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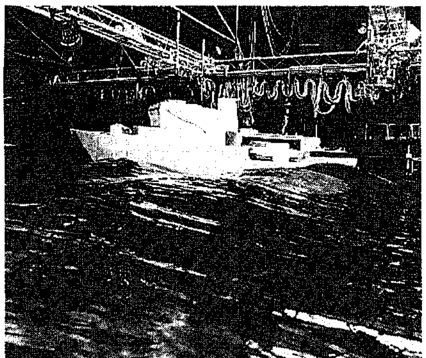


Inhoud

Marine & Offshore Technology

SCHIP EN WERF

A NEW FACE

We live in interesting times in which many changes occur, in this instance also applicable changes in the magazine and journal market. Even the established journals get a 'face-lift' and in this instance it will be 'Schip en Werf's' turn. With the 53rd edition we changed course into the marine and offshore technology and with regard to this we published more English articles.
The Marine Technology is on its way to the year 2000. En route we are encountering 1992, the year in which all European borders will fade away and communication and other traffic will increase substantially. It is within this framework that the Netherlands marine industry should fit.
That is namely the reason why the proprietress of the journal, the Netherlands Society of Marine Technologists and the editors find it necessary to alter the appearance and contents of their official publication so that it can be readable and comprehended not only in the EEC but in all the world of Marine Technology. That is why we have opted for the English language, the speak of the marine world. It is also the choice of the I.M.O. of the United Nations.
WYT & Zonen, the publishers has worked with the utmost zeal and tried to fulfill all our ideas an wishes. The previous name 'Schip en Werf' dating from 1934 stays in existance, only under the heading 'Marine and Offshore Technology'. Future publications of the journal will be mostly in English.

The Editors.

EEN NIEUW GEZICHT

Wij leven in een turbulente tijd waarin veel verandert en ook op de tijdschriften markt verschijnen vele nieuwe gezichten. Ook de gevestigde bladen veranderen van gezicht, evenals 'Schip en Werf'. Bij het verschijnen van de drieënvijftigste jaargang werd de koers verlegd naar het gebied van de Maritieme- en Offshore Techniek en verschenen meer Engelstalige artikelen.
Wij kwamen tot nu toe uit onder de naam 'Tijdschrift voor Maritieme- en Offshore Techniek-Schip en Werf' en het wordt nu 'Marine and Offshore Technology-Schip en Werf'; waarom die Angelsaksische titel erbij?
De Maritieme Techniek is op weg naar het jaar 2000. Op deze weg zullen wij het jaar 1992 passeren, het jaar waarin de Europese grenzen zullen vervagen en de grensoverschrijdende communicatie sterk zal toenemen. De maritieme industrie in het Verenigd Europa zal zich gezamenlijk sterk moeten maken om op de wereldmarkt een zodanige plaats in te nemen, dat het voortbestaan van deze voor de Europese Gemeenschap onmisbare industrie verzekerd is. In dit kader zal ook onze Nederlandse maritieme industrie moeten passen.
Daarom vinden de eigenaresse van dit blad, de N.V.T.S. en de redactie het noodzakelijk het uiterlijk en de inhoud van ons orgaan zodanig aan te passen dat het blad niet alleen in de Europese Gemeenschap maar in de gehele wereld van de maritieme techniek gelezen kan worden. Daarom is gekozen voor de Engelse taal, de taal van de maritieme wereld, die ook door de I.M.O. van de Verenigde Naties is gekozen om wereldwijd te kunnen worden begrepen.
De Uitgevers Wyt en Zonen hebben zich ingespannen om aan onze wensen te voldoen. De oude naam 'Schip en Werf' daterend van 1934 blijft bestaan maar nu onder het Engelstalige hoofd 'Marine & Offshore Technology'. De toekomstige inhoud van ons blad zal voor de merendeel in de Engelse taal zijn gesteld; dit met het oog op een betere verspreiding niet alleen in Europa maar in de gehele wereld. Wij hopen dat onze Nederlandse lezers hiermee kunnen instemmen.

De Redactie.

SHIPBUILDING IN AN ERA OF CONSTANT CHANGE*

*by M. GREY***

Let us begin with a quotation, which if it does nothing else ought to be a little inspiritional to a meeting such as it looks ahead to the prospects for shipbuilders in a new century. It is a translation from the Japanese and they are the words of Seiji Nagatsuka, currently the research director of the Japan Maritime Research Institute. Concluding his recently published assessment and prospects for the world shipping and shipbuilding industries, he leaves us with this thought:

'So long as there are seas in the world, there will be seaborne trades which will require ships to serve as an important means of transport. What matters is who are going to operate and build such ships. For this reason, we cannot overemphasize the need to maintain the sound order of the world shipping and the shipbuilding market, and to do our utmost in making this industry profitable and attractive.'

To people who have had to live with the industry night and day, year after year, much of this might seem just a little obvious. Nevertheless there are a number of quite important lessons here that cannot be restated enough.

Firstly it might be thought of as a ringing declaration that the maritime industries remain desperately relevant to world trade. In this day and age you never have to go far to meet people in authority who would actually question the importance of the marine industry. Shipbuilding and shipping have been industries which seem to have been in recession for decades. Indeed there are now middle grade managers who have never known anything other than the poor results of industries suffering the consequences of overcapacity. Governments look upon industries in long term decline with disfavour, and industries that refuse to emerge from recession become unimportant in the eyes of administrators. They are seen as perpetual millstones around the necks of officials trying to balance budgets, industrial sponges soaking up help that might be better allocated elsewhere. It is a growing temptation to most governments suffering from deeply depressed marine industries to let them go to the wall, perhaps as humanely as possible, but to get the capital and personnel employed on doing something else rather more worthwhile. Perhaps, it might be argued, the marine industries are technically obsolete and they are better left with those countries who can command the cheapest of labour and which can operate and build ships at the lowest possible cost. After all, runs this superficially attractive argument: it is far better to enjoy the benefits of cheap ships as shippers rather than to waste time and money operating them, or worse still, trying to build them economically.

This is why we need the comfort of Mr Nagatsuka's affirmation that ships and shipbuilding are not redundant industries, and that a nation will ignore maritime technology at its future peril.

But the long term recession has tended to deflect public attention from what might be called the glamour of trading with ships, largely because the financial results of shipping companies and firms building ships have been so conspicuously awful.

Overcapacity

Worst of all this has been at a time when technical revolution has been in the air, ships and shipbuilding procedures have been hugely modernised and there never has been a more efficient shipbuilding world constructing more cost effective and efficient products. Unfortunately such has been the overweening effects of the global overcapacity in tonnage all this has done is to once again present the shipper of goods with unparalleled choice of extraordinary cheap shipping space, whatever the route.

This would be no bad thing if the shipping company supplying the cargo space, and the shipbuilder constructing the ship was getting a fair reward for the services, but this in recent years has never been the case. Although shippers of goods may sometimes complain that they would like an even cheaper service it is a fact that most forms of maritime transport are cheaper, in real terms than they have ever been. Shipping costs have become unimportant, and because of this they have tended to feed the belief that the marine industries are also unimportant. An industry where huge losses have become endemic finds a whole range of problems confronting it, from the difficulties of attracting investment to the near impossibility of ensuring that a new generation of bright graduates and other workers enter the industry. More people, like Mr Nagatsuka, need to express their faith in a maritime future.

Doubts about the continuing viability of the industry tend to be fed by the recent decline in world seaborne trade viewed in its most simple form of the number of tonne-miles, which has effectively fallen by some 20 per cent during the last ten years. Of course it is the changing pattern of crude oil trading which has been responsible for this decline, but it is once again the sort of figure which in bandied about to denigrate the contribution and the continuing importance of the maritime industries.

Where there must be cause for real concern is in the inability for the shipping company to obtain a reasonable return on its investment. It is a cause of satisfaction that shipping is so efficient that a bale of wool can be carried all the way between Sydney and Gdansk for only about 5 per cent of the value of the commodity. Or it would be if the sea carrier ended up with a fair freight for the carriage contract, sufficient for money to be set aside for the next generation of ships. It seems an extraordinary advertisement for the efficient ship that coal can be supplied to a power station in the middle of Europe all the way from Richards Bay or Roberts Bank, cheaper than it can be mined and transported from mines less than a day's train journey away. But there is little satisfaction in the technological marvel this represents when it is remembered that the shipping company operating the ship cannot afford to keep her at sea, and the shipbuilder that designed this amazing ship is being closed down.

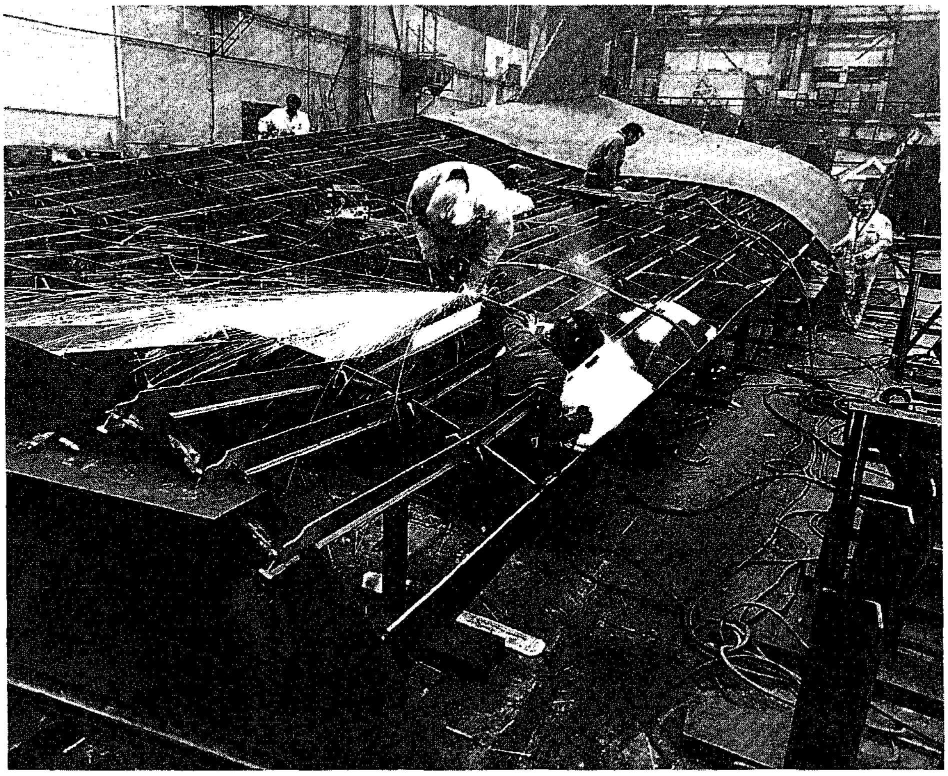
Somehow the worth must be restored in this important maritime industry, and it is not going to happen by itself. One of the real problems faced by anyone who is involved in shipping or shipbuilding is the almost built-in faith that the industry progresses in a series of immutable cycles, prolonged periods of poor results punctuated by shorter and more intense bouts of great prosperity. And it is the over-riding

* This paper was presented at the Seminar 'Shipbuilding 2000' organised by the U.N. Economic Commission in Gdansk (Poland). 5-9 Sep. '88.

** Lloyd's List London.

belief in the good days that are just around the corner which leads all of us into one trap after another. The eternal optimism of shipping people is one of their most endearing characteristics, but all too often this characteristic has proved to be their worst enemy. Even in the early eighties, when all the lessons should have been thoroughly learned, it all started to happen again. Signs in an upturn in demand instantly generated as short term revival in freight rates which in turn convinced many owners that the recession was over and that it was the time to order new ships. The situation has not really been helped by the ready availability, at least in the west, of 100 per cent finance, with soft repayment terms so they could hedge their bets against recovery with the notion that they were not really using their own money.

Sadly, the tonnage which they have ordered to anticipate the long awaited boom, has itself conspired to thwart this happy event. Today, amid the rather more real signs of industrial optimism, we need to make sure that these circumstances are not repeated and that the industry is not led inexorably back again to a situation where over-optimism leads to self-destructive overbuilding.



Shipbuilding in an age of structural change

There is a tendency for shipbuilders, when faced with the pressure of the world to shrug philosophically and suggest that there is nothing that can be done to change the cyclical evolution of world trade. Their responsibility, they argue rests only with the need to build ships at the price that ship operators are prepared to pay. If this is quite insufficient to keep the shipyard afloat, it is regrettable, but there is not a lot that can be done about it. If governments can keep the industry in business just a little longer, the progression of the cycle will eventually mean that demand for ships returns.

Similar philosophies govern the actions of ship operators, who never it seems tire of complaining that shipping is a service industry which is by itself completely unable to influence events that keep freight rates and ship demand at a low level.

It is always somebody else's fault – the banks or finance houses that supply the credit, the government which offers the guarantees. Everyone, it seems, operates in what might be described as an atmosphere of mutual helplessness. Only history, in the shape of those freight rate and world trade cycles is on our side. *Eventually* demand will be restored.

And it probably will be, albeit briefly, and after terrible carnage in the shipbuilding industry. So the cycle will grind on into the next short period of prosperity that will see far too many ships ordered for a demand which will never ever be as large as is anticipated.

Much of the problem lies in the apparent isolation of the various industrial sectors, in that each part – shipbuilders, government, shippers, bankers and ship operators to name but those we are concerned with operates as a seperate entity cocooned against the world outside. And it is important to recognise that this world is changing quite dramatically. Which leads us onto the second part of this paper in which we will look at some of the changes that are taking place which affect every part of the industry.

For as we emerge from the last recession it is important to realise that the world is greatly changing, that the calculation of supply and demand for shipping services and ships are no longer a matter of simple extrapolation. Nobody involved on long range strategic planning in the marine industry in either public or private sector can ignore these fundamental changes that are taking place. And to recognise them is to be taking a positive step towards a longer term recovery.

This paper looks in detail at seven of what I have called *changes in structure*. Some will be familiar, others less so, but all profoundly affect the demand for ships and are essential to the shipbuilder's understanding of the changing world. These are as follows:

1. Scale economics
2. Internationalism
3. Conservation
4. Use of alternative materials
5. Industrial relocation
6. Product miniaturisation
7. Value adding at source.

The effects of scale economics

This phenomena I have elected to begin first with, for of the seven listed this is really the only one which is described properly in economics textbooks. It is also that which most people here will be familiar with, as the economies of scale have been applied to virtually every sector of the shipping industry. Virtually every type of ship today is larger than that of the previous generation, from the deep sea container ship now edging above 3,500 TEU to the extraordinary deadweight that creative naval architects manage to cram into a 'paragraph' coaster. Present generations of product tanker are quite literally twice the size of their predecessors. Ships for the distributive oil trades and parcel tankers have twice the capacity and often twice the flexibility from double the number of tanks. Ro-ros have grown apace and where yesterday you had simple packets on short sea routes offering very basic amenities to the ferry passenger, today you have enormous ships with on-board facilities that would not disgrace a cruise liner.

But there are certain cautions as regards scale economics which we ought to be aware of. The dreadful example of the United States Lines 'Super-econships' showed that a line hoping to secure a competitive advantage by pure scale economics can be confounded by outside factors, and that operating costs are only one part of the calculation.

Similarly, the sheer inflexibility of the ultra large ships is a factor that cannot be ignored. Thus it proved very practical, from a technical point of view to build half-million tonne tankers, but the limitations on their use were so great that it became difficult to re-employ them when their original Gulf – Europe or Japan pattern of trade was interrupted. Very fast ships tend to have their economic raison d'être destroyed by quite small variations in the price of fuel, very economical ships which are extremely sophisticated have been found similarly vulnerable when their competitive advantage is reduced by a reduction in operating costs. Scale economics remain crucial but I would suggest that it is the carefully tailored design for a range of options that tends these days to have the edge over the technical tour de force.

Internationalism

At first sight, shipbuilders might be led to believe that internationalism in shipping is of only peripheral interest to them. By this we mean the profound structural change that is taking place to the shipping sector in so many parts of the world as it struggles to contain its costs. But it certainly is important to the shipbuilder to know who his potential clients might be, and this is not always immediately apparent in the convolutions of modern ship-ownership.

The growth of the international open registers, the spread of bareboat charter arrangements and the complexities of modern ownership which take the ship way beyond the responsibilities of a maritime administration would all appear to be here to stay.

But it is as well to remember that it is not simple logic, but a defence mechanism against higher costs or taxes or bureaucracy which drives a ship operator to seek refuge under strange and wonderful flags. It is worth remembering that the spread of o c operations has facilitated the operation of a separate and supra-national labour market, which, depending upon yor point of view, might be a good, or a bad thing. If you are a convinced internationalist, you will probably rejoice at the wonderful internationalism of it all when you see a ship lying alongside flying a Marshall Islands flag, with Hamburg the port of registry, a managing acengy in Singapore who have sub-contracted the technical supervision to a consultancy in Piraeus, with the Kiribati crew paid by a Bermudan manning agent. You may loudly extol the benefits of a free market in shipping when you discover from the Polish captain that he *thinks* that the mortgages might be held by a German bank and the ship has been bareboated to Italian subcharterers. This is internationalism at its best, you might cheerfully say, and then the ship leaves port in the middle of the night leaving a whole load of unpaid bills, a couple of crewmen ashore and twenty tons of diesel in the dock and you have the job of trying to obtain some financial restitution for the injured parties.

There is a downside to maritime internationalism and that includes the spread of maritime fraud, the exploitation of labour from the poorer countries of the world and a sub-standard shipping fleet which existing institutions based on the concept of competent maritime administrations seem to be having great difficulty in eradicating. Internationalism in shipping may be fine, but it does have certain aspects that tend to negate the effects of well proven international law. This itself throws up its own defence mechanism, for every action produces its own reaction, this being manifested in port state control procedures (which ought not to be needed if every marine administration had a common interest in high standards) or the tendency to arrest the ship first and ask questions afterwards in even the most routine C/P disputes.

And there is plenty here to interest shipbuilders, who after all want to know who their potential customers are. If, as seems likely another example of internationalism is to be a growth in the direct involvement of cargo interests – I offer as an example – a steel company in one country securing a ten year's supply of ore, complete with purpose built shipping arrangements for the whole period, who should the shipbuilder be trying to sell to? In such an arrangement the shipowner, as we know him, may take only a small part, with the financial package, the technical specification and the choice of shipyard and contract price all being within the brief of one of the principals rather than the ship operator, who will be that and little more. In such circumstances the shipbuilder wishing to market tonnage has to re-learn the rules.

Conservation

It is difficult to emphasise enough the effects of conservation upon the demand for ships, for this is one phenomena which is entirely new and which guarantees that the world which is emerging from the recession is a very different one that went into the slump in 1973. Virtually every user of primary materials and energy is making them go further and too few shipbuilders have been really aware of this profound change on the demand for their products. It is just one example of how the relationship of economic conditions to world trade has altered. Energy conservation since 1973 has been remarkably effective in limiting primary energy demand per unit of GDP.

The exact relationship is still changing and has yet to be properly quantified, but we can get a good idea of what is happening from the studies of the International Energy Agency. This has stated that the ratio of total primary energy requirements to GDP in its member countries fell from 0.89 in 1973 to 0.77 in 1981. They have forecast that this will have fallen to 0.71 in 1990 and 0.67 in 1995. For the oil sector alone this has been even more dramatic, with the ratio of oil consumption per unit of GDP falling from 0.46 in 1973 to 0.35 in 1981 and a prediction that this will have fallen to 0.23 in 1995.

These are average figures, but when applied to the most efficient users of energy and other materials, the effects of conservation processes are staggering. Who, for instance in 1973 would have believed that within a decade Japan would be able to reduce the volume of its imported oil by some 50 per cent. High prices and a knowledge that energy sources were vulnerable and finite have been powerful arguments for conservation, whether we are talking about using energy more efficiently or making expensive raw materials actually go further in the production process.

There is a new interest in recycling, and this too is tending to depress the demand for original raw materials.

All of this is already having a profound effect upon the demand for new ships. The changes in primary energy consumption have meant that a resumption of demand for tankers, which might have been anticipated with industrial recovery and an ageing tanker fleet has effectively been postponed. Alternative fuels such as coal, LNG and LPG are being reassessed yet again and there may be changes to demand for ships serving these sectors. The shipbuilder must watch these changes very closely.

The use of alternatives

The demand for new ships is also being greatly affected by the consequences of industry seeking out and using alternative materials in so many of its production processes. It is worth noting, especially if you are concerned with the design of ships for the carriage of iron ore, that a modern car design incorporates up to 40 per cent less steel in its construction than a vehicle of perhaps twenty years ago. And even in the production of that steel, the most efficient users of iron ore have changed their production processes fundamentally. In Japan, for instance, nearly one third of the country's steel production comes from scrap, rather than pig iron and this proportion is growing. There is a tendency for steel industries to concentrate production in the most efficient blast furnaces, on the use of electric furnaces reducing scrap, and on continuous casting processes. In Japan alone, which country has been responsible for at least half the worldwide tonne miles in the iron ore trade and forty per cent in the coking coal trades, this change is of great significance for the shipping and shipbuilding industry.

Then we must consider the effects of alternative methods of transport, such as the long-distance pipelines which are being used with increasing effect as an alternative to the ship for the carriage of oil, gas and even solids transported in slurry form. Al-

though pipelines are often costly and vulnerable, when they directly compete with the ship on a trade route, there is an immediate effect upon the demand for vessels.
If the pipeline is an example of radical new thinking in the transport of raw materials, even more dramatic with a startling effect on the distribution of manufactured goods is the trend towards intermodalism in the liner trades.
The means of true intermodalism have been with us for as long as the sea-borne container has been in existence, and it is surprising that it has taken so long to develop. This has perhaps been a function of its revolutionary nature, that established cargo handling and transport systems which are intimately affected by such changes have fought something of a rearguard action against the spread of intermodal techniques. It represents true transport efficiency, eliminating wasteful and time consuming transhipment processes so that an intercontinental movement of goods, from the centre of one continent to another becomes eventually no more complex than shipping goods from a factory to a warehouse half a kilometer away.
Shipbuilders might stifle a yawn when the talk turns to liner trains and inland distribution systems, but they will do so at their peril as the development of intermodal systems is already beginning to effect the demand for the coming generation of container ships. It must be remembered that here we are talking about a great wave of replacement tonnage which will be ordered to take over from the first generation of containerships which started deep sea containerisation from about twenty years ago. That first generation represented the 'container revolution' that was to sweep away break bulk handling methods. The coming generation must be viewed not as the first, as an upgrading in *sea transport* efficiency, but merely the improved sea link in an *intermodal chain*. The establishment of efficient land transport systems in the shape of liner trains, good trucking facilities for container transport and as important the means to swiftly transport goods across land frontiers is causing shipowners to rethink their needs for new containership tonnage. This is a very fast changing world and shipbuilders must stay closely attuned to the changes which better land links will have on the demand for both deep sea and feeder ships.

Industrial relocation
This too has been with us for a long time, although the scale has changed and there can be no doubt that is has an important effect upon the demand for ships and upon the tonne-miles steamed. There are few industries which are unaffected by the process. On one hand we can see the wishes of OPEC countries to build up their downstream activities in the establishment of their own petrochemical industries close to the source of crude oil – a *value adding* process which I will come to a little later. This has coincided with the need for many of the principal industrial countries to shift many of their manufacturing processes to cheaper locations. Staying with oil, we can see refineries closed down in Europe and the U.S. their products being shifted to new refining centres such as that of Singapore. This is a function of high costs, but it is often a defence mechanism by international corporations seeking to cross tariff barriers. This is amply demonstrated by the dramatic changes taking place in the motor car industry and in many other industries producing consumer durables, with component production and even complete product lines being established in countries thousand of miles away from the original corporation's base. It is always difficult to prove whether the chicken came before the egg, but it is arguable that this type of relocation of industry, this internationalism, would not have been possible without the efficiency of modern shipping, which enables the co-ordination of manufacture from all these various sources to take place in an organized manner, without the need to maintain enormous component buffer stocks.
Here it is very difficult for the shipbuilder hoping to benefit from a growth in sea transport of components to accurately gauge what manufacturing industry is actually doing. All we can say is that the whole process has meant that much oil once transported in crude form is now carried in product and chemical tankers and that an awful lot of criss-crossing of components between producer countries goes on. There is probably a sea transport gain and a demand for more ships resulting. Here as this process continues it will be necessary for the shipbuilder to become attuned to the end users demands rather than those of the traditional shipowners.

Product miniaturisation
We have already touched on this important phenomena which is already manifesting itself in a reduced demand for the

transport of weight and volume, and in the shift of a sizable portion of high value products into the air. It is to be seen everywhere, from the growth in micro-electronics where technology has managed to compress items like computers which once would require hundreds of cubic feet to stow into handportable containers, to virtually all manufactured goods, thinner, lighter and more compact. There may be an enormous growth in the value of the goods shipped these days, but they need far less raw material to produce and they have smaller demands upon the volumes within a ship's hold.

Value adding at source

This too is a function of changing technology contributed to by the internationalism of production. But it is more fundamental than that, representing as it does the ability of so much of the developing world to obtain a better reward from its products, which were once shipped in their raw state, but are now increasingly processed prior to shipment. Possibly one of the best examples of this phenomena is the well-known cargo phosphor rock, once almost exclusively exported in its raw form for processing in developed countries to be re-exported back to the developing world farmers. Today so much of this cargo, which once formed an important tramp trading load is now processed in the producing countries and exported direct as phosphoric acid, thus ensuring a far better reward.

Similarly there is a growing number of food cargoes which are processed at source to provide a far better price to the producer. To process meat prior to shipment makes a lot of sense, avoiding wasteful broken stowage and the needless transport of a great deal of bones and fat. It seems somehow just that the people who actually produce foods get a better reward for their labours, that African factories are processing fish for the Japanese supermarket, that carpet and knitwear producing factories are established close to where sheep are sheared. But it is as well to be realistic about this and to recognise that the demand for shipping *volume* will surely decline as a result of these new processes, which will inevitably transmit itself to the shipbuilder in the form of a fall in demand for ships which once carried all these raw materials.

All of these seven characteristics of modern shipping are continuing phenomena and while they will be better understood by the year 2000, they will still rank as very important in the calculations of all those concerned with the supply and demand for marine transport. For this, we believe is not something that can be simply calculated from a study of past cyclical trends, extrapolating past circumstances to provide a forecast upon which policies can be based. There is too much in a state of change, and we have only alluded to a small portion of the phenomena which will influence future thinking. There are basic changes taking place in ship *ownership* which the shipbuilder must be aware of. It has been suggested that the days of the operating shipowner are numbered with so many of his functions being sub-contracted out to specialist agencies. How often these days do you encounter a shipowner which has retained a large technical staff on his payroll. Most of the time he will retain consultants. As a result of this change so much of the onus for technical advancement devolves upon the shipbuilder. It is the shipbuilder who must produce the designs that he will try and sell, which of course increases both his costs and his responsibilities.

In the field of ship finance too, much is changing with cargo interests taking a much more involved approach, often becoming intimitely concerned with the long term financial package around which a shipping contract is based and for which ships will be built. It might be seen as the customers finally controlling the means of transport, and some have suggested that such a process may well lead to a dampening down on the violent peaks and troughs which have characterised the shipping industry over the years. There is a new interest in leasing and much discussion about shipping equipping itself in the same way as the aircraft industry.

As always, much of the demand for ships in the year 2000 will depend upon what can only be described as political factors. You can read a million words of well argued economic and statistically correst studies, proving that there will be an 'x' percent growth in Mediterranean cruising over the next five years. Then a gang of terrorists strike on a cruise ship in the Mediterranean and all these calculations go out of the window. You can be completely convinced about the requirements for LNG imports into the United States and even build a great fleet of expensive carriers to service this. And then there is a pricing dispute, a political change in the wind that determines energy policies and you have half a dozen of the world's most expensive ships in long term layup. It is worth remembering that energy policies, the decision to raise or lower tariff walls, questions of protectionism, agricultural policies and international trading accords are all fundamental to the demand for future ships. They are also dependent upon decisions made by people who may have other considerations than economic criteria or even logic! Shipbuilders serve the shipping industry. The shipping industry is a servant of world trade, but trade is governed by politics and strategy and even the vagaries of the weather which will cause a whole harvest to fail, or produce unwanted gluts.

I am not suggesting that the shipbuilder ever had it easy, but it certainly was not so hard in the old days where he left the thinking to the customer and just built what he asked for. But today the shipbuilder must anticipate demand and design and market accordingly. And to do this he must have in mind all of what I have enumerated above, and a lot more beside. He must be aware of the overriding importance of the great political events of our day and their maritime connotations, he must attempt to weigh up the effects of protectionism and liberalism, of national self-sufficiency programmes, of Glasnost and Perestroika, of war and peace in the Middle East, of intermodalism and internationalism, of channel tunnels and of farm policies.

All this presupposes a basic change to the sort of education given to shipbuilding management, far beyond the specialities of naval architect and engineer. And it is good to see that this is in fact happening. One only has to speak to some of the products of faculties like that of Polish universities concerned with transport economics, or of the more advanced naval architecture schools were 'total technology' approaches embrace a far wider curriculum than mere ship design to realise that these changes are recognised. But it needs a constant awareness of what is happening in the world to 'top up' this knowledge in a constantly changing maritime environment. This needs good, up to date information about all these various subjects and the provision of such information is dear to the hearts of all publishers in the maritime sector.

If I can end on a serious note, far more erudite speakers than this mere journalistic commentator have pointed out that all of this knowledge and technology and expertise is as nothing, so long as the overcapacity problem in world shipbuilding remains. It is a terrible thing to contemplate the sheer waste there has been in the many wonderfully equipped shipyards, offering fine designs for ships lovingly built by devoted and hard-working craftsmen all today lying idle because of overcapacity. If nothing else it should have told us that an international approach to the capacity of the shipyards of the world is essential and that realistic prices, for non-speculative orders based on sound financing principles offer the only alternative to chaos. We began with a Japanese quotation and let me conclude by a few more words from the same wise source.

'In order for the shipping and shipbuilding industries to stay afloat'... said Mr Nagatsuka... 'they must persistently look far ahead into the development of the world economy, grasp the changes in the industrial and trade structures and percieve users needs in advance by putting themselves in the users place.'

HYDRODYNAMIC RESISTANCE CHARACTERISTICS OF HUMANS, DOLPHINS AND SHIP FORMS*

*by: Dr. Ir. P. van Oossanen***

ABSTRACT

This paper presents an overview of research carried out at the Maritime Research Institute Netherlands (MARIN) on the subject of human swimming. The results obtained of an experimental study relative to the resistance properties of a bottle-nosed dolphin are also reviewed. The hydrodynamic resistance characteristics of various humans are then compared to those of the dolphin and various ship forms in order to obtain a quantitative impression of the human body with respect to its resistance to forward motion in water.

1. INTRODUCTION

Seventy-five years ago, the towing tank was used for testing ship models in calm water, the measurement of the hydrodynamic resistance and the propulsion characteristics of ship models being almost the only types of tests carried out. Then, the towing tank was the only means to determine the power level required to propel a ship at a certain speed, being of vital importance to the naval architect. Today the towing tank is used for many different types of experiments. These encompass not only resistance and propulsion measurements, but also the measurement of the detailed flow behaviour around different types of bodies, measurement of the forces on – and the motions of – ships and floating bodies in waves, observation of cavitation on propulsors and ship appendages, the measurement of the associated radiated noise characteristics, and many more.

It is not generally known that now the towing tank is also used for carrying out research on human swimming and the hydrodynamics of humans in general. At MARIN some notable projects were carried out in this field some years ago. It is perhaps of interest to the practicing naval architect and others to learn of some of the results obtained, particularly with respect to the hydrodynamic resistance properties of the human body. It is perhaps even more interesting to take note of the significant differences in the hydrodynamic resistance between the human body, different types of ship forms and dolphins, the last representing a class of living animals particularly conditioned for swimming in water, which the human body is not. To this end the main particulars and the results of measurements on a model of a bottle-nosed dolphin in one of the MARIN towing tanks are presented as well.

2. TESTS AND MEASUREMENT TECHNIQUES USED IN RESEARCH ON HUMAN SWIMMING AND SOME TYPICAL RESULTS

Human swimming can be studied by observations or measurements. A swimming pool is a poor facility for making adequate observations since the time needed by a swimmer to pass an underwater window is too short. Measurements in a swimming pool is even more difficult since this can only be done by adopting a telemetry system.

MARIN has several large towing basins for experimental studies on ship models. For this purpose the basins are provided with carriages running over the full length of the basins at controllable speeds. Such a carriage is equipped with extensive instrumentation and recording facilities, including underwater television.

The MARIN High Speed Basin is used for experimental studies on swimming. This basin has a length of 220 m, a width of 4 m and a water depth of 4 m. The towing carriage can attain speeds up to 12 m/s. The swimming studies are based on measurements and observations, which can be carried out as long as is necessary. Some results of this research has been presented by Van Manen and Rijken (1975).

Human swimming experiments started in 1968 with a study sponsored by the Netherlands Sporting Federation, in co-operation with the Royal Netherlands Swimming Association, with the aim to measure the contribution to human swimming propulsion delivered by the arm and leg movements separately, for different swimming strokes. A schematic diagram of the equipment used is shown in Figure 1.

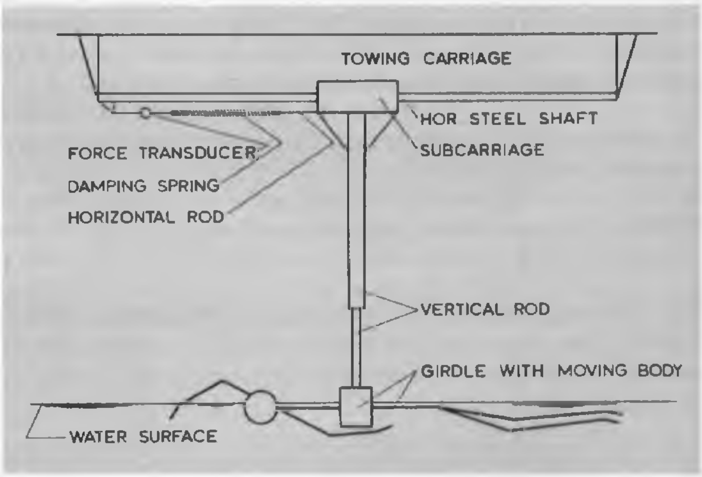


Fig. 1. Test set-up to measure thrust while swimming. The swimmer can either use arms and legs together or arms and legs separately.

When measuring the arm force, the swimmer is fixed to the vertical rod by means of a girdle around the waist. He or she stretches the legs and swims with the arms only. The carriage speed is gradually increased till over the free-swimming speed. At lower speeds a net forward force (thrust) is measured. When the speed is increased beyond the free swimming speed, the net force on the vertical rod is a resistance force. A similar relation is found when the swimmer stretches the arms forward and swims with the legs only. The output of the strain gauge force transducer is recorded and analysed as a function of the speed of the towing carriage. In Figure 2 some typical recordings are presented.

* Paper presented to the Netherlands Society of Marine Technologists and the Marine Technology section of the Royal Institution of Engineers

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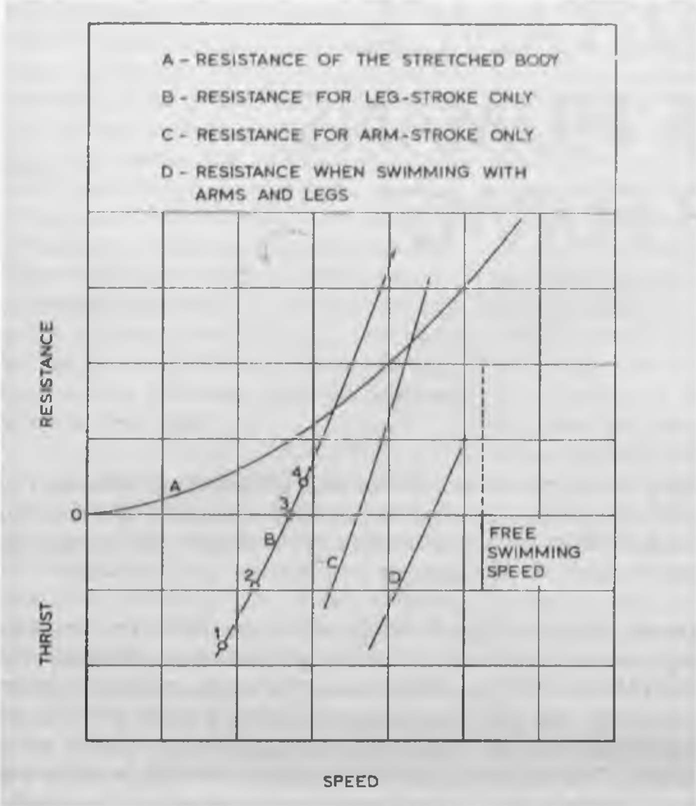


Fig. 2. Resistance (and thrust) measured for leg-movement only (B), arm-movement only (C), and for arm and leg movement together (D).

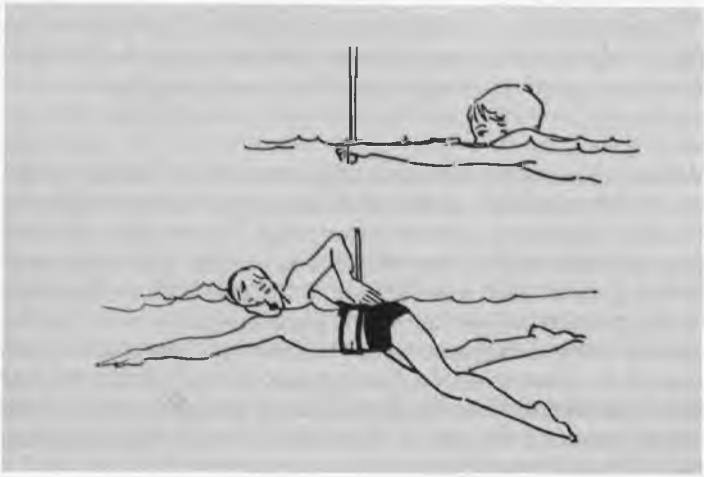
Curve A in Figure 2 is obtained from a measurement involving the towing of the swimmer in stretched position, as indicated in Figure 3.

For comparison purposes the unrestricted, maximum free-swimming speed of the swimmer concerned, swimming freely in the towing tank, is indicated in Figure 2 as well. This speed is higher than the speed found from the intersection of curve D with the zero-thrust (or zero-resistance) line. This is due to the additional resistance of the girdle around the waist and possibly due to the swimmer being somewhat constrained in the girdle.

To demonstrate the significance of the use of this technique some examples are given below.

In 1971 some of the top Russian swimmers were tested at MARIN. Amongst them were the well-known breast-stroke champion Galina Stepanova and Iwan Morchoekof. The Royal

Fig. 3. The two tests involved in composing the graphs as given in Figure 2. The resistance of the stretched body is found by towing the swimmer as indicated in the top figure (also used for determining the thrust of the legs only).



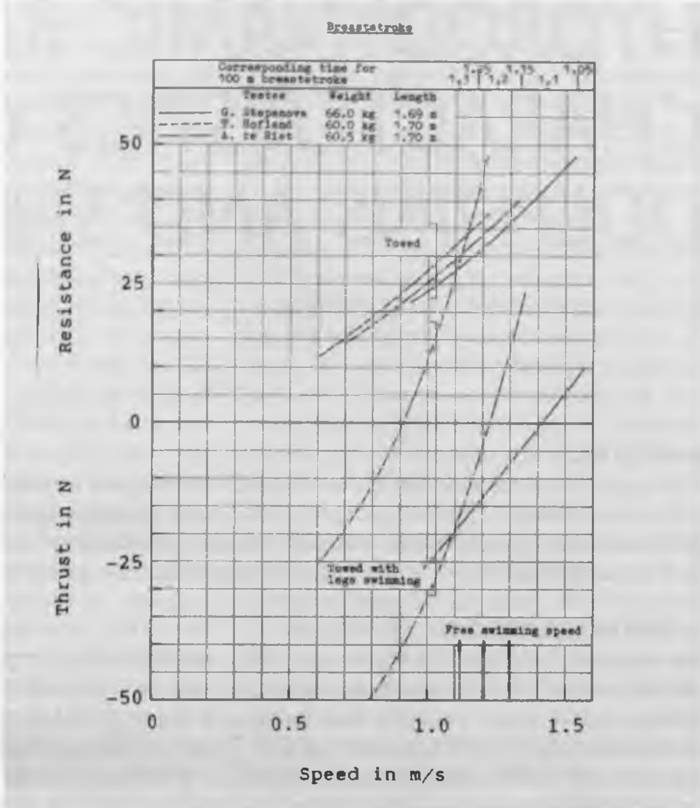
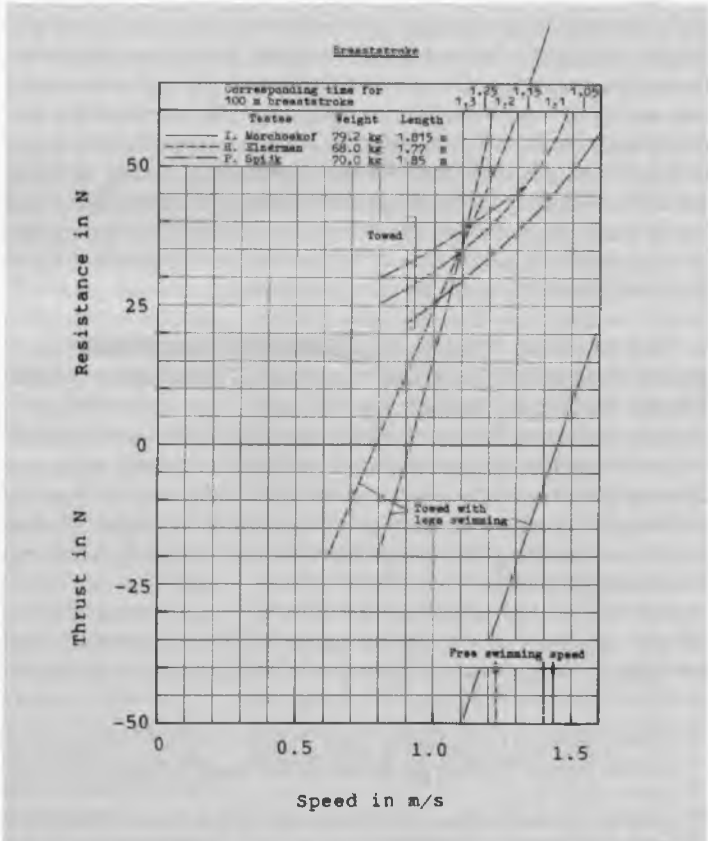


Fig. 4. Significant difference in thrust associated with leg movement for top female Russian breast stroke swimmer in comparison to female Dutch breast-stroke swimmers, in 1971.

Netherlands Swimming Association was particularly interested in the resuls of these two breast-stroke champions because nearly all Dutch breast-stroke swimmers had revealed that the legs con-

Fig. 5. Similar significant differences in thrust associated with leg movement for top male Russian breast stroke swimmer in comparison to male Dutch breast stroke swimmers, in 1971.



tribute little – if anything – to the developed thrust. In fact it was then quite usual to find that the resistance of the stretched human body, utilising his or her legs as during the breast stroke only, and holding on to the tow bars as shown in Figure 3 (top figure), was higher than the resistance of the stretched body with no arm or leg movement.

These two Russian swimmers, however, displayed an appreciable thrust associated with the leg stroke as opposed to the Dutch swimmers. This is revealed for G. Stepanova (in comparison to the Dutch swimmers T. Hofland and A. de Riet) in Figure 4, and for I. Morchoekof (in comparison to H. Elzerman and P. Spijk) in Figure 5.

After analysing the results shown in Figures 4 and 5 in which a net thrust of 42 Newton was found due to the leg stroke for Stepanova and 47 Newton for Morchoekof, at the free-swimming speed, the Dutch swimming coaches decided that the leg stroke should not be neglected as had been done before during training sessions.

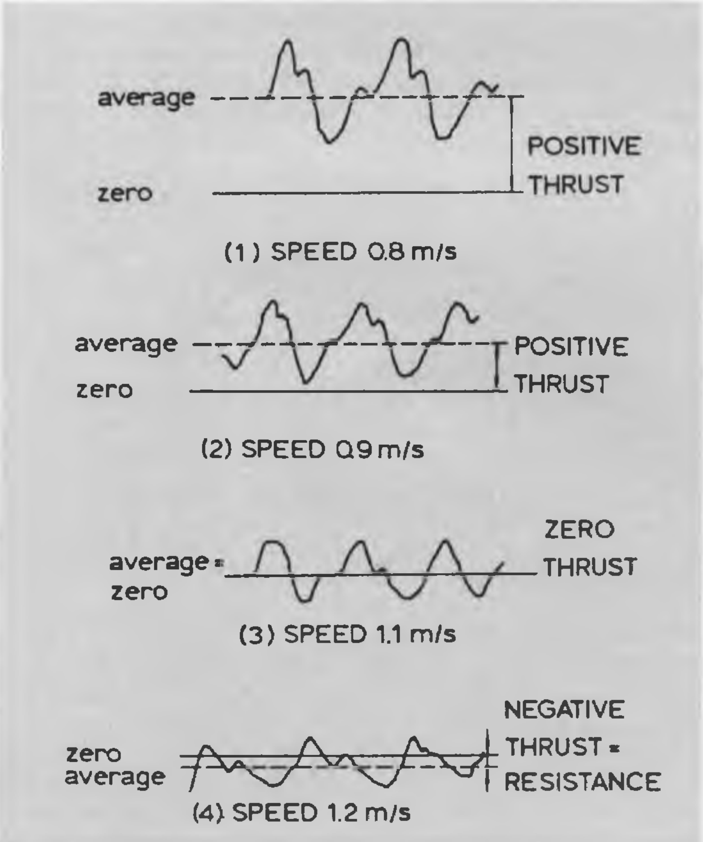
The results shown in Figures 2, 4 and 5 are derived from plotting the time-average values recorded during the tests. The actual measured signals are as shown in Figure 6.

Another study, sponsored by the 'Anatomical and Embryological Laboratory' of the Free University Brussels, was made to investigate the differences between competition crawl and waterpolo crawl. Typical recordings are given in Figure 7.

The main conclusion of this study was that the total energy output for waterpolo crawl is higher than for competition crawl, in spite of the fact that the free swimming speed for waterpolo crawl is lower. Complete results are given by Clarijs, Jiskoot and Lewillie (1973).

Research on various types of women swimming suits was also carried out. It was found that a particularly tight-fitting swimming suit resulted in a substantial resistance decrease compared to swimming naked, as seen in Figure 8. In the same way it was found that a

Fig. 6. Actual measured values during swimming tests. From these time traces the time-average values are found and plotted as a resistance or a thrust.



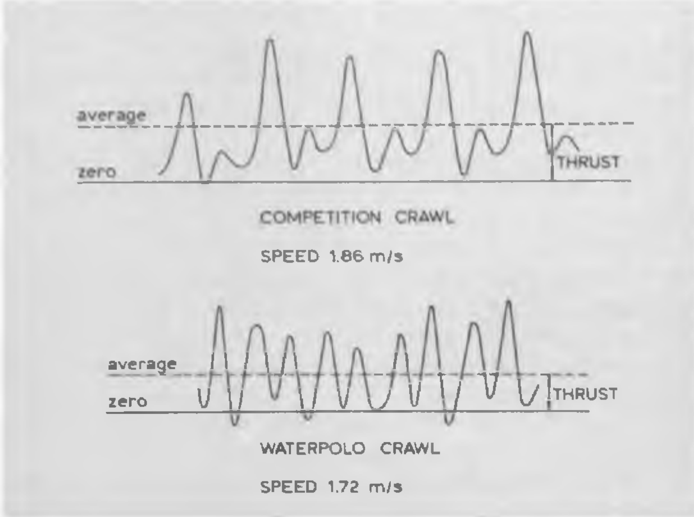
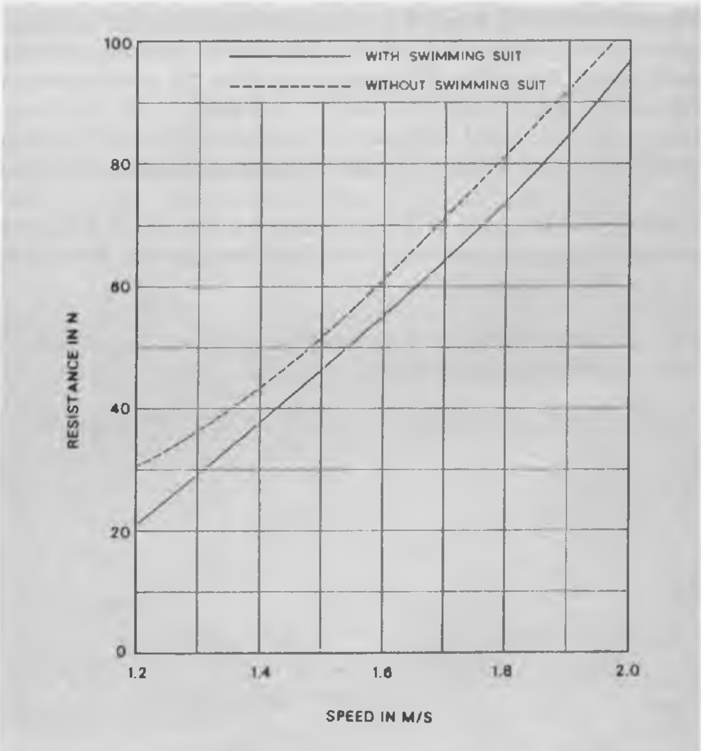


Fig. 7. Despite the higher frequency of arm and leg strokes during the waterpolo crawl, the so-called competition crawl is more efficient and leads to a higher free-swimming speed.

significant resistance decrease also occurs on removing all hair from the male body.

To differentiate between the efficiencies of the left and right arm strokes, special pressure transducers were developed which could be fitted to the palm of each hand. This allowed a continuous recording of the pressure exerted during the whole cycle of the arm stroke, independent of the type of swimming stroke. The significance of this type of measurement had already been pointed out by Councilman (1971). It can be used by swimming coaches to improve the arm stroke of their pupils. Typical recordings for the left and right hand of a competition-crawl swimmer, who is breathing on the right side, are given in Figure 9. The arrow pointing downward indicates the moment where the hand enters the water. The first phase of the stroke is characterised by a pull of the hand; the second phase by a push of the hand. Finally, the hand leaves the water at the moment indicated by the arrow pointing upward.

Fig. 8. A tight-fitting swimming suit in the case of woman swimmers results in a substantial resistance decrease.



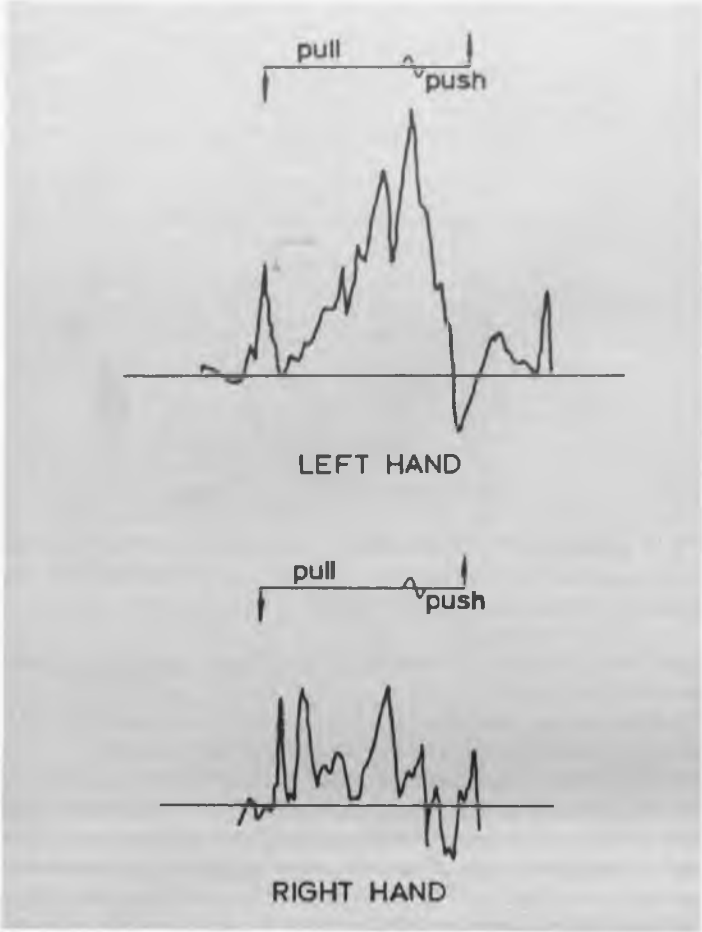


Fig. 9. A recording of the pressure exterted by the left and right-hand of a competition-crawl swimmer. The left hand can be seen to be significantly more effective.

3. TESTS CARRIED OUT WITH A MODEL OF A BOTTLE-NOSED DOLPHIN AND THE RESULTS THEREOF

In order to make the model, accurate measurements were taken of a full-grown female specimen of a Florida bottle-nosed dolphin, *Tursiops truncatus* (Mont.), which had been caught in the Gulf of Mexico off Florida Keys. For this purpose the animal was suspended in a form of sling and the contours of the body and fins determined. A number of drawings based on the measurements were made, upon which the shape of the dolphin was recorded. Figures 10, 11, 12 and 13 show the contours of the body and the cross-sections of the body, the tail, the pectoral fins and the dorsal fin.

Table 1 gives the general dimensions of the dolphin. A full-sized wooden model was made on the basis of the drawings, but as the research was in the first instance aimed at the shape of the body the model was not fitted with pectoral fins.

In order to prevent the tail from producing lift forces at different

Fig. 10 Contours of the body and sections of tail and fins of the built model of the bottle-nosed dolphin.

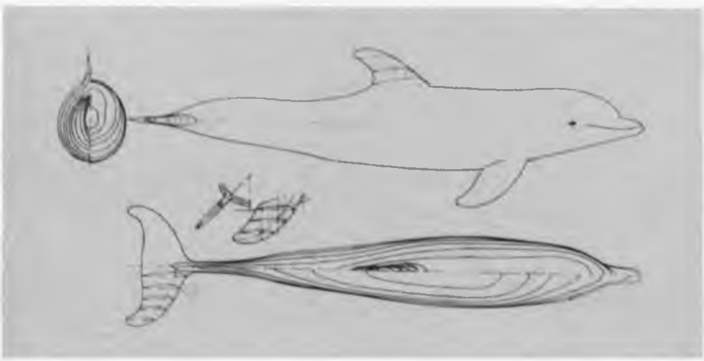
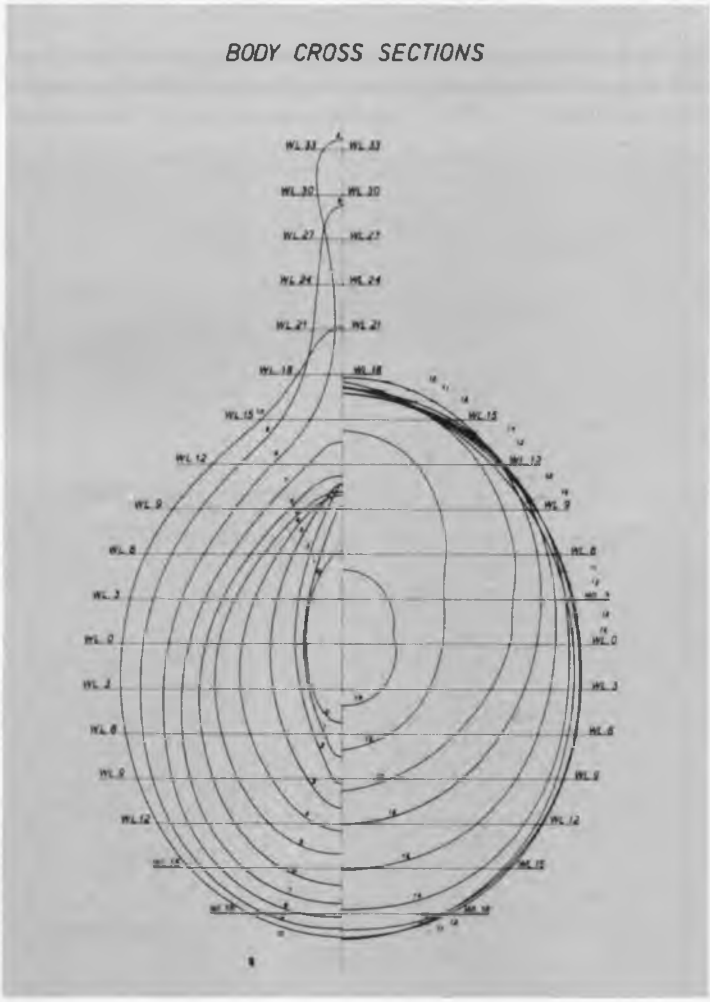


Table 1 Dimensions of the dolphin, MARIN Model No. 3723, scale 1:1

Surface area of dolphin with tail and flippers	1.891	m^2
Surface area of tail flukes	0.171	m^2
Surface area of one flipper	0.068	m^2
Surface area of dorsal fin	0.090	m^2
Displacement of dolphin with tail and fins	100.629	dm^3
Displacement of tail flukes	1.830	dm^3
Displacement of one flipper	0.528	dm^3
Displacement of dorsal fin	1.002	dm^3
Position of centre of gravity of volume of dolphin with tail and flippers posterior to snout	0.909	m
Position of centre of gravity of volume of tail flukes posterior to snout	2.151	m
Position of centre of gravity of volume of flipper posterior to snout	0.670	m
Position of centre of gravity of volume of dorsal fin posterior to snout	1.142	m
Length of dolphin as measured along the nose-tail line	2.250	m
Length of dolphin as measured from tip of snout to posterior extremety of flukes	2.322	m
Maximum thickness of dolphin	0.372	m
Tip of snout to point of maximum thickness	0.808	m

Fig. 11 Body cross sections of built model of bottle-nosed dolphin.



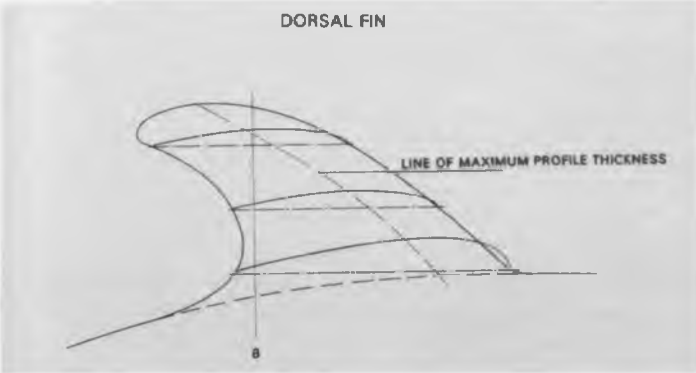


Fig. 12 Profile and cross sections of dorsal fin of built model of bottle-nosed dolphin.

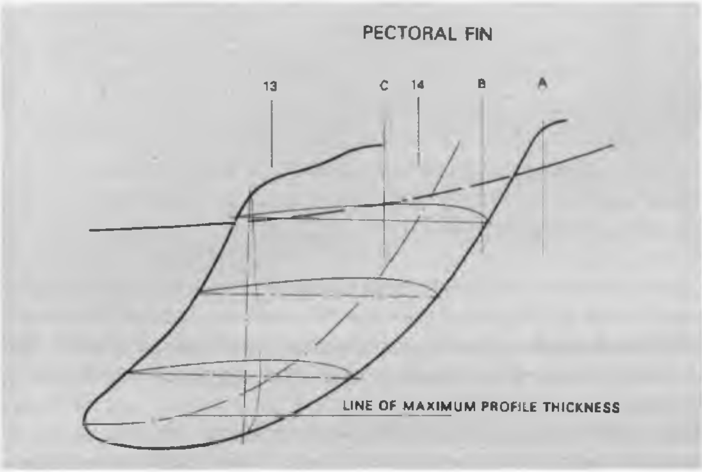


Fig. 13 Profile and cross sections of pectoral fin.

angles of attack, it was attached to the body with hinges and its specific gravity was adjusted to that of the water. Recesses were made in the body to allow for the inclusion of measuring instruments and the former were finally closed with brass plates carefully moulded to the contours of the body to prevent discontinuities. The model was finally given several coatings of waterproof lacquer to give it a fine finish.
For the experiments, the model was suspended from two streamlined struts, the upper ends of which were attached to the towing carriage. Each strut consisted of an inner tube (which took up the forces) and an outer nacelle, which at its lower end was just free of the model. The inner tubes were connected to the model in the manner shown in Figure 14. During the tests the struts were maintained in a vertical position. To alter the angle of incidence of the model with reference to the nose-tail line, the rear strut was moved downward (positive angle of incidence) or upward (negative angle of incidence) and at the same time shifted over a certain distance in the direction of translation. Measuring-unit A registered the vertical component of the force acting on the model at the location of the front strut whilst measuring-unit B registered the component acting in the direction of the nose-tail line. There was a hinge between measuring-units A and B. At the location of the rear strut, there was insufficient room to install a measuring-unit similar to that at the front strut, therefore a statically fixed situation was created by installing a universal bearing in such a way that the model itself could also rotate around this bearing. Measuring-unit C registered the vertical component of the force applied at this point and working perpendicular to the nose-tail line. To keep the line of action of this force continuously perpendicular to the nose-tail line during the tests, visual monitoring of two contact points at each side of the shaft took place to ensure that the shaft was constantly in the middle of the bearing.

Drag measurements were carried out at one set speed and at different angles of incidence. At the optimum angle of incidence the drag was measured over a speed range of 1 to 8.5 m/s so that a correct comparison with data known from the literature would be possible. The shape of the camber of the wooden model, although not a time-average shape, was fairly similar to that of a dolphin in a glide. Since most of the observations on swimming performance of dolphins have been made whilst the animals were at or near the surface, the wooden model was submerged to a depth of 1.20 metres relative to the nose-tail line. It was assumed that at this depth no noticeable wave drag would be produced but on the basis of the results this assumption turned out to be incorrect. The flow pattern was recorded at an angle of incidence of 0 deg. and a speed of 6.14 m/s by means of a 'paint test', whereby paint is applied to the model at a number of points. The direction in which the paint spreads out along the body under the influence of the water velocity indicates the flow pattern, i.e. the trace of the streamlines.

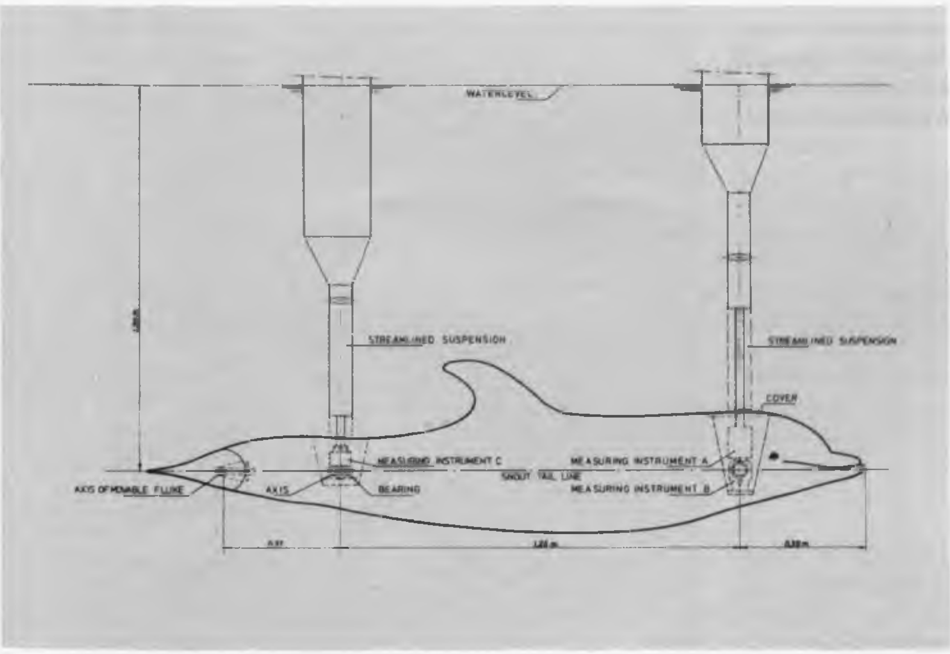
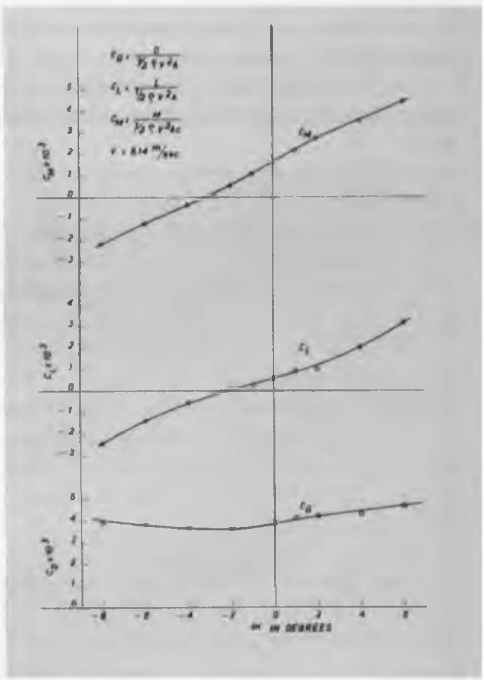


Fig. 14 Measurement set-up for tests in the towing tank.

Fig. 15 Results of lift, drag and moment measurements on 1 to 1 scale model of bottle-nosed dolphin at 6.14 m/s and various angles of incidence of the model. (The area A used is the surface area of dolphin with tail and fins).



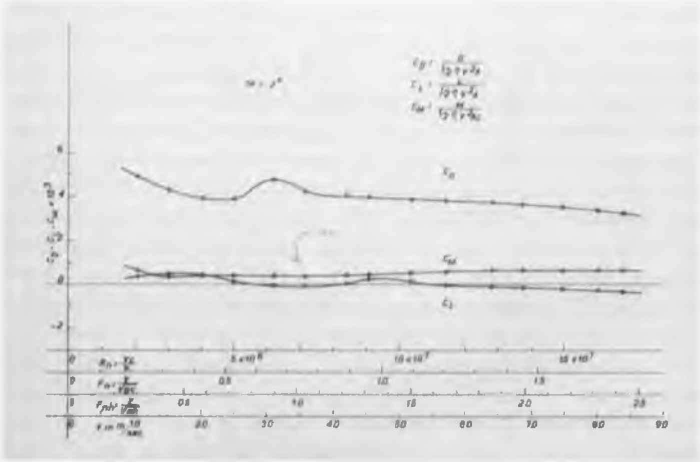
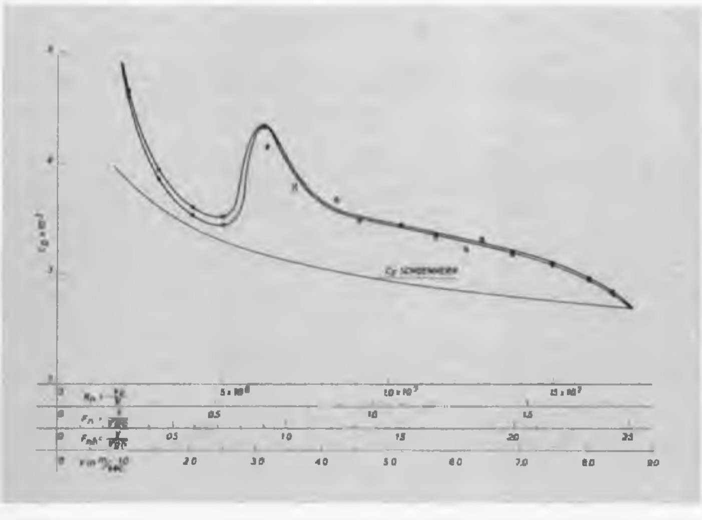


Fig. 16 Drag, lift and moment coefficient as functions of Reynolds number, Froude number and velocity, at an angle of incidence of −2 degrees. (These values are uncorrected for the interference caused by the struts).

The results of the lift, drag and moment measurements are shown in Figure 15. It will be noted that when the model was in motion at zero angle of incidence there was an appreciable lift and upward turning moment about the centre of gravity due to the shape of the body. It is apparent that the minimum drag occurs at an angle of incidence $\alpha = -2$ degrees. The results of the experiments carried out at an angle of incidence $\alpha = -2$ degrees and over a speed range of 1 to 8.5 m/s are shown in Figure 16. Here the C_D curve gives the most salient result.

At $R_D = 6 \star 10^6$ a noticeable wave drag component appears, which is the speed at which a transverse pressure wave has developed. The dimension of this pressure wave is dependent on the submergence h. To avoid this wave-drag the ratio h/t would have to be around 9 to 10 which would require a submergence of 3.30 to 3.70 metres. For practical reasons it was not possible to arrange this.
Interference between the struts and the model had some influence on the test results. Because resistance was the most important component, only those values were corrected for. The correction applied was based on experiments carried out by Gertler (1950). The corrected values are given in Figure 17, in which the friction resistance coefficients for a turbulent boundary layer according to the Schoenherr formula are also given.

Fig. 17 Drag and friction resistance coefficient as functions of Reynolds number, Froude number and velocity, at an angle of incidence of −2 degrees, corrected for the interference caused by the struts. (The upper C_D curve is for the dolphin model with both dorsal and pectoral fins).



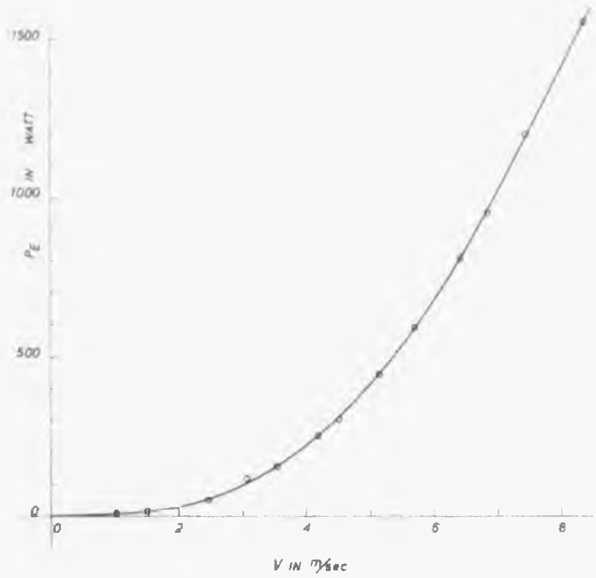


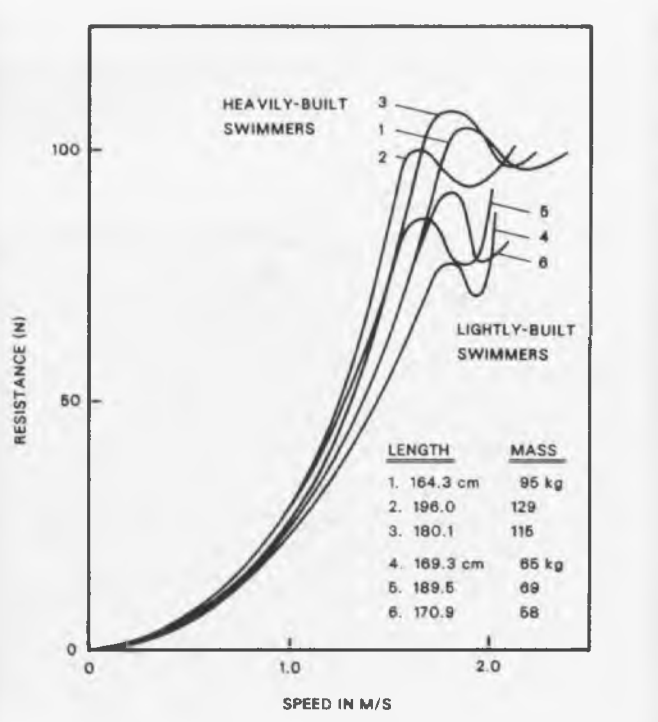
Fig. 18 Effective (towing) power for 1 to 1 scale model of bottle-nosed dolphin as determined from resistance measurements, as a function of forward speed.

Due to the fact that the model on which the experiments were performed did not have pectoral fins, the influence of those was calculated and a correction applied to the measured values. For the calculation, the boundary layer was supposed to be partly laminar.
The power required to tow the wooden model with tail, pectoral fins and dorsal fin, as calculated from the resistance measurements, is given in Figure 18 and it will be seen that at 15 knots or about 8 m /s, this power is about 1500 watts.
Further results of this experimental study have been presented by Purves et al. (1975).

4. THE HYDRODYNAMIC RESISTANCE OF THE HUMAN BODY

From the many tests carried out with swimmers, it is possible to

Fig. 19 Measured resistance in Newton of three heavily-built persons and three lightly-built persons.



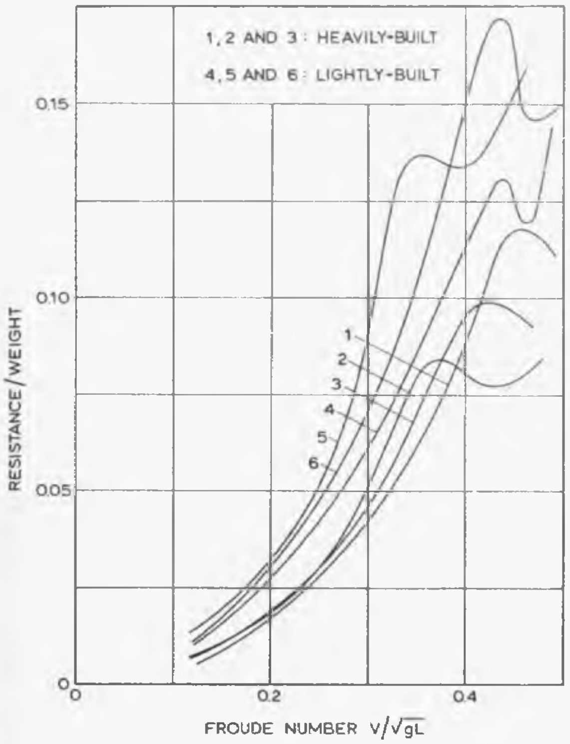


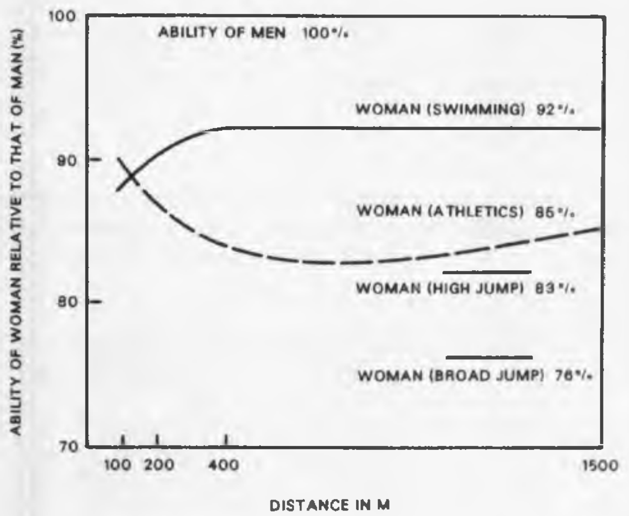
Fig. 20 Non-dimensional resistance-weight ratio against Froude number based on body length for the same six test persons as given in Figure 19.

answer some interesting questions relative to the effect of body shape on resistance, the resistance difference associated with swimming on, or just under, the water surface, and the resistance difference between man and woman.

4.1. Effect of body shape on resistance

To determine the effect of body shape on resistance, a large number of test persons were towed in the stretched position. The results for six selected people are shown in Figure 19, in which the measured resistance is given against speed. Three of the test persons can be considered to be heavily built while the other three test persons can be considered to be lightly built. From this figure it follows that the lightly-built persons have less resistance at, or near, the maximum attainable free-swimming speed of

Fig. 21 In swimming, the ability of women relative to that of men in 92%: much higher than in any other sport.



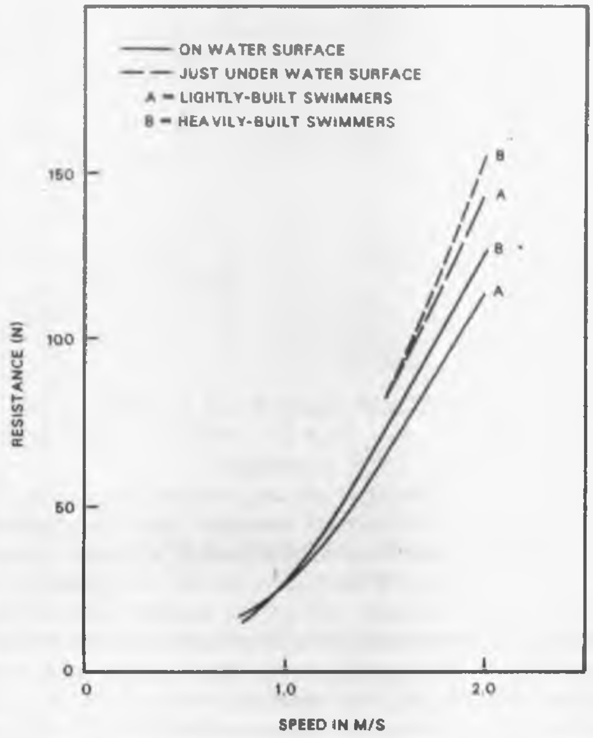


Fig. 22 The hydrodynamic resistance of the human body, just below the water surface is greater than on the water surface.

about 2 m/s. At lower speeds the difference in resistance is less significant.

On dividing the measured resistance by body weight, and on using the Froude number based on body length (L) on the horizontal axis, the results as shown in Figure 20 are obtained for the same six test persons.

From Figure 20 it follows that the resistance per unit body weight is significantly lower for the heavily-built persons than for the lightly-built test persons. It was found that this was mainly due to the difference in body density between the light and heavily-built swimmers. Heavily-built persons have appreciable lower body densities. The results in the fact that heavily-built persons sink relatively less deeply in the water than lightly-built persons, leading to less hydrodynamic resistance per kg body mass, as shown by Clarijs (1976).

4.2. Difference in resistance between female and male swimmers

For the same reason, women have a lower hydrodynamic resistance than men. The female body has an appreciable lower density than the male body. Accordingly, women sink less deep in the water. This results in the fact that the ability of women in competition swimming comes closer to that of men than in any other sport, as shown in Figure 21.

The fact that when more of the human body is submerged, the hydrodynamic resistance increases, was confirmed by experimentation. At MARIN, lightly-built and heavily-built swimmers were towed through the water in the stretched position at various levels of submergence. Some averaged results are given in Figure 22.

4.3. The nature of the hydrodynamic resistance of humans

The average wetted surface area of humans, when completely submerged, is given in Figure 23 as a function of body height and mass. For a height and mass equal to 1.80 m and 80 kg respectively, the wetted surface area is approximately equal to 1.9 m ^{2}. At a free-swimming speed of 2.0 m/s the frictional resistance is approximately equal to:

$$R_F = \frac{1}{2}\rho V^2 C_F S$$

where $\rho = 1000 \text{ kg/m}^3$
$V = 2.0 \text{ m/s}$

$$C_F = \frac{0.075}{(\log R_n - 2)^2}$$

in which $R_n = \frac{V.L}{\nu} \cong \frac{2.0 * 1.8}{1.1 * 10^{-6}} = 3.3 * 10^6$

so that $C_F = \frac{0.075}{(4.52)^2} = 0.0037$

and $R_F = 500 * 4 * 0.0037 * 1.9 = 13.9 \text{ N}$

At 2.0 m/s the total resistance of a human swimmer varies between 90 and 130 N. It follows that the frictional resistance is only about 10% of the total resistance and that the so-called residual resistance, composed of three-dimensional form resistance and wave resistance is about 90% of the total resistance.

Finally, it should be noted that at the maximum swimming speed humans can reach (about 2.0 m/s), the effective power associated with towing the stretched human body is about 200 watt.

5. GRAY'S PARADOX

Gray (1936) was the first to notice an enormous discrepancy between the attainable speed of dolphins and similar cetaceans and the power available from swimming muscles. The resistance tests carried out with the 1 to 1 scale dolphin at MARIN indicate that on utilizing a swimming motion with a 100% efficiency at 8.0 m/s, the required power is about 1.5 kW. For humans at 2.0 m/s, this figure is 0.2 kW. This is about 7 times lower than for the dolphin, the mass of the dolphin being about 100 kg which is only about 20% higher than the mass of the average competition swimmer.

Biologists assume that the dolphin muscle and its various auxiliary systems are of the same quality as those of a trained human being. On the basis of muscle mass, it is assumed that dolphins are capable of no more than 3 times the power output of a human being of equal mass as the dolphin.

Well trained athletes such as rowers and cyclists have been known to develop sustained power outputs of between 0.3 and 0.4 kW for 1 hour. On assuming that competition swimmers are capable of the same, it follows that the efficiency of a swimming stroke at

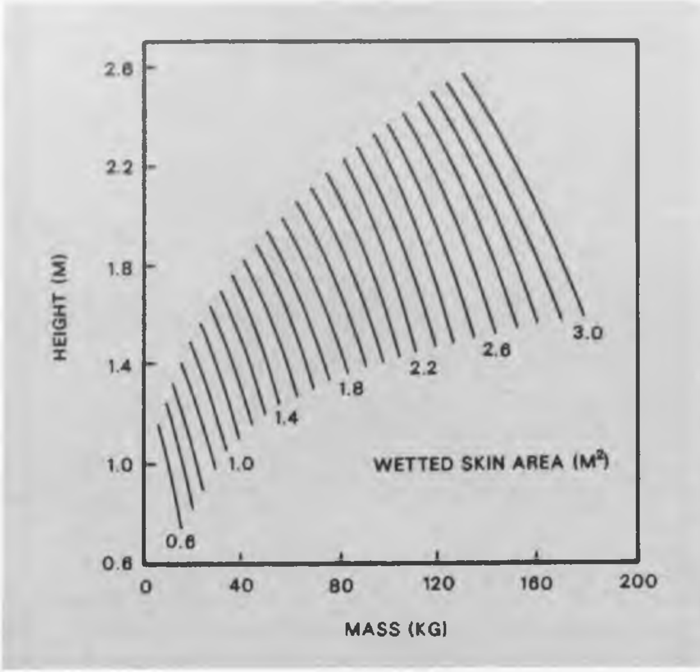


Fig. 23 Wetted skin area of an 'average' human, as a function of body height and mass, when completely submerged.

Fig. 24 Curve of sectional areas and body plan of a tanker designed for a speed of 16.95 knots.

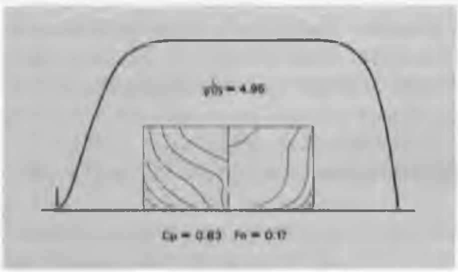


Fig. 25 Curve of sectional areas and body plan of a car ferry designed for a speed of 23.2 knots.

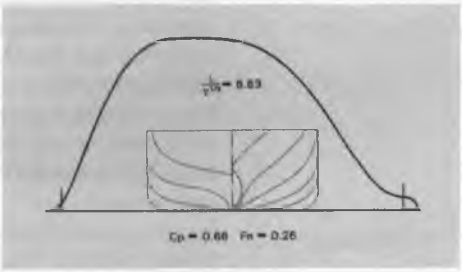


Fig. 26 Curve of sectional areas and body plan of ocean-going tug designed for a free-running speed of 16.4 knots.

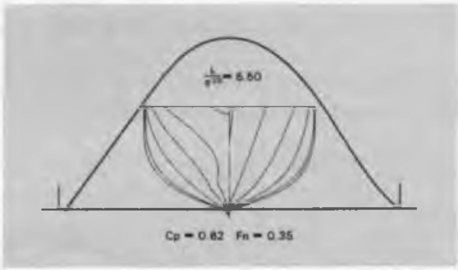


Fig. 27 Curve of sectional areas and body plan of a frigate designed for a speed of 30.3 knots.

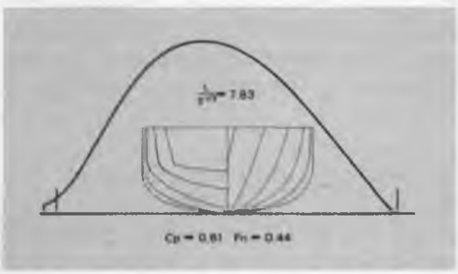


Fig. 28 Curve of sectional areas and body plan of a fast displacement hull according to the MARIN high-speed displacement hull form series, see van Oossanen et al. (1985), designed for a speed of 45 knots.

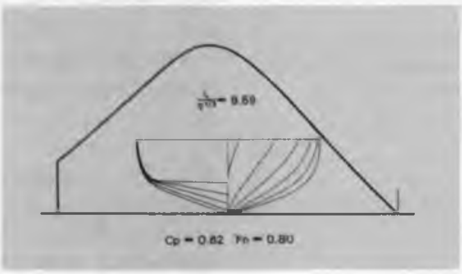
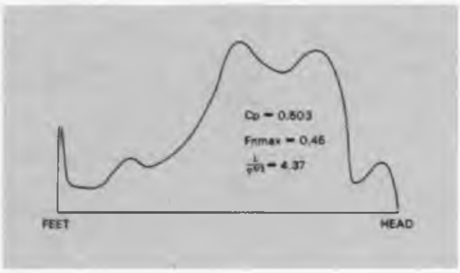


Fig. 29 Equivalent 'curve of sectional areas' of human male swimmer.



2.0 m/s, for which the resistance of the stretched human body is 100 N, is between 50% and 75%. On assuming that the efficiency of the dolphin in producing forward thrust is the upper of these values (75%), it follows that for our comparison the dolphin produces of power output of 0.02 kW per kg of body mass while a competition swimmer of 80 kg produces 0.005 kW per kg of body mass, in which a 50% efficiency factor is utilized.

Although this factor of 4 is close to the factor of 3 mentioned above, being the ratio of the mass of propulsive muscle of the dolphin relative to that of humans, it is often observed that dolphins are capable of greater speeds than 8.0 m/s over long periods of time, see Lang (1963). Hence a discrepancy exists between the assumed resistance values of cetaceans and fish and their muscular power output.

Since Gray first postulated his paradox, many studies have been carried out on this subject. Presently the consensus is that dolphins and other cetaceans are able, through some means, to maintain laminar flow over a significant portion of their body up to Reynolds numbers approaching 5 ★ 10^7. Present theories as to how this is attained vary. One theory is that cetaceans utilize some form of skin damping whereby disturbances in the laminar flow leading to transition to turbulent flow are damped out by the resilient skin. Tests utilizing resilient coatings which act similarly indicate drag reductions of 60%, see Kramer (1962). Another theory involves the concept that cetaceans are able to maintain a body shape so as to avoid any adverse pressure gradient causing transition to turbulent flow, till well past the location of maximum body girth. A third hypothesis involves the idea that laminar flow can be extended by means of unsteady velocity or pressure gradients induced by flexible body movement, see Wu (1960).

6. THE COMPARISON WITH SHIP FORMS

As design speed increase, the optimum ship form from a minimum required power point of view changes. This is demonstrated in Figure 24 through 28, giving the curve of sectional areas and the body plan of a tanker for a Froude number equal to 0.17, a car ferry for a Froude numbere equal to 0.26, a large towing vessel for a Froude number equal to 0.35, a frigate for a Froude number equal to 0.44, and a fast displacement vessel for a Froude number equal to 0.8, respectively. The main resistance characteristics of these hull forms are given in Table 2.

Table 2 Resistance characteristies of some different types of hull forms

Ship type	Froude number (F_n)	Ship speed V_s (m/s)	Wetted area S (m^2)	Resistance R_T (kN)	Resistance coefficient $= \frac{R_T}{\frac{1}{2}\rho \cdot V_s^2 S}$
tanker	0.17	8.72	17354	2301	0.0034
car ferry	0.26	11.94	7134	1538	0.0030
ocean tug	0.35	8.43	702	139	0.0054
frigate	0.44	15.59	2195	1584	0.0058
fast displ.	0.80	23.12	745	701	0.0034

For comparison purpose the equivalent 'curve of sectional areas' for a representative male, competition swimmer is given of Figure 29. The same figure for the tested dolphin is given in Figure 30. The corresponding resistance characteristics are given in Table 3.

Table 3 Resistance characteristics of a male, competition swimmer and the tested dolphin

	Speed (m/s)	Wetted area (m^2)	Resistance (Newton)	Resistance coefficient
Swimmer	2.0	1.90	90	0.024
Dolphin	8.0	1.89	188*	0.0030

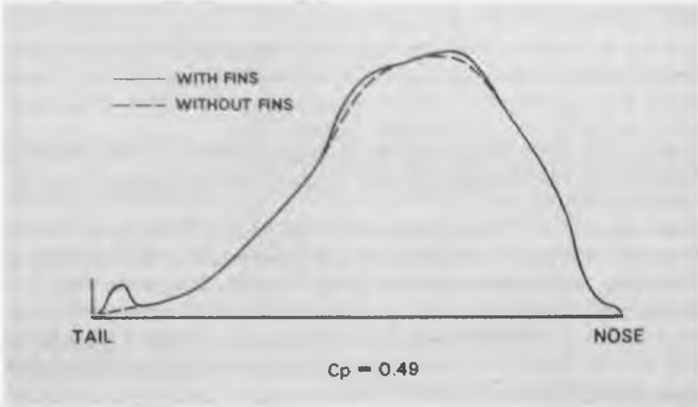


Fig. 30 Equivalent 'curve of sectional areas' of bottle-nosed dolphin model as tested at MARIN.

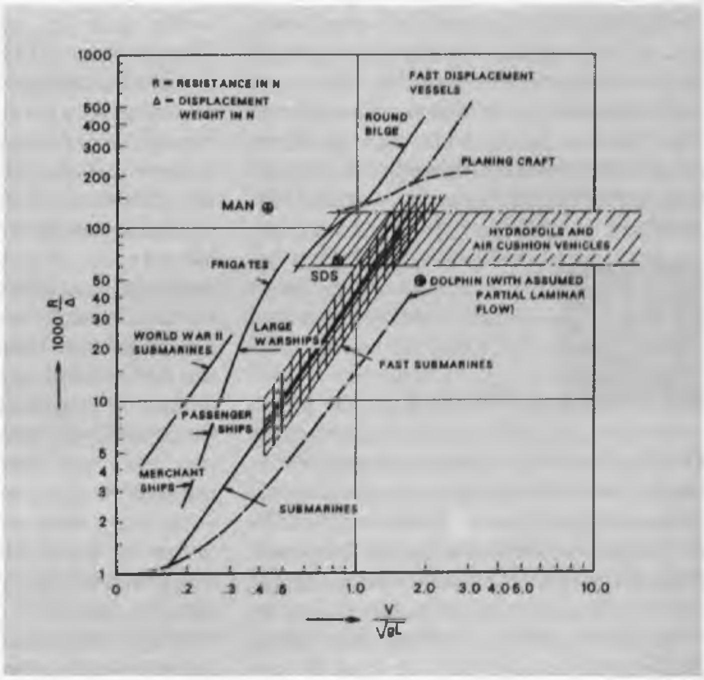
From Table 3 it follows that the resistance of the dolphin, on assuming a turbulent boundary layer as found from the MARIN tests, is equal to the lowest values found for ship forms. The resistance coefficient for human swimmers is 8 times higher. An overview of the resistance of various types of ships, submarines, advanced marine vehicles, a human swimmer and a dolphin, is given in Figure 31.

7. CONCLUSIONS

From the results presented in this paper it will be obvious that human beings are not 'shaped' for efficient movement in water. Compared to a dolphin, a class of living animals particularly conditioned for swimming in water, the human body experiences a specific resistance force opposing forward motion which is at least 8 times greater.

The dolphin is able in some way to maintain a significant degree of laminar flow along its body. On taking this into account, the dolphin and similar cetaceans experience hydrodynamic resistance values which are lower than the values associated with well-designed ship forms. This will remain so until man is able to control the boundary layer flow and maintain laminar flow up to significantly higher values of the Reynolds number then is presently the case.

Fig. 31 Overview of resistance-weight ratio values for various types of ships, submarines, advanced marine vehicles, a human swimmer and a dolphin.



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NIEUWSBERICHTEN/NEWS

Verkochte schepen Sold

Dordrecht

Van Ommeren Shipping, de (bulkcarrier) rederij van VOC, Van Ommeren Ceteco, en Partship Holding, de scheepsparticipatie maatschappij van Bank Mees & Hope NV, hebben samen (50/50) een multi-purpose bulkcarrier van 42.000 dwt gekocht. Het in Frankrijk gebouwde schip, dat in april jl. werd opgeleverd, zal onder Nederlandse vlag varen; het management komt te berusten bij Van Ommeren Shipping.
Het schip wordt voor langere tijd verhuurd aan Transportacion Maritima Mexicana (TTM). Dit past in het streven van Van Ommeren Shipping om de afhankelijkheid van de vaak sterke schommelingen in de droge-ladingvrachten te verminderen. In veel opzichten is de nieuwe 'Dordrecht' een moderne versie van de uit begin 80-er jaren stammende W-drechten. Belangrijk is de grotere containercapaciteit van 2.000 TEU's.

Offshore

Offshore-veiligheidstrainingen

Met de formele bevestiging van de vertegenwoordiging van de Nederlandse Olie en Gas Exploratie in Produktie Associatie (NOGEPA) kon groen licht worden gegeven aan de Commissie van Advies van de Netherlands Safety Training Association (NSTA).
Leden van de Associatie zijn doorgaans instituten werkzaam op het terrein van veiligheidstraining. Alvorens te worden toegelaten moet op voldoende wijze worden aangetoond dat wordt voldaan aan relevante kwaliteitsnormen.
De Commissie van Advies is samengesteld uit deskundigen voor de verschillende sectoren van veiligheidstraining, vertegenwoordigers van doelgroeporganisaties (als b.v. NOGEPA) en vertegenwoordigers van toezichthoudende overheden (als b.v. Staatstoezicht op de Mijnen en de Rijksluchtvaartdienst).
De belangrijkste taak van de Commissie van Advies is het adviseren van het NSTA-bestuur inzake alle aangelegenheden met betrekking tot het NSTA-kwaliteitsbeheersingsprogramma. Dit programma betreft de veiligheidscursussen en -trainingen welke door de leden van de Associatie worden gegeven ten behoeve van werknemers bij bedrijven, instellingen, e.d. van uiteenlopende aard.
Met de toetreding van de NOGEPA-vertegenwoordiging in de Commissie van Advies kan de uitvoering van het kwaliteitsbeheersingsprogramma voor veiligheidscursussen en -trainingen ten behoeve van de doelgroep Olie- en Gasindustrie/Exploratie en Produktie van start gaan. Belangrijk onderdeel hiervan is de beoordeling van de kwaliteit van trainingen door evaluatieteams van de Commissie van Advies. De bevindingen van deze teams vormen de basis voor het al of niet kwalificeren van trainingsinstituut en instructeurs en de vermelding hiervan in de NSTA-Informatiebundel welke binnen de verschillende doelgroepen op uitgebreide schaal zal worden verspreid.
Het ligt in het voornemen analoge kwaliteitsbeheersingsprogramma's te gaan opzetten voor andere doelgroepen zoals b.v. Kantoren/Instellingen en Bedrijven, Scheepvaart en Wegtransport.
Met hun kwaliteitsbeheersingsprogramma's beoogt de NSTA wezenlijk bij te dragen aan de instandhouding van vereiste kwaliteitsniveaus voor veiligheidstrainingen.

Agenda

WEGEMT 13th Graduate school

The 13th West European Graduate Education Marine Technology (WEGEMT) School will be held at the Delft University of Technology in the Netherlands from 23rd October-1st November 1989.
The subject of the two weeks course wil be:
'Design Techniques for Advanced Marine Vehicles and High Speed Displacement Ships'
WEGEMT
The West European Graduate Education in Marine Technology (WEGEMT) is an international foundation established in 1975 by 15 Universities from 10 West European countries. Its aim is to make available, through collaborative activity, short intensive courses (called Schools) through which engineers and postgraduate students in marine technology can update and extend their knowledge and skills. Since 1975 memberships has increased to 24 Universities from 12 West European countries and twelve very succesful schools have been organized on a wide range of subjects. Each School is usually organized by one member university but

many of the lectures are given by leading experts from other member universities, research organisations and the international marine industry. The course language is English and a comprehensive set of lecture notes is distrubuted to each participant. WEGEMT schools are run on a non-profit basis, financed mainly by fees from participants.

School organisers

The thirteenth WEGEMT School is organized by an International Steering Committee under the Chairmanship of Professor Dr. Ing. C. Gallin, Chairman of WEGEMT and Professor at the Delft University of Technology. The hosts for the school will be the faculty of Mechanical Engineering and Maritime Technology of the Delft University of Technology.

More information and brochure from: WEGEMT Graduate School, Delft University of Technology, Congress Office, Stevinweg 1, 2628 CN Delft, The Netherlands.

Training for maritime operations

A one-day seminar on 'Training for Maritime Operations', organized by MARIN and the Nautical Institute, will be held on June 20, 1989. The purpose is to discuss the implications for training standards and requirements in view of the virtual disappearance of national boundaries between the member countries of the European Communities in 1992.

Speakers will be invited to present papers to the seminar on the following topics.

- the current differences between national training standards,
- training for advanced ships,
- training for shiphandling under difficult conditions,
- training standards and future requirements in Eastern Europe,
- a modular approach towards task-oriented training,
- computer-aided instruction: an on-board training tool,
- equivalent qualifications for aviation and interchangeability of these qualifications,
- European maritime training policy,
- topics for discussion.

Additional meetings

More meetings are being arranged for the three days following the seminar:

– The Netherlands Institute of Navigation will host of a one-day meeting on June 21 to discuss and demonstrate simulators for the training of VTS operators at MARIN and simulators for the evaluation of advanced navigation displays such as path predictions and electronic charts at TNO.

– The next day, June 22, the International Maritime Simulator Forum (IMSF) will have its annual meeting and hold a workshop on 'Validation of Research by Simulation'.

– This will be followed by the IMSF executive meeting on June 23.

Except on June 21, the meetings will be hosted at the Royal Naval Establishment in Amsterdam by the Royal Netherlands Naval Academy.

There will also be a ladies' programme.

Registration

Those planning to attend can register for one or more of the meetings, which are to be organized in close cooperation by all the institutes involved. Registration for the ladies' programme is also now possible. Information on all these meetings can be obtained from any of the organizing institutes. More details will be provided by MARIN, P.O. Box 28, 6700 AA Wageningen. Tel: 08370-93911. Fax: 08370-93245.

ICHCA conference and General Assembly – 1989

The XIXth Biennial Conference and General Assembly of the International Cargo Handling Co-ordination Association (ICHCA) will be held May 29th-June 2nd 1989 at the Berns Congress, Stockholm, Sweden.

Hosted by ICHCA Sweden the theme of the conference 'From Confrontation to Co-operation' will anticipate the development of world transport in the nineties. This development will depend on our abilities to cooperate in many ways and on many levels; between transport operators and shippers, between transport operation representing different modes of transportation, between management and operational personnel and also on high political levels between nations in order to relieve some of the existing obstacles due to different rules and regulations.

Further details can be obtained from: ICHCA 19th Biennial Conference Secretariat, Box 27314, S-102 54 Stockholm, Sweden.

Diversen
Miscellaneous

Zeescheepsnieuwbouw krijgt bijna 400 miljoen gulden steun

Minister De Korte heeft voor de periode 1987 tot en met 1990 *f* 95 miljoen per jaar beschikbaar gesteld voor generieke steun aan de zeescheepsnieuwbouw. Dat blijkt uit een brief van de minister van 27 oktober aan de vaste commissie voor Economische Zaken van de Tweede Kamer. Het beschikbaar gestelde bedrag is bijna een verdubbeling ten opzichte van de voorgenomen uitgaven voor de periode 1987 tot en met 1989, waarvoor structureel *f* 50 miljoen per jaar beschikbaar was en waaraan later een incidentele overloop uit de jaren daarvoor van *f* 47 miljoen is toegevoegd.

Met de inzet van extra middelen worden de verhoogde percentages van de Generieke Steunregeling 1987 die gedurende een proefperiode van kracht waren, voortgezet. Met deze verhoging van 5% waren tot 1 februari 1988, het einde van de proefperiode, percentages van kracht oplopend van 5% voor orders van *f* 4 mln tot 19% voor orders van *f* 60 mln of meer. Gedurende deze proefperiode is voor *f* 900 mln aan orders verworven. De evaluatie van de proefperiode heeft uitgewezen dat de hoge percentages nodig zijn om orders te verwerven.

Kleine schepen

Door minister De Korte is bepaald dat niet alleen deze verhoogde percentages gaan gelden t/m 1990, het einde van de VIe Europese richtlijnen, maar dat ook het steunpercentage voor kleine schepen met 5% extra zal worden opgehoogd. Dit houdt in dat steunpercentages gaan gelden van 10% voor orders vanaf *f* 4 mln, oplopend tot 19% voor orders van *f*60 mnln of meer. Daarnaast wordt bestudeerd of voor projecten die een bijzondere toegevoegde waarde hebben een extra voorziening getroffen kan worden.

Nieuwbouworders

Doel van de Regeling generieke steun zeescheepsnieuwbouw is om in de jaren 1987 t/m 1990 voor *f* 2,6 miljard aan nieuwbouworders te ondersteunen. Met deze voorzieningen gaat minister De Korte ervan uit dat de Nederlandse zeescheepsnieuwbouwindustrie tot het aflopen van de VIe Europse richtlijn, eind 1990, een goede uitgangspositie heeft om de internationale concurrentie het hoofd te bieden.

(StCrt. 28-10-'88)

Barentszee voorlopig in goede Gezondheid

De Barentszee is nog steeds gezond, zonder giftige algen of olieverontreiniging, zeggen de wetenschappers die onlangs hun 16de en laatste reis in het arctische vaarwater in verband met het Noorse Pro mare project hebben gemaakt.

Pro mare – of liever 'Voor de zee' is één van de grootste maritieme onderzoekprojecten die ooit zijn uitgevoerd. Het werk heeft 6 jaar in beslag genomen en het heeft 30,5 miljoen gulden gekost. Een vijftigtal onderzoekers hebben in de loop van deze tijd de gelegenheid gehad te zien hoe de voedingsketen onder normale omstandigheden functioneert. Het zal dan gemakkelijker zijn de veranderingen, indien ze komen, te begrijpen en te weten welke schade kan ontstaan bij een verstoring van het ecologische evenwicht of bij olieverontreinigingen.

De definitie van een gezonde zee moet zijn: een zee die niet meer door de mensen is beïnvloed dan dat de biologische processen zonder verstoring hun gang kunnen gaan. Dit is het geval in de Barentszee, afgezien van het feit dat er teveel gevist wordt, zegt de leider van de laatste reis,

een wetenschapper op het gebied van aquatische biologie aan de universiteit van Tromsø.
Volgens één van de andere deelnemers, een microbioloog van de Universiteit in Bergen, W-Noorwegen, zal een olie-spuiter in de Barentszee nauwelijks zulke grote consequenties hebben als men tot nu toe heeft vermoed. Zelfs in de ijskoude Barentszee zijn behoorlijk veel bacteriën en ander organisch materiaal die de olie verteren, zegt hij. (norminform)

Nieuw zeekaartensysteem
De Noorse hydrografische karteringsdienst staat op het punt om het werk van navigators over de hele wereld volkomen te veranderen. Reeds in 1990 zal de papieren kaart vervangen kunnen worden door een elektronische kaart, die eenvoudiger te duiden is en die het manoeuvreren in moeilijk vaarwater veiliger maakt. Noorwegen heeft zich tot doel gesteld om een belangrijke schakel te zijn in deze ontwikkeling.
Enige dagen geleden presenteerde de Noorse hydrografische karteringsdienst een elekronisch systeem dat is ontwikkeld in verband met het z.g. Noordzee-project. Het project dat ongeveer 1,4 miljoen gulden gaat kosten wordt gesteund door de Noorse Raad voor Natuurwetenschappelijk onderzoek (NTNF) en het Directoraat voor de Scheepvaart. Het is één van de grootste projecten in zijn soort en maakt deel uit van een Europese samenwerking voor het oprichten van een test databasis voor elektronische zeekaarten.
Het nieuwe systeem dat overal grote belangstelling heeft gewekt, maakt het mogelijk om kaart, positie en radar te integreren. De kaarten rollen naar voren naarmate het schip zich voortbeweegt. Duiken er plotseling voorwerpen uit zee op, dan kan men met de verkregen inlichtingen een nieuwe koers programmeren. De schaal kan ook naar behoefte veranderd worden. Ook getijmodellen kunnen in het systeem opgenomen worden evenals bijzondere inlichtingen voor vissers. De kaarten worden bijgewerkt via satelliet.
De deelnemers van het project zijn behalve Noorwegen: Canada, België, Demarken, West Duitsland, Nederland, Zweden en Groot Brittannië. (norinform)

Welding and Metal Fabrication
The Publisher of 'Welding & Metal Fabrication', 'Welding Review' and 'Fab Guide' announces the launch of 'EUROPEAN FABRICATION NEWS' – a quarterly newspaper dedicated to the fabrication sector of the European engineering industry.
This new title from International Business and Technical Magazines is testimony to the publisher's continuing commitment to metals based engineering manufacture in which fabrication plays a key role. European Fabrication News, has been launched in October and will be of direct interest both to contract fabricators and to any engineering company in which metal construction forms an important part of its manufacturing operations.
In tabloid format, European Fabrication News will provide its readers with industrial news, features and product information on new equipment, materials and workshop supplies. The wide editorial scope will include metal preparation, cutting, forming, assembly, handling, joining and surface treatment.
More information from: R J Southgate, Editor, European Fabrication News, International Business & Technical Magazines Ltd, Queensway House, 2 Queensway, Redhill, Surrey RH1 1QS. England.

VERHUIZING
Het Algemeen Secretariaat van de NVTS en de Redactie van Schip en Werf zijn op 11 november 1988 verhuisd naar:
MATHENESSERLAAN 185
3014 HA ROTTERDAM
Het nieuwe telefoonnummer is:
010-4361042.
Fax: 010-4364980

NEDERLANDSE VERENIGING VAN TECHNICI OP SCHEEPVAARTGEBIED

(Netherlands Society of Marine Technologists)

Voorlopig programma van lezingen en evenementen in het seizoen 1988/1989

FORUMDISCUSSIE
De toekomst van het hoger maritiem onderwijs in Nederland.
wo. 30 nov. Aula T.U. Delft
(zie S en W no. 22 pag. 464)

GEZELLIGHEIDSAVOND
Vr. 9 dec. Amsterdam
(zie onder Verenigingsnieuws)

Praktijkervaring uit de internationale vaarwegmarkering en ontwikkeling
door capt. R. E. Behrend en ir. H. Keers van Allmarine, Rotterdam.
di. 13 dec. 1988 Groningen
wo. 14 dec. 1988 Amsterdam
do. 15 dec. 1988 Rotterdam.

Duiktechnieken en onderwaterwerkzaamheden m.b.v. de nieuwste generatie semi submersible supply vessels
door A. van der Meijden van NADO en N. van den Worm en E. Nielsen van Smit SOCON.
do. 15 dec. 1988 Vlissingen

CLUBEVENEMENTEN
di. 29 nov. **St Nicolaas**
di. 20 dec. **Kerstwildbiljarten.**

NIEUWJAARSBIJEENKOMSTEN
di. 3 jan. 1989 Groningen
do. 5 jan. 1989 Rotterdam
vr. 6 jan. 1989 Vlissingen

N.B. Dit programma zal in de komende maanden worden aangevuld en evt. gewijzigd.
De lezingen worden gehouden:
1. Bij de T.U. Delft in de Aula, Mekelweg 5, aanvang 20.00 uur.
2. In Rotterdam in de Kriterionzaal van het Groothandelsgebouw, Stationsplein 45, aanvang 20.00 uur.
3. In Amsterdam bij het IHTNO 'Amsterdam', Schipluidenlaan 20, aanvang 19.00 uur.
4. In Groningen in het Stadsparkpaviljoen, Palviljoenlaan 3, aanvang 20.00 uur.
5. In Vlissingen in het Strandhotel, Boul. Evertsen 4, aanvang 19.30 uur.

Alle lezingen in Rotterdam en Delft worden gehouden in samenwerking met de afd. MarTec van het K.I.v.I. en 'William Froude'.

VERENIGINGSNIEUWS

AFDELING AMSTERDAM

Gezelligheidsavond
Het bestuur van de Afdeling Amsterdam heeft het genoegen leden en begunstigers met hun dames uit te nodigen voor het bijwonen van een lezing met dia's op vrijdag 9 december 1988 te 20.00 uur in het Instituut voor Hoger Technisch en Nautisch Onderwijs 'Amsterdam', Schipluidenlaan 20 te Amsterdam.
De heer H. Bouwman, Oud-wnd. secretaris-rentmeester van het Hoogheemraadschap van Rijnland zal een lezing houden over het onderwerp

'Water, Ons een zorg'
Gewoontegetrouw ontvangen wij u met koffie vanaf 19.30 uur en zullen u in de pauze een drankje en hapje aanbieden.
Teneinde enig inzicht te verkrijgen omtrent het aantal te verwachten personen, verzoeken wij u vóór 1 december a.s. aan het secretariaat van de Afd. Amsterdam, Uw komst schritelijk te melden. Deze avond is een goede gelegenheid om het contact met de vereniging te verstevigen.
Namens het afdelingsbestuur
S. de Nobel, secretaris

Personalia

Hoofddirectie Smit Internationale N.V.
De Raad van Commissarissen van Smit Internationale NV heeft het voornemen met ingang van 1 maart 1989 de heer M. A. Busker tot Voorzitter van de Hoofddirectie te benoemen. De heer Busker is momenteel directeur van Shell Tankers B.V.
Het voornemen de heer Busker in de genoemde functie te benoemen houdt verband met de wens van de heer J. Groenendijk, die met ingang van 1 oktober 1987 tijdelijk de leiding van de Smit Groep op zich heeft genomen, per 1 maart 1989 terug te treden.

Ballotage

Voorgesteld voor het GEWOON LIDMAATSCHAP:

ING. H. J. F. J. ARNTZ
Directeur Expertise- en Taxatiebureau G. H. Arntz B.V.
Lodewijk van Deijssellaan 53, 1985 CH Driehuis
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Voorgesteld door R. P. Viersen
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Afdeling: Amsterdam

Eventuele bezwaren, schriftelijk binnen 14 dagen aan het Algemeen Secretariaat van de NVTS, Mathenesserlaan 185, 3014 HA Rotterdam.

ALGEMEEN SECRETARIS NVTS
De heer J. M. Veltman zal m.i.v. 1 december a.s. de functie van algemeen secretaris van de Vereniging overnemen van de heer P. A. Luikenaar.

LITERATURE SURVEY

Verzorgd door het MIC/CMO. Kopieën van de hier vermelde artikelen zijn tegen betaling verkrijgbaar bij: Nederlands Maritiem Informatie Centrum/CMO, Postbus 21873, 3001 AW Rotterdam, tel. 010-4130960, tst. 33.

SW88-12-01
Gas market developments in western Europe
Odell, P. R.
Energy Exploration Exploitation (00845). 8810, 6/5, pg-342, nrpg-19, tab-2. drw-5, ENG.
Prospects for the European gas markets are exellent because North Sea reserves are extensive, the distance to markets small and the latent domestic demand to replace uneconomic coal gas. Nevertheless, expansion in the gas trade has been modest because the industry has not been sufficiently assertive to dispel misconceptions about the adequacy of supply and to deal with pressure from competing energy interests. Increasing rivalry between suppliers can only lead to greater sales effort and the creation of demand, particularly for non-traditional end-users. Expansion of European gas market could be drastically increased through greater efforts by the Soviet Union to export. This could only happen with price competitiveness that would significantly expand gas markets.
There is every reason to expect that the natural gas share of the European energy market would continue to grow until it was the single most important component of western Europe's supply of energy. 0240126

SW88-12-02
Designs for buried pipeline can reduce seismic hazards
Whitelaw, J. A.; Reppond. D. W.
Oil & Gas Jrnl (02387). 8810, 86/42, pg-62, nrpa-7, gr-1, tb-1. drw-5. ENG.
Marine pipelines usually cross a variety of soil conditions, some of which could pose a danger when subjected to seismic movement. The more common ground-failure hazards associated with seismic events, including faults, liquefactoin, densification and landslides will be discussed in this article. Current design practices to limit seismic damage include locating the pipeline away from active faults, steep hillslides, and soft soils, increasing the flexibility of the system by use of more ductile materials and providing 'fail-safe' systems at sites where damage may be anticipated. 0620212

SW88-12-03
Platform monitoring as a tool for cost reduction
Svehla, K. M.; Elliot, P.
Cost Reduction in Offshore Engineering (70679). 8802, pg-53, brpg-14, gr-4, tab-2, drw-2, ENG.
Offshore platform design is more conservative than is the case for onshore structures. This is necessary because of the high cost of failure coupled with the considerable uncertainty in defining the applied loading and the structure's response. The best way to reduce this uncertainty is to monitor the actual behaviour of platforms. The benefit of such monitoring can far outweigh its cost. With increased confidence less conservative designs can be produced without increased risk. Savings can be made both in modifications to the original installation and in the design of future platforms. 0610412.

SW88-12-04
Cost effective structures for the North Sea
Heaf, N. J.
Cost Reduction in Offshore Engineering (70679). 802, pg-41, nrpg-12, gr-1. drw-4, ENG.
The present lower oil price regime has forced both the offshore operators and design contractors to look more critically to the costs of offshore oil facilities. Since the largest individual proportion (30%-40%) of the cost is in the structure of such facilities, a large burden of responsibility for identifying and developing cost effective solutions has fallen upon the offshore structural engineer. 0630410.

SW88-12-05
Some aspects of the removal of offshore production platforms
Penney, P. W.
NE Coast Inst. of Eng. & Shipb. Trans. (03350). 8809, 104/4, pg-129, nrpg-13, gr-3, tab-2, drw-6, ph-8, ENG.
Future progress with platform removal awaits two major developments: the publication of UK Regulations, and the requirement to actually remove one of the larger platforms. Several paper studies have been done and present indications are that companies will opt for piecemeal dismantling rather than ultra heavy lifts using semi-submersibles. Other proposals include flotation devices and converting VLCCs into something akin to a gaint fork-lift truck. Until the end of this century the demand to remove any of the larger platforms seems unlikely to exceed half a dozen, but thereafter, as the pace quickens and more service vessels are demanded, the situation may arise where platforms will have to be dismantled more rapidly. It is then that alternative schemes will be considered more enthusiastically as a major removal and onshore reception industry develops. 0620116

SW88-12-06
Environmental conditions
Ewing, J. A.; Glen, I. F. ; Kieldsen, S. P.; Labevrie, J.; Ochi, M. K.; Quayle, R. G.; Robinson, D. W.: Takaishi, Y.; Truijens, P. E. J.
Int. Ship Structure Comm. (73350). 8808, 1/1, pg-3, nrpg-90, gr-20, tab-1, drw-9, ENG.
Concern for the description of the ocean environment, especially wave current, wind and temperature statistics, in deep and shallow waters, as a basis for the determination of environmental forces for structural design including some consideration on marine growth. Consideration also to be given tot statistical descriptions of ice and earthquake phenomena relevant to design of ships and offshore structures. 0120330.

SW88-12-07
Use of radioactive tracers for detecting cracks in steel structural welds in seawater
Jones, J. E.; Natalie, C. A.; Burns, M.
Welding Jrnl. (03620). 8809, 67/9, pg-47, nrpg-7, gr-2 tab-5, drw-4, ENG.
This report summarizes the feasibility of a system where, during fabrication, a radioactive tracer is included in the interior passes of a multiple pass weldment, but not in the outer cap and root passes. The feasibility has been examined using only chemical tracers.
When a stress corrosion or corrosion fatigue crack penetrates through these outer passes and into the tracer-laden interior passes, the tracer will be released into the adjoining seawater environment setting off a detector. With the proposed technology, a radiation detector would be capable of detecting the presence of corrosion in exposed cracks that penetrate beyond a predetermined critical depth and, thus, warrant repair. 0630512.