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MARINE INDUSTRIAL TECHNOLOGY MONITOR

INAUGURAL ISSUE No. 1

Dear reader,

You are reading the first issue of UNIDO's fourth Monitor. It joins earlier Monitors dealing with microelectronics, genetic engineering and biotechnology, and advanced materials.

This inaugural issue will be used to introduce UNIDO, in the context of the current Monitor and in the broader context of objectives and activities in the area of marine industrial technology; it will therefore not be representative of future issues. The first section is a discussion of the characteristics of marine industrial technology and provides an attempt to sub-divide it into main functional areas. The next section includes a description of UNIDO's programme, both in terms of background and future path, as envisioned at this point. The third and last section is a recollection of the background for the *Marine Industrial Technology Monitor* and a brief description of what the reader can expect from it.

However, first of all: Welcome to Volume 1, Number 1, of our *Marine Industrial Technology Monitor.*

Industrial Technology Development Division
Department for Industrial Promotion, Consultations and Technology

Marine industrial technology

Marine industrial technology is a very wide field composed of a host of various disciplines and areas of function that would be difficult to categorise completely. The traditional marine disciplines like hydrodynamics, ship-design and machinery are no longer sufficient to describe the field. Electronics and cybernetics are used to control subsea vehicles, while accurate positioning systems are needed to perform work tasks in oil and gas field development. Computer aided design (CAD) systems, initially developed in the aircraft industry, are now extensively used in the marine industrial sector to keep up with current demands on efficiency.

The functions performed at sea are numerous and all very different. From the original traditional ship technology, extremely complex systems are now needed to locate and extract hydrocarbons from the ocean floor. Marine transportation rarely exceeded 30 knots only 15 years ago, but is currently being revolutionized by fast vessels with speeds reaching 60 knots. In Japan, artificial platforms are being increasingly used to alleviate the problem of land shortage for both habitation and industrial uses.

The resources to be harvested from the sea are immense. Ninety-eight per cent of all inter-continental cargo is transported on the oceans (Eylers, March 1990), a large portion of the oil and gas production is extracted from the ocean floor and marine biotechnology and aquaculture are viewed as the most promising way of addressing the growing demands on food in a world with diminishing free land space for agriculture. Mineral resources on the ocean floor contain abundant supplies of important metals like manganese, copper, nickel and cobalt, while the energy potential of ocean thermal energy conversion (OTEC) and waves is tremendous. Apart from the questions of economics and sustainment, there is also a growing awareness of the importance of the oceans in affecting the world's climate and in the effect of pollution on sea-based life. Thus, it is clear that activities related to the sea are of extreme importance to both the economic growth and survivability of the planet.

For UNIDO's work in the area of marine industrial technology we have used the following definition, realizing, in regard to the above, that it is impossible to construct a statement that is complete and unchanging. This is merely a tool to guide the programme in its starting phases:

"Marine Industrial Technology means, in the context of the overall objectives of exploration and utilisation of the ocean space, the specialized equipment and technical know-how, including manuals, designs, operating instructions, training and technical advice and assistance, necessary to carry out a viable and sound economic ctivity in a marine environment, or the knowledge to produce these elements."

The following is a suggested scheme for delineating marine industrial technology into manageable components, or areas of concern. Each of these will be briefly discussed in this section:

- Marine systems design
- Marine transportation and communication
- Exploitation of living resources
- Exploitation of non-living resources
- Land expansion
- Environmental protection
- Scientific research

Marine systems design

Marine systems design relates to the production of solutions for problems encountered in the feasible development of ocean resources or ocean space. When faced with a particular problem associated with marine industries the process of resolving it involves several phases. These range from the problem-definition through to the decision-making phases. Although the 'art or science of design' has been recognised for quite some time, it has received intensified attention in lieu of the emergence of powerful computer tools.

There are several indications that the quality and cost of a product relies heavily on the process of developing this product, or the design process. Thus, the increased focus on design has the goal of improving the chance of ending up with products of superior quality. In addition, the aim is to increase the speed and reduce the cost of the process itself. As indicated above, research and development now focusses on the role of the computer in marine systems design, with applications ranging from current drawing programs like AutoCad and such analytical tools as finite element analysis programs to future visions of 'intelligent', or artificial intelligence (AI), systems such as neural networks. However, the ultimate aim is to aid the design process in an optimal way – that is, where the user and the computer interact in the best possible manner.

The importance of this in the current context emerges from the need of developing countries to become self-sustained in all phases of industrial development. Thus, efficient tools that help to resolve design problems, whether they are current CAD or CAM (computer aided manufacturing) systems or advanced AI systems, are essential to increase the capability of developing countries to produce their own solutions for their own particular problems, rather than to rely on solutions produced by outside expertise.

Marine transportation and communication

In the increasingly inter-dependent world of today, transportation and communication is becoming gradually more important. This certainly is reflected in the utilisation of the oceans. Approximately 98 per cent of inter-continental cargo is shipped by sea and there is little prospect that the share of air- or land-borne transportation will substantially increase. A major precondition for the success of global trade and the principle of 'comparative advantage' is a well-functioning transportation system. Thus, if the transportation infra-structure is weak, it will serve as an obstacle to increased trade within the region.

Most manufactured goods are presently shipped in containers, whereas most raw materials are shipped either in ore/bulk/oil (OBO) ships or in regular oil tankers. Whereas these latter products require relatively simple port facilities, container transportation in large volumes puts considerable demands on an efficient container handling facility. This particularly results from the fact that most manufactured goods are of high value and are relatively fragile. Therefore, a delay or careless handling is costly to the cargo's owner.

In addition, where there are few vessels to transport the cargo, the cost of transportation increases, as does the possibility of delay. Thus, the scarcity of ships represents another obstacle to trade. Keeping in mind the 40-40-20 United Nations Conference on Trade and Development (UNCTAD) liner code that reserves 40 per cent of the trade between two nations for the ships from either one and leaves 20 per cent 'un-allocated', it becomes even clearer that trade may be hindered by a deficient fleet on the part of one of the trade partners. For instance, in African trade the freight rates constitute 11 per cent of the total value of imports, whereas the figure for the world as a whole is 6 per cent. Also, the time delay factor is significantly larger than for routes with more efficient systems. This is attributed both to a lack of ships and a lack of proper handling facilities. (Eylers, 1990)

Another aspect of marine transportation is that of transporting people. Lately, the development has been towards the use of high speed vessels for this purpose. These vessels, which are able to operate safely in speeds exceeding 50 knots, are expected to replace existing ferries and supplement land- or airbased routes. Such vessels are also thought to be efficient for transportating precious or perishable goods.

Related to the ocean is the construction of bridges and the laying of electricity or communication cables that connect islands to mainlands or other islands. Such activities are often essential to develop industries and settlements in coastal or island developing countries.

Exploitation of living resources

The situation of the world's food supply in the world is now such that there is very little land left to grow crops. However, the oceans are still largely underutilised, both in terms of existing resources and the potential of mari- and aquaculture. Therefore, the marine environment gives good opportunities for coastal states to increase their self-sufficiency with regard to essential foods.

When concerned with living resources in the wild, such opportunities range from increasing the quality of the vessels themselves, the fishing gear, the detection capabilities and the the food-processing industry. Some experiments with artificial fishing grounds have been very successful in making the fisheries more efficient. In addition, there are several resources such as seaweeds, algaes, shellfish and krill, that are hardly utilised at present. It is conceivable that industries could be established to turn such resources into marketable products.

Mari- and aquaculture hold great promise for the future. Gradually, the number of species that are currently being cultivated in an artificial environment are increasing and the trend seems to be that most species have the potential of being cultured. The establishment of such industries is neither particularly technology- nor capital-intensive, although the environmental concerns constitute a major problem.

Exploitation of non-living resources

The most important non-living resource exploited from the ocean today is hydrocarbons. In 1989, 1.1 billion m^3 per day of natural gas and 14.8 million barrels per day of crude oil were extracted from the ocean floor. However, there are still unexploited fields, for example in West Africa where over 230 undeveloped discoveries have been identified (*Offshore, incorporating the Oilman*, June 1990, page 5). Most of these are crude oil reserves, but about 4.7 trillion m^3 of natural gas reserves are virtually un-utilised. Of the oil produced offshore, approximately 43 per cent is produced in Africa, Latin America and Asia. The corresponding number for natural gas is 22 per cent (Ibid, page 33).

Hydrocarbon extraction is an industry that requires complex systems, advanced technology and large capital investments. The field is therefore dominated by large multi-national corporations and some national state-controlled companies. The technological challenges here include platform structures, drilling technology, pipeline transportation (primarily for gas), loading buoys and power supply.

Other non-living resources include deep sea minerals (manganese nodules, poly-metallic crust and metalliferous sulphides), placer deposits and metalliferous sand. Of these, manganese nodules have received the most attention. These are found at depths of 5,000 metres or deeper and contain abundant supplies of manganese, copper, nickel and cobalt. Areas in the Indian and Pacific Oceans are identified as the most likely areas for industrial exploitation. The technological challenges in producing a reliable and environmentally acceptable system are tremendous, but the payoff may be virtually endless supplies of these metals. Inside the Exclusive Economic Zone (EEZ) metalliferous sands have in some places, for instance in Egypt, been successfully exploited, while in Nome, Alaska, gold is extracted from the seafloor (*Sea Technology*, March 1990, page 35).

Fresh water is another resource to be extracted from the oceans. Some areas, for instance the Arabian peninsula, obtain their fresh water almost exclusively from desalination plants. Also, the harvesting of energy from the sea is receiving increased attention. Waves, tides and currents have been used to produce electric power, though rarely on a commercial scale. In addition, the ocean thermal energy conversion (OTEC), using the temperature difference between deep and surface waters, is a possible source of energy in several locations.

Land expansion and reclamation

In some densely populated areas the oceans are used to provide space for industrial expansion and habitation. Japan, in particular, has built structures and artificial islands to address the lack of ground space. Where the ocean constitutes a threat to already existing populations, dykes and breakwaters have been built as protection against storms and high tides. The most impressive example of this is the system of dykes built along the coast of the Netherlands. In several places, for instance in the United States, platform structures are used as bases for waste incineration plants.

Environmental protection

The environmental problems have received increased attention in the debate over which kind of industrial development is desirable. Basically, development should be 'environmentally sound'. This puts new demands on the technological systems being developed and will affect systems that are to operate in, or in conjunction with, a marine environment.

The pollution of the oceans has a lot of sources, a major part of which is land-based and pollutes through river run-offs and the air. Of the damage done through systems actually operating in the oceans, large accidents involving crude oil tankers and blow-outs from offshore platforms are the most obvious. However, the sources are countless: incendiary waste from ships, diseases originating in aquaculture production facilities and at-sea incineration of chemical wastes are just a few of these.

Another source of environmental degradation is the mis-management of the ocean's resources. Often, fishing practices have been such that some species have been over-exploited and have become almost extinct in some regions, whereas other species are under-utilised. Also, habitation and industrial expansion in environmentally vulnerable coastal areas have led to damages to the local environment.

In addition to the damage done to the marine environment itself, attention is increasing with respect to the pollution released into the atmosphere by marine engineering systems. Examples of this are the release of NOx gases from ship machinery and CO_2 from gas flare-offs on offshore oil production platforms.

The consequences of these 'unsound' practices are increased threats to marine life, and thus to the food supply in some areas. 'Red tides' – algae blooms that are presumably caused by chemical imbalances in the sea – have caused fears of total eradication of life forms in certain areas, for instance in locations on the North, the Baltic and the Adriatic Seas. In other areas, pollution has dealt heavy blows to the tourist industry. In the north-eastern part of the United States, there have been cases of deserted beaches due to dumping of hospital wastes into the ocean. In other areas, most recently in Peru, epidemics have broken out because of filthy water at the beaches, forcing them to close.

The problems faced are alleviated in various ways, either as preventive measures, resource management or reparatory measures. This is reflected in the heavier demands that are put on the technological solutions used. As a direct consequence of the *Exxon Valdez* accident in Alaska double bottom designs for oil tankers calling at ports in the United States will be required. Similarly, the Norwegian verification agency Det Norske Veritas (DNV) has presented a new class of vessels, an 'environment' class, also as a follow-up from the *Exxon Valdez* disaster. There is also a booming industry in the area of pollution clean-up, ranging from advances in oil-spill clean-up equipment to beach cleaning equipment for wastes on tourist beaches.

Scientific research

For a variety of reasons, scientific research in or of the oceans has become a focal point for activities relating to the sea. These reasons include the need to establish background data for resource management, for identifying heavily polluted oceanic regions, for investigating the impact of beach erosion and to investigate the impact of global warming on ocean temperatures and sea levels. Certainly, scientific research has a purpose beyond satisfying our curiosity. Finding commercial deposits of non-living resources on or under the sea-floor, identifying zones of commercially exploitable living resources and gathering information so that good solutions can be proposed for dangerous environmental problems, are all ultimate goals of scientific research.

Research relies increasingly on technological solutions to meet the demands of accuracy and speed. Advanced vessels are built both for national and international organs, databases are established to ease the retrieval of information, and computer programs are developed to analyse this information. Satellites gather data on temperatures, weather patterns and sea-floor mineral deposits and buoys are developed to measure and transmit in harsh oceanic environments over long periods of time. Thus, a growing industry specialises in the research and development of solutions that are saleable in this market.

UNIDO in marine industrial technolgy

One of the main objectives of UNIDO is to "promote, encourage and assist in the development, selection, adaptation, transfer and use of industrial technology, with due regard for the socio-economic conditions and the specific requirements of the industry concerned...." (Constitution of the UNIDO, 1989) The Constitution also authorises UNIDO to "advise on and assist ... the developing countries in the exploitation, conservation and local transformation of their natural resources for the purpose of furthering the industrialisation of developing countries." Thus, distinguished from other organs of the United Nations, such as the International Maritime Organization (IMO), the Intergovernmental Oceanographic Commission (IOC) and the United Nations Environment Programme

(UNEP). UNIDO focusses on *industrial applications in the marine sector rather than on the marine sector per se*.

The most important development concerning the economic utilization of the sea came with the Third United Nations Convention on the Law of the Sea (UNCLOS III) put out for signatures in 1982. The Convention established the principle of the Exclusive Economic Zone (EEZ) whereby every coastal state is given the right to take economic control over the sea to a distance of 200 nautical miles (372 kilometres). Furthermore, UNCLOS III established the resources found on the floor of the deep oceans, or areas outside the EEZ, as "the common heritage of mankind." The benefits from the exploitation of these resources are thus to be available to all states rather than a small group.

While UNCLOS III legislated control over immense resources to most of the states in the world, the capability and capacity to exploit these resources cannot, of course, be legislated. Hence, states need to achieve industrial competence in the marine area before the resources can turn into wealth. Likewise, in order for developing countries to benefit directly from the deep ocean resources, in particular minerals on the seabed, they need to develop ambitions and competence that make them able to join in such industrial development.

Marine industrial technology is relatively new. Granted, ship-building and salt-extraction are two examples of ancient commercial exploitation of the sea, but several opportunities are new. Examples include robotics, communications, mineral resources and energy from the sea. Thus, the definition of marine industrial technology has changed significantly from only twenty years ago. It is therefore a field that in many countries is neglected when compared to other industries.

In addition, the technologies that are relevant to the commercial utilization of the sea are plentiful. Where the area of marine industry could once be described by the disciplines of hydrodynamics and hull and machinery design, the industry has now developed to become one of high technology. Electronics, acoustics, cybernetics and materials science are examples of how advanced technologies become integrated into marine industrial technology. Thus it is clear that activities related to the sea are natural spin-offs from established land-based or focussed efforts. Likewise, it is apparent that research and development in the area will have several applications outside the marine sector as well.

It then follows that the other three areas being monitored by UNIDO clearly have links to marine applications. Advanced materials is one such area, where the emergence of corrosion resistant and light-weight materials is applicable to structures in a marine environment. Microelectronics becomes increasingly more important in advanced sub-sea systems, such as remotely operated vehicles and sub-sea gas wells. Biotechnology is emerging as a way to increase the yield of the sea for human foods and other products for use in areas such as medication, pollution clean-up through bio-remediation (*Sea Technology*, January 1990) and even metal leaching.

What, then, are the mechanisms that UNIDO will use to fulfill its purpose? The remainder of this section outlines the main elements of the emerging programme. However, the process of establishing such a programme is not static – it is rather a result of a growing awareness as to what the nature of marine industrial technology is and which issues are pivotal for the process of aiding developing countries to establish marine industries.

Promotion of centres of excellence, either with participants from developing countries only or with participants from both developed and developing contries, is one such key vehicle for UNIDO. Such centres are of prime interest in that they will implicitly facilitate the transfer and co-development of technology. Joint projects are to be undertaken by the participants of these centres, leading to professional linkages that themselves are catalysts for a greater exchange of technological information. Two regional centres of excellence have been studied so far, in the Mediterranean and Caribbean. The Mediterranean centre is moving close to realization after an initial study commissioned by UNIDO and carried out by the International Ocean Institute (International Ocean Institute, 1988) with the help of Professor Elizabeth Mann Borgese, and an expert group meeting in Vienna in the Spring of 1989. UNIDO is working actively with sponsors and it is expected that the centre will be established by 1992. There have been parallel efforts in the Caribbean region, where a study was commissioned and carried out by Professor David Ross of the Woods Hole Oceanographic Institute (Ross and others, 1990). UNIDO is currently preparing the ground for an expert group meeting to discuss such a centre in the Caribbean.

Another feature on which UNIDO will focus is the dissemination of information. This Monitor is the most visible instrument for this, but there are others as well. In time, UNIDO will build up a database to catalogue information on marine industrial technology – a database that will eventually be accessible to outside users. As another vehicle, UNIDO will use the training of personnel from developing countries, for instance through study tours in selective fields, through seminars, or through the centres of excellence. Other means are expert group meetings and conferences on selected fields in marine industrial technology. UNIDO has in the past sponsored meetings related to such activities, for instance, an expert group meeting was held in Riga in 1986 on alternative uses of algae (UNIDO, 1986). Likewise, under the genetic engineering and biotechnology programme, studies discussing the industrial potential of marine biotechnology for developing countries have been made.

Establishing industrial and academic contacts will be crucial to UNIDO during the starting period of the marine industrial technology programme. Already, UNIDO has intiated special co-operation agreements with the Norwegian Institute of Technology for assistance in matters regarding marine industrial technology and has close contacts with the International Ocean Institute in Malta. Such contacts will be used to identify partners in individual projects and to provide day-to-day advisory services to UNIDO.

Technical assistance projects are also possible mechanisms under the current programme. These would either be initiated by UNIDO or by developing countries having a perceived need in the marine industrial field. During a more general study of industrial development by UNIDO, the 1987 UNIDO Industrial Development Review of the Caribbean Region dealt explicitly with the potential of marine industrial activities (UNIDO, 1988). The review has already served as a source of information for the study on a centre of excellence in marine industrial technology for the Caribbean region.

The promotion of co-operative projects is important because less-developed nations often have insufficient resources to have a consequence in anything other than selected fields. Where the nature of the project is such that several disciplines are involved and the problems to be addressed affect more than one nation, it is clear that a combination of resources makes sense. The centres of excellence are intended to be one mechanism towards achieving this, but such a co-operative effort can also be supported through other means. For instance, a meeting to be held in late 1991 on technology for exploitation of non-living resources in general and its application to deep ocean mining in particular, will deal explicitly with the matter of co-operative mechanisms to ensure the participation of developing countries in the establishment of the industry.

UNIDO and the Monitor

The *raison d'être* for this Monitor is as follows:

The Monitor is established as a mechanism of current awareness to monitor developments in the marine industrial technology sector and to inform governments, academia, and potential and existing industry, primarily in the developing countries, with the aim of stimulating useful incorporation of these developments in domestic scientific, technological and industrial establishments.

With a planned frequency of four issues per year, it is intended to convey information on recent developments in the marine industrial sector. Of particular focus is news on developments of interest to developing countries. In addition, later issues will contain commentaries to the news items by UNIDO specialists in the area. Each issue will also contain an in-depth article written by outside experts – an article that will discuss recent developments in specialized fields.

Each issue will handle a thematic subject – the next issue, for instance, will be on marine transportation and communication. The special feature will be on high speed vessels for transportation. Later issues are in the planning stage, and it is hoped that the readers will identify subjects of special interest. Likewise, feedback with respect to format and scope will always be appreciated.

As space permits and research resources expand, additional information will be incorporated into the Monitor, generally in the form of short news items. Subject areas could eventually include:

Education and training opportunities in the marine sector:

- Short-term courses available for or in developing countries;
- Relevant academic programmes selection criteria, cost;
- Available funding for students from developing countries.

Available equipment and know-how (proprietary):

- Potential utility for recipients of technology;
- Who to approach for inquiries;
- Governmental and other financial benefits (credits, discounts);
- Licensing opportunities.

Available non-proprietary know-how:

- 'Aged' or outdated patent rights;
- Findings in the public domain.

Research and development projects:

- Intra-regional projects (South-South);
- Inter-regional projects (North-South);
- Findings, time scope and contacts.

General information:

- UNIDO news;
- Industrial profiles;
- Reader communication on projects or other useful information;
- Conferences.

The Monitor is aimed primarily at the following groups: departments of industry/ocean affairs; academic institutions in marine technology; existing and potential industrial entrepreneurs and professionals; and research and development institutions in marine technology.

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