Interaction of costs and technological developments in the shipping industry

by

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NO-THROUGH ROADS

The above mentioned topic requires a more detailed explanation. Hidden within the subject-matter are conflicting elements which can only be in harmony with each other after a suitable synthesis has been found. Part of my work consists of giving lectures in the following two fields, Marine Engineering and Shipping. The days on which the lectures on shipping take place begins by taking a critical attitude towards all technologists, especially marine engineers who, armed with facts concluded from optimisation-procedures, are determined to improve shipping. At such a moment the boundary conditions within which shipping must find itself present themselves. There are many conditions: trace balance, investment restrictions, solvency, risks, market trends, price developments, changes in transport methods etc. The interests of a country or those of an individual shipowner should, within the context of international boundaries, be served. The room for manoeuvring is relatively small and is more than often marginal; the space for new concepts is bound by a multitude of rules. As the door of the university opens the first proposition is put in words: "Discussion of Technological Developments approached solely from a technical point of view is, with respect to the other interests at stake, of no avail". Bearing this in mind any direct effect which may be the benefit of a new concept is put into second place. A second proposition supports this: "Technological Developments are not directly, and quite naturally so, responsible for changes in income and expenditure". Due to these propositions technical progress has been moved to second place. It is now quite clear that in order to join the two main elements of this topic an extension of the horizon must be realised. This horizon must be found by using further analysis and the supposition can already be offered that insight and penetration will be gained when the technological aspects are placed in the complete life-pattern of shipping; this pattern includes the people involved and the countries in which they reside. This aspect is considered to fill the first place. Both ways of thinking however, that of the second as well as the first place, call upon caution to be exercised. On the days when lectures on marine engineering take place a critical attitude is then exercised towards all "shipping-people", these being almost completely immune to any technical progress. From of old, when it comes to introducing changes, shipping has been reticent. This being said with the exclusion of recklessness and on-purpose acceptance of risks, whilst thinking in terms of a decently kept ship sailed by a competent crew in all respects. The sea, when indulged in her game of forces with a ship, is without pity and poor visibility or bad weather is of no excuse when accidents occur. The sea answers to no one for her deeds. The risks of a technical-breakdown also include the threats of high costs and operational damages. These effects have left their mark on the character of shipping.

The introduction of important technical developments, being attached to long periods of testing and gaining of experience, leads inevitably to high investment costs. The abundance of boundary conditions relating to a ship however almost always result in doubts concerning the application of laboratory test-results on board without first-hand ship experience.

Both ways of thinking, that of the shipowner as well as that of the technologist, also calls for caution. The first of these two creates false perspectives due to his inclination towards isolation when faced with progress or new concepts, the second however forms false perspectives concerning the demands of the sea or even the complete world of shipping itself.

Should both proceed to exist apart from each other, then the inevitable outcome will be that both shall walk their own separate roads during the span of their lifetime.

The following analysis is aimed at finding some "facts of interest" which will prevent the taking of these "hypothetical no-through roads".

ANALYSIS OF THE SHIPPING SYSTEM

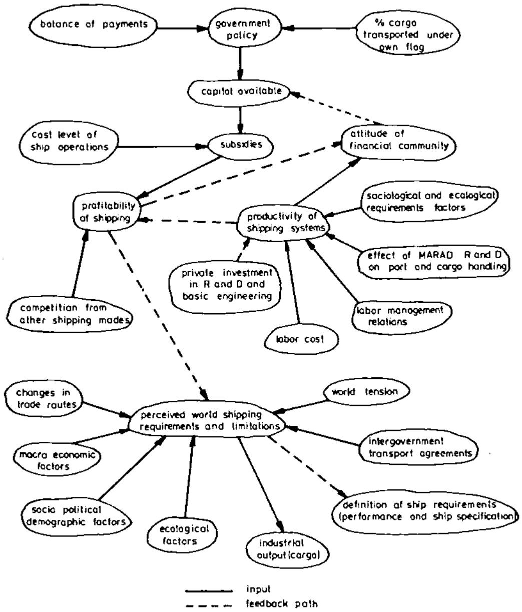
By taking the factors which already fill the first place a form of presentation can be found that represents an integrated shipping-system. The total system comprises of all the elements that govern the behaviour of shipping. For the sake of clarity and supervision the size of the system must not be too large. It must therefore be simplified, be it with the aid of the method of depreciating abstraction or the method of alternating abstraction. Having reduced the size of the system the role played by typical influencing factors will still be noticeable whilst, with the aid of sensitivity analysis, less important factors can be dispensed of.

Within the system shipping one finds the sub-system ship. The conflicts resulting from demands and possibilities are related to the typical influencing factors within the system, from this a dynamic compromise can be arrived at and numerically fixed.

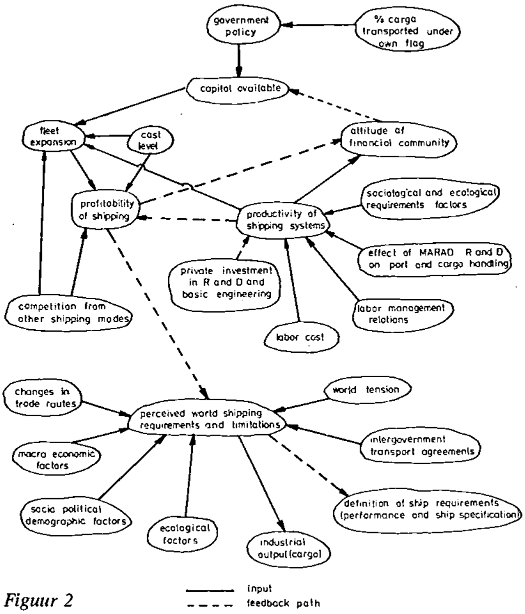
These qualities can be found in the report "U.S. Ocean Shipping Technology Forecast and Assessment"[1], which deals with the future developments of shipping in U.S.A. analysed on the same bases as mentioned above.

The basic-relations diagram can, after suitable remoulding, be used as starting point for shipping under different conditions.

Figure 1 shows the diagram of relation in which governments play an important part. Figure 2 represents



Figuur 1



Figuur 2

the same type of diagram for free enterprise.

The main elements are:

– perceived world shipping requirements and limitations
– productivity of shipping systems
– profitability of shipping
– attitudes of financial community

Perceived world shipping is related to:

input:
- macro economic factors
- production levels per country
- world tension
- intergovernment transport agreements
- socio, political and demographic factors
- ecological factors

feedback: + definition of ship requirements, with regard to capacities and performances

Productivity of shipping systems is related to:

input:
- labor costs
- labor managements relations
- effect of government sponsored research and development on port and cargo handling
- sociological and ecological requirements factors

feedback: + private investment in research and development and basic engineering

Profitability of shipping is related to:

= world shipping requirements and limitations
= productivity of shipping systems

input:
- competition from other shipping modes
- subsidies

Attitude of financial community is related to:

= profitability of shipping
= productivity of shipping systems

input:
- cost level of ship operations
- balance of payments
- % cargo transported under own flag
- government policy
- capital available

When governments play a decisive role the cost level of ship operations, as mentioned under attitude of financial community, is directly related to the office granting subsidy; the latter also regulating influence and monitoring with the government as sponsor.

By free enterprise, without government intervention, changes occur in the system. Fleet expansion is then a result of profit and capital availability.

The sponsoring of research and development remains intact and only the interaction between costs and technological development is apparent.

Via a number of indirect influences technological developments can be freely handled within a combined shipping and economical system of a country. In a way one can see this happening in underdeveloped countries which start with simple, not completely new ships. In these cases the available ships are run on general basic experience resulting in little research requirement.

On the other hand, in countries where priority is given to advanced transport systems which only become profitable after a long introduction period, research may be found to occupy a dominant position. This type of priority is aimed at obtaining a guarantee regarding transportation of a prognosticated cargo-quota by ships sailing under her own flag. The thought of an advantage results in the acceptance of high risks and in the providing of large capital amounts. Seeing as how limited an undeveloped country is in making up deficiencies in her daily exploitation costs, a matter where extreme caution should be exercised even for a developed country, susceptibility for useful and costsaving developments can be strongly felt.

The independant undertaker knows of no subsidy and is entirely committed to the results of technological developments in order to increase his profits.

The three afore-mentioned possibilities are grouped together in table 1.

Table 1 – Control of developments

CD1 no noticible change in low cost developments
CD2 high level of developments sponsored by government investments
CD3 medium level of developments, directly related to short term advantages

These three systems do not tend towards a state of equilibrium. By a change in one of the three uncertainty appears by the other two . Since research and development are both connected to their surroundings, their manifestations will have to be looked into in order to make a more accurate analysis.

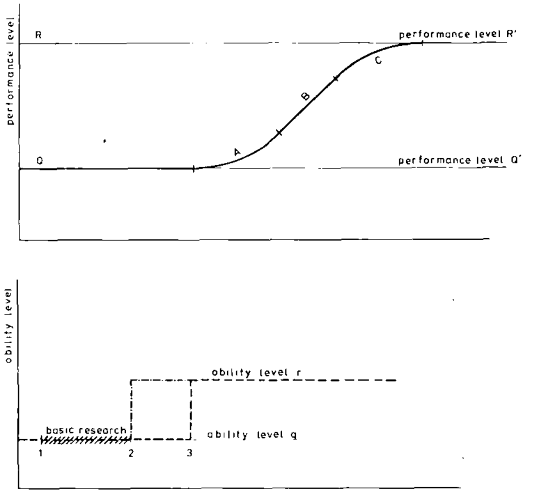


Fig. 3 Time based characteristics (TBC 1)

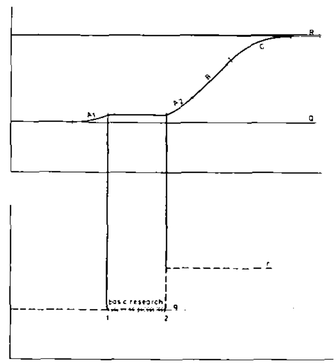


Fig. 4 - Time based characteristics (TBC 2)

MANIFESTATIONS OF TECHNOLOGICAL DEVELOPMENTS

In a simple diagram actual situations and the different phases therein can be drawn up for research in shipping, Figures 3 and 4 show two possibilities.

In figure 3 two lines draw attention, that of ability level and that of performance level. These are both time-based.

At time-point 1 a basic-research program is started and at time-point 2 has reached such a stage that it can be wholly or partly applied. The application possibilities are accepted, or the circumstances are favourable, for the first time at time-point 3.

During application of the newly found know-how or learning the performance curve moves through three different phases, namely A, B and C.

In the first phase A research is directed at finding ways and methods to realise application. It bears the mark of a slow starting period in which each success or small advancement leads to encouragement. With few means an increase in performance level is obtained.

In the second phase B application on a larger scale has presented itself and becomes even larger. Owing to distribution to an abundant number of users a more rapid increase is seen in the performance curve. There is little attention payed to detail improvement, at this stage all effort being concentrated on the advancement itself and there are no unfavourable influences felt because large application has not yet given any feed-back.

In the third phase C feed-back takes an active part in slowing down application as well as introducing itself. Sociological and ecological arguments start to take part in further developments and in this stage also negative effects are recognised and play a part in detail developments. This given picture is of course a strongly simplified one, however it gives us the opportunity to find connecting-points with which we can approach given real situations.

Figure 4 shows a different configuration. In the period A 1 development has begun without any previous basic-research. Some results are gained thus showing the need for further research which in it's turn leads yet again to an increase in results. The remaining part of the performance lines conform with those of figure 3.

To find a suitable way for application in the Shipping Industry a selection must be made of the most important State Variables. Table 2 shows some of these important factors. A further analysis will have to take place in order to be able to apply and appreciate the dependence of these state variables on each other. The time-relationship of these variables must also be taken into consideration.

In the following, examples will be given showing past developments and the different stages therein. As restriction however, it may already be stated that in these examples only new ideas, one could call them boundary rectifying, are used. This means that only phases A and C of figures 3 and 4 are of use. Phase B only deals with partial improvements. An example of this is the container-crane. In phase A the crane is realized and purchased by cargo-handling companies. In phase B research studies are made to increase speeds. The elements which arise out of this are well known techniques, increase of power, application and learning of kinematics, electronic control and the fitting out of a feed-back mechanism in order to correct the followed path via actual readings.

These developments belong to the types of gradual changes which are always taking place in industry and will proceed to do so until eternity.

Table 2 - State Variables

Un certainty
Costs
Technological developments
Interactions
Control of developments
Time based characteristics

PAST DEVELOPMENTS

Around the year 1950 the change was made to heavy fuel 3000 sec. R.I. for ships main engines.

The decision to make this experiment was so abrupt that it is now difficult to know whether ship costs gave the first impulse, or technical curiosity, or the persistence of the oil producers to boost the sale of this fuel type.

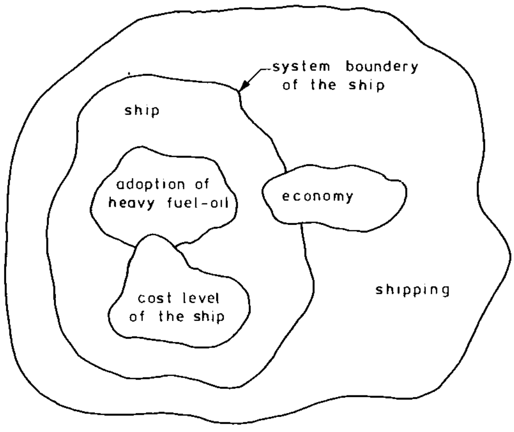
Without any preliminary research on board of ships at all, trials were taken and the involved risks were accepted. Indeed these risks turned out to be rather nasty. Consequently basic research was set up and after a few years the main problem of high cylinder wear belonged to the past. In fact as far as technical knowledge was concerned there was a sufficient amount of this available at the time of initiating the use of heavy fuels on board of ships.

However there was a boundary condition in force which made high demands on the ship's officers at the same time.

Bearing this in mind the table of state variables (table 2) can now be filled in:

Uncertainty	Negligible
Influence on costs	Positive
Technological developments	Favourable
Interaction	Indifferent
Control of developments	CD3 (table 1)
Time based characteristics	TBC 2 (figure 4)

Figure 5 shows the interrelationships.



Figuur 5

Ten years later, around 1960, a far greater and far more spectacular development began to play a role. This development is well known under the name of automation.

This name is a collective term for many intermingling conceptions. In this case the basis mechanisms are otherwise orientated than in the foregoing. Here cost influencing is one of the main aims. Which expenditures can the shipowner cut down?

The choice of the ship follows from an optimization procedure, the capital costs result from the building costs, subsidies, investment decisions and replacement procedures. Insurance is a factor which can be reduced to a minimum by good crew policy and the same can be said for cargo claims. Fuel costs result from the choice of ship.

As a result the most prominent variables with which the total casts can be directly influenced are crew and maintenance costs.

Around 1960 the freight market trend and the in between time strongly increased wage sum resulted in powerful economical pressure to reduce expenditures. Meanwhile, by increasing the dependability of the engines and machines and their production methods while also continuing research in analysing breakdowns, overal increase in reliability of the whole plant was realized. Both of these were stimulated as it happens by competition of the companies involved.

Due to the already mentioned economical pressure a reduction of the crew number became feasible and was put into practice. In fact a remarkable occurance took place because in spite of no research having been carried out automation presented itself as a sort of by-product of knowledge and learning already available. Combined under the word control, conditon monitoring, regulating and automatic operating systems were built up out of the already available arsenal of pieces of apparatus and added to the same.

Characteristic for this phase is that technology was added on and not built in. The period of extremely sober equipment now belonged to the past and this chance did not go unnoticed, resulting in the manufacture of some very fine control desks.

Indeed these developments resulted in feed backs which in turn, via discussions, interpretations of working experiences and further research, lead to a reliability increase for instruments as well as other parts.

There where economics puts the pressure on technology, the way in which the required levels of quality and knowledge adjust themselves can only be apparant after feasibility has been reached. A parallel to this can be found in the construction of the first big container ships.

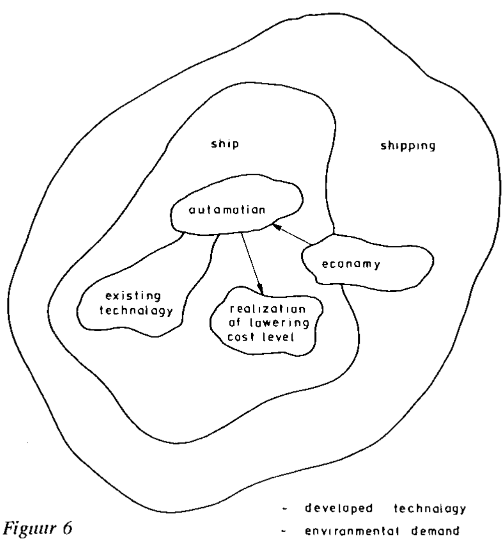
Following transport model operational analysis a new means for transport presents itself. The fact that many of the large ships of the first generations had cracks in their decks and heavy vibrations were present resulted once again in feed back which in turn initiated further study and research out of which an adequate scientific approach to the problems was found. During these transitional periods risks are accepted but no time delays. Exactly the same is happening in the offshore industry.

To-day, as a result of automation, ships are sailing with unmanned engine rooms at night time and during the weekend.

The table of State Variables (table 2) can now be filled in:

Uncertainty	Considerable
Influence on costs	Positive
Technological developments	Insufficient
Interactions	Extensive
Control of developments	CD 3 (table 1)
Time based characteristics	TBC 2 (table 4)

Figure 6 shows the interrelationships.



Figuur 6

A new time era has presented itself. Taking into account the time delay which seems to be intrinsically necessary for ships, this previously mentioned in the introduction, one can expect to see noticeable application from 1980, nominally speaking.

The structure of shipping is changing. Internationally regulated distrubution of cargo has already been a topic of discussion in the UNCTAD.

There are no objections against placing such forms of progress against a background of uncertainties. However future changes themselves are not completely prone to clarity. Never the less uncertainties must not be weighed too much, rational relations carry on.

Indeed speaking from a structural point of view these changes are both complicated and comprehensive. One can summarize the essential point with the following well known term: Introduction of Systems Engineering.

Before a more thorough analysis is made of this, differences with past development phases are brought forward.

In 1960 technique lagged behind. In 1980 technique has taken up a foreground position.

In 1960 economical impulse took up a foreground position, 1980 finds economical aspects separately represented in a field built up of all different types of branches.

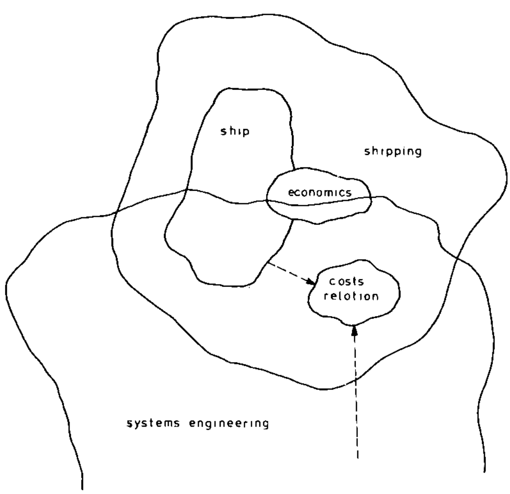
Interaction, until 1960, had the form of an explicit function, in 1980 it is an implicit one. In 1960 research on application came afterwards. 1980 starts with it. A question mark may be placed when considering where costs belong, do they remain of primary importance or become secondary.

Why should shipping, a small part of an economical system, have the nerve to think that she alone can answer this.

The table of State Variables (table 2) can now be filled in:

Uncertainty	Considerable
Influence of costs	Derived Function
Technological developments	Initiative
Interactions	Extensive
Control of development	CD 2 (table 1)
Time based characteristics	TBC 1 (figure 3)

Figure 7 shows the interrelationships.



Figuur 7

SYSTEMS AND COMMUNICATIONS

For quite some time now the want for more principle changes in the structures of shipping and ships, economy and technique, world and transport, have been in the air. While this process is taking place the memories of the slide-rule and simple adding machines are still fresh in our minds.

The computer, having arrived only a short while ago, is already awe inspiring in its performance, the limits of which are still unknown. By the application of the computer in shipping, elementary thinking must take place.

Lines of communication reach out further than before and are more wide-spread. Large numbers of happenings can be numerically expressed and combined together under one number or parameter.

Learning to think in areas much larger than beforehand acknowledges interactions which initiates the possibility to relate different branches of science together while solving daily problems.

As a result of this, thinking is transformed into a more homogeneous form. Laws of physics appear to have the same form of appearance in different branches of science. Sections are taken from these branches and all appear to make up the different elements of a single problem after which their structures and places are rearranged in such a way that a solution to the problem is found.

Time-sensitive happenings can now be described with the aid of interactions based on a wide range of factors which was in past years unthinkable. The fact that this resulted in a long change-over period has already been brought forward and discussed by many people. Problems and procedures are of the heuristic type when viewed from directly social-bound economy and technique.

The reasons, acknowledgement of achievements and their perspectives, resulted in the search by pure science to find suitable connections. The outcome, Management Sciences and Operations Research, now passes through a time of disappointment because out of all the impressive possibilities only a minimum appear to be feasible.

However, such extreme specializations may well be used in small parts of a process but must not be allowed to form unrestrained ties between the different subsystems which make up that process.

Having become conscious of great possibilities, at the same time a boundary sets itself up due to the inability with respect to the system-formulation when the terrain gets too large. Risks are felt even more and the feeling of uncertainty increases.

These rules of conduct for economics, as mentioned up to now, must be critically assessed through and by the system of rational thinking.

Both striking and remarkable is the realisation that a small change, interpretated as an impulse, can be the cause of such a big un-balance, which in its turn lies outside the sphere of quasi-static thinking.

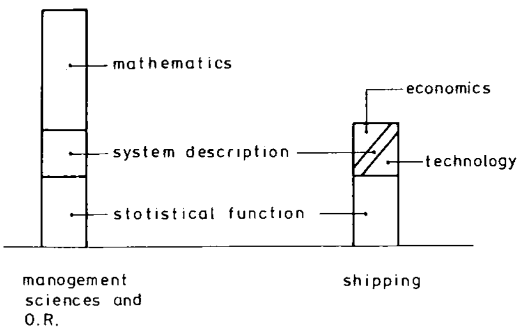
Quasi-static thinking, interpretated statically, resulted in an over increase in the use of energy in the technological plane and in an overproduction in shipbuilding. The excess of tankers is well known in shipping. Model-building in this sector is difficult and hardly worth thinking about without large concentration of research. One should be alert for new equilibrium-disturbers. Especially the cry for new means of transportation and other ships receive easily to much attention, thus opening shipping to new disturbing impulses.

Shipping being governed by technological developments results ultimately in clashes with its boundaries, The use of energy is one of these, high speeds are eliminated by costs, another is pollution of sea and harbour.

A third one is safety because often cargo is carried which is a danger to both crew and the sea. A fourth one is the increase in size of ship which in the light of threatening danger requires an almost faultless crew. The joint action of man, machine and handling is already a subject of mathematical study because faultless is a meaningless term.

Some of these named boundaries are inclined to increase costs and therefore threathen the position of the costs priority. Within system-regulations this can be accepted, without these regulations however uncertainty becomes dynamically amplified. This can be shown by the fact that in the present unstable situation as a result of a change in cargo quota, loss of equilibrium in shipstonnage or fleet expansion can overcome any country. The dynamic amplification becomes greater as the independently influenceable part of the fleet or market becomes smaller.

Even though the necessity of system-formulation is evident there is a lack of sufficient documents and forecasts. This means that, apart from the pure economical side and the surroundings of shipping, technology must function in a certain area and remain functioning there. In this view accepted risks and costs must not change too much or too quickly until the function of the system is thought out, formulated and controlled numerically. Opposing this conclusion are the attitude of unemployment fighting governments with an unlimited volume of production and their almost unlimited financial resources in which only a weak feed back is to be found. The difference between Shipping Pattern and Operations Research is shown in figure 8.



Figuur 8

ANALYSIS OF SHIPPING- AND SHIPSRESEARCH

In the earlier mentioned report from the U.S. Department of Commerce, Maritime Administration [1] a flow diagram of their research methods is given. This diagram can be found in figure 9. According to this, research is carried out into the situation of shipping and shipbuilding for the year 2000. By the collection of a large number of elements and variables which participate in present and future happenings and possibilities an enormous list of interactions and procedures is evolved.

This mixed list is re-arranged by having it judged by different workgroups, checked out against the company's policies, industrial needs, and supply and demand of cargo transport.

As a result of this a number of factors fall out while others, the weighted average values having been decided upon, are re-arranged and put into ranking order. External impulses, if necessary, are detected. By the confrontation with non-economical factors it is plain to see that the idea behind the system itself has not been neglected. Supply and demand of cargo to and from this nation is so large the system boundary "rest of the world" can be omitted.

As part of the conclusions a list of research topics, importance in order of presentation, are shown:

1 – General pollution
Definition of appropriate maritime environmental and pollution control criteria along with a program of research into the technologies needed for meeting these standards.

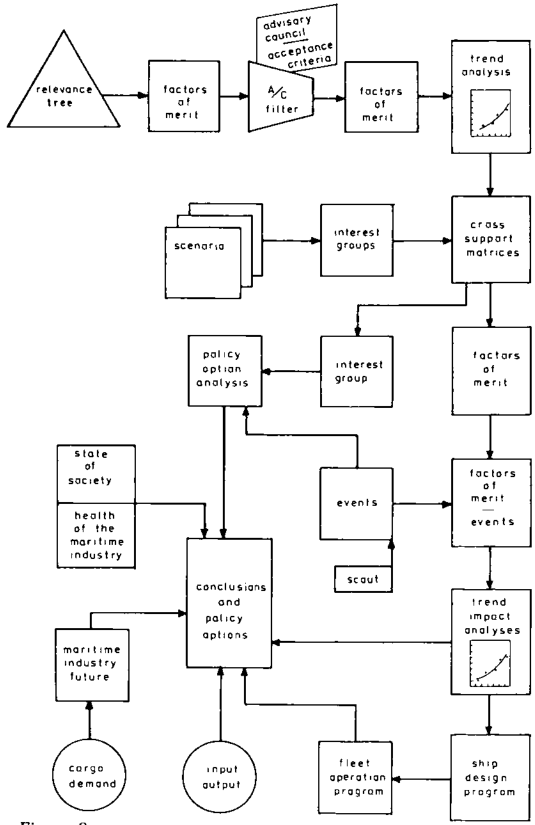
2 – Pollution loading and discharging
Development of offshore cargo feeder systems for liquid bulk.

3 – Pollution, oil spill
Development of effective, economical oil spillage prevention and cleanup systems.

4 – Safety of the ship
Development of low-cost, highly accurate and reliable marine collision avoidance systems for ocean and harbour use.

5 – Technology
Accelerated research on gas turbines directed at reductions in specific fuel consumptions and the ability of gas turbines to operate with low-grade fuels.

6 – Technology
Development of low-specific fuel consumption, high horsepower/weight power plants (especially for ocean express cargo systems)



Figuur 9

After the high priority "Anti Pollution" measures technological aspects occupy the 5th and 6th places. Despite of the subjective starting point of this method and that interpretation also plays a role, a picture is still shown which is in agreement with causal expectations of the near future.

Pollution contesting, as a necessity for human life, receives great attention. Systematic approach has at last resulted in the appreciation of the interaction between life and waste productivity. Disturbances do not allow themselves to be graphically formulated but require calculations on the influences of impulses. In the working out of this system at least the word people has once again come forward.

The next named is safety and here the conclusions tend towards the automation of processes where risks for people are involved.

Between these indications on system techniques and the future lies an enormous piece of research. The element of costs is not directly connected here, so therefore the question smaller ship versus other means does not arise.

The last two points, the gas turbine and the low-fuel consumption low weight plants, are aimed at an important development area which is beginning to gain even more attention. With this, starting points for further developments requiring separate attention have been fixed.

GAS TURBINE TECHNOLOGY

The meaning of gas turbine technology as a development project alone is not a very clear one. One can say that the U.S.A. is more used to rotating engines while Europe more to diesel engines. The heart of the matter remains unaffected by this. The following contains a number of facts concerning the usual types of engines found on board from which preference for gas turbine technology is to be rejected or confirmed.

A number of three demands can be put forward concerning the main engines:

1 – Reproduction of the physical and mechanical processes per revolution.

2 – Registrationable debugging period.

3 – Minimum number of auxiliaries and auxiliary systems.

A ship without engineers requires that the main engines keep running for a guaranteed time and that deficiencies can be foretold.

The analysis is made for each engine type.

The number of revolutions by ships application for a complete debugging is approx. 10^9 revs. Some load variations require a smaller amount, slower processes such as creep and corrosion of materials require a longer amount.

– Low-speed diesel engine	
Debugging period	30 years
Reproduceability	Nihil, piston rings rotate, injection volume varies dynamically
Auxiliaries	Many
– Medium speed diesel engine	
Debugging period	6 years
As above	
– High speed diesel engine	
Debugging period	$2^1/_2$ years
As above	
– Steam turbine	
Debugging period	1.2 years
Reproduceability	good
Auxiliaries	boiler required
– Gas turbine	
Debugging period	1 year
Reproduceability	good
Auxiliaries	few, but expensive

The gas turbine appears to be intrinsically the best engine for an unmanned engine room.

Despite the marked advances made with lined blades fuel consumption is still too high. Principally the view still remains that the gas turbine knows of no other efficiency boundary than that which is understood to be found in the maximum temperature of the gases.

The diesel motor, by increasing the compression ratio of the supercharger, finally changes into a gas generator and therefore becomes a gas turbine.

Dynamic monitoring in the running condition is in its first stages for diesel engines because not all the parameters are understood yet. [3] and [4].

One cannot speak of a forecasting function yet. Only after a long debugging period can the monitoring parameters be found and thus allow programming.

Although hints have been given and many questions remain unanswered, the impression is still given that the rotating engine meets the requirements of the programmed running condition thus making an unmanned engine room and even an unmanned ship possible.

The situation at present is presented against a proposition of priorities. As a result of this the threat is immenent that the in the engine built high reliability, gained through both processed experience and continued research, will be under-estimated. The prediction of failures however still requires understanding of the parameters involved from which the necessary priorities will follow in sequence.

PLANT OF HIGH HORSEPOWER/WEIGHT RATIO AND LOW SPECIFIC FUEL CONSUMPTION

To elaborate this here, without further research, is difficult. Systems engineering must place a number of different possibilities beside each other. A break-through in this direction may only be expected if a second virtual problem has been solved. After reducing the risks in engines and machines a step can be taken towards reducing the number of auxiliaries, finally leading to the abolishment of spare sets.

The condition for each part must be numerically known for this case. This technique still requires much research. To start with, one must return to the basic design idea of the machines and check all the known measurement methods and their validity ranges.

As such, the 1960 phase threatens to return. The detour, via the low frequency monitoring, has already been taken by many and is almost without perspective. In fact there is an explanation for this. The low frequency range was already being monitored by engineers with normal feeling senses. This did not result in condition monitoring and condition forecasting.

The monitoring of low frequency vibrations is up to a certain point necessary for safety purposes, such as the prevention of vibrations due to a broken turbine blade or due to the unbalance of separators. As a criterium for quality this is insufficient, the same being said for the present, 1960 phase, instrument measured parameters.

The 1960 phase ended with a trustworthy engine room plant which met the requirements set at that time: unwatched engine room at night and during the weekends.

Advanced research transforms the shipsofficer into "interpretation officier" and places him as universal officer on the bridge with a numerically monitored plant which at least 100 hours before faults occur gives signals to that effect. Into this same picture fits point 4 of the U.S.A. research program: "low costs, highly accurate and reliable marine collision avoidance system for ocean and harbour use". At the same time together with this, as idea and experiment too early in the 1960 phase, the interpretations officier can now be introduced.

Now the advanced research itself must be analysed in more finer detail. The perspectives of further research lie in the sectors dealing with the control of high frequency side-effects. Here understanding is poor and incomplete.

Due to this lack of understanding too much is being installed and invested and thus the cost price remains too high. There are indications that along these lines remarkable technological developments may yet take place.

These thoughts are induced by systemthinking and result in confrontations with boundary conditions which were earlier ignored or left out of the picture.

EXTERNAL BOUNDARY CONDITIONS

Two conditions are important. In the first place life on board. One cannot reduce the number of crew indefinitely and keep the same living conditions. On top of this, education, daily chores and responsibility must remain in equilibrium with each other.

One of the ways of increasing living conditions is by creating the possibility for all the personnel to meet together at the same time. This means that at one time, or even more, the whole crew must have no specific work to do. This supports the demand that the ship be run by instruments and that these instruments take over the human functions.

Each following step in the development requires higher demands. This corresponds to the C phase of figures 3 and 4. The 1960 phase was started by hard work by one of the groups involved, extensive and expensive research are the requirements for the 1980 phase.

In the 1960 phase one could go his own way, in the 1980 phase a number of boundaries come into sight.

As well as this the set problems, from a technological point of view, are not so simple anymore.

A second condition is that of normalization.

This is based on the following two reasons. High quality products are far mor expensive, even when spare sets have been bannished.

When constructing thinking in terms of reliability is taken as starting point in a similar way as this is done when aircraft modules are calculated.

If the thought of producing in series is allowed then a reduction in the total costs may be feasible.

The second reason originates from the shipsofficer. Due to the extension of his plane of work more types of specializations are required and the boundary, one speciality per instrument, will have to be set up. Changing over to another ship or installation will have to take place via renewed education and training, just as in the airlines industry. Shipping is not used to these conditions. The comparison of purchasing costs play a large part in determining the choice of the manufacturer.

Slowly but surely a point is reached where advancement can be seen in perspective but feasibility remains a function of a number of conditions.

The difference here with 1950 and 1960 is that it is now no longer the individual who takes the next step but that the decision must be taken by the community. Not one factor decides but a series of factors taken from different walks of life. The earlier mentioned explicit costs aspect thereby disappears as one of the system elements.

DIFFERENTIATION

The main lines have been explained, via computer to the system ship, a part of the system shipping.

The followed line of thought is no final target for all shipping. Not all ways in which the target is reached will be the same, as in the past there will be differentiations made.

The advantage of a well formulated system build-up is the possibility of finding several probable solutions, each one itself intrinsically life-like. However these must be placed in the surroundings which adopted them in the first place.

Countries with high crew costs will accept the 1980 phase and make research money available in order to keep a hold on competitive means of transport.

Through this they will accept that ships sail without delay, time for repairs are reduced to a minimum, and that cargo handling is regular and quick.

Countries having a large transport volume of their own may also go through this development, their fleet is a large one and series effect has large financial advantage. In such a case the system shipping shall be both centrally and strictly run.

Then again other countries, with more unfavourable conditions but having a high level of quality, can take on forms of specialized transport methods.

The third countries have little money and not so very highly educated personnel. But the wages are low and shipping is attractive to keep down unemployment and as a means of obtaining foreign currency.

The conclusion must be that the 1950, 1960 and 1980 phases remain together in existence. Each phase accumulating that piece of the transport market which is best suited to itself. Simple cargo for simple ships, expensive cargo for expensive ships.

Technology can react to demands of safety and put a brake on transportation risks. Technology can also react to price levels but not to uncertainty. The latter is done by the system transport and the system shipping, the ship remains a subsystem.

The most important perspective that technology can offer to the specific costs aspect is an important contribution in the formulation of the systemthinking and the application of this for the computer. In the handling of physical and dynamical phenomena and in the struggle to get force and energy to serve mankind, the power lies mainly in the overwinning of uncertainties which the designer must achieve in order to make a functional piece of machinery possible.

This points towards a synthesis, made up out of many branches of science, so that finally with numerical support uncertainties may be limited.

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