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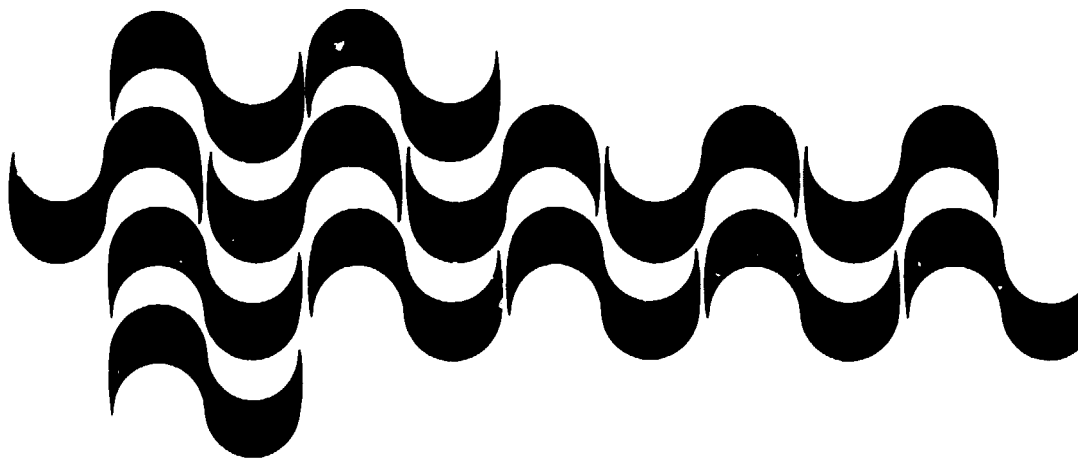
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MARINE INDUSTRIAL TECHNOLOGY MONITOR



High speed vessels for transportation

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1. Introduction

The purpose of this article is to give a brief introduction to the relatively new field of high speed vessels. Lately, the attainable speed at sea for commercial purposes has increased from 30+ knots to 60 knots. The technology is developing very fast and new entrants are frequent. Approximately US\$ 200 million per year is currently (1983) spent on high speed vessels (HSVs) for civilian use, but the potential is by some estimates US\$ 2 billion per year.

The possible uses of the new technology are many, for instance public transport in coastal cities, inter-city commuter connections, day cruises for tourists and the transportation of time-critical cargoes. In particular, HSVs may prove to become a viable alternative to air transport. They are also suited for use in areas where the existing transportation infra-structure is weak, that is, where neither roads,

railways, nor airports exist to efficiently handle coastal or river transport demands. Rapid boat service may provide a flexible and low-investment alternative to expensive, and sometimes impractical, land construction. Such a service has, however, proved to be economically feasible even in areas with relatively good alternative communication, simply because it has the highest transport efficiency.

This article will provide a description of the different technological concepts used and a discussion of their benefits and disadvantages. Thereafter, a discussion follows on the possible uses of these vessels. Finally, there will be a brief summary of the market outlook for high speed vessels.

2. Description of technologies

Several different concepts have been used in the production of high speed

vessels. The following is a brief description of these varieties of solutions and a discussion of their advantages and disadvantages. Figure 1 illustrates the various technologies.

Air supported

These vessels use pressurized air to lift themselves out of the water and thus minimize water resistance.

The Air Cushion Vehicle (ACV) moves on top of the waves with no structure submerged. This leads to minimal friction loss and wave making resistance. The ACV has the potential of diminishing the effect of the sea-state on motion characteristics, but a serious problem has proved to be the engine vibration and the noise from the fans used to create the air cushion.

The Surface Effect Ship (SES) partly utilizes the ACV principle. However, it is a combination with the catamaran concept, where the air cushion is used

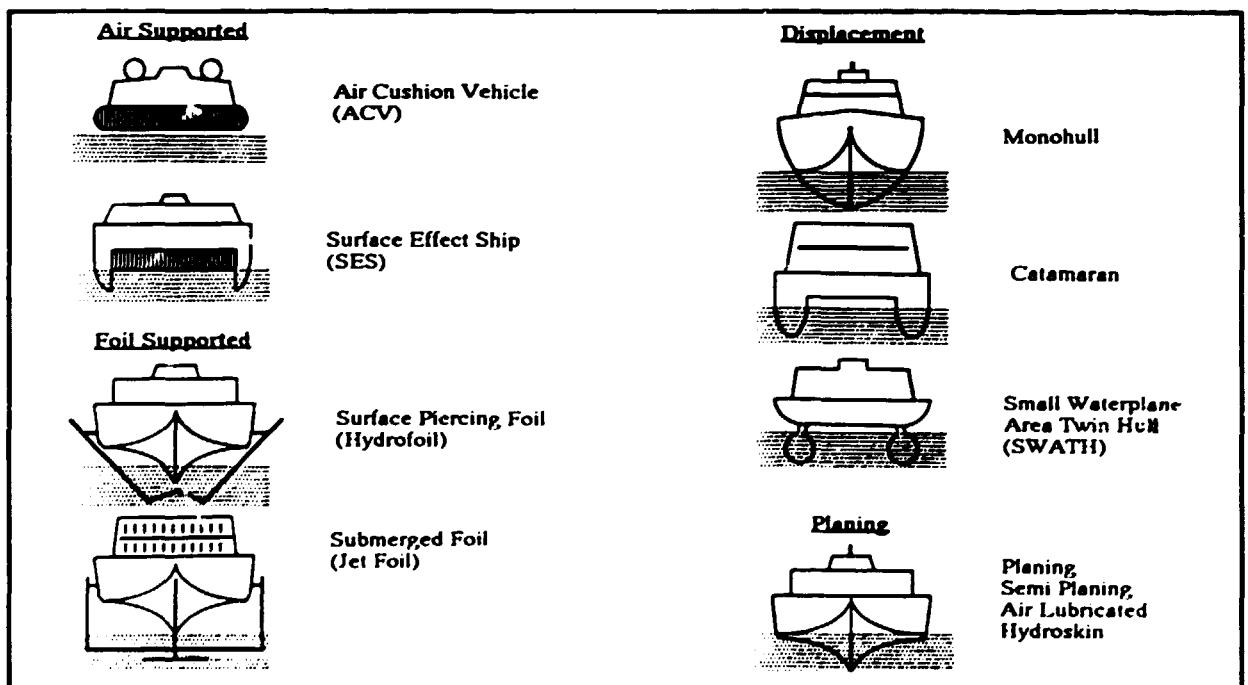


Figure 1: Different concepts for high speed vessels.

Table 1: Features of various concepts for high speed transportation

Boat type	Positive qualities	Negative qualities	Critical parameter for service restrictions
Mono hull	Deadweight Operation in high seas Costs	Propulsional resistance	Bow height
Catamaran	Deck area Stability Speed performance	Ocean-going characteristics	Air gap Forebody buoyancy
SWATH	Deck area Motion characteristics	Deadweight Stability	Air gap
Hydrofoil	Speed performance Motion characteristics	Deadweight Ocean-going characteristics	Distance between foil and keel
ACV	Speed performance in still water Draught during operation	Wave and wind sensitivity Deadweight Fange restriction	Air cushion leaks
SES	Speed performance Deck area	Wave and wind sensitivity Deadweight at full operation	Air cushion leaks Air gap Forebody buoyancy

to lift the vessel partly out of the water, while the hulls are somewhat submerged. One advantage with the SES is that it can be used at variable air pressures and even operate with total loss of air pressure.

In terms of operating advantage, the SES becomes more plausible due to its excellent speed performance in the 30+ knots range. However, the power needed to maintain operating air pressure at high loads becomes very expensive at high displacements and the SES becomes less feasible. In addition, the power requirement and subsequent fuel-consumption limit the range significantly. ACVs are even less advantageous at higher loads due to the large excess power needed to maintain air pressure.

Foil supported

These vessels use dynamic water pres-

sure to get a lift-up from the water. As the vehicle picks up speed, the foil receives increased pressure from the water. This is used to create a force that pushes the vessel upwards. The resistance from waves and friction is thus reduced. While the air-supported vehicles use static pressure to lift the vessel, the foil-supported ones use a dynamic pressure to accomplish the same.

The hydrofoil uses a foil that 'glides' on, or pierces, the surface. The hydrofoil has excellent speed characteristics at low loads (at least in quiet waters). However, with increasing weight or speed the pressure on the foils increases so much that this concept becomes more costly, due both to structural integrity and loss of effect.

On the jet foil the foils are entirely submerged. This reduces resistance significantly, but these vessels have

severe stability problems in addition to those experienced by the hydrofoil. Complicated, costly and still inefficient foil steering systems have had to be implemented in order to overcome these problems.

Displacement

Displacement vessels simply exploit the principles of Archimedes, where the upward force equals the weight of displaced water—there is only a negligible dynamic lift. Generally, displacement vessels show a superiority in potential payload but inferiority in water resistance.

Mono-hull is the traditional hull type used for all kinds of surface vessels, consisting of a single hull to provide buoyancy. These shapes are generally considered to be superior at large displacements and at low speeds. In the range from 20 to 30 knots the propulsive resistance grows increasingly more rapid and so the usefulness of the mono hull diminishes in this range. It is claimed that 40 knots is the upper practical limit for displacement mono-hull ships (Graham, 1985).

In the catamaran the buoyancy is provided by two hulls. This solution addresses some of the problems of the mono hull—particularly motion characteristics. Also, even though the wetted surface is larger, the wave making resistance is smaller on the catamaran than on the mono-hull. In addition, the catamaran makes it possible to increase the deck area cheaply. The catamaran has generally a higher construction cost than the mono-hull.

The Small Water Area, Twin Hull (SWATH) has almost all its buoyancy placed in two pontoons. These pontoons are connected to the vessel through 'thin' connections, which add little buoyancy and thus the motion of the SWATH will be less affected by the sea-state. Even though this is the solution with the largest wetted surface (and therefore largest frictional resistance), the wave making resistance is slight. The speed performance may therefore be almost as good as that of the catamaran.

The main disadvantages with this concept are the stability problems and

Table 2: Suggested relationship between speed, displacement and concept

Displacement (tonnes)	Speed (knots)		
	0-30	20-40	40-60
0-500	Mono hull	Catamaran SWATH SES	SES Hydrofoil
500-1000	Mono hull	Catamaran SWATH SES	SES Hydrofoil
1000-5000	Mono hull	Catamaran SWATH	SES

(Source: Rygg Johnsen, 1988)

subsequent payload limitations.

Planing

Planing crafts use the principles of dynamic lift to reduce the submerged part of the vessel. However, in contrast to the hydrofoil, planing crafts have the force transmitted directly to the hull. The main disadvantage of this solution is that the maximum engine power is used in the transition between 'normal' mono-hull behavior and 'planing' behavior. Therefore, excess engine power must be installed purely for the sake of making the vessel plane. For this reason planing crafts are mostly used for smaller leisure vessels.

Other

HyCat, or hydrofoil-catamaran is a hybrid based on a catamaran with a foil between the two hulls. Apparently, this technology successfully combines the best features of both without compounding the worst.

The wave piercing catamaran is a new Australian design where the hulls on the catamarans are redesigned to 'cut through' the water rather than push it away. This concept seems to have taken the lead in the market for larger ferries, particularly in the car-ferry market.

The monostab concept uses foils at the aft on a mono-hull in order to increase stability. In addition, these foils are used to alter the angle of incidence in the water, enhancing the planing characteristics of the craft.

Technological trend

Motion characteristics are particularly important when using high speed ferries to transport people primarily because of the importance of health and comfort considerations, but also for transporting cargo with a minimum of damage.

Table 1 lists the pro's and con's of the different technological solutions. Table 2 presents the concepts in relation to the speeds and loads at which they are perceived to be advantageous. It must be noted that these tables only give a rough indication of the suited technologies. Operating range and sea-state are two additional important

factors to play a role in the selection of a concept. New hybrid concepts, like the HyCat and the Incat (International Catamarans Inc.) wave piercing catamaran, are not accounted for here.

At present the largest HSV in commercial use is the wave piercer with a length of 71 metres and the ability to move at 42 knots. Of HSVs constructed or on order in 1988, catamarans were the most, comprising almost 75 per cent of the market (Brett, 1988).

The trend seems to be towards larger and faster vessels. However, it is suggested that the ferry market will mainly require two categories of vessels:

- 15-25 metres, carrying 50-200 passengers; and
- 40-45 metres, carrying 300-400 passengers.

The main considerations to take when evaluating HSVs in the future are suggested by Holden (1989):

- Needs for higher speeds, 55-65 knots;
- Low fuel consumption;
- Large demands on comfort, motion, noise and vibrations; and
- High reliability.

Producers tend to specialize in types of vessels. There seems to be a widespread belief in the industry (apart from Norway, Sweden, Italy and Australia) that the mono-hull has the most feasible design because of low costs and superior behaviour. In addition, several other designs, like SES and the hydrofoil, are occasionally referred to as technologically difficult (and thus more susceptible to operational difficulties).

However, producers in Norway and Sweden are on the move towards SES and HyCat designs. It is thought that the development of cheaper, lighter and more efficient gas turbines will make the SES more competitive. The major producer in Italy, Rodriguez, seems to have a steadfast belief in the better seaworthiness of the hydrofoil.

The wave piercer, winner of a new speed record and the 'Blue Ribbon' between New York and London, is also considered interesting, particularly by producers in Australia and New Zealand.

3. Uses of HSV Cargo transport

Perishable goods are an obvious market for high speed transportation. With a sufficiently large market, not necessarily for the same goods or the same geographical location, the introduction of fast vessels is likely to bring benefits. For instance, if meat, fruit, and fresh fish can be shipped in the same vessel, the opportunities are many.

Perishable goods are mostly fresh foods that exhibit quality reduction over time. Examples of such foods are fresh fish, particular kinds of fresh fruit and meat. The problem of decay is currently addressed by the seller through fast shipment, through the use of preservatives, or simply through price reduction according to loss of quality.

Fast shipment over longer distances usually means shipping by air – an expensive alternative. For instance, fresh salmon from Norway to the United States presently go by air at a rate of approximately US\$ 2 per kg. Air transport is also used for fish from Colombia and Costa Rica to the USA, and from Alaska to the rest of the country. Meat, for instance, is sent from Argentina to the European Community by plane.

When noting that fresh fish is generally sold at a price at least twice that of frozen fish it becomes clear that large savings and increased volumes are possible through the use of fast vessels. This is particularly true in warmer areas where refrigeration costs become large.

The aim in the market of perishable goods may be to challenge the air-freight market for such goods (which from Europe to the United States require a freight rate of approximately US\$ 1,500-2,000 per ton). In addition, where road and railway systems are deficient or time-consuming, there is a good chance that HSVs will be competitive.

The vessels may go along routes where (1) the number of ports visited depends on whether there is cargo at the port; and (2) the route may change quite rapidly depending upon the longer term fluctuations in transporta-

tion demands. This justifies the utilization of ships where the speed is variable so that the operator can pick up cargo where there is a demand and be free to plan the routes according to the changing patterns.

Even though the volume from one source is too low to justify a profitable route, there are three factors to consider that apply to most instances (return cargo is, however, an important concern):

- There are normally several sources in the same geographical region. In Northern Europe producers of fresh fish are for instance found in Norway, Iceland, the Faroes, the Orkney islands, Greenland and the Shetland islands.
- Decreased prices and increased availability will most certainly increase consumption, thus increasing shipped volume.
- Cargo can be mixed for one journey, i.e., shipping frozen and fresh fish at the same time.

Ferries

Successful transportation of people and cars by high speed vessels is now mostly limited to Europe and North America, in addition to isolated places in East Asia, in particular Hong Kong, and the Pacific, like the Hawaiian islands.

There seems to be a good possibility that HSVs will be increasingly employed in inter-city transportation. Wahl (1988) suggests a current break-even distance of 75-100 miles between HSV and commuter aeroplanes. With faster and more economical vessels this measure will increase.

On straight stretches it appears that HSVs are not competitive with rail, buses and cars. In other words, running 'in parallel', HSVs are not as efficient as other means of transport.

Thus, HSVs are best employed where road and rail conditions are bad, where mainland transport is lengthy as compared to the sea way, where traffic is congested, or to and from islands.

The sea is becoming an increasingly attractive vacation target. With increasing wealth in Europe, people are likely to seek enjoyment at sea. A large num-

ber of routes exist, but only in a few places are HSVs utilized.

The countries around the North Sea have increasingly promoted the 'Arctic experience', like the Norwegian 'Hurtigruta'. The ships used now are mostly slow and un-economical, and will probably be replaced by HSVs.

The Baltic Sea has so far been quite sheltered from tourism. However, with the changes in political climate and with the heavy population around this sea, the area will probably experience fast growing tourism. To various islands, for instance Gotland and Öland, HSVs are already employed as means for transport.

The Mediterranean has heavy sea-going traffic during the tourist season. For instance, the Greek islands have a high volume of tourism where the only alternative to slow ships is airborne transport. Particularly in Greece, but also in Turkey, higher speed will force its way into the market. Italy has already a well established system of HSVs along its coast.

With increasing pressures upon public transportation systems in the USA, it is likely that coastal cities will move towards seaborne mass transport. A study for the US Department of Transportation concluded that six out of 13 areas studied showed economic feasibility for HSVs (for instance, the San Francisco Bay area, New York area, Boston area, and Miami).

The problem in the Caribbean is the sea-state. With a development towards vessels showing better qualities in rough seas, HSVs may prove to be efficient in the Caribbean.

Most of the HSVs in the United States today are used for transporting tourists (sightseeing and diving vessels). The market seems appropriate for day cruises in, for instance, California (San Diego, San Francisco), Florida (Miami), New England (New York and Cape Cod), the Caribbean (Bahamas), and Hawaii.

The introduction of HSVs in Africa have mostly come to a halt due to operational problems. HSVs may however be good alternatives to roads and railways along the coast where these do

not exist already. Road and rail construction is very expensive compared to the investments needed for HSV services.

River transport may be attractive, provided the draught is not too deep for use during the dry season.

Several of the larger cities in the Far East and Oceania have utilized HSVs in public transport for quite some time. Hong Kong, Singapore and many Japanese cities have a well equipped network. The producers are currently mainly Japan and Australia, but New Zealand, China and South Korea are now entering the industry.

For commuter transport, the focus in Asia will probably be in Japan, the Philippines and around Indonesia, while tourist transportation may be interesting around the many island groups, for instance, Hawaii, Fiji and in the South China Sea.

Little has happened in the HSV area in South America. Some failed attempts have been made to introduce them on Lake Titicaca, and some more successful ones around Rio de Janeiro.

4. Entry into the market

Markets where there is a domestic production of HSVs are very closed to foreign competition. Thus, a new entrant will need to focus on the following:

- Investigate identifying markets where there is little prospect of an efficient home industry (little ability, or experience, in boat-building);
- Study the possibility of selling on the domestic market during the starting phases of development; and
- Examine the possibility of establishing licensing agreements with producers that have large domestic markets, for instance in the USA.

All in all, approximately ten countries are seriously involved in building smaller HSVs. However, Australia (catamarans), Italy (hydrofoils), Japan (hydrojetfoils), and Norway (catamarans, SESs) are leaders in the field.

It is clear that three important factors exist for countries that have a well developed HSV industry:

- There is a large domestic market;

- The domestic market appears protected from foreign competition; and
- There are elements of subsidization.

The major part (approximately 80 per cent) of HSVs are operated in Europe and Australia. However, there are growing markets in North America and in the Far East.

Table 3 shows the most important producers and consumers of high speed vessels from 1956 to 1987. The data are gathered from Holden (1989) and Trillo (1987).

For the selection of 'high speed ferries' minimum of 25 knots and 50 passengers is used as a criterion. Nations with more than 10 crafts produced (by 1987) are listed.

The most interesting observation is that nations with a developed domestic industry tend to be very protectionist in the HSV market. Thus, it may be expected that countries willing to enter the HSV market will close their domestic markets to foreign competition.

There seems to be a move from East Asian (South Korea, Malaysia and China) producers to establish their own HSV industries. Due to their lower labour costs and often high productivity, these nations will probably be able to produce cheaper vessels than in Europe, North America, Japan, or Australia. Thus, other producers may compete on the basis of:

- Sheltered home market;
- National subsidies;
- Licensing; and
- Keeping a technological edge.

Sheltered home markets seem to be common for countries that have a somewhat sizeable HSV industry. It is hard to determine whether the industry has grown due to the protection, or vice versa. However, it is likely that European builders will lose this established protection after 1992. (Of course, in the longer run other nations may be forced to abandon protectionism as well.) A home market will probably remain important, though since a good part of the dominance of domestic producers in the domestic market is a matter of preference for national goods.

National subsidies are disappearing,

Table 3: Tabular representation of producers and consumers until late 1987

Country	Product (number produced)	Producers	Number in operation (foreign/total)
Australia	Catamaran (63) Mono hull	NOF&A (Incat) International Catamaran Design (Incat) n.a.	7/37
Brazil			11/11
China (PRC)			25/25
France	Mono hull (18)	n.a.	10/17
Greece			23/23
Hong Kong	Catamaran (11)	A Fai (Incat design)	72/72
Italy	Hydrofoil (141)	Rodriguez	17/76
Japan	Hydrofoil (63) Catamaran (18)	Hitachi Mitsui	4/146
Norway	Catamaran (102) SES (13)	Fjellstrand A/S Westamarin A/S Brodrene Aa	5/53
Poland			11/11
Singapore	Catamaran (11)	n.a.	n.a.
Sweden	Catamaran (15) Mono hull (11)	Marinteknik n.a.	n.a.
Turkey			10/10
United Kingdom	SES/ACV Catamaran	Hovermarine Ltd. Aluminium Shippers	8/10
USA	Hydrofoil (28) Catamaran (25) Mono hull (12)	Boeing Nichols Brothers n.a.	6/23
Yugoslavia			11/11
Total	Catamaran (263) Hydrofoil (237) SES/ACV (156) Mono hull (81)	25 companies; 12 countries 7 companies; 5 countries 15 companies; 10 countries 22 companies; 10 countries	

(Source: Trillo, 1987, and Holden, 1989)

- Listed countries owning 1) or more HSVs. The total includes other countries as well.
- The category 'hydrofoil' includes jet foils.
- The category 'catamaran' includes SWATH.

at least in Europe, and will certainly become less common after 1992.

Licensing of technology is quite widespread in the HSV market. Such licensing is particularly common with builders having superior technological know-how and good design traditions. It is difficult to see whether the licensee only uses these agreements in the intermediate period between entry into the market and development of in-house design capabilities, or whether this is a comfortable long-term position for the shipyards. In any case, this is one method of getting maximal benefit from superior designs before competitors have caught up with them.

To maintain a technological advan-

tage companies need to invest a good part of their turnover in R&D and design. Marintek (1988) gives expenditures in design for the United Kingdom, Norway, and Australia, where the share of the total costs are 15-20, 10, and 5-10 per cent, respectively. The same report indicates that up to 20 per cent of the turnover is channeled to R&D.

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General

Over the horizon

Cheaper wave power may be possible after a team of engineers from Queens University of Belfast, Northern Ireland, tested a new wave power plant. The plant, the simplest yet to be presented, uses approaching waves to generate a pressure and an outward air-stream to drive a two-way electric generator. However, receding waves generate a vacuum and an inward air-stream, reversing the generator. The air-driven turbine generator produces electricity whichever direction of air-flow. The pilot plant, located at the Scottish island of Islay, is expected to produce an average of 40 kilowatts.

The unique feature with this power plant is that it is technologically relatively simple, it can be placed in a variety of environments and units can easily be added based on local demand.

The EC (European Community) Commission has for the first time included wave power among alternative energy sources earmarked for research funds in 1991. Norway, the United Kingdom, India and Japan have also committed new funds. (*International Herald Tribune*, 27 September 1990.)

Marine biotechnology has been identified by Japan as a possible basis for economic growth in the 21st century. The Japanese Government, industry and academe have joined forces to position themselves as world leaders in marine biotechnology. Two or three institutes to be created have been promised 26.8 billion Yen (US\$ 200 million) over the next decade by the Japanese Ministry of Trade and Industry (MITI) and 24 industrial partners. Furthermore, the Ministry of Agriculture, Forestry and Fisheries (MAFF) and the Science and Technology Agency are moving to build new facilities and support research.

The 24 industrial partners, including Japanese companies in petroleum, steel, liquor, food, chemical, construction and ship building industries came

together in 1988 to form a consortium for establishing the Marine Biotechnology Institute Co. Ltd (MBI). (*Sea Technology*, March 1990, Page 78)

Conferences

The Offshore Technology Conference (OTC) and Exhibition will be held in Astrodomain, Texas, USA, 6-9 May, 1991. Fast sea transportation is the theme of a conference being organised in Norway, named Fast '91, to be held at the Norwegian Institute of Technology in Trondheim, 17-21 June 1991. The topics are expected to include design, construction and operation of high speed vessels, propulsion, safety, seakeeping and transport economics. Further information may be requested from:

Fast '91, Department of Marine Technology, Norwegian Institute of Technology, 7034 NTH-Trondheim, Norway.

The Second International Ocean Technology Congress (IOTC) is to be held in Glasgow, Scotland, UK, 18-20 June, 1991. The discussions and technical papers are expected to focus on the 'balance' between ocean space development and utilization and ocean conservation. Possible topics include renewable energy, living and non-living resources, waste management, space utilization, transportation, environmental assessment, and case studies that reflect the balance between development and conservation.

Further information may be requested from:

IOTC Organizing Committee, 9 Royal Crescent, Glasgow G3 7SP, Strathelyde, UK or Strathelyde Regional Council, Business Development unit, 20 India Street, Glasgow G2 4PF, UK.

Society of Naval Architects and Marine Engineers (SNAME) 1991 Annual Meeting and International Maritime Exposition to be held at the New York Hilton Hotel, New York, USA, 13-16 November, 1991.

Transportation

New fast catamarans are being

developed in Norway. The series of five 21-metre vessels is designed to carry 70 passengers or seven tonnes of cargo and three tonnes of fuel at a speed of 55 knots in one metre waves. Behind the project are CPS Drive AS of Oslo and businessman Jorgen Selmer. The vessels are to be produced in series with the same basic deck structure, to which will be added superstructures for ferry, excursion, container transport, luxury yacht or military and coastguard applications.

CPS argues that the design's combination of high speed and low draught will open up new markets and "completely change the patterns of transportation around the world." Examples include long distance ferry routes in countries like Indonesia and container delivery direct to the shore in areas where there are no handling facilities. (*Fast Ferry International*, June 1990, Page 9.)

A new speed record by a commercial craft was set for the trans-Atlantic route between New York and Bishop Rock in England by an Incat (International Catamarans Inc., Australia) wave piercing catamaran, the SeaCat. *Hoverspeed Great Britain* covered the 3,000 miles in three days, seven hours and 54 minutes, yielding an average speed of 38 knots. At 74 metres in length and 26 metres in beam, the SeaCat is not only the world's largest catamaran, but also the first of this size capable of carrying cars as well as passengers.

Hoverspeed Great Britain will be joined by two other SeaCats to take over Channel traffic from the hovercrafts (air cushion vessels) used by Hoverspeed so far. Aside from higher capacity, the new vessels will offer advantages in reduced engine noise and vibration as well as good seakeeping and stability. The economics of the SeaCats is also advantageous - at a cost of US\$ 15.4 million per vessel, lower maintenance costs, and a substantially better fuel economy than the hovercrafts.

The SeaCat is regarded by many as very promising for the future, and Incat is optimistic. The company has already

produced designs for wave piercers of 100 metres or more, intended to have a capacity of around 800 passengers and 300 cars. (*Marine Engineers Review*, July 1990, Pages 14-15.)

Eight wavepiercers have also been ordered by TNT Shipping, including four 64-metre vessels capable of carrying 300 passengers and 60 cars at cruising speeds of up to 35 knots. The additional vessels will be picked from a selection of 64, 79 and 91 metres with a capacity of 300-800 passengers and 60-170 cars. (*Small Ships*, July August 1990, Page 5).

A novel ship stabilization system has been provided for the 37 metre ferry Monostab. The result of co-operation between Canteri Navale Rodriguez of Italy and Dornier and Deutsche Aerospace company of Germany, the Monostab concept is said to be suitable for fast ferries where high speed, passenger comfort and high efficiency are priority requirements. The mono hull vessel is fitted with two 'hydrofoils' and activators that will direct the foils to optimize stability. Furthermore, a controlled lift system at the stern is said to offer excellent roll stability and help reduce drag, giving Monostab a maximum cruising speed of 35 knots. The new concept may give a new boost to the promoters of mono hulls for fast vessels. (*Marine Engineers Review*, April 1990, Page 56.)

Magnetic Hydrodynamic (MHD) propulsion, for decades a theoretical opportunity, are now becoming a practical one. The US Department of Energy's Argonne National Laboratory is to perform tests on MHD, aimed at removing all moving parts of the propulsion system, reducing the noise level and increasing reliability. MHD works in the following way: Seawater enters a duct and is the medium for an electric field, a field made possible by the salinity of the water. A magnetic field is produced by an electro-magnet surrounding the duct, thus exerting a force on the water and 'jetting' it out of the duct.

The emergence of superconductors

have incited several initiatives in the field, and 'hot' superconductors may make the systems economically as well as technologically feasible. At the present, MHD systems are very inefficient due to the enormous power needed to produce the magnetic fields.

Among several commercial applications, the possibility of using MHD, which may become virtually soundless, in propelling marine biological research vessels stands out due to the need for minimal disruption to underwater life. (*Sea Technology*, January 1990, Page 71).

MHD is also in focus in Japan, where a 150 ton displacement vessel propelled with MHD was launched. The experimental vessel has a propulsive force of total 16,000 Newtons and is expected to achieve speeds of eight knots. Even though the efficiency of the propulsion system is very low and the weight to-power-ratio very high, the experimental craft is expected to be crucial in gaining knowledge in practical use of MHD. The Japanese vessel is the first one to be entirely powered by MHD. (*Marine Engineers Review*, July 1990, Page 10).

Still in Japan, the shipbuilder Mitsubishi Heavy Industries (MHI) has received an order for a 200-passenger craft that aims to eliminate pitch and roll, the main causes of seasickness. The passenger cabins of this 26.5 metre craft are separated from the hull to isolate them from wave motion. "The cabins are arranged on hydraulic cylinders and universal joints mounted on the main hull. The ship's wave oscillations ... are automatically sensed and the hydraulic cylinders activated by computer control to dampen the movements and to maintain the cabins on a level plane." (*Marine Engineers Review*, June 1990, Page 6).

Solar propulsion? The German company Systec in collaboration with the German Ministry of Research and Development and the Konstanz High School are working on a design for a small solar powered craft. Solar propulsion is already implemented in a

7.2-metre test boat, *Korona*, capable of achieving a speed of 6.5 knots with a 9 m² solar cell area and 10 12-V batteries in series with a capacity of 105 Ah.

Although the technology for marine solar propulsion remains on a small scale, the potential exists for solar energy to fill an auxiliary role on larger vessels. Particularly in areas close to the Equator the solar cell propulsion may be feasible – even more so with the expected lowering of prices of such cells. (*Marine Engineers Review*, February 1990, Page 28).

Safety/environment

A new system aimed at preventing small vessels from capsizing, the Seabass system, is being tested on several vessels. Seabass consists of a series of buoyancy bags fitted around the vessels. In the event of danger of a capsize, the buoyancy bags can be inflated with helium virtually instantaneously, thus stabilizing the vessel.

The system can be used for smaller vessels, like fishing vessels, as well as larger transportation vessels, like Ro-Ro (Roll-on – Roll-off) ships. Seabass Ltd. of the UK claims that the system increases intact stability by 500 per cent and damaged stability by as much as 5,000 per cent. The bags are made from nylon or kevlar, depending on their size. (*Marine Engineers Review*, July 1990, Page 27 and August 1990, Page 5).

Two inventions have been patented in Norway, proposing alternatives to double bottom hulls in oil-tankers. After the Exxon Valdez accident in Prince Williams Sound in Alaska tougher regulations have been implemented in the United States requiring a phase-in of double bottom hulls in tankers serving US ports, significantly increasing hull construction costs. The inventors contend that cheaper ways exist to prevent disasters like Exxon Valdez happening in the future.

One concept, IDB (imaginary double bottom), involves the use of specially treated seawater in the tanks. Since oil has a specific gravity less than seawater, the water phase will lie on the bottom of the tanks, providing a 'plug' in case of tank rupture. One year's supply of

the chemical is estimated to cost US\$ 100,000 but additional expenses will be incurred in modifying existing vessels. Furthermore, cargo capacity may be reduced by as much as 10 per cent.

The other invention is called the oil spill recovery system (OSRS) and enables oil to be safely collected in a large fabric container in the event of a spillage. In the event of a grounding or collision, the oil collection container is launched over the side of the vessel and oil from the damaged tanks may be pumped into the container. The system is estimated to cost US\$ 1,000,000. (*Marine Engineers Review*, August 1990, Page 6).

Promising Swedish tests with a new waterspray system to fight engine room fires may produce an alternative to existing fire-fighting methods. Current methods include CO₂ and Halon gases, both damaging to human safety, low pressure foams which are only effective in local fires and high-expansion foams that would probably suffocate people present in the room. Tests show that the waterspray system will not damage injured crew, while damage to the electrical systems will be minimal. "The experience can be likened to being in a very heavy downpour of rain." (*Marine Engineers Review*, August 1990, Page 12).

IMO regulations. MARPOL 73/78, Annex V, dealing with disposal into the sea of garbage generated aboard ships is the most recent IMO requirement to be implemented. The regulations establish strict controls over such disposal, particularly in areas close to the shore and even more so in 'special areas'. The IMO Marine Environment Committee has identified the Mediterranean, the Black Sea, the Red Sea and the Arabian Gulf as such 'special areas'. Within these areas, the discharge of anything but food waste is prohibited and in any case no discharge is allowed within 12 nautical miles from land. (*Lloyd's Ship Manager*, March 1990, Page 49).

Propulsion

A hydrostatic transmission, par-

ticularly for use in high speed crafts, has been developed by the Swiss company Hydromarine in conjunction with Canteri Navali Rodriguez of Italy. The new system, used in some of Rodriguez' hydrofoils, utilizes fluid with very slow flow (0.05 m/s) and high pressure (up to 280 bar) to transfer power from engine to propeller. Among the several advantages to using this system rather than mechanical or hydrodynamic ones are the quick transfer of engine power to torque; it removes the propeller shaft and its associated bearings (critical components of the propulsion system); it reduces the size of the engine needed to drive the system and it reduces noise and vibration from the propulsion system. In addition, loss of effect is minimized due to the slow flow of liquid.

The new transmission, tested on a Rodriguez hydrofoil, led to a 50 per cent reduction of time required to get on the foils. Furthermore, the maximum speed increased from 34 to 38 knots with the same engine. (*Fast Ferry International*, April 1990, Pages 29-30).

Waterjets, long found to be inefficient as propulsion in commercial vessels, are increasingly coming into focus as being viable in high speed vessels. These vessels generally operate in a region between 25-40 knots. Thus, while in the speed range of 15-20 knots, experience has shown a propulsive efficiency of 50 per cent, and about 70 per cent between 25 and 40 knots. KaMe-Wa, the main manufacturer of large waterjets, believes that the market for waterjets can only increase and that the power range will be extended from the current maximum of 14,000 hp. KaMe-Wa already has projects aimed at producing units up to 100,000 hp. (*Marine Engineers Review*, May 1990, Page 37).

The Eurodyn gas turbine, in development by participants from Norway, Sweden and France in a EUREKA programme, is to be tested in spring 1992. The engine promises to be a challenge for high speed diesels and existing gas turbines in propelling fast vessels. It is said to have a very high

thermal efficiency due to a high pressure ratio and high firing temperature combined with high individual component efficiencies.

Eurodyn will reportedly have a fuel consumption that is 30 per cent lower than current models of equivalent power. Furthermore, it will weigh 10-15 per cent of a lightweight diesel engine with the same output and will occupy about 20-25 per cent of the envelope space required by the diesel. Other benefits include a low noise level and little vibration, both important features in engines for fast vessels. (*Marine Engineers Review*, May 1990, Page 35 and August 1990, Page 28).

A new diesel engine for use underwater is being developed by Cosworth Deep Sea Systems Ltd. The main new feature of the proposed system, ARGO, is that it uses a pressure-balanced exhaust sub-system that addresses the problem of power loss due to high water pressure at the gas outlet. The exhaust gases, rather than being emitted directly to the water, are 'washed' in a chamber with seawater where pressure is controlled. The soot, NOx gases and other components are then flushed into the sea through sea water control valves. The cleaned exhaust is recycled to the engine and mixed with oxygen and argon from on-board storage tanks. ARGO, according to Harvey Fox of Cosworth Ltd., "Lends itself for use in a number of significant civilian applications. It can be used efficiently in manned and remotely operated underwater vehicles, including AUVs [Autonomous Underwater Vehicles] and ROVs [Remotely Operated Vehicles], involved in underwater operations..." This is due to its compact size and its relative inexpensiveness. (*Sea Technology*, April 1990, Pages 29-33).

An off-centre propeller in the world's first large ocean going vessel was recently launched by the NKK Corporation of Japan. The new design is meant to take advantage of a phenomenon that until now has solely been a problem; the formation of bilge vortices on both sides of the keel and

the subsequent increase in hull-resistance. By placing the propeller off-centre (1.3 metres) to starboard and letting it rotate clockwise, a greater quantity of counter-clockwise flowing water will enter the propeller, thus increasing efficiency. It is expected that the new design will cut fuel costs by about US\$ 75,000 per year on 12 voyages between Japan and Australia. (*Sea Technology*, January 1990, Page 73).

Improved engine performance and reduced maintenance are said to result from use of the XPCL fuel additive. Recent comparisons of engines run with this upper cylinder fuel oil additive with those run without it show a quite remarkable difference—the claim is that the fuel additives double an engine's operating period. While normal operating periods for the 750 hp engine were 10,000 hours, the engine using XPCL was opened after 14,468 hours and was said to be found in excellent condition. The manufacturer of XPCL, Conservation Systems of the UK, claims that the benefits are similar with larger engines than the one tested. (*Marine Engineers Review*, February 1990, Page 21).

Communication

The global positioning system (gps), a space-based satellite navigation system under development by the US Department of Defense, will have full two-dimensional coverage for marine and surface navigation available by early next year. At present, GPS gives between 12 and 18 hours of 'usable' coverage, subject to location of the user. The new development will ensure 24 hours of coverage, a major step towards the ultimate goal of full three-dimensional coverage in mid-1993. Fully developed, GPS will be able to provide an accuracy of 15 metres, but there are talks of limiting civilian accuracy to 100 metres with a 95 to 98 per cent confidence level. (*Marine Log*, April 1990, Page 42).

A low cost gps is said to be available from Communications & Measurement Technologies Ltd., UK. The sys-

tems, RADACS DPS 800 and DPS 820 differ from others in that computations are performed by the units rather than by an external navigation computer, which is normally the case. The DPS 800 is a single user unit whereas DPS 820 is a multi user system. The accuracies are currently said to be 25 metres in normal GPS mode, but better than five metres CEP (circular error probable) in differential mode. Position updates once every second. (*Dock & Harbour Authority*, May 1990, Page 29).

Electronic navigation systems are under steady development. Laser Plot Inc. of Auburn, Massachusetts, USA, are offering systems where the main purpose is to provide a real-time display on a screen of the vessel's position against a full colour official chart. The charts are digitized from paper charts and stored on a compact disc, capable of containing 70 maps. The operator is able to zoom and scroll the maps, and location, bearing and speed over ground are displayed. The system, 'Chartnav', accepts information from sources such as Loran-C, GPS, Decca and Omega and other navigation devices, and may be used to drive an autopilot. (*Lloyd's Ship Manager*, April 1990, Page 51).

INMARSAT, the International Maritime Satellite Organization, plans to add one satellite, increasing the number to four, by the end of 1990. This will fill gaps currently existing in the coverage of mid-North America and the eastern Pacific Ocean. (*Sea Technology*, February 1990, Page 77).

The rigid 'Chartnav' chart plotter is a new navigational aid that stores electronic charts, enabling the boat owner to track an earlier path, show the current location and plot the future course. The unit has the ability to zoom in on particular marinas and makes available speed over ground, course over ground, contours and depth contours. The standardised charts are available for virtually every country in the world. (*Small Ships*, May/June 1990, Page 40).

Notebook

Hong Kong is set to build a suspension bridge longer than any other in the world. With a central span of 1,423 metres the bridge will connect the Lantau Island and Hong Kong Island as a major part of a new transportation infrastructure. The bridge will carry 6 + 2 lanes of traffic and a high speed railway. The entire Hong Kong transportation programme, which includes a new airport and expansion of port facilities, is expected to cost US\$ 16.3 billion. (**The Dock & Harbour Authority**, March 1990, Pages 313-314.)

The Asian Development Bank (ADB) has approved a US\$ 285,000 technical assistance grant to Kiribati (Oceania) for an inter-island transport development study. The study will analyse the demand for inter-island transport services in Kiribati up to the year 2005, prepare options to meet this demand and review the country's inter-island tariff system. (**Dock & Harbour Authority**, January-February 1990, Page 261).

Sensitive cargoes, like fruit, fresh fish, wine and highly refined products may be protected by using an atmosphere of nitrogen during transportation. The nitrogen is used to displace oxygen the main contributor towards food-deterioration and a main reactant in the case of flammable or corrosive cargoes. The nitrogen may be produced from the engine exhaust gases by removing H₂O and CO₂ and directing the purified gases over the cargo. Other methods exist if very high purity is needed, including absorption or selective permeation from the air (atmospheric air contains 78 per cent nitrogen) through membranes and liquefaction/distillation. However, these methods require more extensive equipment. (**Lloyd's Ship Manager**, January 1990, Page 36)

African seaborne trade is, according to David Hilling, suffering from high rates and inefficiency. In 1985, freight charges constituted 11.3 per cent of the value of imports. This contrasted with 9.6 per cent for Asia, 8.4 per cent for

Latin America and 5.8 per cent for the world as a whole. For example, a 20-foot container from Le Havre to Abidjan cost as much as a 40-foot container to Hong Kong and took almost as long for 40 per cent of the distance. Hilling questions the usefulness of the UNCTAD 40-40-20 Liner Code that reserves 40 per cent of the transportation between two countries for either one and leaves 20 per cent for others. He argues that some countries in Africa do not have the capacity to transport 40 per cent of seaborne trade efficiently.

The African coastline has nearly 150 ports, whereof 60 could be termed international. Port development along the African coast often involves difficult engineering and is performed at great cost. Hilling gives some examples of on-going port rehabilitation projects in Ghana, Somalia, Tanzania, Kenya, Guinea, Mozambique, Nigeria, Morocco, Mauritania and Namibia. These plans will increase African capacity for seaborne trade, but there is still a big gap between supply and demand of shipping and port services. (**The Dock & Harbour Authority**, March 1990, Pages 330-335).

Tourist submarine Moglyn, Japan's first, was launched from the Kobe Shipyard & Engine works. The 40 passenger vessel has an overall length of 18.9 metres, is 3.5 metres wide and 3.55 metres high. Able to reach depths of 50 metres, Moglyn is currently being operated on the shore of Okinawa by Japan Submarine Tourism Co. Ltd. in a joint venture with five other companies. (**Sea Technology**, January 1990, Page 74).

Switzerland will also get a tourist submarine for use on Lake Zurich. The 16-passenger, 12 metre submarine to be built by Sulzer Brothers AG of Switzerland, will be able to reach depths of 100 meters. (**Small Ships**, April 1990, Page 15).

The Blue Water Company, specialists in support and management of development of passenger submersibles claim that the field of tourist submarines is a major growth area in

the leisure industry. The total worldwide revenue resulting from passenger submersibles is said to have doubled every year since 1986. Blue Water says that there are large markets for passenger submersibles in the Mediterranean, Caribbean, Pacific Ocean and the Indian Ocean.

The capital investment required for a 46 passenger submersible is around the US\$ 3.8 million mark, according to the Blue Water Company. (**Small Ships**, April 1990, Page 22).

Oceanautics International Ltd. was recently set up in Jamaica with the aim of building passenger submersibles. This company, established with Government support, will act as a licensee for building a 62-passenger, three-man-crew submersible (Oceanautics S-60) able to dive to 250 feet (83 metres) and designed by Oceanautics of the UK. The Jamaican company will act as an operating centre for submersibles as well as a construction yard. (**Ship & Boat**, July/August 1990, Page 15).