used to minimize the cost of importing the ever increasing oil demands of Europe (see Figure 4-3).

Governments and/or industrial ports in Europe view their requirements for present and future petroleum as the key factor in justifying national investment in deepwater ports. Over 75% of Europe's total import tonnage consists of petroleum and petroleum products. The development of super-tankers and the construction of deepwater continental ports for petroleum will also result in the greater use of larger dry bulk carriers and lower costs of transporting raw materials other than petroleum. These other large commodity elements in the European maritime trade are high content ores, chemicals, iron and steel, cereals, coal, and fertilizers. Bulk carriers are already able to bring iron ore to Europe at a cost that has made many of Europe's internal ore sources uneconomical.

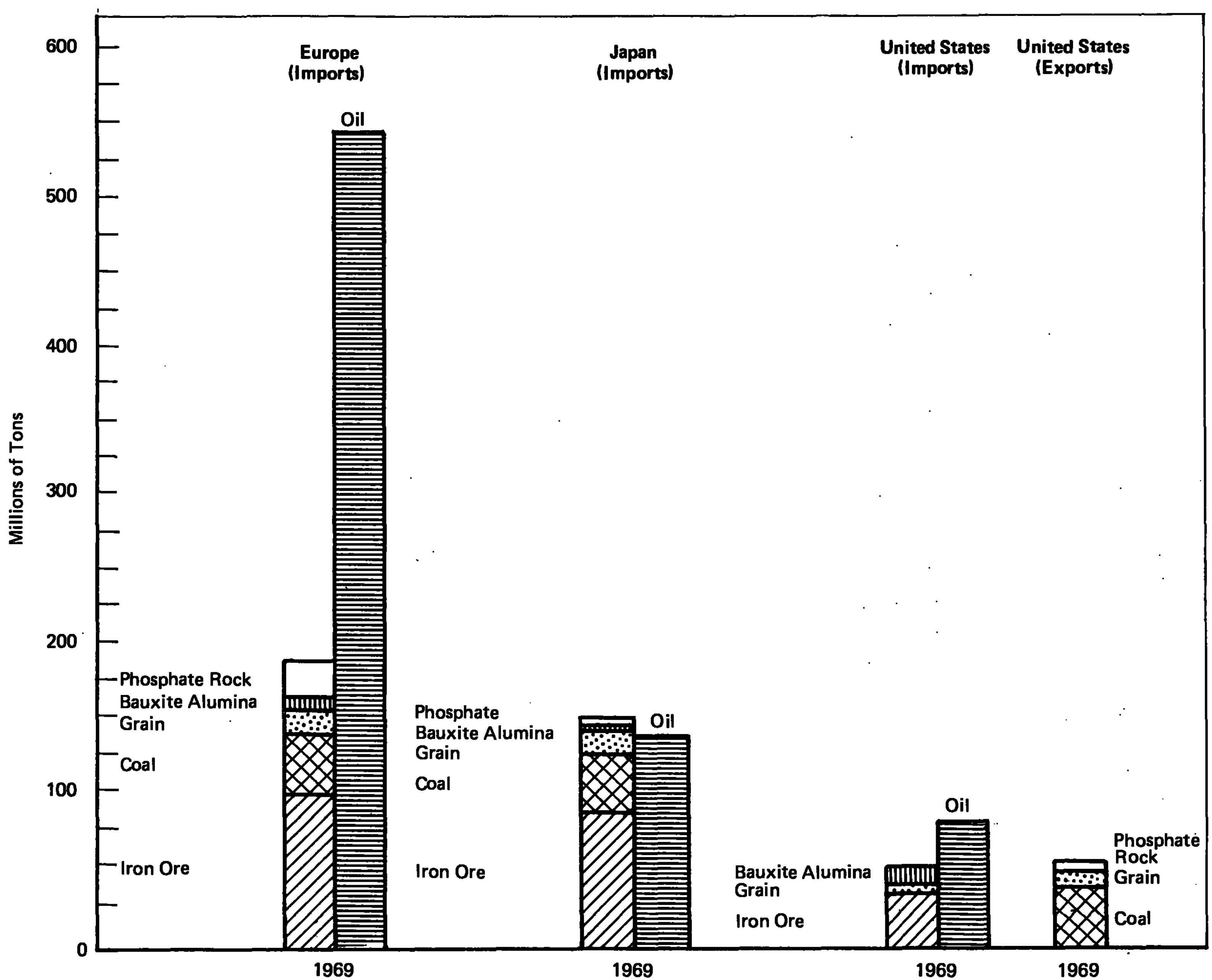
c. Industrial Migration To Coastal Zones

European port development has also tended to produce industrial migration trends to the coastal port zones. Traditionally, shipbuilding, repair, and marine service industries have been located in the port area. In the last two decades, however, there has been an increasing movement of other industries such as petroleum refining, petrochemical, chemical, integrated steel, alumina and power plants to the coastal zones. Industrial migration was strengthened by the "critical mass" effects of these industries (i.e., when a certain threshold was reached it induced an independent growth process, demanding ever more surface acres for industrial expansion). Thus, secondary input and output requirements of these major industry sectors has in turn tended to reinforce the attraction of other supportive and component-using industries.

The basic causes for European industrialization are as follows:

- Increasing requirements for raw material imports because of a decreasing rate of self-sufficiency in Western Europe;
- Increasing exports of manufactured products to overseas markets; and
- A new orientation of European enterprises towards an international market since the creation of the EEC.

FIGURE 4–3 SEABORNE TRADE OF MAJOR BULK COMMODITIES, 1969



Source: O.E.C.D. and Fearnley and Egers

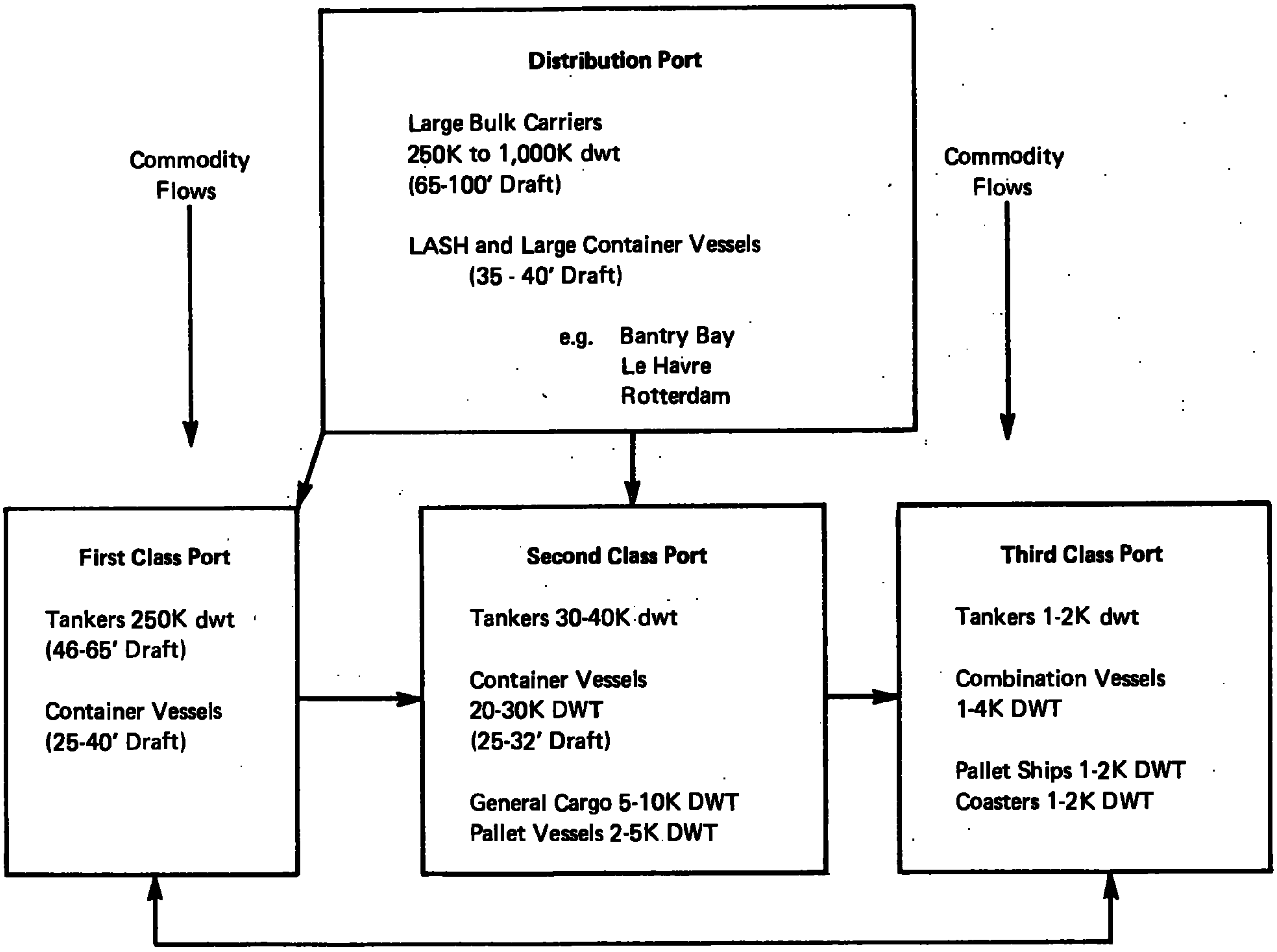
The increasing port traffic tonnage caused by developments in port industrialization and the resulting decreasing dependency on the transfer function with the hinterland have led to a lesser risk of traffic loss for the ports. Moreover, there are favorable influences on the development of regional employment and income as well. These interacting economic forces have tended therefore to be catalytic on capital investment with the result that the port areas have developed into major industrialization poles. Such industrial poles or growth centers generate new employment opportunities and increase the region's per capita income; in addition, in Europe they have also had a positive effect on the balance of payments because they have attracted foreign capital, expanded foreign trade (due to a lowering of transport costs), and increased the generation of financial services activities (e.g., banking, insurance, etc.).

There are problems as well as benefits in this port-related industrial expansion. Because a considerable part of port industry is characterized by a large demand for extensive areas, the availability of such areas is becoming a critical factor in the future competition among European ports.

d. Central Distribution Terminals

Europe's dependence on world trade, its burgeoning requirements for future volumes of raw materials, the major technological developments in the maritime and port interface, the massive cost requirements for developing deepwater port infrastructures, and the limited availability of deepwater port sites are major factors which will encourage the establishment of Central Distribution Terminals. One or more Central Distribution Terminals would act as a focal point for a number of commodities which are heavily involved in long haul maritime transport. Feeder vessels and pipelines would service existing ports and hinterland areas. This concept is depicted schematically in Figure 4-4. The development of such Central Distribution Terminals is not taken lightly in Europe, because they have the potential of becoming major national economic assets for the countries which develop them and because they are likely to alter the existing industrial structure of Europe.

FIGURE 4–4 CENTRAL DISTRIBUTION TERMINAL



Source: Arthur D. Little, Inc.

4.1.4 Government Action

a. Government Response to Port Development

The increase of scale in both maritime vessels and port equipment has forced new requirements on port authorities. However, the most important factor affecting the organization of ports has been the industrial development springing up around the ports.

Very astutely, the national governments in France, Belgium, and The Netherlands have placed port development at the center of broad national, social, and economic development programs. Within these broader developmental programs, the European central governments provide the structural elements of the framework and instrumentalities necessary to spur port development. These are: long-range planning guidelines, semi-autonomous port administrations, port investment subsidies (amounting anywhere from 30-80% of cost), construction of expanded inland transportation and communication networks, and, most importantly, the creation of regional planning authorities whose purpose is to spread the benefits arising from port development to the regional population, and provide planning for industrial, social, and environmental balance in particular regional zones.

b. Financial Inducements

One important aspect of the seaport operation relates to the provision of national subsidiaries supporting the transportation function and to the national financial inducements provided for industrial location.

It is argued that all major industrial developments that have occurred on the west coast of Europe have been the result of appreciable inducements. There does appear the necessity to provide better financial inducements to locating companies until a "critical mass" of port based industry is established. Nevertheless, the locating private enterprise is concerned with the overall economics of location; an available subsidy is only one of a number of locational factors considered.

Firm facts regarding financial inducements are not readily available. The available financial assistance varies from country to country and from port to port. Table 4-7 compares the financial inducements obtainable for foreign investors in four West European nations. Belgium favors the foreign against the national investor; the Netherlands and West Germany generally treat all investors similarly, irrespective of nationality; the attitude of France is more ambivalent.

c. Intergovernmental Cooperation

In Brussels, Common Market officials believe that member countries are not interested in bringing port development matters under the jurisdiction of the Common Market authority. At the moment, the countries are still very much divided on even integrating railroad development policies and rate structures. As long as these issues are not resolved, a common port policy is unlikely to evolve.

France needs at least eight to ten years in order to bring its ports and heavy industries up to a par with the northern European countries. Consequently, France will be hesitant to agree to any Common Market harmonization for transport and port policies. The basic principles of a Common Market transport policy exist on paper and to some degree have been accepted in principle by the European Economic Community (EEC) members; however, the crucial details have yet to be agreed upon. The main principle to which the member governments have agreed is that competition between all transport links--water, air, road, rail, and pipeline--should be as fair as possible. Naturally, each national Government has its own opinion on what is possible and its own definition of "fair".

The Treaty of Rome, which created the Common Market in 1958, established as one of its guiding principles that governments should not aid their own industries to the detriment of other member nations' industries. Consequently, one of the significant problems which the EEC Transport Commission is attempting to face is to ensure that each mode of transport

TABLE 4-7

FINANCIAL INDUCEMENTS FOR NEW INDUSTRIAL INVESTMENTS 1970

COUNTRY	ATTITUDE TO FOREIGN INVESTMENTS	CAPITAL INCENTIVES	CAPITAL RESTRICTIONS	SPECIAL TAX ALLOWANCES
France	Ambivalent, no special considerations, regional incentives informal.	Subsidies up to 25% of investment in fixed assets, low interest loans, land price reductions.	Not on earnings or disinvestment but on ownership.	Extraordinary depreciation rate of 25% of investments in some areas, property exemption, reduced license tax, local tax allowances 50-100%, for up to 5 years.
Belgium	Favorable, special considerations, formal program regional incentives.	Formal subsidies[1] on fixed assets (20%), materials (7.5%) and on interests.	None[2]	Depreciation rate double normal for 3 years, property and registration exemption 10 years, local tax allowances vary, no tax on regional subsidies.
The Netherlands	Neutral, no special considerations, formal program regional incentives	Reduced interest advances with loan guarantees, formal subsidies up to 35% of capital invested.	None	Accelerated depreciation rates on one-third of fixed assets except in West of country.
West Germany	Neutral, no special considerations, formal program regional incentives.	Loan guarantees with reduced interest loans, up to 15% subsidy of investment.	None[3]	Depreciation rate 50% in the first year on equipment and 30% on buildings for 3 years.

[1] Relating to regional incentives

[2] Essentially none but administrative procedures tend to introduce minimal restraints

[3] Except in regard to natural resources

SOURCE: Amsterdam Port Authority

pays the economic costs of the transport infrastructure it uses. The EEC Transport Commission therefore argues that it is necessary to examine the ports and the way they are financed to ensure that no one method of transportation is artificially aided by national subsidies to ports. This claim by the EEC Transport Commission has been challenged by several members, since Article #84 of the Treaty of Rome specifically excluded from Common Market jurisdiction transport to and from places outside the Common Market (which is the transport function provided by ports). The present state of interport competition is, if anything, likely to increase in the future because of French implementation of a major national port policy in which investments will be funded up to 80% by the national government.

4.1.5 Outlook

As developments are now proceeding, and if all the countries strive to realize their long-term port development plans, it looks as though there may well be some over-capacity in European ports by the end of the decade and into the 1980's. A certain specialization of ports and coordination of investment plans seems to be required to prevent costly mistakes in investment allocation. The disadvantages of a non-coordinated investment policy are:

- individual industry and regional over-capacity; and
- distortion of production by subsidies.

This last situation is created when some types of activity derive considerable benefits from infrastructural improvements without any contribution to the social costs.

The policy of port development cannot be separated from regional policy, because a port exerts considerable influence on the economic structure of the region. A wider scope is needed to change an investment policy from one which is oriented to increased port traffic to one which involves growth of all functions both portuary and regional.

Without supplementary regional development measures, the construction or expansion of a port will probably not induce a major industrialization program in an undeveloped area. However, for areas that want to have basic industries, a well-equipped port in the area itself is an important part of a development strategy. For the location of processing industries, port construction is of less importance if a good transport infrastructure network with neighboring ports exists.

4.2 FRENCH STRATEGY

4.2.1 The Role of the Central Government

In France, port development plays a significant stimulative role in the industrial development strategy of the Sixth Five-Year Plan (1971-1976). An appraisal of the structure of the French National Economy indicates that France is as industrially oriented as other European countries (see Table 4-8, Row 1); manufacturing contributes approximately 35% to the Gross Domestic Product in France, 39% in Germany, 31% in The Netherlands, and 30% in Belgium. But the vast majority of firms in French industry are very small family businesses, which have acted as a steady drag on the growth of the manufacturing sector (see Table 4-9). This drag effect is clearly evident in the manufacturing sector, where the historical (1958-1969) growth rate of 5.5% is the lowest of all Common Market* countries (see Table 4-10, Row 10).

In order to maintain its political influence within the Common Market after the next decade, the French Government believes it must concentrate its resources on developing the industrial sector by reorganizing the structure of older industries, and by increasing the scale of operations in newer dynamic industries so as to become competitive in the Common Market and international markets. Timing is also a critical element. The consensus is that France only has between eight and ten years to

*In 1971, the Common Market (EEC) included France, Belgium/Luxembourg, The Netherlands, Germany and Italy.

Table 4-8

National Gross Domestic Product Structure

1969
Percent

		France	Belgium	Netherlands	Germany	Italy	U.K.	U.S.A.
(1)	Manufacturing	34.7%	30.4%	30.7%	39.2%	27.3%	34.6%	28.1%
(2)	Agriculture	6.6	5.5	7.4	4.3	11.0	3.1	2.9
(3)	Construction	10.2	6.6	7.9	6.8	8.0	6.8	4.5
(4)	Mining	.9	1.7	1.6	1.8	.7	1.8	1.6
(5)	Utilities	1.9	2.2	2.1	2.0	2.6	3.6	2.3
(6)	Commercial	36.8	46.4	41.8	36.4	38.5	43.0	46.5
(7)	Government	8.9	7.2	8.5	9.5	11.9	7.1	14.1
(8)	Gross Domestic Product	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Billions of Dollars
(Current 1969)

		France	Belgium	Netherlands	Germany	Italy	U.K.	U.S.A.
(9)	Manufacturing	$44.9	$6.1	$7.0	$63.7	$19.9	$32.8	$265.0
(10)	Agriculture	8.6	1.1	1.7	7.0	8.0	2.9	27.4
(11)	Construction	13.2	1.3	1.8	11.1	5.8	6.5	42.4
(12)	Mining	1.2	.3	.4	2.9	.5	1.7	15.1
(13)	Utilities	2.5	.4	.5	3.3	1.9	3.4	21.7
(14)	Commercial	47.7	9.4	9.5	59.2	28.0	40.8	438.5
(15)	Government	11.4	1.5	1.9	15.3	8.7	6.7	133.0
(16)	Gross Domestic Product	129.5	20.1	22.8	162.5	72.8	94.8	943.0

Source: Organization For Economic Cooperation And Development and Arthur D. Little, Inc.

Table 4-9

SIZE OF FIRMS IN FRENCH INDUSTRY - 1966

Workers Employed*	Number of Firms
0	284,854
1-9	329,265
10-199	69,651
200-999	3,830
Over 1,000	638

*Excluding Employer

Source: Bulletin Mensuel de Statistique Industrielle, 1970.

TABLE 4-10

PRODUCTION OF EEC MANUFACTURING INDUSTRIES

(a) Dollar Value of Production in 1969 (billions)
(b) Structure in 1969 (Percent)
(c) Average Annual Growth Rate from 1958-1969 (estimated)

	FRANCE			BELGIUM			NETHERLANDS			GERMANY			ITALY		
	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
(1) Chemicals, petroleum	$ 8.9	19.8	8.7	$1.1	18.0	8.3	$1.5	21.4	8.2	$10.0	15.8	10.3	$ 4.5	22.6	13.7
(2) Basic Metals	2.5	5.6	5.6	.6	9.8	5.9	.4	5.7	10.7	6.0	9.4	4.3	1.3	6.5	9.9
(3) Metal products	13.3	29.6	5.2	.7	11.5	8.7	1.8	25.7	7.2	21.5	33.8	7.2	4.3	21.7	9.1
(4) Non-metallic minerals	1.8	4.0	9.1	.4	6.6	5.8	.3	4.3	7.0	3.5	5.5	6.0	1.0	5.0	7.9
(5) Wood, paper, publishing	3.9	8.7	5.4	.7	11.5	7.6	.8	11.4	8.6	5.5	8.6	4.5	1.5	7.5	6.9
(6) Textiles	2.0	4.5	2.7	.4	6.6	4.2	.2	2.9	4.0	2.7	4.2	2.6	1.1	5.5	5.5
(7) Clothing, footwear	2.4	5.3	3.9	.3	4.9	5.0	.2	2.9	3.1	3.0	4.7	3.6	.8	4.0	8.2
(8) Foodstuffs, beverages, tobacco	6.1	13.6	2.9	1.1	18.0	3.3	1.0	14.3	3.6	8.1	12.7	5.4	2.5	12.6	5.7
(9) Miscellaneous	4.0	8.9	5.2	.8	13.1	6.7	.8	11.4	---	3.4	5.3	---	2.9	14.6	4.5
(10) Total	$44.9	100.0	5.5	$6.1	100.0	6.3	$7.0	100.0	7.0	$63.7	100.0	6.3	$19.9	100.0	8.4

Source: Statistical Office of the European Community and Arthur D. Little, Inc.

accomplish its goals before Common Market integration will virtually nullify many of France's commercial trade barriers and freeze its industrial posture vis-a-vis other Common Market nations.

French Port Development Policy is not only an instrument shaped by France's desire to maintain and increase its political and economic influence in the European Continent, but it is also shaped by important domestic considerations. French industry and population are overly concentrated in the Greater Paris Basin (with a population of approximately 12.5 million or 25% of the national total). The national rural-to-urban migration pattern has centered upon Paris for the past two decades. If this population flow is not checked, serious social congestion could result in the Paris urban center. To the West, on the Atlantic Coast, and in the South, on the Mediterranean, population and industry are scarce and land is relatively abundant. The port and industrial development schemes are viewed as stimulants to the growth of coastal urban complexes which will counterbalance the economic weight of the capital and, thus, reverse the migratory pattern.

4.2.2 The French Rationale for Port Development

During the beginning years of the planning for the new generation of ports, the basic underlying rationale was that harbor and port development could act as a major attraction pole for industrialization. A number of economic factors support this view:

- First, transportation costs of raw materials are a large component of total manufacturing costs in heavy industry;
- Second, the present and future revolution in maritime vessel size and handling techniques promises to significantly reduce this cost component while changing the pattern and increasing the volume of international trade;
- Third, wage levels in Europe are rapidly approaching normalization because of the unions (and it is conceivable that European wage levels within a decade

or two will be very close to those in the United States and Canada); consequently, reductions in transportation costs will add to the competitive posture of French industry;

- Fourth, French ports lend themselves to major deep water port development projects;
- Fifth, development of modern ports would combat the drainage of northern French trade through ports in Belgium and The Netherlands;
- Sixth, there is an increasing tendency among industrial firms to move to coastal zones;
- Seventh, industries which do not presently require major seaport facilities want to be near port complexes because they feel that within ten years their products and operations may require such facilities;
- Eighth, France is the only Common Market country that can easily spare land for the giant spread of coastal oil, petrochemical, chemical, and steel plants without encroaching seriously on its reserves of open countryside.

a. Selection of Ports

Beginning in 1965, the French government took a major step towards increased national control of the major French ports by the creation of six Ports Autonomes (autonomous ports). Before the autonomous ports were created, the ports were administered by the Chambers of Commerce of the cities. The ports which were selected were Marseille/Fos on the Mediterranean and Bordeaux*, Nantes-St. Nazaire, Rouen, Le Havre* and Dunkirk on the Atlantic.

*Bordeaux and Le Havre were autonomous maritime ports before the 1965 government port reform legislation.

The reasoning behind the selection of certain ports to become deep water ports was based on the following requirement factors:

- Nautical characteristics--the port must be capable of being developed into a deep water port able to receive 800,000 - 1,000,000 dwt crude oil carriers at a realistic economic cost;
- Large acreages of land must be available--heavy industrialization is the economic justification for state subsidies in port development;
- The port must be tied to a close hinterland--not be isolated;
- The port must have demonstrated a viable growth in traffic over the past ten years.

It soon became apparent that financial resources were not available to develop all these ports for heavy industrialization, nor was the time available to do so and also reach the objectives in the Sixth Plan. Because of limited economic resources, in order to achieve the national objectives, it became necessary to concentrate the national investment in only a few ports in order to reach the "critical mass" necessary for large-scale industrialization and to reach the stage of private entrepreneurial industrialization (i.e., critical mass) which is typified by Rotterdam. Consequently, three ports were selected for high priority, which basically means that they will obtain two-thirds of the $2 billion total port development expenditure during the next five years of the Sixth Plan. These ports are : Marseilles/Fos, Le Havre, and Dunkirk.

In the past, the historical stimulator for port development has been the port users who were continually ahead of the port authorities in requesting improvements and expansion. The French government, however, is planning to make a quantum jump in harbor and port facilities in order to take vessels which are somewhat larger than those which are presently in the operational and constructional stages.

b. French Port Investment Policy

Under the new French port plan, the national government increased its share of expenditures on infrastructure or major installations, such as the building of locks, jetties, fairways, and channels from 50 to 80%. (See Table 4-11). For lesser infrastructure work, such as superstructure improvements and secondary works (i.e., lengthening or extending existing quays), the financial division is 60% from the State and 40% from the autonomous port, rather than the previous 50-50 division. The State finances all maintenance requirements in the port, while the Port Autonome must finance all dock-side installations and equipment out of wharfage revenues. The port finances its day-to-day operations from a combination of land and equipment rentals. In regard to capital investment for superstructure work, it relies on a port tax which can be used for collateral for long-term bonds with the maximum borrowing capacity limited by the French government. Each autonomous port will retain control of its day-to-day operations and also have responsibility for providing port planning proposals to the central government for the future development of the port. In order to obtain private enterprise commitment in the port development programs, the government will share the investment costs involved in constructing the proposed artificial islands at Le Havre and Dunkirk. Investment costs are anticipated to be split 15% government and 85% private enterprise or 20-80.

Table 4-11

FRENCH AUTONOMOUS MARITIME PORTS'
SOURCES OF FINANCIAL EXPENDITURE

Expenditure		Previously			Presently		
		State		Ports	State		Autonomous Ports
Infrastructure	=	50	+	50	80	+	20
Superstructure	=	50	+	50	60	+	40
Maintenance	=	50	+	50	100	+	--
Equipment	=	--	+	100	--	+	100

c. Role of Local Government (City, Province) in Port Development

Neither the city nor the provincial governments play a leading role in France's port development scheme. On the contrary, the creation of autonomous ports was implemented in order to centralize control and direction in the central government. The development of the port projects and the associated heavy industrial zones are considered too important to the future economic structure of France to be left in the hands of local authorities.

The French government has established regional planning authorities (OREAM) whose function is to properly integrate and distribute the economic and social benefits resulting from the port development to the region in which the port is based. Thus, the port , surrounding communities, and the province cooperate and coordinate their activities and plans with this regional planning authority. The port cities do not collect taxes from the autonomous ports nor do they provide investment funds to the port. However, they do invest in social infrastructure such as hospitals, schools, etc., which will be needed as the industrialization progresses.

4.2.3 French Regional Planning

DATAR (Commission For Land Use And Regional Development Planning) was created in 1963 to promote de-centralization and orderly, concerted regional development. It had to deal especially with urban development, industrial development, and communications, and came quickly to expand the concept of development based on large existing cities. It concentrated first on the "under-developed" western half of France, the decaying (coal, textiles) northern region of France, and finally defined 8 large metropolises: Lille-Dunkirk, Basse-Seine (Le Havre-Rouen-Caen), Nantes-St. Nazaire, Bordeaux-Toulouse, Marseilles, Lyon, Metz-Nancy, and Paris. These cities form the nucleii in their respective urban areas.

In each region, "OREAM" Regional Planning Teams (multidisciplinary) composed of architects, urban specialists, sociologists, economists, and industry and transport specialists evolved a framework for concerted development (1985-2000) called SCHEMA D'AMENAGEMENT. On the average, 3-4 years and $2 million have been necessary for each regional study. The studies have aimed essentially at ensuring coherent development and identifying problems, particularly covering urban centers and new town development (le Vaudreuil, Basse Seine), industrial zoning, nature conservation (green belt zones), communications (air, road, rail, water) and telecommunications.

DATAR supports the OREAM studies (1985-2000 plan), coordinates these studies for national industrial objectives, and defines actions and objectives by priority. The regions make their 5-year plans, called Esquisses Regionales or Regional Drafts, which shuttle back and forth to Commissariat au Plan (Planning Commission) until merged into the 5-year plan. Once approved, technical solutions are devèloped by the regions.

There has been some attempt to quantify the attractiveness of specific industries for specific needs and to build the ideal profile for a given area but in fact, the planning authorities will take any industry as long as it is located away from Paris.

Where the government has provided the basic infrastructures (deepwater ports), there are only traditional incentive measures (such as low-interest loans to 60% of plant investment for steel plants, but nothing for petrochemicals). In exchange for its infrastructure contribution, the government allows only major and basic industry to locate in deep-water ports. In Dunkirk, Pechiney-Kaiser received an outright subsidy of 200 million francs ($40 million), an "equalization" subsidy to allow a French location rather than Dutch. This represented one-half of the total 400 million francs ($80 million) national subsidy budget for 1970.

In Bordeaux, Nantes-St. Nazaire, Brest, and Cherbourg (i.e., ports that have not been earmarked for major state-supported development), DATAR will arrange for the following incentives (established for the "under-developed west"):

- 25% investment loan without interest to industry to be reimbursed at the rate of depreciation along with taxes;
- Special depreciation methods: 25% of fixed structures and building investment can be depreciated in one year to take into account loss of value on resale in undesirable location;
- Reduced price for industrial land (including utilities) with DATAR paying up to 1/2 and sometimes 2/3 of the price;
- Exemption period from local tax; and
- Grants for professional training of local people.

4.2.4 The Aims of the Three French Priority Port Developments

The development of a major deepwater port at Dunkirk is aimed not only at the development of heavy industrialization in the Dunkirk zone (steel, alumina, oil, petrochemicals) but to reverse the economic stagnation of northwestern France which is based on the declining textile and coal mining industries. In addition, the port planners in Paris view the Dunkirk development as opening up a new supplyline or "breathing lung" to the heavy industrial areas of Germany.

Le Havre is viewed as that port development project with the least amount of risk. It has a massive hinterland based upon the Paris urban complex. The planners foresee the entire Seine River Basin between Le Havre and Paris as being industrialized by the year 2000.

Port development at the Marseilles/Fos area is viewed as that program with the most risk of the three-port development priority projects. The hinterland for Marseilles extends up the Rhone Valley all the way to Southern Germany. Although the hinterland covers an extensive area, it is comparatively light in population and industry. Marseilles/Fos ranks as second in port development priorities (Le Havre being #1 from a national view). Not only is the Marseilles/Fos area close to Algerian and Libyan crude sources, but segments of the port area are adaptable to harbor deepening. It is possible to take larger and larger supertankers by extending the jetty in incremental steps further into the Mediterranean. This option allows the port a great deal of flexibility in that it does not have to immediately go to facilities to take the largest envisioned tankers (such as the Le Havre port development project). At the present time, the jetties are being lengthened to accommodate 350,000 dwt tankers and are scheduled for completion in 1973. The next phase regarding jetty expansion has not been decided.

The planners visualize that after approximately ten years, an extensive heavy industrial complex will exist at the three ports. They then visualize subsidiary industries growing upstream from the big coastal steel and petrochemical plant complexes along the main road, rail, and waterways, stretching inland from the three key ports. They believe that this structural pattern of urbanization and industrialization is particularly suited to France which has grown on a star-shaped pattern around Paris, ever since Louis XIV, but with very little development until now at its western and southern boundaries.

4.3 DUTCH STRATEGY

4.3.1 The Changing Significance of the Gateway Ports

a. The European Industrial Pole

If one looks closely at the European industrial pole, it is striking that this pole is primarily concentrated in the northwest corner of Europe. This was not coincidence, as this location was the most favorable one for industrial concentrations. Along the large north German low-lying plain, coal and iron ore deposits were discovered which set off the industrial revolution in the 19th century.

In Europe, the circumstances were such that the growing industrial center had excellent outlets to the North Sea via the big rivers flowing through the North German Plain in a northwesterly direction. To the south, the Alps formed an obvious traffic barrier. This situation resulted in the Delta ports — the harbors situated in the area intersected by the rivers Scheldt, Rhine and Meuse, namely the ports of Antwerp, Rotterdam and Amsterdam -- becoming the gateways for the industrial pole area. These ports have attracted a transport flow whose origin or destination is found in the industrialized hinterland. Historically, this transport flow has been created and sustained by hinterland industry.

After World War II, many new industries established themselves around the old industrial center, with the new industrial areas expanding mainly in a southerly and westerly direction. This development of the old industrial nucleus into a larger industrial area was largely stimulated by the substitution of oil for coal as a source of energy. In addition, the petrochemical industry based on oil and the resulting related chemical industries were also established in the seaports, where the crude oil was transshipped. As a result, the ports also experienced heavy industrial development. A belt of modern process industries of an entirely new nature sprang up in the North Sea ports.

The industrial spread to the south has occurred as a result of the fact that petroleum pipelines managed to break through the Alps. This enabled an entirely new industrial complex to be developed in Southern Germany, which was formerly considered geoeconomically impossible.

This is the situation which developed in the 19th and mid-20th century. The Netherlands, and especially Rotterdam, assumed an extremely central position in the hinterland transport flows which enabled the Dutch transport firms, the ports, and the new port industries established there, to develop strongly.

b. Trends of Change

The historical developments outlined above are the basis for The Netherlands' economic prosperity. But modern developments have caused change.

One change already pointed out was the fact that the oil pipelines have overcome the Alps barrier. This has created a southerly oil network which supplies the Southern Rhine Valley, the Rhone area, and Southern Germany with oil from Marseilles, Genoa and Trieste. As a result, entirely new industrial areas have emerged in southern Germany, a development which will continue. The question now is, to which ports will these new industrial areas turn in the future: to the traditional northerly situated ports on the North Sea (i.e., Antwerp, Rotterdam, Amsterdam), or to the French ports on the Atlantic, or the Mediterranean? The development means that the transport flow is showing a definite trend to move towards the south. This trend could be boosted if oil from the Sahara were brought to Southern Europe via a pipeline under the Mediterranean, thereby cutting out part of the sea transport by crude carriers. The French plans to develop Le Havre, Fos and Dunkirk into major petroleum-receiving ports could well become a reality if there were a major accident involving several large oil tankers in the congested North Sea. Such an accident could result in the Dover Strait being forbidden to large tankers, thereby forcing Rotterdam-bound tankers to reroute around the Scottish Peninsula. In this event, Le Havre and Dunkirk might become a major alternative to Rotterdam by serving the European hinterland by new pipelines.

The new capacities of the French Atlantic and Mediterranean ports, if they have at their disposal improved inland connections comparable to those inland connections enjoyed by Rotterdam, will have a major impact on the Netherlands. In this respect, the French plans for the improved canal on the Rhone and the connections from it to the Rhine and Meuse are of major importance. An expanded Rhine/Rhone canal connection could perhaps direct a major portion of the entire southerly situated industrial area towards the French ports situated in the south. This also applies to the canal which Dunkirk is constructing to the northern French hinterland and a planned crude oil pipeline from Le Havres through the French industrial center to the Ruhr and the southern German industrial area.

This entire phenomenon, the shifting or southerly expansion of industrial areas and the accompanying trend of changing transport flows in a more southerly direction,* means that the Netherlands finds itself situated on the northern edge of the industrial center of Europe with the risk of being somewhat isolated. This development could be intensified if the ports situated in the South--and these include Dunkirk and Le Havre--were also to have important container terminal facilities at their disposal. If these container terminals were linked by rapid railway connections with the industrial hinterland on the Continent and with the United Kingdom, part of the general cargo flow which now goes via Rotterdam and the other Delta ports could be diverted toward the south.

Port officials pointed out that the transport policy of France and Germany is concentrated more on railways than that of the Netherlands; therefore, container traffic via the French ports could easily be favored. The potential of transferring the general cargo flow to rail transport will be given an important stimulus if, as is expected, a Channel Tunnel is opened. In that case, the British industrial

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*Such a shift is not yet statistically noticeable but such a trend will show up during the next few years.

area would have a direct link via container trains with the industrial areas in Northern France, Belgium and the Ruhr. The British transport policy also strongly favors the railways, therefore there is a very real diversionary possibility away from the Netherlands.

4.3.2 The World's Leading Port : Rotterdam

The transport and port functions must be considered as being of eminent importance for the Netherlands' prosperity. Under the "Mono-port concept," Rotterdam convinced the central Government that there could only be one major port in the nation and that all national efforts should be focused on this port in order to obtain the maximum economics of scale. This concept which originated at the end of World War II was quite logical. The hinterland of the Netherlands (i.e., Germany) was in ruin. The Netherlands at this point in time was faced with a dilemma. How were they going to reconstruct their nation and develop a viable economy which historically had been based upon the transport service function provided for Germany? The answer became heavy industrialization within The Netherlands coupled with a specific industrial focus on the ports themselves. Because of financial limitations of the nation during this period of time and even extending into the late 1950's, it was mandatory that development resources be concentrated in the area having the greatest number of natural advantages. This became Rotterdam.

Whereas historically the transport flow was a function of the industry in the hinterland, Rotterdam now believes that, if the transport flow is to be retained and grow in the interest of her prosperity, then industrialization and port development must continue to take place in the Delta area. This is one of the fundamental reasons why Rotterdam's port strategy has been to expand industrialization in the Rotterdam area; it is the only way the transport flow can be tied to the port. The construction of improved deep-water harbors alone without any industry is not viewed as the answer, because the diversionary tendencies will be too strong and will make themselves felt in the next decade. However, the question of whether 500,000 dwt tankers could berth at Rotterdam is still unanswered because it would require additional dredging and possibly a dredging of part of the English Channel. Alternatives are a possible rerouting of such large tankers around the Scottish Peninsula, or a redesigning of supertanker hulls so that they would have smaller drafts.

From a national viewpoint, a unique and highly successful port and associated industrial complex has been created. The question now is: Has the strategy outlived its usefulness? Rotterdam, if it continues to expand at the rate that it has in the last decade, will at some point in the near future reach a stage where dis-economies will occur in the present port and urban structures. To leap-frog this port obstacle, Rotterdam suggested the southerly expansion of the Maasvlakte I project or the creation of completely new port facilities in the southern delta. Such a scheme, obviously would promote further industrialization but it would also result in eventual devastation of a major portion of the delta lands.

a. Conflicts over Future Development

Rotterdam, the world's largest port, is presently in disagreement with the central government at The Hague over two important aspects of Rotterdam's future development: (1) the central government's unwillingness to grant larger subsidies to the Port of Rotterdam, and (2) the need for new deep-water sites during the remaining decades of this century.

There are, of course, various opinions within either camp. Of the five major Government departments concerned with the port and its finances, Transport and Waterways and Economic Affairs do not view port development from exactly the same angle as the Treasury and the Home Office, which are jointly responsible for the bulk of governmental finance, or Housing and Regional Planning, which is doing its best to spread an overcrowded Rotterdam population and its industry over as many regions as possible. In Rotterdam itself, the Port Authority has shown itself to be more land hungry than various influential civic leaders deem necessary.

The desire for more Government aid in the fight against the increasing competition by other European ports -- notably Antwerp, the French ports and several British ports -- is widely shared among port planning personnel in Rotterdam. This is a recent development, which seems to have been stimulated largely by the French port development program.

b. The Subsidy Problem

If no other European Government subsidized its ports, so the argument in Rotterdam runs, there would be no need for Rotterdam to ask for aid. But Rotterdam cannot finance all its investments out of the various port dues any more. These dues are being kept within narrow limits by foreign competition, and competitor ports are able to keep their dues low precisely because they are being subsidized.

Rotterdam distinguishes three major elements in the subsidy problem: (1) The cost of the infrastructure, from original site costs through dock basins to quays and roads; (2) the cost of superstructure facilities such as cranes and warehouses; and (3) the cost of maintaining the waterborne connection between the port and the sea. The Municipality of Rotterdam covers all the above costs, with the following exceptions: the State covers two-thirds of the cost of harbor dikes; private enterprise covers the investments for superstructure.

Several years ago, when the State approved the city's plan to dredge a seven-mile, $240 million high-sea channel and dike for the Maasvlakte I project, in order to open the port to ships of up to 250,000 dwt, it was generally assumed that the State would pay two-thirds of this sum. The subsequent announcement that the municipality would have to bear the entire cost of the channel dike -- prompted by the central government's severe budgetary problems and supported by the argument that the advantages of the project would accrue primarily to the operators of the 250,000 dwt vessels, notably the oil companies -- came as a considerable shock to Rotterdam.

Officials in The Hague were quick to point to one significant "built in" advantage enjoyed by Rotterdam: its geographic situation. But even they admit that this is being slowly modified by pipelines, which have already given such ports as Marseilles, Genoa, and Trieste the kind of access to the heart of Western Europe which the Rhine used to give only to Rotterdam.

c. The Expansion Problem

The supertanker revolution also plays an important part in the other major area of contention between Rotterdam and The Hague. Reduced to its essentials, this centers on the question of what deliberate limits, if any, shall be set to Rotterdam's further expansion as a port and an industrial center.

The natural coastline ceased to be a boundary some time ago: nearly 6,500 acres of shallow sea off the coast, known as the Maasvlakte I, which will yield 4,025 acres of net usable space for port handling facilities and industrial sites, is now being turned into dry land surrounding several huge dock basins. By common consent this area, which should be completed in the early 1970's (presently 50-60 percent completed), will be reserved for enterprises which must have deep-water access, such as transshipment companies for bulk goods and industries such as refining and possibly a steel plant (although the steel plant proposal is facing stiff environmental opposition).

The Rotterdam authorities believe that all the available space in the Maasvlakte I will have been reserved by companies when the project is completed. Rotterdam is also convinced that the demand for sites on or near deep water will not be stilled by then. A special problem is being posed by enterprises which could theoretically be sited further inland but which insist on a place near the deep-water industries or near a big industrial center. Obvious examples can be found among the producers of the more specialized petrochemicals, who want to be near the refineries, and major chemical plants, who want to save transportation costs.

Sites in the Rotterdam area are already so scarce that companies which cannot convince the government that they require deep-water sites are refused. In such cases, an attempt is made to persuade the applicant to settle elsewhere in the Netherlands. The presence of a large Dow plant on the Dutch part of the Scheldt estuary, and of the Mobil Oil refinery in Amsterdam, both linked to Rotterdam by pipeline, illustrates that such a solution may be possible in some cases. Rotterdam's thesis is that, by and large, rejected applicants will feel unable to find another appropriate Dutch site, and will go elsewhere. The central government, however, is more confident that firms which Rotterdam cannot accommodate may still be retained for the Dutch economy. Not every industry needs the services of mammoth ships.

In basic terms, this poses the question: Should Rotterdam be expanded even further, and if so, in which direction? The technical and economic implications of extending the artificial Maasvlakte I southward are now being studied.

Another possibility is the development of the delta area to the south of Rotterdam. Rotterdam, in fact, foresees the whole area between Rotterdam and Antwerp as developing into a vast and almost continuous port/industrial complex (the "Golden Delta"). The Dutch and Belgian governments have agreed on a scheme to improve Antwerp's canal link with the Rhine. When this development is completed, it will bring all the other projected delta port areas into good waterway communication with the Rhine and the Scheldt. The Dutch government has already gone far, as part of its famous Delta Plan, in equipping the whole area with a first-class road network, and railway links are also to be completed soon. Thus, the delta, now largely agricultural, is potentially available as a vast industrial development area for industries looking for a central position in the European market and for immediate access to a port.

There are two strong obstacles in the way of this plan by Rotterdam. One is the overcrowding of the western Netherlands, to which Dutch public opinion is already highly sensitive. The other reason is that many see the delta as an indispensable area for Rotterdam City itself and feel its sand dunes, coasts and open spaces should be developed for recreation, and its population centers expanded further for Rotterdam's overspill.

Port officials in Rotterdam feel that to a large extent, all these purposes, including the port expansion, could well be combined. A hard argument for doing so can be summed up in the following remark: "For every acre of land turned into an industrial site, it will result in $108,000 worth of added production value every year, and the State will get at least 25 percent of this in direct and indirect tax."* Officials state that if there were one lesson to be learned it is that they underestimated the industrial space requirements and were therefore forced into a position of sandwiching communities in-between industrially zoned land. They feel this was one of the major mistakes made in the past which they would avoid if they had another chance to do the overall planning today.

4.3.3 Amsterdam

Amsterdam is basically a city built upon a huge commercial tertiary sector. The city authorities are apprehensive about their long-term economic outlook. In their view (and rightly so), the tertiary sector will better be able to maintain its vitality if it is based upon a larger secondary industrial base. Acting as a constraint on general industrialization is a labor shortage in the Amsterdam area which has led the authorities to investigate the capital-intensive process industries in the secondary sector. These industries would not require large numbers of personnel but would result in high-value-added products and a significant commodity traffic requirement for the port. These economic objectives have sequentially led to the proposal that new harbor facilities and expanded infrastructure be installed for the purpose of attracting industry.

Amsterdam was straight-jacketed by the "mono-port" policy approximately 20 years ago and has not yet recovered. Amsterdam argues that it is now time for a more balanced regional approach to industrialization. It is argued that Amsterdam should receive priority in regards to development, because

*A Dutch port spokesman.

without immediate investment in the port areas, it is very possible that future cargo flows will not go to Amsterdam but to competing German ports in the Baltic. Amsterdam points to the paucity of heavy secondary industries in the region and the very slow growth in general cargo that has occured during the past twenty years.

Amsterdam is not a foremost contender for a major deep water port. There are hopes, however, to construct a new outer harbor on the mouth of the North Sea canal which would be capable of receiving 125,000 dwt vessels. Although this new outer harbor will not be exceptionally large (only 500 acres of dry area), the municipality of Amsterdam believes that it will be sufficiently stimulative from an economic standpoint to encourage additional industrialization in the area and to generate additional traffic flow.

Amsterdam's economic rationale for port investment is sound and consistent with the central government's regional equalization policy. But Rotterdam, anticipating a potential economic threat from French port policy, albeit long range, is making its case for new subsidies from the central government. The final decision will be political.

4.4 BELGIAN STRATEGY

4.4.1 The Outward-Looking Belgian Economy

Situated in key position in Northern Europe and having a high population density, Belgium has long been an important participant in international trade. Within a 200-mile radius of Belgium's chief port, Antwerp, there are 73 million people whose standard of living is fairly high. In this area, there are the industries of the Benelux, of the Ruhr, the Rhine valley, the Saar, Northern France, and S.E. England. This unique position is strongly supported by other factors such as the high standard and diversity of communications, Belgium's industrial tradition, and the skill of its workers.

Due to the limited size of the Belgian national market and its dependence on foreign imports for the majority of its basic raw materials, Belgium has been forced to look outwards. This explains its liberal history of economic relations, trade orientation, and its desire for European integration.

Economic unions started in 1921 with the creation of the Belgium-Luxembourg Economic Union (UEBL) and continued with the economic customs union between the UEBL and The Netherlands. More recently, there was the formation of the Economic Coal and Steel Community and finally, the birth of the European Economic Community (EEC) in 1958.

Prior to the creation of the EEC, exports vital to the Belgian economy had often suffered from administrative contingencies and quotas set up by many countries to protect their own industries. This phenomenon partly conditioned the traditional structure of Belgian production in favor of half-finished products which were better able to pass through international commercial trade barriers than more elaborate products.

With the formation of the EEC, a considerable effort was made to gain the maximum benefits from the new conditions of liberalized trade, which opened to Belgium countries with whom Belgium had already forged important trade links.

In order to fully appreciate the ever-growing role of foreign trade in the Belgian economy, one must bear in mind certain essential facts. With regard to exports, in 1968, the UEBL exported goods valuing $715 per capita. For comparison, the U.S. exported approximately $200 per capita. In that year, the value of UEBL's exports represented 38.0 percent of the combined Gross National Product, and 62.0% of these exports went to EEC countries. In the course of the same year, UEBL's imports valued $9.3 billion and exports, $8.3 billion.

The great advance in Belgian foreign trade began with the formation of the Common Market. In fact, before the signing of the Treaty of Rome, the rate of growth in Belgium's foreign trade was 5.6 percent per year, while on average, it has climbed 10.7 percent per year during the period 1958-1968. During this time, the annual average increase in world trade was only 8 percent and that of other industrial nations 9.1 percent.

By this means, UEBL's share of total world trade -- although it hardly varied in the period 1953-1958 -- increased from 3.2 to 3.7 percent, and in trade with industrial nations, rose from 4.3 to 4.7 percent.

The concentration of trade between industrial nations is indicated by the following figures: in 1958 the four partners in the EEC took 45 percent of Belgium's exports, whereas ten years later the figure had risen to 62.0 percent. During the same period, the share of imports from the EEC rose from 47 percent to 56 percent.

The industrial experience of Belgium is not new. With several coal fields, an advantageous geographical location, and a solid artisan tradition, the nation had considerable advantages in spite of its limited size. In fact, the large-scale output of the last century, based on iron and coal, remained important for a long time. Even today, the manufacture of crude or half-finished products still plays an important role in the economy of Belgium.

But today, new techniques and new products, which require a supply of new capital, are revolutionizing production methods. In the process of modernization, several unfavorable elements have come into play.

- There are the problems associated with the decline of the coal industry and the gradual replacement of this fuel by petroleum and natural gas.
- The deterioration in commercial relations with the former Belgian colony in the Congo forced industrialists to look for other supplies of nonferrous metals.
- Belgian industries are heavily dependent on foreign markets

for the sale of many products. In certain fields which include chemicals and metals, exports exceed 55 percent of national production. Hence, industries were forced to ensure outlets for their products either by establishing branches abroad for the consumption of their goods or by joint ventures in foreign undertakings.

- A lack of growth in population since the Second World War has resulted in labor shortages.

However, the situation is easing and the domestic labor force should increase by 3 percent by 1975. This figure will be enhanced by the numbers leaving the declining industries and also, by an increase in the female labor force.

Today, within the framework of the EEC, the traditional shackles to international trade are being discarded. As a result, manufacturers have shifted from half-finished products, and there is now increasing production of a number of high-quality finished products in both old and new enterprises. A high percentage of specialized manpower has been absorbed, and the result has been to place a greater value on labor and costly raw materials. Though Belgium's economy has long been outward-looking, an increasing orientation towards Europe is now taking place.

4.4.2 The National Port: Antwerp

Forty-five miles south of Rotterdam is Antwerp, the third largest port in the world and, in Europe, second in size only to Rotterdam. Its long and difficult approach (58 miles up the Scheldt estuary which is mostly in Dutch territory) and its distance from the Rhine put it at a decisive disadvantage vis-a-vis Rotterdam, Le Havre, and Dunkirk as a bulk port in the era of 150,000 dwt vessels, let alone the new generation of 300,000+ dwt carriers.

One of its greatest difficulties always has been that the ownership of the terrain on either side of the Scheldt estuary is Dutch. This means that regional planning, involving networks of roads, railways, and canals, is a difficult job involving complex international negotiations. Nevertheless, Antwerp has been acclaimed throughout the maritime world for its speed and efficiency in dock work and short turn-around times.

Because it is an inland river port, Antwerp does not plan to develop deep water facilities (it will be deepened to take 125,000 dwt vs. 80,000 dwt presently), but rather to concentrate on expanding the size of the port, improving its general cargo handling function and increasing its process-oriented industry.

Antwerp constitutes the most vital industrial center in Belgium. It is estimated that perhaps as much as half of the nation's economic activity takes place in the greater Antwerp area. The Antwerp port represents a major asset to Belgium and is, therefore, of national interest. Perhaps half of all economic activities in Belgium are linked to the export and import of international trade. It is also estimated that approximately 70,000 out of 210,000, or one-third of the people employed in the Antwerp area, are working in port-related activities ; this figure does not include the indirect or tertiary employment accounted for by banks, insurance companies, and others who benefit from the port-related activities.

The main reason for seeking expansion of the port lay with the needs or desires to promote greater industrialization of the Antwerp region and to provide port facilities that will take advantage of somewhat larger ships.

4.4.3 The Petroleum Issue

Since Antwerp will not be able to accommodate 250,000-300,000 dwt crude carriers, an agreement* with Rotterdam has been finalized to transship

*Length of agreement extends only for 10 years. At the end of the agreement Belgium might build its own off-shore oil receiving terminal or obtain crude oil by pipeline from Dunkirk or Le Havre.

oil via a new pipeline from Rotterdam to Antwerp's oil and chemical complex. Landed cost of petroleum in Antwerp will, therefore, be higher than in Rotterdam, and if continued over the long run, it could place Antwerp at a competitive disadvantage in its industrialization efforts.

Petroleum represents approximately 40 percent of the total tonnage handled at the port of Antwerp. It is estimated by European economists* that Western Europe will require 30 percent more power in 1975 than in 1969, and that petroleum's share of the European energy market will increase from 46 percent to 56 percent. Consequently, crude petroleum will continue to be the major growth commodity in European international trade.

After the 1967 Suez closures, major oil corporations were forced to divert tankers around the Cape of Good Hope. The increased transportation costs have been compensated for by ordering new tankers of an expanded capacity. The difference in the cost of transport between a middle-sized tanker (70,000 dwt) and a large tanker (200,000 dwt) is illustrated below. Prior to the Suez Canal being closed, the cost of transporting one ton of crude from the Persian Gulf to Antwerp, in a vessel of the 70,000 dwt class, amounted to about $5.09 and $6.78 per ton when the same vessel had to proceed via the Cape of Good Hope. In comparison, a 200,000 dwt vessel could carry one ton of crude around the Cape for $4.82, which means a cost savings of $0.17 per ton over the Suex route and $1.96 over the Cape route (see Table 4-12).

Supertankers not only pose problems in the shallow waters in this section of the North Sea but absolute restrictions are met at the beginning of the Scheldt estuary. Antwerp, being so far inland, could not berth the new tankers; Antwerp's petroleum companies had to make requests to the Belgian government for pipelines to their port refineries. The

* Westinform Consulting Bureau, The Netherlands

TABLE 4-12

COST REDUCTION POTENTIAL TO ANTWERP OIL COMPANIES

(200,000 dwt VESSELS)

TRANSPORTATION COST ON ONE TON OF CRUDE PETROLEUM

Vessel Size	Suez Route	Cape Route
70,000 dwt	$5.09	$6.78
200,000 dwt	-	4.82
Cost Reduction	$0.17	$1.96

Calculation of Savings

Antwerp Crude Petroleum Imports - Million Metric Tons		Port Revenue Handling Fee $0.075/ton	Amount of Saving	
			Suez Route @$1.16/ton	Cape Route @$1.82/ton
1965	18.5	$1,387,500	3,150,000	36,250,000
1969	24.5	$1,836,500	4,160,000	48,000,000

Source: Arthur D. Little, Inc.

government's initial response was to search for a port on the Belgium coast where large tankers could berth.

4.4.4 A Deep Water Alternative: Zeebrugge

Antwerp's major national competitor, accounting for 7% of Belgium's traffic vs. Antwerp's 90%, is Zeebrugge. Antwerp's and Zeebrugge's inter-port difficulties and differences increased with the coming of the super-tankers.

To accommodate the supertankers, suggestions were put forward, and one that gained most favor was a proposal to establish an artificial island either at, or off, Zeebrugge. The Public Works Minister threatened his resignation if this were passed by the legislature. The matter was considered in what is known as the 'Verschave Report,' published in 1970, but there were many practical difficulties outlined in this plan, and the report therefore emphasized the high cost of such a project. Zeebrugge has adopted the general recommendations in the report but dropped the idea of the artificial island while Antwerp, defending its growing petroleum and petrochemical industry, favored the use of Rotterdam -- its greatest rival. A pipeline has been started between Antwerp and Rotterdam (paid for by the oil companies). Needless to say, this brought great disappointment to the authorities of Zeebrugge.

The government in 1969 approved funds for building a new maritime lock to take vessels only up to 125,000 dwt at Zeebrugge. Belgium's Minister of Public Works, Mr. De Saeger, has stated publicly that 125,000 dwt is the largest ship that Zeebrugge will ever take; however, there is still enthusiastic lobbying in Parliament by Members in the Zeebrugge region for a lock which can take even bigger ships.

The Verschave Report recommended that 200,000 dwt supertankers should be able to use Zeebrugge; it is now clear that they will not use the canal lock but instead will berth in Zeebrugge's outer harbor, under the protection of a break water, and the oil will be carried by pipeline to the refineries in the hinterland.

4.4.5 Resolution of National Port Priorities

New industrial areas and new highways are among other plans of the Zeebrugge authorities. Some 3,250 acres are available for factories and plants , each with its own dock.

Zeebrugge's attitude towards future development has been described as youthful and optimistic, despite the failure of their plans to build a giant artificial port to attract the supertankers.

Antwerp, not unnaturally, was envious of Zeebrugge because the smaller port seemed to be receiving urgent attention from the Government in its planning and was quite concerned with the possible loss of traffic to the rising Zeebrugge. Antwerp believed that her long-term economic position could potentially be eroded by Zeebrugge.

A new national port policy could be the outcome of two conflicting aims: (1) the construction of a new multi-purpose port on the coast, at Zeebrugge; or (2) the improvement of access to the existing multi-purpose port of Antwerp. In both cases, three well-defined types of ships were taken into consideration -- namely, very large tankers, ore carriers of 100,000 to 125,000 dwt, and new types of liners, such as the large container ship and the LASH ship.

Regarding large tankers, Antwerp solved this threat for the short term by constructing a pipeline between Rotterdam and Antwerp as already mentioned.* Only if there should be a change-over to ships of such a size that they could not even enter Rotterdam, would the problem be posed once more. It is, however, obvious that an oil port for 500,000-tonners makes little sense for Belgium in view of the limited size of the national market. Such investment would be 80 to 90% dependent upon hinterland sources of trade, and that is too great a gamble. If such a

*The port handling fees on petroleum will be lost, but the important industrial complex will be safeguarded.

port were required, it would probably be best to think in terms of a European port which, for physical reasons, would probably not be planned in Belgian waters, but in France.

It seems highly unlikely, too, that the Belgian steel industry is going to call for larger ore carriers. It cannot take into consideration lower freight charges alone, since there are more important limiting factors, such as stockpiling facilities, the increased costs of temporary storage and land-transport costs and facilities.

In the light of these facts, Antwerp concentrated on evaluating the respective advantages and disadvantages of the two possible solutions. It was pointed out by Antwerp, that as far as dry bulk carriers and container ships were concerned, Zeebrugge, after the necessary technical alterations, could provide a solution. But the same was true of Antwerp; the Antwerp solution was considerably cheaper, could be more quickly completed and, in addition, there was already a superstructure of ore and container terminals, as well as trained personnel, which was not the case in Zeebrugge. Moreover, Antwerp is much closer than Zeebrugge to the economic centers of the hinterland, and is connected to them by railway, highway and canal, while in the case of Zeebrugge, the railway is practically the only means of transport which can fulfill this role. In the end, the Government decided to confirm formally once again that port priorities would be in Antwerp's favor.

4.5 RELATIVE COMPETITIVE POSITION OF SELECTED EUROPEAN PORTS

The following tables depict the relative position of the European ports surveyed in this study. The ports are viewed from several standpoints: 1) their percent share of total European port traffic; 2) relative percent improvement or decline between 1965 and 1969; 3) volume growth in traffic between 1965 and 1969, and 4) their relative competitive position regarding selected major commodity flows.

TABLE 4-13

RELATIVE POSITION OF SELECTED PORTS

(Percent Share of Total European Port Traffic*)

Ports	1965	1969
Le Havre	6.6%	6.8%
Dunkirk	2.7%	2.7%
Antwerp	9.7%	9.9%
Rotterdam	23.1%	23.5%
Amsterdam	2.7%	2.4%

*TOTAL TRAFFIC includes: cereals, coal, ores and scrap, mineral oils and derivatives, fertilizers, iron and steel, non-ferrous metals, metalware, transport equipment, and chemicals.

Source: Scottish Council/'EMPEO'

TABLE 4-14

IMPROVEMENT OR DECLINE IN RELATIVE POSITION OF SELECTED PORTS

(Total Traffic)

Ports	Improvement or Decline in Relative Position During 1965-1969	Volume Growth in Total Traffic During 1965-1969
Rotterdam	3.2%	48.8%
Le Havre	1.9%	81.5%
Amsterdam	0.3%	43.4%
Dunkirk	0.1%	30.8%
(Average All European Ports)		(28.2%)
Antwerp	-0.4%	22.7%

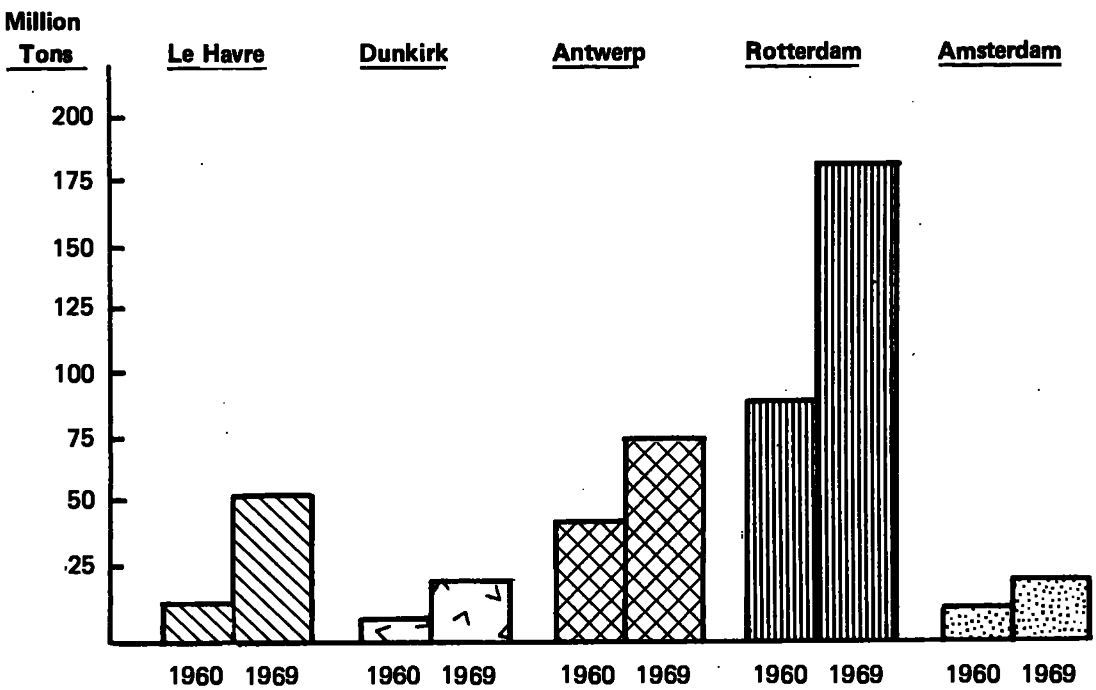
*Source: Scottish Council/'EMPEO'

TABLE 4–15

TOTAL CARGO
(tons in millions)

Ports	1960	1965	1969	Annual Growth Rate 1960-1969
Le Havre	16.6	28.0	50.9	13.3
Dunkirk	8.0	15.9	20.8	11.2
Antwerp	37.5	59.4	73.0	7.7
Rotterdam	83.4	122.7	182.6	9.1
Amsterdam	10.8	13.9	19.9	7.0
Total:	156.3	239.9	347.2	9.3

TOTAL CARGO



	Le Havre	Dunkirk	Antwerp	Rotterdam	Amsterdam	
1960	10.6	5.1	24.0	53.4	6.9	= 100.0%
1969	14.7	6.0	21.0	52.6	5.7	= 100.0%

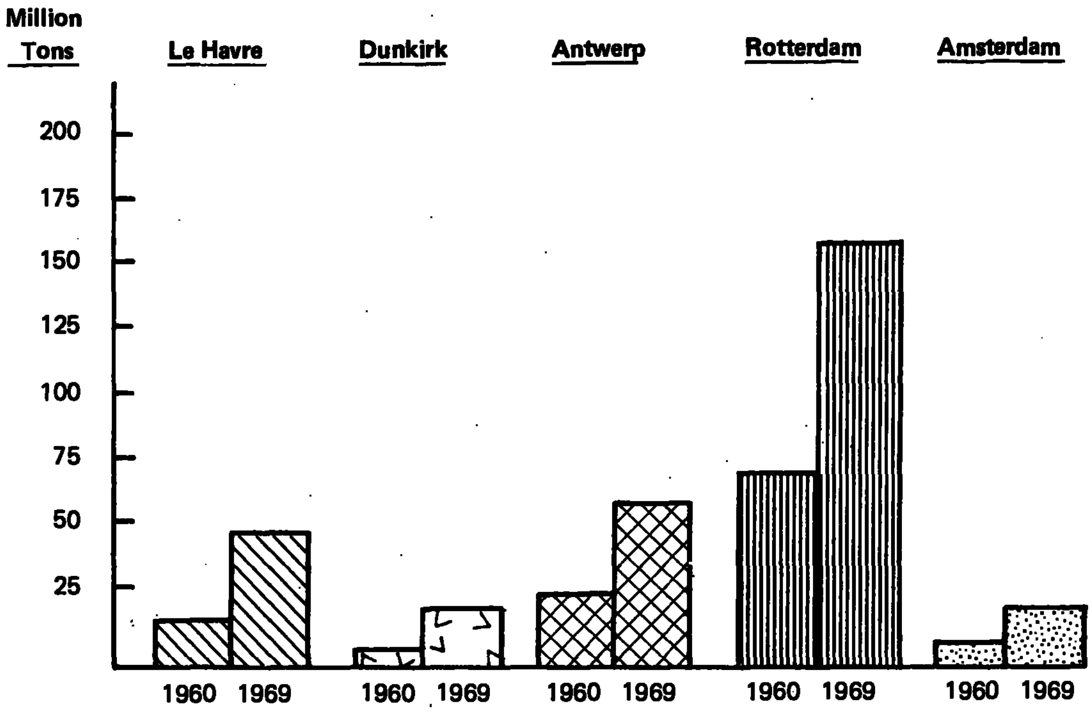
Source: Scottish Council/'EMPED'

TABLE 4–16

BULK CARGO
(tons in millions)

Ports	1960	1965	1969	Annual Growth Rate 1960-1969
Le Havre	13.2	24.3	45.7	14.8
Dunkirk	5.3	12.3	17.3	14.05
Antwerp	22.1	40.6	52.4	10.1
Rotterdam	69.1	104.0	154.7	9.4
Amsterdam	6.7	9.7	15.7	9.9
Total:	116.4	190.9	285.8	9.3

BULK CARGO



	Le Havre	Dunkirk	Antwerp	Rotterdam	Amsterdam	
1960	11.3	4.6	19.0	59.4	5.7	= 100.0%
1969	16.0	6.1	18.3	54.1	5.5	= 100.0%

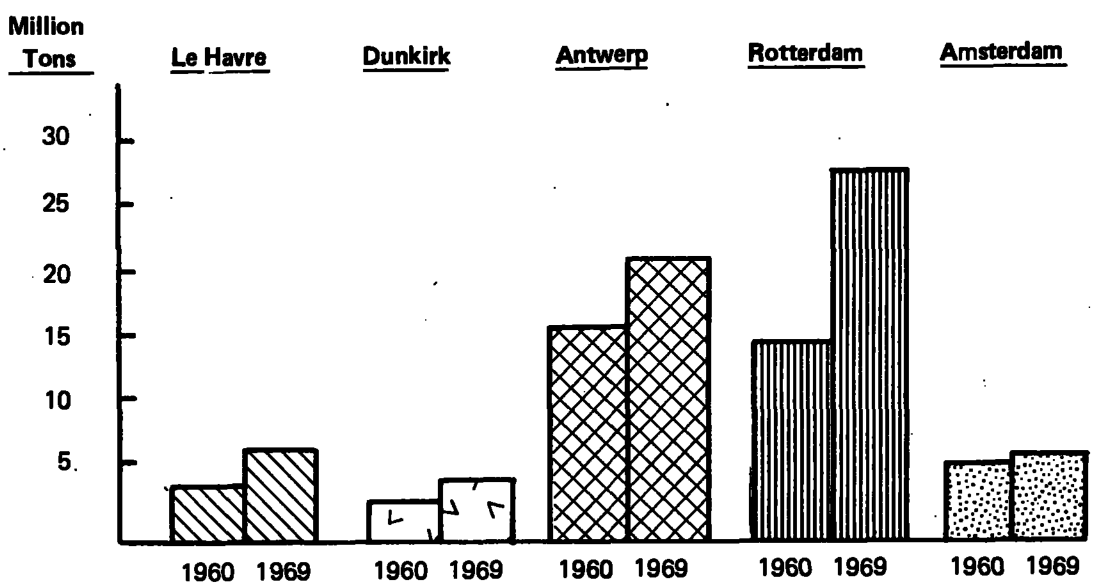
Source: Scottish Council/'EMPEO'

TABLE 4–17

GENERAL CARGO
(tons in millions)

Ports	1960	1965	1969	Annual Growth Rate 1960-1969
Le Havre	3.4	3.7	5.2	4.8
Dunkirk	2.7	3.6	3.5	2.9
Antwerp	15.4	18.8	20.6	3.3
Rotterdam	14.3	18.7	27.9	7.7
Amsterdam	4.1	4.2	4.2	0.3
Total:	39.9	49.0	61.4	4.9

GENERAL CARGO



	Le Havre	Dunkirk	Antwerp	Rotterdam	Amsterdam	
1960	8.5	6.8	38.6	35.8	10.3	= 100.0%
1969	8.5	5.7	33.6	45.4	6.8	= 100.0%

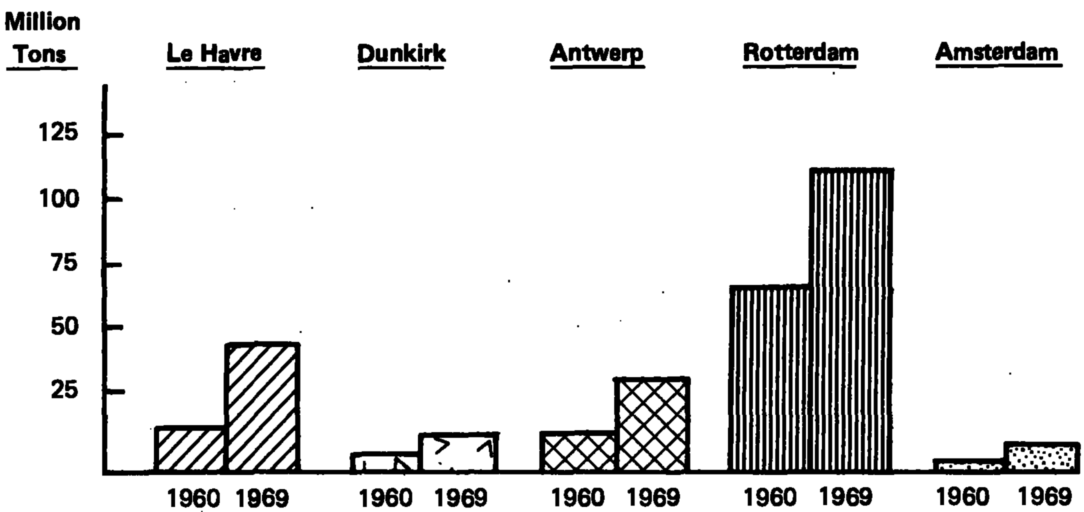
Source: Scottish Council/'EMPEO'

TABLE 4–18

PETROLEUM
(tons in millions)

Ports	1960	1965	1969	Annual Growth Rate 1960-1969
Le Havre	12.8	22.5	43.1	14.4
Dunkirk	4.0	7.2	8.8	9.2
Antwerp	8.5	19.6	28.0	14.2
Rotterdam	60.1	68.6	107.3	6.7
Amsterdam	1.5	2.1	4.7	13.5
Total:	86.9	120.0	191.9	9.2

PETROLEUM



	Le Havre	Dunkirk	Antwerp	Rotterdam	Amsterdam	
1960	14.7	4.6	9.8	69.2	1.7	= 100.0%
1969	22.5	4.6	14.6	55.9	2.4	= 100.0%

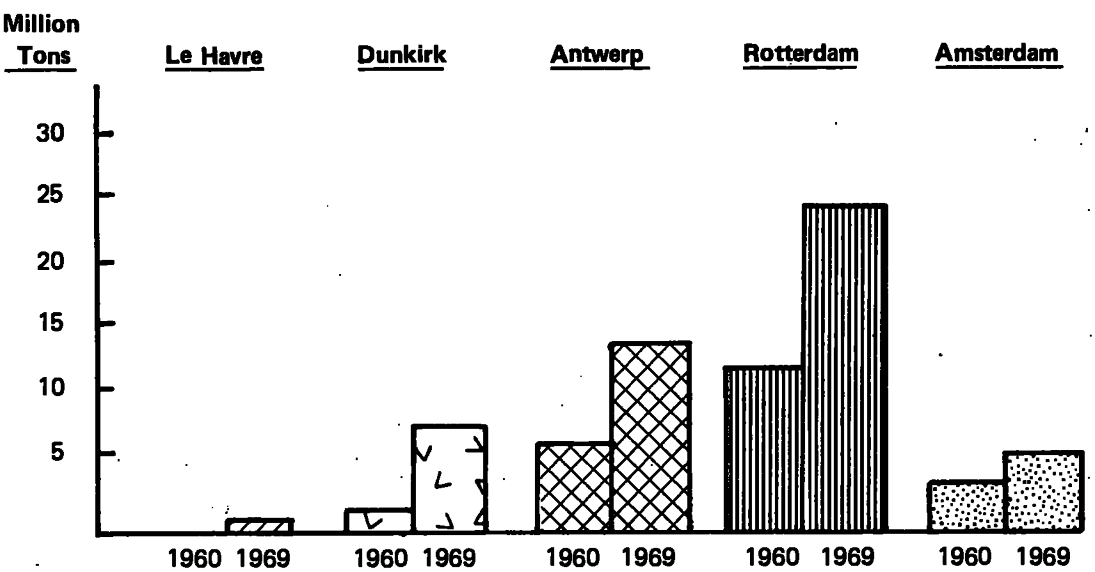
Source: Scottish Council/'EMPEO'

TABLE 4–19

ORES
(tons in millions)

Ports	1960	1965	1969	Annual Growth Rate 1960-1969
Le Havre	–	.1	.2	–
Dunkirk	.4	3.6	6.4	36.0
Antwerp	5.1	10.3	13.4	11.3
Rotterdam	10.7	14.8	23.9	9.3
Amsterdam	2.4	2.6	5.0	8.5
Total:	18.6	31.4	48.9	11.3

ORES



	Le Havre	Dunkirk	Antwerp	Rotterdam	Amsterdam	
1960		2.2	27.4	57.5	12.9	= 100.0%
1969	0.4	13.1	27.4	48.9	10.2	= 100.0%

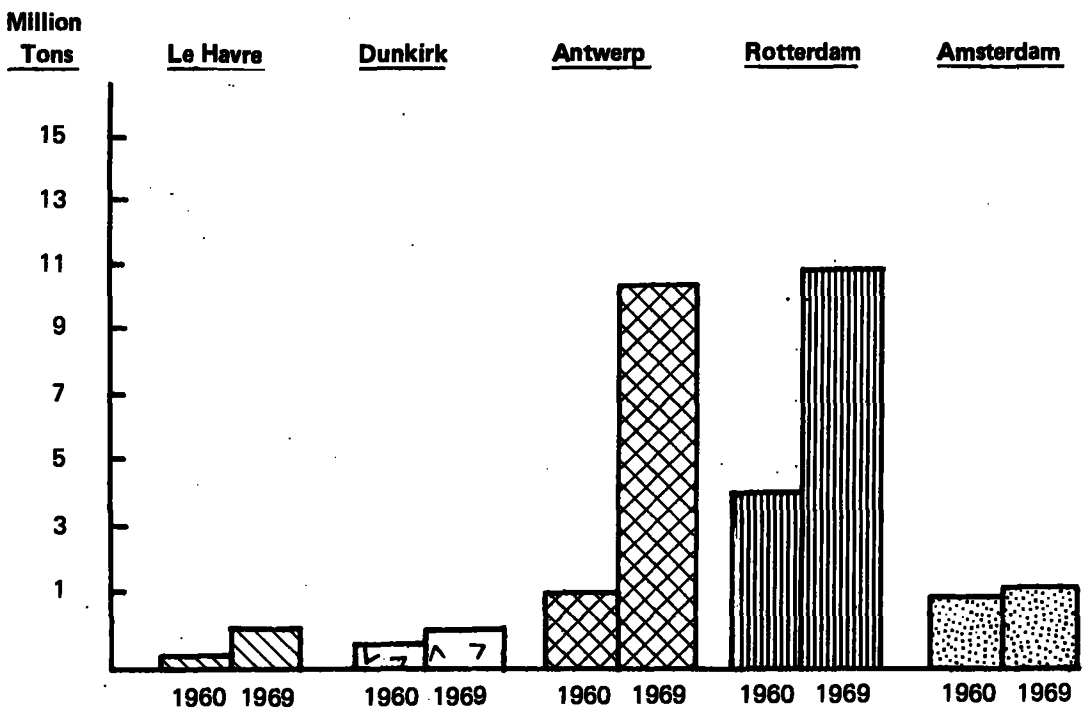
Source: Scottish Council/'EMPEO'

TABLE 4–20

CHEMICALS
(tons in millions)

Ports	1960	1965	1969	Annual Growth Rate 1960-1969
Le Havre	.1	.3	.4	16.7
Dunkirk	.2	.5	.4	8.0
Antwerp	.8	1.7	10.3	33.0
Rotterdam	3.4	5.2	10.8	13.7
Amsterdam	.7	.7	.9	2.8
Total:	5.2	8.4	22.8	17.8

CHEMICALS



1960	1.9	3.8	15.4	65.4	13.5	= 100.0%
1969	1.8	1.8	45.2	47.3	3.9	= 100.0%

Source: Scottish Council/'EMPEO'

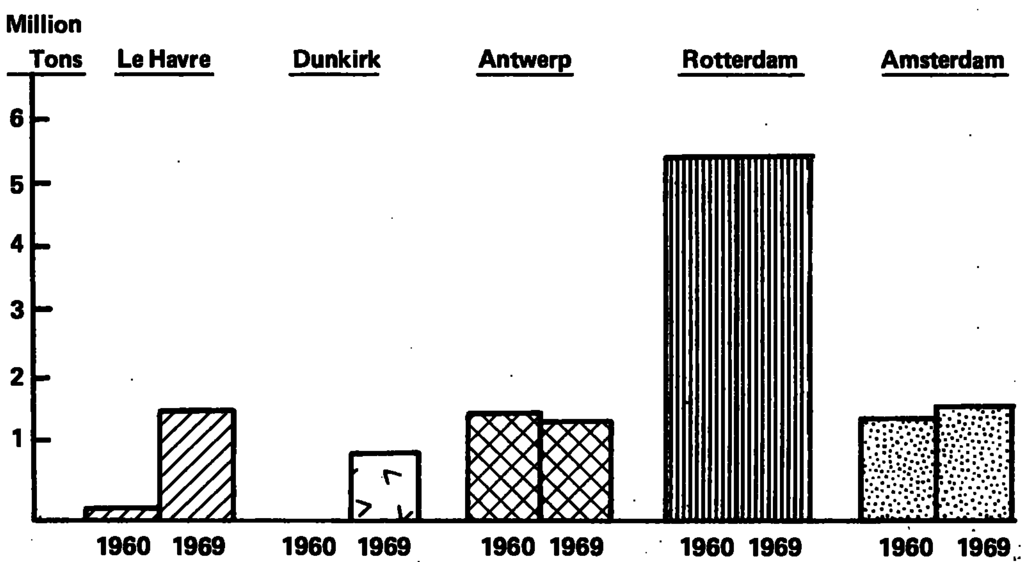
TABLE 4–21

COAL
(tons in millions)

Ports	1960	1965	1969	Annual Growth Rate 1960-1969
Le Havre	.2	.7	1.4	24.0
Dunkirk	–	.4	.8	–
Antwerp	1.4	2.0	1.3	-0.8
Rotterdam	5.3	5.4	5.3	N.C.
Amsterdam	1.4	1.4	1.6	1.5
Total:	8.3	9.9	10.4	2.5

N.C. – No Change

COAL



1960	2.4		16.9	63.8	16.9	=	100.0
1969	13.4	7.7	12.5	51.0	15.4	=	100.0

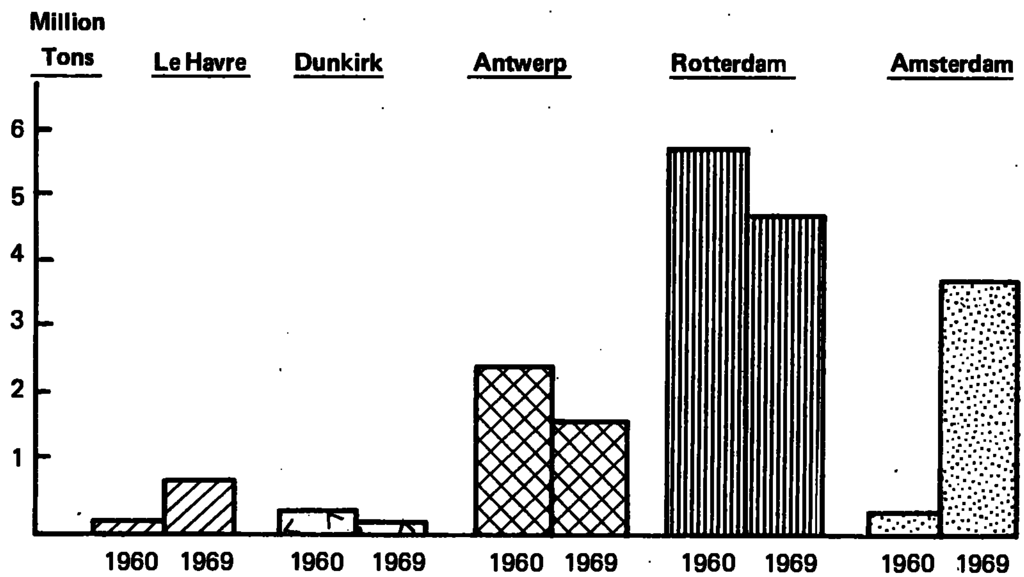
Source: Scottish Council/'EMPEO'

TABLE 4–22

CEREALS
(tons in millions)

Ports	1960	1965	1969	Annual Growth Rate 1960-1969
Le Havre	.2	.3	.6	13.0
Dunkirk	.3	.5	.2	-4.4
Antwerp	2.2	3.2	1.5	-4.2
Rotterdam	5.7	6.1	4.7	-2.1
Amsterdam	.3	2.6	3.5	31.0
Total:	8.7	12.7	10.5	2.1

CEREALS



1960	2.3	3.4	25.3	65.5	3.5	= 100.0
1969	5.7	1.9	14.3	44.8	33.3	= 100.0

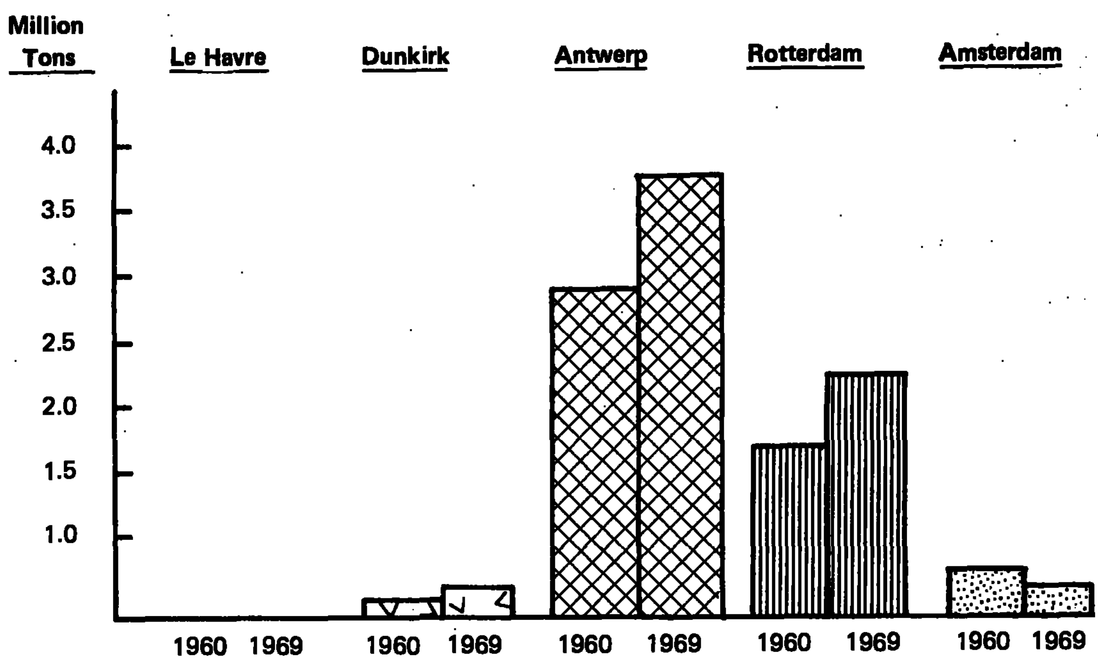
Source: Scottish Council/'EMPEO'

TABLE 4–23

FERTILIZERS
(tons in millions)

Ports	1960	1965	1969	Annual Growth Rate 1960-1969
Le Havre	–	–	–	–
Dunkirk	.1	.3	.2	8.0
Antwerp	2.8	2.6	3.7	3.1
Rotterdam	1.6	1.7	2.2	3.6
Amsterdam	.3	.3	.2	–4.4
Total:	4.8	4.9	6.3	3.1

FERTILIZERS



	Le Havre	Dunkirk	Antwerp	Rotterdam	Amsterdam	
1960		2.1	58.3	33.3	6.3	= 100.0%
1969		3.2	58.7	34.9	3.2	= 100.0%

Source: Scottish Council/'EMPEO'

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13. ABSTRACT

The economic advantages of large scale ocean carriers of oil and ores have developed considerable pressure for the development of a number of deep ports in the United States providing drafts in excess of 60 feet. This report is a study of selected foreign harbors (and off-shore loading and unloading facilities) where the experience was judged to be relevant to the U.S. situation. Specifically, the decision process leading to deep port development is examined, difficulties met and solved in construction and operation, and the relation between anticipations and experience are documented. Impacts on national economic policy, regional development objectives and environmental factors are discussed.

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14. KEY WORDS	LINK A		LINK B		LINK C	
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Techniques of Planning						
Evaluation Process						
Ecologic Impact of Water Development						
Cost Sharing						
Port Development						