Instituto Panamericano de Ingeniería Naval
XII COPINAVAL - Setiembre /Octubre 1991

The Shipping Scene Tomorrow - Needs and Development

TOR-CHRISTIAN MATHIESEN
Vice President, DET NORSKE VERITAS CLASSIFICATION A/S

1. ECONOMICAL OUTLOOK FOR THE SHIPPING INDUSTRY TO YEAR 2000

In order to predict the shipping industry's future and foresee a development which may be even more challenging than what we have seen during the latter decades, we ought to consider historical changes which have taken place. These political changes could well turn out to be rather turbulent and have consequences for the 1990's.

The political changes in central and eastern Europe, with the breakdown of central planning and first steps in the process of transformation to market economics, have put strains on their economies. Incentives to greater efficiency have been improved through more realistic prices including interest and exchange rates. Competition has been enhanced through liberalization of imports and greater privatization. In the Soviet Union, however, specific measures have not yet been spelled out or implemented.

Now that the two major power blocks are no longer at each other throats, many small countries can no longer play off West against East, and we have seen that vetoes may not be used in the UN, ref. the Iraq/Kuwait conflict which resulted in the Gulf War.

Other main factors influencing the economical development will be:

* GATT problems;
* Europe after 1992;
* Growing national and ethnic conflicts.

Despite all these problems appearing in 1990, the world seaborne trade volume never the less increased by 3.0 percent. The world oil supplies were larger than consumptions, and the steel industry showed strength towards the end of the year.

The overall picture for the real GNP for the 1990's seems to be a continued growth set to remain at around the same level throughout the decade, averaging at around 2.5 percent /1/2/.

Cyclic differences between countries will become pronounced. In OECD, GNP has during latter years expanded more for Japan and Germany than for the United States and the OECD.

Sharp increases for short-term periods in the oil prices has impact on macro economic developments. However, less today than for instance during previous oil crises. As an example *energy consumption as per unit of output fell close to 25 percent between 1973 and 1988; oil*

Terms of trade loss, percent GNP /1/

Year		1973/74	1978/80	1989/90
OECD		1.8	2.9	0.5
Japan	Oil import	3.0	3.8	0.8
Norway	Oil export	3.1	-2.5	-5.3

consumption per unit of output by almost 40 percent. This means that the terms of trade loss for OECD countries /1/ will be substantially less than earlier in terms of GNP, and the difficulties associated with oil price will prove to be temporary.

The impact on inflation due to the oil price increase and the Gulf War is projected to be relatively moderate. It is, therefore, likely that OECD's long-term inflation rate forecast for this decade will end up at around 4 percent.

The overall OECD-area's unemployment rate began to drift upwards during the second half of 1990, mostly due to slackening labour demands in North America, UK and a number of smaller countries. In contrast, unemployment in Japan is low, while Germany has absorbed a large number of immigrants over the past years and has relatively low unemployment, but on an upward trend.

Increased R&D spendings have led to new basic and secondary innovations appearing at a greater pace. It can be recognized that the technology swell for the seventies has given rise to substantial productivity improvements in many industrialized societies and particularly within the manufacturing industry.

At the beginning of 1991, other factors are seen which will influence the economic situation worldwide:

* Weakness of the dollar contributing to inflationary pressure in the United States;
* Plunging of equity prices;
* Finance markets - limited bank credits in major countries;
* Environmental development.

These factors, together with the effect of predicted higher oil prices after mid-1990 will, in the short term, give problems in some countries, but may be absorbed relatively smoothly in others, without igniting inflation or provoking recession.

2. WORLD SEABORNE TRADE

Historically, a connection exists between world seaborne trade and growth in energy use. The use of energy in the world has increased steadily with the economic growth during the last century. There are great differences from epoch to epoch among countries and sectors.

The 1988 situation for the energy use is (source BP):

Oil	37.6 %
Coal	30.6 %
Natural gas	19.9 %
Hydroelectricity	6.7 %
Nuclear power	5.2 %
Total	100.0 %

The coal's share of the world energy supply peaked in 1920 when it accounted for 70 percent of fuel used. Oil peaked in the early 70's at slightly more than 40 percent, while the gas proportion is expected to continue its increase.

2.1 Environment

We must accept the fact that we only have one environment - only one global atmosphere. Fossil fuel combustion effects both environmental health and global climate.

We have seen long-range transport of emissions and deposition of acid rain remote from the fossil combustion. Most recently global actions against the greenhouse effect have been taken.

Most of the environmental risks from fossil fuel use are amenable to technical control. It can be reduced to any level required by applying currently available technology. Each increment of reduction in pollution increases the costs, which could become extremely high.

Possibly the most important environmental impact on the shipping sector will be indirect, resulting from changes required in other industries and their adjusted demand for shipping tonnage, in particular the energy sector.

The forecast of the world energy demand may as /2/ describes be divided into two main scenarios: *"the Ecology Scenario"* and *"the Economy Scenario"*.

The Ecology Scenario. This scenario is built on the Brundtland commission's report: "Environment and growth hand in hand". People are concerned about the environmental damages and take the problems seriously. Environment is on the world's political agenda.

The Economy Scenario. Economy steers the scenarios and the "think of yourself" attitude is characteristic. Blocks are formed, ex. the EEC/ Europe and an isolated USA. Supernational sovereignty and global agreements in environmental questions are not covered.

The Ecology Scenario is based on assumptions of stable economic growth and oil prices. The Economy Scenario is based on assumptions like significant fluctuation in the world economy and unstable oil prices. The price level for oil will in both scenarios influence the level of investment, but to a greater extent in the Economy Scenario than in the Ecology Scenario.

The foundation for the Ecology Scenario may be laid in this decade. However, the influence on the fuel consumption may most probably be stabilized by year 2000. Even then CO2 emission from fossil fuels would be 25 percent higher in years 2000 than it is today /2/.

As shown in the figure, both these scenarios predict

an increased demand for energy towards the year 2000. The demand in the Ecology Scenario will flatten out after about 10 years, while, regarding the Economy scenario, will continue to increase. Depending on scenarios, the trend until year 2000 will be:

	ECOLOGY	ECONOMY
Gas	Increase	Increase
Coal	Decrease	Stable
Oil before '95	Increase	Increase
Oil after '95	Stable	Increase
New sources	Marginal	Marginal

Primary energy demand in this decade is expected to vary from one part of the world to another. Most of the increase will occur in the developing world where population growth rates are high and industrialization and urbanization are under way. In contrast, demand is expected to remain stable or drop in the industrialized countries, where population growth rates are low. It could stabilize or decline in Eastern Europe and the USSR, depending on the success of economic reforms. For the next decades much will depend on whether the Ecology or the Economy scenario policies are enacted. Outlook for world oil supply and demand depending on oil prices, See Appendix 1.

2.2 Oil

Seaborne oil transportation fell from 1776 million tons in 1979 to 1188 million tons in 1985 before the trend turned and reached an estimate of 1525 million tons in 1990. Here both crude and product are included. When including coastal trades about 58 percent of the oil consumed is traded by sea. Except for the latter years, where we have seen an increase in seaborne trade of products, and which have proven to be relatively insensitive to shifts in both prices and business climate.

After the Gulf War, it looks as if the oil price will remain low at around or below $ 20/barrel. This should result in more trading of oil, and 1,900 mill. tons could be seaborne by the turn of the century. At the same time, the trading distances will increase because a larger proportion of long-haul Middle East trade will supply the US due to a growing thirst for oil and a decline in domestic production.

Export from the world's largest oil producer USSR fell from 4 mill. barrels per day in 1988 to 2 mill. bpd. in 1990. The "lost" USSR oil will have to be replaced by long-haul crude to Europe of which the main bulk will come from the Gulf. The figures may fall even more, and before the turn of the century USSR may become an oil importer.

Based on Shell Oil equivalent scenario and IEA's scenario (Appendix 1), we have estimated the total seaborne oil trade in the table below:

YEAR	TOTAL SEABORNE TRADE (MILL. TONS)	COMMENTS
1979	1776	max.
1985	1188	min.
1990	1525	est.
2000 Shell	1892	2.18% annual increase
2000 IEA low	1787	1.6%annual increase
2000 IEA high	1933	2.4% annual increase
2000 DnVC estimated	1900	

2.3 Gas

Natural gas is a clean and convenient fuel, particularly favoured for residential and commercial heating, electrical power and certain industrial applications. With increased requirements on emission, a population and living standard continuing to rise, the demand for gas will continue throughout this century.

Natural gas appears to be a politically sound energy option which in addition is efficient and clean. The oil crises of the last two decades and the recent conflict in the Middle East demonstrate the long-lasting instability of oil markets. Natural gas is thus emerging as a reliable alternative to oil, particularly for countries that heavily depending on oil imports.

Currently most gas is transported by pipelines (78 percent), both over land and under water. Underwater pipelines are in use from North Africa to Europe and from the North Sea to Northern Europe. The gas is liquefied at very low temperatures and transported in LPG and LNG carriers to serve overseas markets. The Japanese market for LPG and LNG accounts for about 60 and 70 percent respectively of the world seaborne transport, Europe and the US for the remainder. South Korea and Taiwan, however, are encroaching. The LPG and LNG projects planned will result in an increase in shipment volumes.

Scenarios for natural gas consumption concerning the environment will force reduction of emissions at an international level, i.e. gas' share of the world's primary energy demand will grow from the present 20 percent. This will be the "high" growth case for gas.

In the "low" growth case, much less is done for the

environment on a national or nternational level, and natural gas will maintain its current 20 percent share of the primary energy demand.

World Gas Demand to Year 2010

	LOW	HIGH
Gas' share of the energy market	20 %	20 - 27%
Demand increase	33 %	60 %

Most of this expansion will come after the turn of the century, however, a prediction at just below 20 percent growth should be considered realistic.
The development of world gas trade should mostly benefit LNG trade as opposed to pipeline transportation, which is dominant today. The increase distance, often over oceans between new resources and markets, is working more and more in favour of LNG as compared to pipeline solution.

2.4 Coal

Though the world's present consumption of coal is large, most of it is consumed domestically. In 1990, international trade in coal was only about 8 percent of world coal use. Coal trade expansion by sea during the 1980's has expanded with about 7.5 percent annually. Within the overall trade in seaborne coal, steam coal growth has been most rapid and has averaged some 12.7 percent annually, while coaking coal trade growth though less impressive is still significant at some 4.1 percent annually over the same period. Based on /3/ and /4/ which as predicted would seaborne trade of coal by the turn of the century have an annual growth of about 3.3 percent, i.e. we will by then have a seaborne trade of about 450 mill. tons.

YEAR	MILL. TONS
1970	101
1980	188
1990	335
2000	450

2.5 Iron Ore

The development within the seaborne iron ore trade culminated in 1974 after the general expansion trend that progressed steadily from the mid 1960's. After falling back, as a result of the recession in the early 1980's, the trade level has been fairly stable till it again reached a peak in 1989.
Major import regions of iron ore are the OECD countries where EEC and Japan stand for about 38 percent each of seaborne import trade, while Brazil and Australia are the major export countries with about 35 percent and 27 percent respectively.
In overall terms, the general maturity of the iron ore trade has resulted in a fairly stable general trade structure, despite continued uncertainties as to the annual total level of iron ore demand.
The wide range of forecast demands for seaborne iron ore indicates that it will retain a fairly stable overall structure. This also because long-term trade deals and the existing iron ore mines are breaking close to their maximum deliveries. To start up production in new mines will take about 3-5 years. Based on this, our prediction for seaborne trade of iron ore will be at an average of 350 mill. tons for the rest of the 1990's, with the same ton miles as today.

YEAR	MILLION TONS
1970	247
1974	329
1980	314
1990	350
2000	350

2.6 Grain

The variety of factors influencing the level of grain shipments in any particular year are numerous and varies from particular climatic conditions to political factors. In the long run by far the most important factor determining the development of grain demand will be the general level of world economic expansion. This will have the greatest impact on the developing world markets. In these sectors the level of demand is forecasted to increase sharpest in line with rapid population growth and continued domestic agricultural problems. The conversion of this demand into commercially fundable grain trade volumes will be dependent upon the ability of these nations to pay for the imports.
Another central factor determining the volume and structure of the seaborne grain trade will be the future role of imports into the Soviet Union. Indications suggest that decline in average output has been halted and massive imports will continue to be required to make up domestic production shortfalls.
With regard to grain supply, it is clear that only the US and to a lesser extent Canada have the physical capacity to significantly up-rate average grain output.
The seaborne grain trade has been very stable during the last decade, after a significant increase in the 1970's. According to /3/, the scenario for the 1990's, there will again be an annual increase of about 2.5 percent.

YEAR	MILLION TONS
1970	89
1980	198
1984	207
1990	195
2000	240

2.7 Bauxite/Alumina and Phosphate

Bauxite/alumina and phosphate are sensitive to shifts in price and business climate. A heavy increase in seaborne trade has been seen during the 1970's and a stagnation or a slight drop in tons traded in the 1980's. The trend points toward a minor expansion, however, by the end of the period the amount should be 100 mill. tons.

2.8 General Cargo

General cargo tonnage is employed for an extensive range of products and raw materials. The general cargo trend proved that the trade development has been linked very closely and directly to economic growth in developing countries. This trade is complicated, and the interaction of the general cargo sector is seen with other shipping sectors. Increased penetration of container and/or bulk shipments on many trades has continuously acted as a deflationary factor to general cargo trade growth.

Containerization and bulk penetration of general cargo trades should continue for the rest of the 90's. This is clearly demonstrated in that while there has been an increase in seaborne dry cargo by about 80 percent from 1970 to 1988, there has also been a stagnation in tonnage. The number of vessels has decreased by some 11 percent /7/.

2.9 Containers

During the last 20 years, there has been an explosive growth in the container sector which proves to be a safe and cost-saving form of packing.

Analysis of the world trade/world container trade relations are presented in the table below /3/.

YEAR	GENERAL TRADE	CONTAINER TRADE
1977	100	100
1979	112	131
1981	115	157
1983	116	178
1985	129	211
1987	139	249

It should be noted that whilst the world trade generally expanded 5 - 6 percent per year over the late 70's, container traffic expanded at an average of 14 percent. The respective growth rates slowed down to 3 - 4 percent and 8 - 9 percent at the end of the period investigated.

It is worth mentioning that further growth in the container trade will depend upon overall trade expansion rather than on new route conversion. Generally speaking, overall container traffic growth will continue to be increasingly dependent on external factors, principally the pace of world economic growth and the associated levels of trade, particularly in manufactured goods.

After the recent 8 - 9 percent annual growth, expansion will probably slow down to an average of about 5 percent for the remainder of 1990's.

3.0 TONNAGE REPLACEMENT

There has been a tonnage balance improvement lately, particularly for tankers. See the table for 1990 below.

1990/6/	WORLD TRADE	TANKERS	BULK CARRIERS	OTHERS
World fleet Increase dwt	2.7%	2.7%	4.0%	2.5 %
World trade Increase ton x miles	4.0%	6.0 %	1.0 %	3.0 %

This gives hope for the newbuilding activity for the rest of this decade depending, however, on several factors:

* Ageing tonnage;
* Demolition;
* Newbuilding and repair prices, charter rates;
* Change in size of the world tonnage;
* Newbuilding capacity.

3.1 Ageing Tonnage

The ageing of the world fleet continues despite delivery of new tonnage.

Of the world tonnage, 78 percent by dwt. are tankers, bulk carriers and OBOs. This tonnage will dominate the newbuilding market because of corrosive cargo and ballast water which shortens the ship's life.

The remaining fleet, with a different age profile to the above mentioned tonnage, with container carriers, pure car carriers, reefers and ro/ro ships with lowest age profile, together with general cargo ships and cruise ships which have the highest demolition age.

Scrapping and replacement is, and will remain, a commercial rather than a purely technical or legislative decision and one that is affected by a wide range of market factors.

3.2 Technical Standard

Classification societies establish standard guidelines and rules for the survey of ships. To maintain their classification vessels must be presented for survey at regular intervals. Special Surveys of hull and machienry are spaced at 5-year intervals with intermediate surveys, therefore, special surveys tend to fall at age 5, 10, 15 etc. The basic purpose of the Special Survey system is to assure the vessels' ability to trade successfully until the next scheduled Special Survey.

The average technical standard of vessels seems to decline with age. Corrosion and structural problems with the hull appear to be the most serious, but piping systems, equipment and machinery are also in frequent need of close attention.

This experience has clearly demonstrated a need for more frequent survey of ballast tanks on older vessels, resulting in annual surveys, in particular of ballast tanks on vessels more than 15 years of age.

The deteriorating technical condition of many ageing vessels has resulted in an extension of the scope of the annual and intermediate surveys of such vessels. Vessels which fail to meet the minimum standard as defined by the rules will be required to be repaired or upgraded to maintain their classification.

3.3 Legislation

The environmental concern fuelled in large measure by the "Exxon Valdez" has increased the focus on the tanker industry. As a result, the "US Oil Pollution Act of 1990" was signed in August last year. This is a piece of legislation that, in general, mandates double hulls for all new tankers operating within the 200 mile US Exclusive Economic Zone. There is a phase-out program for all existing single-skin tankers that is scheduled to run from 1995 to 2010. Furthermore, the International Maritime Organization (IMO) is considering new technical and operational requirements for both new and existing tankers.

One consequence of the growing environmental concern is increased attention on the part of Port States regarding old tonnage trading in their waters. Several vessels, for instance, have been stopped by Port State Control in the US due to deficiencies, resulting primarily from a lack of maintenance. The ensuing delay is very costly indeed, and in some instances vessels have been refused permission to unload their cargoes in the US.

3.4 Prices - Newbuilding and Repair

The latter years have been turbulent for the shipping industry. The steady increase of ship value has been followed by a decline, which has caused an increase in the price difference between new and old tonnage.

For most ship types there is a gap between charter rates required to make a newbuilding investment profitable and the rates obtainable on the spot market at the beginning of 1991, see example below.

THE TANKER PROFITABILITY SQUEEZE /8/		
	VLCC	SUEZMAX
Newbuilding price	$ 90 mill	$ 50 mill
Required daily rate	$ 35,000	$ 23,000
Addition for db/d hull	$ 6,000	$ 4,000
Average rate 1990	$ 22,000	$ 12,000
Demolition age 25 years Capital cost assumed to be 10 percent		

For a vessel facing its third or forth Special Periodical Survey (SPS), the need for renewal of steel may be high mainly depending on previous maintenance. The quotation may differ substantially from yard to yard for the same SPS. For a VLCC, for instance, the steel renewal may be anything from less than 100 tons to 1,000 tons, the average being between 400 - 600 tons. An average repair bill for the third SPS could be USD 2.4 - 3.6 mill., excluding of course the offhire costs. For the forth SPS, the repair bill will naturally be higher.

Consequently, for an owner of a vessel, especially tankers approaching third or forth SPS, an important

Tonnage in 1.000 dwt	Tankers % of ton. above				Bulk carriers % of ton. above			
	Dwt x 1.000	15 years	20 years	25 years	Dwt x 1.000	15 years	20 years	25 years
10 - 50	37,174	73%	54%	31%	107,215	78%	55%	31%
50 - 100	57,003	68%	41%	31%	56,434	75%	44%	22%
100 - 200	54,202	69%	64%	24%	47,789	61%	38%	24%
200 +	136,048	76%	73%	27%	9,131	32%	22%	22%

question is whether or not to upgrade her for another period in view of the "price tag" and the risks involved in light of the market forecasts.

3.5 Demolitions

Demolition of old tonnage has remained very low for some years and may well continue. The average age of the world fleet continues to increase despite more tonnage delivery.
The age profile of the world wet and dry bulk fleet to year 2000, including contracts as of 31.12.90, no demolitions and no further contracts will be as shown in the table above (OBOs excluded).

From this table it will be noted that the largest need for renewal will be for tankers above 100,000 dwt. and tonnage below 50,000 dwt.
If considering that all ships above 25 years of age will be scrapped and renewed within year 2000, there will be an average yearly scrapping to year 2000 of 19.25 mill. dwt. The tonnage delivered in 1975, 1976 and 1977, of which about 145 mill. dwt. (86 mill. dwt. tankers) still trading in year 2000, are not included in this scenario.

4.0 CHANGES IN THE WORLD TONNAGE

Below we have estimated the development of the world fleet. This estimate is based on our expectation to world trade and market developments and should be taken as a guide.

4.1 Tankers

There is a long way to go before the tanker market approaches the efficiency it had before 1974 when the fleet was young and efficient. Today the same fleet has reduced speed and relatively high offhire due to repair and maintenances. We see that tankers, OBOs and bulk carriers are used as storage for oil.
By the beginning of 1992, the tanker fleet is estimated to be 254 mill. dwt. and, with an annual increase of 2 percent, about 300 mill. dwt by year 2000.

4.2 Bulk Carriers

The productivity curve for bulk carriers is more stable as the fleet has had a more even increase. It is forecasted that this increase will continue, though at a moderate rate. The bulk fleet at the beginning of 1992 is estimated to be 213 mill. dwt. We believe the average annual increase in this tonnage will be between 1.5 and 2.0 percent, i.e. the fleet in year 2000 will be about 245 mill. dwt.

4.3 "Others"

For "others" in the Fearnley report i.e. mostly the dry cargo sectors, but including bulk carriers for bauxite and phosphate and containers, the productivity curve has for the last 20 years had an improvement of almost 40 percent. This due to increased speed of the vessels, shorter turnaround time in the harbours, larger ships and increased cargo intake for same dimension of ship.
For this tonnage, we have had the least increase during the last two decades, however, there has been a dramatic change in types of ships. The container carrier share has increased while the general cargo carrier share has decreased.
For the rest of this decade we estimate an annual increase of one percent from 140 mill. dwt. to 152 mill. dwt. for this tonnage.

4.4 World Tonnage Year 2000

If we estimate that the combined carrier fleet will be stable, in year 2000 the world fleet (that is tankers, bulk carriers, combined carriers and "others") will be about 725 mill. dwt., an average increase of about 1.55 percent, requiring an annual increase in the newbuildings of 10.5 mill. dwt.

5.SHIPBUILDING CAPACITY

The world order book was at the end of December 1991 at 62.7 mill. dwt, the highest since 1977. Planned delivery in 1992 is 25.4 mill. dwt. This will be the highest since 1982, but only 41 percent of the 1975 delivery. Following the peak in 1975, there has been a shutdown of yards, particulary in Western Europe and Japan, while in South Korea there has been an increase in newbuilding capacity during the same period. Not only has there been a shutdown of yards, but we have at the remaining yards seen a reduction of the labour force.
The above mentioned capacity decline has made the newbuilding market less flexible for absorbing higher demands on short terms, especially due to the cut of an experienced labour force.
Available capacity represents the volume that could be available on short term for seagoing merchant shipbuilding, if demand increase sufficiently and as estimated by /5/ to be 34 mill. dwt. a year. There are projects to build VLCC docks in Japan and South Korea, naval yards will build merchant ships so this may increase the newbuilding capacity towards the end of the decade.
Japan, Western Europe and South Korea will remain the leading shipbuilding areas during the next 8 years. Shipbuilding nations in Eastern Europe, China, Brazil, the US etc. need to rationalize systems and improve productivity to achieve competitiveness in technology and delivery conditions.
Even if the slow rate of demolition continues, there will be a development of the world tonnage and a need for newbuildings.
In our scenarios we have estimated a yearly

newbuilding requirement in the world tonnage on the following assumptions:

Scenario 1: All ships exceeding 25 years of age in year 2000 will be scrapped (see 3.5), and the world tonnage will increase by 1.55 % (see 4.4).

Scenario 2: All ships exceeding 22 years of age in years 2000 will be scrapped (see 3.5). This means that the '75, '76 and '77 generation will be scrapped. No increase in the world tonnage.

Scenario 3: All ships exceeding 22 years of age in years 2000 will be scrapped (see 3.5), and the world tonnage will increase by 1.55 % (see 4.4).

	SCENARIO 1 Mill. Dwt.	SCENARIO 2 Mill. Dwt.	SCENARIO 3 Mill. Dwt.
Demolition 25 years	19.25	19.25	19.25
Demolition '75, '76 and '77 generation		18.00	18.00
Increase 1.55 %	10.50		10.50
Annual newbuilding requiremen t	29.75	37.25	47.75

Based on these three scenarios, there will be an increasing need for newbuildings towards the turn of the century. Our prediction is that the need will be a steady increase from about 25 mill. dwt. in 1992 to about 40 mill. dwt. in the year 2000, averaging at about 33 mill. dwt. annually. The challenge to the industry is to keep ageing tonnage sailing safely while gradually replacing it with new tonnage.

6. IMPACT ON SHIP DESIGN

There are mainly three factors which influence both the size and the arrangement of ships. These factors are:

* Rules and Regulations;
* Market Needs;
* Technical Impacts.

6.1 Rules and Regulations

Implementation of IMO conventions is imposed on a vessel through its flag state. Each vessel is, therefore, governed in design, arrangements and construction by the international agreements ratified by its flag state. In addition each port state may require foreign-flag vessels entering its territorial waters to meet its own set of regulations.

The classification societies establish standards, guidelines and rules for the design, construction and survey of ships. They are concerned with the structural integrity of the ship and its propulsion and steering system.

These requirements must be met for the ship to comply with international convention requirements and obtain a Safety Construction Certificate.

We have seen that the rules and regulations have had impact on the ship designs. Some examples from the last decades are:

* Annex I of MARPOL which intention is to prevent oil spills from tanker operations has diminished oil spills considerably as a result of slop tanks, crude oil washing and separation of ballast water and crude oil with segregated ballast tanks. Tankers have basically changed from deadweight limited carrier to cubic limited carriers.
* Resolution MSC 12 (56) - Adoption of Amendments to SOLAS 1974, Stability of Passenger Ships in Damaged Conditions - has influenced the main particulars of new passenger ships to increase the new requirements to damage stability.
* Classification rules have been through great developments as reliable theoretical quantification of loads and structural response has become common. Together with the introduction of high tensile steel this had led to reduction in ships' structural weight and, consequently, a reduction in production prices and increased cargo capacity.

New regulations which will have great impact on ship arrangements:

* The "US Oil Pollution Act of 1990" and US' unilateral action in the International Maritime Organization will have impact on tanker arrangements. Most of the new tankers will probably have double hull and double bottom. This design will result in little or no penalty in cargo carrying capacity compared to the MARPOL segregated ballast requirements. However, the building price is estimated to be about 15 - 20 percent higher.
* Resolution MSC 19 (58) - Adoption of Amendments to SOLAS 1974, Subdivision of Damage Stability of Cargo Ships - will lead to increased breadth and freeboard and have influence on bulkhead arrangements, specially for dry cargo ships with Lpp in the range of 100 - 150 m.

6.2 Market Needs

Market needs have resulted in:

* Larger ships due to economy of scale;
* The first hatch-less container carrier, reduces turnaround time in harbour, due to more flexible loading and no lashing;
* Tailor-made ships for carrying paper, cars, gases, chemicals, etc.
* Increased carrying capacity of ships, for

instance container carriers, where number of rows of containers in the holds are increased, as are the tiers on the decks.

The development within these sectors will continue. For tankers of 300,000 mill. dwt. or above we foresee few new contracts. However, we will see the first post-panamax container carriers of 5,000 TEU or above since the market and container cranes already exists.

6.3 Technical Impact

The technical development which we have seen in material, material protection, equipment, production etc. has for the shipping industry resulted in:

*Reduced steel weight;
*Automation of engine room;
*One-man bridge operation.

This trend will continue, as will the increased use of information technology (IT).

6.3.1 High Tensile Steel (HTS)

High tensile steel, which has already been mentioned, has been increasingly utilized in ship construction during the last 20 years. In Europe, vessels were built during the 70's with up to 80 percent HTS. The increased use of HTS was due to improved welding and steel-making techniques with attendance to economic benefits.

New design technique allows vessels built today to optimize their steel structure. This implies more efficient structure and use of HTS, and in general less margins to tolerate construction and maintenance errors or unusual operational events. For the new tanker generation with reduced length/depth (L/D) ratio and optimized HTS structure, the plating is so thin that buckling is the most important criterion for scantlings. As buckling strength is very sensitive to thickness reduction, corrosion control is even more important than for tankers built in the 70's.

A corroded surface has much less resistance to fatigue cracking than a smooth one, and when we consider that fatigue life depend on stress level and not steel grade, it is even more important that corrosion protection is initially applied and maintained throughout the lifetime of the vessel.

The internal area of ballast tanks which is mostly exposed to corrosion will for new double hull tankers be in the range of 2.5 times that of single hull tankers. This would require a large number of additional structural details to be designed, fabricated, installed, inspected and maintained.

For container carriers, the use of HTS has reduced the plating to 50 - 60 mm in the deck zones and the upper part of the double hull. This has, furthermore, resulted in a more narrow double hull. As a result of this, panamax container carriers now have 11 rows of containers in their holds. Container carriers are very stability sensitive, and when the deck steel weight is reduced more containers may be accommodated on upper deck.

6.3.2 Propulsion

The market for propulsion engines is a moving target. Therefore, the development of such engines focuses on product refinement and adaption, both with a view to comply with altered operation conditions and production facilities and to meet changes in trade patterns and by legislation.

Key items and requirements of the owners for his propulsion plant will be:

* Suitability for the application intended;
* Flexibility in operation;
* High reliability and operation;
* High efficiency.

It is normal practice for owners to place great emphasis on efficiency i.e. low fuel oil consumption as well as possibility for simple solutions for optimized steam and electricity production.

For ships operating on tight schedules and having an abundance of other equipment installed, all with some degree of complication, high reliability and availability is a key factor as market factors are forcing the manning level and thus the possibility of carrying out routine maintenance down to a minimum. There is limited time to carry out unplanned maintenance, in other words reliability must be second to none. If lost time is to be made up for by increased speed, 1 - 2 percent of offhire time is equal to a minimum of additional 3 - 6 percent fuel consumption.

The reliability and availability requirements call for engines with meticulously designed components, with process pressures, temperatures and material stresses appropriately matched with reassuring margins and the use of the lowest number of components needing overhaul. The latter is achieved by selecting engines with a low number of cylinders.

Additionally, the machinery shall have physical dimensions which allow the yard the most economical utilization of the hull for cargo capacity.

It is quite obvious that the use of computer technology is increasing on board the merchant fleet, that is for performance evaluation engine control, etc. The ultimate aim is the "intelligent engine", an engine which not only constantly monitors its own condition, but which on the basis of computerized performance analysis, automatically adjust its parameters to provide the optimum engine operations at all times, regardless of sea weather or draught conditions.

Recently we have seen that rules limiting exhaust gas emissions are being discussed and also

introduced. It must be expected that these rules will be more and more common in the future.
Whereas the most practical way so far to control the SOx emission is to limit the sulphur content of the fuel oil, the main focus has to a great extent been on controlling especially NOx.
In principal there are two ways of reducing the NOx. emission from diesel engines:

* Primary methods, aiming at reducing the amount of NOx;
* Secondary methods, aiming at removing NOx from the exhaust gas.

At this stage in the development, the primary methods will increase the fuel consumption by around 3 percent, while with the secondary method exhaust gas after treatment will require extensive installations of catalytic convertors.
It must be borne in mind that when evaluating these methods that their influence on engine reliability must be negligible.

6.3.3 Navigation

Over the years, discussions on bridge arrangements have passed different stages and brought us to the enclosed bridge. Nowadays, the discussions are on the one-man bridge operation. Is it feasible or not?
Such a bridge must provide the watch officer with a work station wherefrom he has easy access to all the information, equipment and controls required for keeping the correct course and speed in relation to the waters where to navigate. From this work station there must be proper look-out in compliance with international rules for preventing collision at sea while carrying out his navigation duties. Bridges complying with these basic requirements, and which also are fitted with an alarm system to detect operational disability, may be granted permission by the flag state to operate with single-man watch keeping 24 hours a day, provided the International Maritime Organization (IMO) issues the requirements it is working on.
It may seem provocative to claim that one-man operation improves safety, but we should keep in mind that safety and efficiency are one and the same issue. It is hardly possible to achieve operational safety without ensuring that the functions can be carried out in an efficient manner. This is because lack of efficiency is caused by the same factors which affect safe operation. Such factors are the design of the work place, the reliability and automation level of the technical system, the competence of the watch officer working routines and the operational procedures.
Certainly, there are defined situations which require more than one person on the bridge. Such situations exist when the workload exceeds the capacity of one person, for instance in pilot water, in an irregular operating situation and in an emergency situation. Therefore, just as important as providing a one-man work station for performance of primary bridge functions is to provide additional work stations equipped and located to facilitate specific functions and rational cooperation between the persons responsible for different functions within an operation.
For navigation the paper chart has been the fundamental tool for the last centuries, but in an age where ship operation is being automated, the limitation of this classic approach to navigation can be substituted by the new technology which convert paper charts to computer readable Electronic Navigational Charts (ENC).
In great contrast to the paper chart, the ENC will be an integrated part of the navigation system. It will provide a full-colour display of the most important chart (?) information. The Electronic Navigational Chart display and information system will integrate all of the ship's navigational tools and thereby display the ship's position continuously in relation to planned track, navigational hazards and other vessels.
For the one-man bridge operation the electronic charts, when available, will be of good support for the officer and improve the operational safety.

6.3.4 Information Technology (IT)

Today we are seeing the beginning of a rapid development of a variety of computer-based applications and telecommunication services which will have major impact on the operation of ships, the technical systems installed on board and systems installed ashore to support ship operation. The technology is already available, or will be so in the near future. It is up to the users within the marine community to set the pace of introduction through definition of useful applications. Suppliers will succeed in pushing this development, provided they can prove the reliability of the technology and supply it at competitive prices.
We are seeing the beginning of a development of standardized Local Area Networks (LAN) for installation on board. Today's networks are manufacturer specific, and interfacing of products of different manufacturers is therefore complicated and costly. It is anticipated that manufacturers of marine computerized systems will take advantage of the recent developments of standardized PC networks for office installation to speed up development of open standards for shipboard installation.
Satellite communication is the process of introducing satellite links as a standard service from ship to shore, at reasonable cost. Unidirectional links from ship to shore will be available from modified Standard A terminals. This service should

be available on a global basis in 1992. Plans are being made for provision of bidirectional links.
Introduction of this technology will provide the following possibilities:

* Shore-based work stations may be connected to the network on board.
* Provision of video interconnections, combined with data and speech, opens for a new range of applications.

National telecommunication companies are introducing standard services based on high-speed data networks. Such services are also being rapidly developed on an international basis. These networks are being hooked up to the earth stations and will facilitate easy access to the ship-shore satellite links.
Shipboard and Shore Support IT Systems are systems installed on board and ashore to provide automation, remote control, remote monitoring, supervision and decision support, alarms and shut-downs and technical and administrative support of e.g. spare part and maintenance administration, shipboard management, accounting and purchasing.
Availability of high-speed data networks and standardized methods for exchange of information will make information flow between stakeholders more effective. The ship-shore satellite links will make ship-related information readily available for further processing and distribution.
Today it is impossible to predict all effects of implementation of the above technology and technology applications. The following items are, however, important for prediction of general developments, and above all for each individual owner when he is to select a strategy for the future:

* IT will not dictate a new way of ship operation. Owners will rather be presented to a wider range of feasible alternatives, and the major challenge is to select and IT level which complies with his individual needs.
* Above all, a much closer tie between the ship and the shore organization opens for a larger flexibility in division of work tasks between the two organizations.
  This applies in particular to management functions,and to some extent to handling of the technical systems.
* Careful selection of IT systems on board will support any crew effectively, independent of selected manning and competence level. A large manning/minimum competence crew may be given effective decision support, a correct automation level and maximum assistance from shore. A crew consisting of a minimum staff of well qualified officers supported by a remaining staff with minimum competence could be provided with a system where all critical operations are initiated automatically or remotely from one or two central locations, manual work tasks can be supervised from these positions and an automation level selected not to overstrain the officers. A minimum/high competence crew can be supplied with an automation level, decision support and assistance from shore which complies with the resources available on board.
* Safety and regularity will be improved by implementation of new technology. Particular systems and applications must be expected to become mandatory due to legislation.

7. MANNING

National and international authorities are by their rules maintaining an acceptable lower "safety net" for the protection of human lives, the environment and property. However, there is a number of other aspects to be considered in trading a vessel; economics, operations and maintenance. To keep the required "safety net" in order, the manning of a vessel is an important factor, both in number and in quality.
Over the years, we have seen an increase in the technical standard of vessels from an operational point of view with automation of the engine room and the enclosed bridge with discussions on the one-man bridge operation. This has resulted in a steady reduction in crew sizes, especially in the fleets of developed countries.
/9/ has analyzed the present state of the labour market for seafarers. The result of the analysis indicates that in 1990 the total number of seafarers available to the industry throughout the world was about 1 1/2 million, of which 400,000 were officers and some 840,000 were crews. Against these figures, it has been estimated that for the adequate manning of the world fleet some 450,000 officers and over 600,000 crews are required. Consequently, there is a shortage of some 50,000 officers and a surplus of some 200,000 crews.
A very substantial part of the total personnel comes from the developing countries. This is particularly apparent in the case of crews.
Personnel from a great variety of countries with different languages and cultures are used on board the same ship both as officers and crews, and communication has become a major problem.
There are several factors affecting the demand for officers and crews towards year 2000:

* Retirement;
* Changes in the number of type of vessels;
* Changes in the manning requirements;
* An ageing fleet.

Furthermore, the demand for competence is

increasing due to high technical standard ships, and ageing fleet and stricter environmental requirements.

Some 80 percent of ship-related accidents have been caused by human error or negligence. Consequently, the most effective prevention against accidents are education and training of officers and crew. Therefore, efforts must be directed towards improving routines and procedures and the average level of competence and safety motivation on board ships. Whereas simulators are an essential part of training at every stage in the career of an air pilot, the use of simulators has mainly been restricted to educational institutions where they often are under-used because seafarers from traditional shipping contries have become too expensive or they do not find the profession attractive any more.

What is needed is the development of standardized hardware in the form of simulators that adequately represent conditions experienced on the bridges and where software in the form of cassettes can be switched to provide training for different ports and other restricted areas. If done under the IMO umbrella, such systems could be funded by the major shipping nations. Such simulators should be positioned in training centers in the major flag nations and also in the countries where the personnel of the future will be recruited from.

Simulators do not need to be restricted to navigation, but could also be used as a training board for casualty response and operational problems.

Any step in such direction should be taken at an international level since the development costs are high, and an international solution will offer flexibility, standardization and economics of scale.

Operational and maintenance standards of a vessel must in the future have high priorities. They are areas where manning plays a dominant role. The high technical standard of a vessel cannot compensate a low manning standard. However, a low basic technical standard of a vessel can be compensated by good manning and operational standard.

8. MANAGEMENT ISSUES

Many analysis of the cause of casualties have been carried out for total losses and serious accidents. Published figures show that about 80 percent of accidents are due to human failures including procedural failure, both on board and ashore.

The importance of good management practice to ensure safe ship operations is not new discovery. Proof of such practice is shown by the excellent safety records enjoyed by the LNG/LPG shipping industry in particular and within specific companies operating all types of ships.

The November 1987 assembly of IMO decided to include "Shipboard and Shorebased Management" on the organization's long-term work programme. IMO started developing relevant management guidelines. In the Nordic countries, both maritime administrations and shipowners' associations took an active role in this work, together with Det norske Veritas. Their draft proposals for such guidelines were well received by IMO and are to a large extent reflected in the guidelines adopted by the organization last year.

Faced with increasing demands on the owner to demonstrate that his operations both on board and ashore comply with good management practice to ensure safe operation and pollution prevention, there is a need for standards providing criteria for assessment and audit of management systems. Such standards should, of course, reflect generally accepted principles for management quality under the umbrella of the IMO Management Guidelines. Provided the standard meets the expectations of those concerned with an owner's operation, it should reduce the need for each charterer and insurer to introduce his own standard. Thus a recognised standard will simplify the situation for all parties - not at least the owner.

A further requirement is to implement a system for independent and objective assessment to ensure that the standards are complied with. Classification of management is the answer to the need for recognised standards, independent and objective assessment and regular verification in the form of audits.

High operational and management standards will be essential to ensure safe and pollution-free ship operation, but of equal concern must be the skills and qualification of officers and crew. A potential shortfall in skilled seafarers must similarly call for some rapid initiatives on the part of responsible owners and managers throughout the world's shipping industry.

9. CONCLUDING REMARKS

The rest of the 90's will be challenging years for the shipping industry. We will again see growth in the shipbuilding where new legislations coming up and technology development will influence the design of new tonnage. There will be continuous ageing of the world tonnage which will put increasing demand on all parties involved.

Charterers and oil companies in particular will charter tonnage where the owner of management company can demonstrate that they have management and technical expertise.

APPENDIX 1

Outlook for world oil supply and demand, scenario $ 20 and $ 33 per barrel /1/

Long-term oil outlook

In its most recent annual review of energy policies and programs, the International Energy Agency (IEA) suggested that, if the price of oil remained at $ 20 per barrel in constant 1990 prices and if OECD GNP expanded at an annual rate of 2 3/4 percent, the world demand for oil could grow at an annual rate of 2 1/4 percent over the next 15 years. Demand would rise most markedly in developing and formerly centrally-planned countries. However, the progressive spread of market forces in these countries may somewhat lessen pressures on the oil market by encouraging more efficient use of oil. This scenario would require an increase in Middle East oil production from some 15 mbd. in 1988 to 35 to 40 mbd. in 2005. This gives rise to questions of feasibility and, even if oil production at that level is technically possible, of heavy dependence on this source. In an alternative simulation, the IEA looked at the consequences of a $ 33 per barrel price. In this case, Middle East production in 2005 was projected to be 27 to 28 mbd.

The second scenario still involves an increasing dependence on the Middle East. In this scenario, the demand for Middle Eastern oil, after stabilising in the early 1990's, will start to rise again by 1995. The period of maximum dependence is pushed back to the second half of the 1990's.

If it were held desirable for Middle Eastern production to remain within its historical maximum figures, then, on the basis of the elasticities implicit in the two scenarios, oil prices would have to rise to between $45 and $50 per barrel in real terms by the years 2005. Whatever is the long-term evolution of the oil price which provides a sufficient margin of protection against short-terms supply reductions, satisfactory macroeconomic performance will depend on that evolution occurring in an orderly manner.

REFERENCES

/1/OECD

/2/Energy for Planet Earth.
Scientific American - Volume 263

/3/Ocean Shipping Consultant

/4/Coal Trade Review

/5/AWES - World Merchant Shipbuilding Capacity

/6/Fearnleys

/7/Lloyds Statistical Tables

/8/Japan Maritime Research Institute

/9/The Institute for Employment Research at Warwick University