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MARINE INDUSTRIAL TECHNOLOGY MONITOR

Vol. 3, No. 1, 1995

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PUBLICATIONS

TRAINING COURSES

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TO OUR READERS

In 1993, a comprehensive reform process was initiated within UNIDO, aimed at creating a more streamlined and efficient organization, better able to respond to the new industrial sector challenges faced by developing countries, and countries in economic transision, in their struggle towards economic development. A major objective of the "new UNIDO" is to focus and concentrate activities in selected priority areas in order to optimize the use of resources and achieve real impacts. The changes that have taken place have resulted in a new strategy for UNIDO's work in the field of marine industrial technology. The promotion of marine industries and technologies is now an integral part of UNIDO's programme of work and will be implemented through existing core-programmes related to investment promotion, technology management, technical assistance at the sectoral level (engineering, agro-based and chemical industries), energy and environment, industrial information, and human resource and private sector development.

In the development of its activities in the marine sector, UNIDO will actively seek inputs from its Member States and industry, in order to properly reflect the various national policies and priorities at the governmental, institutional and enterprise levels. The participation of the industrial sector is a critical factor for success. In this respect, UNIDO is considering the establishment of an industrial advisory group with representatives from both developing and developed countries. The substantive part of the programme will be organized as externally funded projects, while programme coordination and project development and management will be provided by UNIDO on a non-profit basis. UNIDO will also be involved in general promotional activities. With the limited resources available, it is necessary to concentrate work on a few priority areas, selected according to factors such as global importance, the needs and priorities of target beneficiaries, industrial relevance, sustainability, potential impacts and linkages to UNIDO's mainstream programmes. Initially, we shall concentrate our activities on the area of business development, focusing on assistance to small- and medium-scale enterprises in the marine sector and the promotion of new marine technologies, with particular relevance to developing countries.

An example of the latter is technologies for conversion of wave energy to electricity. This has significant potential for small island states and remote coastal areas dependant on fossil fuel imports. Due to high transportation costs, wave power could well provide a feasible alternative to diesel-generated electricity. The first article on wave energy featured in this issue concludes that the development of commercial wave power plants is impeded by the lack of financial capital and not, as is commonly thought, by the lack of proven and commercially viable technology. UNIDO strongly supports the commercialization of wave power plants and will actively promote technology transfer, training and the application of innovative financial mechanisms, such as BOT (Build-Operate-Transfer) schemes, in this field. Our goal is to initiate one or more commercially-based wave power demonstration projects within the next two years.

Leif K. Braute
Technical Editor

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A. FEATURES

DEVELOPMENT AND COMMERCIALIZATION OF OCEAN WAVE ENERGY PLANTS

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Norway

Introduction

The emphasis on ocean wave energy research and development was originally prompted by the sharp increase in world crude oil prices in 1973. A high proportion of the world energy supply depended on crude oil, including a good proportion of the electricity supply. The industrialized nations suddenly realized that not only might this supply become substantially more expensive, but the supply might also be short, thereby curtailing and threatening economic growth. For a while the situation seemed to contain enough force to cause a redistribution of global power. Work on alternative sources for energy supply therefore took off with great determination.

Environmental aspects were never included in this early phase of development on alternative sources for energy supply. The 1970s held almost nothing in terms of environmental awareness. The State of California appeared as a lone operator in the field of battle against air pollution with their actions for clean automobile exhausts in 1972-1973. All the other nations of the industrialized world were still in full pursuit of economic growth rates as experienced in the 1960s, and in practice remained with such priorities well into, not to say all through, the 1980s.

There appears to be considerable contradiction contained in this picture when looked upon from the angle of priorities granted by the industrialized nations to the development of new energy resources. This development had the necessary priority in the beginning, but then was motivated by desire for continued economic growth. As the environmental awareness has developed in more recent years and the need for new, clean energy sources is greater than ever before, this priority seems to have dwindled away. Even though the technology now exists, as this presentation will conclude, for wave power plants to be economically implemented, there remains a lot to be gained through research so that an increased number of nations with lesser wave climate may also achieve the benefits of an indigenous, clean energy supply. Relenting in their efforts to make these gains available may not be compatible with the responsibilities carried by the industrialized nations for the adoption of environmentally sustainable policies.

Status of ocean wave energy research

Someone going into the international patent literature looking for wave energy conversion devices (WECs) will find more than a thousand proposals for utilization of this energy. Obviously this is a subject which has tickled and tempted the human mind for a long time. During the last 20 years the challenge was taken up with more financial resources and in a more organized form.

An investigation into the scientific literature in this field today yields a broad scope on WECs, classified according to their work principle and their physical appearance. There seems to be much less discussion on basic theory, except for computer programs and other means of theory adaptations, but this is of little concern, since the theory apparently is well established and agreed upon.

Of more concern is the apparent lack of focus placed on conversion efficiencies. Among the experts, there is actually a discussion on whether efficiency is a good focal object since wave energy is a supply free of charge and the top percentages of efficiency may be hard to achieve. Aside from this reason, the field is left almost open in terms of conversion efficiencies as a tool to distinguish between the various designs.

Of more serious concern, however, is the almost total lack of discussion on economy. One would have thought that the aforementioned discussion on efficiency might have led to the definition of an optimum where the resulting economic parameters were the ultimate premise to distinguish between good and bad. But this is not so. The available scientific literature provides little or no help in finding out what the investment might be per kW installed capacity for a given design, nor does it give much of a clue regarding the operating costs.

Actually, when comparing the large number of WECs with the very limited evaluation on efficiency and economy, it is all too obvious where the priorities have gone. It is certain though that further work on WEC inventions may safely be postponed until the economic exploitation of those already invented has taken decisive steps forward.

Along with the lack of economic analysis goes an absence of discussions on construction. The scientific literature contains a large number of proposals for wave energy devices, but hardly anything on how to build them. From the principles employed, there are impressions to be had on the constructional features, such as general complexity and to what extent there are moving parts in the design. For the concepts which have been developed into demonstration plants, actual construction has, of course, occurred. But even for these, the construction has hardly been precipitated in a competitive economic environment. It appears that the situation calls for a new generation of inventors. This time not to invent WECs, but rather develop means of constructing the WECs already invented, such development being intimately integrated with economic analysis, both on initial investment and operations. Only when this is done may conclusions finally be drawn on the full competitive power of ocean wave energy.

The status of ocean wave energy research would not be completely covered without addressing the aspect of power quality. Waves as they appear show great variations in size, and thereby in energy intensity. Transforming this raw energy directly into an electric grid would cause variations in power far beyond the acceptable. Actually, there are variations in energy content in a number of time concepts. The scientific literature reports a factor of two between the

highest and lowest yearly mean for a particular location on the Norwegian coast. The average wave power for a winter month can be five to ten times the value for a summer month. There can be a variation of x10 between two successive weeks. Waves often come in groups. For the mentioned location, wave power in the groups in certain cases can be fifty times the power in between the groups.

It appears from this that some kind of dampening is needed for wave power to become compatible with the requirements of domestic, electric grids. This is an aspect which is now receiving attention throughout the research community. While some WECs have the decoupling more or less inherent in their concepts, others need more elaborate actions to be taken to become compatible with the requirements. Having an energy storage reservoir between the waves and the electric generator is an example of inherent decoupling. In the Tapchan concept, energy is stored in the water reservoir, which provides significant, and in most cases fully satisfactory, decoupling already when the holding time in the reservoir spans over several wave periods, i.e. a matter of minutes. The two-chamber version of the oscillating water column concept represents an attempt to achieve some of the same results for this concept. Generally speaking, the more direct the route from wave to generator, the more of a problem the variations constitute. Of course, the variations may be smoothed out on the electrical side, as with the Kværner AC-DC-AC conversion, but then at a likely severe cost in terms of lost efficiency.

Discussion on WEC efficiency

Some clues yet appear on efficiency. Generally stated, floating WECs have a problem with efficiency because to some design-dependent extent they move with the seas: heave, pitch and roll. Very large floating structures, such as the semi-submersible drilling rigs used by the oil industry, have very limited movements, which might also be a positive contribution to a stable wave energy electricity production, since it might take the tip off the storm waves, but such big structures as yet have not been tested nor reported modelled for this purpose. Other than this, floating WECs seem to suffer from a low end-conversion efficiency, and maybe therefore have availed themselves primarily for applications where this does not matter: floating navigation lights, etc.

The oscillating water column was the basis for the world's first wave power plant, a 1-kW residential system installed on the French coast in 1910. Since then several have been built, notably in India, Japan and Norway, among others. In most of these devices, wave-induced motion of an entrained column of seawater drives reversing airflow through a pneumatic turbine, which drives the generator directly and produces electricity.

Depending on the details of the design, this concept reportedly may yield a very high efficiency in the primary conversion, i.e. from hydraulic wave energy to pneumatic energy. With an anticipated conversion efficiency in the secondary step, i.e. from pneumatic to electric according to the best achievable, the overall conversion efficiency actually has been predicted to approach 50 per cent. Reports from actual operations, however, are considerably more modest, speaking of overall conversion efficiencies in

Tapered Channel (Tapchan)

In its basic form, this consists of a tapered channel, built of steel or concrete, with a wide-angle opening into the ocean. The channel leads the waves onward through successively narrower, right-angled cross-sections, causing the wave amplitude to get higher and higher until it lifts over the edge and into an adjoining on-shore water basin. The electric power generation takes place as the water flows back to the sea through an ordinary high volume low pressure vertical axis Kaplan turbine.

The device is based on conventional technology, proven and robust, and with no moving parts exposed to wave action. Advanced computer software for three dimensional dynamic modelling of the wave energy flux is used to optimize each device, ensuring maximum efficiency for a given wave climate and location.

Recent work on this concept has given priority to new building methods for the water basin in order to increase the volume so that a 24-hour energy collection cycle may be utilized, thereby reducing the size of the plant and/or the necessary minimum wave climate so that a certain energy demand can be met. Work is also being carried out on constructional methods to suit sedimentary (sand) beaches where the plant is moved into shallow regions offshore. Combinations of Tapchan and OWC (see below) are being investigated, also in new combinations with a separate hydraulic energy carrier (between the raw sea water energy and the produced electric power). This work has given promising indications that competitive wave power may be available for plant sizes of 5-5,000 kW in a variety of coastal environments and with the flexibility contained in a 24-hour water storage. Specific applicability for a given location must be obtained through site-specific analysis, during low-level pre-feasibility studies and/or later full feasibility studies.

Oscillating Water Column (OWC)

The OWC is a fixed shoreline-based device (or located just off the shore in a breakwater). In principle, the encroaching waves excite the volume of the water encased within the device structure to oscillate. The water surface travels up and down the chamber as a liquid piston, analogous to an internal combustion engine. Air enclosed inside the device, above the water, is set in sympathetic motion by the surface and can be forced to do work by venting through a power take-off unit attached to the plenum chamber. A standard or self-rectifying turbine can be used for this purpose.

OWC type devices have the advantages of hydrodynamic simplicity and conventional pneumatic technology. Downstream of the power take-off, electrical generation and control can also be an adaptation of standard current practice. (Source: *Wavelength*, No. 2, 1993).

the region of 20-30 per cent, and even then counting only the periods when the wave climate is good. Recent indications on twin column oscillating systems seem to confirm this. They are said to imply that such twin systems for prevailing long period waves may perform at 60 to 100 per cent higher efficiency levels compared to the single column systems. This would hardly be realistic if the conventional systems already performed at the 50 per cent level.

These last reports seem to correspond reasonably well with a closely related design, i.e. the Masuda backward bent duct buoy. Model tests for this design have been reported to conclude that the primary conversion may have a 59 per cent efficiency (or 59 per cent absorption width as it is called) while the secondary is predicted at 60 per cent. The overall efficiency appears as the product of these two, i.e. 35 per cent if taken literally or 29 per cent if the secondary is held at the more commonly accepted maximum level of 50 per cent.

Appearing more on the positive side in terms of conversion efficiency are the fully hydraulic systems. In these concepts both the primary and the secondary conversion involves hydraulic fluids, either seawater in both cases, or seawater first and then hydraulic oil. Several of these have been proposed, notably from Sweden, Denmark, Canada and Australia, among others, and they have done well, both in terms of analysis on feasibility and in model tests. But no firm experience has been put on the table to indicate what the overall efficiencies in these cases may be.

The Tapchan conversion concept also stands out favourably in terms of conversion efficiency. One 350 kW Tapchan demonstration plant was constructed and put into commission in 1985 on the Norwegian west coast, not facing the North Atlantic, but rather the more confined waters of the North Sea. The plant was designed to lift the seawater to an average altitude of 3 m above sea level, from which it flows back to the sea through a conventional Kaplan low pressure high volume turbine. The storage reservoir was made to have an approximate 8,500 m^2 surface. The wave collector and the tapered channel were constructed with a total length of 170 m, of which the collector, i.e. the wide part with a 55 m opening facing the sea and a total length of approximately 90 m was blasted out directly in the inherent rock with no subsequent surface treatment. The rest of the tapered channel, the inner narrow part, was then cast in concrete. With a total vertical height of 10 m and a medium tidal range of 0.9 m, the subsequent 3-year operation of this plant yielded some 42-43 per cent overall efficiency, i.e. electric energy delivered to the grid in relation to the wave energy hitting the collector entrance. This efficiency number is not believed to be at its maximum obtainable value in this case. Rather, there was a trade-off in the construction phase between efficiency and costs. Using the raw blasted rock surface directly in the collector section creates some turbulance and loss; on the other hand it saves a lot of money. It does not matter too much whether the construction has a large volume if the construction method is cheap.

Based on recent development in non-linear wave theory and computer modelling of the wave behaviour in combination with the operating experience, it is now feasible to assume that the Tapchan concept may be constructed with a considerably shorter channel without any significant reduction in efficiency. These are improvements which will be incorporated in future designs, in all likelihood in Indonesia, according to the preparations for a new plant which are now in their final stages. In combination with a necessary overhaul on the demonstration plant, there are plans to implement these improvements also in the reconstruction. Work began in 1993. When completed, intentions are to have the local electricity supply company take delivery of the plant in their operation and ownership on terms more or less equal to their other conventional hydropower production units. This marks a turning point in Norwegian wave power development.

The importance of efficiency

Correctly, the energy of the ocean avails itself, free of charge. Availability, however, is not abundant everywhere. Actually, availability per cubic metre of seawater is quite limited. Even in the most violent waters of the world, wave energy is correctly characterized as a low intensity energy, meaning that energy collection has to occur over a large acreage, or a large volume of water, for this resource to be significant compared to others.

The final line on this puts focus on the cost of collecting the energy, i.e. the cost of putting the energy to use. Since all machinery increases in price in relation to their physical size, not all increase by the same rate, sophisticated machinery faster than crude machinery, and since this machinery in any case will be large due to the low energy intensity, it makes sense to extract as much energy per cubic metre of seawater as possible. That is why the efficiency is of prime importance.

Nevertheless, not regardless of cost. Going into excessive sophistication to gain access to the very top efficiencies will defeat itself, since the construction will in any case be sizeable. The obvious optimum lies in the combination of crude and simple machinery, which performs with high efficiency. These will be the winners, also in terms of performance over time.

Economics—focal points and indicators

The lack of economic analysis is not entirely complete. Looking into the professional literature in the field of ocean wave energy utilization yields examples of attempted economic analysis, but extremely sketchy and unsuited for any kind of responsible decisions. Good reasons for this are probably easy to find. An analyst will find replies hard to get from those that have answers to them, because with the highly competitive, invention-focused atmosphere which has prevailed on WEC's nobody can afford to give away their secrets. Therefore the observation is quite correctly made, that this field is full of claims to excellence in performance: technologically, economically, in terms of fringe benefits, etc., few of which are really substantiated.

Some will use this observation to draw the conclusion that wave energy utilization is premature. That conclusion is however as lightweight as the claims to excellence. The situation is rather typical for the early phase of entry into a new area of exploitation. At some point someone will have to rely on the available evidence and indications and make a trial to verify conclusions. Available evidence will not be as conclusive as with conventional technology. It will be the strongest for the concepts with a working history on a scale reasonably corresponding to the actual project, however limited its history may be. Beyond that, it will all be indicators and evaluations, and they will be site specific, not general. Typically, wave climate, electrical infrastructure, topography and bathymetry, and geographical distances. Only when these parameters are seen in

combination for a specific site and situation, may positive conclusions be drawn for a project. This will always be the case for new technology in early applications.

On a site specific basis economic analysis has been performed with good results. Reference here is made to the Tapchan concept, which has been analysed with regard to a site on the South Central Javan Coast, facing the Indian Ocean and intended to produce at a level of 1.1 MW. Indications are that this plant will be able to deliver electricity into the existing Java grid at a price of US cents 7-8 per kWh, which is below the electricity price in the area as seen by the small consumer. On the other hand, the acceptability price per kWh may be somewhat above the small consumer price, since this is an area where first generation electricity supply is now being put in and local supply may have implications leading to savings in a wider perspective. The specific site for this plant on Java, is quite favourable if not ideal; bathymetry is good, the topography is wholly compatible with the circumstances for which the technology was previously proven, and with an adequate wave-climate where the extremes are not too far removed from the averages. As it is well known, averages mean income while extremes are single cost items. The message for the various nations bordering the Indian Ocean is that inherent wave climate conditions lend themselves well for wave power utilization. For certain topographies, the technology has come to a point where site specific economic analysis may warrant project implementation immediately. For others adaptations will be necessary, which remove the decisions to be made from actual proven experience, but not necessarily so that a feasibility study will conclude negatively. Time, therefore, seems to be ready for a second generation evaluation of wave power utilization for the countries in this area whose electricity supply situation is such that a contribution of this nature might be desired.

One remark should be made regarding **combination plants**. It is necessary to obtain qualification in the marketplace on the basis of only one product. For example, the economical viability of producing electricity should be justified on its own, not in combination with something else. Because it appears as a basic observations for new products, and particularly where political approval is involved, such split justification will be seen as an implicit admission that the technology really does not qualify commercially, and may be used against the projects. After approval, of course, wave power may be seen in connection with various other products: harbour development, fish farms, fresh water production, irrigation, etc., these will then appear as fringe benefits.

Lifetime, operations and maintenance

Energy projects are generally implemented with no less than a 25-year lifespan. Such a lifespan is necessary for an acceptable energy pricing to be established and realistic from the viewpoint of a proven technology.

This is not entirely so with wave power, since proof is limited both as to the number of plants and experienced lifespan. Nevertheless, no shorter lifespan should be anticipated for these plants than for conventional plants. By placing the perspective at this level the dividing line is actually drawn between the technology at its infancy stages and technology ready for utilization.

Handing over a demonstration plant to the local utility service company would constitute an expression of maturity for the technology, implying the end of the experimental stage and readiness for regular service. The Norwegian Tapchan technology actually reached this stage in 1993 when agreement was reportedly reached that, in the future, the plant would be operated by the local electricity supply company, Nordhordland Kommunale Kraftlag. Put into service in 1985, the 350-kW demo plant had then seen three years of service, with re-evaluations being made continuously. This was considered enough to conclude in favour of future, regular operations.

Not to say that this decision was not without preceding problems and shifts of opinion. On the contrary, the demonstration plant at one point actually had serious damage in the wave collector and ceased working. Large rocks from the construction phase had been left by the contractor at the opening of the wave collector. As storm conditions were encountered, these rocks were thrown into the tapered channel and in the course of time broke holes in the concrete. Such problems will always occur with new technologies. The important thing is to have time and insight to recognize them before a regular buyer is involved, and that they are abatable. A mature technology appears when these initial problems have been hammered out and it performs on a routine basis.

The Tapchan concept is unique among all known WEC concepts insofar as it contains no moving parts exposed to wave action, directly or indirectly, and by the fact that in its original form, it has no corrosive components or materials exposed to the ocean forces. The oscillating water column systems come close, as the exposed chambers may also be made of concrete, but here the whole turbine mechanism is indirectly exposed to the immediate pressure changes as the waves create them. Much more so with practically all the other systems. They have rotating parts, oscillating components, spines, anchoring and cables, pipelines and connecting lines and in one case large hoses exposed horizontally and vertically through the water, exposed for the full wave action. Some of these systems have very good conversion efficiencies and according to their conceptual basis require a minimum of initial investment to be implemented.

In order for such systems, however, to take delivery for a 25-year lifespan, experience would have to be built up gradually over a considerable period of time. Not equally demanding in all cases. For instance, on a location with very mild wave climates and little or no stormloads, such systems might find their applications rapidly, but hardly in the more rough conditions of the world oceans. Assuming, for instance, the mid-Norwegian coast, with wave climates of approximately 30 kW m average, the experience from offshore activities is that the maximum number of loadcycles such a construction may take is 10^7, i.e. less than 10 million loadcycles. With a wave frequency of eight seconds this comes down to a lifetime of 2.5 years. With 60 units at work, as has been proposed for one installation, this would mean exchanging a unit every second week, continuously. And then stormloads are not counted. It is not unlikely that they might cause full breakdown of such systems. There is no experience to draw on for light systems such as these, anchored permanently and with full exposure. The closest one comes is through the offshore petroleum activity, and those systems have their problems even though they are much heavier. In discussions with researchers in the field of wave power, expressions of disgust have sometimes been voiced when

a concept with low technological excellence is apparently the preferred one. It may be natural for research people to see it that way.

But in the harsh economic realities of the real world other factors are more important. The robustness of the concept, a minimum of moving or corroding parts exposed to the seawater, good dampening between the wave impacts and the generator, grid compatible power, a maximum of conventional proven components and finally, a decent conversion efficiency. These are the important factors to decide on in regard to wave power plants.

Closing comments

This presentation has concluded that the technology is now available and that the Indian Ocean region is a scene of primary qualities for ocean wave power generation. Furthermore, a recommendation has been forwarded to the Governments of the various countries to consider a second-generation evaluation of wave power since progress in technology and experience seems to justify this.

The keyword to proceed from this point onwards is co-development. It begins already in the second generation evaluation where the respective countries should consider taking active part with personnel who may come out of such a process fully qualified within the field. On top of that, additional personnel trained with the technology originator when, or if, such additional personnel is deemed necessary. From the Norwegian side we see a future where the technology users are the technology holders and we wish to speak in favour of mechanisms for development that foster this. That is why we think that co-development is the basis on which wave power utilization should now be considered.

Due acknowledgement is given to Prof. Dr. Joh Falnes of the Norwegian Institute of Technology for excellent guidance through written material and personal communication in the preparation of this presentation, and also to Messrs Hagerman and Heller whose paper for the 1988 International Renewable Energy Conference at Honolulu, Hawaii has been a source of background information for this paper.

* * * * *

OCEAN ENERGY ACTIVITIES IN INDIA

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Introduction

India has approximately 6,000 km of coastline. The Exclusive Economic Zone (EEZ) along the entire coastline adds about two-thirds to the land mass and therefore has a tremendous importance for the economic development of the country. While the living resources have been reasonably well exploited over the last few decades, the energy-related activities started during the early 1980s with the formation of a separate ministry of the Department of Ocean Development, Government of India, at New Delhi. India is a power-deficit country and has an installed capacity of only 70,975 MW in the following categories for the entire country:

- Thermal: 49,900 MW
- Hydro: 19,355 MW
- Nuclear: 1,720 MW

The oil resources on land as well as offshore are not capable of meeting the increasing energy requirements of the country. The rate of increase in energy demand is approximately 8 per cent over the last two decades, in spite of a tremendous input into providing additional generated capacity within the country. The shortage of power is expected to be 20 per cent when compared to demand. In this context, the role of renewable energy sources, especially from the oceans is very relevant.

The contribution of ocean energy to India's overall energy requirement could be considerable. Theoretical estimates of ocean energy for India's entire EEZ are as follows:

- OTEC: 40,000 MW
- Wave: 40,000 MW
- Tidal: 8,000 MW

Within the Government of India at New Delhi there is a ministry known as the Department of Non-Conventional Energy Sources, which supervises all possible renewable energy sources, i.e. solar power, wind power, biomass, etc. it had also initially sponsored some studies on possible OTEC plants for India. However, after the formation of the Department of Ocean Development, a steady focus has been given to R&D in the area of wave energy utilization. The main thrust of the technology development at present is the development of smaller power modules for conversion of wave energy into electricity as part of a multipurpose system.

The barrier type of breakwater consists of a number of caisson modules, each with its own wave energy conversion system. Such a modular assembly helps in the phased technology development, which requires limited funding when compared to the OTEC plants requiring a very high capital investment.

Indian wave energy programme

Indian wave energy research began in 1983 under the sponsorship of the Government's Department of Ocean Development. After about six years' research in the laboratory, the Wave Energy Group at the Ocean Engineering Centre, Indian Institute of Technology, Madras, coordinated a project design involving the fabrication and construction of a 150 kW wave energy system[1]. This 10-m wide 150 kW unit is a typical module which, when placed side by side, could form a multi-functional barrier. This could be used as a harbour for shipping, aquaculture etc., in addition to producing energy as a by-product. The average Indian wave power potential is only 5-10 kW m.

hence this multi-functional barrier concept to improve the economics of wave power. The structural cost is shared between that of a harbour and wave energy.

First demonstration unit

This unit is built on the well-known *Oscillating Water Column* (OWC) principle. This device has two parallel guide walls in the front, popularly known as 'harbours' after its proposers Ambli *et al.* from the Norwegian Wave Energy Group.[2] This OWC with harbours is built as a cellular concrete caisson. The design is of the gravity foundation type. This concrete structure weighs 3,000 tons and is further ballasted in its hollow chambers using about another 3,000 tons of sand. This concrete ballasted caisson is placed on a prepared rubble bed. The top of this OWC chamber is a double cubic curved shell of concrete (dome), which acts as a nozzle to accelerate the air flow to a high velocity, suitable for a 2 m diameter Wells turbine directly coupled to a 150 kW induction machine of synchronous speed at 1,000 RPM, which is directly connected to the electricity grid. This prototype, being an isolated offshore structure, had to be located at a suitable site to reduce infrastructural costs for its construction. The site selected was 45 metres in front of the Vizhinjam Fisheries Harbour breakwater, off the Trivandrum coast at the southern tip of the Indian peninsula. The water depth at this location was 10 metres, typical for fisheries breakwaters, and the average annual wave power potential is of the order of 10 kW/m. The already existing breakwater gives the approach needed for this structure.

Caisson module

This 3,000-ton concrete caisson was built using the climbing shutter technique in the protected waters of the fisheries harbour, in floating mode. Flotation stability as well as safe levels of stresses were ensured for each stage of construction. A temporary steel gate was provided at the end of the guide walls with a rubber sealing to ensure that the caisson would float. As construction proceeds, the caisson sinks into the water due to the weight being added. The concrete construction is over after the dome is cast. The floating 3,000-ton caisson with a draft of 9.9 m is then towed to the prepared rubble sea bed. There it is sunk by flooding and fixed to a prepared horizontal rubble bed. However, in the first attempt the fixture was incorrect and the structure failed and was abandoned. Later a second caisson was constructed and successfully installed. Thereafter, the temporary gate was removed and the cellular hollow chambers were filled with 3,000 tons of sand. This gravity structure of 6,000 tons is capable of withstanding non-breaking waves of up to 7 metres. The 45 metres prefabricated steel bridge was then erected spanning between the concrete caisson and the existing fisheries breakwater. A mechanical handling system was then erected on the caisson to install the power module. The capacity of the pulley block is 5 tons.

Power module

The power module is a 6-metre high, 2-metre diameter, steel hollow cylinder on top of the dome. This module houses the turbine and generator required for power takeoff from the bi-directional air flow from the OWC caisson. The power module is sub-divided into components of weight below 5 tons for ease of transport and erection. Rotating components were balanced and locked before transport to site. The first component to be loaded onto the dome was a 2-metre diameter butterfly valve to shut off air flow to the turbine in case of emergency. The remaining components were loaded on top of one another to complete power module erection. The induction machine is connected to the grid through a control panel. The plant was commissioned in October 1991.

The Wave Energy Group has been conducting performance evaluation studies on this plant, even though the Group had to face a number of teething troubles when connecting the cables, butterfly valve, control panel and instrumentation.[3] However, during the last year, we were able to achieve good test results with a peak power pumped to the grid reaching 150 kW, as per the design. The maximum measured turbine efficiency varied from 80 to 85 per cent. Peak efficiency of the power plant varied from 20 to 50 per cent, depending on the wave climate. The major effort of the Wave Energy Group at present is to modify the turbine and generator designs to minimize the variation of the power pumped to the grid. This is going to be achieved by providing a variable speed induction machine as well as modifying the present constant chord bladed rotor to a varying chord bladed rotor of the turbine.[3]

Future programmes on wave energy

The Department of Ocean Development, Government of India, is presently funding the Wave Energy Group to develop the next prototype to be installed at the present wave energy plant site at Trivandrum. This second prototype will be the forerunner of the power module for commercialization and is being standardized at 55 kW. The wave energy caisson module of approximately 21 m will have two power modules of 55 kW each. The caisson will be used as a module in a long barrier-type breakwater and will also have a vertical rear wall to facilitate berthing of fishing boats as well as a road on the top. This caisson has been designed as a breakwater of a new fishing harbour being built at Thangassery in Quilon on the south-west coast of India. It will be a grid connected system.

Extensive developmental work has been carried out to develop a variable speed induction generator with a constant power output, which will be a boon for commercialization of wave energy devices.

The Department of Ocean Development is also considering the installation of isolated breakwater caissons in the various remote areas of the Andaman and Nicobar islands region. The generator and controls have to be different for remote islands because no electrical grid exist on the islands. Separate R&D is being taken up for generator of stand alone systems.

Indian Ocean Thermal Energy Conversion (OTEC) Programme

Even though India has a vast potential for OTEC, the activities in this area have been limited. This programme is being handled by the Department of Non-conventional Energy Sources, Government of India, New Delhi. At their request, the Ocean Engineering Centre, Indian Institute of Technology, Madras conducted a feasibility study during 1985 to install a 1-MW OTEC plant on one of the islands of the Lakshadweep group in the Arabian Sea. Detailed designs were made by one of the consulting firms indicating that the cost of power generation from this OTEC plant will be half the price of power generation on that island by conventional diesel generator. Since proven total

OTEC technology was not available in India nor elsewhere else in the world, the Government of India did not decide to go ahead with the plant. Subsequently, a private firm, M/s. Sea Solar Power, USA, offered to build a 100-MW plant off the coast of Tamil Nadu State in southern India at a distance of 40 km from the mainland. This plant will be located at Kulasekarapatnam and M/s. Sea Solar Power has agreed to arrange the entire financing of this plant with the condition that the Government of Tamil Nadu buys power from them for the next twenty years. *(Author's comment: I understand that a Memorandum of Understanding is being entered into between the Government of Tamil Nadu and M/s. Sea Solar Power, USA, and the execution of the project and the programme is likely to become a reality within the next five years).*

If the demonstration of the OTEC plant proves to be successful, they could provide a tremendous support to the island communities all over the world by providing a renewable and pollution free power source. The major technologies that have to be proven are the cold water pipe technology and the technology for the dynamic positioning of the floating OTEC plants. Further, if only one or two large OTEC plants are commissioned as demonstration plants, reliable environmental impact studies could be taken up. Across the world, limited R&D work is being taken up on the development of OTEC cycles for power generation, namely the *Hybrid OTEC system* and *Mist OTEC system*, which are likely to be more efficient than the open cycle and closed cycle systems being considered at present.

Conclusions

Ocean energy is a promising source of energy for countries in tropical regions. These resources are more valuable for island communities. But specific technology developments are required before commercial plants can be established. Since the OTEC plant cannot be designed economically for an output to the order of 1 MW or less, wave energy is more promising at present for island communities. Large OTEC plants in the order of 100 MW and above will be more economical and will be useful for the mainland only.

South-East Asian nations have vast resources of ocean energy. Joint R&D programmes could be taken up in the area of ocean energy, especially on the installation and operation of demonstration plants, which will lead to commercialization in the next five to ten years. The Department of Ocean Development, Government of India, will be willing to take part in the joint R&D programmes between various countries, maybe through UNIDO. India also has expertise in the area of ocean data collection to determine the wave climate, bathymetry and other oceanographic parameters of the region. The Government of India also owns a research vessel ORV *Sagar Kanya* with sophisticated facilities for all the oceanographic surveying, and will be able to arrange for survey cruises, if the countries of the region request the Department of Ocean Development, Government of India, for such services.

Notes

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B. INDUSTRY NEWS

Baltic shipping in new revamp push

The Russian shipowner with the largest complement of liner trading, Baltic Shipping Company (BSC) of St. Petersburg, is undertaking a massive reorganization programme. The plan is to create a separate profit centre from each of its 12 long-established liner services as a prelude to a breakup and a casting off of less financially sound operations. The average age of the 150-strong fleet is 16 years, and the phasing-out of aged units, which started in early 1993, is continuing. BSC has been having problems finding credit for new buildings and hopes have been dashed that the ambitious resurrection of the fleet programmes of the Maritime Affairs Department in Moscow would bring solace—the treasury's coffers are empty. (Source: *Seatrade Week Newsfront*, Vol. XIII, No. 25, 1-7 July 1994)

Evergreen invests

Ta'wan, Province of China's Evergreen group, preparing for the eventual opening of direct shipping links with China, has plans to invest in building container terminals and other port facilities on the mainland.

Flagship Evergreen Marine Corp. and affiliate Uniglory Marine Corp. have been given approval by shareholders to invest up to $80 million in projects. The exact nature of the investments and their location has not yet been decided, and the projects will depend on Taiwanese and Chinese Government approval.

The projects by the group, the world's biggest container shipping operator, would be the country's first major investments in China's transport sector. Evergreen would help build and manage the facilities.

Evergreen continues to serve the Pacific Northwest-Asia trade with its weekly Medway Pacific Service which links the ports of Tacoma and Vancouver with Asia and the Mediterranean.

The group has also started serving Viet Nam following the lifting of the US trade embargo in February. The company was already well established there. Its Far East-North Europe and Far East-Mediterranean services were linked to Viet Nam about two years ago, transhipping on to common feeder vessels in Singapore.

Evergreen affiliate Uniglory operates a weekly feeder service between Kaohsiung and Ho Chi Minh City, using two of its own container vessels of more than 500TEU. A common feeder is used between Kaohsiung and Haipong. Between the US and Kaohsiung, Evergreen has a choice of shipping containers on three services. (Extracted from *A Supplement to Lloyd's Ship Manager*, June 1994)

Daewoo's capital idea

The Republic of Korea business conglomerates, Daewoo Heavy Industries and Daewoo Shipbuilding and Heavy Machinery, plan to unveil the nation's biggest private sector company in terms of capital.

If the plans are completed as scheduled by 1 October, the activities of the merged giant will range from shipbuilding to industrial machinery and plants, machine tools, rolling stock, aerospace and car assembly.

The merged company Daewoo Heavy Industries will be the Republic of Korea's second largest listed company in terms of paid-in capital.

Analysts believe the merger will benefit both companies. Some say the shipbuilder would see profits improve over the next 10 years, while Daewoo Heavy's business, though strong, would slow down because of sluggish investment.

With an improved cash flow, the enlarged company would be able to invest actively in heavy industry, enabling it to also ride any world slump in shipbuilding by reducing its dependence on that sector. Daewoo plans to cut shipbuilding activity to 31.3 per cent of total sales from 50.1 per cent.

Even though foreign investors are not expected to show the same frantic interest in Daewoo Heavy as they showed in Samsung Heavy, the new issue is expected to attract both foreigners and domestic investors. (Extracted from *A Supplement to Lloyd's Ship Manager*, Vol. 15, No. 3, June 1994)

Regional moves keep costs down

ASIA Pacific Seafoods Pty. Ltd.—established in 1986—is developing regionally into lower production cost countries.

Singapore will, however, remain headquarters of the company's expanding operations. The firm, in line with other seafood companies in Singapore, also plans to move into value-added packing for overseas markets.

Asia Pacific markets around 3,000 tons of seafood products a year . These include about 50 per cent shrimp (farmed and wild), cephalopods, lobster tails and fin fish.

A variety of shrimp species are offered including black tigers, whites, pinks, flowers and browns.

Squid and cuttlefish products available include whole, whole cleaned, squid tubes, squid fillets, cuttlefish fillets, heads and sides, and calamari rings.

Fin fish species are also supplied, including silver and black pomfrets, red snapper, milkfish and croaker.

Lobster products available include whole green, whole cooked, rock lobster tails, slipper lobster tails, deep-sea lobster tails (scampi) and lobster meat.

While most seafood products delivered by Asia Pacific are frozen, the company also deals in canned tuna, mackerel and sardines, as well as dried foods. (Extracted from *Fishing News International*, Vol. 33, No. 3, March 1994)

Wesmar sets-up in Chile

WESMAR (Western Marine Electronics), which has been supplying sonars to Latin America for many years, has set up its own sales and service company in Chile.

Wesmar Chile, established in Santiago, which also serves other South American countries such as Peru, Brazil and Argentina , carries a stock of spare parts and is able to provide a very fast replacement service.

Every Chilean purse-seiner is equipped with sonar. Once a vessel locates a large school with its longer range primary sonar, the skipper will raise the sound dome and

start using his small sonar – usually a Wesmar SS270 – at a range of about 800 metres.

He continues to use the Wesmar sonar until he has the fish in the net, continuously checking this on the screen.

Both sonars are very important to Chilean skippers. However, very long range sets are not required. This is because the companies know where the fishing areas are, get satellite weather information and, in some cases, schools of fish are pinpointed by spotter aircraft.

Wesmar's new HD series scanning sonar is an extremely powerful small sonar that is said to give 40 to 45 per cent more range than the firm's older SS270.

According to David Zaharia, Head of Wesmar Chile, Chilean skippers who have used the new Wesmar HD670E sonar are extremely happy with it. They comment particularly on the set's greater range of 1600 metres and its superior reliability.

Owners requesting a long stroke hoist when ordering HD670E are improving the performance of their new sonar, according to Wesmar.

Air bubbles caused by high vessel speed or wind interfere with sonar performance by absorbing sound energy. Wesmar's new long stroke hoist systems are designed to extend the sound dome below these bubbles, where the sound beam operates at greater efficiency.

The Wesmar long stroke utilizes a self-contained hydraulic system which permits extremely fast retraction. In emergencies, the dome can be quickly retracted into the sea chest to avoid damage—in just five seconds in the case of the HD670E-8. (Extracted from *Fishing News International*, Vol. 33, No. 3, March 1994)

Chilean yard builds between repairs

Chilean shipyard Astilleros Arica S.A., a member of the Angelini group, is building a purse-seiner with a fish hold capacity of 400 cubic metres, between repair work.

The new vessel, which is being constructed for one of the Angelini group's fishing companies, will have an overall length of 109 ft., beam of 29.4 ft. and depth of 13 ft. Propulsion will be provided by a Caterpillar D3516 diesel engine, while the hydraulic net-handling equipment will be from Petrel of South Africa.

The purser will probably operate off northern Chile targeting sardine, anchovy and other pelagic fish.

This region is said to have probably the best fishing weather in the world with fishing over the entire year, except for the one-month closures dictated by regulation to protect resources.

At times, vessels from one port move up or down the coast and deliver in other locations, during which time the crew must be accommodated on board.

Fish are pumped out of the net into the vessel, with the latter delivering to the plants primarily through discharge barges, which pump the fish from the boat through submarine pipes to the plant.

The appearance of much greater amounts of fish off northern Chile towards the end of last year had ensured that the fleets were being worked hard. Astilleros Arica's main activity is repair and the yard constructs new vessels only between jobs. (Extracted from *Fishing News International*, Vol. 33, No. 3, March 1994)

Tuna ship orders for yard in Brazil

INACE (Industria Naval Do Ceara SA), Brazil's biggest shipyard for medium-sized fishing vessels, is responsible to a great extent for a fishing boom in the capital of Ceara.

The yard, with sales of up to $30 million a year, has five orders for tuna ships each worth between $3 and $5 million.

Antonio Gil, owner and president of Inace, sees even more work in renewing and repairing old fishing boats and in the construction of new tuna-catchers.

More boats will be needed if tuna takes off as a viable new fishing resource for the north-east, he maintains.

Today, fishing represents one third of the yard's business and declining fishing fortunes in the area in the mid-eighties forced it to diversify.

Repair work is now a staple and an 80 by 15.5-metre platform means that vessels of up to 4,000 tons can be lifted.

Until 1985 the yard concentrated on building a shrimp fishing fleet for the new companies setting up in the north-east. Over 400 vessels were finished.

Between 1969 and 1974 new fishing boats were built of steel for the first time instead of traditional wood.

New companies emerged including Inprapesca, Orgapi, Marimar and Amazonica, so another 200 boats were built at the Inace yard.

Inace also began to run its own lobster and shrimp processing plant with a 70-strong fleet. Now, over 3,000 of 11,000 boats in the north-east are lobster boats and 3,000 tons are produced by the plant annually.

Antonio Gil says the *jangada*, the archetypal artesanal fishing boat still in evidence along the Ceara coast, was the norm in the north-east in the early sixties.

Thirty years ago the fishing fleet anchoring at Fortaleza's main port would have been inconceivable. Now, the shipyard is spread over an area of 150,000 m² and is close to the old heart of Fortaleza.

Industrial Naval do Ceara was established six kilometres away from the present central site and cost Antonio Gil $1 million to set up.

He was selling kit-type versions of fishing vessels for $60,000. In the early days of the lobster industry they used to cost three times as much. Some 200 boats were churned out by the yard in the first three years. (Extracted from *Fishing News International*, Vol. 33, No. 3, March 1994)

On the beach

There is increasing international concern over the advanced age of a number of vessels in the world fleet. According to statistics produced in mid-1992 by Lloyd's Register, more than 47 per cent of world tonnage was 15 or more years old. This situation is the result of the shipbuilding boom of the late 1970s and the effects of the current world recession. Another factor is a shortage of yards involved in scrapping.

Scrapping ships is a highly technical and often dangerous operation. It was once carried out in two main areas – Taiwan, Province of China and the Republic of Korea – where expertise was high. Environmental and other considerations have now taken a hand and scrapping has passed mainly into the hands of China, India and Pakistan.

But these countries do not at present have the technology to operate as efficiently as Taiwan, Province of China and the Republic of Korea once did. The scrapping of a VLCC, which could be expected to take about a month in Taiwan, Province of China or the Republic of Korea, can now occupy a yard for anything up to a year.

According to the Joint Committee for Shipbreaking Promotion, formed by the Japanese Shipowners' Association and the Shipbuilders' Association of Japan, there is an urgent need to increase the amount of scrapping of older tonnage as part of a concerted effort to eliminate substandard ships. The Committee is currently involved in a campaign to gain support for this initiative.

There is a general shortage of suitable scrapping facilities. The scrapping capacity of a yard is generally expressed as the area multiplied by the productivity, including labour, equipment and technology. This measurement, however, is dependent on how these factors are assessed. There are two main methods of scrapping obsolete tonnage—beaching and demolition afloat.

The steel that is recovered is rerolled into bar, and used predominantly in residential construction. This type of reprocessed steel is generally inferior in quality to that produced in electric furnace steel mills, but is much cheaper to produce. The scrapping industry in some countries can pose strong competition for the electric furnace steel producer which has been established as the main source of supply for domestic steel production. In these circumstances, some administrations have imposed tariffs on ships bought for scrap, in order to protect the home-produced product. This has an artificial effect on the shipbreaking industries in some countries, totally unrelated to market forces. The international scrap market is affected by the supply of ships and the price of steel, both of which are liable to violent fluctuations. This is demonstrated by the light displacement price of steel, which in June 1989 was $240 per ton and stood at $160 per ton in June 1994, having fallen to around the $120 per ton mark at the beginning of the 1990s.

The Committee's forecast for the volume of ships ready for scrapping for the period from 1993 to 2010 is expected to top 58.6 m gt, with a boom between 1996 and 2000, when 18.6 m gt is expected to be demolished. The outlook for scrapping capacity currently stands at about 10 m gt per year, insufficient to cope with anticipated demand, which could rise to 26 m gt. (Extracted from *Fairplay*, 16 June 1994)

Agreement on deepwater subsea technology

The signing of an agreement between the BP Statoil alliance and Brazilian operator Petrobras over the exchange of expertise on deepwater subsea technology and multiphase transport looks set to be yet another example of the rapidly changing face of the offshore industry.

Whilst there have been many examples of joint ventures in various parts of the world going back decades, the concept of an alliance based on the transfer of technology rather than on purely financial terms is not only refreshing but also proves that the principles of the recent Cost Reduction Initiative in the New Era (CRINE) are beginning to develop an international flavour.

For while Petrobras will have access to both BP and Statoil's horizontal drilling and multiphase technology expertise, the Alliance will benefit from Petrobras' deepwater experience for their own E&P activities offshore Nigeria and Viet Nam.

The Brazilians were able to achieve these impressive results by wholeheartedly embracing the very guidelines that have only recently been outlined in the UK sector by the CRINE initiative.

Co-operation between operators has already occurred with the advent of the DeepStar programme, which is designed to allow for companies to pool their experience and resources for developing deepwater fields in the Gulf of Mexico.

In addition, other groupings have been developed. The link-up between the BP Statoil Alliance and Petrobras, could have a major impact in the development of subsea fields in the North Sea and in other areas.

Statoil says that diverless technology is currently being used on more than 100 wells in the North Sea in water depths of up to 350 m. Statoil's experience gained from the subsea wells on the *Gullfaks*, *Tommeliten* and *Loke* developments, which are mainly based on diverless technology, forms the basis of the operator's future subsea technology for remote, deepwater applications. The Statoil BP Alliance is looking at applying these technologies in areas including West Africa, Azerbaijan and Viet Nam.

Together with its own studies, the Alliance closely observed the developments made by other companies, especially Petrobras in Brazil. The Alliance was so impressed by the Brazilian company's expertise in deepwater technology that it approached Petrobras to propose a technology exchange agreement between the companies.

The technology agreement, which was signed in Rio de Janeiro on 13 May 1994, should be of mutual benefit to both countries with their experiences gained in different regions and environments worldwide. (Extracted from *Euroil*, June 1994)

Triple Award

Three companies in the Keppel Integrated Engineering of Singapore group have achieved ISO 9000 status.

Keppel Engineering has obtained certification for the fabrication and erection of steel structures and associated mechanical and electrical works. Sister company Keppel Automation obtained it for the supply, installation, maintenance and engineering services of electronic and automation systems. And Oil Equipment Manufacturing has been certified for the design and manufacture of machined components and steel structures.

Keppel Engineering and Keppel Automation were certified by Lloyd's Register, and Oil Equipment Manufacturing was certified by Det Norske Veritas Quality Assurance.

Keppel Corporation will begin shipbuilding and repair operations in Viet Nam, following the approval by the State Committee for Co-operation and Investment.

Keppel BaSon Shipyard & Engineering Limited, in which Keppel has 60 per cent and BaSon Shipyard 40 per cent, will repair and build ships for foreign and Vietnamese shipowners. It will also provide onshore and offshore steel fabrication and engineering services.

Keppel BaSon will operate from a site belonging to BaSon Shipyard in Ho Chi Minh City on the Saigon River. Under the agreement, the joint venture company will lease facilities from adjacent BaSon Shipyard, including a

slipway and three docks comprising one drydock of 17,000 dwt capacity and two floating docks of 20,000 dwt and 5,000 dwt capacity. The new company also intends to develop its own facilities such as workshops, cranes, fabrication yards and building berths for vessels up to 100 metres long.

The group has also signed a memorandum of understanding with BaSon Shipyard and Vung Tau Shipyard to study the feasibility of setting up another shipyard in Vung Tau, about 100 km south-east of Ho Chi Minh City and located near the centre of oil exploration activities in Viet Nam. The proposed yard will fabricate offshore structures for the oil and gas industry as well as undertake ship repair and building. (Extracted from *Association of Singapore Marine Industries News*, January February 1994)

A second career

Single-hull supertankers may have the chance of a second career—to haul some 39 million tons of ready-to-drink water annually from Malaysia to the Middle East. Backers of the project—Ambangan Selasih Sdn Bhd and Milcon Gulf Ltd.—are looking at acquiring 13-15 second-hand VLCCs for the $561 million venture. Some $331 million will be allocated for the purchase and conversion of the VLCCs into large water tanks, with the rest spent on a bulk terminal and other storage and handling facilities.

The water will be drawn from the man-made Kenyir Lake in Trengganu and relayed by a 70-km pipeline to a modern treatment plant and reservoir located near the coast. Once purified, it will be pumped via a subsea pipeline to a mooring area about eight kilometres offshore. The project, which was officially sanctioned by the Trengganu state government in December 1993, is scheduled to come onstream in 1996.

The tankers will be converted into large water storage units in Polloc Harbour in south Philippines, where Milcon is constructing a larger VLCC scrap yard. Essentially it involves cleaning up the tanks of all traces of crude oil, sandblasting the walls and then coating them to prevent corrosion. Each VLCC modification is expected to take six months. (Source: *Association of Singapore Marine Industries News*, January February 1994)

Third hotel-related contract for SML

Sembawang Maritime Limited (SML) has won a $2 million contract to modify a cargo vessel into a floating hotel. The award from Odesta Pte. Ltd., is the third hotel-related contract clinched by SML.

Work on the *Ocean Paradise*, which began last December, involves fabrication, refurbishment, removal of existing structures and installation of a new accommodation module and other hotel amenities for 128 hotel guests and 55 staff and crew. It will have two generators to supply power to the air-conditioning plant and two fresh water distillation plants to provide fresh water for the vessel. On completion, the *Ocean Paradise* will sail for the Indian Ocean islands of Maldives, where it will be stationed. (Extracted from *Association of Singapore Marine Industries News*, January February 1994)

Two Flying Cats delivered to the Republic of Korea

Kværner Fjellstrand's Singapore yard delivered two Flying Cat 40 m catamarans to operators in the Republic of Korea in less than a month during March-April. The first, *Nam Hae Queen*, is a 349-passenger version ordered by Nam Hae Express for its Mokpo-Hong-do Island route in the south-west of the country.

The second, *Paradise*, has been added to Won Kong Shipping's fleet of 15 conventional ferries operating in the north-west between Inchon and outlying islands. The vessel is equipped for 380 passengers and is, Kværner Fjellstrand says, "amongst the first passenger catamarans to be fitted with onboard biochemical sewage treatment plants and aircraft vacuum toilets". (Extracted from *Fast Ferry International*, May 1994)

Westamarin FoilCat 2900 shipped to Indonesia

The FoilCat 2900 foil assisted catamaran completed by Westamarin West in 1992 was shipped from the Norwegian company's Mandal yard in 1994 and was due to enter service in Indonesia on a route in the northern part of the Straits of Malacca.

Westamarin's Swedish parent, Swede Ship Invest, has recently formed a joint venture company, Swede Ship Intilintas, with PT Pelayaran Intilintas Tirthanusantara, a Jakarta-based company that represents the Swede Ship group in Indonesia. (Source: *Fast Ferry International*, May 1994)

New orientation for fast ferries

The recent commitments of major traditional ferry operating groups in Europe to high speed ventures must stimulate the investigation of fast ferry opportunities worldwide. Asia is a particularly promising arena.

Swedish-based Stena AB, which claims to be the world's largest ferry operator, booked a pair of HSS (High-speed Sea Service) new buildings in 1994 from Finnyards for its Irish Sea route. The massive catamaran is designed to carry 1,500 passengers and 375 cars (or 50 trucks and 100 cars) with a speed of 40 knots-plus yielded by an 81,600 shp General Electric gas turbine KaMeWa waterjet propulsion plant.

The passengers will not be confined to seating (as in contemporary fast ferries), but are free to access lounges, bars, restaurants, tax-free shops and other amenities. A higher volume of onboard sales is expected to contribute to operational profitability.

The Norwegian group Kværner, while reporting a generally depressed market for new fast ferry business, nevertheless logged contracts for 11 catamarans in 13 months. The orders have included 40-metre Flying Cats for operators in China and the Republic of Korea. Kværner's Omastrand facility in Norway will supply a 447-passenger version to the Dalian Steamship Company (its second) for a 32.5 knot service between Dalian and Yantai.

Among the deliveries during 1994 was a 40-metre Flying Cat from Kværner's Singapore yard for Mabua Intan Express of Indonesia. Also commissioned from the Singapore yard was a pair of 449-passenger 34 knot craft for service with the Hong Kong and Yaumatei Ferry Company, running between Hong Kong and Tuen Mun.

Kværner recently restructured its fast ferry building and operational activities under the umbrella of the mainstream shipbuilding division.

Australian fast ferry designers enjoy a high profile in the SE Asian market, particularly in China. Austal Ships, the Western Australian yard, has sold over 20 high speed aluminium catamarans in the 40 metre size range since its first delivery in October 1990, and claims to be the world's

largest builder of such craft. The company, whose current annual production runs to eight vessels, is investing in a second yard. The new Tervoise Bay facility will be capable of building fast ferries of over 100 metres in length and with the capacity to carry up to 900 passengers and 220 vehicles.

Austal ships unveiled a 57-metre passenger car-carrying design in 1994, which reportedly offers a low-cost entry level for operators targeting new and low density routes. Involved in cooperation with a leading North-European ferry company, the craft has capacity for up to 56 cars and 450 passengers. An alternative car deck layout incorporates a raised centre bridge deck to accommodate four coaches.

Speeds up to 36 knots are promised by a choice of propulsion plant options which include Paxman Diesels' new 12VP185 high speed engine. Seakeeping studies have indicated comfortable operations in wave heights of 2 to 2.5 metres, thanks to a new ride control system. (Extracted from *Lloyd's List Maritime Asia*, November 1993)

C. OCEAN RESEARCH

Major EU research programme to assist coastal engineering design

A major pan European research project, code-named NEPTUNE, is being mounted to develop an approach to the calculation of the integrated effects of wave and tidal conditions during extreme storms on shorelines and structures along the north-west European coastline.

NEPTUNE is being coordinated by BMT Port & Coastal in a two and half year project which is receiving a contribution of ECU 1 million from the European Union MAST (Marine Science and Technology) Research Programme.

NEPTUNE involves six prominent European scientific and academic organizations including Lancaster University and the Climate Research Unit in the UK, Delft Hydraul Rijkswatersaat and Erasmus University in the Netherlands and GKSS in Germany. The UK Proudman Oceanographic Laboratory and the Norwegian Maritime Institute are providing special data to the study. (Extracted from *BMT News*, November 1994)

Anechoic tile reduces unwanted acoustic reverberation

Chemists at Seaward International (Clearbrook, USA), teaming with acoustical engineers from Vector Research Company of Rockville, Maryland, have created the SEAWHISPER Anechoic Tile System, a new elastomeric research tank liner, to reduce unwanted acoustic reverberation in underwater research tanks. Built in modular components, the SEAWHISPER material is highly effective, lightweight, and easy to install.

Initial performance testing of the tile system has been so successful that Seaward and Vector have formed an alliance in anticipation of demand. Seaward will manufacture the elastomeric components, with Vector providing acoustic design support.

In addition to the SEAWHISPER Anechoic Tile System, Seaward has developed an entire series of new elastomer products for underwater sound absorption and sonar applications. These include an acoustically transparent sonar window; an elastomeric baffle (patent pending) that blocks sound transmitted from shipboard machinery to the sonar; sonar transducer encapsulants; and elastomeric materials for towed sonar systems.

For more information, please contact George Reagan, Seaward's Vice President of Engineering, at 1-800-828-5360. (Source: *Looking Seaward*, Winter 1994 1995,

The use of composites in marine environments

In a paper presented at the conference "Structural materials in marine environments" organized by The Institute of Materials and held in London on 11-12 May 1994, R.S. Dow and J. Bird who were with the Defence Research Agency, Dunfermline, Fife, Scotland, reviewed current and potential future applications of composite materials in the marine environment. Reference was made to small boats, fishing vessels, larger passenger and cargo ships, naval vessels, high performance craft, underwater vehicles and superstructures in ships and offshore platforms. Their use in the repair of steel structures was also considered. Problems of material selection were discussed with reference to alternative resins and reinforcements, mechanical properties, and durability in the marine environment, as well as fire resistance and electromagnetic characteristics. Problems of structural design were also discussed with reference to stress analysis, fatigue and buckling failure, design of connections and fabrication methods. Comparisons were made between alternative forms of hull design (Source: *Ironmaking and Steelmaking 1994*, Vol 21, No. 6)

Steel — concrete composite construction: behaviour and opportunities in the marine environment

In a paper presented at the conference "Structural materials in marine environments", organized by The Institute of Materials and held in London on 11-12 May 1994, G.W. Owens of the Steel Construction Institute, Ascot, Berkshire, UK, commenced with a historical introduction to the use of composite construction. The paper reviews the primary features of behaviour under static and fatigue loading for beams and columns and describes the more common applications of composite construction, analysing the necessary practical requirements for widespread successful application. It concludes that composite construction has been most successful when sound structural technology is complemented by simple fast construction and is applied in structural forms that offer some additional benefits; these may be as diverse as easy services integration or fire insulation. A similar breadth of consideration will need to be satisfied if composite construction is to succeed fully in marine environments. (Source *Ironmaking and Steelmaking 1994*, Vol. 21, No. 6)

Steel — a versatile advanced material in marine environments

In a paper presented at the conference "Structural materials in marine environments" organized by The Institute of Materials and held in London on 11-12 May 1994 the use of steel as a major structural material for marine applications is discussed in a keynote addressed by J. Billingham and reported in *Ironmaking and Steelmaking 1994*, Vol. 21, No. 6, with emphasis on its versatility enabling it to be used for a number of different applications requiring steel of vastly different strength levels and forms, ranging from low strength (250 MN m^{-2} yield) structural plate to high strength (700 MN m^{-2} yield) mooring attachments. The importance of steel weldability in ensuring that fabrication schedules are met and that fabrication costs are contained is emphasized. Recent trends to make more extensive use of higher strength steels (>400 MN m^{-2} yield) to save both weight and cost are considered, and the advantages and limitations of such materials are discussed together with the key changes in composition and processing which have enabled these developments to take place. Dr. Billingham is Director, Marine Technology Centre, Cranfield University, Cranfield, UK. (Source *Iron and Steelmaking 1994*, Vol. 21, No. 6)

R&D Highlights

Wave energy - JOULE II

Specific interest in the European Parliament in 1990 led to the launching within the Joint Opportunities for Unconventional or Long-term Energy Supply (JOULE) programme of some preliminary research actions in the field of wave energy. A budget of 1.2 million ECU was made available for an 18-month study.

In cooperation with experts from the wave and general energy fields, the Commission drew up a proposal document early in 1991. Their preliminary actions had the objectives of establishing the current state of European wave energy knowledge and producing recommendations for a future focused research programme.

Overall coordination was carried out by the Directorate General XII and an ad hoc steering group composed of 10 experts from six member States, assisted in technical management and information dissemination.

The actions were organized into four research projects as described below. Initial findings were announced at an EC workshop held in Cork, Ireland, and final results presented at the 1993 European Wave Energy Symposium in Edinburgh, Scotland.

Preliminary actions

A. Resource evaluation: established a common methodology for evaluating the wave energy resource. This involved standardization of appropriate parameters to describe a wave climate and its variability of different time scales. The study examined the range of wave data sources and investigated their suitability to wave energy evaluation. Although concentrating on the North Atlantic, other seas were considered, i.e. the Mediterranean and North Seas. The initial study will lead to the production of a European Wave Energy Atlas.

B. Wave Energy converters: many of the barriers to the development of practical wave energy converters are linked to technical uncertainty of systems and components. These produce difficulties for realistic cost assessments. Studies were required to evaluate device technical problems and identify priorities for future activity on both a generic and specific basis.

The project was subdivided into five sections: device fundamentals and hydrodynamics; device components and materials; power take-off systems; electrical systems, controls and grid interactions and methodology for reliability, costing and environmental impact.

C. European pilot plant: investigated locations and design parameters for a medium scale (0.4 - 1.0 MW) shoreline Oscillating Water Column (OWC) type pilot plant. The OWC would be developed in conjunction with industry and serve as a European platform for research into wave energy devices on a practical scale. Of particular interest are problems associated with air turbines, primary control systems, electrical control systems and grid interaction.

D. European wave energy research network: an organization to encourage collaboration between the various groups active in the field of wave energy R&D at both the European and international levels. The Network appraises the exchange of information in relevant technologies, produces newsletters and workshops to focus effort on certain topics and develops themes for joint ventures. The communication system is also used to facilitate exchange of personnel between research groups and encourage common usage of European laboratory equipment. (Source: *WaveXength*, No. 2, Summer, 1993)

European Wave Energy Symposium

The Symposium, which took place in Edinburgh, Scotland, in July 1993, was sponsored by the European Commission and the United Kingdom Department of Trade and Industry and was an important event for the various groups researching wave power. Organized by the National Engineering Laboratory, Glasgow, Scotland, with scientific coordination by the European Wave Energy Research Network Secretariat, the conference was constructed into nine sections, each on a separate, specific topic. Not only was it the first coordinated by a Directorate General, but was also timed to coincide with the announcement of a financial support package under the JOULE II programme. Over 100 delegates from 20 countries attended the three-day symposium.

The technical divisions were: resource assessment; physical modelling, tank testing and power take-off; device technology and development; OWC performance enhancement; air turbine configuration options; general technology and development; existing prototype devices; wave energy converters and planning and economics. (Extracted from *WaveXength*, No. 2, Summer, 1993)

OWC converters

Several variations of the Oscillating Water Column (OWC) converter have already been built around the world, including experimental floating systems in Japan. Outputs range from a few watts on navigation buoys to a 0.5 MW unit on the cliffs of Norway. China, India and the United Kingdom are already operating small devices and all countries plan increases, whilst Canada, Fiji and Mexico are also investigating the technology.

In Europe plans are being drawn up under the European Commission's JOULE II research programme for medium scale (500 kW to 2 MW) pilot plants. Although long-term development will necessitate the use of the open ocean floating devices, the fixed shoreline based units should provide considerable advances in the scientific understanding of economic ways to harness the oceans' vast wave power resource. (Source: *WaveXength*, No. 2, Summer, 1993)

Composites save lifetime costs for offshore oil developments

In the context of current oil prices, the oil industry is looking for ways to save money on offshore facilities and also on R&D programmes. The managed programme "The Cost-effective Use of Fibre-reinforced Composites Offshore" organized by the Marine Technology Directorate Limited (MTD), offers industry the chance to share the costs of a joint industry programme to enable the low weight and durability of composite materials to be safely exploited. The £1.47 million third phase will build upon the considerable success of work in the first two phases to predict the behaviour of composites in impact, fire and sea water, and the performance of pipelines carrying fluids under pressure. This is the largest managed programme so far funded by MTD and the largest programme in the world dealing with the use of composites offshore.

Typical uses for composites, usually glass-reinforced polymers, are firewater mains, structural panels, walkways

and gratings. Research at the participating universities has investigated the fire resistance of panels and pipes, the impact resistance of panels, pipes and grillages, complex design loadings including blast, degradation in process fluids and water, and offshore applications. The programme has collaborated with the UKOOA Fibre Reinforced Polymer Workgroup, which is working to develop international standards for the use of composites offshore, initially for piping.

Important findings have been made about flammability in the recently completed phase. A special test furnace was build to generate fundamental data about the fire performance of GRP components. For example, the combination of thick GRP skins with a refractory core can show impressive levels of structural integrity in hydrocarbon fires. Thick single skin laminates also have considerable potential for passive fire protection. The fire test results have enabled a sophisticated model to be developed for fire resistance of pipes and panels, and further data will be obtained during the new phase of the programme.

One potential hazard for composite panels used in blast walls is damage due to projectiles. Modelling the mechanics of impact, combined with experimental results, should enable designers to quantify the response to an impact of given energy. Similar studies have been made of the results of impact on GRP pipework and composite gratings used for walkways.

The effects of blast following a gas explosion have been the subject of experiment with small- and medium-scale panels and with theoretical modelling. The possibility exists of scaling up the test results to give valid full-scale data. Other results offer scope for detailed improvement in the design and manufacture of tee-pieces in composite pipework.

These and other projects will help the development of design codes and working standards for composite materials, which will help to increase their use offshore. Structural composites have only been researched for 25 years, compared with over a century of sustained investigation of structural steel. By focusing on fundamental work, the management programme will provide the composite manufacturers and users with the basic data that they need to supply the offshore industry with. (Extracted from *Scandinavian Oil-Gas Magazine*, March/April 1994)

Revealing the benefits of composite propellers

The use of fibre-reinforced plastic composites in the marine industry has been steadily increasing and it has been predicted that the use of composites will overtake the use of steel by the year 2010. The number of novel applications is increasing and the range of metal components that lend themselves to a redesign in composite material with consequential benefits is very wide.

The potential benefits to both user and designer of manufacturing propellers in a composite material have been highlighted by a team from the Advanced Composite Manufacturing Centre and the Institute of Marine Studies, both at the University of Plymouth, UK.

Presenting their paper on "The Composite Propeller" to a conference discussing the impact of new technologies on the marine industries, Tim Searle, David Short and John Chudley revealed that the design of a propeller in a composite material allowed for design features not possible with isotropic metals. It was easier to tailor blade deformation for different vessel operating conditions, which had important implications for fuel efficiency and manoeuvrability and a significant weight reduction by some 75 per cent over the equivalent bronze propeller would give a reduction in vibration and faster acceleration to the desired speed.

The authors first studied the loads that a propeller is subjected to in order to produce a composite structure able to support these loads plus give an adequate margin of safety. Material for some of the propellers consisted of 24 plies of unidirectional glass and four plies of quadraxial glass in epoxy resin. But as with any new material, its success depends on the ability of the manufacturing process to produce the designed properties and characteristics. The chosen method was resin transfer moulding – dry reinforcing fibres are placed in a dry mould into which resin is injected at low pressure and or drawn in under vacuum.

Laboratory experiments of a 12 in. dia. three-bladed propeller are being conducted to establish fitness for purpose; so far the unit has performed well and deformations were found to be small for the theoretical load. Tank testing is to be conducted to establish the propeller's efficiency and long-term endurance. (Extracted from *MER – Marine Engineers Review*, March 1994)

D. GEOGRAPHICAL ROUND-UP

Africa

Tunisia: British Gas adds oil production

British Gas plc. has started oil production from Cercina field, north of the Kerkennah Islands off Tunisia.

Initial oil flow is about 1,000 b d from one well, although production is expected to rise quickly to 4,000 b d by two more wells completed during field appraisal.

The production volume is important to Tunisia because the country produced only 89,000 b d of oil during the first two months of 1994. Production was off 14,000 b d from the same period in 1993.

Located in the West Kerkennah permit, which includes offshore acreage and three onshore producing fields, Cercina was developed using three subsea wellheads sending oil by flow line to a production ship for processing prior to storage aboard barges. The barges carry the crude to an export terminal at La Skira.

The concession is owned by operator British Gas and Tunisian State Oil Co. (ETAP), which holds a 51 per cent interest.

The West Kerkennah permits Rhemoura, Gremda/El Ain, and El Hagab Guebiba onshore developments currently produce a total 4,500 b d of oil, which is processed locally and transported to La Skira terminal for export. (Extracted from *Oil & Gas Journal*, 6 June 1994)

Americas

Argentina — infrastructural and port development expansions

The Governments of Argentina, Brazil, Bolivia, Paraguay and Uruguay have undertaken the "Hidrovia Parana-Paraguay" project, which includes a joint government agreement on navigation, regulations, pilotage, buoys and dredging of the waterway from the River Plate to Caceres in the heart of the Brazilian state of Mato Grosso. One of the primary objectives of the scheme is to facilitate the transport of bulk cargoes, minerals, crops (soya beans), lumber, etc. by water (river transport) to the transhipment ports serving maritime shipping in Argentina and Uruguay. Political and financial backing has been partially secured for this massive undertaking which, if carried out, may well result in much of these cargoes being diverted from Brazil's southern coastal ports. The project is still in its early stages and alternative routes by rail and road transport could still be improved to compete with the "Hidrovia" scheme.

Throughout Argentina, signs of competition are emerging in the port system which was once known to be underproductive, expensive in international terms and inefficient. The Argentine economy will now be the biggest beneficiary of port reforms, by slowly shifting a network of ports along the Parana River into private hands. (Extracted from *Bulk Journal International*, May 1994)

Peru proceeds with port privatization

The first port in Peru to be privatized in a drive for increased efficiency of the port services and expansion of trade under private management is the Maritime Terminal of Ilo located in the south of Peru, close to the Chilean border. This privatization is not an isolated project but part of an industrial commercial development policy for the southern region of Peru and Bolivia.

The Governments of Peru and Bolivia have reached an agreement named "Gran Mariscal Andres de Santa Cruz" to establish two free industrial zones to stimulate the economic and foreign trade activities of both countries in Ilo. Additionally, the road from Ilo to La Paz (Bolivia) is being improved to allow the Maritime Terminal of Ilo to offer full port services to Bolivia. In fact, the terminal is planned to be developed as the main harbour for general cargo to and from La Paz and vicinity.

Privatization is to be achieved through a public tender for the concession of the port, which will cover only the basic infrastructure. Before the tender, any maintenance of the port infrastructure will be performed by the Government to transfer the infrastructure to the investor operator in good condition.

The investor operator will determine whether to buy new equipment or buy parts of the current equipment from Enapu, the State-owned port authority. The concession will be for 30 years, with a possibility of renewal for a further 10 years. (Extracted from *Bulk Journal International*, May 1994)

Venezuela — PDV Marina confirms product tanker programme

The State-owned tanker company PDV Marina has confirmed that it will be ordering four 40,000 dwt product tankers as part of a fleet replacement programme. The four vessels will be used in the coastal trades and will replace four existing units. Delivery will be between mid-1996 and mid-1997. Tenders from shipyards around the world will be sought, based on a specification of 40,000 dwt, a maximum draft of 11.3 m, a maximum beam of 32.2 m, and a service speed of 15 knots. These are guidelines, as the vessel will be chosen from yard standard designs. (Source: *Fairplay*, 16 June 1994)

Asia

China — ambitious Dalian

With the finishing touches slowly being applied to a brand new VLCC size building dock, a new era will soon be embarked upon by China's shipbuilding industry, which has enjoyed steady growth and gained prosperity in export business over the last decade.

The new dock will be commissioned for Dalian New Shipyard towards the end of this year, fulfilling the latest phase in an ambitious programme, which is lifting the Dalian shipbuilding complex into the big league. From humble beginnings in 1981, when a handy-sized bulk carrier design formed the first of a tranche of export contracts for Hong Kong ownership, Dalian has become the jewel in the crown of Chinese shipbuilding achievement.

Drawing upon its natural deep water environment, which severely restricts construction size in the south of the country, substantial progress has been made in practical terms towards fulfilling a cherished ambition of building the world's largest ships. Shipbuilding originally began at

Dalian in 1858 with the opening of the eastern complex, but its potential is limited to Panamax size due to the length of slipways and tightness of space. Since 1984, shipbuilding capacity has expanded to the western site where construction of vessels in excess of 100,000 dwt had been planned since 1971.

In order to co-ordinate a new marketing strategy and corporate identity for the modern western complex, this was renamed Dalian New Shipyard in 1991. The eastern site continues to be known as Dalian Shipyard, but the distinctions are very important.

Coupled with its new identity and facilities expansion programme, a vigorous marketing campaign is paying dividends with valued export business in place or under negotiation. The current trend away from construction of domestic ships by the Chinese authorities suits Dalian nicely since it has previously hampered export ambitions. Against a call for a capacity reduction in world shipbuilding, senior management acknowledges the serious risks involved in an ambitious expansion programme. Apart from a desire to build bigger ships which are most cost-effective, and where there is a brighter future, there was an overwhelming necessity to move away from the eastern site. Subsequent moves by the Republic of Korea and Japan to build new VLCC docks would appear to vindicate Dalian's move into the future – there is likely to be a concentration on ordering vessels in excess of 100,000 dwt over the next few years.

In April, Dalian New Shipyard proudly commissioned the biggest vessel ever built in China – *the Samarinda* – which at 150,000 dwt marks the prototype of three units ordered by Belgian and Hong Kong interests. Her delivery underlines the dramatic progress made. One of a pair contracted in late 1991 for a Belgian account, the new bulk carrier has been entirely designed by the yard to DNV class. Being a new design, productivity problems were encountered, but circumstances are sometimes outside of Dalian's control due to the exacting design classification standards it tackles for environmentally safer ships.

The concentration on Capesize units is not without significance. Chinese companies are keen to relinquish their dependence on chartered tonnage and enter into joint shipowning ventures. Chinese steel production is increasing significantly against a booming economy, prompting the largest importer of iron ore Baoshan Iron and Steelworks – to set up direct ship owning ventures.

Two partnerships have been secured with Neptune Orient Lines, Singapore and Island Navigation Corp., Hong Kong. The former resulted in secondhand purchases with a view to new buildings later.

Apart from the new VLCC dock, Dalian New Shipyard offers two slipways for construction up to Cape and Suezmax size. The design portfolios at the yard allow adaptation of bulker hulls for tanker construction, which is the other mainstay of employment.

For example, the Belgian bulk carriers were preceded by delivery of four small ro-ro's to the same group. Using the customer loyalty card, Dalian successfully persuaded Norwegian owner Anders Wilhelmsen, in collaboration with the US based OMI Corp., to place the first ever Suezmax tanker order in China. Dalian Shipyard has in hand an official order backlog spanning seven tankers and taking employment into June 1996. (Extracted from *A Supplement to Lloyd's Ship Manager*, Vol 18, No 3, June 1994)

India to build ocean thermal power plant

The State Government of Tamil Nadu, India, has signed a Memorandum of Understanding with the Sea Solar Power Company (SSP), of the United States, for construction of a 100 MW ocean thermal energy conversion plant.

Under the agreement, the State Government will pay for power delivered at the shore, while SSP would bear the entire cost of building and operating the ocean thermal plant. The plant will be built off the coast of Tamil Nadu, located at the south-eastern tip of India, at an estimated cost of $250 million.

The project is still subject to approval by the Ministry of Environment and the Department of Defense. (Source: *International Solar Energy Intelligence Report*, 16 May 1994)

Japan's industrial science and technology frontier programme (9). Platform technology for exploiting undersea resources

With only limited mineral resources, Japan requires technologies to exploit the non-ferrous metal resources on the deep seabed, such as manganese nodules and cobalt-rich crust, to ensure a reliable supply of rare metals or other essential materials for high-technology industries. In addition, most of Japan's energy resources today come from overseas. In particular, petroleum is a vital commodity for Japanese industry and society. To secure a reliable supply of petroleum, technology to exploit submarine oil fields is necessary.

The challenge is to research and develop technologies concerned with undersea resources, including submarine minerals and oil. The task is more serious for submarine mineral resources. The United Nations Marine Law Treaty in effect as of November 1994 prescribes that mining concessions to exploit deep-seabed minerals should be provided only to companies having the necessary exploiting technologies. The UN will assess the engineering qualifications of the applicant. As Japan has applied for mining concessions off the Hawaiian Islands, technologies advanced enough to qualify as a developer of submarine minerals are needed.

The Industrial Science and Engineering Research Development Institution has begun the research and development of platform technology to exploit undersea resources to secure a reliable supply of minerals and energy to Japan and to boost the growth of resource industries.

The goal is to develop an efficient, economic and safe mining technology to obtain such undersea resources as manganese nodules, cobalt-rich crust and oil. The technology consists of the following systems:

Total system: The feasibility of developed sub-systems is checked. Another objective is to prepare an ocean test plan that will gather the various design data necessary for future commercial production systems. Other tasks include investigation of a laboratory ship and the commercial production system, and coordination among sub-systems.

Collector system: The goal is to develop an automated guided vehicle to pick up deep-seabed ore.

Lifter system: A lifter tube to be developed to act as a transport duct for submarine ore and at the same time a tower cable for an ore collector. Also under development is an ore lifter system based on an air lift.

Measurement and control system: The objective is to set up a system to control, monitor and measure sub-

systems, and to develop a composite high-tension cable containing an optical fibre and high-voltage power supply.

Handling system: The system under development will be capable of lifting a string of oil pipes up and down for submarine excavation or other undersea equipment from a rolling ship.

Gas lift system: The artificial (gas) lift technology will be improved to use gas injected upstream under high pressure.

Research and development was initially focused on manganese nodules. In FY 1992, submarine oil was added, and since FY 1993 the cobalt-rich crust has been included. Activities have been restructured as the development of general platform technology to exploit undersea resources. The experiments have been made more effective and simple to reduce the budget.

As a consequence, at the beginning of FY 1994, equipment development of the lifter and measurement systems was completed, and the handling and gas lift systems have finished component technologies. The development of an automated guided ore collector and investigation and coordination of the total system and sub-systems are being prepared for general ocean tests scheduled for FY 1988.

Engineering development has so far been concentrated on components and independent sub-systems. The current challenge is to build the total system while coordinating the sub-systems so that the 1998 general ocean test can be performed.

Big challenges, such as making a vehicle waterproof and insulated on the deep seabed and understanding the dynamic characteristics of the vehicle running on the seabed must be evaluated. To obtain necessary design data of the ore collector, joint exploration of the proposed experimental sea area was undertaken. The findings of Metal Mining Agency of Japan's investigation will be used in further work. (Source: *JETRO*, December 1994)

Philippines — new well

Shell Philippines Exploration's 3 Malampaya well north-west of Palawan Island flowed 24.8 MMcfd of gas and 953b/d of condensate, setting the stage for Shell to drill a fourth well before deciding on commerciality.

Vaalco Energy Inc., Houston, Texas, is preparing to work over the producing A-1 well to block water-producing zones in West Linapacan field north-west of Palawan. Vaalco's A-4 West Linapacan well, previously the A-2 sidetrack, flowed 3,000 b/d of 32.5° gravity oil. West Linapacan field was due to be back on full production of about 7,000 b/d in June 1994. (Source: *Oil & Gas Journal*, 6 June 1994)

Republic of Korea — New economic and technology zone

Under a 50-year land-use contract, a zone has been opened in the eastern port of Tianjin, for investors from the Republic of Korea. Situated on 1.2 square km in the Tianjin Economic and Technology zone for foreign investors, the new area will enable Korean firms to provide Korean technology and capital for their ventures. The zone is being developed by State-owned Korea Land Development Corporation, at a cost of $30 million.

Singapore's growing fish trading base

With few fishery resources of its own, Singapore is facing increasing competition from other countries in the region as it exports seafood products to international markets.

However, the country's geographical location, developed infrastructure, efficient telecommunications system, good air and sea port facilities, banking and financial expertise, ensure that it is still able to play an important role in seafood trading.

The possibility of any increase in domestic catch is minimal. This is why fishery development priorities have been oriented towards providing support to the fish trade.

Fishing port and market infrastructures have been upgraded to attract a greater number of foreign fishing vessels to land catches in Singapore, where commercial fisheries joint ventures have been encouraged.

The Seafood Industries Association of Singapore (SIAS) has been active in promoting the export of seafood products through Singapore and to seek raw materials from non-traditional sources. It has set up the company SIAS Pte. Ltd., to enable local seafood industries to start joint ventures with interested overseas parties for processing, importing and exporting seafood products.

In the last 10 years the number of fish processing establishments licensed by the Primary Production Department for processing and exporting seafood products has doubled and many of these plants, including those producing surimi-based products, have automated their production lines.

New technologies and processes have been utilized to produce better quality products and new value-added lines, such as imitation crab meat, lobsters and prawns.

With assistance from the Department some of the plants have implemented on-line monitoring programmes for their production lines, to ensure that their products are of consistent good quality.

A safety certification programme to provide health certificates required by importing countries has also been established. (Extracted from *Fish News International*, Vol. 33, No. 3, March 1994)

Singapore — US$100 million investment

US-based oilfield services company, Baker Hughes, plans to invest over $100 million in Singapore over the next three years on a new field maintenance depot in Jurong to service the expanding regional offshore oil and gas sector. This will bring its investments in Singapore to $180 million. Chief Executive Officer James D. Wood expects the oil sector to see annual growth of 5 to 10 per cent from next year till 1998.

Baker Hughes Singapore is the company's regional headquarters for the Asia Pacific Middle East region. It is one of five recipients of the Business Headquarters Programme, a tax incentive programme launched recently by the Economic Development Board to attract companies to base their business headquarters in Singapore. (Source: *Association of Singapore Marine Industries News*, January February 1994)

Singapore — Poorer performance

For the second consecutive year the Singapore marine industry suffered a 9 per cent decline in output. Last year, output dipped to $2.7 billion.

The industry's mainstay, ship repair, repaired almost the same number of ships as the year before, but as hard-pressed shipowners skimped on repairs, work packages were smaller. Margins also fell because of the sharper

competition in Singapore, the Middle East and the Republic of Korea.

The lower margins depressed the marine sector's labour productivity, which fell 4 per cent to $51,451 per worker. Productivity in the major shipyards may have improved, but subcontractors' productivity declined or stagnated because of high labour turnover.

The industry's workforce also contracted, falling by nearly 3 per cent to 21,998 workers. (Source: *Association of Singapore Marine Industries News*, January February 1994)

Europe

Bulgaria has new yard

A new shipbuilding yard is planned in Varna, Bulgaria. It will be created by reconstructing facilities that have been neglected since the 1970s near the existing Varna Shipbuilding Yard, which is responsible for the revival scheme.

Three building berths and two repair docks will be reopened, and the new facilities will create jobs for 1,500-2,000 people. They will be able to build ships of 5,000-60,000 dwt, but initial plans are for production of nine vessels per year, of 5,000 dwt, 11,000 dwt and 12,000 dwt.

A memorandum signed in May 1994 in Bulgaria marks the start of a process to recognize the maritime training centre in Varna as a branch of the World Maritime University. (Source: *Lloyd's Ship Manager*, June 1994)

Cyprus — Port developments

Cyprus' two main ports, Limassol and Larnaca, have developed into major transit centres within the eastern Mediterranean, handling close to 300,000 TEU in terms of containers, or over 2.2 Mt of transit cargoes. These ports are multi-purpose, both possessing container terminals which led to the significant development of such traffic.

During 1994, the Cyprus Ports Authority (CPA) has been implementing a number of projects as part of its master plan for the development and upgrading of the facilities at all of the island's major ports. This includes the construction of several deep water berths capable of serving third and fourth generation vessels. To serve this additional traffic, the port will be equipped with two gantry cranes, and a new tug boat of 35 tons bollard pull has also been ordered. Moreover, stacking capacity is being increased to allow for expanding container traffic.

At the port of Larnaca, the opening of a new passenger terminal in August 1993 permitted it to look forward to a more stable flow of cruise traffic, compared to the volatile traffic of the past, which relied totally on political developments within neighbouring Lebanon. This new modern terminal can handle 500 passengers per hour.

With regard to the port of Limassol, the CPA has already set in motion the realization of Phase A of its plan to create a new terminal with a capacity of 300,000 containers, equipped with new post Panamax cranes as well as the relevant container stacking equipment.

The new berths to be created will have a depth of 14 metres which can be expanded to 15 metres. Moreover, two new Voith Schneider tug boats are expected to join the CPA's fleet in 1995 when the new terminal will become operational.

Along with improvements in infrastructure and in handling capacity, the CPA is expected to embark on a number of measures aimed at enhancing productivity and creating a new institutional framework consistent with modern technological techniques and the requirements of modern navigation and international trade. Procedures are constantly being simplified and computerization has been introduced to link the ports of Cyprus with those of the Mediterranean and Europe. Port operations are expected to be fully computerized by the middle of 1995, whereas the rest of the CPA's activities will be fully computerized by 1996. These significant developments mean that in spite of increasing competition, Cypriot ports have a significant role to play in the island's economy as well as in the Mediterranean. (Source: *Lloyd's Ship Manager*, June 1994)

Greece orders from Ukraine

Lavinia, the Greek ship owning specialist in the maritime transportation of refrigerated cargoes, has ordered seven multi-purpose vessels from the Ukrainian yard "61 Kommunar" for delivery between 1995 and 1997.

The orders follow similar contracts over the last three years by Lavinia, also known as Laskaridis, which specializes in the fish trade. The company last year ordered four 7,504 ft³ units from the Nikolayev yard. These followed delivery in 1992-1993 of five 7,135 ft³ vessels.

Also designed to carry fruit, a sector Lavinia hopes to develop, the new vessels are to be built in two series: four of 14,158 ft³ and three of 7,645 ft³.

The "61 Kommunar" yard specializes in reefer vessels. Most of the ships it has built over the last 30 years have been used in transporting fish processed by Soviet factory ships to the Russian Federation.

The Ukrainian yard's prices are said to be 25 per cent below those practised in Asia. (Source: *Lloyd's Ship Manager*, Vol. 15, No. 3, June 1994)

Ukraine's first management company

Ukraine's first full-service third-party ship management company has been established in Odessa.

Tor Shipping (Ukraine) Ltd. was established at the end of January and director Igor Matveev was expecting the company to begin managing a 30,000 dwt bulk carrier shortly. His Russian clients were completing their purchase and the ship will change hands at the end of its present charter. Negotiations are said to be in hand for further tonnage.

Mr. Matveev and his fellow directors were previously part of the bulk carrier department at the Black Sea Shipping Co. and they emphasize their expertise in this area. They believe that there is a demand for their services, as trading companies, importers and exporters consider investing in shipping despite their lack of experience.

The first client had initially considered general cargo tonnage but, on hearing of Tor Shipping's plans to concentrate on bulk carriers, amended their plans so as to use its services.

Tor Shipping has been set up as a Cyprus-registered joint-venture company, with the Odessa office operating as an agent, as far as Ukrainian tax legislation is concerned. (Source: *Lloyd's Ship Manager*, Vol. 15, No. 3, June 1994)

E. TECHNOLOGY UPDATE

New profile marking and cutting line developed

Total Transportation Systems (International A S (TTS)'s commitment to develop cost efficient production equipment has led to the introduction of a profile marking and cutting line for medium-sized shipyards.

The profile marking and cutting line features a "state-of-the-art" CNC controlled marking machine. This provides the profile with marking for endcuts, intermediate cuts such as waterholes, reference lines and signing. The bending line marker function eliminates the need for templates for profile bending. Cutting is performed manually.

In order to facilitate an increased production capacity the line can be upgraded to a Robot Cutting Line by the installation of a cutting robot. This adaptability of the line enables the yard to meet changing requirements and distribute investment costs over a longer time-frame.

The line requires one operator. The controlling programmes are loaded directly from the shipyard's CAD system. The line has been developed with the collaboration of Kranendonk, TTS's Dutch partner. (Source: *TTS Newsletter*, March 1994)

Robotized production of webs and components

Total Transportation Systems (International) A S (TTS) has developed a robotized line for the production of webs and components, which is an integrated production system for the assembly and welding of sub-assemblies for ships.

The production line is specially designed for processing of plates with stiffeners. The transport system is divided in two parallel line segments: the onload, assembly and tackwelding areas and the welding areas. Workpieces are moved through the line on worktables, which are transported on a roller conveyor transfer system. Each table supports one or more workpieces through the line, from loading to offloading.

For assembly and tackwelding, a manually operated stiffener mounting gantry is used.

When the tackwelding is completed, the worktable is automatically transported to one of the robot stations. The dual-robot gantry or the single-robot gantry will then automatically complete the welding work.

The entire line is computer controlled, and all actions can be monitored on strategically placed terminals. Programming of the robots is performed offline, utilizing macro technology. The computer system can easily be connected to the customer's host computer system for central planning, CAD-interfacing, etc.

The line configuration described here has a production capacity that enables processing of units for 3-4 bulk carriers or container carriers per year (160,000 TDW, 230 work-days, 2 shifts, 3-5 operators).

The configuration by no means is fixed. The production line can be tailormade to suit the needs and requests for a variety of customers, production volumes, and build programmes.

The robotized web and component line has been designed in collaboration with Kranendonk Factory Automation (Holland), and ABB ESAB Robotic Welding (Sweden). (Source: *TTS Newsletter*, February 1994)

Seawater desalination with solar system

Shiroki Corporation and the Industrial Research Institute of Kanagawa Prefecture (Japan), have jointly succeeded in seawater desalination with solar heat.

The system uses a solar system developed by the Industrial Experimental Station as the heat source of a distillation system using low-pressure steam. An experimental plant has succeeded in separating a 3 per cent sodium sulphate aqueous solution (artificial seawater) into a 6 per cent sodium sulphate aqueous solution and fresh water. The running cost, including fuel cost, is decreased substantially, and the company plans to commercialize the system within two years.

The experimental plant is an application of the vaporization technique that is one of several fresh water generation technologies. Low-pressure steam of 110 C generated by boiling seawater through solar energy is piped into a sealed container, then cooled with water and the seawater further vaporized to obtain distilled water by utilizing the temperature and pressure differences generated in the cooling process.

Up to the present, fossil fuel has been used as the heat source for seawater vaporization, with a depressurizing system, which raised the running cost. In contrast, the new system produces fresh water with low-pressure steam, so the depressurizing system becomes unnecessary, and the use of solar energy reduces the running cost substantially. The cost of a ton of fresh water based on the existing vaporization method or reverse osmosis method is ¥ 200-300 t, but using solar energy it enables the cost to be reduced to about ¥ 100 t. Further details from Shiroki Corporation, Solar Technical Dept., 373, Shinyokohama, Kuohoku-ku, Yokohama City, Kanagawa Pref. 222. Tel.: +81-466-44-8571. Fax: +81-466-45-8427. (Source: *JETRO*, December 1994)

Owners are demanding more from the new tanker generation

While OPA '90 may have determined that from now on all tanker newbuildings will have double hulls, it did not present shipowners and builders with a uniform blueprint for standardized tanker design, but provided a departure point for the creation of a new generation of more environment-friendly ships. Also a growing disenchantment with the service experience from a recent generation of tankers has fuelled a reappraisal of tanker design.

Two of the leading classification societies – ABS and Lloyd's Register – have addressed these concerns with their SafeHull and ShipRight programmes. Though each of the two societies approaches the problem somewhat differently, both SafeHull and ShipRight should result in ships that are far better able to withstand real-life operating conditions throughout their service lives.

ABS's SafeHull, for example, is a development of its Dynamic Loading Approach (DLA) to design. This unleashes the power of the computer to handle the gigantic mathematical task of modelling how a hull structure will actually respond to all of the dynamic loads it is likely to

encounter at sea. The first ship to be designed using the DLA technique is Mobil's 280,000 dwt *Eagle*. This 332 m x 58 m VLCC incorporates a host of advanced safety and environmental-protection features that go far beyond anything demanded by OPA or MARPOL.

Mobil pioneered double-bottom tankers more than 20 years ago with a series of five 212,000 dwt VLCCs. It sees the double hull as a further evolution of the double bottom. The inner hull width selected for the *Eagle* is 13 ft on the sides and 9 ft on the bottom. The 9-ft bottom space is ideal for inspection and maintenance, allowing a person of average height to effect a repair when standing on a longitudinal.

The greater width at the side, which resulted from ballast space requirements, also provides greater protection against collisions—which present a more probable hazard than groundings.

Though double hulls may protect against collisions and groundings, they also raise a number of safety concerns in that more of the cargo tank area is exposed to water-ballast spaces, increasing the potential area into which hydrocarbon vapour can leak from loaded cargo tanks.

Mobil has developed a hydrocarbon vapour system that takes samples from the water ballast space. Water ballast lines run in the double bottom of the ship to fill and empty the water ballast spaces. With specific modifications, the company integrated the ballast system with an atmospheric hydrocarbon sampler system, that can be programmed and operated from the cargo control room.

Large vapour samples will be taken from selected tanks and thoroughly analysed for hydrocarbons. If hydrocarbons are detected, the ship can use the inert gas system to quickly remove the oxygen that could trigger an explosion or fire.

Corrosion is another critical concern in double hull designs. Mobil therefore specified high quality, abrasive resistant epoxy coatings of a light, reflective colour, for the ballast tank coatings. The side ballast surface area, which is subject to the effects of sloshing ballast water, was given a two-coat application. The coating system is backed up by a zinc anode system.

The machinery outfit features a number of redundant systems. Thus, at sea electricity is supplied by a turbo-generator powered by waste heat from the 28,000 hp Sulzer 7RTA84M main engine. Alternatively, it can be run off either of two boilers. If neither boiler is operating, then the diesel generators are available.

A look at some other recent tanker deliveries indicates that Mobil is not alone in opting to exceed rather than merely meet OPA and MARPOL requirements. For example A.P. Moller's 299,700 dwt *Eleo Maersk* has a 3.2 m deep double bottom and 3 m wide double sides: 50 per cent above MARPOL requirements. Comprehensive finite element analyses were carried out to produce a structure capable of sustaining a bottom raking damage of 88 per cent of the length between perpendiculars. (Extracted from *Marine Log*, May 1994)

ESP innovation

Centrilift, a division of Baker Hughes Ltd. has achieved a major breakthrough in Electric Submersible Pump design with its new KC 20000. This ESP has a diameter of only 5.62-inch, but the capability of producing over 30,000 b d from horizontal high-rate wells requiring artificial lift. The efficiency for the KC 20000 is an impressive 70 per cent with a head of 50 ft for each stage at the specified flow. Because of the multi-staged centrifugal design of ESPs, where the diameter is often limited by the casing diameter constraints, it has taken innovative techniques in intake and impeller design and manufacture by Centrilift to make this achievement possible. A number of KC 20000s are already installed on BP's Wytch Farm field and on Chevron's Alba project. (Source: *Euroil*, June 1994)

SEAWATCH offers innovative technology

SEAWATCH is a major tool for decision makers who in earlier times were obliged to act with inadequate scientific data and information. A fast-growing marine environmental surveillance and forecasting system of OCEANOR (Oceanographic Company of Norway A S). SEAWATCH consists of the following modules: (i) data acquisition; (ii) data storage, analysis and presentation; (iii) environmental modelling and forecasting; (iv) distribution of data, forecasts and user-relevant information.

The data acquisition includes a network of moored marine environmental data buoys providing real-time data covering meteorological parameters, currents, waves, sea temperatures, oxygen, algae, nutrient contents, radioactivity, etc. The data are transmitted to a shore station where they are further checked, analysed and stored before they are distributed to users.

For further information on the SEAWATCH system, contact: OCEANOR, Pir Sentered, N-7005 Trondheim, Norway. (Source: *ims Newsletter*, UNESCO No. 71, 3rd quarter 1994)

The cpp with blade pitch activated by propeller shaft rotation

The Autoenergy concept from the Spanish company Propulsion SL, is said to be the only controllable pitch propeller on the market which does not require any mechanical installation inside the ship, making the conversion from fpp to cpp a very simple task.

It is claimed the propellor possesses "an ingenious system in the interior of the hub that eliminates all installation inside the vessel." This system, as explained by the company, consists basically of two hydraulic pumps in the propeller hub, one main and one auxiliary unit for emergency purposes, which are fixed to the propeller shaft by gears mounted on a cogged wheel. The wheel is fixed by a rod at the stern post of the vessel.

When the shaft turns the gears rotate, effecting movement of the hydraulic pumps, which then raise pressure and inject oil through a four-way valve and a steering blocking valve into the piston chambers, which in turn effect movement to the blades to change their angle.

A pneumatic control system on the bridge sends a signal to activate the four-way valve in a forward or backward mode which gives blade pitch adjustment.

The Barcelona-based company believes it has a unique system which affords a simple replacement of fixed pitch propellers, achieving considerable fuel savings as a result. It can, of course, be installed on new ships.

The company says it has two of the systems installed, one on a fishing vessel and one on a tug. (Source: *MER—Marine Engineers Review*, March 1994)

Resistant hose

A range of high-performance reinforced coolant and turbo-charger hoses designed for harsh marine conditions has recently been introduced by Samco of the United Kingdom.

Made from various types of silicone, and reinforced to suit the application, the hoses can withstand temperatures ranging from -100° C to +315° C. The company can also supply standard-sized elbows, obtuse angles and straight lengths from stock, with special order items supplied on a fast-track basis.

For further information contact: Samco Silicone Products, 12 Sandridge Park, Porters Wood, St. Albans, Hertfordshire, AL3 6PH, UK. (Source: *Fairplay*, 28 April 1994)

Environment-friendly water-based paints

The increasing concern over emissions of Volatile Organic Compounds (VOCs) from paints and coatings has led to strict legislation in a number of countries, with the aim of reducing such emissions to an acceptable minimum, thereby significantly contributing to the reduction of air pollution and smog formation world-wide. This environmental move will be achieved through either replacing the solvent-based coatings with water-based coatings, or by lowering the solvent content to below defined levels.

However, the legislative position regarding solvent emissions is extremely complicated, being a mixture of enforced legislation and voluntary programmes in individual territories and between cooperating groups such as the Nordic countries. It is inevitable that VOC legislation limiting solvent content of coatings will spread to other parts of the world, leading to changes in product ranges and restriction of choice. It is therefore anticipated that the volume of water-based paint will increase significantly as a result.

Users of paint materials can significantly contribute to the reduction of pollutant emissions in a number of ways. The most practical way, however, for users of marine coatings would be through the selection of coatings such as water-based systems.

Marine Coating Company International's (Courtaulds Coatings Ltd.) solution to ship operators' problems in this area is two new water-based products—Intersheen Aquaprime, a fast-drying acrylic primer, and Intersheen Aquacoat, a durable acrylic finish.

Engineered for a wide variety of vessel internals such as bulkheads and deckheads in engine rooms and accommodation areas, interiors of car/vehicle decks and reefer holds, the water-based systems offer benefits at newbuilding stage as well as maintenance and repair and onboard maintenance.

Compared to alkyds, Intersheen Aquaprime and Aquacoat offer excellent resistance to yellowing, fast drying, low odour, no thinners required, elimination of fire and explosion hazards, and low surface spread of flame for the applied system.

The above benefits mean a better working environment, enhanced health and safety for the applicator and better performance for the vessel operator.

It should be noted that water-based paints are not totally solvent-free, as they contain a small amount of special solvents needed to ensure that the coalescence takes place. The solvent content is, however, kept at a very low level, usually well below 6 per cent, significantly below that of solvent-containing coatings such as alkyds, chlorinated rubbers, vinyls and acrylics.

Water-based coatings do not have many disadvantages, although application at temperatures below 5° C is not recommended and good ventilation is required during the drying period. They have good adhesion to all kinds of substrates, and have a higher degree of both gloss and colour retention over a period of time than comparable solvent-based finishes. Also, water-based acrylic coatings, such as International's Aquaprime and Aquacoat, have good resistance to lubricating oil, which makes them ideal for use in ships' engine rooms.

As regards application procedures, there are no significant differences in the methods and tools of application when switching from solvent-based systems to water-based coatings.

To date, International's new water-based coatings have been used in the newbuilding market, as well as at maintenance and repair and onboard maintenance.

The passenger vessel market (both ferries and cruise ships) will particularly benefit from water-based systems for onboard maintenance work. Due to the fast drying and low odour characteristics of these coatings, onboard application will not adversely interfere with passenger activities or vessel sailing schedules. (Extracted from *Shipcare and Maritime Management*, March 1994)

Amercoat inorganic coating

Ameron B.V., The Netherlands, a subsidiary of Ameron Inc. California, recently introduced Amercoat 738 Polysiloxane Inorganic Coating, a patented high temperature self-priming protective coating with temperature resistance to over 1,000° C. Unlike other high temperature coatings currently available, this environmentally designed high-solids product has resistance to severe acidic conditions and a broad range of chemicals.

The coating can be applied at thicknesses of up to 250 microns per coat and does not require heat cure before service. It is suitable for direct application to steel and stainless steel, both exposed and under thermal insulation.

Since its introduction last year in North America, Amercoat 738 has been tested and proven in high temperature and high corrosion areas in the marine markets.

In addition, the company used its new proprietary polysiloxane technology in the development of a range of coatings offering exceptional ultra violet, chemical and heat resistance properties. These products were field-tested for commercial introduction some time this year. (Source: *Shipcare and Maritime Management*, March 1994)

F. INTERNATIONAL FOCUS

Business innovation centres in the marine sector

Most developing countries today consider business development and innovation together with foreign investment and technology acquisition adaption as critical factors in building internationally competitive capabilities. They supplement and utilize local R&D efforts and provide a strategic framework for the building of technological capabilities in the private sector. In support of this process, developing countries need assistance in several areas, including (i) the promotion of foreign investments and business alliances in the industrial sector; (ii) the strengthening and matching of local capabilities at the enterprise level and formal S&T sector to acquire, absorb and adapt technologies; (iii) by improving the technology management capacity at the enterprise level, in particular the ability to access relevant techno-commercial intelligence information and transform it into competitive business strategies; and (iv) by improving the ability at the governmental level to manage technological changes, and in particular the ability to formulate pro-active policies to maximize synergy effects between the technology acquisition process and domestic S&T efforts.

Following the Law of the Sea Convention, UNIDO has since the mid-1980s actively promoted regional centres for marine industrial technology, with the aim of strengthening the capabilities in marine technology and improving links between R&D institutes and the industry. This concept has now been developed further and seeks to address more directly the needs at the enterprise level. The objective has shifted from focusing on national S&T capabilities towards creating a mechanism which supports and facilitates technology driven business development in the marine industries sector, with a particular focus on small and medium scale enterprises (SME) and north-south cooperation at the enterprise level.

UNIDO has been promoting this concept for the Mediterranean region, and recently the Government of Greece has expressed an interest in creating and hosting such a centre. The main objective of the proposed centre will be to provide institutional support to the existing and emerging enterprises in the marine industries sector, particularly SME, in the field of market assessment, technology management, technical entrepreneurship development, business incubators, venture capital, identification of strategic business partners investors and the development of commercially oriented projects and elaboration of bankable business plans. In cooperation with the Greek Ministry of Industry, Energy and Technology, UNIDO is planning to carry out a pre-feasibility study of this concept, including an assessment of the regional support for the proposed centre, its potential industrial impacts, its financial requirements, its long-term sustainability and its possible funding options.

The results of this study are expected by September 1995 and will be presented at a regional UNIDO Expert Group Meeting in October. For more information, we refer to the UNIDO Technical Paper "The Concept of Business Development Centres in the Marine Industries Sector" and the promotional brochure "Mediterranean Centre for Marine Industries", which are available from the Technical Editor.

Utilization of marine non-living resources

The proceedings of the UNIDO Workshop on Marine Industrial Technology (Madras, September 1993) are now available. The workshop focused on industrial technologies for the utilization of marine non-living resources other than hydrocarbons. The proceedings include: (i) the conclusions and recommendations from the meeting; (ii) separate reports from the three working groups on ocean energy, ocean minerals and environmental impacts; (iii) 10 country papers; and (iv) 17 technical papers presented during five workshops sessions on "Deep Seabed Minerals", "Ocean Minerals within the EEZ", "Ocean Energy", "Environmental Impacts" and "The Development of Marine Industry and Technology". For more information, contact the Technical Editor.

UN develops cooperative oceanic programme

The United Nations Committee on Peaceful Uses of Outer Space (COPUOS) considers multilateral cooperation in the use and exploration of outer space. This includes remote-sensing programmes. The COPUOS Scientific and Technical Subcommittee annually discusses issues in space remote-sensing satellite systems. These discussions were instrumental in the adoption of a non-binding recommendation by the United Nations General Assembly. This Resolution (1) of 22 January 1987 on remote sensing from space included the essential principle that "remote-sensing activities shall be carried out for the benefit and in the interest of all countries, irrespective of their degree of economic, social, or scientific and technological developments".

The World Meteorological Organization serves as a model of this principle with its free and open exchange of meteorological data and information. Different space operators view space data acquisition and use in different ways. Cost justification and recovery can be a major consideration in the funding of specific satellite programmes by the governing bodies of the space agencies. However, IOC and WMO, in collaboration with UNEP and ICSU, are developing a cooperative oceanic programme that may become for the oceans what WMO's World Weather Watch is for meteorology. The Global Ocean Observing System (2) (GOOS) is coordinating a broad spectrum of oceanic observation systems. The WMO and IOC are cooperating in remote sensing oceanography through a new sub-group on Oceanic Satellites and Remote Sensing (OSRS). Co-sponsors will include the WMO's Commission on Marine Meteorology, the IOC's International Oceanographic Data and Information Exchange (IODE) and the joint IOC WMO Integrated Global Ocean Services System (IGOSS). OSRS is a technical sub-group and will carry a major responsibility for implementation of the satellite and remote sensing efforts in the marine environment.

The availability of global oceanic data to all users is a joint activity of the space operators and the user community. GOOS (3) as well as other global environmental programmes depend on this cooperation to provide the satellite data necessary to all who need it to solve pressing environmental issues and problems. To accomplish this, a data

policy is essential that provides data and information to the entire user community according to their requirements and capacities of its members. Also, this policy should not put any member or potential member of that community at a disadvantage The data policy in place for AVHRR and the low-bit-rate data from ERS-1 meets this criteria and should serve as an example for future data policy negotiations.

Notes

(1) Forty-first session, United Nations General Assembly, Agenda Item 72, Supplement No. 20, A/RES/41/65.

(2) James D. Baker. Toward a Global Ocean Observing System, Oceanus, Summer 1991.

(3) The Approach to GOOS (IOC document) IOC-XVII/8 Annex 2 rev., Paris, 12 March 1993 (English only), 18 pages. Available from: IOC Secretariat, UNESCO, GOOS Support Office, 1 rue Miollis, 75732 Paris cedex 15, France; Fax: (33-1) 4056 9316; omnet: goos.paris.

(Extracted from *ims Newsletter*, UNESCO, No. 69/70, 1st Semester 1994, Author: J.W. Sherman, III)

UN programme framework for integrated coastal area management

At the second session of the ACC Subcommittee on Oceans and coastal Areas (Geneva, January 1995) the participating United Nations agencies with activities in the field of coastal management suggested promoting a joint UN framework for Integrated Coastal Area Management (ICAM), including the establishment of a common conceptual approach in which the activities of each agency could be integrated. Priority areas include the development of sectoral guidelines, interconnection of information and data systems and human resource development. UNIDO is focusing on the industrial sector, and will seek to coordinate its sectoral strategies for Ecological Sustainable Industrial Development with the multisectoral approach of ICAM. UNIDO is also providing assistance related to monitoring of industrial pollution in aquatic ecosystems and technologies for decision support and data management in ICAM systems.

UN Committee on Oceans and Coastal Areas

The oceans, including enclosed and semi-enclosed seas, are an essential part of the global life-support system. They cover much of the Earth's surface, influence climate, weather and the state of the atmosphere and provide food and other resources for the growing world population.

The Law of the Sea provides an international basis for the protection and sustainable use of the seas. However, oceans are under increasing environmental stress from pollution, over-fishing and degradation of coastlines and coral reefs. Agenda 21, which arose from the Rio Declaration on the Environment and Development, is a dynamic programme addressing the pressing problems of today and also aims at preparing for the challenges of the next century. It reflects a global consensus and political commitment at the highest level on development and environment cooperation.

After the United Nations Conference on Environment and Development (UNCED), held in Rio de Janeiro in June 1992, the General Assembly created a functional commission called the Commission on Sustainable Development (CSD) to implement the results of UNCED. The New York based United Nations Department for Policy Coordination and Sustainable Development (UNDPCSD) was charged with servicing the CDS. To coordinate involvement of the United Nations system and facilitate the preparation of reports to the CSD, the Administrative Committee on Coordination (ACC) created a coordinating body called the Inter-agency Committee on Sustainable Development (IACSD).

At its second session, the IACSD approved the responsibilities and functions of Task Managers for the various chapters, issues and programme areas of Agenda 21. The main functions of these Task Managers are to promote information exchange and interagency contact, catalyze joint activities and programmes and develop common strategies to implement relevant parts of Agenda 21. In addition, the Task Managers are to prepare, in collaboration with the organizations concerned, coordinated inputs for the consolidated report of the Secretary-General, which will focus on common UN system strategies for the implementation of Agenda 21 and identify areas for further action for consideration by the CSD.

The Task Manager for Chapter 17 of Agenda 21 (Protection of the oceans, all kinds of seas, including enclosed and semi-enclosed seas and coastal areas, and the protection, rational use and development of their living resources) is the ACC Subcommittee on Oceans and Coastal Areas, which held its first session in Rome (Italy) from 19 to 21 April 1994. Its members are drawn from a number of United Nations entities and programmes, specialized agencies and related organizations.

Chapter 17 of Agenda 21 (Protection of the oceans, all kinds of seas, including enclosed and semi-enclosed seas and coastal areas, and the protection, rational use and development of their living resources), identified a number of programme areas (listed below) where new approaches to marine and coastal area management and development could be carried out at the national, subregional, regional and global levels. These approaches are integrated in content and are precautionary and anticipatory in ambit.

(a) Integrated management and sustainable development of coastal areas, including exclusive economic zones;

(b) Marine environmental protection;

(c) Sustainable use and conservation of marine living resources of the high seas;

(d) Sustainable use and conservation of marine living resources under national jurisdiction;

(e) Addressing critical uncertainties for the management of the marine environment and climate change;

(f) Strengthening international, including regional, cooperation and coordination; and

(g) Sustainable development of small islands.

At its first session, the ACC Subcommittee on Oceans and Coastal Areas made a number of decisions regarding its work plan and operating methods. In noting that Governments were to report directly to the Commission on Sustainable Development on their implementation of Agenda 21, the Subcommittee agreed to focus its work on progress made in the implementation of Chapter 17 through the United Nations system. On the methods of work the Subcommittee identified the types of action that each sub-task manager would be expected to undertake in meeting the terms of reference of the Subcommittee, as applied to the assigned programme area. Table 1 shows the

assignment of responsibilities of the various United Nations bodies involved in Chapter 17, while table 2 sets out the action expected to meet the terms of reference of the Sub-committee. The Subcommittee expected to hold its second session in late January 1995 in Geneva (Switzerland), with a third session late in 1995, possibly in New York.

Table 1. Assignment of responsibilities

Programme area	Sub-task managers	Participating agencies	Associated agencies
A			
Integrated management and sustainable development of coastal areas, including exclusive economic zones	United Nations/UNEP	WMO, IOC, IAEA, FAO, Habitat, UNESCO, [WTO][a]	IMO, World Bank, UNDP, ITU
B			
Marine environmental protection			
Sea-based pollution Land-based pollution	[IMO UNEP]	[WMO, IOC, IAEA][a]	FAO, United Nations, World Bank, UNDP
C			
Sustainable use and conservation of marine living resources of the high seas	FAO/United Nations	UNEP	UNDP, IOC, World Bank
D			
Sustainable use and conservation of marine living resources under national jurisdiction	FAO	UNEP	UNDP, World Bank, IOC, United Nations
E			
Addressing critical uncertainties for the management of the marine environment and climate change	IOC	WMO, IAEA, FAO	World Bank, UNDP, UNEP
F			
Strengthening international and regional cooperation and coordination	ACC Subcommittee on Oceans and Coastal Areas	UN, WMO, FAO, UNESCO, IOC, IMO, IAEA, ITU, [UNCTAD, UNIDO, ILO, WHO, IFAD][a]	World Bank, UNDP
G			
Sustainable development of small islands	United Nations	WMO, UNESCO, IOC, FAO, IMO, IAEA, UNEP, Habitat, [WTO][a]	World Bank, UNDP, ITU

[a] Subject to confirmation

Table 2. Action expected to meet the terms of reference of the Subcommittee

Terms of reference of the Subcommittee[a]	Action
Monitor and review progress in the implementation of chapter 17 and related matters of Agenda 21 and report thereon to IACSD	Periodic progress reports will be filed and implementation will be monitored at sessions of the Subcommittee
Prepare proposals to IACSD and other relevant bodies to enhance the effectiveness of cooperation and coordination, and facilitate such in the implementation of chapter 17 of Agenda 21, including financial means	Based on monitoring and review, gaps, difficulties and proposed solutions, including financial implications, will be identified. Probable focus will be areas at the interface between chapter 17 and other subject areas, such as freshwater, atmosphere and biodiversity
Consider and give effect to the possibilities and means of joint activities and programming for the implementation of chapter 17	The Subcommittee as a whole will identify ongoing and new opportunities for joint activities in which expanded collaboration would enhance implementation
Identify the needs for and facilitate the coordination of activities of the United Nations system relating to chapter 17	For implementation at the regional level, linkages between the UNEP Regional Seas Programme and regional bodies of other members will provide a viable framework for more effective collaboration. Activities at all levels will be reviewed to determine those of interest to more than one United Nations agency. Studies on areas of common concern will be commissioned. Will be considered at sessions of the Subcommittee
Interact with joint scientific and advisory bodies, such as the Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP), which may provide the scientific basis for policy recommendations	Present practice of referring to GESAMP certain questions for advice, especially in the field of coastal area management, will continue. A listing of other potential advisory bodies will be prepared for each programme area
Enhance the exchange of information, including information on relevant intergovernmental agreements and decisions, existing and proposed programmes, operational activities, and cooperative and coordinating arrangements; and promote, where appropriate, harmonized and shared information systems	Each sub-task manager will keep all members aware of relevant meetings, projects, decisions and publications to avoid duplication and increase efficiency. The Secretary will arrange for the inclusion of members in relevant ICAM database systems. The use of ASFIS as a joint information system will be kept under review.
Assist in the preparation of system-wide reports, as required, on developments with respect to oceans and coastal area issues and the implementation of Agenda 21 as regards the protection of the oceans, all kinds of seas, including enclosed and semi-enclosed seas, and coastal areas, and the protection, rational use and development of their living resources and related capacity-building	The Subcommittee will respond to any such requests as they occur

[a] ACC/1993/24, annex IV, para. 4

Trends in modern shipbuilding

Around the year 1900, building time on berth was almost equal to the total construction time of the ship. Three and a half to four years were needed in order to complete a ship.

Ships were constructed without any prefabrication of steel sections. A typical productivity level constituted 450-500 man hours per tons of steel.

Between 1930 and 1940, welding was introduced to the shipyards and larger cranes were installed at the berths. These two events made the construction much more rational and both construction time and productivity were improved considerably.

From 1940 to 1970 the technical development of the yards concentrated on further sophistication of the welding processes and improvements in construction philosophy as a result of increased lifting capabilities.

Numerically controlled cutting machines were introduced in the 1970s. CAD systems were developed and improved, and the data from these software systems were transferred to the cutting machines by means of hole punched tapes. The introduction of NC cutting machines

was an important milestone for the shipbuilding industry.

During the 1970s, the VLCC tanker boom occurred. The yards developed production lines for mechanized production of panels.

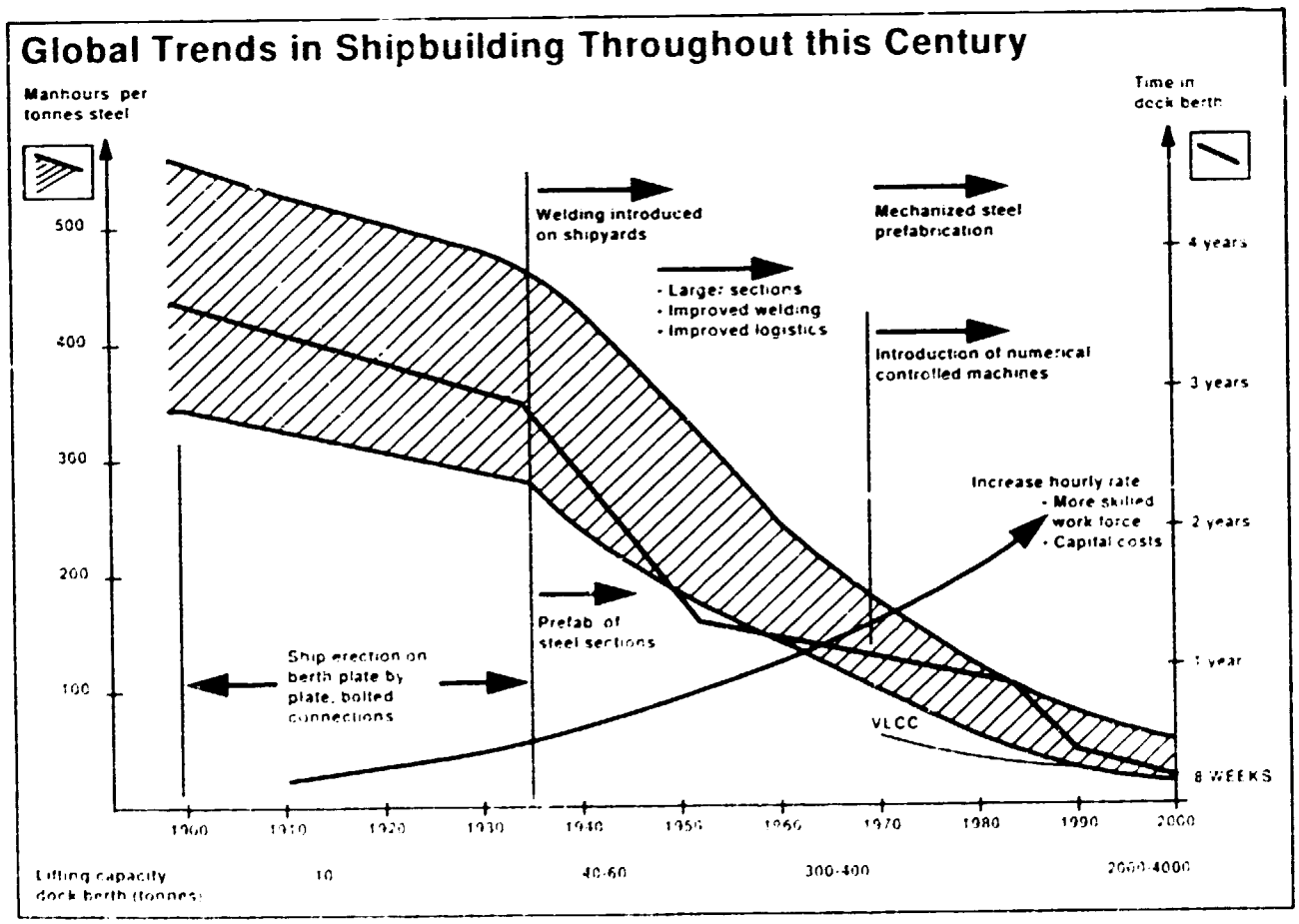
After the 1970s, development concentrated on the same areas, mainly heavy lifting and transport equipment, resulting in more efficient ship assembly methods, welding technology, computer integration, and mechanization of prefabrication of steel and outfitting. *Most of the current research and development is concentrated in these areas but on a more sophisticated level.*

In addition to the traditional areas of concern, efforts are being made to improve the operations at the yards. Key works like Organizational Development, total Quality Management, Project Management, Planning and Cost Control are essential in making the shipyards as profitable as possible.

Today's most important development work concerning shipbuilding technology may be summarized in the following:

- Heavy transport and lifting equipment are being developed further in order to improve productivity and capacity of the yards by making possible the prefabrication and preoutfitting of large units in front of the dock, i.e. improving the construction approach.
- Traditional welding processes, such as MIG MAG and SAW are being developed further in order to decrease heat input and increase welding speed.
- Keyhole welding techniques, such as laser and electron beam welding, are being continuously developed to facilitate the special requirement set by shipyards. The main goal of this development is the same as for the other welding processes as well as the reduction of consumable costs.
- The development of Computer Integrated Manufacturing Systems has been going on for several years. Such systems are now being utilized by shipyards. Further development is expected.
- New technology in prefabrication of steel and outfitting components makes all transport and handling work less time consuming. The welding and cutting technology is also further developed and automated. Prefabrication lines are linked to computer systems ensuring prompt and correct data transfer from the CAD system, and allowing feed back to the planning material control systems. Prefabrication of the ship is no longer the most labour intensive part of the production process.
- The mechanization of steel prefabrication has rendered the production process homogenous, resulting in improved dimensional accuracy. This feature, along with increased capabilities within computer integration made use of robotics attractive for the shipyards. Major developments will be performed within this field in the coming years.
- Organizational development, including implementation of Total Quality Management systems, is performed.

(Extracted from *"The Competitive Challenge for the International Shipbuilding Industry"*, ITS paper, November 1993, printed in *ITS Newsletter*, March 1994)



Maritime policy reform

Initiatives have been announced by US Secretary of Transportation Federico Peña. The US Coast Guard has been directed to execute a four-point programme to enhance maritime policy reform. The programme would permit reliance on standards promulgated by classification societies and permit fewer inspections of companies instituting rigorous quality management systems. Provisions will be initiated using a voluntary program developed by the Coast Guard in cooperation with the maritime industry. Contact: US Department of Transportation, Office of the Assistant Secretary for Public Affairs, Washington, DC 20590. (Source: *ISTM Standardization News*, September 1994)

Prospects of deep-sea mining

Commercial production from deep seabed mining remains "likely at some time in the future", though full-scale commercial production is not expected before the year 2010. This is the prognosis of a report submitted to the Preparatory Commission for the International Seabed Authority and for the International Tribunal for the Law of the Sea.

The report of a Group of Technical Experts on this topic, presented to the Commission at the first part of its 12th regular session (7-11 February 1994, Kingston, Jamaica), noted that poly-metallic nodules, found on the deep seabed beyond the limits of national jurisdiction, continued to represent "potential commercial prospects" which will be mined at some point in the future. The Group based its assessment on a number of factors, including the vastness of the resources on the ocean floor and "the absence of insurmountable technological obstacles" to their mining.

Despite its overall positive conclusions, the Group noted that an assessment of the time when commercial production from deep seabed mining may be expected to commence, can be made with further precision only when large-scale feasibility studies and deep seabed tests are undertaken over a sustained period. Source: Division for Ocean Affairs and the Law of the Sea, Office of Legal Affairs of the UN, New York, USA. (Extracted from *ims Newsletter*, UNESCO 1994)

ECOR: an NGO on ocean engineering

The Engineering Committee on Oceanic Resources (ECOR), which is an international non-governmental society of professional engineers and an advisory body to IOC and IMO, carries out a number of studies within the realm of its mandate. These projects are implemented by international working groups, which must report their findings within three years. Examples of such studies include: (i) a reliability analysis of offshore oil and gas structures, (ii) a working group on marine robotics (supported by IOC) which explores the potentials of automated underwater vehicles (AUVs), and (iii) the potential of modern underwater acoustics methods and equipment for applications to coastal erosion, pollutant dumping and discharge. For more information on ECOR, and how to obtain its published reports and its magazine ECOR *links*, readers may contact: Ms. Dolly Loth, ECOR Executive Secretary, c/o SUT, 76 Mark Lane, London EC3R 7JN; Tel: (44-171) 481 0750; Fax: (44-171) 481 8001. (Source: *ims Newsletter*, UNESCO 1994)

Health of the Ocean (HOTO) model

A 10-member scientific panel met at UNESCO Headquarters in February 1994 to put finishing touches to the Health of the Ocean (HOTO) model, one of five (the others deal with climate, living resources, coastal zones, and marine operational services) being set up under the new Global Ocean Observing System (GOOS).

Initiated in March 1992 by the Intergovernmental Oceanographic Commission (IOC) of UNESCO, in cooperation with WMO, UNEP and the International Council of Scientific Unions (ICSU), GOOS is expected to become fully operational by the year 2007 and will build on existing programmes, like the IOC Programme for Global Investigation of Pollution in the Marine Environment (GIPME).

However, GOOS will go much farther in its practical applications as an internationally coordinated system for data collection, analysis and prediction. Dr. Andersen, head of the scientific panel, said that "the easiest way to understand GOOS is to compare it with the world-wide meteorological system. So far we have no such structure for the marine environment."

As a framework for monitoring contaminants and assessing their effects, HOTO will serve as an early-warning system essential to the well-being of coastal populations and their economic activities, such as fishing and tourism. (Source: *UNESCO Sources*, No. 56, March 1994)

OI '94 is strong on technology and GOOS

Every two years commercial and industrial interests come to Brighton to display their latest marine technology. In March 1994 more than 500 companies exhibited their products and services; and the parallel Conference heard more than 130 presentations on technical themes. Twenty-five years ago, at the first Oceanology International, the future was clear. Offshore oil and gas production was becoming a major market for diving tools, cables, control equipment, surveys and logging equipment. Today the variety of equipment developed for these markets – making use of new computing powers, satellite images and communication channels, and measuring instruments – has prepared us for the next challenge of monitoring the ocean and forecasting operationally on local, regional and global scales.

The IOC and its programmes were well represented. The Global Ocean Observing System (GOOS) was the theme of several conference sessions. The Chairman of I-GOOS, Michel Glass, indicated how member States are committed to designing and implementing an observing system, which, although drawing on diverse existing observing programmes, will demand new technologies and bring new benefits. John Woods explained that the benefits will include reduced costs for existing operations and a range of new applications, including the exploitation of resources at the continental margin. Compared with most industrial sectors, the present spending on marine research and development, around 0.2 per cent of a $2 billion per day operating budget, is very small.

Challenges abound. At present there are no instruments capable of measuring air-sea heat fluxes to sufficient accuracy, and robust methods of measuring carbon-dioxide concentrations in the surface layers of the ocean are only now being tested. Even the application of existing technology for stable long-term measurements in the ocean's present industry with challenges and opportunities. The

Continuous Plankton Recorder, a pioneer in the field of monitoring ocean biology, is being redesigned by Valeport Ltd. for more accurate and more robust operation. Data gathering and transmitting buoys are not new, but the new generation, including that of the SEAWATCH system is capable of a range of measurements, accuracies and long-term unattended operation undreamed of in 1969. Satellite transmission allows instant application of the remotely measured data.

The theme for the 1994 meeting was "Looking forward to the next 25 years". Expansion, some of it rapid, is certain: the demands on the oceans – and particularly on the coastal zones – will continue to increase. The coming challenges with respect to developments required for coastal areas, food production and forecasting for management were also discussed. For this, the contributions of ocean research, technology, systematic observations and their integration are extremely important. The need for management strategies has already generated an industrial base for surveys and analyses of the marine environment. Most of these demands are being met on a local basis, but users are aware of the interdependence of the coastal and open oceans. Local observing and forecasting systems will be most effective if they are located within – and contribute to – a global network of observations. Once again we are being asked to act locally, but think globally.

IOC and its partners in GOOS have made a commitment to that future. Inevitably, the next 25 years will bring a huge expansion in our monitoring and managing of the oceans: the Exhibition at Brighton made that future very clear. (Source: *ims Newsletter*, UNESCO, No. 71, 3rd Quarter 1994)

G. SOFTWARE PRODUCTS

DNV Software supports design and research

In late 1993, three Chinese shipyards and educational institutions acquired the DNV-developed software system SESAM, for use in structural and hydrodynamic design and analysis of marine structures. The three are Dalian New Yard, Dalian Ship Design & Research Institute and Shanghai Jiao Tong University (SJTU).

Contact between the SESAM group in Det Norske Veritas (DNV) and potential users in China began in the early 1980s. This contact was first established through Chinese who had worked in DNV research and who had become familiar with SESAM. In addition, the PILOT programme from DNV had already been installed in several places in China, and established DNV in China with regard to numerical design verification of ships. DNV also marketed SESAM to Chinese yards, Dalian New Yard being one of these. In 1992 marketing was further strengthened with a concentration on the offshore side, where SESAM is regarded as the world's leading system. In August 1993 Dalian New Yard leased the first SESAM ship package installation in China. Later, the Dalian Ship Design and Research Institute also bought the ship package, and Shanghai Jiao Tong University – China's equivalent to the Massachusetts Institute of Technology – entered into an agreement for an extensive package of SESAM programmes within the university's research and training areas.

Det Norske Veritas Sesam AS (DNVS) can see a promising potential in China, particularly in the shipping sector where the use of the Finite Element Method (FEM) is becoming steadily more relevant. DNVS has good contacts with several of the most important designers and research institutes in China, where focus is placed on the use of FEM analysis. The company believes that more SESAM installations will follow in China in the near future. With SESAM, DNV offers a comprehensive tool in the form of software, competence and technology, which can help China to develop as a shipbuilding nation.

SESAM is a dedicated software system for structural and hydrodynamic design and analysis of marine structures. The objective of SESAM is to help the engineer achieve greater engineering efficiency and reduced costs in the construction and operation of marine structures that meet requisite standards for quality, safety and reliability.

The system is a specialized and efficient tool for the offshore and maritime industry with an integrated and special purpose facilities for structural modelling, hydrostatic and hydrodynamic load generation, including first and second-order wave diffraction analysis, linear and non-linear, static and dynamic FEM-based structural analysis, pile and soil analysis, results presentation and extended calculations for design, such as fatigue analysis and the checking of structural performance according to codes of practice for offshore structures.

SESAM is today used world-wide for design and operation of offshore and marine structures. Examples of typical structures are concrete gravity structures, steel jackets, a detailed FEM-model of a tubular joint and ship hull structures.

The programmes are used for small, medium and large models. For larger models of gravity-based or floating structures, such as tension-leg platforms, SESAM is routinely used on FEM-models exceeding one million degrees of freedom. (Extracted from *DVT Forum*, No. 1 94)

H. PUBLICATIONS

Environment and aquaculture in developing countries

Aquaculture and the disputes over its alleged impact on the environments of many developed countries are already well-known and widely publicized. There has been far less written about aquatic farming in the developing countries, where it is often part of the rural economy and a useful provider of jobs and food. But it could become a problem, as has been seen in countries such as Thailand where the expansion of shrimp pond farming has threatened mangrove forests.

The question is how to make the best possible use of the productivity of natural systems without radical environmental changes and at low levels of costly inputs.

"What is needed for the future," writes Dr. Martin Bilio of the German organization GTZ, "is an approach which makes use of the experience available adds to the existing know-how through continued research efforts, elaborates and refines guidelines, and creates appropriate frameworks for further development. Aquaculture production is in great demand, but it must not be achieved without due regard for safeguarding our basis for survival."

These matters were discussed at an international conference convened by GTZ and the International Center for Living Aquatic Resources Management (ICLARM), and Dr. Bilio comments in a foreword to the proceedings of the conference, edited by R.S.V. Pullin, H. Rosenthal and J.L. Maclean.

Included in the 360-page book is a comprehensive overview of environmental issues in developing-country aquaculture, aquaculture development and environmental issues in the developing countries of Asia, and aquaculture and management of freshwater environments.

Other regions covered include Africa and the Tropical Pacific. There are reports on shrimp culture and the environment, on the environmental impact of tropical inland aquaculture, on harmful algal blooms, and microbial safety of produce from waste water-fed aquaculture.

The book *Environment and Aquaculture in Developing Countries* concludes with a report on the conference discussion and recommendations. Edited by R.S.V. Pullin, H. Rosenthal, J.L. Maclean. ICLARM, MCPO Box 2631, 0718 Makati, Metro Manila, Philippines. Soft cover. US$ 22 airmail or $15 surface mail. (Source: *Fish Farming International*, Vol. 21, No. 3, March 1994)

I. TRAINING COURSES

Protection and utilization of oceans

Together with German and foreign partners the Carl Duisberg Gesellschaft e.V. (CDG), a non-profit organization, engages in international advanced professional training and personnel development. The practice-oriented programmes are geared to the specific interests of skilled staff members and executives from developing countries, Germany and other industrialized countries and from the former communist countries of central and eastern Europe.

The programme on the protection and utilization of oceans is geared to scientists employed with research institutions and observation stations world-wide. A broad range of topics is covered by the advanced training programme. Participants will receive intensive education concerning the nature of the oceans and their processes, e.g. the structure and genesis of ocean basins, composition of ocean water, marine sediments and organisms, or the influence on the climate. The role of oceans as a waste water discharge and dilution medium and permanent waste disposal site will be examined as well as marine resources (living and non-living natural resources). Course participants will learn to characterize oceans with respect to structure, geology, hydrodynamics, the composition of ocean water and ecological systems. Case studies and evaluation criteria will make it possible to assess the consequences of man's utilization of the oceans. Furthermore, there will be instruction on the relevant international and national legislations. An important thematic complex is the international cooperation in the framework of research and monitoring projects, which is demonstrated with main focus programmes for marine research drawn up by the European Union.

The advanced professional training has an overall duration of 14 months. The first weeks will be spent at the CDG reception centre in Saarbrücken. As the complete advanced training programme will be held in German and English, there will also be an intensive German language course, followed by a specialized technical language course.

After six months the specialized part of the advanced training commences at the Centre for Marine and Climate Research of the Hamburg University.

An essential part of the programme is practice-oriented. Along with the theoretical advanced training, participants will have the chance to broaden their newly acquired knowledge in Germany.

Applicants are required to have a university degree, preferably in the field of marine ecology, marine biology, marine chemistry, oceanography or geology and their professional activities should focus on the environmental protection of the oceans. Good knowledge of English is also necessary to understand the lectures.

The current cost of living, cost of the advanced training in Germany, and travel expenses necessary during the advanced training as well as health insurance are provided for by the German Federal Government. At present, participants with a completed vocational or professional training receive a monthly scholarship of DM 1,100, whereas participants with a degree acquired at an institution of higher education receive DM 1,450.

For further information, please contact Carl Duisberg Gesellschaft e.V., Hohenstaufenring 30-32, D-50674 Köln. Tel.: ++49 221 2098-0. Fax: ++49 221 2098-111. Telex: 8881762.

Meetings

International Conference on Remote Sensing and GIS: 3-6 December 1994, Hyderabad, India. Application to environmental planning. Section on satellite oceanography. Contact: I.V. Muralikrishna, Centre for Remote Sensing, Jawaharlal Nehru Technological University, Mahaveer Marg, Hyderabad-500 028, A.P. India. Tel.: (91-40) 253 254. Fax: (91-40) 227 648.

Circulation of the Intra-Americas Sea: 22-27 January 1995, La Parguera, Puerto Rico (USA). Call for papers. *deadline for abstracts: 1 October 1994*. Contact: AGU Meetings Dept., IAS, 2000 Florida Ave., NW, Washington DC 20009, USA. Tel.: (1 202) 462 6900, Fax: (1 202) 328 0566, E-mail: meetinginfo *at* kosmos.agu.org.

27th International Liège Colloquium on Ocean Hydrodynamics: 8-12 May 1995, Liege, Belgium. Contact: C.J. Nihoul, Modelenvironment, University of Liège, B5, Sart Tilman, B-4000 Liège, Belgium. Fax: (32-41) 56 33 53. (Source: *ims Newsletter*, UNESCO 1994)

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