15th International TNO Conference

Trade, Transport and Technology

The Functioning of World Seaport
Areas in the Eighties

Co-sponsored by:
VNCI (Association of the Dutch Chemical Industry),
and by:
FME (Association of the Mechanical and Electrical Engineering Industries FME),

and in co-operation with:
- Orde van Organisatiedeskundigen en -Adviseurs (OOA)
- Vereniging voor Strategische Beleidsvorming (VSB)
- Sociaal Economisch Management (SEM).

Hilton Hotel - Rotterdam
25 and 26 March, 1982.

Published by: The Netherlands Organization for Applied Scientific Research TNO
TNO Corporate Communication Department
P.O. Box 297
2501 BD The Hague, The Netherlands

Editor: P. M. Baven

Opening address

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Ladies and Gentlemen,
It is a pleasure to welcome you at the 15th International TNO Conference, which will deal with the functioning of World Seaport Areas in the next ten years.
This welcome applies particularly to our speakers; their willingness to speak before this Conference is very much appreciated. Although I can safely conclude that all our speakers lead very busy lives by simply looking at their positions in the field with which we will be concerned during the Conference, I would like to make one exception: we are grateful to you, Dr. Terlouw, Minister of Economic Affairs, because you have consented in giving a paper during this morning's session, in spite of your complex and no doubt time-consuming duties.
I also note the presence of many foreign guests, most of whom have come to the Netherlands from overseas. I hope that you will benefit from the Conference programme, and that you will return to your home countries with interesting information about what goes on in this part of the world and, perhaps, also with some ideas that may be fruitful in your own environment.

Since the present Conference is held at a time when TNO is preparing to celebrate its 50th anniversary, early in May of this year, I intend not only to introduce to you the Conference theme, but also to pay some attention to the past, present and future of TNO, the Netherlands Central Organization for Applied Scientific Research. Since it is always instructive to learn from the past, I will begin with a brief look at TNO's history.

Around the turn of the century the importance of applied scientific research for society, mainly in relation to economic development, began to be recognized in many countries. Developments in agriculture, the iron and steel industry and, particularly in the chemical and process industries, are early examples of this trend. This also applies to the Netherlands, but it was not until the early 1920s that several scientists in this country, among them the famous physicist Lorentz, proposed that an organization be formed to co-ordinate and carry out applied scientific research in the public interest. Although priority was given to the industrial sector, every field in which research efforts would be fruitful for society as a whole was to be included, according to their thinking.

As usual, the debate went on for almost ten years before these ideas became reality. In 1930 our Parliament passed the TNO Act, in which the tasks and the structure of TNO were laid down. This must be regarded as something of a novelty, because the new research organization was given a good deal of independence. This was based on the idea that scientists should be given sufficient freedom to come up with new ideas and concepts, even in the applied field.
Moreover, such independence is a must if the Organization is to carry out contract research for customers other than government departments or government agencies. It was also recognized at that time that direct control by the State is not feasible in view of the high degree of specialization required. It goes without saying that this attitude on the part of the law-maker met with some stiff opposition: it is, to put it mildly, somewhat unusual for many in our civil service to part with some of their authority, and to give a mandate to what may be called 'outsiders'. As a result, it did not only take another eighteen months before TNO was actually formed, but even several years later one of my predecessors, Professor Van Iterson of the Delft University of Technology, complained that co-operation with government officials could hardly be obtained because of lack of interest on their part. I hasten to add that conditions have much improved since then; I could even say that we could do with a little less interest in TNO's internal operations from the side of a few sectors of our civil service.

The growth of TNO was slow at first, not only on account of the deep economic crisis of those years, but also as a result of World War II, although during the latter period the then small Organization did some useful work to help in keeping production going, finding substitute raw materials of local origin, and developing substitutes for existing products and processes. But it was not until the late 1940s that the growth of the Organization accelerated markedly. During this period TNO played a significant role in industrializing the Netherlands by generating and importing new knowledge, and assisting industry in implementing and applying it. It was a period in which almost every venture met with success; few real choices had to be made in those days. As a result, TNO grew from little more than 200 employees in 1939 to almost 5000 today, with research activities in many of the main fields of public interest, such as industrial technology, food and food processing and nutrition, research in many areas connected with public health related to medical as well as environmental problems, and defence research.

Since it is obviously impossible to give a comprehensive survey of all our activities in the short time available to me, I will just give you some examples. In doing so, I will use the subjects of the 15 International TNO Conferences as a guide.
This series of Conferences started in 1968 with the subject 'New Synthetic Fibres'. One of our Institutes is the Fibre Research Institute. Of old, many of its activities were concerned with natural and synthetic fibres for use in the textile industry; other work dealt with paper. These industries in the Netherlands have decreased appreciably during the past ten or fifteen years; accordingly, the 'research market' of the Fibre Research Institute has diminished in size, and changed in nature. As part of a much more extensive reorganization of TNO, the Fibre Research Institute is now being reprogrammed and reorganized; emphasis will shift from 'fibre' to 'fabric and fashion'. The new programme is intended to provide support to the Dutch clothing industry mainly in the field of high quality products. Thus, one of the subjects that is now under active consideration is the use of computer-aided design and manufacturing in the textile field.

The second International TNO Conference dealt with surface coatings. Among our Institutes the Paint Research Institute is a relatively small one; our coating industry carries out a fair amount of in-house research development. Still, we do provide some technological assistance to the industry, and we are active in developing special products. Examples are: anti-corrosion agents, and coatings for marine uses which reduce the growth of marine organisms on e.g. ship's hulls. One of the results is that the energy consumption for propulsion is significantly reduced. The Institute is also setting up a long-range multi-sponsored research programme for industry, to which Dutch as well as foreign firms can subscribe by carrying part of the costs.

In 1970, the Conference theme was 'The Interaction between Marketing and Research and Development in the Chemical Industry'. In this connection, it is worth mentioning that a survey of the research market in the Dutch chemical industry was made just over a year ago. It was aimed at small and medium-sized firms in this sector. The information obtained was translated into a marketing plan for the division of TNO active in the field of chemistry and chemical technology; implementation is already under way. Assistance in developing new or improved products, and in replacing scarce or expensive raw materials by more attractive feed stocks is being provided. I should add that our chemical activities are among the oldest within TNO: for instance, as early as World War II we assisted industry in developing a process for the production of vitamin C from locally available raw materials.

The subject of the 1971 Conference was 'Plastics and Metals - Competitors and Allies'. TNO has both a Metal Research Institute and a Plastics and Rubber Research Institute. The Metal Institute covers a wide field, being concerned not only with production methods, but also with such subjects as welding, corrosion and corrosion prevention, and computer-aided manufacturing in the related industrial branches. Some of its CAM software and know-how was marketed successfully in the U.S.A. during the latter half of the past decade; it is only in recent years that the Dutch industry has become increasingly aware of the fact that the application of such technology is essential for its competitive position -perhaps even for survival. I think that this case is illustrative of the difficulties which we sometimes encounter in transferring our know-how to industry: conservatism sometimes prevents the timely adoption of new production methods until it is almost too late.

Our Plastics and Rubber Research Institute presents another example of an institute that has played an important role in the development of the pertinent branch of industry, it is true, but which has seen its market change appreciably during the past five or ten years. This Institute has gone through an extensive reorganization which has now almost been completed; it was merged with a department of another TNO Institute with related activities. Its internationally famed, sound scientific basis has enabled the Institute to draw up an entirely new programme, keeping the changed market conditions in mind, and to make a good start with its implementation, judging from the increase in the number of research contracts. Apparently, the Institute has kept the subject of the 1972 TNO Conference in mind; this Conference called the task of 'Increasing Versatility in Research: a Challenge to Industrial and Public Institutions'.

Then, in 1973, Industrial Innovation appears for the first time as a subject on the programme; the 1974 and 1979 Conferences centred around the same theme. In 1973 it was rather an early example of what may be called 'the Innovation Circus': at first sight, one gets the impression that much employment was generated in Western Europe and elsewhere by simply talking about innovation.
Still, much has been learned about the innovation process which has enabled among others the Dutch government in formulating a policy on the subject. I do not think I should dwell very long on innovation; let me just say that we at TNO are trying to stimulate innovation not only by doing research, but also by providing assistance in the fields of development of products and processes, and by giving information in such fields as production organization and finance.

The 1975 Conference dealt with the 'Effects on Industry of Trends in Food Production and Consumption', a subject of great interest to this country, because agricultural products are of prime importance for our economy. It is an area in which the provision of information to producers - farmers - and the introduction of modern methods of food production and processing has long been practised, even as early as the latter half of the 19th century. Our research potential has been integrated successfully in the entire system; perhaps this is why the Dutch farmers and the food industry have remained competitive on account of the high quality of the products, and in spite of the high wage level, one of the highest in the world. However, such a competitive edge based on quality must be maintained: this requires continuous attention to the innovation process. We at TNO participate in this process in our Central Institute for Food and Nutrition Research, an Institute which carries out a large volume of contract research, a sizeable proportion of which is done for small firms. The proportion of its activities devoted to contract research is so high that much attention is needed to avoid that insufficient exploratory research is done. This, of course, is the basis of our contract research of tomorrow.

It is not surprising that in 1976 the 'Energy Accounting of Materials, Products, Processes and Services' was discussed during the Conference held in that year. The subject is related to one of the largest research areas of TNO, viz. energy research. More than 10 per cent. of our total annual budget of Mƒ 550 is spent on energy research. To remain competitive, this research area in which many TNO Institutes are active, has been and still is the subject of extensive reprogramming: by the end of this year, 80 per cent. of our energy research will deal with subjects which differ from those of four years ago. Highlights of the programme are: energy conservation, coal utilization with particular attention to environmental aspects of coal usage and fluidized-bed combustion of coal, heat pumps and solar energy. New subjects that are being initiated are certain aspects of coal exploration and geothermal energy.

The next two subjects, 'Risk Analysis' and 'Consumer Interests and Manufacturing Considerations', are both areas in which TNO, as a public research organization serving industry, government as well as groups of other interested parties such as consumers organizations, can be active as a more or less impartial and objective agent. Even so, it is sometimes difficult, also internally, to find a common denominator between such divergent approaches as occur in the case of risk analysis: some are mostly concerned with quantifying risks as an aid in formulating a policy, whereas others place most emphasis on the perception of risks. Since low-probability risks, such as those involved in atomic power generation, are perceived by many as serious risks, it is obvious that a high degree of impartiality is a must, the more so because the perception of risks seems also to be a function of the view in which industry is held by public opinion. So working in this field means that one runs the risk of satisfying nobody, but I still think that TNO should continue to do this type of work.

In 1980, the TNO Conference on Biotechnology attracted a large and decidedly international audience. At that time several of our Institutes were doing research in this field, and since then these activities were intensified appreciably. This applies, first of all, to recombinant DNA work, for which a national centre is being built at our Rijswijk location. This centre will not only offer facilities to TNO Institutes, but also to other parties, to do this type of work in the CII and CIII safety categories. As for TNO, the current recombinant DNA research is not only of a medical or biological nature, but it also intends to explore industrial applications. With this in mind, research on bioprocesses is now being rapidly expanded. We were fortunate in finding sufficient funds, mostly from government sources, which enabled us to initiate projects in several TNO divisions. I hope that the delays caused by a public over-reaction to the risks involved in recombinant DNA work can be made good; otherwise, they may have serious consequences for the industrial application of biotechnology in the Netherlands.

Last year the 'Information Society' was the subject of the TNO Conference; the 'Changes, Chances and Challenges' of informatics applications were discussed from a variety of viewpoints. It represents one of the areas in which TNO does not do much research, although informatics is an auxiliary component in many of our projects and programmes.

A somewhat similar situation is found with the theme of the present Conference: it does not coincide with one of the main items on our programme, but the list of current research which is or may be of interest for the further development of world seaport areas and, in addition, of subjects in the field of marine technology, is surprisingly long. When preparing for this Conference, we decided to pay attention to a subject which is important economically as well as technologically, not only for our national economy but also seen internationally. Since Rotterdam is certainly placed high on the list of the most important world seaport areas, and because on a national plane the area has what one may call a 'vanguard function', it seemed a good choice at a time when our national economy must make a new start to ensure our prosperity.

So in the next two days we will have an opportunity to investigate and discuss a number of questions, the answers to which may be decisive for the course of events in the next decades. To name but a few of these:

- What are the relations between industry, seaports and the transport system?
- What changes can we expect in the energy field - will the role of coal really be as important as was predicted several years ago?
- What new technology will be needed or become available?
- What will happen in the chemical and oil industries, in view of the tendency in oil-producing countries to do some of the bulk processing locally?
- How about the risks involved in the large-scale transportation of e.g. LPG? Can we reduce these to a sufficient extent by introducing new methods, such as: new traffic guidance systems and new training methods for captains of large vessels?
- Can we take sufficient precautions against possible environmental hazards of large concentrations of heavy industries, particularly if these are partly based on coal?

These and other questions, including those on the economic policies of the national and local governments, will be on our agenda. Perhaps some of these questions will be answered or, if this is not fully possible, some problems that lay ahead will become clearer as a result of this Conference.

Finally, let me come back to the future of TNO, which, I think, is closely linked with the future of this country. I will use a phrase which was mentioned in a report of the 'Wagner Committee' dealing with the revitalization of the Dutch economy. In this report, it was shown that there are many chances for what might be called 'the Netherlands, Ltd.'. Our seaport complexes are among the strong points that may serve as nuclei for growth and modernization. The TNO Organization is attempting to become this company's research facility. And this is why we are actively looking at new fields, and concentrating our attention on some of our present and growing research areas. Some of these were already mentioned, such as biotechnology, computer-aided design and manufacturing. Others are micro-electronics, coal exploration and simulation technology. Several of these efforts are and will be directed to small and medium-sized firms, which are expected to generate much new employment.
I certainly hope that we will find the means to do this. These means do not only include sufficient funds and manpower, which constitute a major problem. What one also needs is a new drive and a positive attitude from the part of government, industry general public as well as TNO. We, from our side, will do our best to play our part.

Ladies and Gentlemen, I now open the 15th International TNO Conference, wishing you a pleasant as well as fruitful stay in Rotterdam.

Thank you for your attention.

Longer Term Prospects for World Economic Development, with particular reference to International Seaborne Trade.

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Growth in international interdependence will continue to be a major global feature during the remainder of the century, although today already global as well as sectoral interdependence have reached an unprecedented scale. Throughout the past 25 years, this growth in interdependence has generally had a favourable influence on economic prosperity, but there is some potential for problems in the future. These might stem from further changing relationships within the OECD, as well as between industrialized and developing countries, from the increasing significance of global issues, and from the constant interaction between national and international developments. In particular, those forces which have created considerable imbalances since the early 1970s, and which have contributed to an increased external vulnerability of some national economies in the past, may persist in the future.

In considering the longer term prospects for world economic development with particular reference to international seaborne trade, while avoiding at the same time any attempt at dubious forecasting, there would appear to be four major steps of analysis:
The first refers to the question of changing general patterns of the world economy. The second concerns specific aspects of the development of industry and international trade. This leads, thirdly, to particular considerations on international sea-borne trade prospects. And finally, attention has to be paid to some major policy issues in world economic development and to the strategies to be implemented in this context.

Global development patterns

Prospective analysis suggests that over the next 25 years there will be further change in the respective weights in the world economy of various nations and groups of countries, particularly within the OECD and between the OECD and the Third World. Even though longer term growth rates must be considered as speculative, depending as they do on the methodological approach as well as on the assumptions made, rough orders of magnitude and basic consequences may be presented as follows:

The North American share in gross world product will decline from nearly 30% today to about 20% in the year 2000. Despite this, the role of the U.S. will continue to be very important, but in a different manner than during the past decades. In a multi-polar world it has already ceased to be a totally dominant power, and has become one leading world power among others. Nonetheless, the U.S. continues to enjoy considerable advantages: a relatively small degree of dependence on the world economy, a rich endowment of natural resources, a lead in some basic technologies, a currency recognized as a reserve currency (even if this entails some disadvantages from time to time), and a strong military position. Even in a world of growing interdependence the U.S. may therefore still be in a better position than other industrialized countries to pursue policies of its own.

The increasingly important role played by Japan, whose share in world income may still grow from 8% to about 10% or more by the end of the century, rests on quite different factors: a great ability to process information and to decide and act collectively, plus an ability to make structural adjustment more quickly than other large nations. All these are essential factors of strength in an era of interdependence. Japan has geographical advantages in the proximity of China and South-East Asia, but has weaknesses which are no less important: no energy or raw materials, and an agriculture with limited possibilities. There are also specific problems, such as: land use, national defence and the rapid ageing of the population. Nevertheless, with the rise of Japan, the further industrialization in South-East Asia and the new policy of China, there is emerging in the Far East an area which in the second quarter of the 21st century will become an increasingly important centre of the world economy.

The case of the European Community is more difficult. Its share of world income could fall by nearly one quarter --from about 20% to about 15%-- by the year 2000. With the problems of a rapidly expanding labour force throughout the 1980s, strong pressures for industrial restructuring and related unemployment, the impact of lower growth could affect the EEC more than the U.S. or Japan. Since EEC-countries differ widely in economic structure and social organization, the nature and intensity of the problems will also vary considerably. But all ten countries face common problems of insufficient structural adaptability, given the national and regional features, and the superimposition of the Community on national decision-making processes, and an ageing population.

As regards the centrally planned economies the estimate is that the share of the Eastern countries in gross world product may increase slightly from 16% to 18% over the next two decades. This assumes that OECD economies will still represent 50% of world income, the Third World about 24%, about 8%. Furthermore, even if USSR and Eastern Europe trade with OECD and the Third World remains limited, its level and content may change sufficiently to have a significant impact on world industrial competition.

Industry and international trade

The general development picture outlined above may be given more shape by proposing some specific transformations which, in the course of the next twenty years, may affect the development, organization and distribution of industry and international trade.

As a phenomenon the continuous change in industrial structures and trade patterns is nothing new. It was one of the main features of the postwar period. Just as industrial expansion in Europe and Japan was a driving force behind structural change in American industry during the 1950s and 1960s, the growth of industrial activities in the Third World, and especially in the newly industrializing countries, is likewise set to have a powerful structural impact on the economies of the OECD area now.

However, there are at least five elements which indicate differences between the future and the past.
First, the interaction between industry and scientific research, as well as the complementarity between industry and numerous service activities (mainly in the developed countries) will progressively deprive the concept of industrial activity of the precise contours which it used to have.
Second, a new generation of key industries will gradually replace those which brought about industrial growth in the postwar period. In particular the electronics complex, covering automation, data processing and telecommunications, will constitute one of the major poles around which the productive structures of the advanced countries will be organized.
Third, there is also likely to be an exacerbation of competition between the most advanced countries to control the future trend of the international division of labour at the level of technology.
Fourth, onto the changing industrial relations among North America, Western Europe and Japan, there is superimposed a broader interaction involving the industries of Southern Europe, Eastern Europe and the Third World.
Finally, the process of structural change will increasingly take place within sectors and not between them. One of the outstanding features will be a further fragmentation of production processes, and an intensified intra-company, international division of labour, mainly under the auspices of multinational corporations, together with a further expansion of industrial sub-contracting.

Consequently, the growth prospects for the Third World, and in particular its industrialization, cannot be separated from the growth performance of OECD countries and the whole process of industrial redeployment. Whatever probable future development path is considered, prospective analysis suggests that the OECD share in world industrial production may still be in the order of 50% in the year 2000, and that the Third World (China excluded) might, by the end of the century, be producing about 18% of the world's industrial output. This last figure may look unsatisfactory, if mirrored against the so-called Lima target; however, compared with about 8% in 1970 and even less in 1973, one tends to under-estimate the achievement as one is matching this with too far-reaching objectives.

As far as international trade is concerned, the share of developing countries in manufacturing exports might increase from about 12% in the early 1970s to about 20% to 24% by the end of this century. Nevertheless, different scenarios clearly show that the absolute volume as well as the OECD import shares greatly differ; depending on the different assumptions made.
These concern firstly, economic growth performance, in particular in the OECD area; secondly, general North-South relations as far as co-operation or confrontation are concerned; and thirdly the course of trade policies, be it further liberalization or increasing protectionism. Whatever the case, the strongest industrialized developing countries (for example, South Korea, Singapore, Brazil, Mexico, and Algeria) will further improve their international competitive position in trade in manufactures, even if a certain trend to protectionist attitudes does continue in the future.

Overall developments in international seaborne trade

In spite of increasing competition, from air and land transport, the prime importance of shipping as a means of international trade will continue in the future. Having increased by sixfold, or 8% annually since 1950, international sea-borne trade reached a volume of more than three billion tons per year in the early 1970s. Growth rates increased during that period, rising from 7.5% in the 1950s to about 10% at the end of the 1960s. This high growth was sustained until 1973, but suddenly stopped by the recession following the oil-price increases. It appears unlikely that it will be regained in the 1980s, in view of the probable economic development of the years to come.

Expectations about future economic growth can be summarized in the general belief, that the rates of increase in the major industrialized countries may not reach their longer term pre-1973 level again, but will settle on a somewhat lower path, even if the present efforts to re-establish sustained, non-inflationary growth and higher employment are successful. As far as the total of the OECD area is concerned, the average annual growth rate of GDP was 4.9% between 1960 and 1973, and the estimates for the longer term future tend to be at least at one percentage point lower.

Looking at major countries in this context, the most remarkable reduction of economic growth will occur in Japan, a country which contributed to a large part of past seaborne trade growth. It has been calculated that more than half of the total growth in dry cargo trade and nearly three quarters of trade growth in raw materials between 1965 and 1972 was due to Japan. Certainly, in the longer run part of this flattening in growth trends of developed countries will be offset by economic development in newly industrializing and developing countries. However, major effects in this direction may probably not be expected before the last decade of this century.

Future seaborne trade growth will not only be affected by a slower GDP growth in the industrialized countries, but also by structural changes in the growth process as well as in the international trade patterns. In the most developed countries future economic development will increasingly be determined by the growth of services. This does not mean that OECD countries will decrease their industrial production in the future. On the contrary. Neither does it imply that OECD countries will not remain the most important exporters of capital equipment goods. However, sea-borne trade generation per unit of GDP growth could decrease under these conditions. There are also certain elements within industrial production which point in this direction. First, there is a general trend in the international division of labour in industry which may be described as a continuous process of change from materials intensity to knowledge intensity in the industrial activities of the developed countries. Second are efforts of the developing countries to intensify the processing of their own raw materials.

Although these aspects primarily affect dry cargo trade, they already give a clear indication that the fairly stable relationships between GDP growth and the growth of principle sectors of seaborne transport observed during the 1960s and early 1970s, can hardly be extrapolated into the future.

If we compare the two periods 1965 till 1973, and 1973 till 1980, it becomes obvious that the three main elements which consitute seaborne trade took wholly divergent routes in the periods before and after 1973, with the main bulk cargo, which had grown faster than GDP, coming into line with it, general cargo and minor bulks holding their rates of growth against economic slowdown, and oil completely reversing its direction.

Changing trade structures and shipping requirements

Nevertheless, the transport of oil, oil products, gas and coal, will continue to constitute the largest single element of shipping demand. In 1980 nearly 60% of world cargo fleet was employed in moving these commodities. As regards the industrialized countries in which the share of oil in total energy supply should drop substantially over the remainder of the century, the absolute level of oil consumption is likely to remain almost constant, even allowing for a substantial growth in synthetic and other non-conventional oil. More uncertain is the demand of the non-oil producing developing countries, whose economic growth cannot be separated from oil. The prospect of increasing oil prices is likely to put them in a vicious circle, in which their economic development, and hence demand for oil, is hamstrung by their excessive indebtedness to pay for that oil. The best guess is therefore that total demand for oil will remain stagnant for some years to come, and hence that crude oil trade will not grow very much. Oil and oil products ton mileage is most unlikely to exceed the 1977 maximum of 11.5 trillion, but it is difficult to see it falling below 9 trillion during the remainder of the century.

Somewhat offsetting this will likely be a growth in ocean trade of coal, but there appears to be a complete lack of agreement on the extent of the growth that will take place.
From the shipping point of view, the biggest problem is, that today less than one twelfth of the world coal production enters seaborne trade, with the result that small changes in demand levels can have a disproportionate effect upon the marginal supplies, which are likely to be those shipped internationally. The spread of estimates for the 1990s suggests a margin of between an 80% and 200% increase, with an end-of-

century level between three and a half and six times of that of 1979. However, it should be noted that the 160 million tons moved in 1979 utilized approximately 26 million dwt tons of shipping.

Assuming that there is no change in ship productivity, the bulk carrier fleet required for coal by the end of the century could fall between 90 and 150 million dwt, but even the higher level is equivalent to only an extra 6 million dwt per annum. It may be noted that during the next two years the world dry bulk carrier fleet is expected to grow by over 30 million dwt. There would seem to be no problem of supplying the ships to meet the growth of trade in coal, and the reserves are there. The bottleneck lies in the political and environmental area, complicated by the fact that decisions to switch between coal and oil is very sensitive to small changes in the relative prices of the two commodities, and by the high capital investment and long leadtime required to bring in new coal sources and improve ports and their land infrastructure.

The gas sector is even more influenced by political and technical problems outside the shipping sector. Moreover, the volume of tonnage that has been ordered and delivered years before the project they are destined to serve comes on stream was very considerable in the past. In the period between their two surveys in 1978 and 1980 the Shipbuilder's Association of Japan nearly halved their LNG estimates for 1990, and their current estimate of 13.6 m^3, which is higher than many figures put forward recently, would involve a net annual addition of less than 8 standard 125,000 m^3 LNG carriers throughout the decade. Estimates for increased gas demand in the 1990s suggest furthermore, that the areas where demand will be particularly concentrated, with the exception of Japan, are likely to draw largely on indigenous resources or be supplied by pipeline rather than by ship. Accordingly, the growth prospects for seaborne gas supply in the latter period are even more uncertain.

While the margins of uncertainty, at least for the 1980s, are less wide for the remaining dry cargo sectors, there is nevertheless significant scope for variations between the 'optimistic' and the 'pessimistic' scenarios. The two largest elements in the equation, iron ore and cereals, together constitute at present 27% of the non-energy cargo moved by sea, in terms of tonnage, and over 40% in transport performance (because of the longe hauls involved). The iron steel industry is particularly sensitive to changes in economic growth, and as a concomittent, seaborne iron ore (which, if the USSR is excluded, amounts to nearly half the world production) also fluctuates violently with the growth between 1972 and 1974 of 33%, and a slump between 1974 and 1977 of 16%. Recent estimates for the 1980s suggest annual growth rates during the decade as low as 1.4% and as high as 7.3%, giving a tonnage requirement, on present productivity levels, between 55 and 95 million dwt.

Seaborne cereal demand has also shown wide variations, but since this has been related essentially to climatic and not to economic factors, growth predictions have been little more than guesses. By and large, one may expect a gradual upward trend, but it is hard to see an end-of-decade level more than 50 million tons higher than the present level, which would be equivalent to a maximum additional shipping requirement of some 10 million dwt, taking into account the high average haul length. Looking beyond into the 1990s, the situation will depend entirely on the success with which the developing countries of Africa and Asia manage to increase their agricultural output in line with the population expansion, and the extent to which any shortfall can be met from traditional cereal exporting countries. At the present stage any suggestion as to the level of movements would be pure speculation.

In considering the minor bulk and other commodities, while there has been a considerable number of individual assessments of particular cargoes, the general conclusions of a number of across the board assesements are that the minor bulks will grow somewhat more slowly than the overall GDP rate following the post-1973 trend, whereas seaborne movements of general cargo commodities will continue to grow somewhat faster than the GDP rate, as they did throughout the 1960s and 1970s. In this sector, however, the issue is further complicated by the need to assess how the bulk carrier, the unit-load ship, and the general cargo ship (with part container capacity), each having very different productivity characteristics, will share the available cargo among them. A tentative evaluation of general cargo demand, undertaken by the OECD earlier this year, suggested that if it was assumed that all incremental general cargo demand was met by specialized unit-load shipping, the general cargo-fleet required in 1990 might be expected to be between 10 and 20 million dwt higher than at the beginning of the decade.

As most of the speculative elements which have an impact on the future structure of world seaborne trade are not primarily related to shipping but to general economic development and policies, the conclusions drawn from the foregoing analysis may again reflect the aspects of general prospects for world economic development, of basic challenges and policy issues, and of possible strategies.

Prospects and policies

Two fundamental questions arise from the analysis. The first is still about prospects and asks to what extent the probable future path of development may be unstable or give rise to dangerous breakdowns. The second is about policies: how in the context of increasing interdependence can co-operation between governments be strengthened, procedures for settling disputes be improved, and thus possible conflicts at the international level be contained within bearable limits? This issue, that would seem to want the prior attention in this context, arises in four areas: the successful re-establishment of sustained, non-inflationary growth and higher employment; the energy transition; common efforts for the development of the Third World, and new forms of international co-operation.

Economic growth in the industrialized countries is not only subject to macro-economic constraints, such as inflation or budget deficits and to the problems of energy supply, but it is also encountering deep-seated structural problems. In a broader context, these include the emergence of new values and new social demands, changes in the age structure of population and labour force, and the consequences of a possible future fragmentation or oligopolization of society.

In the narrow economic sense, structural adaptation implies accepting the necessary changes in production and employment structures. In both respects there is a two-way relationship between economic growth and structural adjustment. On the one hand, higher growth could certainly facilitate structural adaptation; on the other hand, a decreased ability or willingness to re-allocate resources flexibly could turn out to be a crucial obstacle to successful demand management. Hence the danger of the persistent slow growth together with the problem of unemployment, if conventional macro-economic policies are not accompanied by effective structure adjustment policies.

Even moderate rates of growth in OECD countries which, it is sometimes argued, could make the problem of energy supplies less acute, do not exclude the possibility of a breakdown originating from his sector Inadequate investment by OPEC and other oil producing countries to increase extraction capacity, and weak policies within OECD with regard to nuclear energy, coal and energy conservation could lead once more to an inflationary recession. This could slow down growth still further and increase the risk of social disturbances. Thus, despite the present calm on the world oil market, each country should intensify its national efforts in the field of energy, while at the same time striving for co-operation between oil-consuming countries, and and between those countries and oil-producing nations as well.

The sources of instability and no less great in the Third World. They exist in the OPEC countries, where the pursuit of a rapid economic growth is undermining the historical social structures, and whose governments may have to face difficult choices in the post-oil era. They are apparent in the rapidly industrializing countries which may be confronted with the protectionism of the already industrialized countries. These countries may oscillate between the search for a new international economic system and present international institutions. Stability will also remain in the poorest countries.

However, the future is not yet written. Even if it is not entirely in the power of governments, and still less in the sole power of western developed countries, governments can act to improve the likely course of events and reduce the risk of breakdowns, not only by domestic policies, but also by a renewed and strengthened international co-operation. This involves at least four dimensions of great importance. They include the political will for international co-operation; clear recognition of the linkages and long term aspects of the key fields where co-operation is necessary and potentially attainable; and, last but not least, a certain minimum concensus about guidelines for action.

The political will for international co-operation particularly implies a larger sharing of responsibilities on the one hand among developed countries, and on the other between OECD countries and the developing countries. Priority will have to be given to certain key fields. Apart from military co-operation and continuing efforts for disarmament, the most important issues include: North-South relations, natural resources management, trade policies and structural adjustment in industry, co-ordination of short term economic policies, and questions related to the international monetary system.

As far as the minimum concensus for action is concerned, this implies that each country in conducting its own affairs taking into consideration the diseconomies it imposes internationally on others through inadequate national policies. Structural adjustment and energy policies are only two examples of where this principle appears to have been seldom observed in the recent past. Government ought to aim at strengthening the market mechanisms, by trying to eliminate their imperfections to improve their functioning and to complement them where they are ill-adapted.
In conclusion, it must therefore be made clear that the call for more international co-operation should not be understood as a plea for bureaucratic management of the world economy. This would hardly contribute to solving its future problems.

Thank you very much.

Relationships between Transport, Seaport and Industry: A Critical Analysis of their Evolution in Antwerp and Rotterdam

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Preamble

Although industrial activities, i.e. production, are not a necessary characteristic of any seaport*), most seaports -and especially the ones in Western Europe- consider it of extreme importance to have industries settled within their own borders.
Besides, the so-called 'golden sixties' are characterized by a sucessful harbour industrialization. The questions plainly remain whether this evolution will and can go on, and whether the M.I.D.A.-phenomenon**) will also be of interest to developing countries.

To get more insight in this complex matter one needs to know as much as possible about causes, consequences and interrelationships concerning modern port industrialization.

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*) Cf. The definition of 'seaport' according to the Port Working Group of the Commission of the EEC:
'A seaport may be understood to be an area of land and water made 'up of such improvement works and equipment as to permit, principal- 'ly, the reception of ships, their loading and unloading, the 'storage of goods, the receipt and delivery of these goods by inland 'transport and can also include the activities of businesses linked 'to sea transport'.

**) 'M.I.D.A.'s are areas of land of sufficient size, with access to 'deep water, to enable industries themselves, as apposed to merely 'their importing facilities, to establish themselves' (J.M. Gofford).

Importance of the industrial function of a seaport

For a long time many governments have recognized the vital importance of adequate ports to the nation's economy and defence. The maritimization of industry no doubt reinforced this line of thought, because -at least theoretically- plenty of advantages can be gathered, viz.:

a. From a national economic point of view 'ports are much more than piers' (Cf. MarAd; 1978, p.10); they are servants to and customers of the economy. They therefore need to invest, provide jobs and income, and pay taxes. The more they become industrialized, the more they may become real growth centres. In that context it should not be forgotten that ports as such do not show a relatively high activity multiplier, unless there is an important follow-up of port expansion programmes, e.g. by means of industrial settlements in and around the port. On the other hand, however, ports show a relatively high sensitivity or capacity indicator in relation to overall changes in the economy, that is to say in economies like the ones of Belgium and the Netherlands.

b. From a port economic point of view industrial settlements within the border of the port are considered as a draw for guaranteed success, i.e. they may induce extra traffic.

c. From a private economic point of view the seaport can be considered a nucleus creating a whole set of agglomeration and/or scale economies.

But the relationship between port and industry is not so straightforward as it may seem to be. The solid image of a highly industrialized port does not exclude misallocation of scarce resources nor mislocation of industries. And therefore in the long run port industrialization could be misleading.

Disadvantages, diseconomies of agglomeration, are indeed to be taken into account as well.

And last but not least: one must not neglect its consequences, both positive and negative, upon labour, environment, income and regional development.

M.I.D.A.'s and M.U.S.*)

Since the successful maritimization of a series of important industries from the early sixties on, there has been a constant concern about the creation of large industrial sites. One only has to catch a glimpse of different maps concerning recent port expansion plans to become aware of the widen scopes of the projects involved.
The need of land in the seaports is not so much determined by the land required for the port and its storage and transshipment of goods, but to the larger extent by the amount of land required for the establishment of several big industries. And indeed these industries are very 'land-extensive'.
At the beginning of the seventies one could even speak of some megalomanic approaches. At that time numerous publications in various colours of the rainbow were issued, all with the aim to defend the extension of the port of Rotterdam in the best possible way. Think of the green book: 'Examination of some Aspects of Development Possibilities for Seaports in the Delta Region' (5.11.1968); the blue study undertaken by Frederic Harris Inc. and Associated Industrial Consultants Netherlands n.v.: 'The Greater Delta Region - an Evaluation of Development and Administration' (10.1.1969); the orange book of the Van Tilburg Commission: 'Examination of Future Employment in the Rotterdam Port and Industrial Zone' (15.1.1969); and last but not least, a yellow study by the port authority and the services for municipal development and city works of Rotterdam entitled: 'Plan 2000+' (19.2.1969). The last-mentioned study contained fully elaborated plans for the further extension of the port into the sea as well as unto the islands, together with plans for a satellite city with 500,000 inhabitants (so-called 'Grevelingen').

In fact we are thus discussing the movement towards deep water of a well-defined set of industries.
But what has been responsible for the concerned change in location pattern? Research into island versus mainland seaport location patterns (W. Winkelmans; 1979, pp. 137-173) has demonstrated that apparently the

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* "M.U.S." are "Major Users of Seaports".

location pattern per industrial sector differs more with regard to site features than with regard to sector features, whereas per location there appeared to be quite a remarkable industrial economic individuality as regards location decision (W. Winkelmans, 1974, pp. 205-253). In other words: theoretical location (factor) definitions do not apply a priori, as could be supposed on the basis of a contingency table between various possible users and several stimulating criteria. Many so-called important location factors have in fact only a very relative importance once the location motivation is 'dynamized' by the introduction of alternative sites.
The place of location itself indeed often overshadows every possible technical and/or commercial factor determined by sector and/or time. Certain motives for the place of location, such as transport costs, can vary strongly with the location one has in mind. And some location factors (recreational facilities, production costs in connection with water and energy supply, costs with regard to transport of labour, etc.) are in any case so closely linked with site, that they take on extreme values, either in a positive or a negative sense.
So every time an alternative location is put forward, important shifts in the relative importance of the factors of location can be noticed. In fact we see here the influence of the location itself on the interaction of different location factors.

Applying these findings to the examples of Antwerp and Rotterdam proves once again, that the seaport as such does not account for the establishment of so many industries near deep water. The location shift in question has been induced by an overall process of reducing the transfer costs through technical improvements and/or innovations in production and transport which, of course, altered the locational significance of distance and volume.
Nevertheless, at that time some seaports (not all) proved to be the best alternative site. Elaborated and empirical location analyses pointed out that the nearness to deep water was not always of exclusive importance. Neither the industrial import figures nor export-over-sea figures explained significantly the importance attached to proxy-variables of deep draught (W. Winkelmans, 1973, pp. 91/2).

The seaports in our case, i.e. Rotterdam and Antwerp, are not the result of one location factor or motive, but of a complex of location decisive factors. And indeed, the fact that plenty of industries have been established in seaports like Rotterdam can be explained more by the presence of techno-economic and commercial linkages (think of deliveries across the fence, labour skill, local know-how, follow-up techniques, etc), than by the presence of the port itself. This so-called 'agglomeration effect', i.e. having industries close to each other capable of either supplying specific raw materials or becoming purchasers of semis, has no doubt increased the potentiality of certain seaports as a growth pole.
This holds for one seaport more than for another, because some ports were more pre-existent centres than others. They had already one or more balancing refineries settled; or they could already show some world famous names of industrial establishments. In short, they had already appeared to be a propitious situation.
Whether for that reason the industrial activities themselves became more or less port-linked is quite another question, which is to be studied separatedly.

Critical analyses

A survey of well-known M.I.D.A.-projects in five North Sea countries in the early 1970s led to the unbelievable amount of more than 100,000 ha of gross port expansion (Cf. Winkelmans, 1974, pp. 30/1).
Nowadays, considering especially the latest developments in international trade, even the most optimistic estimation of additional land requirements of M.U.S. could not show such a need for the provision of industrial sites in or around seaports. (Think of alumina and aluminium, blast furnace and steel, petroleum, petro-chemistry and basic chemistry). Roughly speaking, there exists rather a danger for overcapacity, but this, of course, is not true for every 'candidate' as such. Indeed, the aforesaid thousands of ha must not be lumped together under one heading (Typical in that sense is e.g. the reaction of S.V.N. saying that 'overcapacity in one seaport must not lead to forbidding extension in another seaport' (Economisch Dagblad 28.12.1981, The Hague). Accordingly, it is taking much too definite a stand to assert that there should be no problem of acreage or space organization. I

shall come back to this later on.

First of all it should be recognized that today, as a consequence of mentality changes of whole populations with respect to environmental questions, there exists a strong trend towards governmental planning and intervention, and towards the preservation of cultural space and reorganization of industrial space. (Seemingly, the aforesaid flood of expansion plans produced the reverse effect. Recently, the Deputy States of Zeeland e.g. decided to cancel the project of Baalhoek-kanaal', because it would affect too much agricultural land). Perhaps, one thing and another, could account for the actual resistance to all seaport projects of too large a scale, as well as the implementation difficulties as regards the approved projects. So, any unlimited port expansion belongs to the past. However, there remains the demand for further expansion of certain 'industrialized' seaports, which have recently proven to be successful.

Then again the question arises whether port industrialization is a 'must' on behalf of investors or a "wish" on behalf of port authorities. And in this respect some characteristics should be taken into consideration:

a) As to the subsequent phases of the process of <u>site-reclamation</u>, <u>site-issue</u>, <u>site-selection</u> and <u>site-occupation</u>, it is necessary to know that the first two phases, like so many port investments, are discontinuous by nature.
   Site-occupation may develop more smoothly, whence it should be noted that the it is not identical to site-issue.
   Too low sit-occupation ratios should always be avoided, because production and labour expansions are not fully reflected in gross site-issue figures, so that further port expansions based upon such figures may lead to serious overinvestment. Let me give you an example.
   The industrial labour force per ha gross in Rotterdam for chemical industries declined from 14 in 1960 to 11 in 1971 per ha issued company by company. If we want to investigate possible repercussions upon employment from a specific port expansion programme, this

figure would be seriously misleading, because the site-coefficients in fact amount to more than 20 man per ha occupied (W. Winkelmans, 1973, pp. 50 and 129).
One must not forget that the average size of port industrial sites appears to be rather large: for petroleum refineries between 150 and 220 ha, for chemical companies between 30 and 85 ha. One can therefore easily understand why the size and availability of the sites have proven to be among the most important location factors in the maritimization ation of industries. (W. Winkelmans, 1973, pp. 53 and 75). If one also knows that the production elasticity of the site-occupation both in Antwerp and Rotterdam likes to be less than unity, it becomes clear that one should be careful with too ambitious site-reclamations (site-occupation ratios for Antwerp and Rotterdam have for a long time been in the order of 40 to 50 per cent. (W. Winkelmans, 1973, pp. 127/8 and 134). However, this does not mean that a kind of reservation of large port site areas is not to be recommended; by site-reservation one might create an important option-value for the future.
At any rate only a wise and severe site-selection policy of the port authority can guarantee an economically justified site-issue. It is also the basis of a trade-off between, on the one hand, the permanent danger of creating uneconomic overcapacities and, on the other, the wish to hold all possible trumps by the reservation of appropriate areas.

b. As to the relationship between port industrial production and port traffic it is worthwhile to realize that the general assumption, that an industry in a port should use this port and thus conduce an increase in the overall port activity, is not so straightforward as one would have thought at first sight.
An estimation of the net effect of production and site-occupation by industrial companies in the port on the port activity demonstrates fairly clearly the ambiguous character of the underlying relationship :
- On the one hand steady production growths did not always result in the expected growth of related sea transports. (Indeed, notwithstanding permanent increases in supply and production, sometimes

at an annual growth rate of 20 per cent. and more, there was a relative decrease in the sea transport of the pertinent industries decreased relatively; W. Winkelmans, 1973, pp. 143/4); calculated sea transport coefficients roughly show that at the end of 1965, 30 to 50 per cent of the production volume of chemical plants was transported by seavessels; at the end of 1970, however, this percentage had declined to 10 to 30 per cent.
Consequently, the production-elasticity of the sea transport often appeared to be less than unity, too, which proves that site and production expansions within seaports are sometimes weakly reflected in the comparable sea traffic growths.
The fact that there are some exceptions also proves that an underproportional growth of the seaport traffic need not inevitably be a general rule.

- On the other hand, the estimation of industrial port traffic coefficients, giving the relation between specific industrial imports and exports over sea by the port-industry, and the total imports and exports of similar goods or products in the port of settlement, shows that a keen increase with time is possible. (The effect e.g. of the chemical industry on specific port activities was initially rather small. If we take the situation before 1970: as to the unloadings in Antwerp on an average somewhat upwards of 30 per cent., and in Rotterdam only 14 per cent.; as to the loadings 7 and 13 per cent respectively. Yet there is a clear increase with time (W. Winkelmans, 1973, p. 153). This implies that seaport traffic induction by port industrialization varies substantially with concrete situations (think of the introduction of pipelines within the port). As to the impact of chemical industries upon total port traffic, the related evolution between 1960 and 1970 both in Antwerp and Rotterdam, showed that this impact appeared to be rather limited, viz. hardly 2 per cent.
  Of course, one thing and another do not prove that since that time nothing would have changed. One conclusion, however, can always be drawn, namely: the location of an industry in a harbour does not necessarily imply an intensive use of the port, because as Peston and Rees stated in their Preliminary Report MIDAS (Nat. Port

Council London, 1970, p. 10):
'It is not necessary that industry is located at the port for the
'advantages of efficient port facilities to be felt provided that
'inland transport facilities are adequate'.
Other transport ways are in use as well, indeed.

Finally, and for all the above reasons it should be kept in mind that the planning of too large a number of berths or waterfronts, especially for industries in the port, may have certain disadvantages from a developing point of view.

a. Creating deep water over kilometres and kilometres (think of Rotterdam-Europoort), principally for the establishment of petroleum refineries, is a highly costly matter and from a socio-economic point of view not necessarily the best solution. (In Antwerp some 14 kilometres and in Rotterdam some 19 kilometres of waterfront, are occupied by crude refineries, W. Winkelmans, 1973, p. 195).
b. The huge storage requirements for most industries in the port are rather land-extensive, but not always quay-linked and/or berth-linked, certainly not in the case of liquid bulk.
   According to the goods explosion model of Prof. Meeuse, which takes into account the technological interrelationship between weight and appearance of goods to be transshipped, it can indeed be demonstrated that for most industrialized activities in the port, or for practically all continuous conveyances, the distance between quay and storage may really be enlarged unto areas outside the port area. Anyhow, it can hardly be acclaimed that by far the largest parts of seaports, like Antwerp and Rotterdam, can be found under tankstorage sites.

Conclusions and future outlooks

Quite a lot of new transport technologies, such as (c)lash activities, transport by canalization (slurry, belts, chains,...) and feeder line services, are enabling a wholly new port conception. Country planning of the seaport then just become a must, also with respect to the industrial function of a modern seaport. The creation of, for instance, three port zones could be a logical consequence:

1. a primary (or wet) zone for quay-linked and/or berth-linked activi-

ties (e.g. steelworks);

2. a secondary (or intermediary) zone for more port linked activities such as some basic-chemical plants;
3. a tertiary (or dry) zone for more port directed, i.e. only commercially linked, activities such as many petro-chemical industries.

One thing and another imply a more functional than loading-directed thinking, which will have as a consequence maximum separation between industrial and port infrastructural investments from the stage of planning and construction on.

Seen the huge amounts of investments, acreages, labour forces, etc., which are involved in port industrialization schemes, inducing interesting values added, it is quite understandable that public authorities and/or central governments are interested in the good functioning of port industrialization projects.
The implementation of such plans, however, becomes increasingly difficult, especially in densely populated regions. Reconsideration of the relationship between port authorities and communities will perhaps solve the deadlock at which many West European seaports have arrived in so far as it concerns their expansion plans. In the meanwhile, we presume, the international holdings (multinationals) will not loose sight of the possibilities which exist in developing countries. The establishment of industries in developing countries has been relatively interesting since the oil-crises, and the subsequently altered transport and production conditions as regards cost prices and circumstances. Developing countries should best draw a lesson from the positive as well as the negative aspects of the industrial function of seaports, as it runs to seed in countries like Belgium and the Netherlands.

It remains no doubt advantageous to have industries settled in the port, provided, however, that they are well-located. And this applies not only from a private company view point. For that reason, too, it might be wise to consider port industrialization as an integrated part of the national industrial policy.
Nowadays, governments may prevent the establishment of a certain industry on a certain site, it is true, but they cannot compel that

industry to move to another specific area. They may, of course, try to facilitate such a settlement into the direction of their seaports. The follow-up of such a policy is then fully a matter of concern of the port authority. In the long run a severe selection policy will help the promotion of this kind of industrialization.
At the moment it becomes also very important to know what combination of site aspects deserves most attention, or again, which sites, given a series of location aspects, should be eligible for improvement, or seaport expansion.

The actual tendency towards full integration of all classical links in production and transport chains, whence the importance of a seaport as a 'necessary' transit location diminishes, seems to counter the maritimization trend of certain industries.
Therefore, the future of a successful port industrialization will depend upon the final art of the seaport: the more it incorporates various functions (e.g. a big commercial place, city, finance centre, intellectual metropole, etc.), the more it will conserve its attractiveness in the field of industrial location. (Of course this does not exclude the feasibility of specific industrial ports, which, however, are of a quite different nature).
Or in one simple sentence: investing billions of dollars in a seaport today is perhaps a necessary step towards desired port's growth pole economies, but it is certainly not a sufficient one.

Thank you very much.

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Comment on the lecure of Prof. W. Winkelmans

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Mr. Chairman, ladies and gentlemen,
First of all I would like to thank Prof. Winkelmans for his presentation of the case of the North Sea Island project before this distinguished audience, and especially before the Minister for Economic Affairs. This project, namely, was a 100 per cent. private business initiative, on which some 26 Dutch companies, together with a few other European companies, have been working. The feasibility study of this project was presented to the Dutch government for comments, and it is up to the central government through its various departments to create the basic economic framework for this huge project.

This remark leads me to my question to Prof. Winkelmans:
In a broad outline I agree to his conclusion on the allocation and re-allocation of port-zones, which I certainly can visualize in the case of a port still to be constructed, such as the North Sea Island project. However, it does present bigger problems in existing ports of longstanding.
Could Prof. Winkelmans enlarge a bit on how to solve the re-allocation problems as a consequence of existing overcapacity, which result from changes in cargo flows and changes in handling techniques?

Thank you.

Reaction of Prof. Winkelmans to the comment of Dr. R.W. Mouw

It's quite difficult, of course, to give a very brief answer to this question. But, Mr. Mouw, you put a very fundamental question, it's true. Because, if one criticises the situation of industries in a port, then, of course, you may ask what the alternative is, and what should be done about it.
Let me first say that I don't think the actual situation is dramatic. Not at all. Neither is it in Antwerp, nor in Rotterdam. The only big problem is that both seaports are steadily demanding further expansion, which is also a normal situation in a free market economy.
Secondly, or together with their demand for further expansion, there exist demands for further expansion of smaller ports. And then I think the problem we have today is that we cannot be sure about the multiplier effect as we had in the past.
Let me give you an example, which is very interesting I think.
It is known that during the 1960s, both the local and national governments invested about ten billion Belgian francs in the so-called ten-year plan for Antwerp, which lies at the basis of the then modern port expansion, especially for industrial purposes. The answer of the private economy was twelve to fifteen fold in a couple of years: more than 150 billion Belgian francs were invested by private companies, especially industries, but also cargo handling companies. And that's what I call ,macro-economically speaking, really a success. Of course. But I think that today -and I don't know the exact figures- the same is true for Rotterdam.
However, since the mid-1970s the governments have continued to invest even bigger amounts of capital in seaports, hoping the the multiplier effect, by investments of private companies, would come, and would be the same as in the past. And this is our problem today. It does not come. I know especially well the situation in Belgium. You have several projects which so much money in pumped into. And now that the reaction from the side of the investors must come, one is not sure whether it will.
As to your question about re-allocation, I would like to remark that I don't think it will be necessary to re-allocate what is existing. The critical analysis I've made concerning the ports of Rotterdam and

Antwerp is more meant to apply to the future. If one is going to extend ports further with industrial purposes, then I think it would be wise to take to heart lessons from the past. But that doesn't mean it is necessary to re-allocate what already exists. That's the answer I can give right now to your question.

The Economic Policy of the Dutch Government with respect to the Dutch Seaport Complex.

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Mr. Chairman, ladies and gentlemen,
Naturally, I wish to begin my address by extending cordial congratulations to the Central Organization for Applied Scientific Research in the Netherlands, TNO, which is celebrating its 50th anniversary this year. In these 50 years TNO has come to occupy a place in our society, which it would be hard to imagine unfilled today. I for one have the greatest appreciation for the stimulative activities displayed by TNO in the area of innovative thinking. TNO has rightly placed its applied research increasingly in a wider social and economic context. And it is my fervent hope that the organization will be able to successfully continue its work of national importance.

This brings me to the subject which TNO has selected for today: 'The future function and development of world ports. My contribution will deal with the policies of the Netherlands government to strengthen the country's economic structure. And it goes without saying that in this country seaports play a major role in the economic structure.

Let me start by pointing out that the government's economic structural policies are aimed first and foremost at improving the general conditions for industrial activity, including the operations of firms in seaports. In brief, general economic policy seeks to give firms in this country the financial elbow-room they need for making sizeable investments.
In past years this elbow-room has been much curtailed, and the result has been an alarming drop in business investment. All the same, major investments will be needed if the Dutch economy is to maintain its position in the world in the coming decades. Dutch industry is badly in

need of structural renewal in several respects. Drastic changes in the energy situation and the international division of labour, and a fast-moving technological development are compelling us to make major adjustments in our production and marketing patterns. Such adjustments will have to be found mainly in higher-grade and more specialized activities.

As this country possesses only a relatively small home-market, it has to sell most of its products and services abroad. Yet, both at home and abroad Dutch industry faces increasing competition by countries that have stolen a march on us in innovative efforts. To keep up with these rivals we have to supply high-grade goods and services to justify our relatively high wage and energy costs.
All this calls for a drastic increase in private investment, which is impossible without a fundamental improvement of the financial elbow-room of firms. In its general economic policy to this end the government is giving priority to curbing the huge burden which the collective sector has come to impose on the national economy.

Both government and social-security spending has been rising steeply over a number of years. The resultant increase in taxes and social-insurance contributions has eroded the staying power of businesses. A drastic change of course is overdue, a painful but inevitable operation which the government is now carrying out in the awareness that for the time being a restoration of investment has top priority.

Curbing the increase in public-sector spending is a necessary condition for alleviating the burden on industry. I am thinking not only of the burden of taxes and social-insurance contributions, but also of the high interest rates facing businesses as a result of extremely high public sector borrowing requirements among other causes.
In addition to turning round the trends of public-sector spending, the Government is determined to continue to create conditions for further wage cost restraint, which is another way to boost the staying power of firms.

Yet the Government does not intend to stop short at curbs and restraints. Even though these measures will afford firms a breathing spell, they are not enough to avoid various sorts of obstacles in the way of necessary new business initiatives. Supplementary measures are needed and also a number of specific stimulative policies.

You may know that recommendations have been made on this point by an Advisory Committee on Industrial Policy in a report released last year. Headed by Royal Dutch/Shell board chairman Gerrit Wagner, this Committee of industrialists, union representatives and scientists adopted a unanimous advice on a number of major policy areas in line with specific capacities and expertise and general comparative advantages of this country.
One of these main policy areas are the Dutch seaports and their many-varied related activities, which brings me to the particular subject of my contribution to this Symposium. I wish to note that the Government does not view seaport policy as an isolated matter, but as an integral part of the overall structure policy to be pursued in the years to come.

Needless to say that the seaports already played a major role in the postwar industrialization policy. Thanks to, among other things, the favourable geographic position of this country Rotterdam and Amsterdam have of old been important harbours with major transport and service functions. The industrial function of these ports had been relatively small at the outset, to assume a fully-fledged role only in the 1950s and 1960s.
Many new industries arose as a result of the scaling-up of maritime transport and rapid technological development. The growth of the petrochemical industry in the ports was particularly spectacular and had radiative effects on ancillary industries and knowledge-intensive services.

Postwar industrialization policy strongly stimulated the industrial function of the ports. Major infrastructural works were carried out to make the Dutch seaports accessible to ever bigger ships. Sufficient room for industry was provided in the seaports, and links with the hinterland were improved for all they were worth. New seaports were

built in the south and extreme north of the country --the Sloe and Eems harbours-- to secure a better spread of industrial employment.
The industrialization policy pursued after World War II was so successful that people began to ask in the mid-1960s whether further industrial growth was a good thing. They pointed to undesirable consequences for the environment and town and country planning.

The discussion touched also --and especially-- on industrial activity in the ports, and raised the question of what economic structure was desirable for them. As a matter of fact this structure had developed rather one-sidely into the direction of the oil refining, petrochemical and engineering industries. In 1966 a governmental Policy Statement on Seaports confirmed the view that further expansion of activity in and around seaports was important. All the same there was a growing insight that town and country planning problems and environmental aspects imposed limits on the economic development of this densely populated country. Besides, the 1973 oil shock brought a new awareness of the need to make a sparing use of energy and raw materials. The Government, in its economic structural policy, takes these limits duly into account. And as said, the seaports play a major role in this policy.

I will now enter into some aspects which, I think, are of special importance in this policy area, and which deserve special attention and stimulation under government policies. I am referring notably to activities and facilities in the areas of container handling equipment, vessel traffic management systems, pipeline transport, specialized services and consultancy.

To start with container handling equipment. Developments in this field, especially in the port of Rotterdam, have a major impact on its storage function and have left clear marks on its traditional stevedoring role. It looks as if this will have a drastic and lasting effect on transport technology.
The shift in handling techniques from man-load to unit-load has been fast. The period that saw transport technologies like 'sea-bee' and 'lash' emergy, is already behind us, and roll-on/roll-off transport is still on the upgrade. Today the chief development in transportation

technology is in the use of containers. We cannot afford lagging behind in this field, even though it requires huge investment, and payout times are long. It is a project that will continue to affect the Dutch economy far into the future. Hence the Government is doing all it can to assist the industru in this respect.
And I am happy to find that the joint effort of government and industry has already yielded know-how in the area of container handling equipment which has no match anywhere else in the world.

Now for vessel traffic management. The starting-point is that activities on water and land, in ports and rivers must progress smoothly and safely. Let me take shipping to and from Rotterdam as an example.
Under the watchful eye of shore-based radar systems this shipping traffic has been fully satisfactory for many years, but now the time has come for a change. A new, highly sophisticated vessel traffic management system is being installed in close co-operation with industry and research centres. Work began in 1978 with the drawing up of requirements which the new system had to satisfy, and the operational stage commenced recently. The new system is scheduled to be in operation in the Rotterdam river delta in 1985.
I mentioned this drastic renovation with a view to the requirements which a changing and densely populated seaport must fulfil, which are:
- the seaport must remain competitive;
- the living environment must be protected;
- the available room must be used optimally and efficiently.

As pipeline transport is also referred to in the Wagner report, I would like to make a few remarks about this subject as well.
The most spectacular job accomplished in this field in the Netherlands after the 1973 oil-crisis, is the construction of a pipeline corridor connecting Rotterdam with the Belgian border. This important extension of Rotterdam's infra-structural equipment is State-owned and operated by a foundation.
Because of the change in world oil supply and the present recession in world trade, this transport facility now shows a degree of capacity utilization which is much lower than was imagined at the time of its construction. However that may be, I am of the opinion that a revival

of general economic activity will in all probability bring about a more important role for this transport facility within the framework of Dutch seaport activities.

I now have a few remarks to make about the specialized services in the context of port activities. As basic research is indispensable in this field, the Ministry of Economic Affairs recently commissioned research on the emporium function, to find out which services out of an overall cluster qualify for government stimulation.
The study covers a wide field since an emporium function involves many aspects of specialized services. It is not only entreport trade, storage, feeder and onward transport, but also transit trade, arbitrage, distribution, transport, financing, insurance and information. For the Netherlands, which has played an emporium role of old, the processing, distribution and grading of products have been connected with the storage of commodities for centuries.

A search is in progress for ways to develop public warehouses. After the American example, the function of public warehouses is seen as one of storage in the first place. It will be clear in the light of the foregoing that the demands of modern commerce have filled out this function. The government intends to provide incentives wherever they are needed.

Whereas in former days defective communication and transport techniques resulted in irregular onward transport and deliveries, so that buffer stocks were vital, the situation today is completely different. The number and quality of traffic links and communication facilities have been brought to a point of near-perfection. This has made the emporium function of seaports less obvious. Besides, the far higher costs of storage and handling today are hardly helpful.
Fast means of transport and improved communication, moreover, make it no longer necessary to tie the emporium function to a physical location. All this has turned the emporium function into a matter of dynamics and change. This imposes more stringent demands on the parties involved and, government policies should take this into account.
In this connection promotion of the so-called mainport function is a

major starting-point of government policies. The mainport function bears a number of clear traits of the emporium function: feedering from Rotterdam is already taking place all along the Atlantic coast. But the mainport function can be promoted only if thorough attention is given also to the shippers' cost aspect.

In considering the shippers' cost aspect, the advantages of building container, ore and coal terminals in Rotterdam's westernmost port of Maasvlakte, as close as possible to the sea, are coming more and more to the fore. Both container and coal trade appear to be on the threshold of a period of explosive growth.
Prognostications are that Dutch container handling may rise from a current 1.25 million units a year to a possible 3 million by the turn of the century.
There is even less doubt about the growth possibilities for coal. World coal transport, which stood at some 160 million tonnes in 1979, is anticipated to double in the course of the 1990s. Rotterdam's share in this trade is even expected to increase five-fold to some 25 million tonnes a year by 2000. All this requires a huge investment, including further dredging to make the port of Rotterdam accessible to carriers of up to 350,000 dwt.
Scaling-up on the seaside will not fail to bring structural changes in hinterland transport. Four-barge pushtow shipping is already common. But as world bulk trade increases, and the effects of the trend to process raw materials at the place of production make themselves felt, the time will come when a further scaling-up of inland transport can no longer be postponed. The government has been discussing the introduction of six-barge pushtow shipping for some time now.

Consultancy is another main area of port activities as pin-pointed in the Wagner Committee's report.
This sort or service is anticipated to assume an ever more important role in ports in the throes of change and adjustment. This has been clear in the Rotterdam region, with the port functioning as a dynamic nucleus where many technologies and their uses interact. It is fair to regard this centre as a shop-window for the many supporting and knowledge-building agencies and organizations, and an ideal base and jumping-off

board for know-how exports.
Tenders for the supply of complete ports as turnkey project to distant countries are a normal procedure for Dutch engineering consultants. They have a firm base in expertise resulting from a long-established infrastructure and top-level training.
The government is well aware of the risks involved in offering turnkey projects in the field of building, industrial and infra-structural construction in countries outside the European Common Market, often at staggering costs. This may also apply in the case of technological consultancy to these countries. The Ministry of Economic Affairs has set up guarantee schemes for these purposes.

I do not doubt that the radiative effects of the activities in the Dutch seaports will continue to be great, and I think that new activities will have a knock-on effect. In conclusion I would like to make the following general observation:

Maybe economics is just common sense made difficult, a wisecrack that comes irresistibly to my mind at the end of this speech.
And then government policy, aimed at developing the Dutch seaports, may be just following the old commercial maxim, that a good merchant looks after the quality of his speciality, hires expert staff and adjusts in time to what his customers want.
Well, that's just about what I have wanted to convey to you.

I thank you for your kind attention.

Transport Flows in the Year 2000 - a Prediction

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Mr. Chairman, ladies and gentlemen,
Before discussing the trends in the predictions of transport flows, which the NVI has made for the year 2000, I think it is worthwhile first to dwell on the meaning of the word 'prediction'. The making of predictions, namely, is a very tricky business, especially over a planning horizon of nearly 20 years,.
The definition of the word 'Prediction' given by 'The Penguin All English Dictionary' is: 'That, which is asserted or affirmed!'.

However, when making long term predictions I do not have the feeling that my prediction should indeed be 'asserted or affirmed'. On the contrary, the more I progress in the process of making a prediction, the more convinced I become that the predicted outcome will be only one among many other possible outcomes. A lot of assumptions regarding the development in the determining variables have to be made; assumptions which may prove to be different from actual developments. In this respect one may ask what the benefit from the effort of making predictions may be.

In answering this question we have to keep in mind that all our activities are focused on the change in the actual situation in order to improve it. This means that we must have a notion both of the actual situation and of the future one. In this respect predictions are a kind of a classification of possible future situations.
The process of predicting is therefore like walking in a town on a very misty evening: when going through this town, one can only observe some of its roads and buildings; nevertheless, on the basis of these limited observations one tries to build a logically acceptable idea of the town.

Analogically, a prediction provides us with only some of all the possible future situations, on the basis of which a further exploration and identification of other possible situations could be carried out. The identification of a future situation and accompanying appreciation of that possible situation affects our way of thinking and acting. The result of this knowledge is itself working as a causafinalis. As such the prediction forms a reference for our actions. And I would like to stress this point, as it has to be kept in mind when appreciating the predictions, which I shall present in this lecture.

Today the prediction of transport flows over a long-term planning horizon is very tricky. This may be ascribed to today's economic and environmental situation. Several factors which play a role in this respect are:

- The economic situation
  Little certainty exists about the possibilities of economic growth.

- The energy crisis
  Due to the energy crisis research for energy saving techniques has been intensified. The outcome of this research is already noticeable, although its exact extent in the production techniques cannot be observed yet.
  An uncertain factor, however, is the development of oil prices. They do not seem to reflect the supposed long-term scarcity.

- The change in international trade relations
  A change in the attitude can be observed. A switch from free international trade towards bilateral trade occurs in which the price mechanism is no longer the determining factor. In this respect I would like to mention the proposal France has made to pay 25 per cent. over the market price for Algerian gas on the condition that the same amount be spent by Algeria in purchasing French products. This change in attitude will certainly affect the pattern of trade flows and therefore that of the commodity flows.

- <u>The increased protectionism</u>
  The increased protectionism which can be observed both in trade and transport policy.

Fortunately, today we are better informed about the possibilities of energy saving technologies. The conviction exists that due to energy saving technologies the industrialized world is better able to cope with increased energy costs. In this connection I quote from: 'The Industrial Structure of Japan in the 1980s, Future Outlook and Tasks, MITI, Japan', which expresses these expectations:

'In the transportation sector, utilization of railway transportation
'will decline, while that of automotive, air and seaborne
'transportation is expected to grow, suggesting that the unit costs for
'energy in the transportation sector as a whole is likely to increase.
'However, vigorous implementation of the proposed energy saving mea-
'sures will help the nation hold down the share of energy demand of the
'transportation sector to the current level of 15% to 16% of the
'national's total energy demand'.

This and the inquiries made into energy consumption on the transportation sector by, among others, the NVI (along with others) gives support to the assumption that optimization of logistical systems occurs in conjunction with the reduction of stocks within the system, thus favouring the use of fast transportation techniques.

Against the background of these considerations, recently a prediction has been made of commodity flows within the EEC member states, for the year 2000. This forecast emphasizes only international trade over land and sea.
The methodological basis of this forecast model was the relation between Gross Domestic Product (GDP) and the trade flows, and thus the transport flows. The prediction of transport flows other than by extrapolation of the existing flows is not possible due to the lack of consistent statistical data. Let me give you an example:
Trade flows from the U.S.A. to the German Federal Republic find their

actualization in the transport flows. These transport flows can appear as (a) a domestic transport flow, if the final delivery takes place within the country of the port through which it passes, and (b) as international transport if the final destination is another state.

Consequently, a relation has to be established between the trade flows and transport flows. This relation is based on the premise that international transport flows are the direct results of trade flows. In that case it means that, if it is possible to produce forecasts of trade flows based upon indicators of economic activity, it follows that it is also possible to produce forecasts of the transport flows.

Since in a trade relation the conveyance of a commodity can be made by the successive use of the sea and inland transport modes, or by direct continental transport between the origin and destination countries of the trade flows, the relation between trade and transport flows can be described by the different stages of transportation between the places of production and consumption.
The methodology of forecasting international transport means the forecast of trade flows by means of the determination of the growth factors for the trade relations within the study area.
In this case the trade flows between two countries is related to the GNP per commodity as well as the distance between them, whereas trade facilities due to the membership of an economic community or association are taken into account as well.

The trade relation between two regions $T_{(i,j)}$ per commodity group can then be described as:

$$T_{(i,j)} = \alpha \log Yi + \beta \log Yj + \log D_{(i,j)} +$$

$$a\ BENI + b\ EEG_{(ij)} + c\ FA_{(ij)} + d\ DUMNLI + constant.$$

After the determination of the trade flows per commodity, flows are transformed into transport flows. Thereupon these transport flows can be split over the inland modes (Table 1).

Table 1. Modal split; Year 2000, Transport International (Units: tons)

Commodity group	rail	share	road	share	inland navigation	share	total
1. Agricult	4,160,393	9	9,887,201	20	34,605,139	71	48,652,725
2. Foods	5,829,492	13	35,802,022	81	2,481,753	6	44,113,261
3. Fertiliz	3,109,050	25	2,870,136	23	6,402,780	52	12,381,991
4. Minerals	4,658,944	4	41,733,450	32	83,179,369	64	129,571,776
5. Ore-Nonf	6,479,612	19	1,767,468	5	26,419,320	76	34,666,402
6. Chemical	7,656,797	9	49,779,188	57	30,375,055	34	87,811,020
7. Metals	13,334,517	33	13,680,051	34	13,180,941	33	40,195,551
8. Otheragr	974,845	7	11,294,288	86	933,816	7	13,202,909
9. Solidful	3,780,173	26	676,963	5	9,844,894	69	14,302,029
10. Crudeoil	904,382	62	3,506	0	551,300	38	1,459,187
11. Oilprodu	3,418,753	3	7,918,355	8	89,023,173	89	100,360,311
12. Cem Lime	1,253,989	18	3,370,911	49	2,305,490	33	6,930,382
13. Buildmat	328,452	3	12,991,577	95	304,495	2	13,624,522
14. Finished	20,076,362	25	54,607,627	70	3,634,453	5	78,318,455
TOTAL	75,965,761		246,382,743		303,241,978		625,590,521
		12.14%		39.38%		48.47%	

With the help of this model forecasts are made for the year 2000 with respect to the transport flows to, from, and between the countries and harbours mentioned in table 2.

Table 2. Zoning system international transports

1. Antwerp	
2. Le Havre	
3. Marseille	
4. Rotterdam	
5. Amsterdam	
6. Hamburg	
7. Bremen	
8. Belgium	
9. Denmark	
10. France	
11. U.K.	
12. Ireland	<u>Rest of the country</u>
13. Italy	
14. Luxembourg	
15. Netherlands	
16. F.R. Germany	
17. Spain	

Forecasts are made on the basis of:
(1) a 1 per cent. growth in GNP,
(2) a 3 per cent. growth in GNP, and
(3) a 1 per cent. growth in GNP, combined with an 3 per cent. increase per annum in the energy costs.

With the aid of this model a prediction for the international transport flows per commodity group excluding those for solid fuels (9), crude oil (10), and oil products (11) can be made. The results presented in table 3 do demonstrate a decrease in the share of the rail, whereas road transport is supposed to increase by 3.4 per cent.

Table 3. International transport flows solid fuel, crude oil and oil products not included

Modal share per inland mode

	1978	2000	
inland navigation	47.2%	48.5%	+ 1.3%
road	36.0%	39.4%	+ 3.4%
rail	16.8%	12.1%	- 4.7%

The predictions were made on the assumptions that:

- The competition between the West-European harbours remains unchanged, and
- the growth in the added value is 1 per cent.

For the commodity groups 9, 10 and 11 special scenarios were developed, which are the basis for the projection for the year 2000. The growth per commodity group is given in table 4.

Table 4. International transport flows, solid fuel, crude oil and oil products not included

	1978	2000
1. Agricult	100	170
2. Foods	100	167
3. Fertiliz	100	121
4. Minerals	100	154
5. Ore-nonf	100	68
6. Chemical	100	253
7. Metals	100	95
8. Other agr	100	150
12. Cem Lime	100	108
13. Buildmat	100	183
14. Finished	100	195

The growth rate in the freight flows differs per commodity group. An extremely high growth rate for chemicals is foreseen, whereas a large reduction in the freight flows for ore and non ferro is expected as a result of the reduced European activity in this sector.
In conformity with this a lower freight flow of metal products is forecasted. Furthermore, a slower growth in the building activity is expected, and thus only a slight increase in the international transport flows of current and lime is predicted.
In the modal split a further switch from rail to road and inland navigation will occur under the given premises. The logical explanation can be found in the expected increases in those commodity groups where a preference for road and inland navigation exists.

Because of the difficulty in comparing international transport flows, it may be better to illustrate this prediction by showing the predicted transport flow for the Rijnmond Harbours with the prediction made in the report 'Between Full Speed and Stop' (Dutch title: 'Hollen en Stilstaan'), by the Port of Rotterdam, i.e. 'Havenbedrijf der Gemeente Rotterdam', (variant C.1).

	NVI-prediction, excl. commodity groups 9, 10 + 11	Port of Rotterdam excl. crude oil + oilproducts (p. 50)
inland navigation	59.5 mln	71.0 mln
road	8.0 mln	8.1 mln
rail	2.5 mln	5.9 mln

A closer observation of these figures shows that there exists a valid explanation for the differences. These are namely due to a difference in assumptions.
In the NVI prediction the assumption regarding the competition between the West European ports differ from that, made by the port authorities. Here a strong mainport effect in favour of Rotterdam for minerals is expected. The NVI predicted for minerals a total of 28.15 million tons,

whereas the Port of Rotterdam prediction mentions a flow of 41.6 million tons. If this flow is corrected according to the NVI assumptions, the results are:

	NVI-prediction, excl. commodity groups 9, 10 + 11	Port of Rotterdam excl. crude oil and oil products
inland navigation	59.5 mln	71 - (41.6 - 28.15) = 57.55
road	8.0 mln	8.4 - (0.2 - 0.36) = 8.56
rail	2.5 mln	6.1 - (3.7 - 0.6) = 3.1

If one takes into consideration that the two predictions were made independently, and that for the predictions use was made of different basic data, one must say the results are in remarkably close harmony.

There exists a larger difference regarding the freight flow from the hinterland to Rotterdam. This difference is mainly due to differences in the predicted level of the freight flow for chemical products.

Comparison	NVI	Between full speed and stop
inland navigation	13.9	10.6
road	7.6	6.3
rail	2.0	2.3

It may be worthwile to consider the importance of the assumptions made. To illustrate this importance, another, high growth prediction which the NVI once had to make is compared with the high growth variant A.1 of the Rotterdam port authorities.

The assumptions made by the Rotterdam port authorities are:

(a) a reduction of the export shares for West Germany from 35 per cent. to 15 per cent.;

(b) no increase in oil consumption is projected, while a 3 per cent growth per year in added value is assumed;
(c) a slower growth in the refinery capacity.

On this basis a predicted transport flow of oil products by inland navigation of 17.9 million tons is calculated (cf. p. 42).

The NVI high growth scenario had to start from the following assumptions:
(a) a constant export share of 35 per cent.;
(b) an increased oil consumption of 66 per cent. due to a 3 per cent. annual growth in added value;
(c) a higher growth in refinery capacity, which is twice that assumed by the Rotterdam Port authorities.

Beginning with the 2000 figure of 18 for oil products, we can translate it by adapting the assumptions made by the port authorities to those the NVI had to start from. The results then are:

a. export share increase: $\frac{35}{15} \times 18 = 42$ million tons

b. increase in energy consumption due to the 3 per cent. growth
$\frac{166}{100} \times 42 = 69.72$ million tons

c. increased refinery capacity: 2 x 69.72 = 139.44 million tons.

The NVI prediction, which was based on a higher estimated 1979-figure amounted to 132 million tons.

What conclusions can we draw from this?
First of all it shows the importance of the assumptions made, regarding the development of the exogenous variables on the predicted values. Secondly, it shows that it is worthwhile to make predictions and compare these with the ones made by others. They thus form a frame of reference by which the logical acceptance of the assumptions is made visible. By doing so, we may obtain a better understanding of the future developments.

Table 5. Export; Year 2000, Port of Rotterdam (Units: tons)

Commodity group	rail	share	road	share	inland navigation	share	total
1. Agricult	97,365	0.6	360,691	2.2	16,277,452	97.3	16,735,508
2. Foods	54,154	2.3	1,736,693	75.1	521,355	22.5	2,312,202
3. Fertiliz	41,591	2.0	55,437	2.7	1,982,482	95.3	2,079,510
4. Minerals	224,056	5.5	191,786	4.7	3,681,784	90.0	4,097,626
5. Ore-Nonf	444,521	1.8	169,460	0.7	24,462,779	97.6	25,076,760
6. Chemical	480,866	4.0	2,873,753	24.1	8,567,725	71.9	11,922,344
7. Metals	67,633	2.3	503,811	17.3	2,336,036	80.3	2,907,480
8. Otheragr	36,279	4.1	400,378	45.0	453,836	51.0	890,493
9. Solidful	-	-	-	-	-	-	-
10. Crudeoil	-	-	-	-	-	-	-
11. Oilprodu	-	-	-	-	-	-	-
12. Cem Lime	0	0	35,264	85.2	6,114	14.8	41,378
13. Buildmat	369	0.3	86,286	62.8	50,733	36.9	137,388
14. Finished	1,012,099	27.9	1,569,240	44.0	1,021,030	28.1	3,602,369
TOTAL	2,458,933		7,982,799		59,361,326		69,803,058
		3.52%		11.44%		85.04%	

Table 6. Import; Year 2000 - 1%, Port of Rotterdam (Units: tons)

Commodity group	rail	share	road	share	inland navigation	share	total
1. Agricult	3,308	51.0	395,363	4.2	1,290,797		1,689,468
2. Foods	68,599	2.3	1,042,921	1.5	492,775		1,604,295
3. Fertiliz	2,575	11.7	4,778	63.0	293,943		301,296
4. Minerals	9,921	32.0	213,445	14.7	2,955,552		3,178,910
5. Ore-Nonf	764	5.3	15,248	2.6	25,058		41,070
6. Chemical	269,858	3.1	2,758,540	3.0	5,488,294		8,516,692
7. Metals	66,553	3.2	410,765	5.2	1,663,376		2,140,694
8. Otheragr	18,131	1.0	145,076	1.3	27,272		190,479
9. Solidful	-	-	-	-	-		-
10. Crudeoil	-	-	-	-	-		-
11. Oilprodu	-	-	-	-	-		-
12. Cem Lime	25,871	1.7	10,277	43.8	414,384		450,532
13. Buildmat	12,902	1.9	126,891	1.9	107,972		247,765
14. Finished	1,510,122	0.3	2,453,924	2.0	1,159,666		5,123,712
TOTAL	1,988,604		7,577,228		13,919,089		2,348,921
		8.47%		32.26%		59.27%	

Oil, Coal and Chemicals: Change and Chance for Rotterdam

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INTRODUCTION

Rotterdam and oil

In terms of volume traded, Rotterdam is the largest harbour in the world. Its favourable geographical position and the availability of cheap and abundant energy in the past, have led to the creation in the Rijnmond area of one of the largest oil handling and processing industrial centres in the world.

More than half of the imported and exported goods in Rotterdam are crude oil and refined products. Approximately 65 per cent. of all the refined products is exported. When one takes into account the fact that somewhere in the order of one fifth of domestic production (9.5 out of 52.8 million tonnes in 1980) is feedstock to the chemical industry, and that the chemical industry itself exports some 60 per cent. of its total production, the direct and indirect exports of refined products are substatially higher.

From our own refinery in Pernis, about half the oil production goes abroad. In addition, three-quarters of our petrochemical production from the Pernis and Moerdijk plants are exported. How contrastive these figures are with those of a few years ago: between 1979 and 1981 total sales from our Pernis refinery fell from 18.4 to 16.4 million tonnes with exports remaining roughly at the same level (8.8 and 8.6 million tonnes respectively). In 1979, 1.9 out of 2.8 million tonnes of our chemical sales went abroad, which had dropped to 1.4 out of 2.3 million tonnes by 1981. So it is obvious that significant changes are taking place.

Energy and Rotterdam in the future

The future of the port of Rotterdam will be strongly influenced by developments in the energy sector. These in turn depend on what happens abroad. This is the main issue I will discuss today: the importance of oil, chemicals and coal for the future of the Rijnmond area.

CRUDE OIL AND REFINED PRODUCTS

Dutch refineries in the past

Historically, the Dutch oil industry supplied some 10 per cent. of overall West European oil demand. In the 1960s and early 1970s, spectacular economic growth was accompanied by a booming demand for oil and oil-related products. Correspondingly, throughput of the Dutch refineries grew rapidly.

Between 1966 and 1973, the supply of crude oil to the Rijnmond ports tripled (from 43 to 142 million tonnes). About half this supply was destined for Dutch refineries; the rest was either reloaded onto smaller ships for redistribution in North Western Europe, or transported by pipeline to West Germany, Belgium and Luxembourg. The peak processing level was reached in 1974, when crude throughput in Dutch refineries equalled 73 million tonnes, and installed primary refining capacity amounted to 100 million tonnes. The top year for reloading onto smaller ships was 1973, with 27 million tonnes being transferred. Pipeline transportation to West Germany peaked in 1972 with 19 million tonnes throughput.

The effect of the oil crisis

It is plain that since 1974 the tide has turned.

'Security of supply' has been replaced by (extreme) uncertainty and the fragmentation of sources of oil. The successive price increases have adversely affected demand for oil and oil-related products in the European economies. Crude throughput through Rotterdam has fallen to under 100 million tonnes, a 30 per cent. reduction as compared to 1974. In 1980, approximately half (54 per cent.) of (OECD) Europe's energy demand was covered by oil. In the past, Dutch refineries had the 'balancing function' between supply and demand for Western Europe, which in a time of rapidly growing demand led to high throughput levels. This favourable position has been threatened by the overall drop in demand. As a consequence, in 1981 many Dutch refineries experienced lower levels of throughput. Their European counterparts --generally geared only to home market demand-- maintained capacity utilization at more acceptable levels.

European demand expectations

The trend towards diversification of energy sources and increased energy efficiency which followed the past two oil crises, may be expected to continue in the future. At the same time, the exceptionally high exonomic growth performance of the last few decades is unlikely to be repeated in the coming years. Our expectation therefore is that the share of oil in the energy requirement of Western Europe will drop from some 50 per cent. now to about 30 per cent. by the year 2000. Assuming a modest economic growth, and a continuously increasing energy efficiency and substitution by other fuels, the actual demand for oil by the 2000 is expected to be only 60 to 70 per cent. of its 1980 level. It goes without saying that such a drop has implications for the entire oil refining industry.

Capacity rationalization

Capacity reductions have been taking place since 1978. By 1st January of this year, primary distilling capacity in the Netherlands stood at 85 million tonnes.

In 1980 installed capacity in Western Europe amounted to 1000 million tonnes per annum. Considering that the major part of this capacity was installed after 1960 --with some 30 per cent. constructed after 1970!-- reductions will not be easy. The decline in oil demand we have experienced since 1974, leads to the expectation that by the year 1990 the annual, combined call on Dutch refineries (domestic demand and exports) will amount to perhaps 50 million tonnes at the utmost. Installed primary distilling capacity in the Netherlands is then expected to stand at around 65 or 70 million tonnes.

Source refinery

However, the decline in oil demand is not the only factor necessitating a reduction in capacity. In the latter half of the 1980s this need will be strengthened by 'source-refined' products entering Europe . At the end of this decade, for instance, Saudi Arabia will have two million barrels per day of refining capacity available, of which 400 to 500,000 barrels per day will be available for exports. Also the possibility of package deals with both Europe and Japan, where crude contracts would be coupled to product imports, further reduces the need for crude processing in Europe.

Future capacity in the Rijnmond area

But it would be mistaken to paint too pessimistic a picture for the future of the Dutch oil refineries. The need for capacity rationalization and 'source-refining' will affect European refineries as a whole, it is true, but it need not have the same impact on Dutch refineries. Rationalization argues for the concentration of refining activities in larger, modernized, coastal refineries.

A second reason for optimism lies in the expectation of a further 'whitening of the barrel', which is to say that the demand for lighter products is expected to increase relative to heavier products. A drastic drop, in particular for fuel oil, is expected to originate from a drop in demand from the side of the power sector and industry.

For this reason, and for financial reasons, refineries must upgrade to complex refining. Our industry in the Netherlands is well able to take advantage of such developments. The excellent infrastucture in the Rijnmond area, the high business expertise, and the favourable geographical position will continue to give Rotterdam the same competitive edge as it had in the past. An indication of this may be the average 5 per cent. lower drop in crude movements the Netherlands registered in the first half of 1981, compared to Belgium, West Germany and France. Proper support from national and in particular local authorities will be a pre-requisite to maintain that competitiveness.

I shall come back to this later.

Dutch demand expectations

So grounds for optimism do exist. Nevertheless, we must expect that competition will be tough for the oil industry, and will sharpen between harbours. We cannot expect diminished export opportunities to be offset by a boost in domestic demand. Even if we assume an economic growth of some 3 per cent. thoughout the 1990s, demand in the

Netherlands by the year 2000 will be unlikely to exceed current levels by much more than 10 per cent.

Oil and the future of Rotterdam

The above described changes in the supply and demand of oil and oil products will have a significant impact on the port of Rotterdam. The future import of crude oil and export of refined products will be at substantially lower levels than those realized throughout the 1970s. Product imports, however, are likely to increase, as source refineries will come on stream in the latter half of the eighties. This implies that facilities for the reception and storage of imported products may have to be increased, possibly combined with a reduction in crude tankage.

Tanker traffic

It will be obvious that the developments I have portrayed so far, will have significant consequences for tanker traffic. As far as tanker size is concerned, there is little propect for fully laden tankers in excess of 250,000 tonnes. Ultra large crude carriers (ULCC) are usually on a two-port discharge schedule. In the past, the level of crude arrivals in Rotterdam has roughly been double the crude processing level in the Netherlands. Given this relationship, it can be expected that the future will see a reduction in crude tanker traffic, although some increase in product traffic is probable.

CHEMICALS

Ladies and gentlemen, I have so far devoted my time to developments in the oil sector. These last ten years, however, the chemical industry has gained in importance. In 1969, 6 million tonnes entered and 7 million tonnes left the Rijnmond area, which by 1979 had become 11 and 12 million tonnes repectively. Dutch industry is concentrated on bulk-chemicals, with a sizeable share of petrochemicals. This concentration on bulk-chemicals was the natural result of the easy and low-cost supply of feedstocks via ship, pipeline or lighter. The high share of petrochemicals was due to the availability of abundant and cheap feedstocks from the oil refineries in the area. As a consequence, large petrochemical plants are found in the Rijnmond area.

Chemicals today

The Dutch chemical industry is very much export-oriented, and like the oil business, it must adapt to a future of less dynamic growth. In particular in the bulk-chemical sector, there exists excess capacity on an international scale. Between 1974 and 1980 the 'name-plate capacity' (i.e. installed capacity) for the production of the feedstock ethylene in the Netherlands went up by some 40 per cent. (from 2 to 2.8 million tonnes). However, over the same period, capacity utilization fell from 88 to 68 per cent. (90 per cent. is considered a technical maximum). Since then, our own Pernis cracker has been closed down, and a few weeks ago newspapers reported that the Gulf cracker will likewise close down.

European demand expectations

The future of the chemical industry in Europe depends on the resilience of demand, and thus on the extent to which economic activity will recover, as well as on the extent to which capacity rationalization will take place. A reasonable assumption is that in Western Europe growth in chemicals will be some 2 per cent. above expected growth for average production. However, at this point it must be remembered that it is no longer industrial production, but the service sector which has the greatest influence on GNP growth. The chemical industry in the Rijnmond area is perhaps more vulnerable than its European counterpart, since it is concentrated on petrochemicals, and is relatively little active in terms of fine chemicals and speciality products.

Source chemicals

It is estimated that less than 15 per cent. of bulk-chemicals produced in the Netherlands are further processed to final products in this country. By 1985 new chemical plants will be coming on stream in the oil-producing countries. In Saudi Arabia, Libya, Iraq and Bahrein alone 19 petrochemical plants are presently under construction. It is to be expected that their products will find their way to European markets for further processing, in part displacing European production of bulk-chemicals. Inside Europe, cheap and plentiful ethane will give the oil-producers Great Britain and Norway the competitive edge in the production of ethylene.

Prospects for Dutch petrochemical plants

In view of these developments, it may well be assumed that Dutch petrochemical plants will have more problems in maintaining their share in the European market. The implications for the Rijmond area are clear. At this point one may speculate on a possible restructuring of the chemical industry in the longer term. The kind of upgrading we are seeing in oil refining, may similarly apply to the chemical industries, with oil-producing countries replacing simpler processing in Europe, and the European chemical industry upgrading production by specializing in high and exclusive technology, on fine chemicals and specialities. Capacity rationalization will have to be the first step in this direction. One thing is obvious: the chemical industry will in one way or another be part of Rotterdam, and developments in the chemical sector will affect its future.

COAL

Coal in the past

The last topic I am going to discuss is the significance of coal for the future of the Rijnmond. In 1966 the import of coal into Rijnmond harbours amounted to some 1.5 million tonnes. By 1974 this figure had dropped to less than 0.1 million tonnes. During this period Dutch power plants switched almost completely from coalfiring to gasfiring, whereas domestic heating was switched onto natural gas.

Coal today

By 1979, what had once been perceived as an irreversible trend away from coal, had completely changed. Imports grew as some power stations began to use coal again. Coal coming from the U.S.A., South Africa, Australia, and Poland is transferred into barges not only for the Netherlands, but also for its hinterland: West Germany, France, Switzerland, and Belgium. Coal from West Germany is loaded into sea-going vessels for transport to Italy, France, and the U.K. In 1981 alone, coal throughput grew with 23.5 per cent. to 14 million tonnes.

In the Netherlands, coal currently provides some 6 per cent. of primary energy use, which is expected to grow to around 20 to 25 per cent. by the year 2000. In physical terms, this represents a coal use of four to six times its present level. The precise amount used will be influenced by many factors: the outcome of the nuclear debate; the extent to which industry can switch from oil and gas to coal; the extent to which new technologies are developed and applied; and so on.

New technologies

Shell is in the midst of this with the near completion of a 50 tonnes steam per hour fluidized bed combustion installation at Europoort. At the same time, a coal gasification plant at Moerdijk is under study, while Shell also participates in the Maasvlakte coal terminal.

Infrastructure

Not only in the Netherlands, but also in the rest of Europe, the extent of coal penetration will depend, among other things, on whether we shall be able to develop the necessary infrastructure. In the future the Rijnmond area will play a significant role in the landing and distribution of coal. Shell's investment plans help this, but the realization of such growth must also rely on the Rotterdam port authrorities and the Dutch government.

European demand expectations

For the year 2000, WOCOL (the World Coal Study published in 1980) envisages at least 27 million tonnes seaborne imports for domestic consumption; transit to West Germany and France by barge and train will amount to some 10 million tonnes; seaborne transit to Scandanavia and the U.K. could grow to some 3 million tonnes; finally, coal passing Dutch ports from West Germany to overseas destinations could amount to 5 million tonnes by the year 2000.

Maasvlakte coal terminal

The Maasvlakte coal terminal will have an eventual throughput capacity of 25 million tonnes annually. It is the location on the mouth of the river Rhine, which will allow for an international coal distribution function of Rijnmond ports. Only a limited number of large import terminals can be supported by the European market, and Rotterdam combines a favourable geographical position, modern equipment, ample depth of water, and an extensive network of water and railways inland, to be able to take on a leading role in the distribution of coal to Europe.

Constraints

Whether the opportunities I have decribed will be fully exploited, depends on a number of issues.
I have mentioned the need for heavy investments not only in plants, but also in infrastructure. In a small country like the Netherlands --very much dependent on exports-- investments must be considered carefully. Even more so under adverse economic conditions such as we are experiencing right now, and will be likely to experience in the foreseable future.
There is every reason for national government and local authorities not to charge industry with any costs which are not absolutely necessary. Environmental affairs receive a great deal more attention today than they did 10 to 15 years ago, and rightly so. But this should not prevent us from examining whether environmental demands are truly justified. Neither should it stop us from paying particular attention to the pertinent extra cost industry will have to incur. The balance between different interests must, particularly in these difficult times, be carefully weighed. The Rijnmond area is of great importance to the competiveness of our industry on international markets. It should not be forgotten that 50 per cent. of our GNP is derived from exports, which in turn depend on a healthy industry. The Rijnmond area plays a key role in helping generate this income, and in the process it employs large numbers of people. I need not elaborate on problems in the industrial and employment sphere. Suffice to say that we can no longer afford to take such aspects lightly.

CONCLUSION

In conclusion it may be said that changes and opportunities await Rotterdam in the field of energy.

The import of crude oil and export of refined products will in future be at substantially lower levels than in the past. Product imports are likely to increase, and this carries implications for port storage and tankage facilities. A significant increase in crude oil tanker capacity is not foreseen.

On the chemical side, stabilization of production is expected to occur at present levels. A loss of market share in bulk-chemicals to oil-producing countries is not unlikely. New opportunities will centre around specialities and fine chemicals. The presence of large oil refineries in the Rijnmond area, guarantees a future for the chemical industry there.

Coal will be the major growth sector for Rijnmond. A unique opportunity to become one of the main receivers, storers and distributors for Europe, will follow sufficient investment by private industry and the public sector.

The future of Rotterdam and Rijnmond will be determined by the extent to which the above opportunities are exploited and by the extent to which industry and government co-operate to keep Rotterdam a modern, efficient and competitive harbour.

Thank you very much.

The View of Rotterdam on the Development of its Seaport Complex, and the Transportation Facilities with the Hinterland

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It is a particular pleasure to me to add my share to the central subject of this conference, which -as you will find out- is one of the topics of this city. Besides, it gives me a chance to express the great appreciation which the Port of Rotterdam feels for the celebrating Organization for Applied Scientific Research TNO.

Your institutes are within easy reach of this city, and we know where to find them whenever we need them. You on your side are taking great interest in Rotterdam affairs, as is shown by the choice of the subject of this conference: 'Functions and development of world seaport complexes in the future'. We are one of those world seaport complexes, and we are proud of it.

Ladies and gentlemen, I find that TNO's request for a Rotterdam variation on this theme comes at an interesting moment. The results for 1981 have made it clear that this port, too, is feeling the chill of the recession. Cargo handlings were appreciably down on 1980, which had not been a very good year either. Many of you will be familiar with the main facts, as other ports are feeling them too, to a greater or lesser extent. The main impact on our annual results was due to a sharp downturn in West European oil consumption. Landings and loadings of crude oil in this port plummeted by 21 per cent. to 94 million tonnes in 1981. Difficulties in the West European steel industry also had their effect, with ore transshipment dropping by 11.5 per cent. to 37 million tonnes. Fortunately, there were other commodities with much better performance. But bigger volumes of coal, other bulk and general cargo failed to compensate for the cargo losses in the crude oil and ore sectors. All told, this port handled 255 million tonnes of cargo in 1981, which amounted to 8.5 per cent. down on the previous year.

Now, TNO has asked me to talk about Rotterdam's future, and you have heard me begin in a minor key. I hasten to correct this impression. Notwithstanding the less than buoyant results for the past year, we know that the port of Rotterdam is in good health. We find that the recession has been slow in getting a grip on activities in Europoort and that there's nothing really wrong with Rotterdam's ability to compete with its West European rivals. On the contrary, there are quite different reasons for recording the year 1981 in the proud history of this port, and these reasons have got very much to do with your conference theme. The point is, namely, that last year the City Council passed decisions on a number of major port projects, which will prove to be of the utmost importance for the future of the city and its region. If the port administrators and political bodies made one thing clear in 1981, it is the fact that there's no reason to be pessimistic about the future of Rotterdam. Still, we are well aware that major changes lie in wait for us. Economic and technological developments, most of them on a world scale will not leave our port alone. We will be faced with a global redistribution of industrial activities. The emergence of young industrial nations, nations, seeking to process home- produced raw materials is in full swing.

We understand and fully respect the desire of the mineral-rich developing countries to export semi-manufactures and final products rather than raw materials, and their strenuous efforts to acquire the industrial complexes and infra-structure needed to this end. This is only a matter of time, the time needed to earn through raw material exports the money to pay for the construction of their own blast furnaces, petro-chemical industries, road systems, and ports. It is far from simple to predict these developments and their consequences in a logical coherence, but we are trying to in a general way. We just have to try and calculate these consequences for world freight flows, so that we can adapt our policies in main outline. 'Scanning the horizon' is something we have been doing constantly for the last twelve years. The most recent result of this activity was a report on prognosticated freight flows for the next two decades. It was prepared by a project group of economists, econometrists and statiticians of the Rotterdam Municipal Administration, whose special job it is to study world-wide developments that may be important to the port of Rotterdam. Future freight flows, their size and especially their nature, do not depend solely on what is about to happen in a number of rising young industrialized nations; they will also be affected by the way western society -and in particular the West European society- is going to move. This is one of the insights which the Freight Flows Project Group has rightly embodied in its recent report. The time when prognostications of future freight flows were just extrapolations of current figures is truly past.

Well, if they find that future freight flows depend partly on the direction which society is going to take, what does that mean in clear terms? I shall confine myself to three possibilities. There is the A-scenario which assumes that the economies of many western countries will show vigorous recovery in the coming years. Economic and social views will remain basically unchanged: industry will continue to determine the market range and, in a sense, consumer wants. New technologies will be developed energetically.

Now, the other extreme, the C-scenario, looks as follows: Vigorous growth as is presumed in the A-scenario is made impossible by worldwide conditions and is no longer desired either by broad social currents. Even though it has raised incomes,the old free-for-all has nevertheless left us with major problems. The role of industry undergoes major change. Social forces acquire a much stronger grip on consumer needs. Producers become followers instead of leaders. The goal becomes a socially desirable production with emphasis on quality and durability.

These are two extremes. There is, of course, a middle road, which is the B-scenario. Its characteristics are moderate growth with some trends that are typical of the A-scenario, and a fair (and possibly increasing) number of features belonging to the C-scenario concept. Anyway, we may be sure that densely populated Western Europe will have to put its house in order as regards relations between industry and environment. It is clear that the A, B, and C-scenarios have contain indications of the growth of the gross national product, and this gives

us some important data for judging future freight flows.
There is yet another element that must be introduced into the calculations, which is that Rotterdam is an energy port par excellence. For prognosticating future freight flows it is, therefore, of vital importance to ask whether Western Europe will succeed in cutting back energy consumption. It looks very much as if it will. Energy use in most West European countries will in all likelihood grow less than the gross national product.

How big energy savings will be in the long run is everybody's guess. The Freight Flows Project Group decided to make its calculations with two different expectations, a high and a low one. Linked with the A, B, and C-scenarios, these expectations yield various tracks to guide the chief commodity categories. Three scenarios and two conservation factors among them engender six reasoned prognostications. The final outcomes differ widely. The lowest scenario predicts an overall freight flow of 260 million tonnes in the year 2000, while the highest puts aggregate volume at 440 million tonnes.

I told you earlier in my paper that Rotterdam handled some 255 million tonnes of cargo in 1981. So if the lowest scenario came true, the volume of cargo passing through the port of Rotterdam in the year 2000 would be hardly more than in 1981, showing roughly two per cent. growth. If the highest estimate of 440 million tonnes came true in the year 2000, growth would be 70 per cent. over 1981. Faced with six reasoned prognostications, the Rotterdam port administrators had to pick the most most likely winner. And you won't be surprised to learn that they chose the median B-scenario, the low-energy-use version. The B2 median scenario puts cargo volume for the year 2000 at 302 million tonnes. No matter how interesting these figures may be, the Rotterdam port administrators needed to know more, e.g. changes in the sizes of the individual cargo categories, because not all sectors will grow.

Shifts in the sizes of the individual freight flows will be considerable under each scenario.
Let us take e.g. the one with the lowest final outcome, C2, which predicts 260 million tonnes in the year 2000. If it came true, and the

total freight flow remained more or less as it is now, there would still be fairly big changes in the shares the various commodity categories would have in this total:

- The success of the container and Rotterdam's strong competitive edge in the world container market would increase general cargo handling one and a half times up to 2000.
- Volume in the dry bulk sector (coal, ores and grains) would grow half as large likewise.
- On the other hand, the flow of liquid bulk (crude oil and petrochemicals) would drop to about two thirds ot present tonnage. Given the size of landings and loadings of these products at Rotterdam, this would have major consequences for the port.

We are well aware that the outcome of this horizon scanning must be handled with care. None of the scenarios, and that includes the B2 median one, can be right on the mark, of course.

At the same time it is clear that such systematic peering into the future is necessary; it can help us to make the correct investment decisions. And I'm happy to say that the year 1981 was particularly rich in major events and decisions that will prove to be important for the future of this port. Let me give you some examples:

- An all-out effort was made to establish an open link between the busy Hartel Canal and the Oude Maas river just before the turn of the year. Until then ships has to pass through locks on their way from one waterway to another. The locks system had grown too small and could no longer cope with the busy traffic. Waiting times are anathema to the port of Rotterdam. For a long time planners had been thinking of increasing capacity by building another locks system, but fortunately it was found to be technologically feasible to establish an open link between the canal and the Oude Maas, which is part of the river system of the delta. In consequence, the Hartel Canal was thrown open to the tides, which required a host of adjustments. The Hartel Canal is a vital waterway, carrying tens of millions of tonnes to the international hinterland every year. And it is evident that traffic on the canal will grow even busier when dry bulk flows (coal, ores and grains) are going to multiply by one and a half in the next two decades. Adjustment of the Hartel Canal was a costly operation, but of vital importance with a view to the future.

- The refitting of the Hartel Canal was made necessary by another fact: the Rotterdam City Council permitted the construction of a major coal terminal at Maasvlakte, a large-capacity handling and storing facility, accessible to very deep-drawing carriers. The coal terminal will be operated by a combination which includes some oil companies.

- Even if crude oil flows to Rotterdam are expected to decline in the coming years, it was nevertheless decided to deepen the Eurochannel, the trench in the North Sea bed leading to Rotterdam's western deep-sea ports. Work has already begun. The big bulk ports of Maasvlakte and Europe will soon be accessible to ships drawing 72 feet and at a later stage perhaps to 75-feeters.
Let me briefly explain to you why we made this decision. Even if we must count on a further of the crude oil sector due to falling international demand, the flow remaining after stabilization of the market will still be huge. In the new situation economies of scale will remain as big as ever. The very large carriers, which can offer the lowest freight rates, will stay in business. The result of the Eurochannel being deepened will be that Rotterdam and its international customers -and especially those with pipelines to this port- will have the cheapest possible crude oil flows at their disposal, especially if Rotterdam were to take the next step and dredge to a depth of 75 feet. Proof that our economists had done their sums well, was quickly forthcoming. Two specialized ore and coal-handling firms announced that they were building new quaywalls for ships drawing 75 feet. And I repeat 75 feet! Construction on one of these walls started before the year was out. These are not oil firms, mind you, but coal and ore handlers, which shows that these sectors, too, are expecting the size of carriers to increase. Dredging the Eurochannel is not only important for oil tankers.
- General cargo, too, is expected to increase.
And what is Rotterdam doing to be able to cope with developments and shifts in that sector?

Engineers of the Municipal Port Administration have been concerned foi some years with the problems posed by obsolete and undersized harbours, some of them dating from the last century. Most of these harbours and their quaysides have become too small for the ever-growing vessels that have been the hallmark of maritime transport since World War II. Firms outrunning their facilities took up other locations elsewhere, but did not always abandon their place of birth. As a result, big companies came to straddle a number of sites (sometimes five or six). As fractionalization impedes efficiency, reparcelling and restructuring was resorted to, with one eye to the future which promises more containers but hardly any traditional general cargo.
Viable firms which are unable to rid themselves of obsolete and undersized sites, have to be aided. In 1981, the City Council adopted a General Cargo Policy Statement, setting out proposals for a scheme to help these firms over the stile. It is now possible to pre-finance with government money all kinds of civil engineering works to give such firms new chances under the restructuring scheme.

- In the meanwhile the success of the container called for new measures. The City Council cleared the way for the construction of a new container terminal at Maasvlakte by leasing 200 acres of land to ECT, Rotterdam's biggest container handler, for the first stage of the project.

- But the list of major investment decisions taken in 1981 is not yet exhausted. The City Council also approved proposals to build a wholly new vessel traffic management system to bring safety in the port of Rotterdam to an unprecedented level. The heart of the new facility will be a completely new, shore-based radar-system.

Ladies and gentlemen, you see that Rotterdam is far from being discouraged by the disappointing results of last year. And, I have another revelation to make. We plan to write off these governmental projects fairly quickly: the dredging of the Eurochannel in about twelve years, the refitting of the Hartel Canal within 25 years, and the new vessel traffic management system within some fifteen years. Why did we decide to do so?

There is reason to assume -and the Rotterdam port administrators do assume- that competition among the big West European ports will become fiercer round the year 2000. By that time several large developing countries are expected to have developed their industries to such an extent that maritime shipping will carry fewer raw materials, but more semimanufactures and final products. Well, as long as they continue to carry cargo ..., you may say. You are right, but the port administrators feel that overall volumes may well be smaller. Anyway, Rotterdam is preparing for that eventuality. Come the year 2000, this port will have an excellent infrastructure and the costly improvements, which we have just decided to make, will then be written off or nearly so.

The port of Rotterdam does not only handle vast flows of freight; it also serves vitally important industrial functions. Since World War II the city has pursued a single-minded policy of providing the regional economy with a strong basis by a vigorous industrialization of the port. In the 1930s, when Rotterdam was still depending largely on its port alone, the Great Depression caused so much social misery that there was a consensus in the 1950s that it should never happen again.

Industrialization has been so successful that Rotterdam is now one of Western Europe's industrial centres. Today world trade is stagnating again and nobody can say to what extent the post-war industrialization is cushioning the effects of the current depression. But that it is doing so to some extent, and that there is a wide difference between the fate of unemployed people in the 1930s and today, are things which I consider to be beyond any doubt.

Still, it is bad enough that in a unique workshop like our city there should be unemployment again. Following the lead of the Netherlands Advisory Council on Government Policy and the Advisory Committee on Industrial Policy (headed by Royal Dutch Shell chairman Gerrit Wagner), the city administration of Rotterdam will do everything it can to support the city's industry.

Strikingly, the Wagner Committee's report contains many points of application to Rotterdam's industry. It is our belief that the billions of guilders' worth of investment which some major oil companies have promised to make in the Rotterdam region can be a stimulus to all kinds of ancillary industries. You may know that the investment will be in plants to extract more light fractions from heavy oil. We hope that other high-technology projects will have similar effects. I'm thinking of coal gasification plants. We intend to use our best efforts to help such industrial plans along.

At the same time we shall announce to the world that Rotterdam is back in the market for new business establishments. It is our policy to curb electricity rates. Chances to do so are provided by an integrated energy economy, meaning utilization of residual gases, residual heat, and electricity surpluses in our region. Greater use of coal for power generation may also reduce costs.

I cannot conclude without saying a few words about reserves of industrial sites in Rotterdam. Availability of suitable land for building is of vital importance for economic growth in the coming decades. We distinguish between 'dry' and 'wet' sites; 'wet' sites have waterfronts, 'dry' ones haven't. At the moment some 173 acres of 'dry' industrial sites are available in Rotterdam. This is still sufficient, both in terms of quantity and in terms of quality. But in the longer run an annual increase by some 37 acres will be desirable.

As for the 'wet' sites, I have to note first that most big firms in the new ports have sites in reserve -areas which they have leased with a view to future expansion, but have not made use of yet. It is hard to say how much of this area will again become available later on. Assuming that there won't be any special change in current land utilization, I think that in a more distant future --say by the year 2000-- there is likely to be a shortage of big 'wet' industry. A careful study of way to expand our industrial area would seem in order. It is clear that such a study should involve first of all Maasvlakte, which still offers expansion potential. A decision to expand this important harbour and industrial area should be made in 1985 if the new sites are to be ready by the turn of the century.

I would like to conclude my paper with a recommendation to everyone who is involved in this decision-making in the city or region. In the past Rotterdam has consciously and finally barred certain geographic developments which were felt to be undesirable; in most cases they were port developments. Now, let us not do so with regard to possible enlargement of Maasvlakte, which may be badly needed by the year 2000. To my mind the coastal region off Maasvlakte and Oostvoornse Lake should be planned and developed in a way that will allow the cheapest possible construction of another Maasvlakte in due time.

Comment on the previous lectures

P.K.H. Meyer Swantee
Chairman of 'Scheepvaart Vereniging Zuid'
The Netherlands

Mr. Chairman,
What you asked me to do is basically to give a comment on an exercise of chrystal ball gazing. At least that's the impression I get from being shown the figures for the year 2000. And when such figures are shown to me, I at the same time always wonder whether that particular year has some special magic about it, because no one seems to dare to look beyond it. And I think we are just as well interested in what is going to happen after it. Still, what you are doing today by organizing this conference, Mr. Chairman, is very welcome, and our association is very grateful for this opportunity to exchange our views.
Funny enough (and you may have noted it), I understand that the institution of the gentleman who just commented and gave his views, Mr. Van Rens, is organizing a similar happening at the same time in Amsterdam. And I just wonder whether we are talking about the same subjects, and are coming to the same conclusions. And that makes me even more careful in expressing myself here, knowing that it may be published, and that I could find myself contradicting someone more knowledgeable in Amsterdam at the same time.

We -and I'm talking on behalf of an association which has 260 companies, which are all active in the port of Rotterdam- are certainly impressed by the exercise of the institution of Mr. Van Rens.
As I said, we are all very interested in the future, and we would like to invest -and this is what it's all about- wisely in the future.
It so happens that I have been in banking and stockbroking, and it's a well-known thing in stockbroking that every investor looks at the chart readers and all the analysts, who are predicting the stock-exchange for tomorrow and next year. Banks and all sorts of investment funds are doing the same thing, and the layman is very often impressed.
And quite frankly, having been doing that job for twenty years, I have

learned to wonder what the actual use of all that is. Because, very often people find that predicting is just as difficult as it has always been.

If we now look at the figures produced by Mr. Van Rens, and at the same time by the port authority, I must say that it is a most interesting and valuable document.
What we are doing basically is, I think, exactly the same thing any entrepreneur is doing. If he sees an opportunity today, he jumps at it, and hopes to make a profit. And if he is somewhat successful, his colleagues, or rather his competitors will try to jump on the bandwagon and do precisely the same thing. And this is what we are faced with, i.e. both the local government, our City Council, our government and private enterprise. We try to jump on the bandwagon and do better than others.
But at the same time, I think, we have learned that shipping is a good example (and there are many other examples) of how careful we have to be. And so, if you look at figures, I think the essential part is -and Mr. Van Rens will not contradict this, I'm certain, and neither will the port authority- that we welcome the work you are doing, the figures you're producing should be improved, and we are ready to help you. But the final interpretation of these figures remains with private enterprise and -if you like- with the government.
This means that you must be very careful, because competitors very often influence figures. To take you back to the stock-exchange, Dow Jones reading -to give you an example- was a very sophisticated sort of thing in the past. This lasted until one became so clever as to say: 'Okay, if the chart breaks out we can help it to break out'. And this meant that you got a new tendency, and the market would follow it. And if the market did so, all the poor investors were going to lose money. I think the same thing is happening in industry. Some people can influence figures, and therefore it remains a tricky business, as you so rightly pointed out.

Now I just want to enter upon a few things where we have query marks. The input for producing this sort of information is essential, I think. In the port of Rotterdam, the port authority and our association, the stevedores in particular, have come to some sort of agreement to help each other in producing statistics. So as to input we can be fairly accurate indeed. The same thing holds for the methods of interpreting the input.

Looking at your paper, Mr. Van Rens, I found a sort of formula of how you interpret it through your computer, and I thought: 'Gosh, do I have to comment on a man who can produce that sort of knowledge and wisdom'. So I take it for granted that the formula you're using is excellent. But then I come to the third pard, and that's the assumptions. You already mentioned the assumptions, and I think this is where the weakness in all this sort of exercise is.

What about -and I'm just mentioning a few factors which according to my findings have been omitted to be taken into account- what about the growth of world population going from three billion to -I'm told- six or seven billion by the year 2000? What about the enormous problems in food supplies leading to different freight flows?

And I'm thinking for example of the port of Rotterdam, where we see today what politics can mean in the Russian-American grain flows. All of a sudden, namely, you see so many USSR carriers which were not there last year. And still nothing much has changed, and still it has a major effect.

You talked about the energy needs and the energy carriers. I would like to add the high interest rates, which lead to fast distribution and transport systems, and underemployment of capital resources which can no longer be allowed.

I also miss any assumption on what for instance a tunnel under the Channel connecting Britain and France would mean. I heard about micro-processors this morning -and TNO is very knowledgeable about that- as well as bio-chemical and other developments, and I really don't know whether those are going to influence the freight flows.

I know that the USSR government is working hard to improve the Trans-Siberian train connection, and there are suggestions -it is perhaps no more than that- that by the end of this centrury their rail system would replace and outdate the sea-connection between the Far East and Europe. And we know that the Pacific basin area is developing economically so much faster than Western Europe.

So we are left with all these query marks, but still I want to encourage you to go on. Because what you're doing is excellent, even if you have your difference with the port authority.

As you already suggested, we would like to base our decisions in the future partly on what you are producing. We would only be too happy to help you, and the more often the information becomes available the better. You were referring to this city which this morning is in the fog or in the mist. I think we are in those circumstances in Rotterdam: you take the underground and you know for sure where you're going. And I think that's the way we operate today: we base ourselves on the things that we know, but what if we want to be launched into the 21st century? I think we are like the pilot in the rocket or the spacecraft. And that is today. He is highly dependent on the information, the computer, the whole system which has to be put together to give the go-ahead and make things a success.
I think the similarity is there: we cannot go into the 21st century without you and the port authority developing the computer models any further, to enable us to step into the next century with the confidence which you certainly have tried to help establish this morning.

Thank you.

Comment on the previous lectures

H.J.J. van Ass
Group's President of the SHV, Harbour Transport and Transshipment Group
The Netherlands

Ladies and gentlemen,
I have dreamed up some controversial remarks, not so much because I cannot live with what the previous speakers, Messrs Kastel and Kleinbloesem, have said, but more to stimulate thinking and discussions.
Mr. Kleinbloesem has given a fairly optimistic view on general development of the Rotterdam port and the actions and decisions that are taken today to prepare the port and anticipate future developments.
I stress the word 'general', because the developments are indicated in broad terms, such as: growth of dry bulk (although you've heard form Mr. Van Rens that one could query this growh), decrease in liquid bulk, and increase in container handling as part of a declining general cargo handling.
These changes in pattern are even 'true' in the so-called C2 scenario, in which total traffic flow in the year 2000 will be about the same as it is now.
It is not clear on what scenario the current topics in the Rotterdam port, as mentioned, are based. To mention some topics: the open link in the Hartelcanal, the Maasvlakte Coal Terminal, ECT going to the Maasvlakte, and deepening the Eurochannel. My question is: is this deepening indeed a must?

Mr. Kasteel already very clearly expressed the view of the oil industry that the flow of products from resource refineries most probably will contribute to the detriment of the flow of crude oil, which means a larger amount of relatively small ships and a smaller amount of big ships. These developments have to do with the change in type of goals and means of transport. The question is: what is the real relationship between the B2 scenario and the topic of the port-topics today?; is it the fairly quick write-off?; who is going to pay for it?; and what is the reason why the competitive position of Rotterdam in the year 2000 is worse in comparison with its position today?

The critical note here is that the outlined B2 scenario, except for just a few points, has little to do with what the port is doing today. Choosing the B2 scenario brings me to the conclusions that it is the product of societal uncertainty of what the basic developments are going to be, and of insufficient foresight how to influence developments based on an analysis of Rotterdam's strength and weakness. Talking about societal uncertainty, this is reflected in various groups, and can be summarized as follows:

a) the government, whose only problem seems to be the dollar value and the price of oil, determining the deficits that may be manifold of what we really think they will be;
b) the unions do not wish to take a decrease in wages, because they doubt what it will lead to;
c) the industry in general is hesitant in making investments, given the political environment; and that apart from pertinent economical factors, such as high interest rates.

The point is what will be the degree of flexibility which the various groups do allow themselves and do allow others? What possibilities will be created for companies, for instance in the field of coal handling and coal transportation, to increase flexibility? For example:

- the development of new technologies to decrease handling and transport costs (transshipment dock, coal slurry);
- increasing the functions of coal ports to strengthen distribution and storage functions;
- supporting the development of new utilization of coal usage.

These and other features are influencing port developments more that do scenarios and general trends.

Now I would like to turn to the presentation of Mr. Kasteel.
It is not that I don't have any comments on Mr. Kasteel's oil and chemical paragraph, but I would rather focus my questions and statements on the coal paragraph.

Mr. Kasteel mentioned in his speech that the trend towards the diversification of energy sources and increased engineering efficiency, which followed the past two oil creses, can be expected to continue in the future. Furthermore, Mr. Kasteel stated that Rotterdam combines a favourable geographical position, modern equipment, and ample deep water into a unique opportunity to become one of the main receivers, storers, and distributors of coal even for Europe. I cannot agree more! In this respect my question is: why hasn't SHELL taken the opportunity to develop a gasification project in this area rather that concentrate the development abroad? Gasification will be one of the mentioned diversificaton projects of energy sources.
Moreover, the Netherlands -the main natural gas source in and for Europe- will remain for a long time the centre of gas supplies and pipeline distribution in Europe. Or isn't it an item for consideration to start gasification in the Netherlands?
I'm convinced that if we had started the development of gasification projects in the Netherlands right after the first oil crisis, we would have gained enormous know-how, and also the possibility for the Dutch industry to become involved in future supplies of equipment and knwo-how related to a mature gasification process built in the Netherlands.
In this repect my critical note will go more strongly into the direction of the Dutch government, which has not seen or created the opportunity, and has not taken the advantage of spending part of the natural gas income on this development. Even the 'GASUNIE' has met with more opposition than support from their shareholders in developing an own gasification process, although based on a Lurgi system.
I thought it would be better to have a process and upgrade it, that to discuss the pros and cons of processes, and let the realization take place outside the gas country.

Now that we have lost track with nuclear developments, I'm convinced that we are going to miss the boat in gasifications, if we keep on waiting for developments from abroad. I really hope that we have stopped to talk on the pros and cons of gasification systems and processes, and that we start indeed to utilize and upgrade a gasification system near the deep water facilities in the Netherlands.

There must even be room for more than one project with the support of the government, which every year earns over 22 billion Dutch guilders from levies and taxes on the Netherlands natural gas production.

I feel this would be more advantageous to everybody than fighting around between VEGIN, GASUNIE, and the like for a theoretical future position. I would very much like to have Messrs. Kasteel's and Terlouw's opinions on this.

Thank you.

Comment on the previous lectures

Drs R.W. Mouw
Head Economics and Planning
Phs Van Ommeren N.V., representing

M.J. Muller
Member of the Board of Management of
Phs Van Ommeren N.V.
Rotterdam
The Netherlands

Mr. Chairman, ladies and gentlemen,
You are going to listen now a few minutes to a multi-purpose human being. Because I'm going to represent both a very practically and logically thinking gentleman, Mr. Muller, who is a member of the Board of Management, and myself having sometimes a theoretical approach, although I will try to avoid it.
Before I give my brief comments on the speeches, I would like to make a few preliminary remarks.
Over the years I've gained experience with ports, mainly as ship-operator in the liner and tramp business, as tank operator and as shipping agent.This experience has convinced me that the basis of all these activities is rendering the service required by principals, while on the other hand I, as a principal, may expect to obtain services from the port authority. In other words: as a private enterprise one tries to obtain as much business as one can. This in combined efforts with the authorities, bearing in mind that the totality which forms a port, can only function if it it renders good and efficient services to the economy at large.
It is therefore essential that we together carefully evaluate what our clients require, now and in the future.

Let's no mistake. It is our client -the shipper or the receiver- who determines which port and which terminal will be used.
What basic elements does the customer take into consideration?

a) Does the port provide all the facilities he needs? (Hinterland connections, railroad, infrastructure of the port, and so on.)
b) Is the service and the price asked for the service competitive?
c) Does he get a reliable and quick service and handling of his products?
d) Is there an efficient customs organization?

For a shipowner in particular the following additional elements are of importance: repair facilities, slop-receiving facilities, good medical treatment and services, up-to-date pilotage system, ship-chandler services, low strike record, return cargo, quick turn-round of his ship, and many more. In short: a complicated living organization which needs a flexible management to adapt quickly to changing circumstances.

In this rapidly changing world it is extremly difficult to plan ahead for longer periods of time. I think we've had sufficient proof in the last decade. However, bearing these factors in mind planning is still required.

When considering the theme of this conference, namely: 'The functioning of world seaport areas in the eighties', one immediately faces the problem of the different interpretations of the role which the entrepreneurs and authorities as partners have to play.
In the Netherlands we seem to have solved this problem to a certain degree by applying the principle of partnership between port authorities and business community in setting up the 'Voorlopige Nationale Havenraad' (Provisional National Port Council).
And in this connection I'm happy to not that Mr. Terlouw seems to share my opinion when he mentions in his speech that the task of the central authorities is to create the general conditions for industrial activities, may I call it the framework, within which the parties directly involved in the port (port authorities, private entrepreneurs, employers as well as employees) discuss practical solutions and measures without direct involvement of the central authorities.
In the affirmative, Mr. Miedema, representing Mr. Terlouw, does the Dutch government see possibilities to realize this framework also in a wider West European area in order to create optimum functioning of

ports in such areas, and avoid overcapacity and overinvestment?

You can well imagine that in principle I can fully subscribe to the ideas of Mr. Terlouw when he says that the Dutch government wants to give top priority to the restaoration of investment. I can certainly agree when he seems to indicate -and I hope my interpretation is correct- that this should be coupled with a restoration of the profitability of industry, also in respect of port port industry.

Perhaps one of the most difficult problems lies in identifying the cargo flows to the main port areas in the world, required real increase in regional handling capacity, and the efficient distribution of this requirment over the various ports. A very good example of recent time is the various steam coal forecasts for Western Europe, which in a matter of a year soared to astronomical figures, whereafter the forecasts were scaled down gradually over the last few months.
Hoe do the speakers of today expect to tackle this planning and scenario problem? Who is going to make the forecasts about the cargo flows? Will it be done by international working parties of experts in their specific fields (as for instance has been done in the WOCOL report on coal)? Or by I.C.C.teams? Or even by UN-committees, or otherwise?
In my opinion the main cargo supplying customers should be participating and consulted. I would very much like to have the reaction of the panel.

My final comment is more a personal remark.
In the report 'Interfutures, Facing the future', which was finalized in 1978, and in which Prof. Michalski has greatly participated as a member of the project team, I read that 'Interfutures' has concentrated chiefly on the economic dimensions of the world of tomorrow.
Under the heading 'critical issues' in the conclusions of 'Interfutures' it is said that behind the economic difficulties there is the absence of a grand design that represents the consensus of society. The existence of such a design played a vital role in the succes record of the quarter of a century following World War II.
I'm convinced that we need such a new scheme.We can, namely, be

confronted with changes, and are likely to experience just moderate rates of economic growth. The trend of international trade will be very sensitive to growth rates, to the nature of the north-south relation, and to the decisions of the main countries on whether to opt for liberalization or for a neo-protectionism. And newly industrialized countries, the NIC's in the Far East. will no doubt have an impact on the welfare and well-being of Europe.The relatively high economic growth in this pacific area is remarkable.

Apart from economic factors there is one common mentality factor noticeable in that part of the world, namely: Faith in the future, supported by private initiatives, high productivity, and a steering government policy. Also we in Western Europe need such kind of new and fresh impulses.
In Western Europe we hear too often that yesterday was nicer and better than tomorrow will be. But if we continue this kind of doomsday thinking, we aim at the precipice instead of a prosperous future. And with this future we have to deal: politicians, business men and scientists with models, scenarios and decisions. The alternative is intuition, but can lead to the use of the dice or the consulting of astrologers.

I'm convinced that the process of economic growth, be it moderate, can be sustained for a longer period of time. Impacts of socio-economic elements, such as allocation of time, work and leisure, and life style may play a role. But industrial technological innovation will continue in production processes, which probably more than ever will be fragmentized by the stimulation of transnational enterprises. Forms of international co-operation, for instance in joint ventures between North and South, will emerge from the interdependence of our world.

Do you share, Prof. Michalski and the other members of the panel, that it is time now for the preparation of a second report 'Interfutures', in order to create the right mentality to implement the selected scenario in the world of the eighties?

Thank you.

SUMMARY OF THE PANEL DISCUSSION ON 25th MARCH, 1982.

Chairman of the panel

Mr. S. Doyer
Member of the Board of Management of the
Nedlloyd Group, and
Chairman of the 'Koninklijke Nederlandse Redersvereniging' (Royal Dutch Shipowners Organization)

Members of the panel

Mr. H.J.J. van Ass
Dr. J. Kasteel
Dr. C.H. Kleinbloesem
Prof. W. Michalski
Dr. S. Miedema (representing Dr. J. Terlouw)
Dr. R.W. Mouw (representing Mr. M.J. Muller)
Dr.Ing. J.H.P. van Rens
Mr. P.K.H. Meyer Swantee

Mr. Doyer

Ladies and gentlemen, I welcome you to the panel discussion which is to conclude the session of today. First of all I would like to thank Messrs. Meyer Swantee, Van Ass, and Mouw for their comments on the lectures we heard today. You've all heard a lot of questions, some of which were also asked by the audience, and I hope that we can deal with most of them during this discussion.
May I first of all go to Mr. Van Rens and ask him to comment on two aspects mentioned by Mr. Meyer Swantee, namely:
'When making your prediction, to what extent did you take account of the impact that the Trans-Siberian railroad may have?', and: 'To what extent did you take into consideration the tremendous growth in world population which is forecasted?'.

Mr. Van Rens

The forecast we've made, i.e. the last production we've made in this respect, did not consider the Trans-Siberian railroad, because there's

no information available regarding the impact of Trans-Siberian railroad different from the existing one. But on the basis of the information we have in this respect we don't expect there'll be much change.
Regarding the world population, I can inform you that within the scenarios regarding the push and pull factors implicitly the world population of each country and of each region is taken into consideration. And to that extent did we cope with this problem. And the proposition we made regards the projection with respect to the development in world population in the regions taken into account. I must say the world population predictions are among the most sound and most easily made predictions, and the general predictions made by the U.N. have been taken as a basis in it.

Mr.Doyer
Thank you Mr. Van Rens. I thought I heard you say that the world population forecast is a very easy one. But to be quite frankly, I think that when people didn't know about the pill, they had quite different ideas, I mean including the forecasters.

Mr. Van Rens
One point, which has proved to be true even in India, is that although one has made quite a lot of efforts to get to a family planning policy, one has never succeeded in getting a right, acceptable reduction in population. I like to stress in this respect the developments in the People's Republic of China. I would also like to stress the development of the population in France, where they did their utmost in terms of social security, financial aid, to increase the population. Nevertheless the results are still marginal. So speaking of a planning horizon of 20 years, I feel myself entitled to do that.

Mr. Doyer
You're welcome to it Mr. Van Rens. But I would like to come back for one moment to the Trans-Siberian railroad problem. I think that the ports --and I understood that's the background of Mr. Meyer Swantee's remark-- would be very interested to know, and so would be the shipowners, if in these forecasts you could distinguish between

whatever is transported by sea, and whatever is transported by the Trans-Siberian railroad. It has, namely, a tremendous effect on investment planning etc. for the ports as well as for the shipowners. But I appreciate you have just a total figure, and that you don't make that distinction, or could that be done?

Mr.Van Rens

It could be done actually. But it hasn't been done in this run, because you must then have more information regarding the change in distance decay due to shipments by the Trans-Siberian railroad or by boat. You have to make that comparison.

Mr.Doyer

Thank you Mr. Van Rens.
May I then go back to the exposé of Mr. Van Ass. He said that he put a query mark behind the necessity of deepening the Eurochannel. And I have also a question from the audience here, which I would like to read out, because it gives a somewhat more explicit background to the question. It runs as follows:
'When hearing about vessel sizes of some 350,000 tons deadweight for coal carriers, it would be interesting to learn whether there are intensive contacts with the planning authorities at the loading ends. Developments to this tune, namely, are very costly, and would be unnecessary if such an expansion is not a certainty. (Until now nowhere coal ports of such a size have been contemplated.)'
May I ask Mr. Kleinbloesem to answer this question?

Mr. Kleinbloesem

As to the need for deepening the Eurochannel I would like to remark the following. You can regard that from the point of view of oil, of ores, and of coal.
Let me first take the oil question. Deepening the Eurochannel is necessary for the functioning of the port of Rotterdam in bringing crude oil to North Western Europe. And it has quite a number of aspects.
First of all I would like to mention the fact that today out of every four tankers arriving in the port of Rotterdam, one has a maximum

draught of over 68 feet, so can not fully laden enter the port of Rotterdam. The existing fleet of vessels over 68-feet draught is in the order of more than 70 million tons of deadweight, which means as much as the total world tanker fleet 13 years ago.

Then there's the aspect of the economies of scale of these vessels. And even in case the Suez Canal would be deepened according to the second phase of the Nasser-plan to 67-feet draught, even in that situation the economies of scale of the 350,000 tons and 72 feet would be favourable for this type of vessel, if you take that vessel in laden condition via Cape of Good Hope and in ballast via the Suez Canal, in competition with the 250,000 tonner which makes the trip both in laden and in ballast condition via the Suez Canal.

And if you take the market situation of last month, you can calculate still a cost advantage in the order of Dfl. 1.25 per ton, plus difference in eventual raising of the canal use of the Suez Canal in the event of such a deepening.

Moreover, it's not sure whether Egypt will execute that second phase of deepening the Suez Canal. There are two alternatives:

(1) widening the existing canal in order to make traffic in both directions possible, and

(2) making a second, separate Suez Canal.

So I think that for quite a number of years to come there will be a lot of uncertainty in that respect. And even if the Suez Canal would be extended, there's still the argument of the strategic importance. I think that after the event of the first Suez-crisis, the Western World has learned its lesson, and will not put all its eggs in one basket.

The economies of scale of the big tanker of 72 feet against the 68 feet that we can at present accept in Rotterdam, means a reduction of the landed price of crude oil for all refineries which accept that crude via the port of Rotterdam, and use these bigger vessels. And I think that might also be an important feature in the problem of survival of the fittest among the refineries in our continental hinterland. Because the savings in landed price are in the order of 50 to 100 per cent. of the refinery margin.

And finally, even if not more than 25 to 30 million tons of crude were imported by this type of vessel, the effect on the balance of payment would be in the order of 75 to 90 million Dutch guilders a year, which

would mean a repayment of the entire deepening of the Eurochannel in less than eighteen months.
In 1976 transshipment of crude coming to Europe which was done in the open sea in competition with the port of Rotterdam and Le Havre, amounted to a quantity in the order of some 25 to 30 million tons a year. That meant clearly a loss of trade of our ports of incoming and outgoing crude carriers. Even with the sharp plummeting down of the total transport of crude to North Western Europe last year there still was a handling in the open sea from the big carrier into the smaller one of some 6.5 million tons of crude. I think that if we could attract that portion of traffic to the port of Rotterdam by deepening our channel, about 50 per cent. of the extra costs would be covered simply by the normal harbour due at the present rate.

The second aspect is the ores. Even in a time that nobody believes in the big tanker anymore, they're still there. But perhaps in ten or fifteen years they won't be there. We're depreciating, planning that in a period of twelve years. But very soon after the decision of the Municipality to go to deepening the Eurochannel to 72 feet, the iron and steel industry decided to build two new quays for ore handling. And they'll pay the extra cost of constructing these quay walls for 75 feet instead of 72 feet. Because that's also the last chance within the existing Maasvlakte to construct such quay walls.
And, of course, it's nonsense to make such a facility in an unloading port, if there's not a harmony between loading port, ship, and unloading port. Such a harmony does exist if it concerns ore. There are already ports which are able to accept 76-feet ore carriers.
As to coal it's true that at this moment there are no loading ports which are able to accept such vessels, except Vancouver in Canada. But that's a long way off. I think the adventure of the 350,000 tonner, the 72-feet draught for the coal carriers is still some years off. I don't expect such vessels before 1990, but I personally am convinced that they will come in the '90s. But the problem is that at this moment you have to construct a coal terminal within the existing Maasvlakte. And if you don't choose your depth for constructing your quay wall, then you've lost your last chances there. And the only way-out would then be to go to an extension of the Maasvlakte. And in my lecture I already

expressed that leadtimes to develop new port areas are getting increasingly longer. The leadtime for the first decision on Europoort was a matter of two months, and I think we now have to count with ten to fifteen years.

Mr. Doyer

Thank you very much Mr. Kleinbloesem. Indeed it's a problem of the leadtime and the long term planning which you have to do as a port authority.

May I now refer to Mr. Kasteel and ask him to answer the question of Mr. Van Ass, namely:

'Why no coal gasification on a large scale in the Netherlands?'.

Mr. Kasteel

Although there's a highly technically oriented gathering of people here, it's maybe worthwhile just to recall very briefly that if you talk about coal gasification, you're not talking about anything very new. Coal gasification has been in existence for quite some time, and the processes are there, and we know --and a lot of us know-- that for instance in South Africa they're really working.

Now SHELL is one of the oil companies working on coal gasification, but there are also other companies, such as EXON and TEXACO, working on it. And this process has been under development with us for some time now, and the Netherlands have not been outside this development process. We have a pilot plant in the Amsterdam laboratory, which admittedly is on a modest scale, but that's how things in our pilot plants are.

The second phase for the coal gasification was the coal gasifier with a size of 150 tonnes a day, which was constructed a number of years ago in our Harburg refinery in Germany. During last year or so this gasifier has been working there on and off, as it should do in a development stage.

And now gradually we're trying to move up to the next stage, which would mean a coal gasifier on the SHELL process of the size of about 1000 tonnes a day. Now that decision is still under consideration. It's a very difficult one, because --as you know-- there are various directions one can take with coal gasification. I mean you manufacture a synthesis gas, which is a mixture of inter alia carbon monoxide and

and hydrogen, and can subsequently be applied in different directions. Of course, the easiest one would be methanol; the next would be hydrocarbons as one is actually doing in South Africa; and still another direction would be using the gas, for instance, in power generation in gas turbines or a combination of gas turbines and steam turbines.

Now, it goes without saying that we've been interested in both ways. And should we decide to enter the next phase, this phase will most likely be executed in the Netherlands, where we have identified a site in Moerdijk, which would offer both possibilities. First of all it would be on the site of our chemical plant there. So if it would be necessary to integrate it, or if it would be interesting to integrate it into our chemical facilities, the possibilities are there.

Secondly, it's near a possible location for the local power generation facility of Noord Brabant.

But once again, the decision hasn't been taken yet, and it's a difficult decision. Economics also play a part in these things, and I think Mr. Van Ass will be the last to deny that economics <u>have</u> to play a role. But it's certainly not so that the Netherlands are out of the race, or that the Netherlands would not be under consideration. And there's no question that SHELL should have decided to build gasification projects elsewhere, and that they've fully forgotten about the Netherlands. This country is still very high on the list.

<u>Mr. Doyer</u>

Thank you Mr. Kasteel. I must admit that I'm a complete laymen in this field. But perhaps when day-dreaming about the future, one would be inclined to say: 'we have the pipelines for the natural gas, when that's finished we'll have a tremendous coal gasification plant in the Netherlands, and we have all the pipelines ready for supplying Germany, France, and so on'. But perhaps this is a bit of day-dreaming on my part.

Now I would like to ask Mr. Miedema to comment on this particular aspect, and likewise on the question:

'What about the idea of using some of the natural gas income to increase the know-how of gasification technology?'

Mr. Miedema

Mr. Chairman, maybe you'll allow me first to say a few words about my presence here. You know that the Minister for Economic Affairs wasn't able to attend the afternoon session, and participate in the panel discussion.

I can tell you that within the Ministry we had quite an interesting discussion about who was to represent the Minister. Because as a matter of fact we have five directors-general at the Ministry.

Firstly, the director-general for foreign ecconomic policy. He might have been a very good candidate, because given the theme of this conference, you're talking about among other things, world trade, and so on, and he is an expert in that field.

Secondly, we have the director-general dealing with industries. He knows a lot about the chemical industry, a topic also elaborated this afternoon by Mr. Kasteel; he knows everything about innovation. So he would have been a good candidate, too.

Thirdly, the director-general in charge of energy. Now, from the discussion that we had just now, it's quite clear that he could well have participated in this discussion.

Fourthly, the director-general responsible for, among other things, trade and services, including consultancy, etc. And what I heard this afternoon also dealt with that topic.

Finally, I'm the director-general dealing with, among other things, general policy. And eventually it was decided that, since this conference is concentrating on transport, trade, technology, and on seaports, it was I who should represent the Minister. And from this brief introduction you'll understand that I have my limitations, but I promise you that I'll try to hide them as much as I can.

Now, Mr. Van Ass mentioned the point of the Government revenues from natural gas. He said they amount today to Dfl. 20 billion, which is true. First of all I must say that here, of course, is also the wisdom of hindsight. Twenty years ago we had no idea that these revenues would amount to such a huge figure. But I tell you that gradually we're trying to utilize these revenues as much as possible also in the field

of energy. Firstly, I would like to mention that we have now a fund amounting to about Dfl. 6 billion for premiums to investments. And one type of investments which get special premiums, are investments in the energy sector, including coal gasification.
Secondly, we also use part of these Dfl. 20 billion for energy-saving devices, which I think is also very important in the overall field of energy policy.
Thirdly, we've set aside special funds for energy research which includes energy diversification, and also coal gasification.
And the last point is that the Government is very much in favour of coal gasification in the Netherlands, because of the very same argument mentioned by you Mr. Chairman, that we have a very good infrastructure, a very good network in the Netherlands, and also a network from the Netherlands to abroad, which we could also use to supply other countries with gas. That's why only yesterday, after negotiations with the northern region, the Minister for Foreign Affairs sent a letter to Parliament, saying that he would like to promote as much as he can the establishment of a big coal gasification plant in the north of our country, provided that the enterprise is profitable.

Mr. Doyer

Thank you Mr. Miedema.
I think the following question will interest the audience very much.
It's a question for you Professor Michalski, and it reads as follows:
'Professor Michalski, you expect the EC-share in world income to diminish. How should this be interpreted when speaking in absolute terms? In which sector of transport will this development manifest itself most clearly?'
I think, Professor Michalski, that the interested parties here will be very eager to hear what you can tell us in this respect.

Prof. Michalski

Mr. Chairman, I would like to underline that any indication that the share in world GDP is declining doesn't necessarily imply negative growth rates. On the contrary. I also said that the U.S. share will decline, and that the share of Japan will only slightly increase or remain constant.

The point is that in the meantime there are other parts in the world, in particular the newly industrializing countries, who are catching up as we did after World War II in Europe, and as Japan did in the '60s. And this is a process, which I think is quite normal. The more you're advancing to the forefront of economic and technological development, the more moderate your growth rate will be. Because it's less determined by possibilities of importing ready-made technology packages, or by further structure change which goes far beyond the speed of the development of new technology. Considering these circumstances I would like to underline --and this is partly a response also to some of the comments made by Mr. Mouw-- that a decreasing share in world GDP doesn't necessarily imply any pessimistic view on the future. It may well be that, although they'll be slower than in the '50s and '60s, the growth rates will be high enough to continue to increase social welfare in a very considerable way.

Now as far as transport is concerned, I personnally believe that the main aspects of this changed position of Europe have been indicated by me in my introductory interventions in stressing on the one hand the changing circumstances of industrial relations and international trade of manufactures, and on the other hand the continuation of partly new trends, in particular in the area of bulk transport. And I must say that the translation from GDP development into transport demand in the future will certainly be much more difficult than it was in the past. And this was one of the messages I tried to convey to you, because this apparently simple relationship between economic growth and transportation is more complex. It's related to technological developments, to new developments in the field of infrastructure (the Trans-Siberian railways have been mentioned here), but it's also related to political developments, which are far outside any considerations which have something to do with let's say prospective economic analyses, just to mention certain ideas which developing countries e.g. have in terms of cargo sharing, and so on.

So I do <u>not</u> think that the main impact of shifts in transportation demand would be determined by those effects which have been stressed by the question. I personally believe that the trend-breaks will come from the other end.

Mr. Doyer

Thank you Professor Michalski, but could you give us any idea in absolute terms what the development of the European Community's GNP will be? Do you know that by heart, or is it too difficult a question to answer off the cuff?

Prof. Michalski

I would say this is a highly speculative question. All of us who tried still in the '70s to do forecasts have burned our fingers so much in this business that we don't do this kind of analysis anymore.
Already in 'Interfutures' we avoided to analyse the future development on the basis of one scenario only, in particular in the light of the longer term prospective, which was under consideration. We have five basic scenarios in 'Interfutures', which are interrelated. At the time when most of our colleagues still operated with some kind of higher growth rates in the latter half of the '70s, in the hope that sustained, non-inflationary growth and higher employment could be re-established relatively easily, and not taking into account the possible effects of the second oil-shock at the end of the '70s, we were already convinced that in our report our high growth scenario was merely a line of reference, and that moderate growth scenarios in the order of 3 to 3.5 per cent would be much more realistic in the future. And I personally believe that this is in the order of magnitude which is perhaps still valid for the long run. But this doesn't say anything for the next three years.

Mr. Doyer

Thank you. I also understood from your exposé that another difficulty which we have to face in these forecasts, is that the service industry will have a greater share in the GNP of the developed world, and that in itself is already a difficult point.
In his comment Mr. Mouw said that he very much appreciated to learn from Mr. Terlouw that the Government intends to build up a framework in which the private sector should and can operate. And he asked a question which comes down to the following:
'Is there any chance of co-operation, or communication maybe, with the other EC-countries, so that jointly we could try to obviate overcapa-

city inside the Common Market?'
I would like to have your reaction Mr. Miedema.

Mr. Miedema

I understood that this question was put forward in connection with the 'Provisional Seaport Council' ('Voorlopige Nationale Havenraad'), which we have in the Netherlands.
Before I answer the question, I think it might be of some use to say what the overall policy of the central government is with respect to the seaports.
About two years ago the central government presented a white-paper to Parliament. And the main issue of the Government policy with respect to the seaport reads as follows:
'The management of the harbour is in the hands of the local or regional governments. The central government does not wish to change this situation fundamentally, because a healthy development of seaports will be promoted in the most efficient way, when the responsibility for the seaports rests with the public bodies, which are the parties directly concerned. It is the opinion of the central government that in this way the interests of private enterprise in the various seaports can be dealt with in the most efficient way'.
Now, why do I quote this paragraph? The Provisional Seaport Council is a council which has not its own responsibilities. The main responsibilities are with the local port authorities, but they have to try and reconcile, if possible, the difference in views between these authorities. So this Provisional National Seaport Council has only an indirect responsibility.
Now I come to the question of Mr. Mouw. As far as the Netherlands are concerned, we try to promote also co-operation between the various European countries as much as possible. We started within Benelux, especially with Belgium; for many years now we've had a kind of Benelux council, in which from time to time we talk about these issues. But on a European level it appears to be extremely difficult to start such a council. First of all we tried it through the European Commission; and it appears that until now the European Commission has been rather reluctant. Why are they reluctant? I think only because it's extremely difficult to get all the other countries around the table.

But the national policy of our Government is to have the same kind of co-operation between the European countries as we try to promote it within the Netherlands, each harbour having its own responsibility.

Mr. Doyer

Thank you very much Mr. Miedema. I think that indeed our Government is very much in favour of this type of co-operation and consultation. But I also think it's not so easy to convince our colleagues in the EC as we've experienced in other fields of business.
I see that Professor Michalski would like to come back briefly to the remark of Mr. Mouw, that we should have a second report 'Interfutures' with the subtitle 'Faith in the future'.

Prof. Michalski

I think this is a very interesting proposal, although my own interpretation of 'Interfutures' is that the 'Interfutures'-report was not at all a doomsday study. It was even more or less a response to all the doomsday studies which were produced e.g. by such circles as the Club of Rome.
What we in fact tried to do was to present neither a pessimistic nor an optimistic view. Our aim was to use this kind of future-oriented, all-embracing study, not so much to present forecasts or figures, but to draw the attention of policy-makers, industry, unions, and the public at large to the major issues of the future. And this was done in two ways.
One was the analytical dimension of identifying trends, which could continue, (and one of these trends was e.g. the demographic development in Europe), of disclosing possible trend-breaks (one of those was that in fact there might be a second oil-crisis), and of assessing scope and limits to developments of very new features.
And on the other hand there was the political dimension, the question of policy responses. And I think that within this field we presented alternatives with regard to natural resource management in the energy field, but also with respect to food, agriculture, non-energy mineral raw materials, and the environment. But the greater part in this was certainly the economic dimension. The latter dealt with the question of the medium-term strategy in economic policy, emphasizing not only the

difficult balance to be made in the future between monetary and fiscal policies, but at the same time stressing the point that both these strategies, in whatever combination, will certainly not be successful, if they are not supplemented by efficient supply-side policies, by positive adjustment polices. Because under these conditions, if this is not the case, you won't be able to face out in due course the built-in inflationary potential of all the rigidities we have to face, and you'll always end up either with unemployment or with inflation, or even with both. And this is the kind of consideration we try to bring forward also in the north-south context.

The question whether it's now the right time to launch once more this kind of study, or whether some other strategy wouldn't be more promising. And I think that before we can answer this question, we have first to answer another question, namely: 'What should be the objective of a new study?'.

Of course, one objective could be to elaborate further the details, and correct those events which have already occurred and proven to be wrong in our considerations. But this is something which is permanently done, not only by national administrations and private research organizations, but also by OECD in the specialized committees and directorates.

On the other hand there would be the possibility to start once more a general framework analysis. I personally must say that I don't really see a reason to start anew, because the main issues which were identified some five years ago are not resolved. I think the very issue which is in fact least resolved is the one of having more faith in the future. But this is a very political issue; it's the issue of political leadership, I believe. And political leadership is not within the responsibility of international organizations or research institutions.

<u>Mr. Doyer</u>

Thank you very much Professor Michalski.

Ladies and gentlemen, I'm afraid that, although we still have a lot of questions here, I must stick to the time-schedule as it was arranged.

First of all I would like to thank the members of the panel for their participation in the dicussions.

Finally, to conclude this panel discussion I would like to sum up

briefly the discussions of today, although I must admit that I find it extremely difficult to formulate a real summary. However, I've made some notes, which I would like to read out for you.
The first note I've made was that deep seaports play a very important role in the national economy of countries, such as the Netherlands and Belgium. This is true if ports succeed in attracting many basic industries to and around the port areas. As a spin-off these basic industries will in their turn attract other industries, inter alia those for which they produce the feedstock, such as the chemical industries. And I think it's very important to note that this process will continue in the future, and I should add here, a future in which we can have faith. I believe that's a very important attitude.
However, I would also like to say that this process requires close and harmonious co-operation between the national government, the local governments, industry and the unions. And this co-operation is a prerequisite for success of an entrepreneurial private enterprise style, so that jointly we can exploit the chances and opportunities which lie in the future. The private sector must supply the innovative management, but the labour unions must create greater flexibility for management. The authorities must supply their services at competitive prices. More generally said: the authorities should provide the framework, as explained by Mr. Terlouw, for the private sector to operate. And thus I think we shall jointly be in a position to convince our customers to use our ports. Because, as I said earlier on, and which was also stressed by Mr. Mouw, it's the customer who takes the decision in the market place. And that's what all of us should keep foremost in mind.
And may I then finally conclude this panel discussion by saying to all of you: let's go all of us at the job of attracting customers.

Thank you very much.

The Design, Construction and Maintenance of Ports

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1. INTRODUCTION

In world trade, sea transport and consequently seaports with their facilities play an indispensable role. These ports are always located at or near the coast, where they provide sheltered berths for the transshipment of all kinds of cargo, for the embarkation and disembarkation of passengers, and for repair and maintenance of ships. Nowadays, too, large industrial complexes are often integrated in the port system.

In the past the choice of the port location was often determined by the availability of naturally sheltered areas, which were accessible from the sea. However, such sites were not always to be found at places where ports were needed, which was in fertile river deltas with high concentrations of population. This was, for instance, the case in the Rhine-Meuse-Scheldt delta, where the world seaports of Amsterdam, Rotterdam and Antwerp have come into being.

No wonder, then, that in such an area an industry has developed for the construction of man-made ports and their approaches. Whereas as early as the 16th century small scale dredging was being carried out with the hand-operated mud mill, the actual improvement of the approaches to the ports only started in the second half of the 19th century with the dredging and excavation of the new shortcut waterways to Rotterdam and Amsterdam. Most of today's Dutch, privately owned dredging companies originated around the turn of the century. Thanks to the spirit of enterprise, which has always been its main characteristic, this industry has now expanded to its present-day international level and reputation. It is active all over the world, and with its annual foreign turnover of more than five billion Dutch Guilders is one of the major Dutch export industries.

In this connection Royal Boskalis Westminster --currently employing more than 10,000 people-- has been active for 75 years in the construction and maintenance of ports throughout the world. The range of experience gained during that period varies from projects in the tropics to projects in the Arctic, from the industrial world to the Third World, from delta regions to rocky coasts, and from single-purpose seaports to total ports.

It is against this background of history and our own experience and in the framework of this conference, that I -as a representative of Dutch-based international contractor- give you my impression of how I foresee our role in the 1980s, a decade which already started two years ago.
To that end I shall first spend some time touching lightly on our present interest and involvement in port construction, maintenance and design. My account will be illustrated with examples of projects abroad as other speakers will no doubt focus attention on the Dutch ports, most of which, needless to say, we have also been involved in.

2. PRESENT INVOLVEMENT OF THE INDUSTRY IN PORTS

Speaking in broad terms, these past few decades port construction has mainly taken place:

- in Europe, for energy carriers with VLCC's, raw materials and grain and for import and export of general cargo (containers)
- all over the world, but in particular in the oil exporting countries, for export terminals for oil, LNG, coal, raw materials, and so on.

The involvement of the construction and dredging industry in such ports extends from the sea into the hinterland and vice versa. For the purpose of this presentation I shall distinguish three areas in the whole port region, viz.:

- the port-approach, extending from the sea where sufficient depth is available up to the berth itself. This area ususally includes the outer channel, the port entrance, the inner channel, and various basins and berthing areas.

- the dock and harbour area, composed of the various cargo terminals where the actual transshipment, storage, and often industrial activity take place. It includes quay walls and jetties; harbour sites, with the necessary platforms, storage areas, sheds and warehouses; terminal equipment for the transshipment of goods, in which the contractor is usually not involved; dry docks, slipways.

- the hinterland distribution network through which the various categories of cargo are distributed from the port areas into, and/or collected from, the hinterland. It include road connections and motorways, railways, pipelines, and inland waterways.

Let me say at once that the infrastructure between the port and the hinterland is an absolutely vital factor in the economy of the whole area in which the port is located.

a. Involvement in construction

With respect to the construction of ports I would like to give you an impression of the nature and magnitude of the work which has been carried out up till now, -the early 1980s. The scheme I have just presented will be followed from the sea into the hinterland.

As regards the port approach area, often in combination with other contractors we have been involved in the construction of many ports in the world, and in particular many European deep-water ports, mainly in the following three types of operation: dredging, breakwater construction, and slope and bank protection works. To give a few examples of European ports:
- in France, the construction of a deep-water oil port near Le Havre for tankers of more than 500,000 dwt (exposed breakwater, rocky coast);
- in Milford Haven, in the South Western part of Wales, a deep-water

oil port (channel 10 km, depth 19m, severe sea conditions and rock dredging).
Only 75 km to the east, at Port Talbot, a new port was constructed to accommodate 100,000 dwt ore carriers;

- In Wilhelmshaven the approach channel and an oil terminal were built to accomodate 250,000 dwt tankers;
- In Gothenburg a port approach for 100,000 dwt ships;
- At the moment in Zeebrugge in Belgium, a new sea port is under construction for 125,000 cubic-metre-LNG tankers and for general cargo;
- Last but not least, in the Netherlands, the construction of the approaches to the ports of Amsterdam, Rotterdam and Scheveningen.

In spite of the growing competition it may be said that the Dutch dredging industry has played a significant role as far as dredging and marine civil engineering works are concerned. As regards the construction of breakwaters, stronger foreign competition is encountered.

In the second area of the scheme, the dock and harbour area, the port construction industry is mainly interested in the dredging of basins, the reclamation of piers, harbour sites and industrial areas, and the construction of berthing facilities such as: quay walls, jetties and locks. Examples of our own work include the building of a container port in Southampton about 20 ha in area, the extension of the container port at Felixstowe by 24 ha, the construction of a 200 ha deep-water terminal at Teeside. Recently, a terminal for the petrochemical industry has been built on the southern bank of the Tagus River near Lisbon.
Notwithstanding the fact that our greatest involvement is in dredging and reclamation works, numerous civil engineering works have also been realized in many parts of the world. Examples are: quay walls and jetties in Malaysia, Pakistan, Nigeria, and in Wilhelmshaven; port offices and warehouses in Malaysia; and large drydock schemes in the Netherlands, Cadiz, Barcelona and Mexico.

Also in the third section of the port region, the hinterland distribution network, the port construction industry plays a very active part.

In a number of places in the Netherlands and Germany, motorways have been built in areas sometimes characterized by very soft subsoil, such as the motorway between Gouda and Utrecht in the Netherlands. In the field of railway engineering, our industry is involved in the laying and ballasting of railways and marshalling yards in the Netherlands, the U.K., as well as in places outside Europe. A recent project to be mentioned, is the 130 km-long Aqaba railway in Jordan.
In this respect special mention should be made of our expertise in the construction of bridges, viaducts, and flyovers in these road and railway networks, and in particular the experience in the construction of submerged tunnels, such as the railway tunnel near Amsterdam.
Many ports in the world make use of inland waterways for their connections with the hinterland. Our interest in this respect is multifold, and ranges from the deepening of rivers with specially designed river trailers to the excavation and dredging of new canals. Examples are: the Amsterdam-Rhine Canal and the Scheldt-Rhine Canal in the Netherlands, and the construction of various locks and weirs, such as the lock complex in the River Meuse in the Netherlands, and the weir-lock system in the Rhine-Main-Danube canalization project.
During the last decade our industry has become more and more involved in the construction of pipeline networks, often as a connection between the hinterland and the port. A recent example is the 1000 km-gas transportation pipeline in Algeria.

b. Involvement in maintenance and operation

In the maintenance of ports our interests are mainly concentrated in the regular dredging of approach channels and harbour basins, in most cases when these waterways and basins are in open connection with the river and/or coastal water regime. Whereas in several countries the authorities themselves assume responsibility for maintenance dredging, because of its continuous character, a large number of ports still have to rely on industry. As I mentioned previously, the deepening of ports results in most cases in increased maintenance. Because of the huge quantities involved on the one hand and the high risk element introduced by the large crude and bulk carriers on the other, a lot of research has been done to optimize maintenance dredging.

As regards port operation, so far we have been active in the Middle East and in Africa in the pilotage and berthing operations of VLCC's.

c. Involvement in port design

A conspicuous development in the port construction industry in the seventies was the growing interrelation between the port authority, the designer and the contractor. Ports are getting bigger, more capital intensive (sometimes purpose-designed equipment is required), and the time available for construction is becoming shorter and shorter. This has resulted in, among other things, the development of departments and companies within contracting groups responsible for the design of ports and waterways. In our group, 'Hydronamic' is such a company, as also the design departments of the divisions.
Among a great variety of projects outside the Netherlands we have been closely involved in the design of the deep-water port near Le Havre and the new port of Zeebrugge. In addition, port approaches have been designed for ports in Italy, France, Portugal, the Middle East, Africa, and South America.

With this I hope to have given you in a helicopter of how our industry has so far been involved in the construction, maintenance and design of ports. This world-wide experience and insight in the developments around ports in various countries brings me to the next part of my presentation: 'What are the trends of development of ports in the world today, and what role in can our particular industry play in them?'.

3. TODAY'S TRENDS OF DEVELOPMENT OF PORTS

To what extent we shall be able to continue in the 1980s the package of services the port construction company has rendered in the 1960s and 1970s --or perhaps even to enlarge its scope--, or to what extent we shall have to change our approach, will depend on a large number of factors. For each port concerned the most important of these factors are the following :

- is there a need for new port building? This will, of course, depend to a large extent on the economic expectations and the consequences for the transportation of the various commodities, matters which

have been dealt with by the previous speakers at this conference
- the availability of finance
- are there local design, construction and maintenance organizations available?
- the growing protectionism in various countries.

Apart from the development of world trade as a whole, these factors will differ from country to country. For the purpose of this presentation I shall discuss my views concerning four different types of countries we can distinguish in the world today, viz.:
- the industrialized world, i.e. North America, Europe, Japan, South Africa, Australia
- the oil and gas exporting countries, such as the Arab countries, North Africa, Nigeria, Venezuela, Mexico
- The newly industrialized and more developed Third World countries, such as Brazil, Argentina, Mexico, China, Korea and Taiwan
- the real developing countries
- the East Block countries (which I shall leave out of discussion at this stage).

a. The industrialized world

In the industrialized countries we see that most of the ports and their related infrastructure have already been realized; port authorities --mostly government organizations-- have fewer financial means available; the amount of port work is decreasing; the engineering and construction capacity is large and of good quality; as a consequence there is a trend towards an insufficient volume of work. However, port development in the 1960s and 1970s has led to various problems, such as:
- The quantities of maintenance dredging have increased. The dredge spoil is often contaminated due to water pollution in and upstream of the port from population and industrial activities. Population in and around port regions are very environment conscious. Where do we leave the dredge spoil? How do we improve the environment, etc?
- The dangers for the environment and safety have grown with the size of the ships. We all remember the disasters with the Torrey Canyon and the Amoco Cadiz and the anxieties connected with the transport and strorage of LNG.

- Government involvement in and knowledge of the problems have increased enormously; unfortunately, the tendency to solve them has not.
- The North American situation is different; for local companies the construction market is very well protected; however, there is a great need for deep-water port facilities, which is of great interest to our industry.

In addition, we can detect a tendency towards a change in the kind and origin of energy carriers. This may, in turn, have an influence on the ports, namely: the replacement of oil by coal; increasing coal transportation between industrialized countries (U.S.A., Australia, South Africa); development of more exposed oil and gas reserves in the industrialized world (North Sea, Arctic); gas imports from the East Block; and the development of 'sun-water-wind' energy resources; and such like.

This philosophy has the following consequences for the port construction and dredging industry:
- maintenance dredging goes on, and, if possible, must be made more economic. This means further improvements in dredging technology.
- solutions must be found to overcome or prevent environment and safety problems. Once more a demand for improved technology.
- the necessity for proposals, plans, and so on, to solve the problems continues to exist. In this respect there will always be a need for private initiative. That is why, in our view, contractors must continue to develop their engineering facilities (with special emphasis on the environment, safety and energy).

Some steps have been taken already in line with the trends of the 1980s, such as:
- the construction of the new oil combat dredger 'Cosmos'
- the development of solutions for safeguarding the environment against pollution, and for increasing safety and for energy by means of projects like the Island Projects of Boskalis and the 'Eau Claire Project'
- the setting-up of engineering entities to deepen and broaden port and

dredging technology
- the setting-up of a U.S.-company with American-built dredgers.

After considering the other catergories of countries, I shall go into more detail about each step we have taken ourselves.

b. The oil and gas exporting countries

The oil exporting countries have been booming as regards port construction since the 1973 oil crisis. Hardly any local engineering and construction facilities were available, but there were considerable funds to develop projects. Because of the decreasing trend as regards oil consumption and oil prices in the world, the availability of funds in these countries will be reduced; as a consequence there will be less of a boom in new projects, and concentration will probably be more on the improvement of the infrastructure between the ports and the hinterland. Furthermore, local engineering and construction facilities are still limited. This may offer possibilities for our existing plant. There is also a growing demand for skilled operators and management to run and maintain newly built facilites.

c. The newly industrialized and more developed Third World countries

In the third category of countries, the newly industrialized and more developed Third World countries, ports and other infrastructure already exist to some extent. However, these are much less advanced than in the industrialized world. Generally speaking, there are only limited financial means available, in particular foreign currency. On the whole there are considerable engineering and construction facilities available. These countries may offer us the best chance for introducing specialized construction plant and specialized engineering know-how. For traditional engineering and port construction there is only a very limited market, but if we are able to provide finance for projects on attractive terms, the opportunities are greater. This is particularly the case when such (port) projects bear some relation to energy carriers. To provide a financial package that is attactive in many respects, the support of the home-country government is essential. Summing up one may say that for our industry the chances are the following:

- to provide highly specialized know-how and equipment in the field of infrastructure, particularly if this is related to water and soft soil. In this respect one should also think in terms of the environment. Yet, many ports in these countries have enormous populations.
- to provide total packages, i.e. finance, design and construction.

In this connection we have already taken certain steps, such as:
- the development of specialized port engineering know-how (dredging, hydraulics, nautics);
- we were asked on a framework contract basis to develop a coal port in the People's Republic of China, and the Dutch financial world was asked to make a proposal for the financing of this port project. Due to political and financial obstacles the project has not gone through yet.
- we have been more successful with a total package for a gas pipeline project in Argentina (total contract value Dfl. 3 billion), which included the design, construction, financing, and operation of the project. Thanks to private initiative in combination with the support of the Dutch government, we have been able to create a considerable amount of employment.

d. The real developing countries

Finally, I should like to devote some attention to the real developing countries, a group of countries the world has good reason to worry about. A side feature at the opening of our new offices in Sliedrecht was a symposium we organized, entitled: 'Third World and the International Contractors'. These countries lack everything: food production and infrastructure are underdeveloped; often they do not have their own energy sources; there are hardly any financial sources. They depend largely on the support of international institutes and development aid. Port construction is usually financed by international institutes and tender procedures are followed as a rule. The industry has to come up with competitive prices. However, on a bilateral basis, certain small-scale projects may be realized.

I am fully aware that the actual situations are often even less clearly defined, but I hope to have given you by this schematic analysis an impression of our vision on the main trends of development in the world.

4. DEVELOPMENTS FOR THE 1980S WHICH ARE ALREADY UNDER WAY

As I mentioned before --besides our interest in carrying on present day business-- against the background of our philosophy for the 1980s, we are already pioneering a number of this decade's other technological highroads. Allow me to call your attention to few of them:

a. The new oil combat dredger 'Cosmos' as a practical solution to cope with environmentally hazardous problems in the newly created deep-water ports and waterways. The dredger has been built by 'Cosmos Dredging', a consortium of three contractors: Boskalis Westminster, Volker-Stevin, and Holland Dredging Company.
   Several disasters with large VLCC's in important navigation routes, which caused major oil spillages, have shown that to date there are still no effective means to deal with pollution on a large scale.
   Since the construction and operation costs of a large oil combat ship would be prohibitive in view of the very limited time it would be in use, it was decided to build the ship in such a way that during its idle time (a high percentage of the time) it could operate as a maintenance dredger. Thus the so-called slicktrail 'Cosmos' was designed and constructed in close co-operation with the Dutch Ministry of Transport and Public Works.
   Some characteristics of the dredger are: length 114 metres; beam 20 metres; total oil storage capacity 6,500 m^3; it can handle at least 15,000 m^3 of oil in three days; when operating it can clear a single path with a width of more that 50 metres or, in other units, roughly 20 ha per hour; the oil combat operation is possible up to wind force 5.
b. The U.S.-built trailer 'Stuyvesant', a developed approach for protected markets and the deep-water port market.
   Due to the so-called 'Jones Act', the American dredging market is still not accessible for non-U.S.-built equipment. For this reason we have formed a partnership with the Zapata Corporation, named the 'Stuyvesant Dredging Company', which now has its first trailing

suction hopper dredger being built in New Orleans. This $ 55 million trailer, named 'Stuyvesant, is to be the largest dredger in the U.S. It will be operational by mid-1982, and is designed specifically for the development and maintenance of U.S. ports and waterways. The 'Stuyvesant' is an ocean-going hopper dredger with a hopper capacity of 6,750 m^3, and equipped with the most technologically advanced navigation positioning and dredge process control equipment. The dredger, which is 114 metres long, and which has two trailing suction pipes, can operate in busy waterways without delaying normal shipping traffic. It is also able to operate efficiently in heavy swell and sea conditions.

c. The development of new markets and the creation of solutions for large infrastructural and environmental problems in the industrialized world.
The emergence of such problems often leads to lengthy social and political discussions tending to try and stop activities instead of finding practical solutions. As an industry accustomed to creating projects, we see a role for ourselves in the 1980s to present suggestions for dealing with large-scale infrastructural and environmental problems, and to elaborate and study them with the authorities concerned. An example is our Sea Island Project, developed in the early 1970s, you may remember, a Dfl. 200 million-solution for the treatment of all Dutch waste. An example, alas, of too much talk and too little constructive action. The many 'Lekkerkerks' and 'Dordrechts' in the Netherlands are costing our society a multifold. Nevertheless, let us not forget that the island idea has meanwhile become an important export item for our country. We have built six man-made islands in the Beaufort Sea, and now other dredging companies and even the Dutch Ministry of Transport and Public Works, are also active in the Arctic.
Since we believe in close co-operation between government authorities of the home countries and our industry, we continue to present new ideas, such as recently the 'Channel Tunnel Project', and the 'Eau Claire Project', a proposal for a pipeline for sewage and salt transport under the river-bed of the Rhine based on the same principle as sewage and fresh water pipes under streets. At

the moment we are involved in a new energy-wash-polder island concept. This time we hope that it will be given serious consideration, and that it will be further analysed, not by government bodies alone, but in close co-operation with the industry itself.

d. Further specialization of our skill and technology in dredging and port design and cultivation of export of this know-how (mathematical models).
As regards ports we have noticed that throughout the world there is a need for short-term assistance in rather complicated design situations. It usually relates to problems for which rather sizeable problem and complex laboratory studies are required.
In order to provide short term answers to complex questions at reasonable cost, our engineering company 'Hydrodynamic' has developed a large number of very advanced computer models, such as:
- ship's manoeuvring simulation models to advise on channel dimensions, required space for berthing, and even to be used for the training of pilots. The model includes tidal currents, wind and waves, as well as port and ship characteristics;
- models for ice and water flow in rivers;
- mathematical models for the reproduction of tides, even for such complicated estuaries as the Tagus Estuary in Portugal, which may serve for all kinds of purposes, including pollution problems;
- wave penetration models;
- and last but not least, models for the calculation of sedimentation and erosion, by means of which annual maintenance work can be calculated, erosion of islands, and so on.

e. Co-operation with the home country government in order to obtain total projects (China, Argentina).
You may recall the prospect some years ago of building a coal port in the People's Republic of China. Unfortunately, the project has been postponed by the Chinese authorities. However, as far as our organizational set-up in the Netherlands is concerned, this was a good example of how to obtain and organize a total project.
A consortium ('Port and Delta Consortium') was formed, consisting of contractors, consultants and suppliers. The government would contri-

bute its know-how to the consortium, and supervise the project for the Chinese government. There was close co-operation with Dutch banks and port operators. Although the project did not materialize, it served to demonstrate how the industry and government can proceed hand-in-hand to obtain a total project.
In passing, I should like to mention another project in the total capability approach where we have been more successful, namely: the three-million-dollar gas pipeline, 1,750 kilometres in length, which was put into operation some months ago. The project included design and construction (together with the Gasunie, NAM, and British Gas Corporation), and finance (Dutch banks), while the project was guaranteed by the government.

5. SUMMARIZED VISION OF INDUSTRY IN THE 1980S

Arriving at the end of this presentation I would like to summarize my views as to how -in relation to port construction- the industry should approach the 1980s.

First of all, we should keep our share in this field of business in a world of growing competition by continuing to improve and optimize our operating capabilities. Do not forget that maintenance work has to go on.
Secondly, we have to find solutions for the upcoming protectionism (our U.S. Company).
Thirdly, in combination with government authorities we must try to develop solutions for environment and energy problems (Cosmos, Islands, and Eau Claire).
Fourthly, we must cultivate further all and any opportunities for exporting our highly specialized know-how and skills, not only as regards design and construction, but also with respect to the operation of projects.
Finally, together with the home country government, we must seek to generate so-called 'total projects' (like China, Argentina).

With respect to the last two conclusions in particular, close co-operation between the industry and the govenment of our country is

essential with, in my view, the wet-up being as follows:
the industry --with its enormous international experience-- at the reins of the projects, and the government as the authorizer and supplier of know-how.

Thank you very much.

Ports in Technology

Professor Ir. G.Ch. Meeuse
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Today's society is more and more characterized by the interrelations between the various activities necessary for us to survive. Participants are no longer permitted to act autonomously. All things considered, we find that the interdependencies make control and management rather complex, and that they can hardly be executed any longer by hand.

Ports form concentrations of transport activities serving the flows of commodities. They are of a service-rendering character, and it is only since recently that their influences on the other participants in the transport world has been accepted. Feedback on the goods they handle can only be effectuated with much care.
In order to get some grip on developments, and to avoid surprises, it is necessary that port operators, and more so decision-makers, should widen their horizons in more than one respect.

In earlier publications, based on studies I made together with Professor drs. H.J. Noortman, we drew already attention to the fact that ports no longer only exist to serve the traffic in a more or less satisfactory, passive way, but that they form parts of transport systems, and are even components of technological systems.
This development can be illustrated by the general pattern of the history of human material activities. This history shows rather spectacular change-overs, and can be described in three stages:

- In the past, autonomous activities were performed by individual workers through manual labour. This period can be best characterized by craftmanship. During this -static- period mechanical handling tools and equipment formed the means to support the physical labour.

- Co-ordinated links of transport and product chains can be found after energy became available. The changes in this stage are so spectacular that we speak of the first industrial revolution, during which technique came into being.
  Production and transport become more and more mechanized; the various activities are no longer considered static. Considerations are no longer directed to the objects themselves, but to their functions; the activities are joined into processes. This present -dynamic- stage still considerable determines our age.

- Finally, the introduction of information offers cybernetic control of systems. Mass, energy and information are the components of technology. Transport chains are to be integrated, account being taken of their mutual interdependencies.
  This event again caused considerable commotion. We are today in the epicentre of the so-called second -technological- revolution. And those who wish to comply with the consequences, need to adapt their attitudes accordingly. Consequently, technologic systems comprise all the activities, i.e. both production and transport, necessary to take products from their origin to their destination in the right shape, to the required place and at the most convenient time.

The above stages of development also apply to ports (Figure 1). On their way from origin to destination the flows of products pass through these ports, which are either seaports, landports, airports, railway stations, or trucking centres.
Also the accompanying and more ore less synchronized data flows, i.e. the complementary elements of transport processes, meet these ports, and are also transferred, stored and handled.

The various subsequent stages can be visualized when we observe ports in a helicopter view. From various altitudes impressions can be obtained similar to the earlier described characteristics of these periods: past, present and future.
Here we can distinguish three altitudes by their increasing aggregation levels (as far as it concerns operations, functions and relations).
Still on earth we can smell the products to be handled, and see the

silhouettes of carriers and port equipment. These primary sensory perceptions of port activities already indicate some important parameters to be taken into account when we study the phenomenon of 'port'.
After take off, first the operational aspects become noticeable. These aspects tell us something about the structure and organization of the field of activities. Regardless of the equipment used and the methods applied, the proper functions performed are off real significance. These aspects can only be observed after we have gained more height, that means more distance.

Speaking in terms of function, a port can be said to be a location where conveyance activities are either completed or find their starting point (Figure 2). For the different types of ports even a specific qualification, i.e. a name, was imposed by the dominant mode of transport they serve. Such a practice is bound up closely with a restricted, one-sided view, too often found in ports. Within technological systems there should be an equivalency of activities, e.g. production and transport. Now, I must admit that already in the transport level itself, there is no equilibrium of power.
As I mentioned before, main modes of transport dominate all others that meet in a particular port. Consequently, the so-called 'sealeg' of a seaport is generally well developed, wheras the 'landleg' still can be improved considerably. Similar observations can easily be made for airports, railway stations, etc.
When flying still higher, the helicopter finally allows for a still more aggregated picture, showing the principles of transport, or better of technology, on the location under consideration. Such a picture can only be obtained through a system approach of the transport problems.

The description in accordance with such an approach reads: 'A port is a location in which products are transferred form one stage within a (transport) system to a subsequent one' (Figure 3). Such a location can be called a terminal, and a collection of terminals together form a port. The role of such terminals, whatever type we may have in mind, can be considered a component of the transport, respectively of the product chains. The ports form the cross-sections of the different product chains passing them. This implies that terminals and ports also belong to the basic technological systems of which they also form the components.

The position of the cross-section within a product chain indicates the degree of completion of the technological series of activities a product has to undergo before it reaches its final goal (Figure 4). Roughly speaking, this can be expressed in terms such as: raw material stage, semi-manufactured stage, and finished goods stage. A more accurate way of expressing this could be found in a technological percentage. Anyhow, the position of the cross-section should be determined, and more particularly, changes of this position should be watched carefully.
In the flow of products from less developed areas such shifts due to primary production activities can be easily expected. For a not so well prepared observer they come as a surprise.

Besides this technological completion percentage, which indeed can be considered a magnitude to characterize a port, the volumes of the transport flows through the transport chains and the appearance of the goods must be given all the necessary attendance.
On account of their physical properties, most products and articles are not simply suitable for transport. Until recently, it was considered a good practice in transport enterprises to develop all kinds of adaptations of the means of transfer and handling aids, in order to suit the varying requirements of the specific goods to be transported.
A next step in system approach of the optimization process was reciprocal, through efforts directed towards the cargoes themselves. One of the spectacular results was the introduction of assembled unit-loads of uniform dimensions, neutralized characteristics and appropriate weights. Of these unit-loads the container is the most outstanding, attracting a considerable and ever-growing share of so-called general cargo.

Now, what can we consider an appropriate weight?
Historically speaking, it was a load that could be borne pickaback by a docker. In this stage bulk cargo had to be bundled to 'manloads', and

heavy or voluminous loads had to be broken down to manageable pieces. The various types of commodities can be depicted according to ascending dimensions of the particles and pieces to be handled (Figure 5). However, this manload orientation of commodities cannot last much longer. Not only because it will not be considered decent to make use of human beings as if they were pack-animals, but perhaps even more because modern requirements of efficiency (such as weight, dimensions and speed) are no longer met. And this results in the transformation of manloads into unit-loads and bulk cargoes.
As mechanization makes progress throughout the transport chains, the weight restrictions can gradually be removed, or at least be moved up considerably.
However, as long as not all the stages in the chain of transport have been mechanized properly, the units will have to be broken down into manloads again at the poorly equipped locations.

If products become available in sufficient quantities, the assembly of unit-loads becomes superfluous. In that case, special, adapted implements and methods for continuous conveyance must be available in every stage (Figure 6). This process of adaptation will go even further when the products themselves are provided with other appearances for reasons of transport efficiency. Examples are: liquified gas, slurrified solids, and pettelized ores.
For many interested parties the development from 'manload orientation' to bulk cargo and unit-loads came as a complete surprise; and the phenomenon is therefore called: 'goods-explosion-model'. This explosion brought a tremendous part of intercontinental freight transport into the category of bulk cargo; of the total volume of dry cargo over 80 per cent.
On the other hand the manloads found their way in the already familiar forms of unitized cargo. So, speaking in terms of volume, unitized cargo is far in the minority as far as it concerns intercontinental transport. However, expressed in value, the breakdown in bulk transport and unit cargo is probably closer to 30 : 70!
It goes without saying that this explosion in the appearance of goods was not made possible solely by the technological developments; it was introduced by basic shifts in the relative costs of the handling and

transportation of goods.
To prove, or at least to justify the goods-explosion-model, it can be shown that already ten years ago the cargo flows passing through the port of Rotterdam successively in the years 1965, 1970 and 1980, gave a forecast of what is considered today a crisis in general cargo (Figure 7). This event is in no way to be considered conjunctural, but it is purely structural.

When we try to give answers to the points raised above, the best instrument to use seems to be the 'systems' approach (Figure 8). Following this approach, port activities have to be seen in the first place as a sub-system of the total transport system. (Total) transport systems should in their turn be considered as sub-systems of the still broader, technological systems that envelop both transport and production systems. (It should be kept in mind that the objective of production and transport is the addition of value to the product; production adds value by virtue of shape, whereas transport adds value by virtue of place or time.) By applying the systems approach to ports it is possible to gain control over the tremendous number of variables involved in port activities. Many activities take place: at several places, at the same time, or with a time-lag.

The systems approach makes it possible to keep control. It enables simulation in advance (Figure 9), and the determination of which uncertainties in future developments are relevant to decision-making, and which uncertainties are not. The systems approach is necessary if we want to conduct an anticipatory policy, instead of merely reacting to events.

In general, transport activities may be specified in a fairly detailed manner in so far as it concerns the type of goods, their origin, and their destination. In using the systems approach, it must be borne in minde that a port as such is usually part of more that one transport systems. And in particular a seaport forms a collection of activities serving to connect sea transportation with the various modes of inland transportation. This means that in decision-making concerning port activities, we should not only take into consideration the relevant variables for each individual product chain, but also the optimization possibilities opened up by the fact that a whole range of product chains is passing through that port at a given moment. In this connection it is interesting, that time and volume specifications are not completely exogenous, but can be influenced by those who are responsible for decision-making in ports.

The earlier considerations can be summarized as follows:

a. Port activities as parts or transport chains.

Because product origins and destinations are in most cases not the quay side, harbour activities form in general part of transportation 'clusters'. Clusters are the several transport activities (e.g. storage, conveyance, and transshipment) which together comprise a transport chain.

It will be understood that within such a chain, port facilities as such are influenced by the other transport activities, so that optimizing the port activities in fact comes down to optimizing the clusters that together form a transport chain.

(b) Transport chains as parts of transport systems.

The above-mentioned clusters of transport activites do not stand on their own. They form an element of transport systems (Figure 10). Other elements which must be taken into consideration are: the products that have to be transported, and the data accompanying those products.

Again, it should be realized that decision-making in (the links of) a transport chain calls for a broadening of scope, in this case towards considering the transport system as a whole.

Until recently, the means of transshipment and conveyance were adapted to the requirements of the goods to be transported.

If the goods are considered one of the elements of the transport system, the appearance of the goods is no longer 'external' data. The appearance then becomes an indigenous variable within the system, and only the physical characteristics of the products belong to the external data.

The data accompanying the product has to be seen as a part of the transport system. This will be obvious when we realize that the actual transport time through the whole transport chain is limited by the speed of two flows, namely: the flow of goods, and the flow of data. The slower of these two flows dertermines the actual do-to-door transit time. It makes little sense to increase the speed per link in the transport chain, if it is not possible to achieve a parrallel speed in the data flow.

(c) Transport systems as parts of technological systems.

As mentioned before, a transport system can be viewed as a sub-system of a technological system that embraces transport activities as well as the production system (Figure 11). In fact, the whole set of a technological system spans all the processes during which a product is transformed and transported, starting with the extraction of the raw material, and ending with the final consumption.

Such a technological system can be symbolized by a product chain. In terms of the systems approach it will be understood that decision-making cannot be optimal when it is limited to the transport sub-system. The production sub-system(s) have to be taken into consideration as well.

It is also clear that widening the horizon from the transport sub-system towards the technological system as a whole becomes more necessary as the time horizon recedes.

This integrated decision-making process of considering production and transport together is part of the process of thinking in terms of business logistics.

(d) The port as a meeting point of a number of product chains

A port should not only be seen as a sub-system of the transport system, which in its turn is part of the technological system, the port is also the geographic location where a number of product chains meet. In many cases, however, the cross-section of each of these product chains is at a different level. The level of cross-section is of importance in port model building.

Although technological changes may appear to be sudden for naive observers, there are still signals from which such surprises can be foreseen. I must allow that such signals are not always obvious though, because they are often not readily available, or lying upon the surface. Still, it is worthwhile to trace them, because --as I said earlier in my paper-- substitutions or shifts may have unpleasant effects, in particular when they take place quite unexpectedly. Such technological accidents can be avoided, if we are not frightened by them. Explosions are only swift processes which can be controlled, if feedback and steering can be made faster.

Ports which have been set up in accordance with the principles of participation in (technological) systems have properties deviating from conventional ports.
In the first place the various phases of activities are disconnected. This means that no direct transshipment from one carrier to another will take place. The common direct discharging from seagoing vessel into inland vessel and other combinations will no longer be performed for reasons of overall economy.
Extra handling does not necessarily mean extra costs, when considered in a wider context. This includes an optimal service to all carriers concerned, and a more intensive use of quays, sheds and similar facilities through indirect transshipment.

This principle allows for the introduction of intermediate transport equipment for the geometrical spreading of discharging and storage areas (Figure 12). Speaking in terms of transport systems, a weakening of quay-ties, and particularly of storage, can be said to be obtained. This means that expensive quay surface need no longer be used for the storage of products. Such a port model also allows for making a principle distinction between industrialized ports and integrated ports, contrary to usual views. A port can be very well integrated with serving and served industries lying at considerable distances from one another.
In particular, when connections via continuous transport equipment are available, these distances are less relevant; and thus valuable port surface can be spared.

In conclusion, I would like to make a number of observations with respect to the foregoing paragraphs.
The commodities are increasingly changing, and will obey the rules of the explosion model. The conveying equipment grew in dimensions and speed, and there were hardly any limits to their growth. These implements might become more integrated in the adjacent links of the transport chain, which will reduce their properties and bring them back to usual and reliable levels.
Investments in equipment mounted aboard means of conveyance (such as cranes and elevators aboard ships and aboard vehicles) might have to be considered interim solutions lasting until the moment that the terminals, which serve the modes of conveyance, will be equipped adequately. The exploitation of the vehicles must be satisfactory, i.e. reliable and efficient. The transshipment can be carried out by their parties, provided that the conveyance is not hampered.
The modes of conveyance themselves will develop towards more reliable and energy-saving solutions. However, all the solutions which divide the driving-unit from the carrying-unit will also be temporary, except in cases where a great number of verhicles are at stake, e.g. barges and railway cars.

Finally, ports will more and more tend to be locations near the sea-coasts. At the same time the storage of goods will develop towards stockholding facilities, and even towards some kind of transformation of the goods handled.
The earlier mentioned tendency of the division of transshipment and storage, i.e. the fact that the necessity of coupling the two stages no longer exists, allows for transshipment areas on the seaside, and storage and strockholding facilities more inland and closer to, or right in the middle of consuming areas.
Anyhow, it is no longer the technology that will determine decisions. Economists, ecologists, and politicians will have opportunities to seek their own decisions, and can no longer hide behind technical and technological considerations.
So <u>'ports in technology'</u> can be considered a rational basis to safeguard the decision-makers against surprises by applying systems approaches and by building relevant models.

I have purposely given this contribution the title: 'Ports in Technology', and not 'Ports and Technology'. The latter, namely, would have suggested only another attitude, in which the developments that take place are taken for granted, the ports only being allowed to react in a flexible style.
'Ports in Technology' means participation, and when a stage of integration can be reached, a logistical future.
'Logistics' in this sense means the fully integrated stage in which transport plays a role equivalent to production and trade. Transport is still service-rendering, but now in a more positive and active way. This means that ports are not fully dependent on whatever development, but it stands for ports which -- like all other participants in the game-- can shape their own future.

Thank you.

development of transport			
period	past	present	future
dominating	craftmanship	technique	technology
movement: appearance, place, time, control	matter (static)	matter, energy (dynamic)	matter, energy, information (cybernatic)
characteristics	manual manipulation	transport proces	transport system
transport chain	autonomous links	coördinated links	integrated links in industrial chain
consideration directed on	object	function	function + relationship
field of profession	mech.-handling equipment	mech.-handling technique	transport technology

Figure 1.

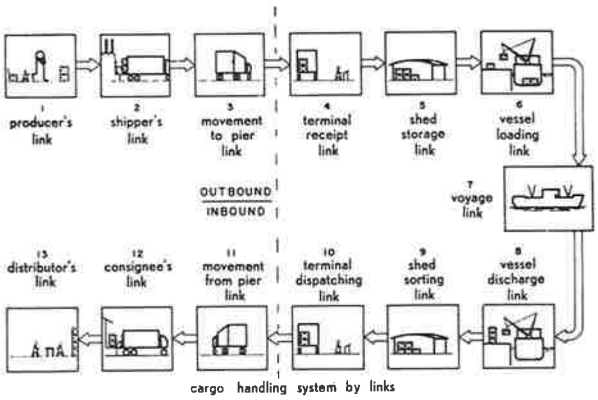


Figure 2.

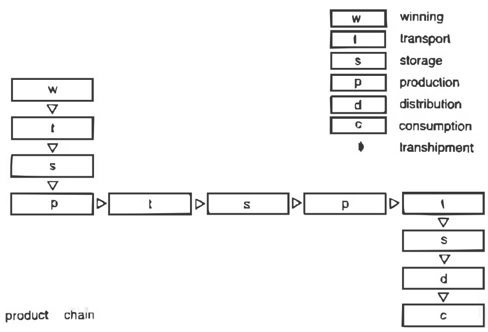


Figure 3.

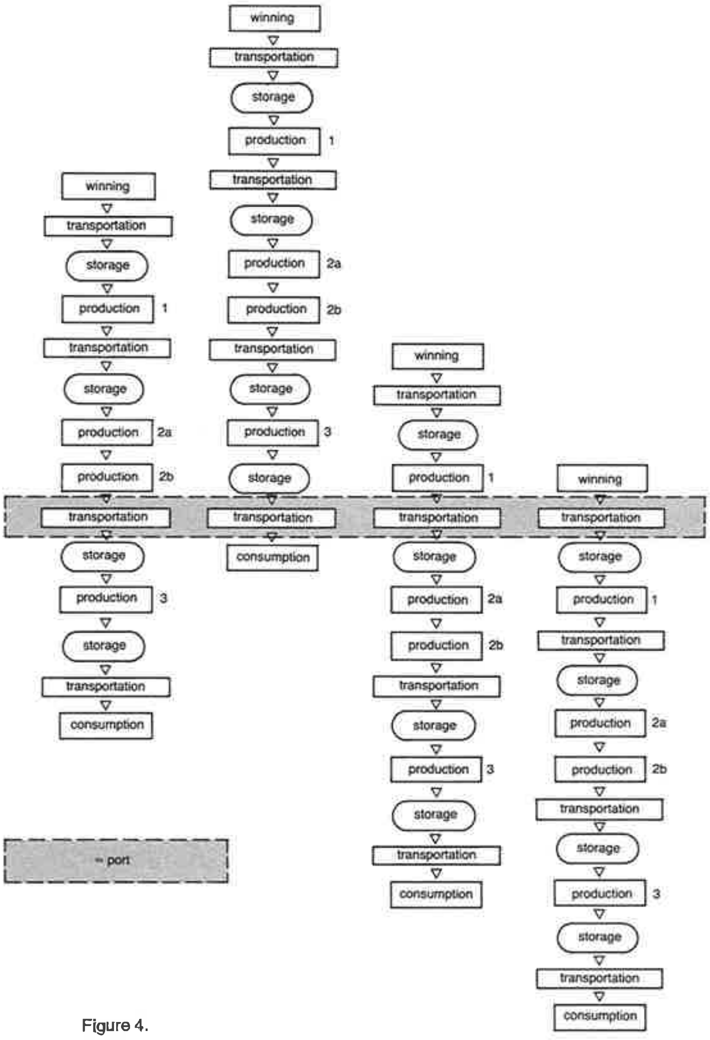


Figure 4.

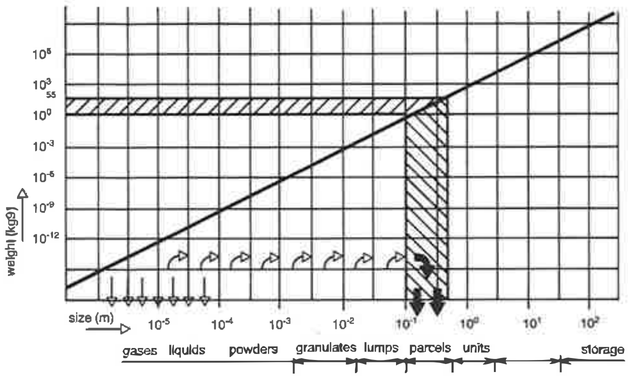


Figure 5

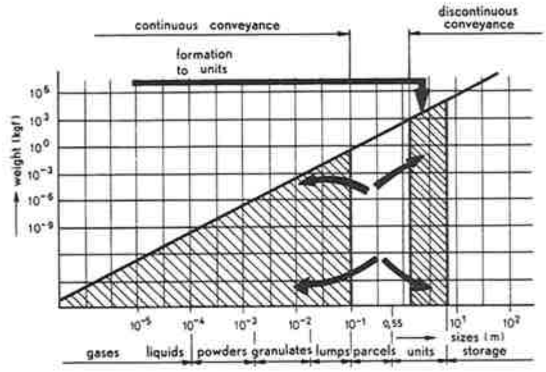


Figure 6.

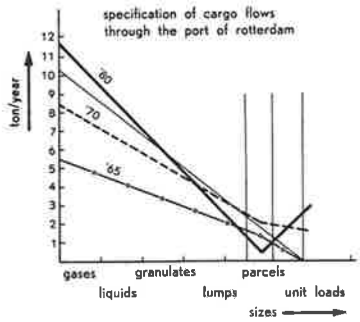


Figure 7.

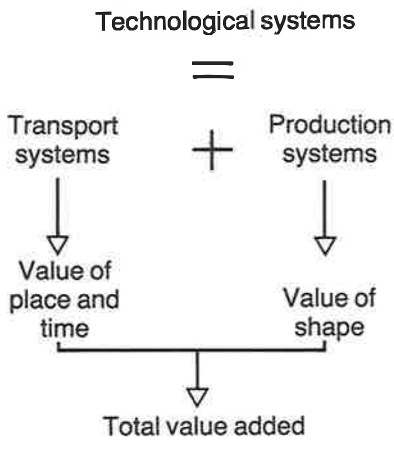


Figure 8.

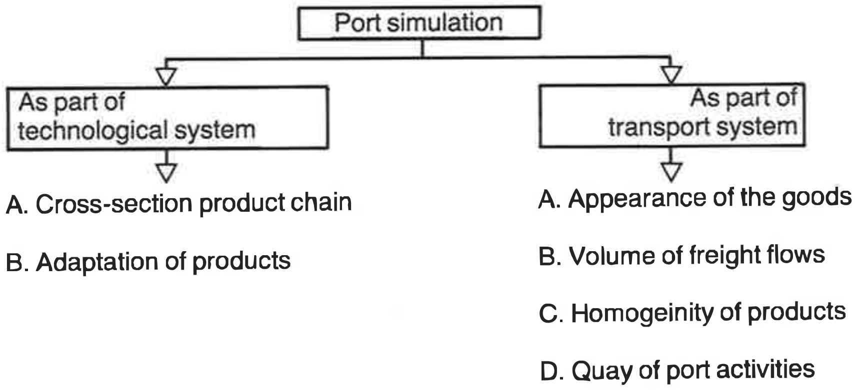


Figure 9.

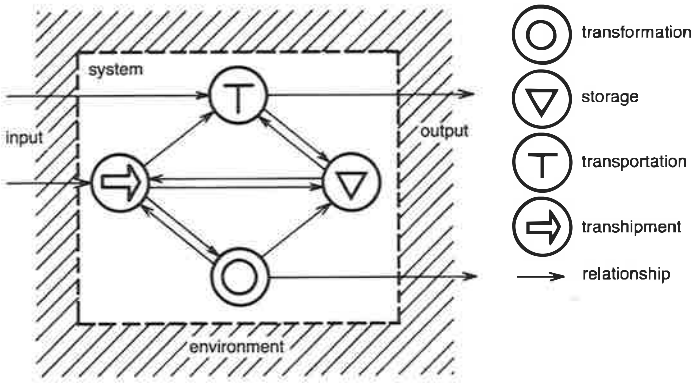


Figure 10.

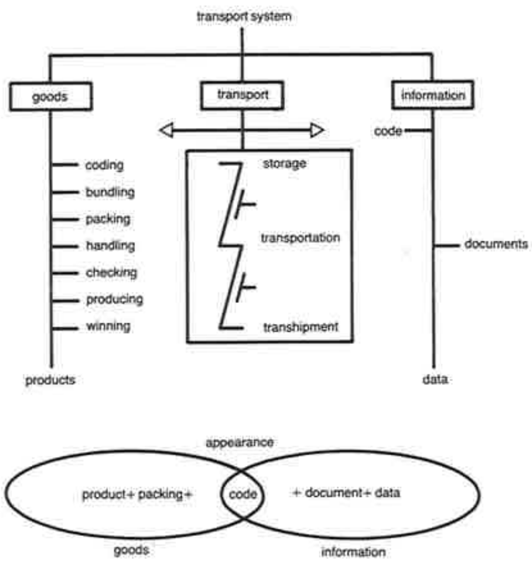
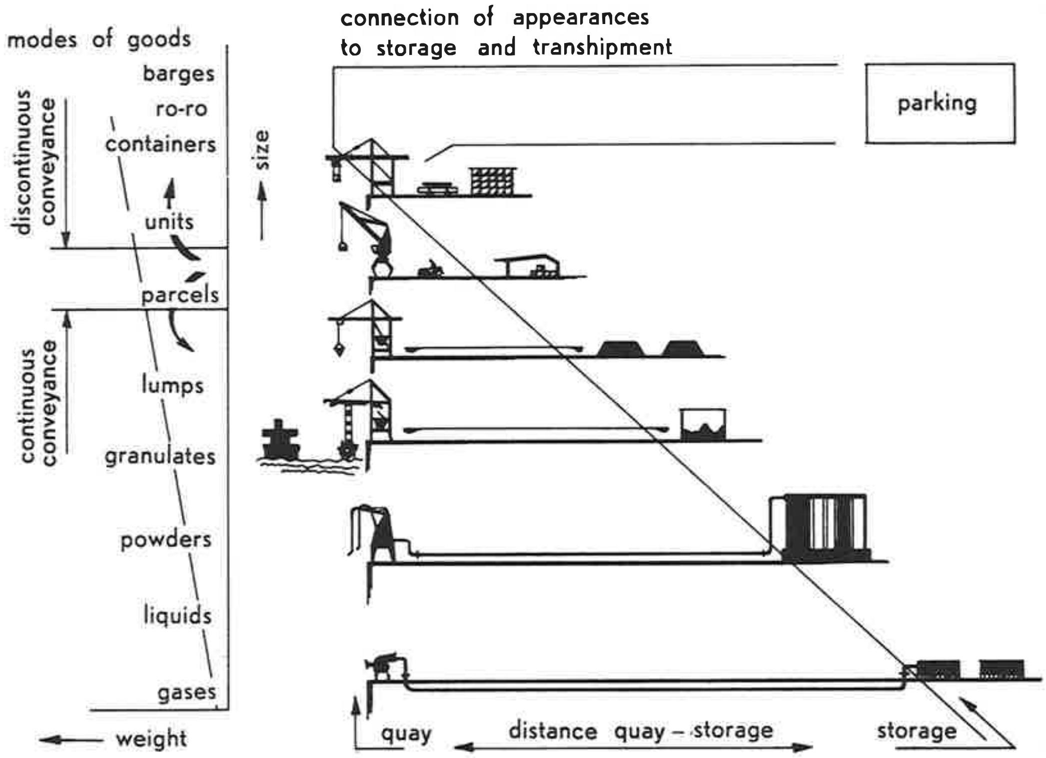


Figure 11.



modes of goods
barges
ro-ro
containers
units
parcels
lumps
granulates
powders
liquids
gases
discontinuous conveyance
continuous conveyance
weight
size
connection of appearances
to storage and transhipment
parking
quay
distance quay – storage
storage

Figure 12.

Developments in Inland Transport Systems

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The function of a harbour implies much more than merely the unloading of seagoing vessels and transferring the load to inland carriers. Storing, collecting and distribution, refineries and industries of all kinds are directly linked to the harbour function. This means lots of transports that are statistically hardly measurable, and have little to do with the direct function of transferring goods from seagoing ships to inland transport and v.v..

Nevertheless, the functioning of a harbour and its prospects are still mainly dependent on the transport facilities to the hinterland; these facilities in fact determine the size of the hinterland.
They consist of a combination of infrastructure and suprastructure, in which the infrastructure comes first. The most flourishing harbours stem from a good natural water infrastructure. Rotterdam is a good example of a harbour that got its position from natural infrastructure. Once in existence the natural infrastructure asks for amendments, not only in the waterway, but also for other transport systems, such as rail, road, and pipeline. It seems worthwhile to stress the importance of the infrastructure. The position of the harbours of Rotterdam and Amsterdam is to a high degree the result of the far-seeing investments in infrastructure made in the past. This implies the seaways as well as the railway and road. The suprastructure may urge for improvement of infrastructure, but the suprastructure both to the port and to the hinterland originally follows the infrastructure.
If the far-seeing approach in the 19th century stimulated the harbours in the past, infrastructural problems can frustrate the future development.

Four main categories of inland transport systems can be distinguished:

Total international transport (1980)

pipeline	44.1 tons	14.5%
waterway	180.5 tons	59.2%
rail	15.2 tons	5.0%
road	65.0 tons	21.3%

These modes are primarily complementary and secondary competitive. In declining order they are fitted for mass transport.

As to the pipeline, infrastructure and suprastructure are practically identical. This mode is fitted for big flows, e.g. crude oil, but is in principle not confined to liquids. Therefore, the pipeline is by nature confined to a very small number of flows, which, however, can have an important share in total inland transport.

In inland waterways there is a clear distinction between infrastructure and suprastructure. The infrastructure is multipurpose: besides the natural waterways artificial infrastructure has often a function in the water household, too, especially in the Netherlands.
The ships' carrying capacities give inland navigation an advantage in mass transport, and unlike the pipeline, inland navigation can carry a wide range of commodities. However, due to the limited infrastructure and the relatively low speed the possibilities in the smaller transport lots are limited.

The railway infrastructure is also multipurpose (passenger and goods transport), and in general it is more detailed than the water infrastructure. The larger accessibility to different destinations and the higher speed give the railway an advantage over inland navigation for the smaller transport flows. Nevertheless, the railway is primarily fit for relative big transport flows. Railways can compete with road transport in full train loads; separate wagon loads are rather costly.
The road has the disadvantage of limited carrying capacity per unit, but has by far the most detailed infrastructure, and can carry out door-to-door transport in short transport times.

Road haulage fits very well in small transport flows of high-valued goods that ask for rapid transport. Nevertheless, on short distances road transport also carries massive flows of low-valued goods (e.g. sand or gravel). The infrastructure of the road is also multipurpose (passengers and goods). Moreover, the road is the prime means of communication in a society.
The multipurpose infrastructure in inland navigation, rail, and road transport makes it very difficult to charge properly the infrastructure costs to the direct users. Moreover, there are many cases where infrastructure has been built in order to develop harbours or regions with no direct regard to the actual users. This makes the discussion about charging the proper infrastructure costs to the direct users rather complicated, and in fact this issue is still not solved.

The modal split in goods transport is to a high degree defined by the transport flows, but grey areas in which different transport modes compete do remain.
The possiblility of competition is enlarged by the possibility of transport by road in conjunction with rail and inland navigation. This construction, however, gives extra handling costs.

A graphic comparison between the costs of transport by inland navigation and road transport is given is figure 1.
The advantage of road transport is relatively large on the short distance and declines according to the size of shipment at increasing distance. The position of inland navigation deteriorates sharply when distribution by truck is necessary at the end.
This is a very general graph; the total transport organization can have considerable influence on the competition possibilities. In fact we then switch from competition to co-operation.

If we confine ourselves primarily to inland navigation and road, we can see a number of developments.
One is easily inclined to look upon inland shipping as a rather static industry. The development between 1960 and 1978 shown in the table hereafter demonstrates a number of changes in the past that contradict this view. The number of companies the Dutch fleet is composed of

decreased sharply, and also the structure of the fleet changed considerably.

number of ships per company	number of companies					
	1960		1970		1978	
1	6545	88.9	5267	88.1	4404	90.6
2-5	707	9.6	649	10.9	381	8.4
6-9	49	0.7	32	0.5	16	0.4
10-19	37	0.5	19	0.3	17	0.4
20 and more	21	0.3	14	0.2	10	0.2
total	7359	100	5981	100	4528	100
	loading capacity (x 1000 tons)					
1	1837	47.6	2297	52.7	2559	59.2
2-5	623	16.2	864	19.9	774	17.9
6-9	138	3.6	191	4.4	108	2.5
10-19	280	7.3	257	5.9	248	5.7
20 and more	975	25.3	744	17.1	633	14.7
total capacity	3854		4353		4320	

Over the whole period the total tonnage grew, and between 1970 and 1978 the decline in carrying capacity was very moderate. The average carrying capacity per ship rose by about 100 per cent. from 376 tons in 1960 to 745 in 1978. This means a decrease in cost per ton transported. The real decline was still larger; total tons transported per ton carrying capacity rose from 17.6 tons in 1960 via 27.9 tons in 1970 to 28.5 tons in 1978.

In the same period the structure of the fleet also changed considerably with respect to vessel type:

type of ship	share in total carrying capacity		
	1960	1970	1978
motor vessels	55.0%	67.3%	74.6%
towed barges	44.5%	27.7%	12.0%
push-barges	0.1%	5.0%	13.4%

In the push-barges there are three to four generations:

- ca. 1960	1600 tons barges	4 per convoy
- ca. 1966	2300 tons barges	4 per convoy
- ca. 1970	2700 tons barges	4 per convoy, (technically possible is 6 per convoy)
?	3500 tons barges	4 per convoy

It is interesting to note the growing share in total tonnage of the small companies. From the point of view of financial resistance and external costs their position is very strong, because the owner operates the ship himself at a net income that the market offers. This makes it difficult for the larger companies to maintain their competitive position in the market for motor vessels. The latter, namely, are confronted with external labour costs. This explains their decline in share. These companies can only survive in the market, if they apply themselves to specialized transports in combination with direct access to clients, or if they are daughters of larger companies in transport or industry. The large shipowners, for instance, operate the push-barges where economies of scale are evident. Besides, they are very often daughters of larger companies, so that they have direct access to the market.

The market for inland shipping is split up into two main categories:
a) the market for contracts covering a large number of transports
b) the market for single transport (spot market)

The small companies operate mainly in the spot market, and only via

co-operations they have restricted access to the contract market. In the spot market they do not deal with the clients, but with intermediaries. This means that although their position may be strong owing to their financial resistance and external cost basis, as parties in the market the one-ship companies are very weak; they have to transport at the prices that the market offers.
They can only adapt (and did so in the past) their carrying capacity to the market demands.

In road haulage some developments are in line with inland shipping; a declining number of companies and a growth in carrying capacity per company. However, in road transport the growth in capacity per company is primarily due to the number of units per company, and only slightly due to a growth in size of transportation units. Contrary to the inland shipping, the medium-sized and (relatively) large-sized companies grew rather strongly, while the position of the small company diminished.

Composition of the road haulage industry according to carrying capacity

carrying capacity in tons	loading capacity		
	1960	1970	1979
less than 25 tons	35	13	5
25 to 50 tons	22	13	8
50 to 100 tons	17	17	13
100 to 500 tons	23	39	44
500 tons and more	3	18	30

In road transport the direct contacts with clients prevail, and the companies offer transport services and auxiliary services dimensioned on the clients' needs. This is in favour of the medium-sized and large companies, who can offer a package of services in transport material as well as in auxiliary services that small companies cannot offer. However, the risks involved as well as the financial implications, led to a situation in which many of the large companies gave up their independance, and became daughters of holdings or of other big firms in transportation.

Both in road transport and in inland shipping the productivity rose sharply in the period 1960-1978. The productivity development in road transport --an industry in the service sphere-- was in line with the productivity development in the manufacturing industry.

Future developments

If the prophecies that the western economies will be more and more dependent on high-valued products come true, the share of mass transport of low-valued goods will diminish, and the share of high valued goods will increase. At first sight this seems to be in favour of road transport and to diminish the share of rail and inland navigation. There is, however, an other aspect in this development; the transport flows of high-valued goods will grow, and that will make them interesting for rail transport and inland navigation.

The competition between rail and road, and inland navigation and road, did not preclude road transport from being used in many cases in conjunction with rail transport and inland navigation. What we see now is the growing co-operation between rail and road, the rail carrying the trailer or the load unit over a certain distance. This rail/road combination, initiated by the rail, grows slowly and has its advantages only for a moderate part of road transport.
The potential growth of this form of combined transport depends on the level of service of the rail and kilometre costs of road haulage. The latter depend to a high degree on fuel costs.

Studies are now carried out to make a similar option for the combination inland navigation/road transport. This is non too speculative, because we now see more and more containers being transported by inland navigation.
Via a system of inland terminals the inland navigation/road transport combination is a possibility that can also include ro/ro in inland

transport. This possibility poses the question why these services should not be extended to short distance oversea transport.
This looks profitable for inland navigation, it is true, but could also be the Trojan Horse. Namely, if inland navigation can expand to seatrade, why should the opposite situation not happen, and should seagoing shipping not expand its area to the river Rhine?

The weakness of road haulage and inland shipping is in their small size; they lack financial and organizational power to design and operationalize big systems, whereas seagoing shipping and harbour industries do have these possibilities. We saw this happen with the container and the LASH-development, in which the traditional inland transporter had no other rôle than to adapt and to subcontract. Co-operative actions of the inland transport companies could yield the potence, but I fear that this is sheer theory without help from outside. Nevertheless, especially for the small inland navigation companies, it is important to look into the future possibilities and try to get hold in these new developments. There are examples of co-operative actions that were successful.

The development of combined transport will affect road haulage, but the important rôle of road haulage in direct transport will continue. To be fit for combined transport, the flows must have a number of characteristics, such as:

- considerable distance, in order to overcome the extra handling costs;
- rather concentrated origins and destinations, so that the main distance is covered by rail or inland waterway;
- no sharp constraints as to tranport time and care for the goods;
- availability of return loads in the neighbourhood of the inland terminals, so that the benefits of combined transport in one direction is not outweighed by transportation costs of empty units.

Transport flows from the harbour seem to be most fit for combined transport, because there are rather big flows that have already to do with handling costs and rather long total transportation times.
The problem of the return load, however, asks for an adequate

organization. The tendency in road transport to use new communication channels (Viditel) in order to come to an exchange of freight and to avoid as much as possible empty trips could be very useful in the setting up of such an organization.

In mass transport we see a decline in ore transport, which probably is structural. As to inland navigation this decline can be compensated by an increasing use of coal for electric power generation. The question arises if the use of imported coal will grow to such a volume that it becomes interesting to transport coal by pipelines, which is technically possible.
Given the scatter in destinations and the high rate of interest that will probably hold on for quite a long time --especially when the economy improves--, it does not seem very likely that this possibility will be realized in the medium term. Transportation by inland shipping, possibly in a six-push-barge convoy, is cheap, and with declining ore transport the capacity is available or can be enlarged at moderate costs.

In road haulage the supply is extremely flexible: the rapidly growing flow of containers over the road in the past could be transported without problems. The lifetime of a vehicle is relatively short, and it is easy to combine a truck with different kinds of towed vehicles. Because of the legal limits to size and gross weight a further growth in average capacity per vehicle combination will be restricted.
These limits are of great importance for the transportation costs (cf. Figure 2).
An extra complication is that the limits in the various countries are different.

Important for the costs of road haulage is the utilization of the total traffic ton-kilometres for effective transport.
During the last decade the utilization of traffic ton-kilometres has risen considerably, and the question is whether there are possibilities for further improvement. The development of the minicomputer and microcomputer brought the computerization within the scope of the transport company. This computer is not only used for book-keeping

purposes, but can be used for management information systems and vehicle disposition.
The minicomputer also gives the possibility to enlarge the services to the client, especially for the firms that are engaged in distribution and warehousing.
A new development to improve the utilization of traffic ton-kilometres is the use of new communication modes, such as Viditel, to exchange freight between companies. This development is in an experimental stage.

Apart from these combined transport possibilities, which include inland navigation and can change the inland transport pattern from and to the harbour considerably, other drastic changes are difficult to forecast. The tendency of industries to move towards the sea will probably continue; coal at the harbour conveyed over long distances is now cheaper than coal at the spot which has to be brought up from 1000 metres under the ground.
Seagoing shipping changed the economic pattern considerably. This affects inland transport, and primarily inland mass transport. This trend, however, cannot go on indefinitely, because the availability of, for instance, space and labour is limited.

And there are numerous other questions which certainly do not facilitate forecasting.
For instance, will Western Europe change from basic industry to more sophisticated industries, and which are these sophisticated industries? Already substantial part of the automobile industry, electronic industry, photocamera industy, and chemical industry moved to the Far East.
Can Western Europe export sophisticated products and know-how, based on basic industries that it lost? And, in robotizing its industries, does Western Europe need to lose basic industries, such as steel industry, automobile and electronic industry?
Will we live in a world with free exchange of goods? The western world has had poor results in exporting democracy; why should it have good results in free trade as a basis for optimal functioning of the world economy.

All these are questions, I cannot answer. Neither can I answer the question whether the present crisis is conjunctural or structural. Maybe the key to the answers to these questions lies in the availability of cheap energy, but nobody knows what the future will bring and what political decisions will be taken. We even do not know whether these decisions will be taken on the basis of knowledge or facts or for emotional reasons.
This uncertainty asks for flexibility, and at least that is a strong point for road transport and inland waterway.

Thank you.

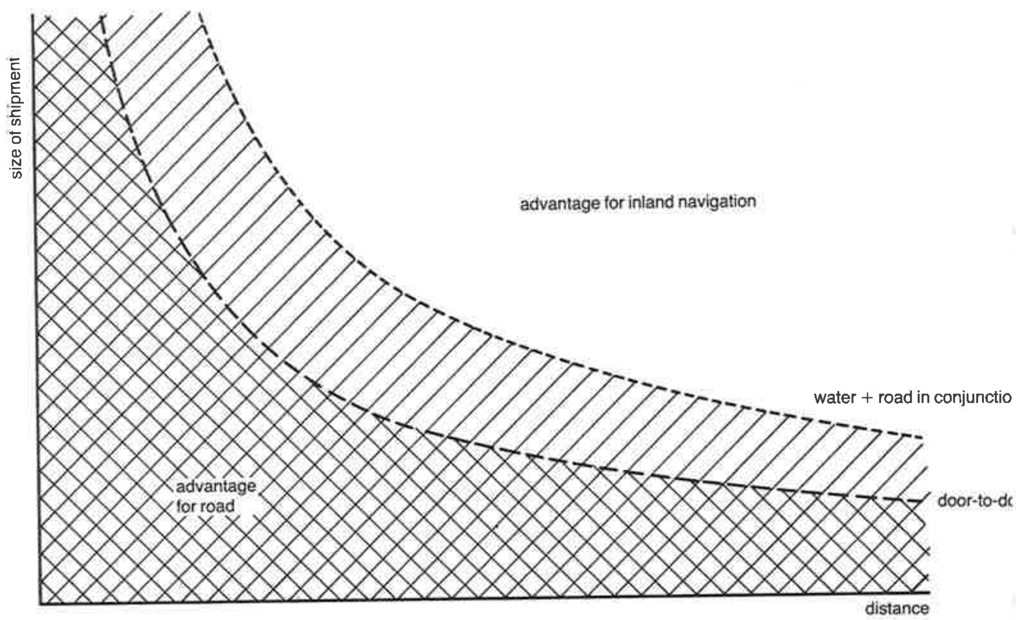

Figure 1.

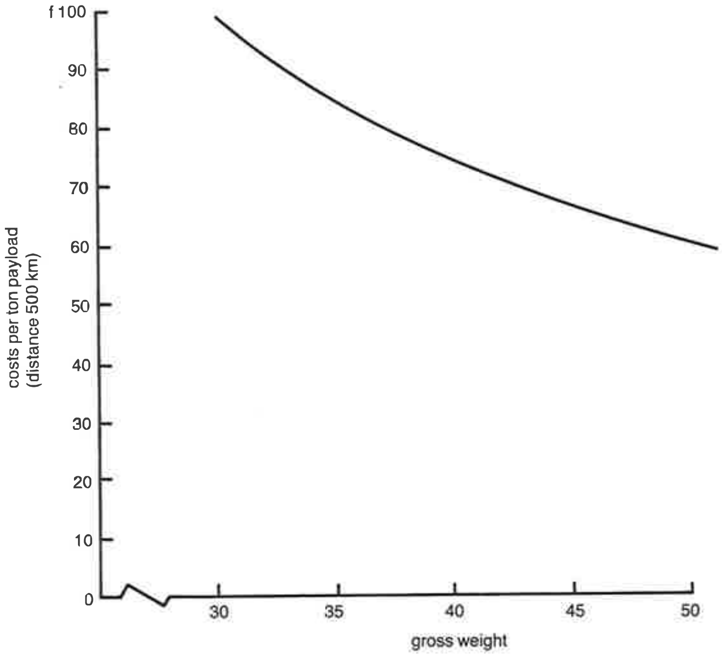

Figure 2.

Shipping Safety: Research by the U.S. Coast Guard*)

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Introduction

Shipping safety is one of the fundamental missions of the U.S. Coast Guard. The connection between the U.S. Coast Guard and this mission has been so strongly established that the two may be almost interchangeable concepts in the public mind. Shipping safety is not, however, a task which can easily be limited to a narrow range of problems. What is required instead, is a comprehensive concern for all aspects of the problem of marine safety. The U.S. Coast Guard has initiated a broad range of programmes in response to this task.

Within this range of programmes there are both direct and indirect approaches to improving the safety of the waterways. There are programmes concerned with commercial vessel handling and port traffic control. Both of these approaches directly attack the problem of protecting individual vessels from harm or, at least, limiting the extent of potential damage. Other programmes approach the problem indirectly by attempting to plan for future harbour safety needs. This is done by forecasting technological innovations and studying navigational needs for anticipated cargo handling facilities and uses.

This paper provides a brief descriptive outline of the approaches taken

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*) The opinions expressed in this presentation are not to be interpreted as official statements of policy of the U.S. Coast Guard. The author alone is responsible for the accuracy of the information presented.

in the U.S. Coast Guard Office of Research and Development to address the problems of marine safety. Descriptions of the techniques and approaches used will be supplemented by a more in-depth look at one particular programme. This programme is the analysis of the requirements and design of vessel traffic systems for port safety and security. The descriptions of the diverse programmes will highlight their common elements. One may then understand which safety questions are perceived as problems, and where solutions are expected to be found.

The discussion will restrict itself to U.S. Coast Guard research and development programmes which have been active within the last months. This paper will not consider programmes which have been instituted in the past to address old problems. These problems either have now been solved or may soon be made irrelevant by new techniques and operating procedures. Nor will this paper discuss solutions which have been designed in the field. Problems which yield to field engineering solutions are often minor, are of immediate need, and are not generally persistent. They are the problems that will disappear on their own as new technologies or trade patterns arise.

The problems assigned to research and development generally do not yield to short run solutions. There often is a lag of several years between the time that the problem is first examined and when the solution is implemented in the field. Whenever resources are scarce (and time is such a resource), such commitments of time are appropriate only for the most critical problems. These critical problems are the ones for which field engineering alone is not sufficient. A short run, fixed technology viewpoint will not carry the organization into the future. Flexibility and innovation are the only means available to prepare the firm or agency for the myriad of unanticipated and unforeseeable problems which can arise. An organization's approach to research and development will provide a sure indication of the future course for that organization. Only the moribund need not concern themselves with the long run.

The range and nature of safety programmes

The principal safety programmes are concentrated in four major areas: recreational boating safety, commercial vessel safety, port safety and security, and the broad programme (such as general technology forecasting). In addition, there are U.S. Coast Guard projects addresing environmental response and protection, ice operations, aids to navigation, and telecommunications. These programmes also contribute to the advance of shipping safety. In order to keep this talk from becoming simply a catalogue of programmes, however, these topics will receive only slight reference. Details of only the four major programmes areas will be given.

The tasks that constitute these major safety programmes usually study either the qualities of hazardous chemicals or the dynamics and prevention of vessel collisions. There are two major motivations for preventing collisions: to prevent loss of life, and to lessen the risk of catastrophic environmental damage. Although saving lives is paramount to the U.S. Coast Guard's mission, environmental protection is often equally important in setting programme objectives. In policy planning there may be a tendency to centre the discussions and the evaluations of projects on environmental protection rather than lifesaving. This does not mean that the U.S. Coast Guard is more concerned with pollution than with human lives. The costs of environmental damage can more easily be assigned a dollar value than the cost of human life. When policy and budgetting decisions are based on quantitive analyses of the comparative costs and benefits of a proposal, then quantifiable information will be used to justify the decisions made.

The commercial vessel safety programme seeks to minimize shipping hazards through a multi-faceted approach. Its tasks include studies of hazardous material characteristics and the containment of such materials; the prevention of collisions, rammings, and groundings; insuring ship seaworthiness and safety standards; the prevention of vessel flooding and capsizing; and safety standards for ship personnel. Universities, U.S. Government laboratories, and private contractors have been employed to accomplish these tasks.

The recreational boating safety programme is much smaller than the commercial vessel project. It relies principally upon private contractors to perform studies of regulations and standards to reduce the frequency of boating accidents and of methods of recovering boats after an accident has occurred.

The broad programme studies trends that are important to shipping. These trends include new developments in maritime systems, forecasts of technology (such as new data processing methods and new sensors), and the development of sea use management.

The port safety and security, or waterways management, programme studies traffic management systems and equipment. The programme includes projects to analyse the impact of traffic rules on harbour safety, efficiency, and capacity; tasks to study the stresses which affect the performance of traffic control personnel; and studies to develop surveillance, communication, and data handling equipment which will aid traffic control. This programme has relied upon U.S. government and Dutch research centres, universities, and private contractors to accomplish its tasks. The port safety and security programme did not have the opportunity to make a complete study of the problem before the first traffic control systems were installed in San Francisco. The waterways management programme is an attempt to adjust an ongoing operation as new experience is gained. It is also a plan to direct the future course of the field operation.

The programme originated in the 'Ports and Waterweays Safety Act of 1972', in which the U.S. Congress required the Coast Guard to establish and operate traffic systems in those ports and harbours where vessel traffic became congested. These systems would co-ordinate traffic to aid the vessels in the harbour in avoiding collisions with piers, bridges, structures, or other vessels. In especially dangerous situations, the vessel traffic service (VTS) could schedule vessel operations as necessary to avoid accidents. The VTS was also empowered to establish harbour safety zones to isolate dangerous or contaminating cargoes within the harbour.

The specifics of implementation, equipment, and design of the VTS's were left to the Coast Guard. With the installation of the initial traffic systems, it became apparent that the U.S. Coast Guard would need to evaluate the performance of these systems. The means to do this had to be developed. The Office of Research and Development was asked to formulate a method to evaluate the effectiveness of the VTS's. The methods developed in this research might also provide the means to examine the impact of new traffic management strategies upon any harbour before these rules were implemented in the port. If new strategies could be so tested, the technology could also be applied to planning the next generation of VTS's for their orderly implementation.

The design of vessel traffic systems was subject to an additional limitation. The U.S. Coast Guard does not actively control the movements of vessels within waterways. It may establish restricted areas and does have the authority to direct vessel traffic under certain circumstances. The U.S. Coast Guard, however, does not generally engage in the direction and command of pilots. This limits the function of the U.S. Coast Guard to that of an advisor. The surveillance equipment and communications net that are in place are used to provide information and advice to pilots within the waterway. The local pilotage associations are often under a local jurisdiction; they are not emplyees of the U.S. Coast Guard. This situation gives them a degree of autonomy not commonly found elsewhere.

The approaches to research and development

The Office of Research and Development manages a large and diverse collection of projects. Among these programmes there are certain common approaches to problem solving which seem to appear in each project plan.

The first common element is the care that is given to defining the problem to be studied. Much project time is invested in problem definition and identification of problem areas. The specifics of the problem area are not assumed to be initially known. In many cases, there is originally only a general sense that a problem exists. Before effective research and development can begin to address a problem, it is necessary to separate the problem from its symptoms. To begin a study with a preconceived supposition of the nature of the problem is to advance the study toward a particular solution. Careful problem definition avoids precluding potential solutions that may first be thought to be irrelevant.

In each of the major project areas, a large amount of time and funds has been allocated to the definition of the problem. One example of this is found in the recreational boating safety study. The first part of the study identified and defined problem areas and determined methods to measure the effectiveness of standards, education, and enforcement programmes. The commercial vessel safety programme likewise concentrated its initial efforts upon investigating the marine accident data available. This data has been intensely studied in order to develop a typology of casualty types and classify causes and consequences of accidents.

In the case of the vessel traffic management study, there were two phases to the definition of the problem. In order to choose the ports in which a VTS would be established, censuses of vessel traffic were conducted in waterwys throughout the United States. The data collection proceded through the use of side-looking airborne radar, films of radar displays, and counts of VHF-FM channel usage. The initial VTS's were selected use being made of this data.
The second phase of the data collection occurred as part of an extensive, three-year study of the total traffic management problem. This part of the research project conducted investigations into the frequency and causes of vessel accidents, the adequacy of the data available, the physical requirements for vessel navigation, and the options for managing vessel traffic. These studies consumed approximately one third of the total time of the study.

Another major characteristic of safety research at the U.S. Coast Guard is the reliance upon computer models. Several of the safety studies allocate funds for the generation or acquisition of a compute simulation. The models are used to conduct 'experiments' of testing different techniques and modes of operation for the programme which owns the model. The U.S. Coast Guard has access to a towboat simulator, a simulation of tankers in a deepwater port, an oil spills model, a model of vessel traffic controller tasks, and a harbour vessel traffic model.

The waterways management programme has developed two of these computer simulations. One model simulates the tasks and workflow of a watch-stander, or controller, at a vessel traffic centre. The model was derived from direct observation of the watchstanders at their duty stations. Analysts from the Transportation Systems Centre of the U.S. Department of Transportation recorded the sequence and time duration of manual operations by the watchstanders in performing their duties. This model will be used to study the effects of heavier workloads or changes in operating procedures on watchstanders.

A second computer model simulates the flow of traffic in a port. The model was originally developed at TNO-IWECO. It has been modified by a private contractor and by a team of analysts from the Transportation Systems Centre. This model will be compared with a new simulation recently acquired by the U.S. Coast Guard from TNO through a joint agreement with the Port of Rotterdam. This model will be used to assess the effects of changes in the operation of the harbour. Using the model, the analyst can conduct experiments by simulating changes in harbour system operations, such as changes in local rules of the road. The experiments will be evaluated on the basis of increases in simulated vessel groundings or close passages with other vessels and changes in average harbour transit time or harbour capacity. By using a fast model in this manner, it is possible to gather data that would require years to collect in the field. These model experiments have the added advantage of not endangering real vessels. The ability to obtain quickly inexpensive, riks-free experiments in port design greatly increases the flexibility and innovation available to the programme manager in examining port system designs. This would not be possible if the project manager had to depend upon actual, physical trials.

The third common aspect of these projects is the plan to develop a data base system. A well designed data base system facilitates the collection of information as part of the operating system tasks. The collected information will be available in a concise format for ease of analysis. There are data bases which are designed to monitor events in the field as well as simulated events. A data base of information gathered in the field will be used to evaluate the operation of an implemented solution.This information can provide an early warning that the developed operating procedure is in need of review. An example of the use of information collected in the field is found in the commercial vessel safety programme. This programme is responsible for developing a data base to retain information on vessel casualties. In this case, continuous analysis of the data will be used to assess the current and the future hazards to navigation, safety, and the marine environment.

The vessel traffic management study is engaged in the design of two data bases. The first data base is a selection of statistics to be compiled as a result of computer simulation runs. These statistics must characterize the critical trends that would result from changes in the local harbour traffic rules. This information will be the means for studying the effects of new harbour designs on vessel safety. Scenarios generated in the model will be compared through these statistics. The second data base is a compilation of data on vessel casualties and incidents in ports. The data from ports which have a VTS can then be easily compared with casualty statistics from ports which do not have a VTS. This information will be useful in preparing studies of the effectiveness of the vessel traffic systems in meeting the objectives of the systems.

The risks of the methods used

If these are the means by which research is conducted, then it is wise to consider the risks that are taken in such approaches.

To begin a study with a broad sweep of the problem area is to risk losing control of the study. There is a constant tension between not wanting to force solutions by maintaining too narrow a scope for the problem and not wanting to misallocate time and funds on studying the entire universe within which the original problem fits. The logical extension of either approach may lead to useless conclusions. In one case the solution will be found to be too specific to be of much use beyond the immediate situation (and may fit poorly with other aspects of the problem area which were excluded from consideration). In the other case the problem will be determined to be too general or even beyond solution because of its complexity.

Another aspect of this risk is that the analyst studying the problem area and his client may end by not being concerned with the same problem. This can only be avoided by close and frequent consultation among the interested parties. Even this may not be sufficient to guarantee that the client is satisfied. As an example, after three years of work on the vessel traffic management study, some persons at the U.S. Coast Guard were dissatisfied with the results of the contractor's study. It was contended that this was not what was in mind when the project began. The contractor could only respond that the client had not been very definite about the problem at the beginning of the study. There is no judgement that can be rendered here, except for the warning of the potential for a study to carry itself forward and away from the original scope.

To rely upon a simulator to generate experimental observations requires extreme caution. Any doubt about the validity of all aspects of the model imposes a severe limitation on the usefulness of the model's results. Model validation includes more than the guarantee that the computer programming is free of flaws. Validation also verifies the model's ability to produce predictions that correspond with actual physical phenomena. To proceed with a model that has not been extensively and thoroughly validated is probably to study a fiction that may bear no resemblance to the situation originally addressed. This would result in the design of a solution that is inefficient or inappropriate, if not totally disastrous.

Establishing the validity of a model is not to be done in a piecemeal or approximate fashion. Consider, for example, the various simulators of vessel traffic now in use at the U.S. Coast Guard and other maritime organizations in North America and in Europe. The aim of these models is to simulate the movement and handling characteristics of individual vessels or the large area dynamics of vessels traversing a waterway. The equations which determine ship handling and, often, the associated parameters of those equations are based upon ship theory. If this were all that is necessary, such models would be available to almost any agency without the expenditure of any noticeable amount of effort. In such a world, the constructed models would satisfy their owners from the first usage. It is doubtful, however, that any individual who has been associated with the development of a ship simulation will testify that he was completely satisfied with his initial model. That the model was unsatisfactory, suggests that the analyst held some implicit validation criteria against which the model's results were compared. Unfortunately, these criteria are often vague or they insufficiently characterize the essential elements of the behaviour to be modelled. A simulation is sometimes accepted on the grounds that 'it seemed to behave realistically'. If nothing more is asked of the model, then there should be extreme caution exercised in basing decisions upon it. It would be difficult to justify a harbour design for the vessel traffic service on the grounds that the sole source of the decision was data which was generated under alternate management schemes that 'looked fairly good' or 'seemed to behave realistically'.

If more specific criteria are used, these will generally test the path, or track, of a vessel that is generated by the model against an actual, recorded vessel track. This procedure is a systematic analysis of the behaviour that is to be simulated. Choosing a numerical measure, however, is not enough. It must be studied to ascertain its properties. For example, one easy numerical measure is the average difference between the simulated and the actual vessel paths over a series of sampled points in time. This measure seems reasonable, but it must be used with caution. A simulated vessel track which weaves back and forth across the actual path could yield a very low average difference. On the basis of this measure alone, the model would be acceptable although it is doubtful that a client would actually be satisfied with it. On the other hand, a model which exactly duplicated the path of an actual vessel except for the chance displacement of the path at one point in time would probably be rejected on the grounds of its average error. An acceptable validation criterion will not simply appear. It must be derived through careful analysis. This goal is being pursued for the vessel traffic simulator at the U.S. Coast Guard.

The design of a new data base also presents difficulties. It is not easy to select either the information that is to be stored or the format in which it is kept. When the system is designed to monitor the progress or operation of a physical function, the measurements taken must be relevant to the problem as analysed. It is too easy to choose measurements which have only the merit that they are readily available or readily yield to numerical manipulation. What is important is that these measurements accurately monitor the functioning of the implemented solutions to the studied problem. If this is not so, the information is a waste of time or even misleading.

The vessel traffic management study demonstrates two types of difficulties that can occur in the design of a data base. In the case of compiling data from the computer model, the difficulty is restricting the data collection to an amount that is still manageable and understandable to the human analyst. The most informative items may be lost in the volume of data that can be collected. The computer can monitor almost anything which occurs during its run. The selection of a data base scheme for the actual harbour is made difficult for exactly the opposite reason: there may be too little information available. Many of the characteristics, such as close encounters between vessels, which are easily measured in the computer model may be almost impossible to gather in the field.

This leads to a problem of congruence between the data bases. If the model is used to design a harbour system, it may be based upon measurements that cannot later be collected in the field for comparison. The project manager might then be making judgements upon data that can not be further monitored when the decision is implemented. Even collecting data can be difficult.

Conclusion

These are the types of problems that are addressed by the U.S. Coast Guard in its research to improve shipping safety. The prospect for obtaining useful, productive solutions to the problems of shipping safety depends heavily on the appropriateness of the research techniques which have been selected. Although each of these techniques appears to have been fruitful thus far, they are also prone certain failings. Constant vigilance is necessary to keep the research directed toward the end that is targeted. To be blind to these risks can cost money and time, and much more in the waterways.

Thank you.

Traffic Management in the Port of Rotterdam

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Vessel Traffic Management

Every port has an organization to create some measure of order in the movement and berthing of vessels. In a small port this organization may consist solely of a harbour master. In a large port maintenance of an adequate level of safety and efficiency requires a complex organization, in which many disciplines work side by side. The task performed by this organization can be termed 'Vessel Traffic Management'. In other words: Vessel Traffic Management is the entire complex of activities required to ensure safe and expeditious flow of vessel traffic. The people manning the organization, together with their equipment and procedures, constitute a Vessel Traffic Management System (VTMS).

In many ports it is appropriate to consider the various elements of vessel traffic management such as pilotage, patrolling of the port, and port administration separately. Since recently, however, a change in approach has become evident. This change has not only been brought about by the high costs of running a port and growing awareness of the inherent dangers of transport of large quantities of polluting cargoes.

As a port grows, the complexity of port management increases. Numerous specialists are needed, and an increasing number of disciplines must work together. Planning, co-ordination and rapid exchange of accurate data become more and more prerequisites for efficient functioning of the port. When conditions warrant significant changes in parts of an existing Vessel Traffic Management System, it is therefore essential to consider the system in its entirety before implementing modifications.

At the Fourth International Symposium on Vessel Traffic Services held in Bremen in April 1981 it was concuded that:

'Any port or harbour considering setting up a VTS should involve all 'parties concerned at a very early stage and should continue to involve 'them'.

and that:

'The service provided by the pilots and other members of the VTS should 'be fully integrated'.

Phased development programme

Such a situation arose in Rotterdam during the seventies. The Radar-chain along the New Waterway had become both technically and operationally obsolete. A three-phase programme was undertaken to build an integrated VTMS. Phase 1, an in-depth study of the present functioning of the port, was executed in 1978. Phase 2, definition of the future system, was completed at the close of 1980. Phase 3, system implementation commenced last summer, after the final decisions at the policy setting level had been taken. If no unexpected delays occur, the new system will become operational at the close of 1985.

The system to be implemented is based on what is probably the most comprehensive research and development programme performed in the field of vessel traffic management to date. At the outset it was felt that there was lack of sufficient understanding of how the separate organizations constituting the existing VTMS interact with each other. Although experts could explain how the port functions from their point of view, differences in opinion were considerable.

Phase 1 gave us sufficient understanding of the present functioning of the port, so that it has become clear where changes are required, and what the consequences of these changes will be. Phase 2 enabled us to develop the new VTMS in great detail and to verify the design with all interested parties. Much time was spent discussing the various proposals, so that those with best insight in the day-to-day functioning of the port could be made aware of new possibilities, and aid the researchers in defining a system which would not only solve the identified problems, but which would maintain the practices which in the past had proven their value.

When many different groups (more than thirty in Rotterdam) are involved in defining changes, more often than not little more than a compromise is achieved. Since changes and shifts in emphasis in the total system may lead to reduction of job satisfaction in some quarters, there is in general a reluctance to accept changes. This creates a valuable negative feedback mechanism ensuring that modifications made are not too radical.

A complex system, such as the functioning of a large port, is usually the outgrowth of many years of practical experience. Everyday working is more often than not reasonably effective. However, while such a system may appear to work well from the point of view of port users, it may in actual fact be quite inefficient. Our Phase 1 in-depth studies of the flow of information in the port brought unnecessary and undesirable duplication of information to light.

More serious than inefficiency is the danger that a system, which has grown entirely in daily practice, may not be able to respond quickly enough to avert undesireable situations. As the transported quantities of polluting goods grow, both the probability of a mishap and the possible consequences become greater. In order to maintain the existing level of safety, additional measures are required. But how does one go about taking these additional precautions without unduly interfering with the existing day-to-day practice? How can one ensure that the operational personnel, the most important element in the system, are convinced that modifications are required?

In Rotterdam we have instituted a continual feed-back between operational personnel and the system developers. At each stage in the development, criticisms of descriptive documents are sollicited from all operational disciplins. In response amendments are proposed and consensus is sought and to a great extent found. The few remaining issues, for which no compromise can readily be reached, are resolved at a higher level.

At the outset of the development programme it was suggested that it would be wiser to quickly replace the obsolete radar-chain with new radars and displays. Based on experience gained from the use of the new equipment more extensive changes in the VTMS could be defined and implemented. It was, however, felt that this approach could lead to serious errors. Our awareness of the danger of implementing changes without a deep understanding of the details of the functioning of the port led us to the approach which we have taken at Rotterdam. This has allowed us to define and verify carefully the design of the new VTMS in its entirety with respect to the various aspects, such as required equipment, operations and port management policy.

The studies performed during the phases 1 and 2 are briefly described in a paper entitled: 'VTMS Rotterdam - a progress report', (R.K. Bleekrode, Proceedings of the Fourth International Symposium on Vessel Traffic Services, Bremen, April 1981). The net result of these studies was the definition of our new VTMS which in fact is the minimal modification of the existing system required to solve the problems which have been identified.

The new organization

Our studies showed us that the existing VTMS is in fact a network of numerous organizations, each performing its own traditional task on the basis of working practice. The demarcation of tasks and responsibilities is more or less clear in daily practice. However, due to the lack of formalization, problems can occur as soon as unusual situations arise. It is therefore necessary to develop formal working agreements between the various organizations, which clearly delineate responsibilities under all circumstances. The feeling that there is a need to define what vessel traffic services do and precisely who does what, is also felt in other ports. The Bremen symposium concluded that:
'The success of any system depends on a precise definition of the
'scope of its application with regard to the services, the area and the
'ships made subject to the control';
and that:
'There is an increasing need for clear operational and legal statements
'of responsibilities not only in the co-ordination of traffic but also
'in the integrity of information systems'.

A more serious problem is the apparent lack of a clear organizational structure with sufficient integration within the authorities involved, resulting in certain inefficiencies and difficulties for port users under exceptional circumstances. This is due to a division of responsibility between various government bodies which, for legal reasons, cannot easily be changed. The problem will be solved by instituting a traffic management organization which to outward appearances is a unified entity, while in actual fact the involved parties maintain control in the areas which fall under their jurisdiction. This organization is to consist of two levels, one for policy setting and one for daily traffic management.

In the future system the policy decisions will be prepared by a co-ordinating committee in which the governmental parties, the Directorate General for Maritime Affairs, and the Rotterdam Municipal Port Management are represented. The co-ordination of daily operations will be performed at a Harbour Co-ordination Centre (HCC), in which representatives of the various organizations work side by side in a closely integrated structure. It is at this centre that traffic planning and traffic control are to be performed. The HCC will, however, not communicate directly with vessels visiting the port. Information and, in rare instances, directives are passed to the vessels from a number of traffic centres and posts spread throughout the port area. Figure 2 illustrates the VTMS organization as it will appear to port users.

Data handling

The most costly part of the programme is the implementation of the required instrumentation. The advanced equipment is made necessary by the increasing need for planning, co-ordination and rapid exchange of reliable data. A diagram of the technical system, which represents almost 60 per cent. of the programme costs, is given in figure 3. 'Hollandse Signaal Apparaten' bears the overall systems responsibility, and will deliver this equipment with the exception of the communications subsystems. The buildings and masts will cost approximately 15 per cent. of the funding, while the remaining 25 per cent. represents the cost of system development (phase 1 and 2) and other services required during system implementation, such as: training of operational personnel, and system introduction to port users.

The heart of the technical system is an extensive Data Handling System which will be at the disposal of all groups concerned. This system will be fed by an automatic tracking system which processes signals coming from 26 high-quality radars covering the port area and its seaward approaches. Hydro-meteo data is input from various sensors including devices which automatically measure the range of visibility in seven locations in the port area. The data handling system will be able to combine administrative data with the actual traffic situation at all times. Thus it becomes possible to plan arrival and departure of vessels in order to make effective use of port facilities, and to eliminate the possibility of congestion at critical places along the fareway.

The accident analysis performed during phase 1 proved that a major proportion of accidents occur when vessels enter or leave the main traffic stream. Planned clearance of deberthing and port entry allow traffic to be regulated in such a way that the accident risk is significantly reduced. By taking the availability of resources, such as pilots and tugs, into account these resources will be utilized more efficiently, so that the reserve capacity can be reduced. Here we have an example which illustrates how an integrated VTMS at one and the same time enhances safety and improves efficiency.
A vessel preparing to depart or to enter the ports makes its intentions known. In the new VTMS such an intention will as a rule be known well beforehand and will have been programmed. In instances when this is warranted the departure or entry will be delayed. Various aspects will be taken into account in determining whether a vessel may participate in the traffic flow, e.g.:

- Will the intended movement be hazardous under the existing traffic conditions? The type of cargo being carried and the manoevrability of the vessel must be considered.
- Will the vessel be able to leave the traffic flow without delay? Arriving vessels must have a place to berth.

- Are the required resources readily available? There should be no delays due to late availability of pilots and tugs.

Port authorities have the right to enforce directives on vessels. However, in order to ensure a flexible and efficient functioning of the port, this right must be excercised sparingly and consistently. The situations in which binding directives are given should be clearly defined and commands must not be conflicting. For this reason planning and overall traffic control will be centralized in the HCC. Regional Traffic Controllers located in the traffic centres and posts communicating directly with the vessels in transit, the Traffic Attendants, will only be entitled to give binding directives on behalf of the traffic controllers.

Automatic tracking

The traffic attendant function has evolved from the traditional radar operator task. Originally this task consisted of informing piloted vessels on the main throughfare of their actual position during periods of poor visibility. As equipment on board improved, emphasis shifted. Vessels were informed more and more about the position of other vessels and the traffic situation in general on a round the clock basis. The task of the traffic attendant will be to inform and advise individual vessels and to pass binding directives given by the HCC to the vessels. Our ergonomic studies performed during phase 1 indicate that radar operators are presently too heavily loaded under busy circumstances. Interpreting the radar picture, maintaining a mental picture of the identity of each echo, and communicating the necessary information to the vessels constitute such a mental load that the quality of information which is passed to the vessels can deteriorate. Without special measures this problem would become serious in the future, as the new VTMS will serve inland vessels as well as all sea-going vessels; presently the emphasis is on seagoing vessels only.

In order to reduce the load on traffic attendants, new technology had to be developed. During phase 1 and 2 the automatic tracking system, which I mentioned earlier, was developed. Each of the 26 radars is coupled to

a single radar tracker which, from the radar-video, determines for each vessel in the coverage area: position, size, heading, course and speed, and echo strength.
The output of all single radar trackers is compared by a Multi Radar Tracking Processor (MRTP). The main throughfare and the critical areas in the harbour basins will be able to generate vessel data of very high integrity. Ghost echos will be recognized and suppressed, tracks lying in the shadow area of one radar are filled in using data from another radar. The tracking system delivers the traffic attendant a clean picture.
More significant, however, is the ability of the system to maintain automatically track identity. Upon initial entry into the traffic flow from sea, a traffic attendant will identify the vessel with the aid of a Radio Direction Finding system and tag the appropriate track. The coupling between identity and track will automatically be maintained as the vessel passes through the port. The pictures used by the traffic attendants contain vessel identity, and no effort is required to build up a mental image of the existing traffic situation (Figure 4). The traffic attendant can concentrate on his real task, i.e. analysing the traffic situation, so that he can inform and advise vessels underway.

Traffic sectors

Using the area which can be handled by one individual during busy traffic conditions as a criterium, the port has been divided into twelve sectors as shown in Figure 5.
Each sector has its specific radio channel. As a vessel proceeds through the port, it is handed over from one traffic attendant to be on the spot. He should be located near the critical area in his sector. On the other hand, direct communication between the traffic attendants is necessary. From this second point of view the traffic attendants should be located in one room together with the traffic controllers. After extensive discussions and study of various aspects, such as the relevant information content of direct view of traffic, it was concluded that the port should be divided into three regions: (1) the approaches and the deep-draft basins (Europoort); (2) the Botlek area, where the chemical industries are concentrated; and (3) the city.

In each region a Traffic Centre will be located with a direct view of the most critical crossing. Closed circuit television will present pictures of other critical areas. In addition, Traffic Posts will be placed at the inland approaches of the port on the Oude Maas river and to the east of the city on the Maas Boulevard. Vessels entering the port will be identified visually or by radio contact when passing these posts. The direct view requirement led to the development of a new workstation. Much effort was spent designing a console containing large screen displays, Visual Display Units and TV-monitors. A sketch of this console is shown in Figure 6.

As can be seen in Figure 2, the Traffic Posts are in fact annexes of the Traffic Centres. Figure 5 shows the location of the HCC, the three Traffic Centres and two Traffic Posts. Figures 1 and 7 are sketches of the Traffic Post Maas Boulevard and the Traffic Centre Botlek.

Concluding remarks

To summarize, the new Vessel Traffic Management System for Rotterdam will unite the three basic elements of vessel traffic services, pilots, patrol vessels, and the shore-based organization. The tasks and responsibilities of all participants will be clearly and logically defined. But above all, the system will be easy to understand from the point of view of the port user.

A great many man-years of effort have been spent determining the best system for Rotterdam. A joint effort on the part of all concerned with the Port, both in private enterprise and within government circles, has led to the solution presently being implemented. It is hardly possible to give due credit to those who have created the new system: too many would be forgotten. However, it is fitting to make an exception for the representatives of operational personnel and to thank those who have spent many hours discussing and modifying the various proposals. It is this work which will ensure that, when the switch is made in 1985, vessels visiting Rotterdam will be served by a modern system based on the know-how of the last 25 years. Thus the Port of Rotterdam will be assured of an even greater level of safety and efficiency for the coming decades.

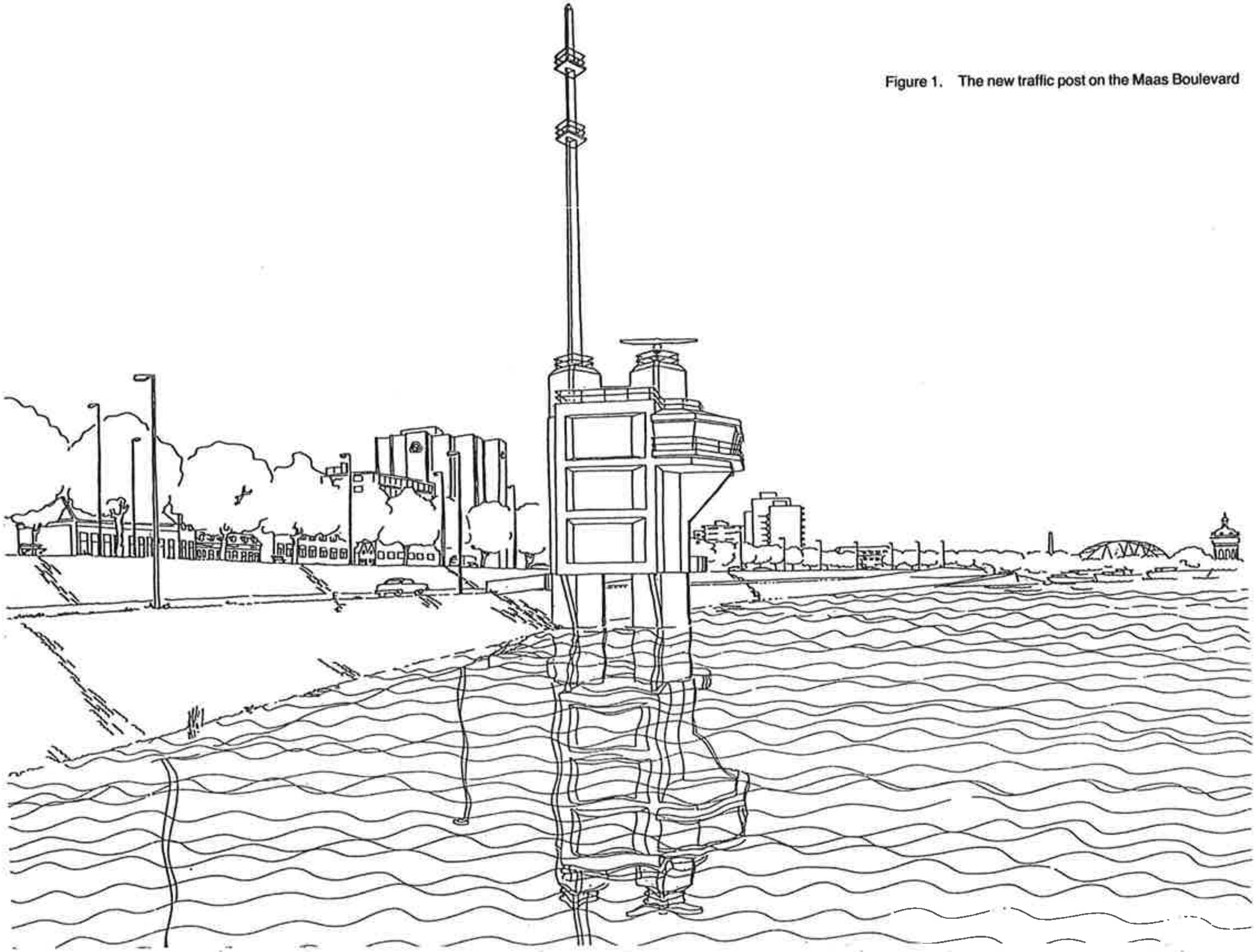


Figure 1. The new traffic post on the Maas Boulevard

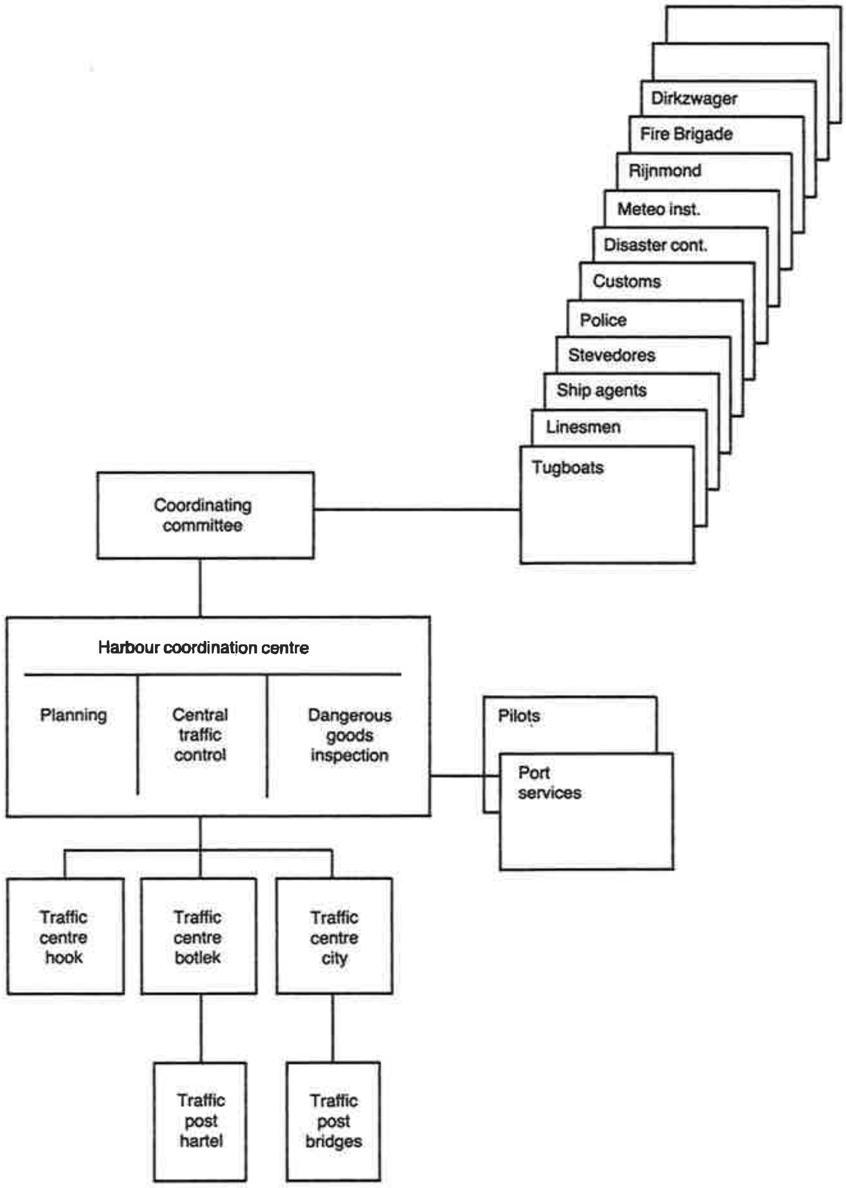
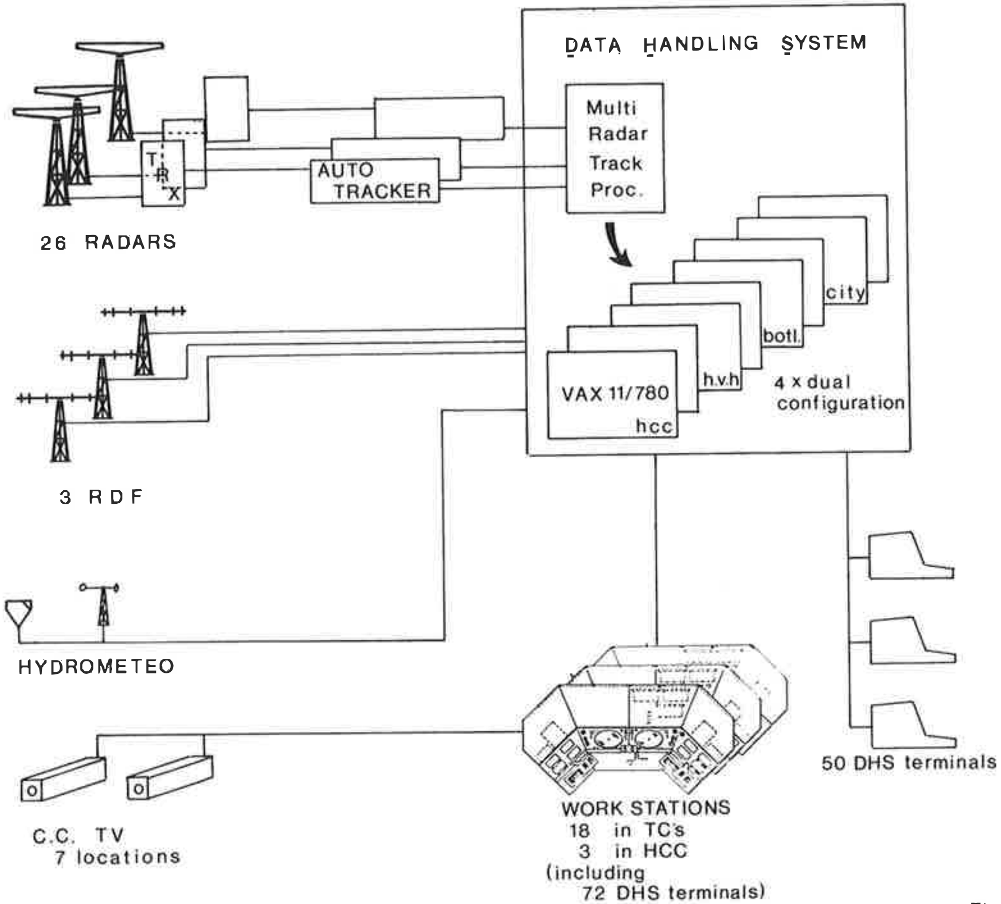


Figure 2. VTMS organization



COMMUNICATIONS

VHF Radio
mariphone
mobilophone

Telephone
direct and
public lines

Telex

RECORDING

all voice communications

all system tracks
on command

PREDICTION

expected congestion
during next 4 hours

local traffic situation
after max. 15 minutes

Figure 3 VTMS EQUIPMENT

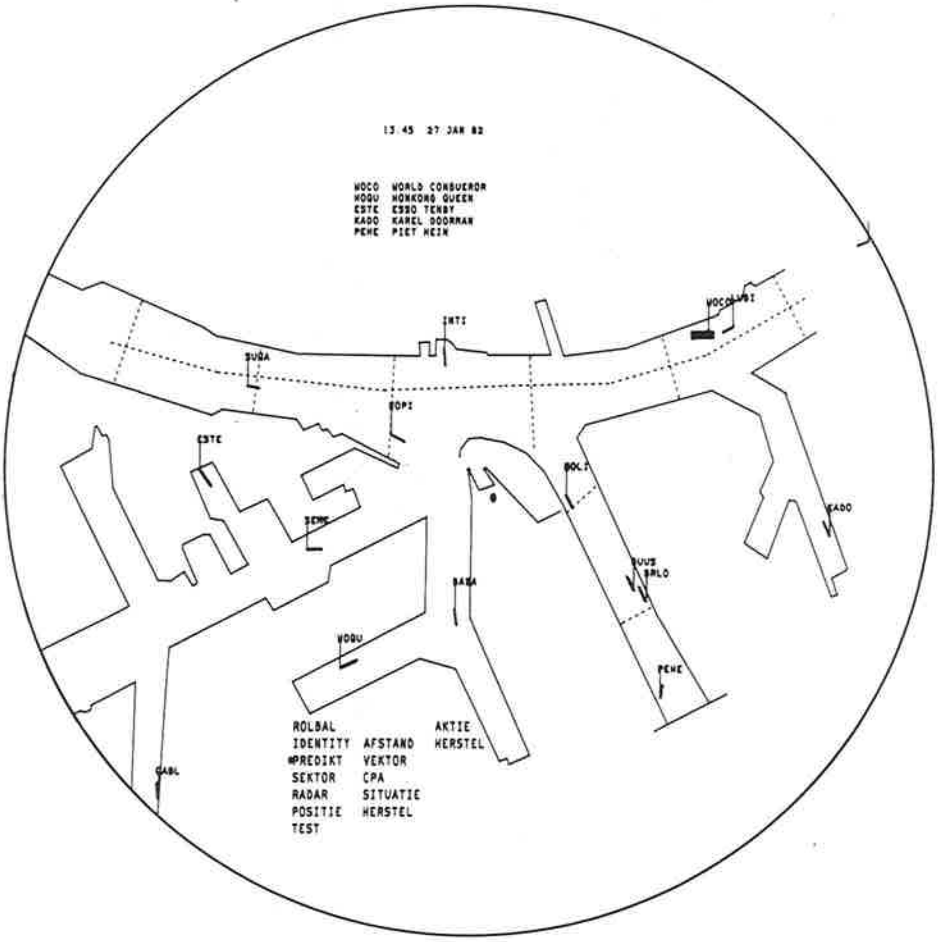
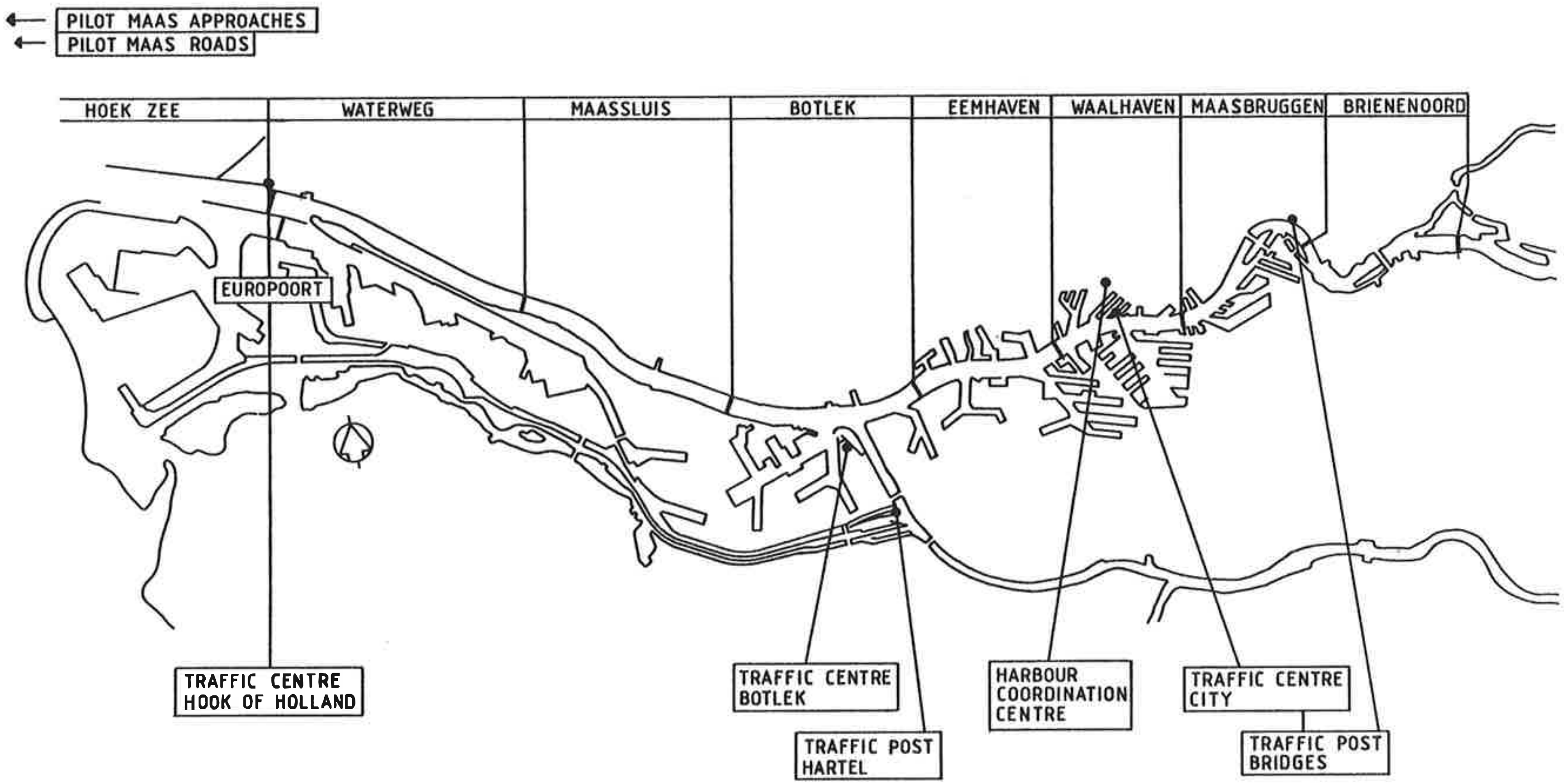


Figure 4. Computer driven displays present the Traffic Attendants a clean picture with taged vessels.



Figuur 5. Sectors

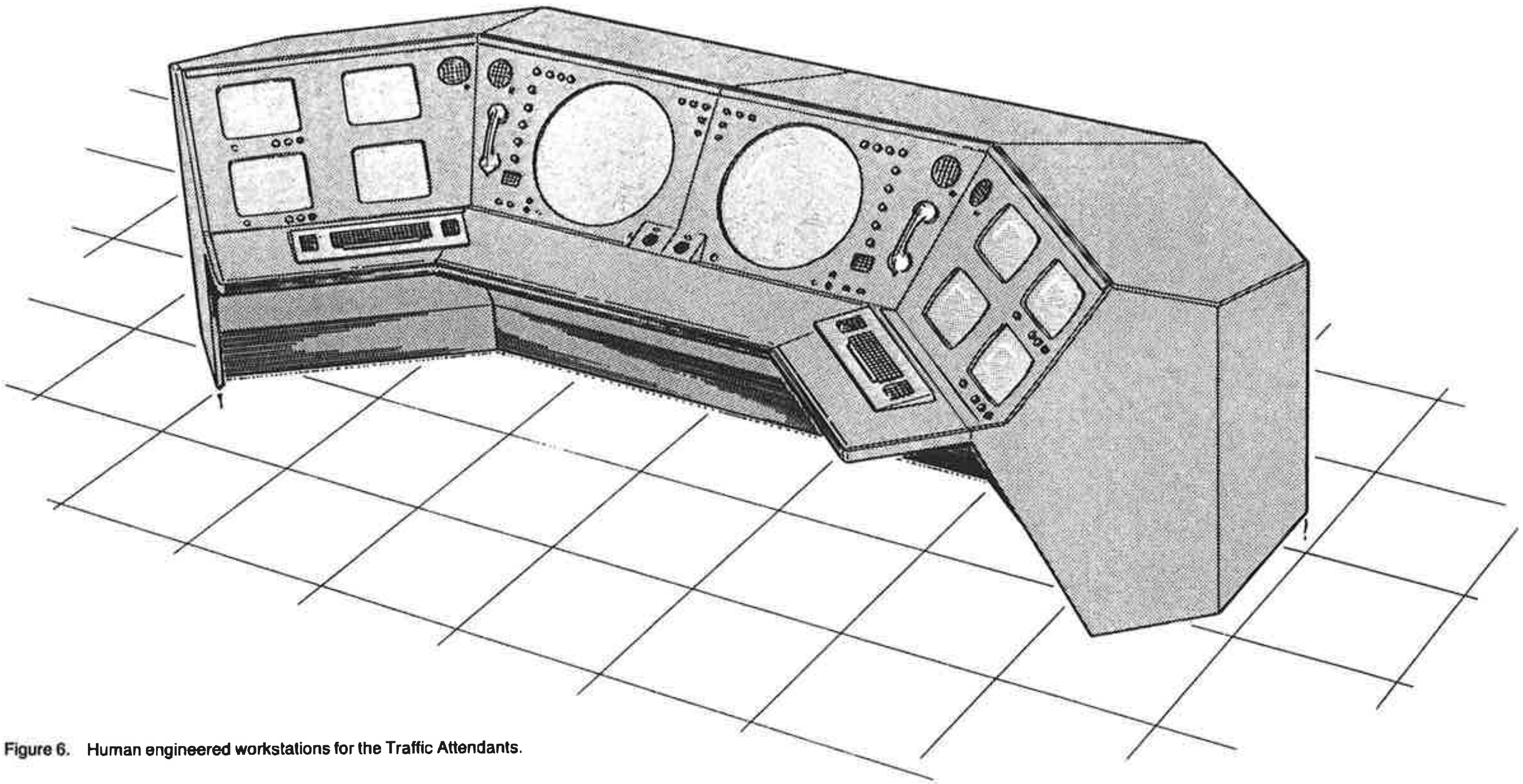


Figure 6. Human engineered workstations for the Traffic Attendants.

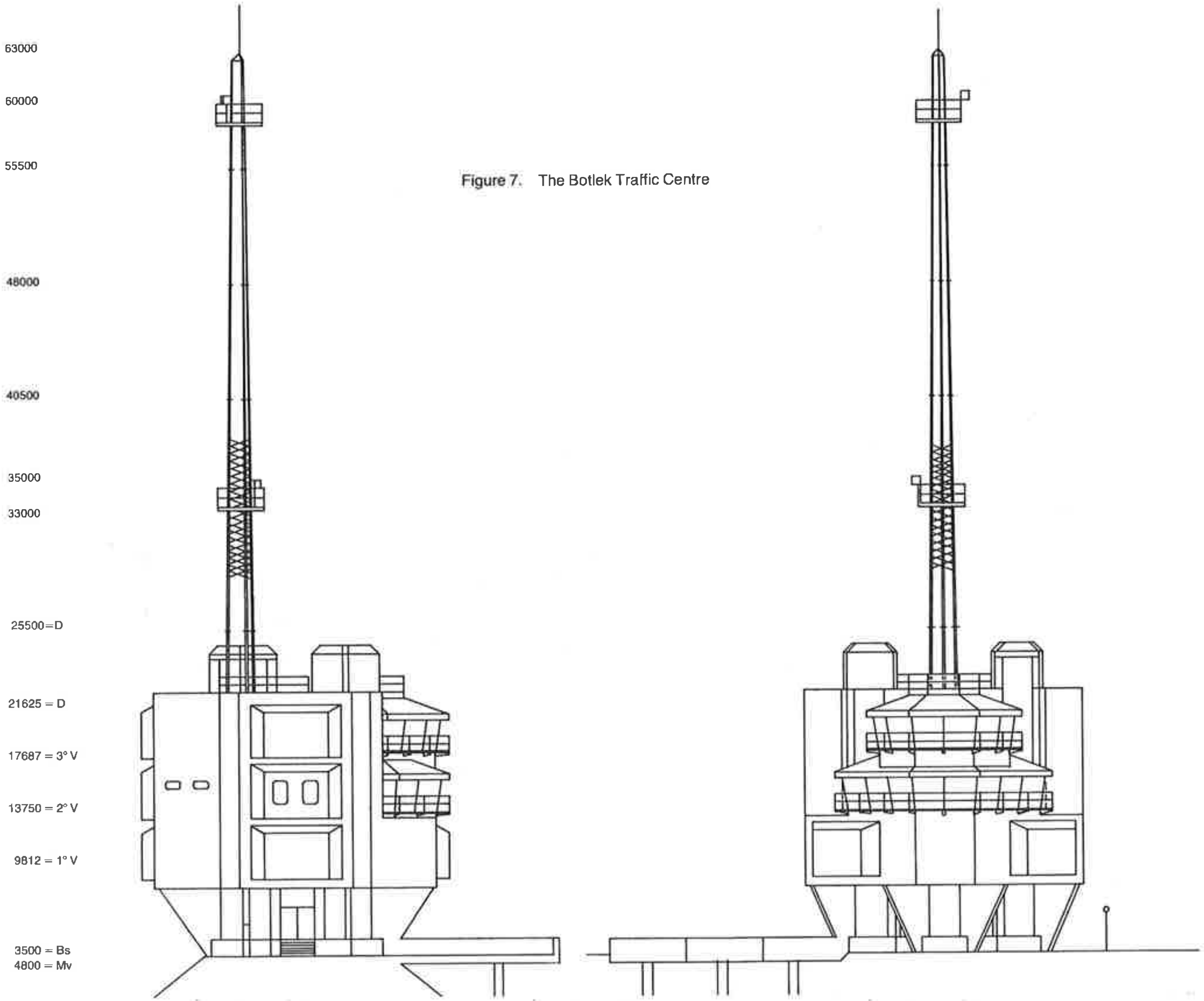


Figure 7. The Botlek Traffic Centre

Safety and Efficiency Aspects of Vessel Traffic in the Port of Rotterdam

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Introduction

The world merchant fleet has grown enormously since World War II. Not only the number of ships has increased but also their cargo capacity. Moreover, new types of ships, adapted to the specific demands of the cargo to be transported, have continuously been developed. Examples of highly specialized ships are the very large crude carriers, the fast container ships, and the ships built to transport liquefied gases. Also the goods to be transported have changed. Nowadays, hazardous, combustible, and poisonous goods constitute a considerable part of the maritime transport (1).
As a consequence of these developments, traffic densities in and around the major harbours have increased significantly. In addition, the manoeuvring characteristics of the individual vessels vary considerably. As a result, the probability of accidents, such as collisions, rammings and groundings, has strongly increased. Moreover, due to the larger ship dimensions as well as to the kind of goods transported, the effects of accidents nowadays are in general considerably more serious than some decades ago.
As long as only a few ships sail in the harbour area regulations are not needed. But as the number of ships grows, they may become hazardous to each other. To reduce the risk of collision rules of conduct have to be adopted. With a further increasing number of ships, the need to make a more efficient use of facilities increases, too, and safety gets more emphasis. Now regulation takes place on a secondary level. Ships must report their movements to the shore, captains have to be advised by pilots, and shipping is supplied with information from the shore. In several ports or congested shipping areas, a saturation point has

already been reached. Therefore serious endeavours are being made to develop something that could be called a third level vessel traffic management system, with instructions given to shipping from a shore-based surveillance station. Even a fourth level system is being developed, in which management strategies for a complete port area are developed in a traffic centre, instructions are given to the sub-centres which are communicating with the pilots, who in turn are advising the captains. In such a system, the elements (the individual ships) have not only their own needs, possibilities and behaviour, but also their own responsibilities. Hence, 'multi-level' does not just mean the passing on of instructions via many levels to a ship or group of ships. Instructions should in general not determine the behaviour of the vessels; on the contrary, an efficient system makes use of this behaviour. This can only be achieved by taking the right measures at the right moment, leaving enough room for initiative at the lower levels, depending on local conditions, and for the correction of errors (2). This is necessary, because the 'control centre' is not present in the periphery, does not know everything, and cannot predict everything. It must make use of the intelligence in the periphery.

To be able to select the proper measures the traffic centre must know the effects of a particular measure. For instance, how are safety and efficiency affected by a particular admittance strategy? What are acceptable limits with respect to density? And, what is the effect of allocation of an extended domain for a particular ship on the behaviour of other ships?
These kind of questions must be answered before a measure is taken. In this paper I shall pay particular attention to the problem of how this information can be obtained.
The approach normally followed is to solve the problem by accident analyses. However, this does not offer a complete solution, for the following reasons:
- the data available on accidents are, in general, very limited and not always reliable;
- the number of accidents which have taken place under similar conditions is often too small for the data to be analysed in a statistical way;

- it is often very difficult to determine the effect of measures to be taken.

In this study a vessel traffic simulation model has been used to investigate the relationship between nautical risks and parameters characterizing a particular traffic situation. The model, developed by TNO-IWECO (3, 10), has been adapted to the Rotterdam harbour as part of a project to develop a new vessel traffic management system for this harbour (4, 5). In the following section I shall give a brief description of this model.

2. The TNO-IWECO Vessel Traffic Simulation Model

The output of the model is the position, heading and speed of each ship present within the simulated area at each time step. The input of the model consists of the ship's characteristics, their starting positions and starting times, and their destinations. The behaviour of each simulated ship is described by the same sub-model, but the parameters of the sub-model correspond with the type of ship and its dimension. A block diagram of the sub-model is given in figure 1.
To take into account the local conditions, a system of so-called system or reference track lines has been defined. An example of such a system is given in figure 2, where the reference track lines with respect to the area near the entrance of the New Waterway are shown.

Based on certain criteria, the ship selects the optimal route to be followed. For each type of ship and each track line the planned offset distance to be maintained from each track line, and the planned speed for each track line have to be specified. By specifying maximum allowable distances for each track line, fairway boundaries can be taken into account. The 'Route Following Part' of the sub-model selects the proper data from the list of input data. When the ship approaches the end of the current track line, the planned speed and the planned distance are adapted to the next track line.
Each vessel in the harbour area considers the relative position of the other ships and looks for potential conflicts ('Conflict Detection and Resolution Part'). If necessary, the planned speed and/or planned

offset distance are adapted in order to avoid conflicts. The results of this decision-making process are called the desired speed and the desired distance.

In evaluating possible conflicts only vessels are considered which are sailing in what is called the area of observation. In reality, the area of observation is probably dependent on ship size and speed. However, during this study the radius of this area is kept constant. The identification of the type of conflict is based on the pertinent traffic rules, for instance, the International Regulations for Preventing Collisions at Sea, or those given by the governmental and municipal authorities. In the model three types of encounters are recognized:

- Overtaking situations, when the course of the subject vessel is about the same as that of the vessel observed, and when this vessel is sailing in front of the subject vessel.
- Head-on situations when two ships are meeting on reciprocal or nearly reciprocal courses.
- Crossing situations when the track to be followed by the observed ship crosses the track of the subject ship.

When the type of encounter has been identified, a prediction has to be made about whether or not there is a conflict. A conflict exists when a ship enters the domain of another ship. The ship-domain is the area around a ship that a navigator would like to keep free of other ships (6). In general, the dimensions of the domain will depend on factors such as: sizes of observed and subject ship, speed of the ships, ship types, etc. For the time being, the ship domain in the model only depends on the length of the observed vessel and the actual speed of the subject ship. However, other factors can be taken into account without extensive modifications of the model.
When the extrapolated track of the observed vessel crosses the track of the subject ship, the subject ship wants to keep free a distance A_{sj} ahead, and a distance C_{sj} astern. When the observed ship follows a track parallel, or nearly parallel, to the track of the subject ship (that is in the overtaking situation of the head-on situation), the subject ship wants to keep free a lateral distance B_{sj}. The extrapolated track of a ship is described by a straight line through the centre

of gravity in the direction of the reference heading (see figure 3). To avoid the conflicts, the Conflict Detection and Resolution Part first considers the head-on situations and the crossing situations. The conflicts resulting from head-on encounters are solved by increasing the distance from the reference track line in such a way that safe passing is possible. The conflicts resulting from crossing situations are solved by reducing the speed of the ship that has to give free passage to the other. When the subject vessel discerns a vessel ahead, sailing at a parallel track, and when the desired speed of the subject vessel is greater than the speed of the predecessor, the subject vessel will try to execute an overtaking manoeuvre by adapting the desired distance relative to the reference track line.
Depending on its size and the available space the subject vessel will overtake at the port or at the starboard side. If an overtaking manoeuvre is not possible, the desired speed is adapted to the speed of the predecessor in order to stay at a safe distance behind the predecessor.

After the Conflict Detection and Resolution part has determined the desired distance to the reference track line, a desired heading is computed, which has to be steered by the 'Helmsman Dynamics Part', a correction to compensate for current effects being taken into account.
The '<u>Ship Dynamics Part</u>' consists of a linear first-order differential equation to compute the ship's rate of turn resulting from the rudder angle. By integration of the rate of turn, the ship's heading is obtained. The ship's behaviour with respect to the forward speed is described by means of a non-linear first-order equation. The output is the ship's speed. This model has been used to develop criteria for risk and efficiency. The development of these criteria will be discussed in the following sections.

3. A risk criterion

The problem can be started as follows: Given a particular traffic situation, what is the probability of a collision? A first step towards the solution of this problem is to determine the parameters characterizing a traffic situation. The next step could be to analyse traffic data to determine how often a particular situation occurred in the past, and how many times such a situation resulted in an accident. If the number of accidents is sufficiently large, the required information can be obtained. However, this information is only valid for the area considered in the analyses of the data.

A study was commisioned to TNO-IWECO by the Rotterdam Port Management on behalf of the parties involved in the development of the new vessel traffic management system. In this study the following approach has been used: Based on data from literature a tentative relationship between the risk of collision and parameters characterizing a traffic situation has been derived. This relationship is called the risk function. If the risk function fits the available data on accidents, the function may be used to predict the risk of collision in situations where no data on accidents are available. In this way a framework is constructed to compare sets of accident data for different traffic areas.
A similar approach is possible for analysing the risk of stranding. However, this aspect has not been investigated in this study.
The probability of a collision in a traffic situation depends on a number of factors, such as: the manoeuvring characteristics of the vessels involved, the quality of the crews, the number and position of vessels in a certain area, the geometry of the fairway, the current, the time of day or night, and the weather conditions. To obtain an estimate of this probability of collision, a traffic situation as shown in figure 4 is considered.
The risk of ship s, the subject ship, colliding with ship j depends on the position of ship j relative to ship s, given by the co-ordinates (x_j, y_j). The greater x_j and y_j, the smaller the risk of a collision. In literature, the ship domain concept is well known (10, 14). According to this concept each ship is connected with an area which the master or navigator would like to keep free of other ships. In other words: the probability of collision between the subject ship and another ship is low when the other ship is sailing outside the domain of the subject ship; it becomes higher when the observed ship approaches the subject ship. The boundary of the domain could be

regarded as all the points for which the probability of a collision is constant.

According to Fujii (7) the boundary of the ship domain can be described by a semi-ellips (cf. figure 4). Based on the findings of Fujii the factor P_{sj} has been defined, which indicates how far the observed ship 'j' has penetrated into the domain of the subject ship 's'. If the position of both ships coincides, the penetration facor P_{sj} equals 1, whereas P_{sj} is zero when the distance between both ships approaches to infinity.
In addition to the relative position (x_j, y_j) also the angle α_{sj} (cf. figure 4) is important. This factor indicates how far the subject ship has the possibility of avoiding the observed ship j. If ($\alpha_{sj}/2\pi$) equals 1, the passage of the subject ship is impossible.
Based on the foregoing the risk function R_{sj} is defined as follows:

$$R_{sj} = w_s \cdot w_j \cdot \frac{\alpha_{sj}}{2\,\pi} \cdot P_{sj}$$

The factor ($\alpha_{sj}/\ 2\pi$). P_{sj} can be regarded as the probability of ship s colliding with ship j. The factors w_s and w_j are included to take into account the effect of a collision depending on factors such as the cargo, the quality of ships and crews, and the location of an accident. This means that w_s and w_j are dependent on the earth fixed position of ship s and j respectively.
If a number of ships are sailing in the vicinity of the subject ship, the total instantaneous risk function R_s is defined as follows:

$$R_s = \sum_{j=1}^{n} w_s \cdot w_j \cdot \frac{\alpha_{sj}}{2\,\pi} \cdot P_{sj}$$

This Risk criterion must be considered a first step. Many aspects are not taken into account. However, the choice what other factors should be included can only be made after experience with this criterion has been obtained.

4. An efficiency criterion

To keep the risk within acceptable limits, measures have to be taken by the port management. However, the selection of measures should not be based on safety considerations only; efficiency aspects must be taken into account as well. The problem is to predict the delay of a ship as well as the losses due to a delay, in relation to the traffic situation in the port area. The solution to this problem cannot be given easily. The losses due to a delay depend on factors, such as: running costs of a ship, cost of cargo transported, and kind of cargo. For the time being only one aspect has been considered in this study, namely: the delay of a ship due to the traffic situation in the port area. The losses themselves have not been considered. To investigate the delays of ships during their journey in the harbour area, the following function is proposed as a criterion for efficiency:

$$E_s = \frac{U_s}{U_{pl,s}} ,$$

where U_s is the actual speed, and $U_{pl,s}$ the planned speed. The sub-script is used to indicate that the ratio relates to ship s.

5. Simulations

To analyse the usefulness of the risk function defined in section 3, and to investigate the relation between risk function values and parameters characterizing a particular traffic situation, simulations have been carried out with the model described in section 2. At present, the parameters w_s and w_j in the risk functions are made equal to 1. In the future other values should be determined on the basis of e.g. cargo transported by the ships. In addition to the risk function values, also the efficiency function E_s has been computed for each simulated ship at each time step.
The area simulated includes the main routes of the Rotterdam harbour (Nieuwe Maas, Oude Maas, New Waterway, and Calandkanaal), the approach area, and the most important harbour basins.

Simulations have been carried out with 16 different ships: 9 different seagoing vessels, and 7 different inland vessels.
To start each simulation with a realistic initial condition, the situation at the end of the previous run was used. The initial condition for the first run was obtained by a simulation of about six hours, with no ships present in the harbour area at the start of the run. Four runs of six hours each were carried out. During the first and second run each 50 seconds a ship started at one of the ten possible starting positions; during the third and fourth run this time interval was 40 seconds. In this way different levels of traffic density were obtained. The traffic density represented realistic, engaged conditions.

6. Results

During the first and second simulation the time step between two departing ships was made equal to 50 seconds; during the last two runs the time step was made equal to 40 seconds. To get an impression of the density, the number of ships simultaneously present in the system as a function of the time is given in figure 5.
During the simulations, at each time step of 15 seconds the values of the risk function R_s, and efficiency function E_s have been calculated for each ship. To achieve a reduction of data the means and standard deviations for all ships and for the complete area were computed. The results of these calculations are presented in table I, in which also the average number of ships for each run is given.

Table I. Mean and standard deviation of Rs, Ps and Es for all ships

Run	Number of ships		Rs		Es	
	at start	average	mean	stand. dev.	mean	stand. dev.
I	51	89.3	0.0160	0.0462	0.9279	0.2434
II	96	101.3	0.0182	0.0718	0.9223	0.2528
III	96	124.9	0.0238	0.0584	0.8830	0.3042
IV	145	136.6	0.280	0.0722	0.8611	0.3254

In figure 6 the average values of R_s and E_s are plotted as a function of ship length for three categories of seagoing ships and for each simulation run. From the data given in Table I a relationship between the number of ships present in the whole port area and the mean values of R_s and E_s can be obtained.

However, the average number of ships present in the port area is not necessarily a useful criterion for density. An anlysis of the data showed that the ratio between the area required by all the ships within a certain area and the available sailing area can be considered as a useful criterion for density. The area required by a ship is that part of its domain which depends only on the ship itself. In figure 7 the average risk and efficiency values for each track line on the main route are plotted on the basis of the average density. For the calculation of this density the planned ship speeds are used.

7. Discussion

Figure 5 shows the number of ships simultaneously present in the model for each of the four simulation runs. As can be seen in this figure the number of ships varies with time even during those periods during which a more or less constant number could be expected. For instance, during the fourth run the number fluctuates around 150 ships during the first hour to decrease later on to about 130 ships. This phenomenon is not observed during the second run. The fluctuations in the fourth run are caused by some slowly sailing ships blocking the fairway in such a way that they can hardly be overtaken by other ships. When planning strategies are developed, it is this sort of congestion which needs to be prevented. Hence, the model used in this study could probably be used to indicate when congestions may be expected to occur in reality. A verification of the prediction results with real world data is needed to be more definite in these matters.
In figure 6 the average values of R_s and E_s as a function of ship length are shown for some categories for each simulation run. The very large ships of category 1.3, i.e. the ships belonging to the group of VLCC's, show mean risk function values and mean speed ratios, which deviate clearly from the trend shown by the other ships. These devia-

tions are caused by the fact that the destination of these ships is somewhere along the Calandkanaal. The Calandkanaal is used by only few other ships, which makes the probability of a collision small. The high risk values of the large, fast, seagoing ships (category 1.1) is caused by the high speeds of these ships. Obviously, the manoeuvring characteristics of these ships, at least in the simulations, cannot be regarded as a compensation for the higher speeds. The simulation results show risk function values which increase with ship length. This corresponds with data from accident analyses given in literature (8, 9).
One of the aims of the study was to provide information on the relation between nautical risks and parameters describing a particular traffic situation. The relationship shown in figure 7 may be considered part of the desired information. However, traffic density is not the only parameter to be taken into account. Other parameters are fairway geometry and weather conditions such as wind and visibility. In the future more attention should be paid to these aspects.

8. Concluding remarks and recommendations for further research

The problem stated in section 1 was to obtain knowledge about the risk of collision in relation to parameters characterizing a particular traffic situation. Moreover, efficiency aspects had to be investigated. To solve this problem simulations with a mathematical model describing vessel traffic behaviour were carried out. To analyse the risk, a so-called risk function was developed, while the ratio between the actual speed and the planned speed of the ships was taken as a criterion for efficiency. Based on the simulations the following conclusions could be drawn:

- Simulation of vessel traffic can be a useful tool for predicting traffic congestions.
- The criteria for risk and efficiency developed are a good starting point for investigating safety and efficiency. However, it still has to be investigated how the risk function values correlate with the actual risk of collision.
- The simulation results indicate that larger ships are more collision prone than smaller ships. This is in accordance with results from accident analyses. However, larger ships may in reality be better

equipped than smaller ships. The cargo also affects the risks involved. These aspects have not been taken into account, and this should be kept in mind when using the computed values. However, if such factors can be quantified, it is possible to take them into account.

- The simulation results show a relationship between the risk function values, the speed ratio and the traffic density. Knowledge of this relationship is useful in the planning of vessel traffic. In bad weather conditions the relation between the risk function, speed ratio, and density will probably change. This aspect was not investigated.

Based on the results and the problem stated in the first chapter, the following is suggested for further research:

- One of the first activities in the context of this project should be aimed at gaining an insight into the extent to which the developed risk function correlates with the actual risk of collision.
- After the new Rotterdam Vessel Traffic Management System has been installed, the collection of real world data becomes much easier. This offers the possibility to compare the simulation results and the computed measures with realistic data.
- The continuous recording of ship positions, speeds, and headings, as well as the recording of the ships characteristics, make it possible to analyse critical situations in more detail than with accident statistics. Also a comparison of simulations with the traffic model and the recordings may be of interest. Such a study would probably result in a better understanding of what really happened, and how it might have been avoided. The study would also increase insight into the developed risk function and its use.
- After an insight has been gained into the relationship between the risk of collision in a realistic situation and the computed risk function values, it is suggested that the defined risk and efficiency criteria are applied to a concrete problem situation, e.g. in the development of planning strategies with respect to ship traffic. In this research also the effects of bad weather conditions should be taken into account.

Acknowledgement

The author gratefully acknowledges the contribution of Mr. O.W. van Wijk (P & P) and Mrs. S.J. Angwin (TNO), and the co-operation of the Rotterdam Port Management, in particular the contribution of Mr. P.P. Noë.

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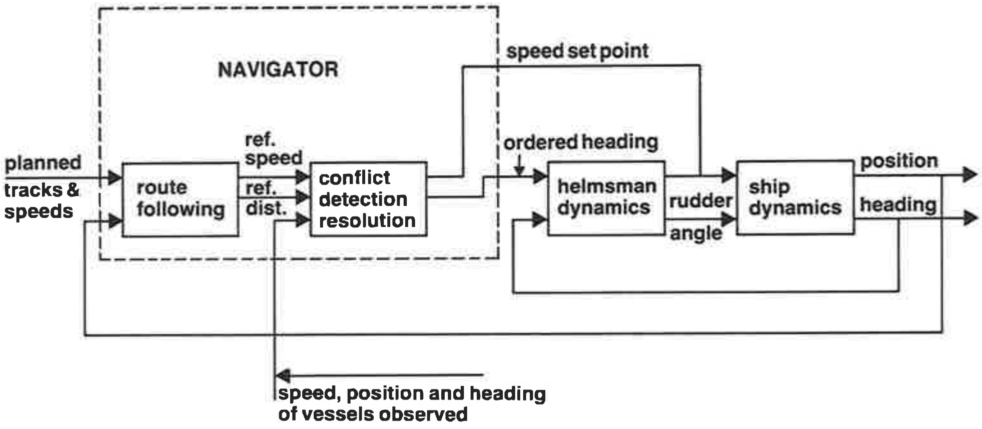


Block-diagram of the sub-model describing the behaviour of each simulated ship.

Figure 1. Block-diagram of the sub-model describing the behaviour of each simulated ship.

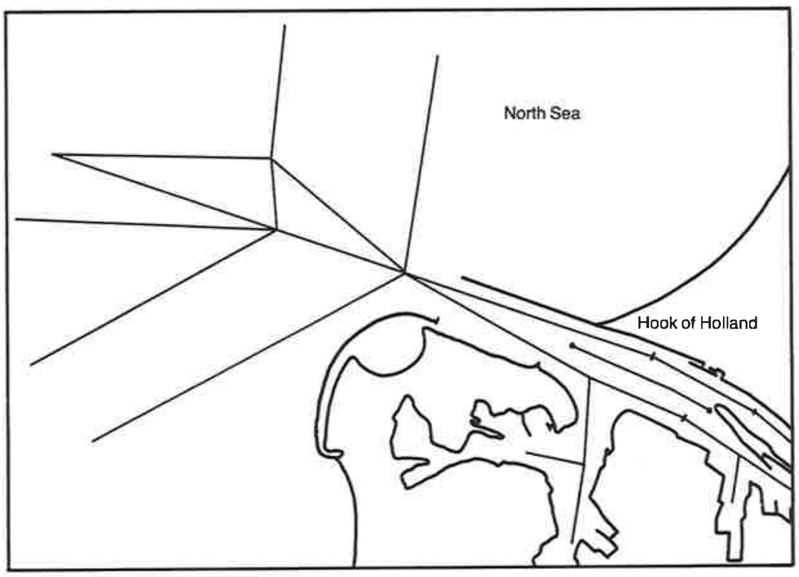


Figure 2. The reference track line system used to simulate vessel traffic in the Rotterdam weave area (5).

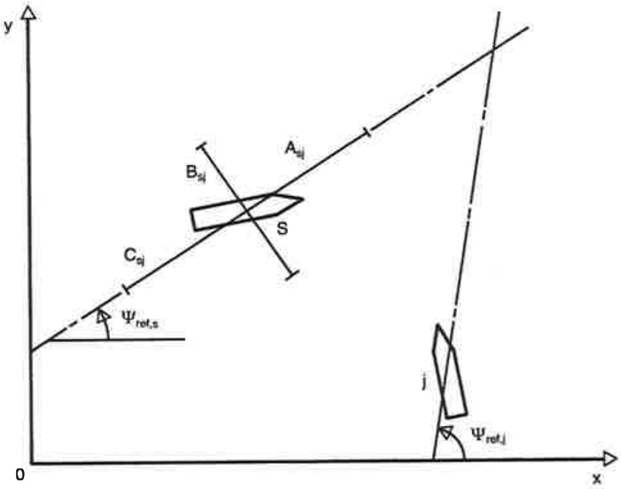
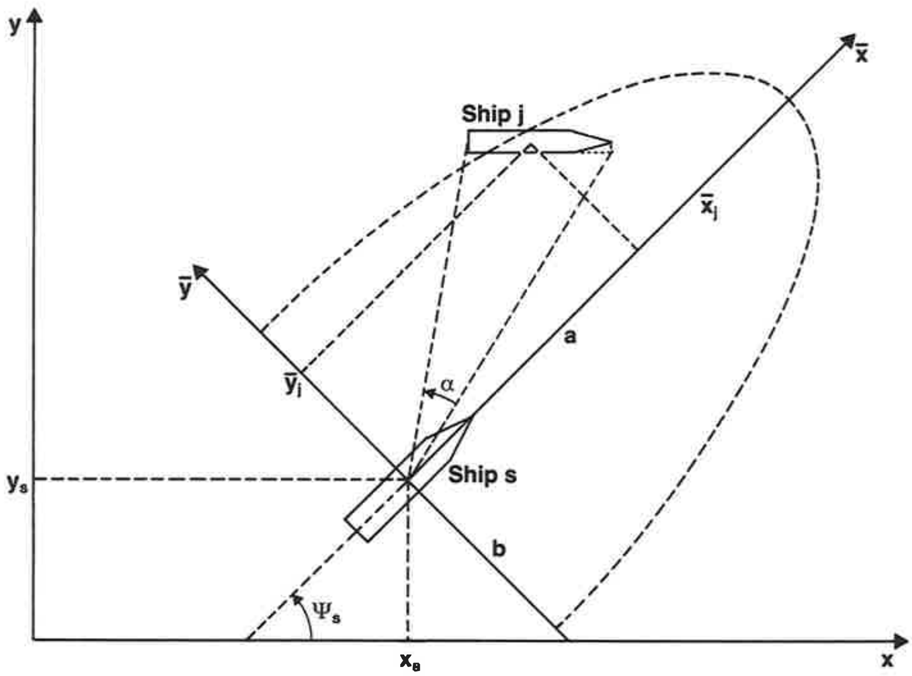


Figure 3. The ship domain concept as used in the model.



Example of a traffic situation

Risk function R_s:
- **ship domain dimensions**
- **penetration factor $P = f(\bar{x}_j, \bar{y}_j)$**
- **blockage factor α**

$$R_s = \alpha . P$$

Figure 4. Example of a traffic situation.

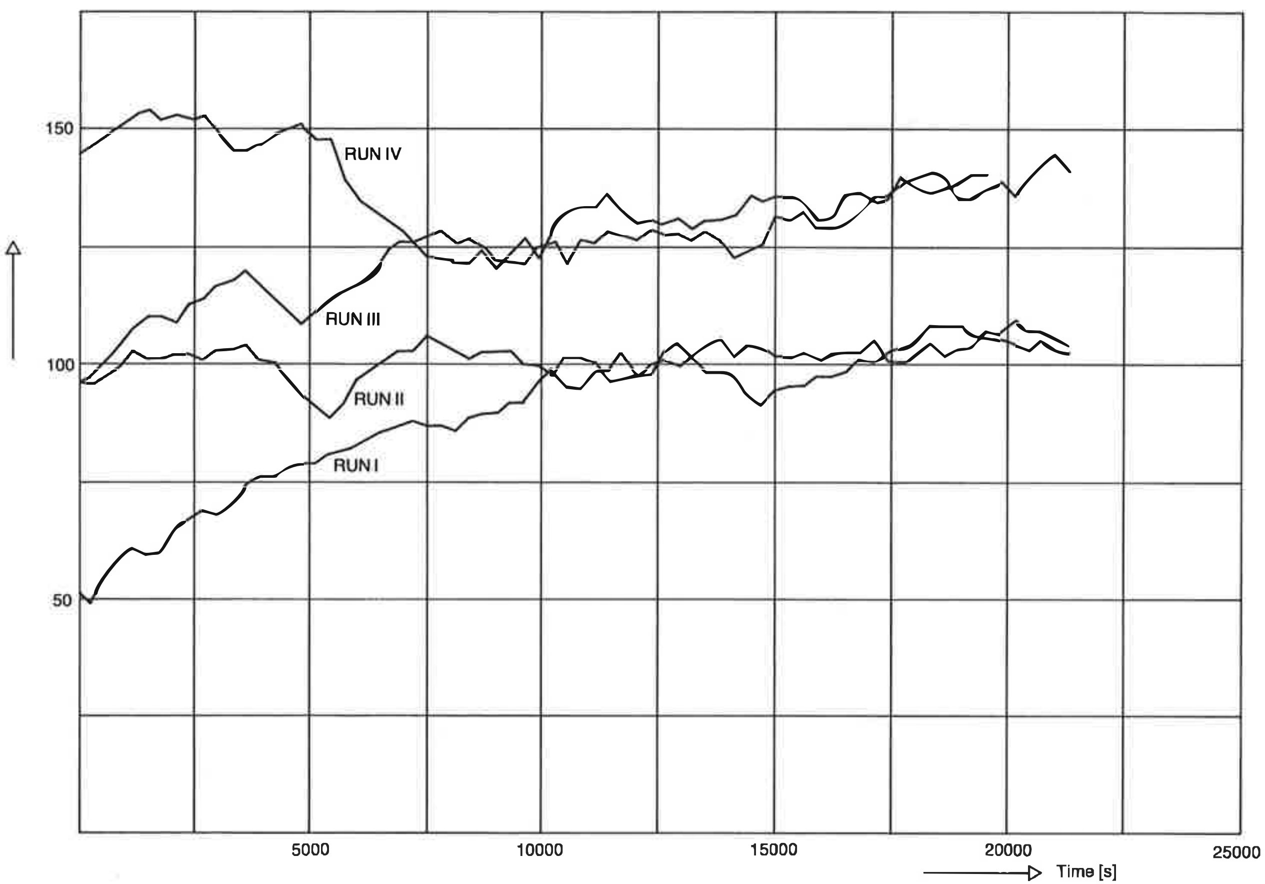


Figure 5. The number of ships simultaneously present in the model.

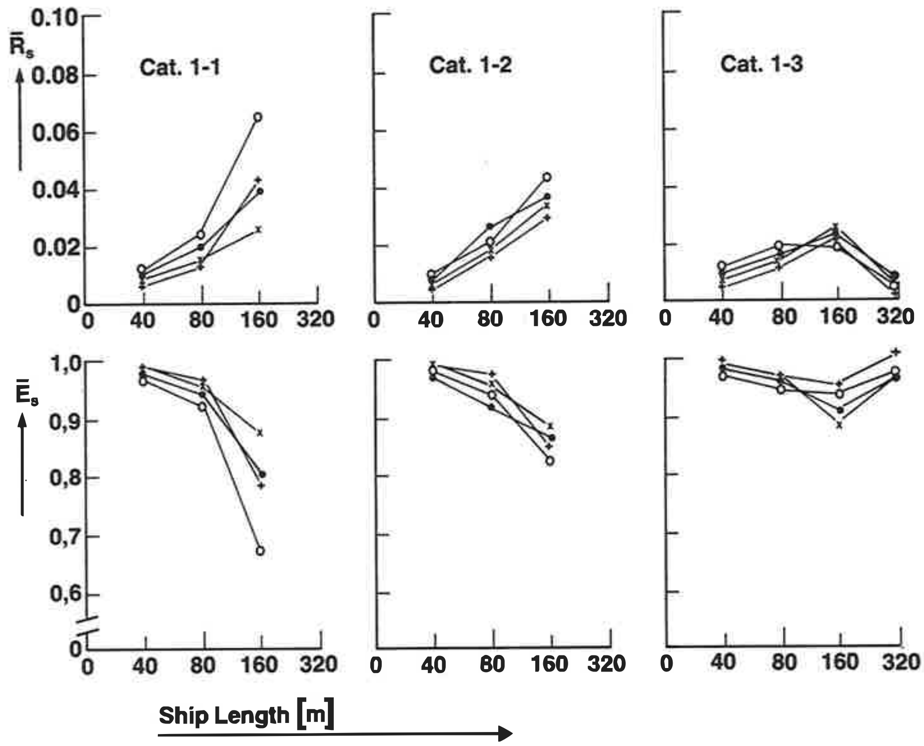


Figure 6. Average values of R_s and E_s as a function of ship length for three categories of seagoing ships.

+ RUN I
★ RUN II
● RUN III
○ RUN IV

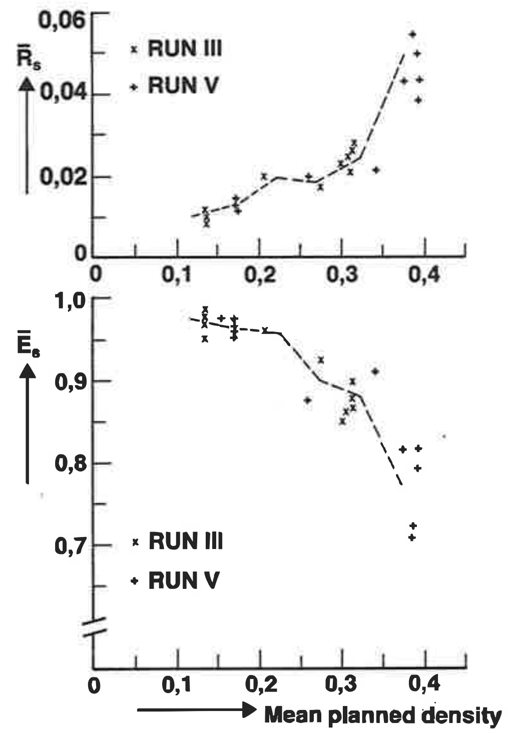


Figure 7. Mean R_s and E_s values for the route Nieuwe Maas-Weave area (Hook of Holland) as a function of the average planned density (Run III and IV).

Safety in the Seaport Complex

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Mr. Chairman, ladies and gentlemen,
In the previous lectures of this conference some speakers discussed, among other things, shipping safety. This, however, in fact forms only part of a more general problem, which Mr Van der Schaaf and I will discuss now, namely: the industrial safety in large seaport complexes and the pertinent industrial activities.
First I shall discuss in particular the way in which safety studies may contribute to furthering the industrial safety.
After I have given you a more or less general consideration on the subject, one of my TNO colleagues, Mr. Van der Schaaf, will explain to you how in a concrete case, namely the importation of LPG in bulk, an in-depth safety study was performed by TNO.

Industrial safety
Now, by the term industrial safety may be understood all those activities which are directed towards furthering the safety of industry. Industrial activities, namely, inevitably involve the danger of accidents to occur. In some cases these accidents may have very serious consequences, both for those who are directly involved in these activities and for those who live in the vicinity, and are exposed to the effects of such accidents.
I'm glad to say that serious accidents occur only sporadically; however, that does not mean than we can simply ignore the fact that in the past, more than once numerous people became the victims of great fires, explosions, toxic substances being released, and failing constructions of, for instance, offshore platforms. And that apart from the large material damage which was caused.
For all those involved it is therefore of vital importance that in the future such accidents are reduced to a minimum and, in case they should

as yet occur, to reduce their consequences to a minimum.
This has been become imperative, the more so as industrial activities are taking place on an ever-increasing scale, and because large industrial complexes have come into existence, such as for instance in large seaport complexes, on account of which the potential consequences of accidents have considerably increased.
Besides, it should be noted that along with these developments better and safer technologies have been introduced as well, and that more attention is devoted to safety measures. For a large part these measures come under the responsibility of industry, and the government plays in this respect a regulatory role through its laws and regulations, and its licence policy.

Safety studies

To be able to design appropriate measures to further the safety we need to perform safety studies. The objective of these studies is to identify the potential unwanted events within a certain system, and to quantify the potential unwanted consequences according to magnitude and probability of occurrence (unless, of course, the former can be considered negligible).
To make safety studies we have several methods at our disposal, and these methods vary from 'very rough' to 'very comprehensive'. The choice of the method is closely connected with the demarcation of the system and the required depth of the study. In the case of a well-defined system, such as a storage tank for some hazardous substance, the method to be applied will as a rule be different from the method used in the case of a not so well defined system, such as the transport of a hazardous substance by tank car in ever-changing surroundings. The required depth of a safety study depends on the aim of the study, the stage of development of the system, the experience people have had with the system, and the potential hazard for the vicinity.

This aim can, for instance, be the optimization of an installation or the choice of the process. And in this case the result of the study will be used in particular within the industrial firm in question. However, when the safety studies are executed on behalf of the

..oyees and those who live in the vicinity, the results will also be judged by people outside the company.
The stage of development of a system can vary from the laboratory stage to a detailed final design. The depth of a safety study in a certain stage of development will mainly depend on the available amount of information about the design.
The experience gained with a given system provides information about the unwanted events that might occur within the system. The more experience we have gained, the more and better the information will be. This information can be available in the form of, for instance, codes, standards, and guide lines. And it goes without saying, that the fact whether empirical data are available or not, has great influence on the required depth of a safety study.
The potential hazard of a system (or parts of a system) strongly determines the depth of the study: higher demands will be put on the depth of the study, according as the recognized potential hazard becomes greater. It is therefore desirable first to rank the objects, or parts of a system, to be investigated, according to the potential hazard. This can be done with the help of so-called rapid-ranking methods.

Risk analysis

Now, I shall not dwell upon the methods themselves. What I will do is give you a brief explanation of the possibilities and limitations of safety studies. In doing so, I shall pay particular attention to more or less comprehensive risk analyses, which are used by Government and industry as a basis for their safety policy.
In 1977 the 10th International TNO Conference was entirely devoted to risk analysis, and you may regard the following as a complementary explanation of some interesting facts.
In principle a risk analysis is composed of the following phases:
- the completest possible identification of, from the view-point of safety, unwanted events;
- quantification of the unwanted effects (damage) for man and environment of the identified potential unwanted events;
- quantification of the probability of this 'damage';
- determination of the damage expectation; that is all the combinations

of damage size and the coherent probabilities. This is called the risk estimation.

Until this phase of the risk analysis, i.e. the numerical calulation of risk, we make use of techno-scientific disciplines. To be able to use the results of this calculation, i.e. the estimated risk (often called the calculated risk or the objective risk) for managerial decisons, the next step to be made is the risk evaluation. And this means judging the objective risk by its acceptability.
And thus I have raised another point, namely: the perception of risks by individuals or groupings exposed to them. However, we do not know very much about the perception of risks (the subjective risk), the influence of information about the perception of risks, and the comparability of risks. Neither do we generally know much about making decisions with respect to the acceptability of risks.
At the moment much attention is paid to research into these aspects, in which in principal other than technical disciplines are involved.

Finally, in conclusion of this part of my paper, I would like to note that in the final decision-making concerning the acceptance of risk-involving activities, besides this risk, other aspects have to be taken into account as well, such as: economic aspects, financial aspects, social aspects (including ethic aspects), employment and environmental aspects.
This means that an acceptable risk of a risk involving activity is not really accepted until there is an actual need of this activity. The results of risk analyses in the form of a calculated risk provide information on behalf of decision-making.In fact this comes down to technology assessment. In this context risk analysis can therfore be considered part of technology assessment.

Possibilities and limitations of risk analysis

Now, I will discuss the possibilities and limitations of risk analyses in further detail.
Preventive safety studies can be carried out for various reasons, namely:

- Tracing unsafe situations in the design of an installation in order to indicate measures which should prevent them,
- The choice of safety systems, the determination of maintenance and inspection procedures;
- Investigations into the possible causes of incidents and drafting procedures to prevent the consequences of such incidents;
- Designing safer processes and procedures;
- Risk estimations in order to obtain licences;
- Comparison of the alternative possibilities of a certain industrial activity in order to come to an optimum choice;
- The performance of studies to provide a basis for Government and industry when formulating their safety policies.

As to the possibilities of more or less in-depth risk analyses I would like to remark the following:

- The study provides an insight into the possible causes and consequences of accidents, and also into the most hazardous parts of a system. It can thus lead to well-directed measures to prevent accidents and/or reduce their effects;
- The study provides an insight into the relative safety of alternative designs, provided that these have been calculated in the same way;
- The study provides an insight into the relative safety of a new activity, as compared with an already existing comparable activity, provided that it has been calculated by the same methods;
- The study provides a numerical estimation of the risk of an activity.

In so far as the results are only used in a relative sense (such as in the first three above-mentioned cases), risk analyses can be considered good methods to provide a better basis for (policy) decisions. As a rule, the limitation inherent to their application will to a great extent be determined by the funds available for this purpose.
However, it is still subject of discussion whether the results of such studies can be used in an absolute sense when decisions have to be taken about the permissibility of industrial activities implying new developments (the fourth above-mentioned possibility). The question remains, namely, whether these studies yield pictures of the risks

which are reliable enough to enable a correct judgment of the risks. In this respect it should be noted, that both with regard to the quantification of the effects of accidents, and (especially) with regard to the quantification of the probabilities of accidents, there are gaps in the available knowledge. And this implies that the accuracy of the results is only limited.
The most important limitations of risk analyses can be summarized as follows:

- Any possible causes which have been omitted in the identification phase, will not come back in the further course of the study. A special problem in this respect is formed by external causes of possible accidents. Think for instance of sabotage, the crashing of planes, and so on. These external causes are often difficult to estimate.
- There are gaps in the knowledge about the methods for calculating effects and damage.
- The lack of sufficient data for the chance estimation, including human failure.
- The quality of management influences the risk considerably, but is difficult to quantify.

Considering the above limitations and the limited accuracy of the results, we may not attach any absolute value to the numerical results of risk analyses. If we want to be able to determine as yet the value of a calculated risk, the risk analysis should be accompanied both by a sensitivity analysis, i.e. an analysis of the influence of the probabilities of individual events upon the final result, and by an analysis of the accuracy of the results. When presenting the results, one should take account of the aim of the study, and, consequently, of the minuteness of the results. A complete risk analysis yields data about (many) accidents with great chances and minor consequences, as well as about (few) accidents with small chances and considerable consequences; and these results should be presented in a well-balanced way.
Besides, the presentation has to be oriented towards the way in which the results will be used. For instance, if the results of a study are to be judged by experts only, the requirements for the presentation of

these results will be quite different from the requirements in case also non-experts are involved in the judgement.
On account of the high costs on the one hand, and the limited accuracy on the other, it is to be recommended to apply the instrument of comprehensive risk analysis only selectively. And if such studies should be commissioned, it has to be made clear what demands must be made upon the results of the study with respect to the accuracy, and the way in which they are to be presented.
Now, I regret to say that until now this has been done insufficiently. For this reason, and considering the experience gained with these comprehensive, costly studies, I would like to stress once again the necessity that the performers of risk analyses and decisions-makers come to a dialogue, and clear up the demands to be made on risk analyses, so that the studies may contribute adequately to the process of decision-making.

Safety of an industrial area

After these more or less general remarks about the possibilities and limitations of safety studies, I will now briefly discuss how these studies may contribute to increasing the safety in industrial conglomerations, such as we have here in Rotterdam.
Every industrial firm which is managed in a responsible way will devote much attention to the aspect of safety; and to this end it will perform the necessary research either itself, or it will have the necessary research performed by other institutions. In the Rijnmond area a form of co-operation among the various firms has come into existence (the so-called 'Europoort-Botlek Foundation'). Apart from other aspects, this co-operation also comprises industrial safety.
In addition, Government has its own responsibilities concerning the furtherance of safety in this area. And to be able to conduct a well-balanced policy, they must have a good insight into the risks involved in the industrial activities.
I'm glad to say that recently industry and Government have made a first step to obtain this insight. It goes without saying that, on account of the high costs they entail, the risk analyses needed for this purpose cannot be all very comprehensive. Comprehensive studies are only justified in case of high potential risks, such as is, for instance,

the case with the risk analysis of the importation of LPG in bulk, made by TNO. Mr. Van der Schaaf is going to talk to you about this subject in a few minutes.
For this reason it is at the moment being investigated how such a 'risk registration' can be made in the most efficient manner possible.
It goes without saying that in assessing the pros and cons of industrial activities, a process which precedes the final decision-making, we should not forget that the people living in the industrial areas are also exposed to other risks than those of industrial accidents.

Mr. Chairman, ladies and gentlemen,
I would like to end my paper with the following remarks.
As to the relation between technology and society it has to be concluded that in the 1970s our society has grown increasingly critical as regards the negative consequences of technology. Society now makes its demands on technology, safety being one of the limiting conditions.
Industrial activities in a port complex, such as the Rijnmond area, may have a great impact on the vicinity. For that reason possible locations for new risk involving activities should be subjected to careful contemplations.
On behalf of society, which now evidently wants to have a say in decision-making concerning industrial activities, it is necessary to make the inherent risks tangible. And for this aim risk analysis is a good instrument.
For final decision-making within the framework of an integrated policy we shall have to contemplate more and more the use of Technology Assessment: i.e. weighing up all the pros and cons of the activity in question.
Also for TNO it would be a good thing to broaden its scope of activities in the field of industrial safety into this direction.

Thank you very much.

Analysis of the Risk inherent in the Importation of LPG in Bulk to Four Sites in the Netherlands

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The Netherlands

Ladies and gentlemen,
It is my pleasure to enlighten the presentation of dr. De Graaf by an example of a risk analysis study. This study regards an analysis of the risks inherent in the importation of LPG to four sites in the Netherlands. The project was commissioned by the Dutch Minister of Health and Environmental Protection in 1979, in order to get a basis for the evaluation of the safety aspects of a future LPG policy of the Dutch government. The study was performed by the Department of Industrial Safety TNO, in co-operation with the Netherlands Maritime Institute.In order to arrive at results that are as realistic as possible, the analysis is based on existing ships, quayside installations, and operational procedures, and the study was done in co-operation with the Dutch industry, shipowners and authorities concerned.

The aim of the study was to provide a general insight into the risks associated with the importation of LPG, and to allow comparison of the different terminal sites in terms of these risks. Specific plans had at that time been made for terminals at four sites (figure 1):
- Amsterdam, in the 'Amerikahaven' near the Oil Tanking GmbH installation;
- the Rhine estuary, on the 'Beerkanaal' near the future BP Shell terminal;
- Moerdijk, the industrial estate near the possible future Polygas installation;
- the Western Scheldt, in the 'Sloehaven' east of Flushing near the Eurogas Terminals C.V; installation, and in the 'Braakmanhaven' near Terneuzen at Dow Chemical Nederland B.V.; the route to Antwerp is also covered by the study.

The figures 2 - 5 allow us to have a closer look at the possible sites for the importation of LPG and the approach routes that were studied. Figure 2 shows Amsterdam in the 'Amerikahaven', near the oil tanking installation. Site 2, the the Rhine estuary on the 'Beerkanaal' near the future BP Shell terminal, is shown in figure 3; and the third location, the industrial estate near the possible future polygas installation in Moerdijk in figure 4. Figure 5 presents the fourth site, i.e. the Western Scheldt in the 'Sloehaven' east of Flushing, near the Eurogas terminal installation and in 'Braakman haven' near Terneuzen at Dow Chemical, and the route to Antwerp also covered by the study.

In view of the differences in ship's design and the manner in which LPG is stored in the ships' tanks, a distinction was made between three types of ships (cf. Figure 6). These types were:

- ships suitable for the carriage of LPG under pressure, with a total tank capacity up to about 5,000 m^3;
- ships suitable for the carriage of LPG at atmospheric pressure, with a total tank capacity up to about 70,000 m^3;
- ships suitable for the carriage of LPG at atmospheric pressure with a total tank capacity up to about 125,000 m^3.

An existing ship was selected as a model for each of these catagories, and these catagories can be considered as representative of ships carrying LPG in the future.

The features of the fairway from the sea to the jetty and the quayside installations determine which type of ship can be expected to call at a specific site in the future. Figure 7 indicates the types of ships assumed for each site.

The LPG importation system was divided into three sub-systems: the ship as a storage system of LPG, the ship/shore transshipment, and the sailing ship (Figure 8). With respect to the ship storage system it was concluded that the probability of tank failure due to internal defects, such as metal fatigue, resulting in substantial quantities of LPG being released into the environment is considered to be so low as to be negligible.

The study also extended to the possibility of errors being made during the unloading operation, resulting in an LPG carrier no longer exceeding the maximum admissible shear stress and bending moment requirements, which may lead to deformation of the ship's structure. The conclusion is that, although failure of the ship structure and/or of a tank or tanks is possible, it is unlikely, and the likelihood can be reduced further by stringent official controls.
The calculation of damage to the environment of the approach route and the terminal itself was therefore based solely on a critical collision resulting in the penetration of the ship's tank wall.
It was further concluded that, in view of the siting of the terminals accidents during the transshipment of LPG are unlikely to cause damage to residential environment. Such accidents may, however, claim victims among the ship's crew and personnel working at the terminal and other installations nearby.

Undesirable events as a result of damage to the cargo tanks may occur after a collision with another vessel or with a fixed obstacle or after the ship has grounded. The probability of a ship being involved in such an accident, was first established (Figures 9 and 10). The investigation then turned to the probability of a given level of damage to the cargo tank in the event of such a collision or grounding and to the quantity of LPG that might escape in such cases.
The probability of a critical collision or grounding has been calculated by the Netherlands Maritime Institute, for each site by reference to accidents that occurred on the same fairways in the past. As experience with gas carriers is too limited for a reliable figure to be obtained, the calculation is based on accidents involving all merchant vessels. In the translation of this information into a figure for gas carriers account has been taken of the specific features of such ships, including the compulsory presence of a pilot, the ban of movement on inland waterways when visibility is poor, the route followed by the ship, risk-reducing measures applicable to ships carrying dangerous goods, the handling qualities of LPG carriers, and the size of the ship.

The probability that tanks will be damaged in the event of a critical collision or grounding, and of LPG thus being released into the envi-

ronment depends on a large number of factors, e.g.: the strength of an LPG carrier; the elasticity and deformability of the tanks; the speeds of the vessels involved in the collision; the angle at which the carrier is struck; and the obstacle on which the vessel goes aground (for instance, sand, rocks or a wreck). As the number of past accidents involving gas carriers is limited, the effects of these factors cannot be determined by analysing the past accidents.
Consequently, TNO has commissioned the German classification society, 'Germanische Lloyd', to calculate the minimum speeds of various types of colliding ships required to result in a large hole in a cargo tank.

It was concluded that where a ship goes aground on the Dutch coast, its tanks are unlikely to be damaged in a very short time to such an extent that major instantaneous release from a tank can be assumed, although after one or more tides such damage may well occur. No calculations were done on the damage that might occur in this situation, because TNO assumed that steps can be taken in time by governmental agencies to prevent fatalities among the public.

The calculated quantities released were used to calculate the distances over which certain physical effects (heat radiation as a result of fire, and shock waves caused by an explosion) may occur. The resulting damage and the probability of its occurrence have been established from this calculation and from information on the environment.
The following scenarios given a release of LPG were evaluated (figure 11):

- yes or no immediate ignition?
  Immediate ignition results in a pool fire and damage to the environment due to thermal load.
- yes or no delayed ignition?
  Delayed ignition results in a flash fire of a gas cloud and possibly in a shock wave. The damage to the environment is then a result of pressure and thermal loads.

These scenarios have been used to quantify the extent of the possible damage, expressed as the number of fatalities among the public in the residential environment, in the event of critical collisions on the

route from the open sea to the terminal. The translation of physical effects to personal damage is done via vulnerability models issued by the U.S. Coast Guard. A ship may be involved in a collision at any point along the route. For practical reasons, calculations have been made of every possible effect at intervals of one kilometre.
The probability of the calculated number of fatalities occurring depends on:

- the probability of a critical collision actually occurring at the assumed accident spot;
- the probability of immediate or delayed ignition occurring;
- the probability of a given type of weather and a given wind direction;
- the probability of an explosion in the event of ignition of the gas cloud.

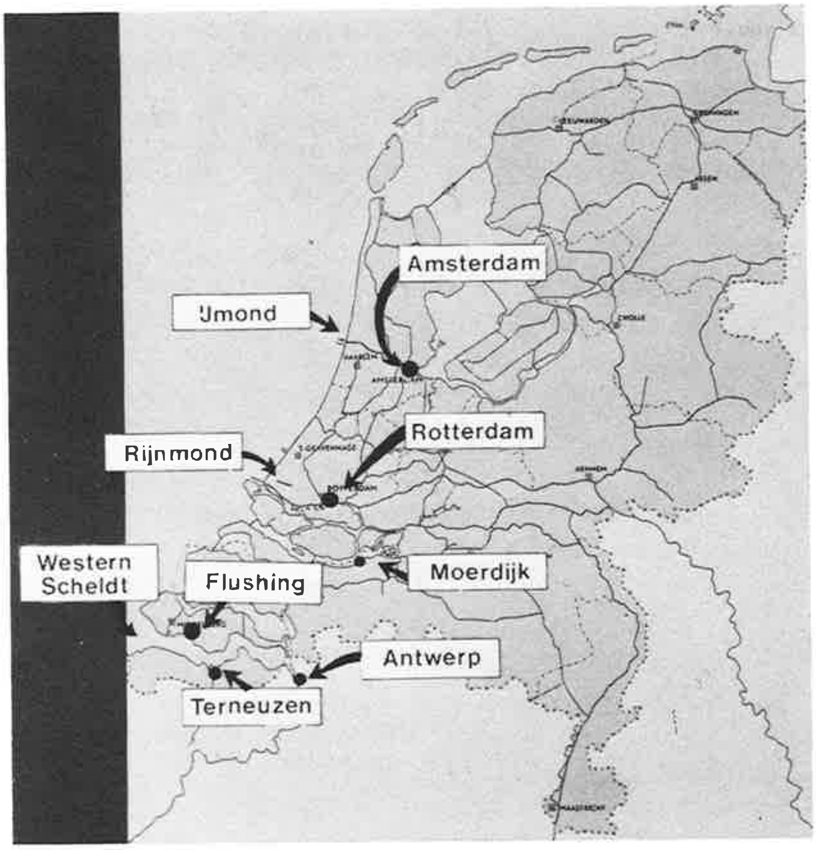
By comparing the affected areas defined by calculation with the actual situation in that area, the resulting number of fatalitites is established.

Results of risk-analyses can in principle be presented in many different ways. It was agreed with the Ministry that this study should describe both the consequences of possible disasters (in this case the number of expected fatalities), and the probability of such consequences. In the diagrams (Figures 13 - 17) these data are related both to ship movements and to one million tons of imported product.

As is demonstrated by the resulted curves for the Amsterdam location, (figure 13) the risk per transit of a 5,000 m^3 carrier is significantly lower than the risk of a 70,000 m^3 carrier. However, when we present the results in terms of million tons of imported product (figure 14), these lines come together, because of the relatively larger number of transits needed by the 5,000 m^3 carrier.
The curves for the BP Shell location presented per transit are given in figure 15, and the results obtained for the Western Scheldt area in figure 16.
Comparing the different locations with each other for the 70,000 m^3 ships (figure 17), we see that as far as safety is regarded, the BP Shell location can be preferred, because the frequency as well as the

number of fatalities expected are much lower. That seems clear. However, when we look at the political decisions made until now with respect to the governmental LPG policy, it is clear that other factors play a dominant role in this decision-making process.

Thank you.



Amsterdam
IJmond
Rotterdam
Rijnmond
Western Scheldt
Flushing
Moerdijk
Antwerp
Terneuzen

Figure 1.

	total capacity	tank capacity	IMCO type	tank type	cargo
1	5000 m^3	2000 m^3	II PG	C	pressurized
2	70,000 m^3	14,000 m^3	II G	A	refrigerated
3	125,000 m^3	28,000 m^3	II G	membrane	refrigerated

Figure 2. Ship types

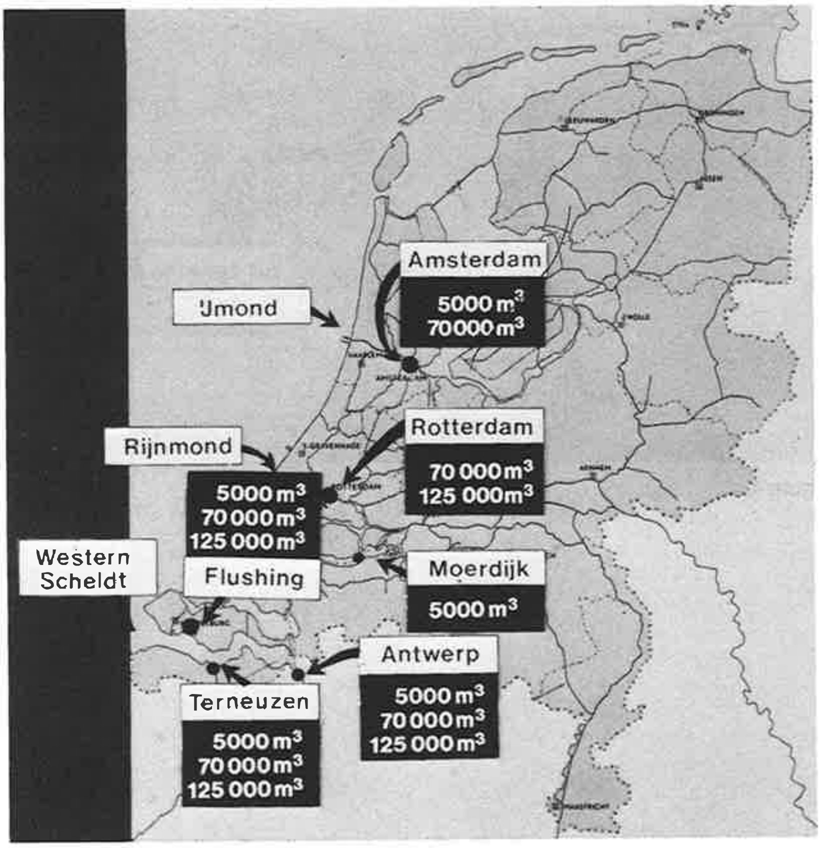


Figure 3.

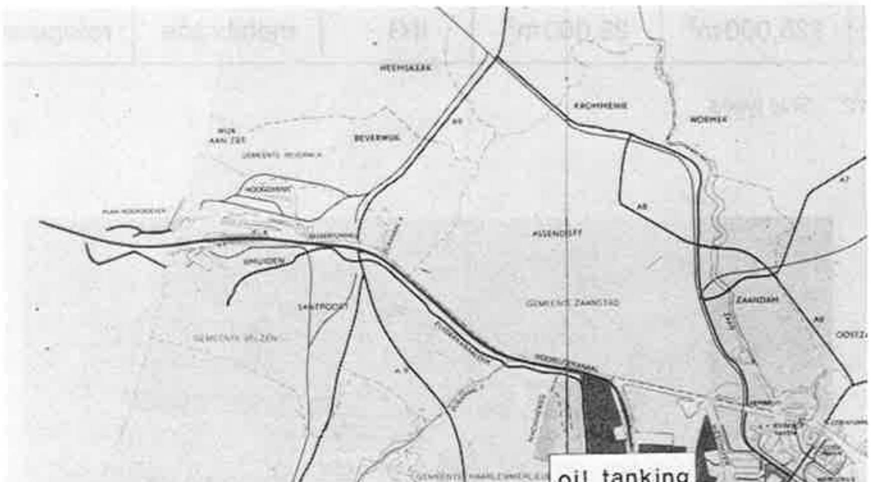

HEEMSKERK
BEVERWIJK
KROMMENIE
WORMER
ASSENDELFT
ZAANDAM
IJMUIDEN
SANTPOORT
oil tanking
HAARLEM
ZANDVOORT
ZWANENBURG
AMSTERDA

Figure 4.

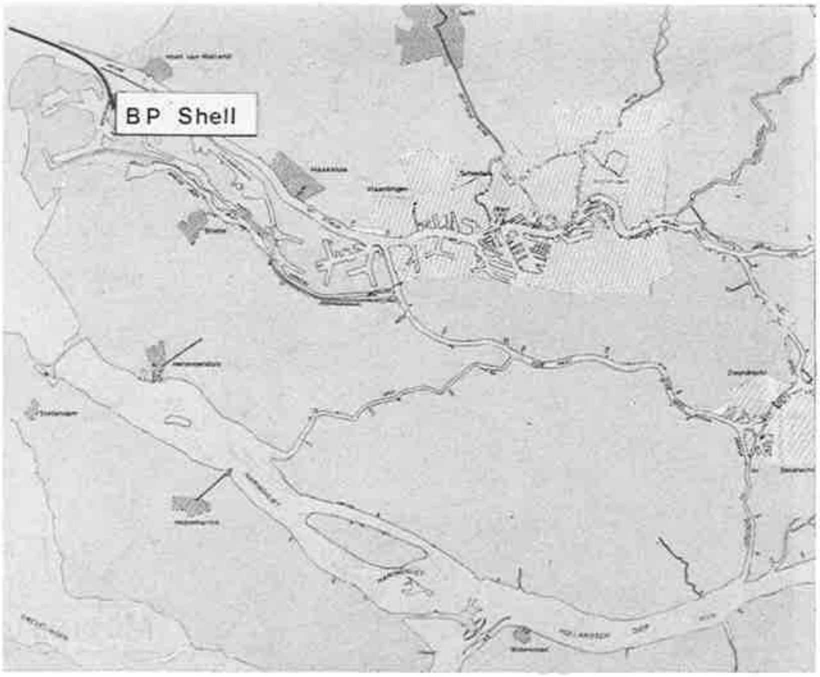


Figure 5.

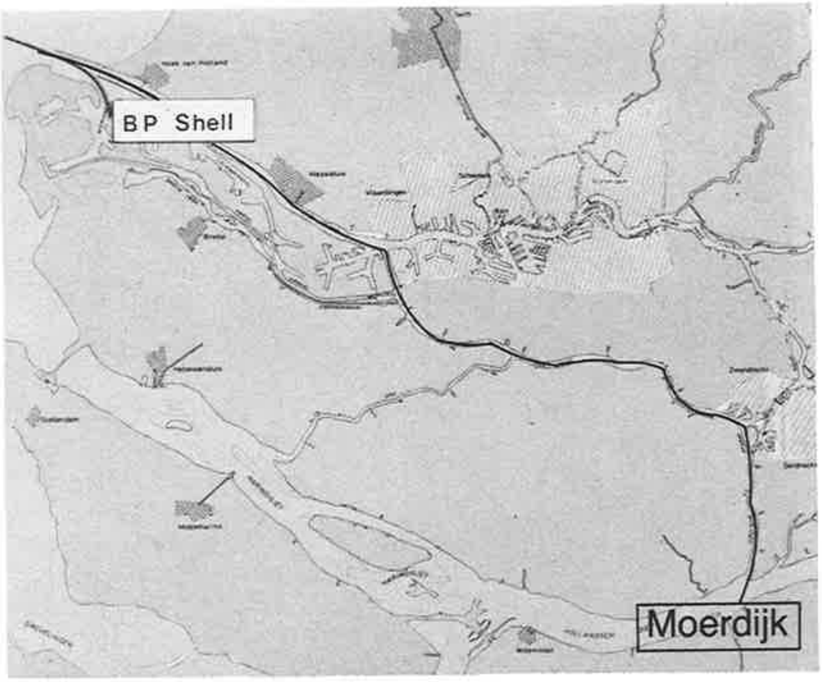


Figure 6. Human engineered workstation for the Traffic Attendants

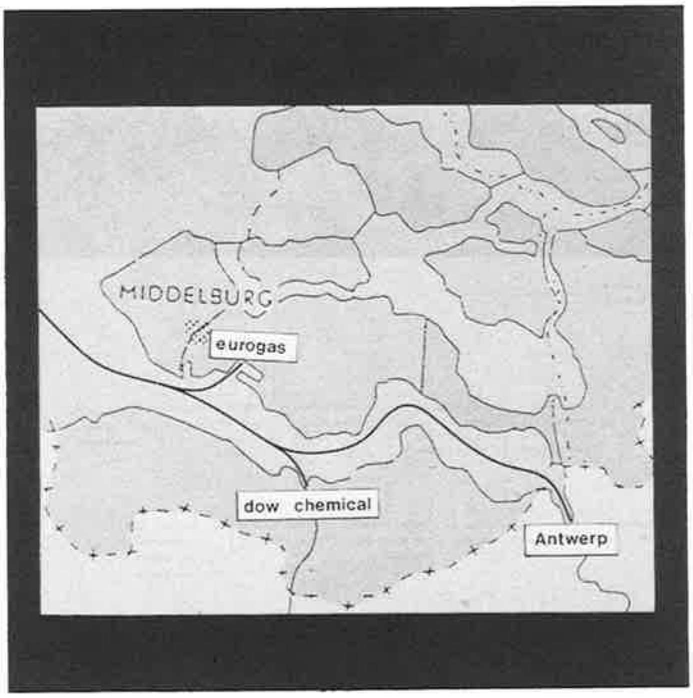


Figure 7.

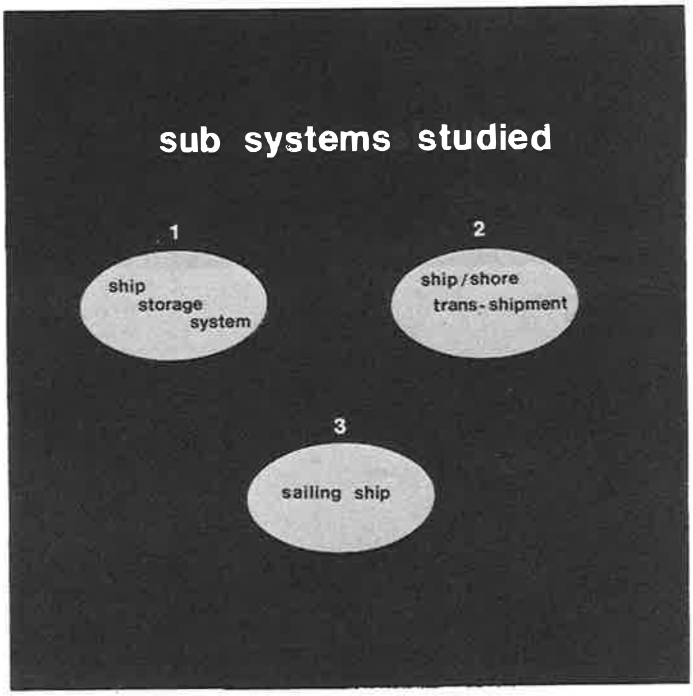


Figure 8.

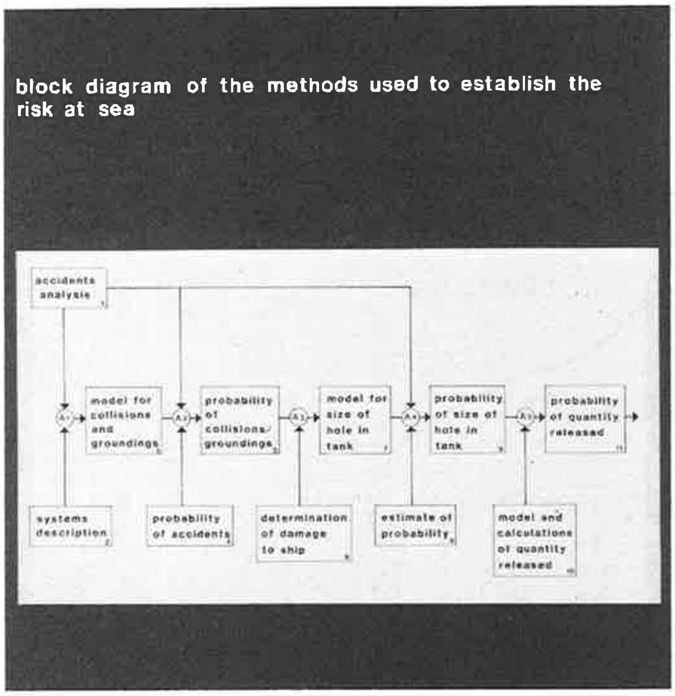


Figure 9. Block diagram of the methods used to establish the risk at sea

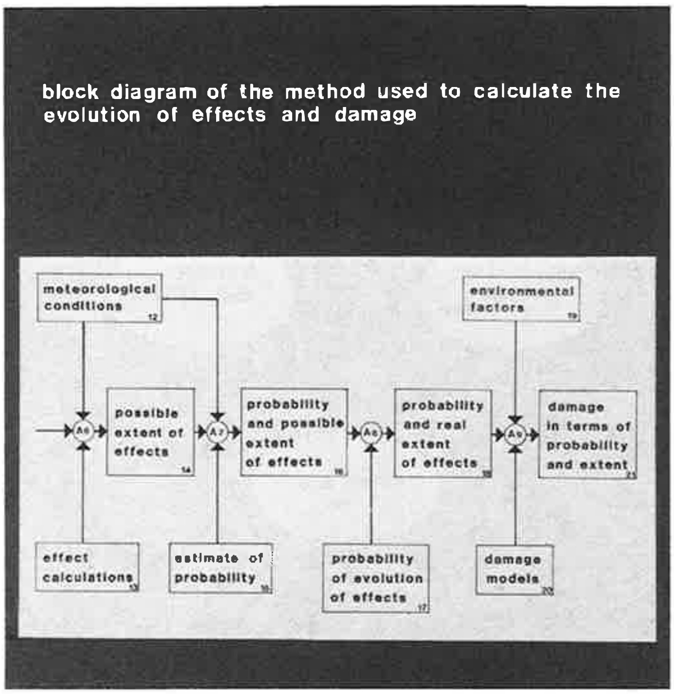


Figure 10. Block diagram of the method used to calculate the evolution of effects and damage.

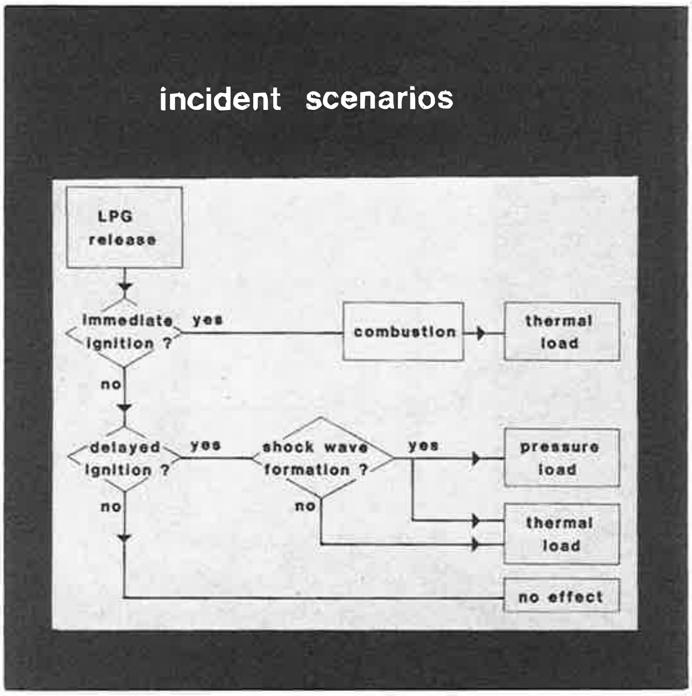


Figure 11. Incident scenarios.

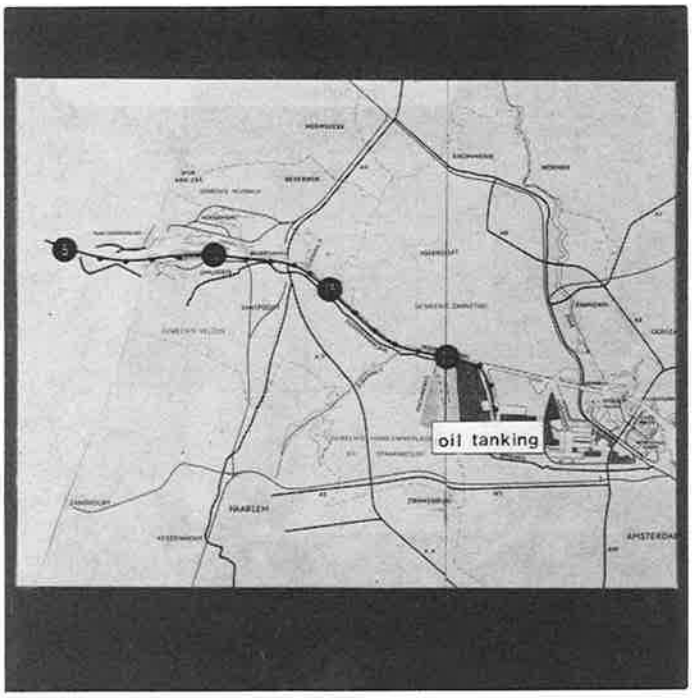


Figure 12

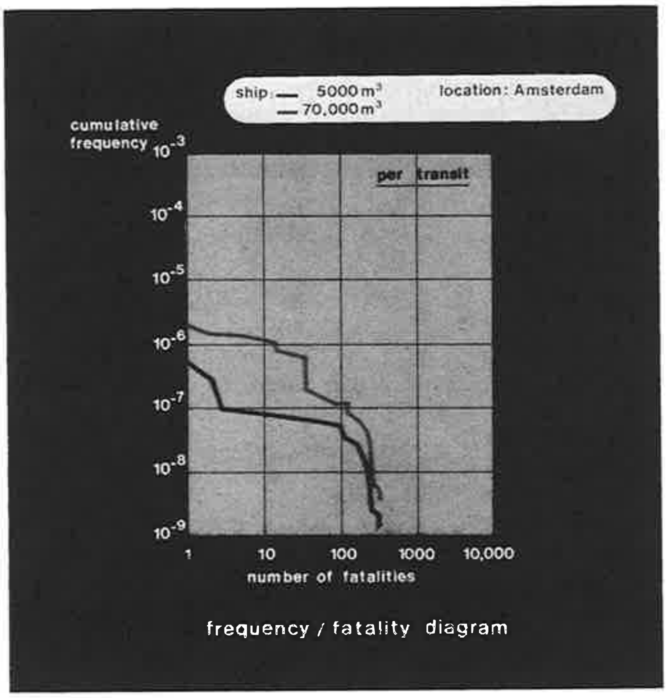


Figure 13. Frequency/fatality diagram

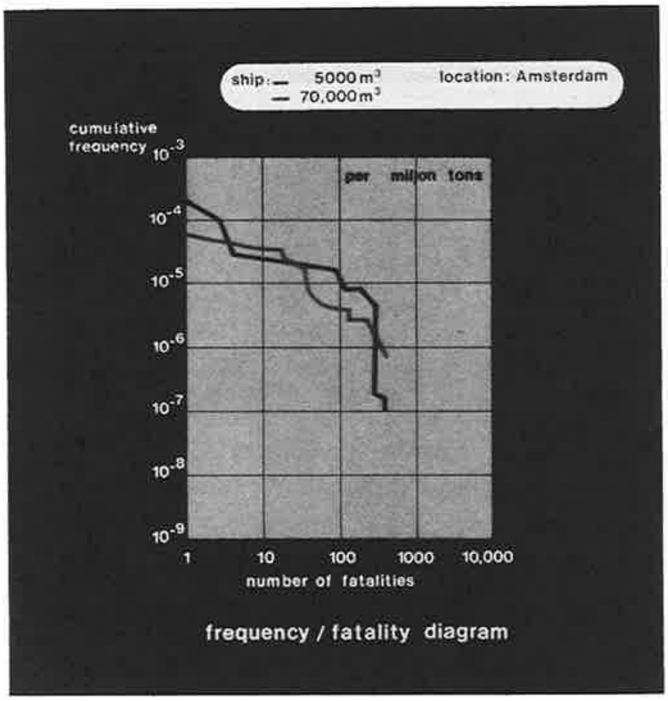


Figure 14. Frequency/fatality diagram

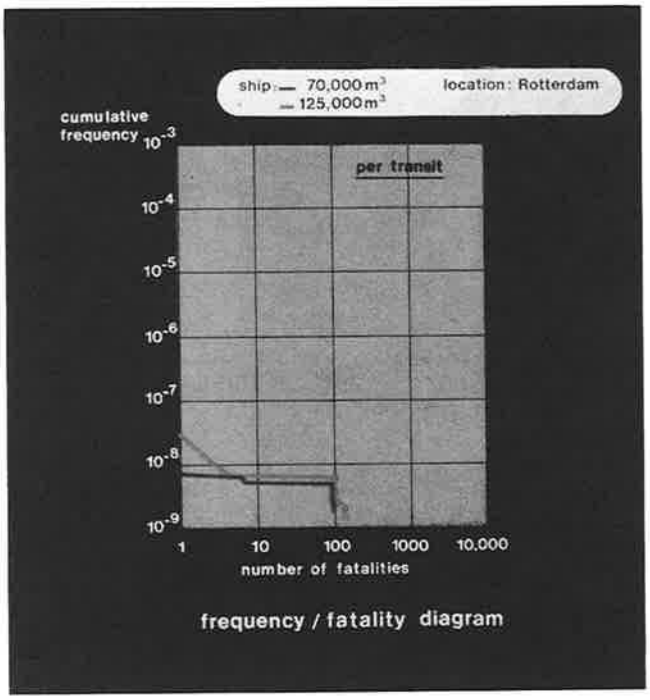


Figure 15. Frequency/fatality diagram.

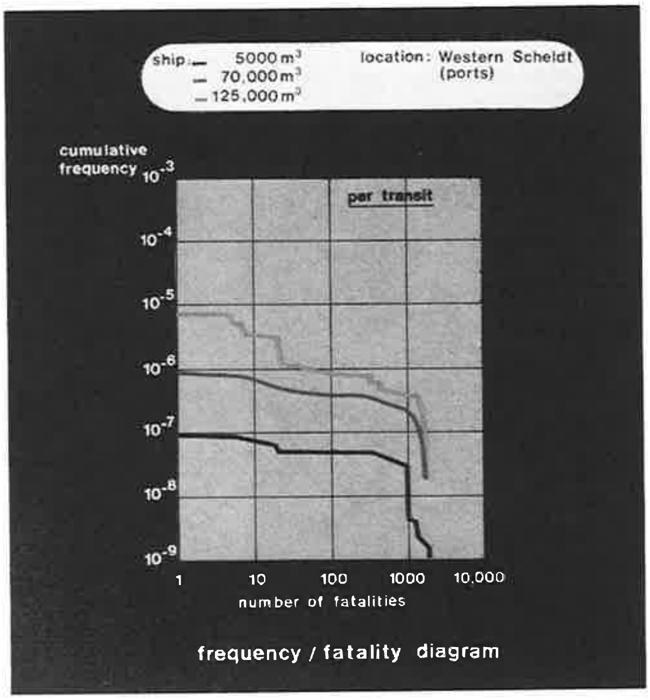


Figure 16. Frequency/fatality diagram.

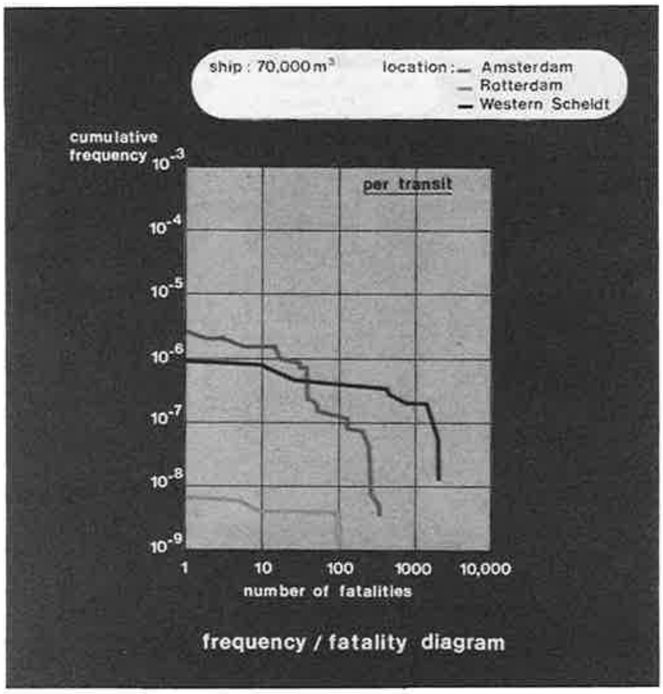


Figure 17. Frequence / fatality diagram

Comment on the previous lectures

Dr. A.P. Oele
Chairman of the Rijnmond Council ('Rijnmondraad')
The Netherlands

Mr. Chairman, ladies and gentlemen,
A first and more general remark I would like to make with respect to the papers presented this morning, concerns the value of forecasting. And in this case it concerns the making of predictions on port development, and on trends in port development. I think you have two factors to consider regarding the future, namely: the trends in technology, and the trends in social and polictical development.
The first factor is more predictable than the second. It will be clear to you that it is nothing new that especially nowadays the social and political development is rather insecure. And it is not a good thing to face discontinuity. The complicated technical society should be based on a line, a basis of continuity. We have more or less succeeded in taking in hand technological development, it is true, but we have not not succeeded in taking in hand the political, international development. But in port technology and in port development the international environment is more decisive than any other thing in the social and political scene. And let's hope that the international scene will provide sufficient security for making true all those nice things that were said this morning on the possibilities of port technology in the future. One element which stands out, and is most actual, is that we must hope that the energy market will prove to be sufficiently stable. And I'm here to express my personal opinion, which is that it may be a very bad thing for us if oil prices would fall as fast and as deeply, as they have risen during the two oil-crises in the '70s. That does not look logical at first sight, but you may believe me it is very sensible to hope for continuity in this field, too.
Mr. Chairman, coming from the greater Rotterdam area, and being more or less responsible for the socio-political environment in this region, it is always a temptation to tell people --and this is nothing new for you-- that the Rotterdam port is the biggest in the world. And having

said this, and having given way to this temptation, I think I am more or less obliged to tell you what the reasons for this bigness are.
Of course, the geographical location, the location in the mouth of the river Rhine, has helped quite a bit. And also the dynamic character of the Rotterdam people, the flexibility to use the opportunities at hand, and the Rotterdam business community have helped quite a lot. But I may also tell you that also the factor of the well-being of the economical growth and position of the hinterland in the Rhine basin is a most essential link in this chain. And in Rotterdam people are well aware of it. They also know quite well though that they depend not only on the hinterland as such, but also on the development of world trade. And that makes them more or less -well schizophrenic is not the right term for it-, but they are more or less dualistic about it. Because they know they need a Common Market, but every time when something pops up in the Common Market scene of regulations and market measures, they are afraid that world trade will suffer from it. So all in all I think the Rotterdam people responsible for the harbour are more internationally minded and more open to the Atlantic freedoms etc., than they seem to be to the European context and the European Common Market policy. Nevertheless, these two elements in international politics are both as important as the other elements I mentioned earlier, and they need to be in equilibrium for good port development here in the Rotterdam area. This morning most attention was devoted to port technology as such. I have not heard much about the deep water-connected industry. And in the Rotterdam port there is a kind of combination of port activities and water-connected industry. There is even a kind of complementary economy between the port and the industries connected with the port. It is not just the hinterland, but also a lot of end-use of the imported materials, and a lot of converting materials imported by ship. So it can be found just in the immediate neighbourhood, too. And it is mostly refineries, petrochemical bulk industries, which form the other part of the complementary economy in the Rotterdam port area. And maybe this is the time to tell you that this industrial part of the dualistic port economy in Rotterdam is more or less in trouble. We had, and maybe still have, a refinery capacity of more than 100 millions tonnes. At this moment, however, the refinery capacity is shrinking and we must hope that it will not fall below the level of 50 or 60 million metric

tonnes per year. And that indicates the trouble we are in.
This has something to do with energy conservation, with the energy crisis, and also with the fact that in the build-up of this port economy the industrial pattern was somewhat too homogeneous. There was not enough variety to remain in good shape during that time. It would therefore have been a good thing, and it will be a good thing, if this economic part of the industry connected with the port activities were strengthened with other activities. And on various occasions I have already suggested that the food processing industries, or treatment industries, and other activities connected with recycling should find a place in this area.
Mr. Chairman, another subject dealt with in the papers of this morning was safety. And considering what I have said about the more or less one-sided, homogeneous character of the petrochemical industry in the Rotterdam area, it is maybe worthwhile telling you that the environmental conscience of the people living in this region is very much influenced by the fact that the huge chemical industry has its negative effects, i.e. in the form of air-pollution and water pollution, and the existence of smog. Now, more than ten years ago these were abated, and we are on our way to come to a far better situation. However, one thing and another have awakened our inhabitants in the sense that they are far more sensitive to safety concerns, than you would normally expect. And that is one of the reasons why TNO has done studies on the risk analysis of LPG and LNG. TNO has even studied it very thoroughly, and in two phases, in order to give our Council the security, the real idea and real guarantee, that there would be no big hazards.
Well, you may have seen that the chances of those hazards were in the order of magnitude of 10^{-6} and 10^{-8}. In this context you must realize that we live in a part of Holland were the chances of some kind of inundation -and Mr. Prins, the Chairman, knows all about it- are much greater than 10^{-6}, even after the implementation of our Delta plan concerning our dykes. They are in the order of magnitude of 10^{-4}, I think. Nevertheless, the Rijnmond Council, the Rotterdam Municipality, and Dutch Parliament, influenced also by our inhabitants, hesitated to take a decision on the LPG affair here in Rotterdam. And that had everything to do with the fact that there was, and there still is a

serious air-pollution, and that people do not want to have added up to it the safety concerns connected with the large-scale landing and inland transport of LPG.
And this brings me to the last topic of this introduction.
I have not heard much about the ideal physical planning, ideal lay-out of an industrial port together with a inhabited area, i.e. an area in which you do not find a port only, but also a city or a town with some concentration of people as well as industrial activities. And maybe you remember the slide in which you saw the Rotterdam region. And you may remember that the main concentration of the inhabitants is to be found about 20 miles inland from the coast. And the port area has started up here from this city, and has stretched along the Waterway to the coast with the industry alongside the port in an elongated fashion. Our refineries are on a narrow patch of land, about two miles wide and 20 miles long. And, surfacewise, it is the biggest concentration of refineries in the world! And our biggest port is near the sea, which is quite logical.
Now, what would Mr. Kraaijeveld van Hemert of Boskalis do if he had the freedom and the possibility to invent a port, or to lay-out a port in a new area? Would he do the same thing? I doubt it. We have asked ourselves: 'where would ideally spoken the port of Rotterdam be situated if we could have designed it beforehand, and if it had not grown throughout the ages in the way Rotterdam did? Well, we would have located Rotterdam in the middle, put our industry more to the east, and put our port area to the west. Now, we are not in a position to change it. But when you can start from scratch, I think it would be a good thing to introduce the element of physical planning to port technology and port industry in order to come to that combination of sites and locations which would make up for an ideal port.
Mr. Chairman those were the ideas and the remarks that I wanted to make in this connection.
Thank you for your kind attention.

SUMMARY OF THE PANEL DISCUSSION ON 26th MARCH, 1982.

Chairman of the panel

Dr. J.E. Prins

Director of the Delft Hydraulics Laboratory

Members of the panel

Dr. R.K. Bleekrode

Dr. J.G.A. de Graaf

Ing. J. Kraaijeveld van Hemert

Prof. G.Ch. Meeuse

Dr. J.B.R. van der Schaaf

Dr. S.M. Vajs

Dr. W. Veldhuyzen

Dr. H.H. van der Woude

Dr. Prins

Ladies and gentlemen, I welcome you to the panel discussion on the 2nd day of this conference. We got quite a lot of written questions and I would like to take a few of them, but please feel free to enter the discussion when you have remarks on the subject.

First of all, however, I would like to thank Mr. Oele for his introduction. And in this introduction Dr. Oele asked a question to Mr. Kraaijeveld van Hemert on the ideal design or lay-out of the Rotterdam port. I would like to ask Mr. Kraaijeveld van Hemert whether he could answer this question.

Mr. Kraaijeveld van Hemert

That question is easily put by Dr. Oele, but I think it's rather a complicated question, for the simple reason that Rotterdam seems to me anyway one of the most complicated harbours of the world. We've got almost everything. We need deep water, we have a hinterland, we're a transit port, we need railways, roads, canals and everything.

But I think if we take part of the study we made for a man-made island in the sea, the industrial island, you can see that we made quite a lot of studies on what would be the best thing. I must disagree to Dr. Oele's easy answer to put the industry on the east. I think that's

transferring a lot of pollution to your neighbours in the hinterland. We all know that mixing the polluted air from traffic and houses with fresh air is much better than to pollute it even further. Therefore the industry must also go to the west. That means that in my opinion we could have a nice sea-resort named Rotterdam, around the Hook of Holland with beaches, and somewhere there to the west we have to create the new port. We have the deep water there, although as a dredging contractor perhaps I prefer the shallow waters, but as a tax-payer and economist you should put it to the west. And being in the west you have the deep water available, and you have to think very long about the connections for the river transport. Those industries who need the river are exceptions in my opinion. The industry has only to do with the products coming in and many times the products going out, so they should be more to the west. But the transit activities in the port linked to the rivers should come as much inland as possible. And there you'll ask the engineers --and I definitely won't do that myself Mr. Oele--, how that port will look like. But if you're interested, I'll give you a small study on what we think it could be like.
And I think from that study you can get some idea of what we think what you can do with nuclear energy, with polluted dredging materials, what you could do with new industries being developed, and with deep-water berths. I think we have quite a long way ready in the study, so that we can easily make the promise come true to give you in a few weeks' time a little draft proposal.

Dr. Oele

I would only be too happy to have this study, Mr. Chairman. Of course, we can't change a situation that has grown throughout the ages. I agree with you that, when you would start from scratch and not in an area where you have this important river, but in a kind of area where you have a bay, the best solution would be the one you suggested. However, in the case of Holland and of the Rotterdam area you have to reckon with prevailing winds, and your solution would pollute Delft, the Hague, and the Randstad area, where as you know the population is very dense. And that's the reason why I would prefer some location more inland. But it's just theoretical. When you go to another part of the world, even my size is a typical example of the bay area method. And I think then you can have a more favourable location for the inhabitants.

Dr. Prins

Thank you Mr. Kraaijeveld van Hemert and Dr. Oele.
I think the next question is very closely related to what has been said: 'Professor Meeuse promotes systems approach, but a system is not better than the data you feed into it. Dr. Van der Woude puts a query mark behind the future industrial development. How do the gentlemen handle this?'

Prof. Meeuse

It goes without saying that systems are as good as the components you build them with. We have this definition of a computer, saying: 'it's just a good as the man handling it'. So I think 'garbage-in and garbage-out' is the best fitting definition I know.
Data may have some spreading in their reliability; but if you build a system consciously, and if you're aware of the interaction of the system and its environment, and if you build it consistently from well-balanced components, then even with a set of data which is not ideal, you can already reach some results. And you must be aware that the reliability of the system is then probably even higher than the reliability of the data which you used for your input. However, it's still restricted in its applicability. A system is more than only a computer model. That's I think the best brief answer I can give at the moment. But perhaps Dr. van der Woude could go deeper into the matter.

Dr. Prins

I think the problem was that the data you feed into it also deal with the future, and that was the concern of the person asking this question.

Prof. Meeuse

But isn't that the problem of forecasting in general that there is only one problem and that is dealing with the future?

Dr. Van der Woude

We've been engaged in prognostications for quite a long time now, and the only thing we know for certain is that things always appear to come true somewhat differently from what we thought they would. Indeed, I put some query marks behind the question whether our economy will change radically. I even doubt whether we can afford to change it radically, and make only sophisticated products and export know-how without having some of the most vital industries of our own. And that has nothing to do with the short term forecasts. I think to get a system going you need short term forecasts. And in that case I can agree with what Professor Meeuse said. Road haulage, rail and inland navigation, of course, are doing much work for the harbours, but they also have to deal with their own clients having their own systems somewhere else. But they could fit in such a system, and co-operate and work as they do now. The only thing is that they want to be among those making the systems. Our fear is that if the systems are made, they come from the big companies, the big sea-going companies maybe. They make the system, and just like the container and the LASH-barge, it comes over us, and it goes where it doesn't work. The container worked, the LASH is not so favourable. But our concern is that we see developments coming into the hands of big industries, and we just have to accept them. And that's not always the best way.

Dr. Prins

Thank you Dr. Van der Woude.
I have a question here, which is also closely connected with this subject. It runs as follows:
'Dr. Vajs, you told us that the U.S. Coast Guard also has a task in research into general technology forecasting. How is this performed, on which term, and on which subject?'

Dr. Vajs

I can only answer this question in a very general way. It's done by trying to examine particular trends in certain areas, such as trends in data handling and communication. I think they've been fairly easy to work with, because they were the good-engineering sort of problems. But it requires a survey of problems that rest around the world, and careful noting of the types of approaches that are being taken. As an example, with the question of coal (which seems to be a general concern

from discussions that I've heard), careful attention has been paid by the people responsible for the project within the U.S. Coast Guard to monitor any development that's being discussed. The Japanese concerns with coal particularly, because as was pointed out to me by the project officer in charge, it's necessary to design simultaneously a coal loading facility and a coal unloading facility, so that you have complementary technologies.
I don't know if I can really go beyond that. Well, it's very hard to say we use this chrystal ball, and it works from here, etc.

Dr. Prins
I think you're still with the chrystal ball. I had hoped that looking into the future could be more specific. Do the other members of the panel have observations on this?

Dr. Oele
It would, of course, have been very interesting if Dr. Vajs could have told us something about the images in the chrystal ball on the future of port development on the American east coast. Everybody knows that there could be some need for deep-water facilities over there, and you could expect the American Coast Guard with its specialized service to look into that matter.

Dr. Prins
The word 'coal' has been mentioned, and it will be mentioned more than once I think. It was also mentioned yesterday, and there's a pertinent question for Dr. Van der Woude:
'Yesterday Mr. Kasteel informed us about the starting of coal gasification plants in harbour areas. Dr. Van der Woude dealt with inland navigation. When ready gas energies are presented to industry, what will be the effect on coal transport for inland navigation, or gas transport by tankers, and on pipeline transport?'.

Dr. Van der Woude
I must say I'm really sorry that I wasn't here yesterday. But as far as I can see, the use of coal will be of great interest to inland navigation. In this respect it should be noted that, technically speaking,

you can make slurry, and throw it through the pipeline. However, economically speaking, it's hardly possible to do these kind of transports by pipeline. Inland navigation could do these transports both over short distances and over longer distances at very competetitive prices. And that means that for inland shipping, this would be of great interest, and it could compensate somewhat for the lack of ore transport. But perhaps Prof. Meeuse can answer this question better from the technical point of view.

Prof. Meeuse

If today I had to advise on an investment in inland navigation, I should certainly warn that within the near future a substitutional method of transportation should come up, caused by the gasification plant. So in the scenario the substitution of coal by gas should certainly be taken into account. You should look for the leadtime, i.e. you should take into consideration the time you need to get a gasification plant operationable. For the distribution of the gas produced in such a plant there is a public distribution network already available. We have such a network, so you don't have to invest in that. In the meantime in the scenario even another substitution for slurrification might be taken into account. I'm not telling today that I expect that next year there will be a slurrified coal transport in the Netherlands, but technologically speaking, it is possible now. You can calculate what you need to invest for it, what the cost of exploitation will be, and in any prediction you should certainly take into account these two substitutions. Technologically speaking, this future is not very dark. You can see already what's going on there, and which possibilities can be awaited. And it's depending on economical, ecological, and political decisions whether or not they'll come true.

Dr. Prins

Thank you Prof. Meeuse.

A question which takes us to the total project capability concept brought up by Mr. Kraaijeveld van Hemert, is the following:

'In which respect do you depend on Governmental support to finance total projects. Aren't we in a minor position in comparison with the

Japanese and American industry?', and if I may put the question in my own words:
'How about the finance, does that depend on Governmental support or oherwise?'.

Mr. Kraaijeveld van Hemert
It's not new, this total project capability. In the old days we learned to live with the turnkey principle. But later on, when finance became so important, we abandoned that name. When you want a total project capability, you need the co-operation of many institutions. I starts e.g. with a government to government deal. We can see it all over the world now that the government is invited on a friendly treaty to provide certain services or a project. However, it seems to be difficult to find each other, and we must look for ways and means to improve on that. If I say: 'Are the Netherlands big enough for the finance?', the answer of course, is: 'No, the Netherlands are not big enough'. But that's no reason to stay away from it. The Netherlands can take the lead.
If I may quote to you the example of the Argentine pipeline: the construction cost and the running cost for fifteen years is calculated at Dfl. 3 billion, and the finance cost alone on top of it is Dfl. 1 billion. You'll realize that this is not a Dutch affair anymore. We can take care of the construction ourselves; with local assistance, of course, but that's more a political question, than that it would be necessary from a technical point of view. But, although the AMRO bank is the leader with a large bank in the U.K., for the finance they joined forces with 18 others. And they provided the finance; it's a completely international arrangement, where the money comes from everywhere, and of course, directly or indirectly also from the Middle-East. But, you can't execute such a contract without a Dutch government. The Dutch government must give the green light e.g. for the credit insurance. But before they do so, they must know more about the contract than merely a nice story about some contract we're very anxious to obtain. That means that there must be a certain knowledge within the Government to be able to judge what's going on.
Now, I'm the last to say that the Gasunie is a government institution (you know the Government has a large interest in it, directly by taxes,

and indirectly perhaps through the State Mines), but in this case they were able to judge if the system could work and could also advise the Government. And here you can see that you need each other. The Dutch government then said: 'Okay, you can go ahead. But what's the use to execute such a large contract in the Argentine? What's the use for the Netherlands?'

And they made the stipulation that at least Dfl. 800 millions should be procured in the Netherlands. Now, that's easily said. As you know, a pipeline consists mainly of steel pipes, and as a matter of fact the Netherlands are not producing steel pipes. So you come into some sort of bartering agreement. You must make agreements with 'Hoogovens' in the Netherlands and say: 'If we order them through you, could you obtain a counter-order from abroad for your product?'.

And before all those things have been worked out, you need the Government again. And this will illustrate that you have to be able to co-operate with your Government. As you know, we've been very doubtful about that in the '70s, but the will to do it existed. And you must be willing to do it, because it's obvious you need each other: you need a government to go and look for projects, and sell your products; but on the other hand we have to make them available to those who want them. And in those forms of co-operations you can go for a total capability. I'm not worried that the Netherlands should be too small. I think we can do it together. I only have to mention in my own profession the Rijkswaterstaat and the Ministry of Transport. They are in the possession of tremendous amounts of knowledge: all the designs of the Delta works, and also of the Zuyderzee works; the main ports in the Netherlands have been designed by the Government, and so on. But to make that knowledge available, you need a civil servant to come out, go abroad, and help you with your export, and work alongside you.

Now, in the Netherlands we're always quick to mention the word 'corruption', and say: 'Yes, but one day that civil servant is your boss on the site in the Netherlands, and another day he's your collegue on another project abroad'.

I think those stories belong in the '30s, perhaps in the '40s, I don't know. But we must forget them. If you co-operate you have to do it on an equal level. You have to trust each other, should not misuse it, for the simple reason, that we have a lot to offer. And if we don't combine

our efforts, we'll get lost and we'll loose to the Japanese, for they don't have any problems with that; you'll loose to the French, who will protect everything they can export, or they can have. I think the Netherlands should not be ashamed to do exactly the same things.
I would like to add one more thing: at the moment everybody seems to realize that we've got quite a lot of products with which we can almost be exclusive in the world, but it means a hell of a lot of effort. As far as industry is concerned, there are really no complaints apart from the one that co-ordination among the government institutions could perhaps improve. But we all have to learn, and we should not be pessimistic about it. Sometimes it's difficult to see where to start, because you never know where you'll end. And I think one face of the Government will be much easier for industry. On the other hand, however, this imposes the duty on industry to show their own government one face, too, and not many faces as they sometimes like to do. But I think we're on the right way, and I'm quite optimistic about it.

Dr. Prins
Perhaps I may refer in this connection to the Commission Wansink that deals with -say- the export of Dutch expertise, and has proposed to install a council for consultation consisting of Government consultants and contractors to join and to have a better performance abroad. I think in this respect, too, it sounds that government is willing to give a helping hand.
The next question, which may also be linked with this subject, is a question to Dr. Van der Woude, and also to the other members of the panel:
'Dr. Van der Woude mentioned the danger of the drying up of know-how, if in the future we don't have sufficient industrial or port activities aroused at home. How should we safeguard our know-how?'
First of all I would like to have your comment Dr. Van der Woude.

Dr. Van der Woude
I think it's indeed a question which should be dealt with by the other members of the panel, because I myself don't know how to solve this problem. One of the things I do know is that Dutch transport does not comprise the conveyance of goods as such onlu, but also the use of ser-

vices of others. Those involved in Dutch transport are in fact organizers of transport. Why are they organizers, and why can they remain organizers? I think it's because they also do transport themselves; they know about a steering wheel, and they know about anything that may come on their way in transport. I fear we would loose, for instance, our position in the transport area, if we would only organize transport and wouldn't do the big share of the work ourselves. And I'm afraid that this holds good not only for transport, but also for the automobile industry, which in my view is a very vital industry, and also rather a sophisticated industry. But I'm curious to know what the other members of the panel think about that.

Dr. Oele

Considering the important and even impressive works in the field of hydraulic engineering, I don't think there should be any immediate danger of our know-how drying up. There's a lot of tax money going on e.g. in the Delta region in the form of the Dam in the Ooster Scheldt. There are even some examples of part of that know-how, which still has not been sufficiently proven, already being exported to Alaska etc. But in the general field of transport technology, with respect to the home base of that, we have to be careful not to fall back because of important developments elsewhere. And this has more to do with economical stagnation here in Western Europe than with any other thing. It would be a good thing, if we could at least maintain a minimum level of innovation, and also of re-novation, in our port facilities so that we shall be able to remain in the forefront.

Prof. Meeuse

I'm not so afraid either of the risk that our knowledge should be drying up. I think this very conference is a good demonstration of what we have achieved in the Netherlands. The other night Mrs. Smit Kroes made a plea for exporting the Netherlands as a transport country. And today we've had very good examples of advanced methods and technology, and technological achievements being presented. And last but not least, what our transport industry has achieved in the past, and is still achieving today, is a sufficient guarantee. But we must concentrate all our efforts on the fact that we have something to offer. We must combine our efforts and join hands to gain strength and show one consistent face.

Dr. Oele

Yes, but we could do with social innovation as well, because that's also part of the package. And maybe I could add something to it in a more positive way: it's also very worthwhile to know by own experience how things should not be done.

Dr. Prins

I have some more questions on the expertise which we're trying to promote. This question is to Dr. Bleekrode about the VTMS:

'There is always a traffic mix of small vessels and large vessels. How do you deal with this traffic mix? How do these vessels appear in your system, or don't they appear at all?'.

And another question about the VTMS is:

'It was mentioned that in the last phase there was prediction of four hours ahead. What is fed into the simulation model?'

Dr. Bleekrode

These two questions are indeed very closely related. First of all I must extend my apologies to you, but if one tries to tell a story which takes roughly three quarters of an hour in 20 minutes, one does leave out some details.

We have been using prediction in the new system in two ways. One is to predict a form of congestion at three major crossings in the port area, and this is where the prediction over a period of four hours comes in. What we want to do is to be able to predict for every quarter of an hour the expected congestion for the area near the Hook of Holland, the area near the Botlek crossing, and the area near the Waalhaven.

Another form of prediction that we intend to use is to allow the traffic assistant to move his picture on his screen forward a number of minutes. On his screen he sees a traffic situation, and by pressing the button he can extend that traffic situation forward in time. And (allow me to get a little bit technical), we do it at sixty times real time. That means that one minute occurs on his screen after one second. What

we want to do with these two forms of prediction is, firstly with the long term prediction to enable the central traffic controllers to be on the sea, when a situation can occur that they need to react to. Secondly, with the short term prediction we want to help the traffic assistant in untangling complicated traffic situations.
Now, in a few moments I would like to ask Mr. Veldhuyzen, to say a few words about this, because he's the man who's actually building the model for us and knows a lot more about it than I do.
But I think I would like to handle one element of the question myself, and that is: where does the information come from? I think one of the sophisticated elements in the new system, something which is entirely innovative, is the fact that we'll be able in the new system to take all data coming into the VTMS, and use it together. At present there are people who know where vessels are in the port; they are the people manning the radar stations. As a matter of fact, at present only one man in a radar station knows where a vessel is, because there's no communication of importance between the various radar towers.
There's another stream of information which goes through the port. When a vessel is expected to come to the port, the agent informs the Harbour Co-ordination Centre (HCC). That's the beginning of a whole administrative process, which follows that vessel all the way through the port, until it leaves again. There is an information flow, so that at any time we know precisely where the vessels are, which vessels contain hazardous goods, and what they contain. This means that at any point in time the appropriate authorities can get all the information they need. All this information is available as input to model.
One of the questions I think that Dr. Veldhuyzen might go into is the problem we've had in letting the model work for all objects. Technically speaking, it's now possible for the model to take into account virtually all the vessels, very large ones and very small ones. However, that does present some computing problems. But perhaps these had better be explained to you by Dr. Veldhuyzen.

Dr. Veldhuyzen

Let me start with the short term prediction model. The model we use for that application is in fact the same as the model I told you about this morning, namely: the model we use for the analysis of safety and effi-

ciency. When we use the model as a predictor model, the input of that model is the actual position of each ship, its characteristics, length, draught, etc. But what we should also know, and that's the problem, is the ship's destination. This is mostly known of the seagoing ships, it's true, (excepts perhaps of one or two ships which come into the harbour without saying who they are), but the problem is the inland ships. Some of them, those carrying hazardous cargo, also have to say who they are, and where they want to go, but at this moment a lot of smaller inland ships don't tell us, so that we don't know. We can guess, of course, that is possible to a certain extent. If there is e.g. a harbour basin, it might be possible that the inland ship should go there. But it is a problem, and we are studying it. I think we'll use the data as far as these are available, i.e. we take into account the inland ships in so far as we know their tracks. It seems as though we throw away about 50 or 60 per cent of the ships, but it's most probable that in the future also the inland ships will have to tell who they are, and where they want to go, i.e. for the harbour area.
For the long term model we use the seagoing ships. Inland ships are considered as a group of ships more or less constantly present, and constantly contributing to congestions. Most of the time the seagoing ships are known, together with their expected times of arrival and departure, so we use those data. I hope that's the answer to the question.

Dr. Prins
Thank you Messrs. Bleekrode and Veldhuyzen. The next question is to you dr. Vajs, and concerns more or less the world:
'There's a tendency for a number of industrializing countries to build their own fleet. Do you think that international measures are sufficient to guarantee safety at sea?'

Dr. Vajs
I wish I could answer this question again by just 'yes'. It would be unwise for any country I think to disregard the movements forward any international co-operation. Whether such means themselves, i.e. international agreements, alone are sufficient, is something I'm not sure I would agree to.

Dr. Prins

Isn't IMCO an organization taking care of it?

Dr. Vajs

Well, the IMCO has been working fairly well for some time. I mean we still do have certain problems with safety at sea. Therefore I don't think that they are sufficient. Otherwise there would be almost no point for a lot of our discussions here today. Accidents do occur, and it's technically in that difficult area, the transition to open water from each nation's jurisdictional waters. That sort of smooth and risk-free transition is equally critical. So I think that each nation must also take their own concerns.

Dr. Oele

In Rotterdam we've had some limited experience with that huge amount of shipping there, with the safety on board ships coming from different countries. And it's maybe something of a surprise that our experts don't think that ships from industrializing or developing countries as such, i.e. their technical provisions and so on, should be less safe than ships from more experienced countries. There's not a very significant difference; it's all a matter of the crew. And here too, although you would expect some difference, the difference isn't so big. And in those cases where serious problems have occurred (we had one about a year ago with that energy concentration tanker), it was just a matter of human failure, i.e. as far as we know. It was located with the crew, and in the juridical handling of the question it was concentrated on one person. Anyway, I think you have to be very careful in jumping to conclusions.

Prof. Meeuse

Just joining Dr. Oele in his comment, I think the international bodies, whether they are governmental bodies or employers and employees together in the tripartite organizations, like I.L.O., already give some guarantee. The best guarantee I ever knew is the insurance companies. They have strict rules, and if you don't obey, you're not going to be paid. And that seems to be better than a punishment by law.

Dr. Prins

Ladies and gentlemen, before concluding this panel discussion, I would like to come back to the introduction of Dr. Oele, in which I heard some criticism on the performance of today. He thought that although it was all very good information, it was perhaps too technical. He also pointed out that on account of the air pollution in the Rijnmond region, the people who live in this region have become more conscious of safety aspects. However, the social aspects have not really been discussed, though I think we were on the edge of it. Therefore in conclusion of this panel session, I would like to ask Dr. De Graaf to give his view on that subject.

Dr. De Graaf

In my opinion the social aspects are very important. In my lecture I pointed out already that in the decision-making process there are many important aspects. Those can be financial aspects, but also social aspects, employment, and ethical aspects, such as with DNA research. I agree with Dr. Oele that social aspects are very important in decision-making, and I think they'll be subject of research in the future.

Dr. Oele

That would be very interesting. In exporting and transferring technology on port development, I think you should also include the know-how of how to deal with such issues as employment, education, environment, and the perception of risks.

Dr. Prins

Well, we've really come to an end now. First of all I thank the members of the panel for their contributions. And I must say I'm happy with these last two speakers, because earlier this afternoon we heard Dr. de Graaf in fact ask for intensification of the dialogue between decision-makers and risk-analysts, and just now we heard the other part of it from Dr. Oele. I think, however, that in the '80s a dialogue will hardly be a satisfactory mechanism for discussion, as technologists, risk-analysists, economists, decision-makers, and representatives of society will all require their share. The question remains whether this will result in a concerted action or in a cacaphony. Thank you very much.

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