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TO OUR READERS

The potential for economic utilization of the ocean and its resources has created a wide range of marine-based industries and related services, ranging from small-scale enterprises producing for the local market, to large-scale heavy industries with multinational companies operating in a highly dynamic international market. The marine industrial sector contributes significantly to the world economy. One third of the world's oil and gas production is being extracted from the ocean floor and a growing share of future oil and gas demand is expected to be met by production from offshore fields. Over 95 per cent of all intercontinental cargo is transported on the oceans, and rapidly developing technologies for large high speed vessels are expected to redefine the role of marine transportation, particularly on shorter distances. The fisheries and fish-processing industry provide an essential part of the global food supply, and to meet the increasing demand for marine protein, fish farming is expected to become a significant industry world-wide, with projected output up from about 9 million tons today, to about 38 million tons by the year 2010. While sustainable development and management of the oceans is becoming increasingly recognized as the emerging challenge of the 21st century, the gap between industrializing and industrialized countries with respect to technological and financial capabilities is dramatically widening. To be able to meet the growing demand for food, energy, raw materials and coastal space, most developing countries need to strengthen their capacities related to marine industry and technology.

The United Nations Convention on the Law of the Sea, which enters into force later on this year, provides a legal and policy framework for industrial utilization of ocean resources within a nation's Exclusive Economic Zone (EEZ). Sustainable development, integrated management and effective control of the EEZ is crucial for a country in order to benefit from its ocean wealth. The lead article in the current issue of the *Monitor* is focused on the framework for ocean policy and EEZ management, and indicates the complexity of the problems faced by national ocean managers.

Within its mandate to promote and assist industrial development, UNIDO provides a cluster of integrated services that relate to industrial information technology management, feasibility studies, investment promotion, direct technical assistance and project development and management. UNIDO is in the process of strengthening its services to marine-based industry in developing countries, and we hope the *Marine Industrial Technology Monitor* will be an efficient tool for the exchange of information and ideas. We would therefore welcome contributions and information from our readers, including company profiles, industrial and technology development projects, government policies and programmes, etc.

Leif K. Braute
Editor-in-Chief

THE EXCLUSIVE ECONOMIC ZONE AND DEVELOPING COUNTRIES IN THE WAKE OF UNCED

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INTRODUCTION

This article is dedicated to the importance and modalities of development and management of the exclusive economic zone (EEZ). Since its acceptance as part of the package deal at the Third United Nations Conference on the Law of the Sea (UNCLOS III) in the mid-1970s, the EEZ has seen fast national adoption and implementation by both developing and developed coastal states. This has been partly due to the perception that exclusive control over an adjacent marine area up to 200 nautical miles from the coast promised greater access and control of resources that would enhance socio-economic development and better resource management. This belief ensured that the EEZ featured as a central institution in the United Nations Convention on the Law of the Sea 1982 (UN Convention).

THE CHALLENGE OF OCEAN MANAGEMENT

Today, more than a hundred states claim exclusive economic zones (EEZs) or exclusive fishery zones. Coastal states do not need to claim continental shelves for by customary law they already possess them as natural prolongations of their land territories. There is no question that where technological and financial resources were available, the EEZs saw a sharp increase in development activities world-wide. What is striking about these activities is the absence, or frequent insufficiency or even failure of concomitant management practices.

Most notably fisheries management, a major rationale behind the establishment of exclusive resource control in the EEZ, has met with little success in either developing or developed regions. Major developed countries such as Canada and the United States invested heavily into science-based fishery management, but judging by the current crisis resulting from stock collapses in the major Grand Banks and Gulf of Maine fisheries, as a result of which tens of thousands of fisherfolk lost their livelihood in the first six months of 1993, it is clear that development capabilities far outstripped management capacities. This lesson is not to be taken lightly. Advanced economic, scientific and technological standing may facilitate development, but does not necessarily ensure good management.

If this state of affairs is indicative of the state of ocean development, then the prospects for ocean management may appear bleak. In reality this is only one aspect, or "sector", of a more complex environmental and human scenario. First of all, the dictum in the preamble of the UN Convention that "the problems of ocean space are closely interrelated and need to be considered as a whole" provides a rationale for integrated management. There was a correct belief at UNCLOS III that no ocean sector is insulated, and sectoral activities are bound to impact other activities, directly or indirectly. The nature of the ocean medium ensures that an ocean use is likely to impact the marine environment, and in turn the health of the marine environment may affect the pursuit of an ocean use. However, the marine environment itself forms part of a larger whole, and ocean managers today are increasingly aware of the importance of understanding the boundaries and workings of ecosystems. It is thought that the reasons for the collapse of the North Atlantic stocks may have been due to a combination of human and environmental factors, including temperature and salinity changes. It remains to be seen how the collapse of cod and other demersal stocks will affect other levels of the food chain in their ecosystems.

Second, the coastal zone is a premise for EEZ development and management, for there is no activity at sea that does not have a premise on the coast. In turn, the coast is a meeting point between what happens inland and offshore. There is a heavy concentration of people and activities in many coastal areas around the world, and what happens at sea is no more that a socio-economic and cultural extension of human settlements. In some instances environmental processes in the coastal zone may originate far inland. One dramatic example is the river Ganges. The upstream damming of the river has significantly lowered the level of the river flow downstream, reducing the flushing effect of fresh water in the coastal area in the Bay of Bengal. The result is that the salinity line is moving further inland in Bangladesh, rendering large areas useless for agricultural purposes, thus forcing population movement. Chapter 17 of the United Nations Conference on Environment and Development's (UNCED) Agenda 21 has now recognized the intrinsic unity of the coastal

zone and the EEZ for management purposes, and has strengthened the rationale for an integrated management approach.

Given these premises, ocean management promises to remain a continuing challenge in both developing and developed countries. Perhaps it is the case that the utilization of scientific knowledge needs to be reconciled with the reality of human behaviour. In a rush towards the objectivity of science as a basis for decision making, in the past ocean managers did not give traditional forms of knowledge the attention they deserved. Representing an intergenerational intellectual capital, traditional knowledge often includes knowledge of ecosystems. Equally important is community participation, including community-based management, which ensures a role for coastal communities as prime stakeholders in coastal and ocean management.

And yet a further reason to look forward to ocean management as a challenge will be the coming into force of the UN Convention in the near future. With these initial thoughts, it is useful to look at the basic elements of ocean management in view of assessing the nature of the challenge.

FRAMEWORK

Ocean development and management have to be pursued within the framework of the international conventional and customary law that created or consolidated the regime of modern maritime zones. As the principal legal instrument in this regard, the United Nations Convention on the Law of the Sea is not only an "international contract" but also a "constitution" governing the allocation and use of ocean space and its resources [1]. Hence the nature and extent of coastal state authority over the EEZ, as well as other maritime zones such as archipelagic waters, territorial seas, contiguous zones and continental shelves are defined in a legal and policy framework that provides not only rights, but also duties, responsibilities and modalities for cooperation. On a regional level, developing and developed states have also concluded numerous other conventions that address the specific needs of the various marine regions they share. And the ocean manager has to bear in mind that ocean development and management are conditioned by both global and regional levels of law and policy. Indeed national law and policy-making frequently implement international agreements.

The conventional and customary norms and rules governing national maritime zones reflect the needs and aspirations of developing countries, the maintenance of international community rights such as the freedom of navigation, the intrinsic unity of the marine environment, and most importantly principles for responsible governance including a duty to cooperate.

From a purely policy perspective the framework has received further elaboration at the United Nations Conference on Environment and Development (UNCED), convened in Rio in 1992. A number of important principles had already been established two decades earlier at a similar UN conference on the human environment [2]. For ocean managers the major importance of UNCED lies in Agenda 21, and particularly Chapter 17 on ocean and coastal issues [3]. Here is a global coastal and ocean action plan endorsed by all the states represented at UNCED.

It is to the UN Convention and Chapter 17 that we now turn to trace the basic elements of the legal and policy framework relevant for the modalities of ocean development and management.

(a) The UN Convention

One of the major objectives of UNCLOS III was to develop a package deal that would effectively stop creeping national jurisdiction. The phenomenon of gradual national appropriation of ocean space is ancient, and in a way still continues today [4]. The UN Convention constitutes a compromise between the need of coastal states for ever larger areas of national maritime jurisdiction and the preservation of international ocean use rights within those areas. Accordingly, the coastal state's maritime jurisdiction includes not only the activities of its nationals or persons licensed under its laws, but a measure of control over the activities of foreign nationals.

There are important legal differences between sovereignty, sovereign rights and jurisdiction in the UN Convention that affect the ability of the ocean manager to regulate ocean use. **Sovereignty** is the coastal state's total legal and exclusive territorial authority, which it exercises over land, internal waters, archipelagic waters and territorial seas. Although exclusive, **sovereign rights** are only specific elements of that authority that may be exercised for resource exploration and exploitation purposes in the EEZ (which includes the seabed and water column up to 200 nautical miles) and the legally defined continental shelf (which includes the seabed and subsoil only and in some cases may extend to 350 nautical miles). **Jurisdiction** is the exercise of state authority in the EEZ for specific purposes such as environment protection, marine scientific research and the establishment and use of offshore installations and artificial islands. Jurisdiction may also be exercised up to 24 nautical miles in the contiguous zone for customs, fiscal, immigration and sanitary purposes. Beyond the maritime zones, the only jurisdiction that the state can exercise is on the basis of vessel registration under its laws (i.e., as a flag state). What this implies is that coastal state jurisdiction within its maritime zones may not be exclusive, and indeed where foreign registered vessels are concerned, it is concurrent. But generally, the extent of the coastal state's authority declines, the more seawards an ocean use takes place. Conversely, international community rights increase in a seaward direction.

It is clear, therefore, that the ocean manager has limited legitimate regulatory authority for certain functions and to different extents in the various maritime zones[4] In comparison, the land use planner is backed by the full weight of exclusive territorial sovereignty, and as a result is significantly less constrained than the ocean counterpart in performing jurisdictional and regulatory functions

The national ocean manager has to contend with international norms and rules specifically applicable to maritime zones, and again these do not have counterparts on land The first set of rules relate to international community rights Even in archipelagic waters and territorial seas, where sovereignty is exercised, there is an international servitude in the form of international community rights for "archipelagic sealanes" "innocent" or "transit" passage for ships The coastal state has the right to regulate such passage but not in such a way as to restrict freedom of navigation The international freedoms (and consequent rights) of navigation and the laying of submarine pipelines and cables have been preserved in the EEZ

There are also international resource rights Traditional fishing by neighbours of archipelagic states in what are now archipelagic waters has been safeguarded In the EEZ the coastal state has a duty to give access to surplus stocks after it determines the total allowable catch, with preference to be given to landlocked and geographically disadvantaged developing countries and traditional fishing states These resource rights apply only to living resources There are no international rights to non-living resources within national maritime zones Naturally, unless there is an EEZ claim, the traditional freedoms of the high seas apply to the water column over the continental shelf

Another set of norms and rules the coastal state is required to abide by are those related to resource management and environment protection Particularly in relation to marine living resources there are duties relating to conservation and utilization Whereas on the one hand the coastal state has sovereign rights over the exploration and exploitation of living resources, it also has duties to ensure proper conservation and management, taking into account the best available scientific knowledge to guard against over-exploitation of stocks and dependent species. The reference to associated and dependent species is a basis for ecosystemic approaches, and although the provision that follows stipulates that states "shall promote the objective of optimum utilization" of living resources, this is placed within a management and conservation, as well as an economic framework Hence the coastal state has been equipped with the consequent right (and arguably a duty) to enact laws and regulations, and take the measures necessary and consistent with the UN Convention for fisheries management A similar management and conservation ethic applies to anadromous and catadromous species straddling stocks and highly migratory species and marine mammals

Curiously, there are no management and conservation norms and rules for non-living resources, other than those of a sea use planning nature (e g , non-interference with navigation) and environment protection

The exercise of jurisdiction for the purpose of protection and preservation of the marine environment is similarly a right and duty Indeed all states have a duty to protect the marine environment nationally and internationally on global, regional and domestic levels The rules of the Convention deal with pollution of the marine environment and the measures that states are required to take for its prevention, reduction and control The principal pollution categories of a domestic interest addressed are from land based sources, seabed activities within national jurisdiction, dumping and vessel source As in the case of fisheries, coastal states have been endowed with authority to enact laws and regulations for the protection of the marine environment within their jurisdiction. Legislative authority is also accompanied by an enforcement regime based on a triad of coastal, flag and port state jurisdiction In theory, this regime could provide an effective arrangement to ensure that rogue vessels do not escape prosecution Indeed, there are already in existence several port state control cooperative arrangements on a regional basis that are effectively implementing the IMO international maritime law conventions on safe ship operation and navigation practices, safety of life at sea, standards of training, and marine pollution.[5]

Finally, the general recognition given to the unity of the marine environment and its resources has encouraged the adoption of a cooperative ethic and the stipulation of duties for cooperative conduct in the pursuit of ocean development and management The duty to cooperate directly or through competent international organizations appears throughout the UN Convention. There are also numerous other instances where a specific conduct is prescribed, which also amounts to cooperation There are now well-developed rules requiring cooperation in the taking of measures in several areas including marine environment protection and related enforcement procedures the management and utilization of shared living resources, marine scientific research and technology co-development and transfer

(b) Chapter 17

The policy side of the framework has been greatly strengthened with the adoption of Agenda 21 as an integrated action plan for the reconciliation of development activities and environment protection in the 21st century.[6] Sustainable development has been proposed as a unifying policy objective In this context, Chapter 17 of Agenda 21 proposes an integrated approach to coastal and ocean development and management, and by doing so it both complements and further develops the rationale of unity of the marine envi-

ronment in the UN Convention. The coastal zone, the oceans and their resources constitute an environmental and human use continuum. A contextual understanding of the dynamics of this continuum is fundamental for the pursuit of sustainable ocean development. Management is required at both sectoral and multisectoral levels. "Integration" thus assumes paramount importance from spatial, policy, legal, institutional and planning perspectives.

MODALITIES FOR "INTEGRATION"

There is no one answer to the question as to how integrated planning and management should be pursued. Chapter 17 addresses integration in the objectives, activities and means of implementation of the programme areas proposed. The major task will frequently be organizational: building and servicing decision making and implementation mechanisms necessary to use coastal and ocean areas efficiently and equitably, but in a manner which does not prejudice continued use by present and future generations. There is no one formula. The ocean manager will need to comprehend the "management scenario" in terms of values, actors, processes and context. User interactions and impacts need to be analyzed before any organizational prescription can be put forward. Hence the ocean manager needs to be equipped with analytical and organizational concepts and skills, and finally with communication skills. It is often overlooked that the ocean manager has to deal with a broad range of decision makers and stakeholders in the public and private sectors, coastal communities, special interest or service groups and the public at large.

(a) Problems, issues and objectives

The functionalist approach necessitates an identification of the management problem, in the French sense of *problematique*, and the various issues or issue-areas constituting it. Hence, although a collapsed stock suggests excessive harvesting capacity resulting in overfishing, in reality there may be a complex problem with various aggregating factors at work, such as administrative (e.g., weak licensing system, poor surveillance and enforcement), economic (e.g., market forces), scientific (e.g., insufficient understanding of population dynamics, role of species in the ecosystem, long-term oceanographic factors, etc.), technological (e.g., acoustic capability, ship size, engine capacity, type of fishing gear, etc.), social (e.g., issues related to coastal communities) and political (e.g., simplistic use of science in political arenas, special consideration of electoral constituencies, etc.) issues.

Although each issue area requires the setting of clear management objectives, it is equally important to set over-arching integrating goals in the interests of a unified problem-oriented approach. The setting of objectives is a socio-economic and political process influenced by the variable values and interests perceived to be at stake.

(b) Context

Problem and issue definition risks being simplistic if there is no or insufficient regard to context. The context has geographical, environmental and human dimensions. The ocean manager needs to identify the parameters and relationship of the management problem to other problem areas in the proper geographical and environmental contexts. Context helps identify the full known range of impacts of ocean us This exercise may identify constraints, as well as opportunities.

From another perspective, context definition may also require ecosystemic factors to be taken into consideration. This is increasingly the case with fisheries management, where the harvesting of one species may affect interacting species. The question then is whether to deal with small or large ecosystems.

Due regard needs to be taken of the jurisdictional limits and potential overlaps with other jurisdictions. Hence, almost invariably, the national ocean manager will initially be concerned with domestic jurisdiction and it has been seen that regulatory authority varies in relation to different maritime zones. However, it is eventually often the case that the definition of the problem area will involve international boundary zones (whether maritime boundaries with neighbours are in existence or not). Resource management (e.g., straddling stocks) and environmental problems straddling maritime boundaries cannot be successfully managed unilaterally. The conservation efforts on one side of the boundary may be completely defeated on the other side. Indeed even the development of certain non-living resources straddling maritime boundaries (e.g., oilfields) require a cross-boundary definition of the development area.

Chapter 17 has stressed the importance of dealing with small island states as integrated units. Due to their small size, it may not be possible or even rational to distinguish between the coastal area and the hinterland. The context in these cases will involve both marine areas and the entire land territory.

Definition of context may suggest the type of participation that may be necessary. Certain problem areas may suggest a sub-regional or regional management reference area. Thus marine pollution in semi-enclosed seas might require a sufficiently broad definition of context to include an entire sea. The United Nations Environment Programme (UNEP) Regional Seas Program is motivated by this rationale.

(c) Concepts and approaches

Today the ocean manager is equipped with a number of useful concepts that serve to define approach. The most recent arrival on the scene is "sustainable development." There is no one generally accepted definition, but for our purposes there are two useful ele-

ments. The first is that a particular development activity be started or continued over time without prejudicing its continuation and environmental integrity, thus suggesting an important management objective; the second is the element of inter-generational equity, i.e., that similar interests of future generations should not be prejudiced. It is possible to read other elements in this concept, but its usefulness lies in emphasizing responsible development and in providing an overall integrating management concept with long term goals.

"Integration" as a concept and an approach has already been discussed. Suffice to add that this concept serves to promote a multi-dimensional approach to planning, decision-making and implementation.

"Interdisciplinarity" is closely related to integration. No one branch of human knowledge can claim to provide a multi-dimensional view of a problem area. Ocean management in fact can be described as a "field" in which disciplines from the natural and social sciences and engineering disciplines meet. The ocean manager needs access to a diversified knowledge base. Thus, in our earlier fisheries management example, it is important to include, among others, inputs from economics, biology, oceanography and anthropology. It is not only the resource that the manager is dealing with, but indeed, and most importantly, the subject of regulation will be human behaviour.

Another recent arrival is the "precautionary" or "preventative" approach. Although this concept finds acceptance in a number of important international instruments and policy statements and finds increased adoption at a domestic level, its precise denomination and content are not consistent. The importance of this concept lies in the type of action that an ocean manager may advise to be taken. In the absence of sufficient knowledge of the likely impacts of a particular development activity, caution is advisable. Even in the presence of a scientific knowledge base, cautious decision-making is still advisable. Here there is necessarily a strong element of discretion involved, and generally the ocean manager will have to proceed on the best available knowledge, scientific and other.

The "polluter pays principle" is relatively old and refers to two distinct situations. First, pollution should be considered as a type of subsidy with the result that a particular production process does not fully take into consideration all the costs involved. Second, the polluter should actually pay for the pollution damage caused by his acts. The principle is important in setting standards for human behaviour and improving efficiency. However, it can be very difficult to put in practice, especially where production processes may not be utilizing state of the art science and technology. In some situations, this difficulty may result in inequity for developing countries in the absence of appropriate technology transfer.

(d) Processes

Land use planning, coastal zone management and sea use planning are frequently addressed and pursued independently of one another. This will have to change under the pressure of increased integration. Planning for coastal area use necessarily involves land use planning. Similarly, sea use planning also involves planning for onshore support for ocean uses. At the risk of embarking on an unwieldy exercise, the attention of the ocean manager must focus on the full spatial extent of patterns of human behaviour, activities, interactions and impacts. The actors will be many.

The major tasks of the ocean manager will be to develop planning, decision-making and implementation processes that find support among the constituencies they are intended for. These processes may have to take into consideration a broad range of decision makers and stakeholders. The actors are as many as there are ocean users, communities and regulatory agencies. There is no one ideal decision-making system, and in reality the ocean manager will have to make do with what is available. At a governmental level the reality is that governmental functions are organized along sectoral or interest lines. There may be inadequate communication between agencies. The result is that there are different sources of decisions, making coordination a major task.

The challenge of the ocean manager at this point is to earn the necessary confidence and establish communication lines with all relevant actors, governmental and non-governmental. It is often overlooked that public consultation processes and environmental impact assessment studies are exercises in meaningful processes as much as means to specified ends. Central authority decisions, which favour a coastal or ocean use over another without previous consultation, may not be implementable. Likewise, plans by industry for ocean uses that tend to displace other established uses may meet resistance. Instances where fishing communities slowed down or effectively stopped offshore activity are not unknown.

Increasing importance is being attached to community-based management in local areas as an alternative to direct central government intervention in what are micro-management issues. The advantage of coastal community and stakeholder involvement in management and decision-making, as distinct from mere information and consultation, is that the community is more likely to cooperate than would otherwise be the case. In some instances, communities may have a traditional knowledge base in relation to a resource that facilitates management. In such a case the community has a direct interest in maintaining traditions and a way of life that revolves around the use of a particular resource. Naturally, what works in one culture may not work in another and the manager must avoid quick and easy extrapolations out of context.

On an international level, the above processes may require the involvement of neighbouring states, or possibly constituent political entities and communities. Cooperation may be a necessary means to achieve an otherwise unattainable end.

(e) Tools

Finally, the ocean manager will need to use a broad range of policy, organizational and technical tools. A starting point is a knowledge and skill base. Most developing countries lack the necessary knowledge base and trained human resources to perform ocean development and management tasks. A human resources development plan is essential, for at the end of the day institutions remain fictitious entities unless actual tasks are performed by personnel.

Modern ocean development and management requires at least a minimum of national scientific and technological capability.[7] In some regions knowledge has been pooled. In the Mediterranean, the scientific research and monitoring component of the Mediterranean Action Plan (MAP) consists of a wide network of scientists and laboratories whose work is coordinated by the MAP Coordinating Unit. In the South Pacific, the small island member nations of the Forum Fisheries Agency have developed a common tuna licensing system applicable to all their EEZs and administered by one agency. These are two examples of the type of cooperative action that may strengthen shared scientific and technological capabilities. UNIDO continues to support initiatives for the eventual establishment of regional centres for research and development in marine industrial technology.

The sectoral organization of government will need a mechanism to facilitate integrated planning and management. The marine mandate is invariably shared: fisheries (frequently part of agriculture), oil and gas (usually part of energy or natural resources), shipping (part of transportation or infrastructure), tourism (does not fit easily in other sectors, but can be in services), environment (frequently part of health, education or public works), etc. Further, since these marine functions are normally smaller ministry functions, it is frequently the case that they are performed by junior ministries or departments. Senior ministries are normally occupied by finance, education, health and public works, without pure marine mandates. The case of Canada with a federal ministry dedicated to fisheries and oceans is not a frequent one. In any case, the broad distribution of marine functions will need to be addressed. One option is to centralize all marine sectors in one agency, but this is likely to be politically very difficult. The former Ministre de la Mer in France is an unhappy example. The second is to designate an existing senior ministry as the lead agency through legislation, as in the case of Canada. This second option may not always be politically feasible. The third and most practical option in many countries is to set up inter-agency arrangements, possibly through a committee or council established by legislation. This last option normally leaves the inter-agency body an advisory and coordinating, but no executive functions, thus making it more acceptable politically.

As a policy vehicle, legislation performs a number of useful social functions. The UN Convention empowers coastal states with legislative authority in many issue areas. A look at each maritime zone suggests a number of issue areas. Legislation is useful for regulatory (e.g., ship safety, dangerous goods), administrative (e.g., establishment and administration of licensing system), promotional (e.g., promoting sectoral development through fiscal incentives), organizational (e.g., establishment of new organizations, such as statutory bodies), distributive (e.g., social assistance, compensation schemes) purposes, or simply as a vehicle for value statements. The type of legislation will vary according to function and issue area. However, this versatile tool to influence human behaviour would not serve its purposes without an efficient enforcement system. Law infringement followed by impunity weakens a legal system and management efforts.

Hence legislation as a useful management tool needs a sound institutional basis for implementation and enforcement. Government line departments will be responsible for implementing legislation touching their sectors or as prescribed by statute. Enforcement can be both administrative and judicial, in which case the line departments and the courts may be sharing enforcement. In turn, enforcement is effective to the extent that there is effective surveillance, monitoring or policing, as the case may be. The navy, coast guard, maritime policy and other units with marine or aerial assets will need to be included in the planning process. This will be the establishment of monitoring, control and surveillance systems (MCS), where the actual enforcement may need to be carried out with assets not in the possession of the fisheries agency. Increasingly, navies are being called upon to perform constabulary roles and this will entail the need for greater cooperation with civilian agencies.

CONCLUSION

In the wake of UNCED and on the eve of the coming into force of the UN Convention on the Law of the Sea, development and control of national maritime zones will continue to be on the agenda of most coastal states. Because of its multi-functional nature, geographical extent and impact on other users, the EEZ will continue to be the most important maritime zone and the one with the most challenging planning and management responsibilities to balance its development potential. The problems and issues requiring an integrated approach are many and diverse. Sustainable ocean development will require a precautionary approach in the absence of sufficient ecosystemic knowledge. Such an approach should not be considered a shackle on current development, but rather as

insurance for the future. The challenge of ocean management is in fact the challenge to maintain long-term development.

No one state can go down this road on its own. The unity of the marine environment ensures that development and management costs and benefits will have to be shared. No one state can live in a geographical, environmental, socio-economic or political vacuum. Cooperation in its multifarious forms will be the only option for sustained growth in the long term.

NOTES

1 The UN Convention is not the only international instrument providing a global framework for coastal state action. A number of other specialized conventions including the International Convention for the Prevention of Pollution from Ships 1973/78 (MARPOL), the Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter 1972 (London Convention) and the Convention on Safety of Life at Sea 1974 (SOLAS) also provide vital rules promoting environmental and human health and navigational safety. When the UN Convention comes into force 12 months after the 60th ratification, in relation to parties it will supercede the four 1958 Geneva law of the sea conventions: Convention on the Territorial Sea and Contiguous Zone, Convention on High Seas, Convention on Fishing and Conservation of the Living Resources of the High Seas, and the Convention on the Continental Shelf.

2 Resulting in the Stockholm Declaration on the Human Environment and in an accompanying Action Plan.

3 "Chapter 17. Protection of the oceans, all kind of seas, including enclosed and semi-enclosed seas and coastal areas, and the protection, rational use and development of their living resources." A/CONF.151/4 (Part II).

4 For instance, through an improper use of the straight baseline method for the purpose of determining the breadth of national maritime zones, it is possible for many stats to increase the areas falling within internal waters. Internal waters are subject to the same type of sovereignty as land. On the seaward side, there are still several states claiming 200 nautical mile territorial seas (not EEZs) when the territorial sea entitlement is 12 nautical miles. At least one state (Chile) has put forward a doctrine to justify a "presence" *(mar presencial)* in an area including the water column beyond 200 nautical miles.

5 The major regional arrangements signed by national maritime authorities cover Europe, Asia-Pacific region and Central and South America. Canada and the United States also have separate port state control regimes.

6 Chapter 17 proposes the following programme areas: "(a) integrated management and sustained development of coastal areas including EEZs, (b) marine environment 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 of the management of the marine environment, (f) strengthening international, including regional cooperation and coordination, (g) Sustainable development of islands."

7 There are now a number of technical tools and techniques to assist the ocean manager. For instance, from an information perspective to determine patterns of spatial uses to facilitate problem identification and analysis, geographic information systems (GIS) are achieving widespread use. GIS helps not only with use inventories but also with zoning (e.g. to define license areas) and environmental auditing.

OFFSHORE OIL AND GAS

WORLDWIDE REVIEW: MORE ECONOMIC WAYS TO DEVELOP EXISTING RESERVES

It has become evident over the past year that the international offshore petroleum industry has undergone a rapid and as yet unfinished transformation from domestically based spheres of activity to a worldwide theatre. This reality has been difficult to accept for many who had founded their enterprises with a single-market focus. These operators and service companies struggled valiantly to stay alive and, ultimately, have had to venture into parts unknown to find their niche in the new world of international petroleum. And for the most part, those firms succeeding have been the companies with the least baggage. They left most of their preconceived notions about Africa, Latin America, or Southeast Asia at home and took instead their expertise, their technology, products, and services and went out to do business. International exploration and production was at full swing during 1993, as operators sought to expand their reserves while reducing operating costs. The movement to downsizing, consolidation, merges and acquisitions slowed as companies found their comfort zones and set about improving assets.

North America

During the first three quarters of 1992 US production continued to decline, but as the year-end approached, the increased price of natural gas and its new found popularity began a return to the US Gulf of Mexico of exploration and development activity. Other than projects well underway, deepwater programmes in the US Gulf have been postponed until oil prices rise.

Central and South America

Latin American exploration and production continues to be, for the most part, an onshore phenomena, although there is growing activity off Argentina and considerable activity offshore Brazil, where Petrobras has discovered three giant fields – Marlim, Albacora and Barracuda – at water depths between 200 and 2,000 metres in the Campos Basin. Most of the Petrobras' studies covering production from these deepwater fields indicate that FPS technology is probably the best method of developing their huge reserves. Much of the excitement sparked by BP's Cusiana Field discovery onshore in Colombia

has subsided as the true size of the reservoir became known, but service and supply companies are still stirred by the prospect of an expanded drilling programme in other parts of Latin America. Peru has expanded its onshore drilling programme, as has Ecuador, and the aquatories of nations from Nicaragua to Chile are being probed with seismic and some drilling in hopes of discovering new plays. Much of this renewed effort is in response to the continental move to privatization of one or more sectors of the various state-owned petroleum industries. Offshore, there is no boom anywhere but Mexico, albeit several very important offshore plays are underway. A British seismic study of the Falklands/Malvinas' 200-mile exploratory zone has revealed that the area has enormous oil potential. Seismic data indicate that crude reserves may exceed by more than 50 per cent the reserves of the UK sector in the North Sea. A second stage survey is scheduled to begin this year, as is the first offering of exploration and development licenses. Drilling would likely begin in 1997, with first production in 2002-05.

North Sea

Just as natural gas appears to be the saving grace of the aged and faltering Gulf of Mexico and the stimulus to wide-spread development in Southeast Asia, so, too, is it the likely future of the North Sea, which is now showing its age as well. But, then, could the North Sea's turn to gas come at any better time, with Europe melding itself into a single, massive market for essential commodities, including gas, the energy choice of the European Community. The UK anticipates having a production rebound to 2.5 million b/d by 1995, when many of the fields now in development will be kicking in. Norway's production is expected to stay approximately the same for the next few years, however. But gas is still the forecast for the foreseeable future. Combined UK gas production from probable field developments may reach 3.4 bcf/d by the year 2000, some 40 per cent of potential production. Norway is working hard to bring on its US$4.79 billion showpiece, the huge Troll Field, one of the world's largest offshore gas fields, with recoverable reserves of 46Tcf gas and 400 million bbl of oil, expected to go onstream in 1996 with daily production of 2.3 bcf/d almost the same as Norway's entire production in 1991. Pipelines are, of course, the North Sea's conduits to cashflow, and they are proliferating rapidly to get the abundance of gas (and oil) into the European network. Altogether, there are now some 3,500 miles of pipeline already in place. More than two-thirds of this North Sea network is dedicated to transporting natural gas to the UK, Norway, and the European mainland. Explorations are being extended into the northern frontiers of the North Sea, outside Floro, and farther north still, into the Norwegian Sea's Voring Plateau, where sea depth ranges between 800 and 1,200 metres. The vast majority of North Sea deepwater drilling is taking place in Norwegian waters, as Norway prepares for the future. Other fields, particularly in the central North Sea, continue to be drilled and brought into the development stage. The numerous smaller fields, long discovered and awaiting development, will for the most part, still be left for future exploitation after the turn of the century.

Mediterranean Sea

The Mediterranean Sea saw considerable activity during 1992 and 1993 and will most likely enjoy even greater activity in the near future due, for the most part to an upswing in exploration and appraisal drilling throughout the Mediterranean's African continental shelf hydrocarbon plays, from Tunisia to Egypt. On the Mediterranean's African CS activity has been brisk. New and exciting discoveries and the unfolding development of a Tunisian offshore petroleum industry indicate Tunisia may very well become the major Mediterranean play in the next decade. Some 17 international and national companies are currently involved in Tunisian oil and gas E&P and more are expected. Libya's massive Bouri Field continues to be the focus of a major development effort. By far the largest offshore field in the area, Bouri, already has between 40 and 50 wells completed but is still being further developed. Egypt continues to enjoy enormous offshore success not only in its Red Sea province, but also in the Nile Delta and North Sinai prospects in the Mediterranean. Discovery after discovery are being made in the Delta, a primarily gas-producing province.

Black Sea

Beyond the Mediterranean to the east lies the Black Sea, where renewed interest is generating expanded exploration. Romania's Black Sea shelf is drawing both local and international attention. Although there is currently no offshore petroleum production off Bulgaria, it is believed to be a prime exploration area. Despite the presence of numerous undeveloped or only minimally developed gas fields offshore Rostov in the Sea of Azov and near the oil port of Novorassysk, Russia's interests for the time being are on its arctic offshore region.

Russia

Irrespective of the immense attraction of Russia now that democracy and a market economy appear to have gained a foothold there, it is and probably will remain until the year 2015, a mostly onshore area. The new Russian Federation holds some of the largest and least-touched petroleum reserves in the world, but almost all of them are in Western Siberia or associated regions. International operators are clamouring to claim them, but finding it not as simple as stepping in and taking over E&P in many Third World plays. This, not so much because of technical or geophysical difficulties, although these are factors in some instances, but because of the lack of a cohesive bureaucratic structure with which to deal and a lack of infrastructure in which to work. Decisions are not eas-

ily come by, nor are regional power centres willing to relinquish their new-found power to central organizations. Moreover, Russia's Gazprom announced recently that direct foreign participation in the petroleum sector will be limited to projects that require technical expertise that is unavailable in the country. With estimated offshore reserves of approximately 550 billion bbl of oil and 250-300 billion cu ft. of natural gas, however, Russia is, nevertheless, one of the world's most attractive venues for exploration and production by international companies and a potentially huge market for industry products and services. It is generally agreed that Russia's Arctic Barents and Kara Sea provinces and its Okhotsk Sea province north of Japan will most likely replace the North Sea as the World's big offshore petroleum plays for the first half of the 21st century. Because of environmental sensitivity, Russia's Caspian Sea sector will be closed to hydrocarbon development for the foreseeable future. Currently there are eight rigs working offshore in the Barents and Kara Seas and seven in the Sea of Okhotsk. In all likelihood, it will be the Caspian Sea that enjoys greater development by international companies during the coming decade than the offshore fields of the Russian Federation, simply because of easier accessibility and less bureaucracy with which to contend.

Middle East

It is, of course, in the southern half of the Caspian Sea where most activity has been focused, in the Middle Eastern provinces of Azerbaijan and Turkmenistan. Although the giant Tenghiz Field lies just onshore in Kazakhstan, that new republic has had no indications of offshore plays. Considerable offshore development has, however, occurred in the waters along the Aspheron Sill between Baku an Aladzha, Turkmenistan for more than a hundred years, albeit that development and the production from it has been very basic and is now generally inefficient or unproductive. To rectify this, the Azeri government has led the CIS in launched joint ventures for the development of new and existing fields within its Caspian aquatory using the latest technology. First the new ventures to go on the block was the Azeri Field, the 1.5 billion bbl oilfield discovered by Kaspmoneftegaz in 1987. Plans call for five first wells and construction of six to eight fixed platforms in water depths up to 200 metres. The field should be onstream within three years of the signing of the final agreement. In addition to Azeri, some 25 fields lie off Azerbaijan, and most are sizable. Seventeen are already on stream, but in need of redevelopment. Across the Caspian frontier, Turkmenistan has begun offering concessions to international operators for joint ventures and production-sharing arrangements. In the southern Caspian, Iran has increased its interests by providing services and supply from its territory for the development of both Azeri and Turkmen fields, and it is thought that several joint development projects are in the wings not only near its frontier, but in the Sill itself. In the Arabian/Persian Gulf, Iran has almost completed the rebuilding of its oil and gas installations that were destroyed during the war with Iraq and is extending its exploration and development to include virtually its entire Gulf province. A major drilling programme is underway and foreign participation is being sought for new developments to increase its production capacity. Some foreign involvement in the petroleum sector has begun, but suffers from opposition to foreign equity participation. Iran's South Pars Field, is being extensively developed by Saipem and the French company Technip, which is drilling three appraisal wells during 1994. The project includes platforms, subsea pipelines and a gas treatment plant. Recoverable reserves are said to be some 800 billion cu metres of gas. The showpiece of the Arabian/Persian Gulf is, of course, Qatar's mammoth North Field, which is now producing more than 50,000 b/d natural gas liquids and 700 million cf/d of gas almost all for the electric utilities of Japan. With proven reserves of more than 150 Tcf of gas, it is one of the world's largest known gasfields. Approximately 800 MMcf/d are being processed from the field initially at the associated production and gas treatment plant. The Kingdom of Saudi Arabia is putting renewed emphasis on its offshore fields in the Gulf, particularly those in the Safaniya area, including Marjan and Zuluf. In addition, Saudi Aramco is expanding its exploration and development programme to thoroughly cover its Gulf province in the hope of finding further fields through higher technological approaches, including 3D and modelling. The Emirates, especially Abu Dhabi and Dubai, are each in an all out effort to expand their exploration and development programmes appreciably.

West Africa

With the depressed petroleum industry in the Gulf of Mexico and North Sea, West Africa's Gulf of Guinea attracted major players in record numbers in 1992. Despite the presence of civil war and internal strife, and low oil prices and price expectations, the area continues to be one of the world's major venues for the international offshore petroleum industry. A difficult region to work in efficiently due to political unrest, bureaucracy, and graft, it is, nevertheless, witnessing tremendous growth in offshore activity. Concessions offered by any of the nations from Senegal to the Cape are readily taken by the majors, consortia of European and Asian state oil companies, and many of the larger independents. The entire West African continental shelf from the Ivory Coast to the Cape of Good Hope has been awash with exploration and development and from all indications, the entire swath appears to have good promise. Some 78 oil fields that have already been identified in Gabon, Angola, Congo, and the other Gulf of Guinea countries will be coming on stream with the next five years, adding another 1.4 billion bbl to the region's already considerable known reserves. It is in Nigeria,

Gabon, and Angola, however, that the most rapid increase in exploration and development is taking place. In South Africa, licencing of international participants in its petroleum sector is planned for the first time this year. Although only one small gas reservoir has been found in the country, hopes are high that considerable hydrocarbons will be found off the country's west coast. To that end, exploration licensing should begin soon.

South Asia

Hoping to boost its production by 16.5 million bbl a year and to generate US$1 billion in foreign investment in its petroleum sector, India has not only altered its policies to allow private and foreign investment in the development of existing oilfields and begun a programme of year-round bidding, but has begun a major (and controversial) privatization programme. ONGC, the Oil & Natural Gas Commission, India's major E&P company, is to be converted into a private company in a massive restructuring conducted by the petroleum ministry.

Southeast Asia

Major economic growth is driving the big boom in Southeast Asia's petroleum sector. Last year's average economic growth rate of 5.3 per cent for the ASEAN countries shot energy demand through the ceiling and set off a scramble of exploration, development and production activity that continues at a hectic pace. Centred mainly in Thailand, Indonesia, Malaysia, Vietnam, and Australia, the boom stretches from China's South China Sea to Australia's Bass Straits. Also Cambodia is active, with five companies working prepared to begin drilling this year. China's offshore province in the South China Sea has been somewhat of a disappointment so far, but further explorations may still prove it to be a major part of China's petroleum picture. More than US$2 billion has been invested in explorations of China's continental shelf, but results have not been exceptional. Nevertheless, China expects to increase its offshore production to 100,000 b/d this year, basing this on anticipated output from those fields it now has under development. Thus exploration continues, as does development of the most promising finds. Several heavy oil fields in the South China Sea (including Liuhua 11-1) may help reach that goal when developed, but until then, the most likely producers are the collection of fields n the eastern part of the Sea, south of Hong Kong in the Huizhou area. Agip, Chevron, and Texaco (the ACI Consortium) in cooperation with CNOOC are developing the fields. More than 100 wells have been drilled in the area since 1984. China's potential offshore reserves are estimated at 6.2 billion bbl of oil and 4.9 Tcf of gas. The Philippines, on the east side of the South China Sea, has been enjoying tremendous success with its Palawan Island prospect, where Alcorn, Shell, Occidental, and Philodrill have had discoveries in the last year and a half. The West Linapacan Field, operated by Alcorn International, a Philippine-US consortium, looks to be a major field, with recoverable reserves of 109 million bbl. Northwest of Palawan, the Oxy Shell Malampaya Field, with reserves of more than 300 million bbl, along with Camago and Calao Field, may each prove to be major fields in their own right. In the Sarawak Basin of the South China Sea, Brunei continues to witness increases in its production level, mostly due to extensive development being done by Brunei Shell petroleum on its Champion Field, where 22 development wells have been drilled. In addition, the company's Southwest Ampa Field has five new development wells, a deep gas appraisal well, and a deep high pressure gas well. Malaysia's sector of the Sarawak Basin has been highly productive as well. Extensive exploration efforts were undertaken over the past year off-shore Sarawak and Sabah and several notable discoveries were made. Off the mainland Malaysia peninsula, other new formations were found that also led to discoveries by both Shell and OPIC. Probably the most exciting venue in Southeast Asia over 1992 and the beginning of 1993 has been Vietnam. With new production sharing contract favorable to foreign operators, the country is enjoying major exploration and development activity. During 1992, BHP plucked the plum with award of giant Dai Hung Field (600 million bbl), but others are in the offing: Bach Ho, operated by Vietsovpetro, the Russian-Vietnamese joint venture with reserves of 175-300 bbl. Rong, also held by Vietsovpetro, with 150 million bbl, and Blue Dragon, expected to hold at least 300 million bbl (unconfirmed). A full contingent of European and Asian operators is there in force, drawn by estimated offshore reserves of more than 3 billion bbl. After having been burned by the loss of its principal supply of oil during the Gulf War, Thailand has undertaken a major effort to expand its offshore production capacity and thereby reduce its imports and increasing oil debt concurrent with becoming a newly industrialized nation. Thus, to facilitate foreign participation in this new expansion programme, government policies have been changed to favor international operators investing in Thai exploration and production. And it appears to have worked; scores of major and large independent operators are in the Gulf of Thailand seeking oil and gas and/or bringing it onstream. Foremost among these, is Total, with its mamoth Bongkot Field in the centre of the Gulf. With estimated recoverable reserves of 1.5Tcf gas and 25 million bbl condensate, it will go a long way in aiding Bangkok's energy effort. Indonesia is desperately trying to find more oil reserves to stave off the imbalance in production and domestic consumption, expected to reach 1.4 million b/d oil and 1.7 bcf/d gas by the year 2000. And it hopes to cease importing oil in the mid-1990s. This by hefting oil production, now at 650,000 b/d, and making a dramatic increase in its gas production. Because of this massive effort, tremendous opportunities exist in Indonesia

for offshore exploration, development, and production. E&D expenditures in 1991 were US$2.3 billion, they were even larger in 1992, and are expected to be further increased. To achieve these levels of production, Pertamina is pushing hard to increase international participation in Indonesian exploration and production and is offering a new, more attractive production-sharing contract to all comers that has paved the way for high levels of exploration this year and next. Because of Indonesia's heavy emphasis on developing its natural gas and building a world class LNG industry, the most exciting projects of all may well be in the Natuna Sea, where Conoco is constructing the Stage II development of its Belida Field, where 94,000 b/d oil will be produced, and Esso's US$16-19 billion East Natuna Sea LNG project centered on Esso's giant L Field, where reserves are estimated to be over 240 Tcf. LNG production is, of course, at an all-time high, and although domestic gas consumption is at an all-time high, so, too, are exports, mostly to Japan. It is predicted to become Indonesia's principal export in three years if greater oil production does not occur. Australia's offshore continues to look promising. Known reserves are 1.7 billion bbl, but will probably go higher as the current extensive exploration programme brings in additional finds. Drilling and discoveries are at an all-time high. The Northwest Australian CS has become a major play for Australian and international operators, as has the new prospects off southeastern Australia. Much of its heightened activity is attributable to a new, more favorable policy for both domestic and foreign operators, and considerable stimulus is due to the ready market for LNG presented by Japan. (Extracted from **Offshore/Oilman** May 1993, **Offshore Engineer**, April 1993, and **Offshore**, January 1994).

WORLD SUBSEA MARKET

An analysis of operators future plans over the next five yearsindicates a distinct movement towards the extended use of subsea production and floater technology, with more subsea systems being installed worldwide over the next five years than were installed over the past twenty. While in 1992 the subsea element represented about 10 per cent of international capital expenditure (between $ 5 to 9 billion peryear), according to Norland Consultants, by 1996 this portion will increase to about 15 per cent, a quite distinct trend, which also shows the confidence of the industry in subsea technology. Also evident from this analysis is the extended anticipated use of floaters in field development work. Admittedly, extended use of horizontal wells offshore will favour the use of fixed wellhead type of steel structures for shallower waters, and the trend on the international scene is for activity in deeper areas. The overall trend in offshore oil and gas field development is therefore the extended use of subsea and floater technology at the expense of the use of conventional fixed platforms. In the meantime, platform technology is also changing in order to accommodate different functional requirements and to meet the need for lower development and operations costs. Increasing industry confidence in multi-phase flow technology is also a major contributing factor in the changes envisaged for field development technology. The subsea market is the most relevant indicator of industry confidence in key technology developments. According to Norland Consultants' latest five-year survey, while a total of 150 wells will be completed as subsea producers or injectors in 1993, this figure will have increased to 181 wells in 1995. The subsea equipment supply industry is already squeezed for capacity. One of the characteristics of this sector is the relatively low number of suppliers. Substantial engineering demand increases with subsea Christmas tree manufacturers. This therefore could emerge as a possible bottleneck factor and the industry could face a squeeze in both deliverability and prices in this sector. This may account for the emergence of alternative suppliers who are now appearing on the scene. (Source: **Euroil**, June 1993).

NEW SUBSEA INNOVATION AREAS

Operators interested in subsea development are always on the lookout for new technology that will make their lives easier and their projects more economically viable. Two recently announced projects – one in the North Sea and the other in the Far East – give a good indication where the next wave of accepted "new" technology will come from. Amoco Orient's Liuhua 11-1 is in deep water (330 metres) off China, will see a pair of floaters – a semi-submersible drilling/workover vessel and a tanker production, storage and offloading system – producing from 20 subsea wells to an unusual "building block" subsea manifold. The key technology element is that each well will have its own downhole pump (dhp) to provide wellstream boosting for this field's heavy cude oil. In general terms, it is acknowledged that wellstream boosting downhole would be more efficient – it is done in single phase as any gas present would be at a pressure above breakout – than multiphase boosting beyond the reservoir. To date, there have been no subsea wells with dhps for a number of reasons. Firstly, dhps have in the past a notoriously short meantime to failure (MTTF). This is not such a problem on a platform where workovers are not very expensive, but on a subsea satellite development the cost of mobilising a rig or, in the least, a monohull workover vessel, too often would make the use of DHPS prohibitively expensive. Secondly, there have been no subsea Christmas trees designed for dhps. In conventional subsea trees, it would be necessary to pull the tree and possibly the tubing hangar to remove a failed dhp, a costly exercise. The obvious answer is to design a wide bore tree that could remain in place while the dhp is removed. Finally, a dhp is a high power consump-

tion item requiring a highpower connector. In this case, it would also need to be able to pass through the Christmas tree for internal connection.The development of a horizontal, or spool, Christmas tree to accept a dhp has been under development for some time. One of theadvantages of the system is that installation of the completion and tree can be done with a generic marine riser, with a resulting cost-saving. One of FMC's tree designers concludes that additional work needs to be done on the tree design, to ensure that it meets all current standards and safety codes and also on operating procedures.There has been a great deal of work done to improve dhp reliability, including moving away from the conventional electric submersible pump (esp) to hydraulically driven units.The other project that will feature new technology is BP's DonSouthwest. A cost-saving scheme, which features a long-reach (4kms) well drilled close to the existing manifold, thus eliminating the cost of a flowline, brought this project to life. BP had to come up with a scheme to measure and apportion production. The operator has gone for a downhole flowmeter developed by Exal. Not only had this new piece of equipment never been used in a subsea completion, it has never even been used offshore at all. BP has been testing a prototype at its onshore Wytch Farm complex and has assisted in adapting and refining the original design. The flowmeter will be used not only to measure flow to allow allocation of fluids, but water cut as well. Like a downhole pump, this meter benefits from operating at a pressure above the bubble point so that it does not have to handle the problem of multiphase flow after gas breakout.The success or failure of the Exal flowmeter will have asignificant effect on the market where companies and research groups are working on the development of multiphase meters (mpm). At a seminar held in April 1993 on mpm, the consensus was a fully proven top side mpm should be available on the market in two years and a marinised version for subsea application in three. (Source: **Euroil,** June 1993).

NOVEL SPOOLTREE SOLUTION

The Gryphon field development, for which Annex B Approval was granted in December 1992 by the UK Department of Trade and Industry, will utilize up to 14 subsea wells tied back to a floating production system consisting of a turret-moored tanker.The water depth is 370 feet. Gryphon is one of the latest-generation fields with reserves of around 100 million barrels, where use of innovative technology has made development attractive. One of these novel features is the use of the new SpoolTree™ subsea production system. Kerr-McGee Oil (UK) PLC has been working closely with Cooper Oil Tool to determine the specific requirements for the subsea trees. The SpoolTree subsea production system was selected since it is applicable to all four types of wells required for field development (8 oil producers, 1 water injector, 1 water supply and1 gas injector).Compared to conventional subsea trees, the SpoolTree system hasadvances in safety, operability and cost. It has a different basic configuration than a conventional tree. The stackup arrangement is wellhead/tree/hanger so that the hanger is landed in the tree rather than in the wellhead. This allows primary access to the completion without removing the tree. In addition, all valves are external to the tree body with no vertical valve runs. The tubing hangar is landed on a dedicated shoulder in the tree. Its elevation and orientation is accurately controlled. The SpoolTree tubing hanger is a mono-bore design, allowing thecompletion to be installed on a single work string rather than on a costly conventional dual-bore workover/completion riser.The most important safety benefit is that completion activities can be performed under conventional blowout preventer (BOP) control at all times during the completion operations. (Source: **Euroil,** June 1993).

VALVE CLOSES OIL WELLS IN TEN SECONDS

Using a new safety valve developed at NTH (Norway) an oil well in the North Sea threatened by a blowout can now be shut down inseconds. The valve, which is placed inside the well together with the rest of the drilling equipment, will probably make oil production from the sea both safer and more economical. Present day safety valves are either placed on the seabed (floating platforms) or on deck (permanent installations). It can take several minutes from the time the platform crew discovers an impending blowout until they manage to close the valve. Nevertheless, even if the well is closed in time, there is also a danger of the well pressure propagating all the way up to the surface. The core of the new safety equipment is a mini-computer that receives signals from the oil rig and controls a small motor inside the valve unit. When a developing crisis situation is discovered, the drilling supervisor pushes the button to activate the Down Hole Blow Out Preventer and pressure pulses are sent through the drill mud to the valve, which order the system inside the well to activate the expandable rubber gasket that closes the well. The shut-down operation takes ten to twenty seconds. Meanwhile, the nozzle over the valve ensures that the drill mud can continue to circulate on the inside and outside of the drill pipe. After the situation is brought under control, the valve can be opened again by sending a new pressure pulse. It is also possible to fill the well with cement and permanently seal it. (Source **Gemini**, December 1993)

GREAT POTENTIAL FOR FIBER-OPTIC CABLES IN OFFSHORE APLLICATIONS

As the offshore industry turns to remote working to improve safety and efficiency, technological advances in automation and transmission will be the keys to better production. Opera-

tors who embrace state-of-the-art technology will be the ones to benefit from the remote revolution. The offshore industry both above and below surface, is undergoing some of the greatest changes since it began in the 1970s. For the sake of safety, workers are being removed from rigs and in the last seven to eight years, the number of divers working in the North Sea has fallen to 50 per cent. Automation is on the increase in a bid to keep costs down and fields in deeper water are being tapped. As the trend gains momentum, greater demands will be placed on the technology needed to transmit information accurately and quickly from and to rig and subsea operations. Information from remote sites will create increasingly complex networks of video for both security and entertainment, two-way audio intercom, security and instrumentation sensors to transmit and receive data, computer control systems and radar. With remote operations, this mix of data, audio and visual information has to be transmitted to and from a control area – at its simpiest a surface control on board, or at the other end of the scale, a central base, perhaps linking a network of well heads and using troposcatter or microwave links to return information to the control. Traditionally, copper cable would be the medium used in these links. The need to minimise any possible risk of explosion, however, makes copper cable, with its inherent problems of sparking and faulty current, no longer a safe or economic option. Until recently, the alternative – fibre optic cable – was prohibitively expensive, but just as quickly as the offshore industry has evolved, optical fibres have become cheaper and its applications more advanced. Fibre optics are inherently suited to underwater engineering work or for rigs based greater distances offshore. It can carry huge amounts of information over distances without the need for amplifiers or repeaters, and can also provide substantially higher resolution pictures than those economically viable over copper. On one level this allows more accurate surveillance or inspection and better control of tooling, but it also has important benefits in terms of perceived effectiveness of remote working – the better the quality of the video range, the better the quality of the operation as a whole. With safety in mind, fibre, unlike copper, neither interferes with nor suffers interference from electrical cables. Many ROVs still need copper cabling in their umbelical to receive their motive power. On a sea bottom trencher or cable laying ROV for example, the high voltage power needed can create problems with information sent back to the surface if copper cable is used for both. Other developments include modules so small that they can be installed directly on to cameras and specialist products that make use of fibre's high bandwidth to transmit radar, other navigational aids, sonar, graphics and high resolution black and white pictures. A revolutionary fibre-based frequency-agile FDM system allows operators to "channel hop" between cameras just as we would use a remote control on a television at home. The advantages for monitoring and collecting information on ocean floor wellheads or large-scale unmanned operations are enormous. In the near future, fibre optic applications will be a prerequisite for safety, efficiency and economy in rig and subsea engineering. (Source **Euroil**, June 1993)

THE MOLE FINDS OIL AND DIGS CABLE DITCHES

A drilling machine that may revolutionize oceanic oil exploration and municipal "ditch digging" on land has been developed. The Kolibomac drill machine can be used to find oil reservoirs several kilometres under the seabed. On land, it can dig trenches for water pipes or telephone cables without digging up streets. Kolibomac was designed at Norway's NTH Department of PetroleumTechnology (IPT). The researchers believe that one of the main advantages of using the new drilling machine is the resulting increase in safety. A series of sensors mounted inside the machine instantly register any abnormalities. If there is a possibility of an oil blowout, the Kolibomac can tighten the packing in front of itself to plug up thehole. In addition, the operator on the surface always knows exactly where the machine is and can manoeuvre it around difficult rock formations and if necessary back it out of the hole. When the voracious torpedo-looking device devours its way through the sub-stratum, it leaves a hole 25 to 31 centimetres in diameter. A new patented drill tip mounted on the front drills twice as fast as other tips. (This tip was also developed by the Department of Petroleum Technology and is being used by several oil companies.) Using a plastic material, the machine reinforces the walls of the hole it drills. The drilling mass can be pumped up to a ship on thesurface. In this way oil companies avoid leaving large quantities of drilling debris on the seabed, as is current practice. The machine is not dependent on a platform with a full crew, meaning that the drilling process may be less expensive than it is today. The only infrastructure requirements are a ship with room for the drilling machine and the requisite reels of cable. The drilling machine can wind its way forward under street foundations as well, between old pipes and cables, without being noticed. Water pipes, for example, can be placed inside the finished plastic pipe that the machine leaves behind. The researchers envision a multitude of such applications in municipal engineering. (Source **Gemini**, December 1993).

RELIABLE SUBSALT SURVEYING REQUIRES SPECIAL TECHNIQUES

Until recently, 3D seismic exploration beneath tabular salt was considered a very expensive waste of time, but over the past three years, acquisition techniques have been perfected that are capable of providing almost error-free data on the substrata lying below sheet salt formations. Concurrently, computer power increased to proc-

ess that data rapidly and accurately making it possible to reliably image the subsalt zone for the first time. Subsalt revelations via new acquisition technology and the power of massively parallel supercomputers have created the equivalent of a whole new country for exploration. For example, in the Gulf of Mexico where tabular salt covers some 36,000 square miles, not only is there a significant reserve potential but operators can take advantage of infrastructure already in place. Several major operators are beginning to base their site selectionand drilling on high-tech 3D data acquired with the newly developed technology. Phillips's Mahogany discovery in Ship Shoal Block 359 and Amoco's South March Island Block 169 dry well last year, as well as Phillips's South Timbalier Block 260 well currently beingdrilled, are recent US Gulf of Mexico examples (Source: **Offshore**, January 1994).

HORIZONTAL HYDE TESTS TEAMWORK

The traditional relationship between oil companies, drilling contractors and service companies is undergoing a dramatic review by many of the major operators. Non-core activities are being moved out from the oil company to the contracting and service industry. BP Exploration has been to the fore of these moves, but rather than choose a relatively easy candidate for its first partnered well in the UK, the company opted for a technically ambitious development on its marginal Hyde field. As a result, the Glomar Baltic I, under the supervision of the combined Hyde drilling team, drilled the North Sea's longest and the world's third longest horizontal well. When the well was suspended in March 1993 it had a horizontal section measuring 2 169 metres at a total vertical depth of 2,930 metres. Time and quality based incentives yielded additional revenues for the drilling contractor and the service companies and its productivity precluded the need for an additional well saving BP £5 million on Hyde project drilling costs (Source: **Offshore Engineer**, May 1993).

NORTH SEA ORDER FOR SANDVIK'S STAINLESS STEEL TUBES

Sandvik Steel UK has received an order from Kvaerner Energy (Norway) for super duplex stainless steel tubes for use in the North Sea Troll field, intended for a new type of umbelical where service lines for methanol injection, hydraulic tubes and electric cables are made into one bundle separated by elements of extruded PVC. The company claims the electro-hydraulic umbelicals offer superior strength to the traditional thermoplastic hoses and eliminate the risk of collapse. They also provide a maintenance free service performance over the total design life, which for current sub-sea developments is around 30 to 35 years, according to Sandvik (Source: **Metal Bulletin Monthly**, October 1993).

HIGH-POWER WELDING FOR OFFSHORE DRILLING AND ENVIRONMENTAL ENGINEERING

By combining two well-known processes the Austrian firm Fronius KG has developed a new welding technique intended mainly for thin plate welding assignments calling for high-quality welding seams. The combination of tungsten inert gas with hot-wire welding has resulted in faster welding and an improved seam quality. The so-called TIG hot-wire technique is particularly suitable for the construction and repair of flue gas desulphurisation facilities and for special offshore drilling jobs, i.e. on drilling platforms. One example is the construction of linings from a plate of highly corrosion-resistant nickel alloys. Thanks to their favourable mechanical, technological, physical and corrosion-resistant properties, such alloys are growing steadily in importance for chemical plant construction as well. (Source: **Austrian Economic News**, 4 1993).

RESEARCH GROUPS JOIN TO AUTOMATE WELDING

UK and Norwegian research organizations are putting together detailed proposals on a project to develop enhanced technology for subsea hyperbaric welding. Research will focus on totally automated, faster and deep-water hyperbaric welding techniques for use on subsea installations and structures in the North Sea. Cranfield Institute of Technology, the National Hyperbaric Centre (NHC) in Aberdeen and SINTEF Welding Centre in Trondheim signed the general co-operation agreement in early October 1992. Automation is a key goal. Current hyperbaric systems although highly mechanised, still need divers. NHC will probably opt for total mechanisation using state-of-the art robotic technology originally developed in the motor manufacturing industry. NHC has acquired a robotic arm and is in the process of adapting it for offshore use. As an alternative to manual metal arc techniques where water depth has a detrimental effect on weld quality, the group will also look at recent advances in electronic control systems for gas shielded welding processes in deep waters. For example, TIG welding could be used at 500-600m depths, MIG welding to 1000m and plasma welding beyond that. (Source: **Offshore Engineer**, January 1993, p 26).

SHIPPING AND SHIPBUILDING

RETHINKING MARITIME PRIVATIZATION IN AFRICA

While recognizing the need for increased participation of the private sector in the maritime industry of developing countries, there is a need to go beyond the call for privatization in terms of mere change of ownership from state to private sector as the only solution to the inefficiency of the maritime industry in developing countries. This limited understanding of the maritime problems of these countries abounds in the literature on maritime privatization. The study suggests that maritime privatization will not necessarily result in increased efficiency of the divested maritime enterprises. Rather, it argues that maritime problems in these countries have less to do with ownership than with the structural constraints in world shipping together with internal management and local politics. The maritime industry in West and Central Africa is used as a case study and recommendations such as selective privatization, programme contract, and most importantly, corporatization, are suggested as alternative strategies that could enhance maritime privatization and the development of the maritime industry in developing countries. (Source **Maritime Policy & Management** Vol 20 No 1 January-March 1993)

LEBANON NEW BEGINNING

With World Bank and EC loan programmes imminent, the Lebanon is on the brink of expansion and growth. Although shipping links with the Lebanon continued throughout the 1975-91 civil war, international businesses, including many maritime companies, are now returning to Beirut to re-establish ties. The port of Beirut, which re-opened in 1991, has three basins covering 56 hectares. It is easily accessible and protected by a 3.88 metre jetty. Total quay length equals 3,784 metres with a draft between 8 and 13 metres. One of the basins is earmarked for a modern container terminal. The port is well equipped with handling gear, including many mobile cranes available up to 100 tons and fork lifts up to 35 tons. On the bulk handling side, an annual trade of between 55,000 and 700,000 tons, comprising two thirds wheat and one third corn, is handled at the 12,000 ton capacity grain silo terminal. Vessels up to 10,000 dwt can be loaded without shifting at a rate of 200 tons an hour utilizing two gantry crane suckers. There is also a soja-bean meal traffic of 50,000 tons a year, which is discharged directly on to trucks. Oil majors have their own terminals in the petroleum port about three miles from the commercial port. (Source **Seatrade Reveiw**, May 1993)

CHINA CITIC TO DEVELOP DAXIE AS DEEPWATER PORT

The China International Trust and Investment Corporation (CITIC) has plans to develop Daxie island off Ningbo as a world class deepwater port, creating a trans-shipment centre for containers from the Yangtze River delta, a transit point for liquid chemicals and refined petroleum products and industrial and storage facilities. CITIC plans to invest Yuan 4 to 5 billion ($460-575 million) and is looking for a further Yuan 20 billion from international investors who would site facilities on the island. One terminal operator currently looking at various Chinese locations suggested that the Daxie development was at a very early stage and until bridge and rail links with the mainland were confirmed it would be unlikely that chemical terminalling facilities could be conveniently located on the 12 square mile island site. Currently he believed the best area for development is the New Port area to the east of Ninbo, where the depth is around18 metres. (Source **European Chemical News**, 7 February 1994)

CHINA: PROSPECT OF WESTERN STYLE RESTRUCTURING

The People's Republic of China (PRC), already the world's largest shipbuilder, is planning to radically restructure the industry along western-style lines. The China State Shipbuilding Corporation (CSSC) is to be split into seperate units with greater degrees of autonomy than before. The next few years will see yards and groups of yards around the country transformed into independent shipbuilding companies with their own productivity goals. Some will be floated on stockmarkets in a bid to attract overseas investors and raise capital. In particular, two separate developments at different yards give a clear indication as to the future development. Late in 1992 it was announced that the Quangdong yards in southern China, the most efficient within the CSSC group, are to be floated off into a separate company and up to 50 per cent of its shares placed on the Hong Kong stockmarket. The three SCCS yards in Shanghai could soon be placed into one company and some of the shares would then be floated on the emerging Shanghai stock exchange. The two largest Shanghai yards, Hudong and Jiangnan, both continue to enjoy a high reputation abroad and will have order books that give them work until at least the end of 1994. The demand for domestic tonnage means the work is unlikely to dry up, but senior economists at both yards realise that fundamental changes must be made to attract orders from overseas. Bai Shuangxi, senior economist at the Jiangnan yard, said there

was a willingness among managers to make the changes, but there were no illusions as to the scale of the task. He said that other changes in the loosening of the ties to the central bureaucracy were now taking place that would benefit Jiangnan, such as now being able to acquire steel for production on a much more flexible basis, whereas before it often took four to five months delivery. A move that will have major implications for all CSSC yards is the scrapping of the Mineral Import and Export Corporation monopoloy onsteel supply to the yards. Many yards choose alternative suppliers for steel, enabling them to achieve greater flexibility in supplies. Behind those changes lies the belief that China can take advantage of the expected ordering glut that must come as tonnage needs to be replaced before the end of the century. Such is the potential of the local market, it has now overtaken Taiwan in tonnage output to become the world's third largest shipbuilder. By 1994 the annual output figure is expected to rise to 1.4 million dwt and the current total orders in hand amount to 3.5 million dwt. It seems likely that for the moment, the slowdown in foreign orders will be more than offset by the continuous ordering by domestic shipping companies following China's dramatic economic growth. The fleet renewal programme of the state carrier COSCO and the growth of the regional shipping companies means that CSSC will certainly win more orders. Anotner SCCS plan that has aroused international interest is a planned move into ship demolition at three separate facilities in northern China, Guangdong and Shanghai. (Source **Shipbuilding and Ship Repair**, Summer 1993)

RUSSIAN AGREEMENT FOR KVAERNER

A cooperation agreement with the Russian Sever shipyard at Severodvinsk, near Archangel, has been signed by the Scandinavian shipbuilding and engineering group Kvaerner. This is designed to help the yard to convert from naval to civilian production. (Source **The Naval Architect**, June 1993)

QUALITY FOCUS DESPITE A TOUGH MARKET

While a sluggish world economy and over capacity in nearly all sectors of the market have combined to depress shipowners' earnings, the shipping industry faces continuing pressures to upgrade the quality of both its tonnage and its operations. As far as the industry's ships are concerned, it is significant to note that 46 per cent of world gross tonnage is now past the 15 year mark, according to Lloyd's Register statistics. The average age of the Greek-owned fleet, the world's largest, is now 21. Japan's fleet has an average age of nine years and those controlled by USA and Norwegian owners have average ages of 20 and 19 years respectively. Maintaining and operating elderly ships puts new stresses on shipping company managements and those aboard ship. Increasingly, leading shipowners and managers are looking to quality assurance schemes, such as ISO 9000, as a means of reassuring clients they are running quality operations. A related ongoing international industry headache is the underlying shortage of qualified seafarers. The President of the International Shipping Federation believes that the need to ensure the professional competence of the seafarers who man the ships is one of the most important issues the industry faces today. Even the most modern, well-equipped ship is a potential accident if it is not manned by seafarers of appropriate experience and qualifications. The International Chamber of Shipping is also helping ship owners cope with another continuing challenge – that of meeting higher public expectations in the protection of the environment. It has published a new code of practice that gives guidelines for the avoidance of pollution from a wide variety of sources. (Source **Marine Log**, June 1993)

THE LIFE-EXTENDED SHIP

The desire of some owners to extend the life of ageing but viable tonnage is addressed by the major classification societies with schemes or programmes tailored to assist in defining and executing the required hull renovation work. Apart from securing a life-extended vessel with perhaps a higher re-sale value, the owner may benefit from preferential charters (though not necessarily higher rates) and possibly lower insurance premiums. The prohibitive cost of a one-off specialist new building is another reason for investing in the life extension of an existing vessel on a dedicated scale. By June 1993 the Marine Specification Services Department (Marspec) of Lloyd's Register (LR) had carried out the condition assessment of some 36 ships. Sixteen of these have so far benefited from subsequent hull renovation projects and received appropriate certification. The others are awaiting the owner's decision to proceed with renovation or a suitable dry docking opportunity. A substantial number of other ships are reportedly in the pipeline as candidates for LR's Condition Assessment Scheme (Hull Renovation). The scheme was originally envisaged for oil tankers – the present condition-assessed reference list embraces 14 such vessels, of which seven are VLCCs. But other types logged include bulk carriers, general cargo vessels, a gas carrier, a supply ship, a cement carrier, unitised cargo ships, a ro-ro vessel, an ore carrier and a bitumen carrier. The average age is 18 years, with the oil tankers ranging from 14 to 26 years old (the VLCCs from 14 to 19 years) and the dry cargo tonnage from 13 to 29 years. The most economic age for a candidate is around 15 years, LR suggests, since the hull renovated ship can then promise the best payback. Marspec reports a recent upturn in the number of enquiries from owners considering hull renovation projects after a lull lasting several months. The enquiries include what would be the first OBO carriers to be

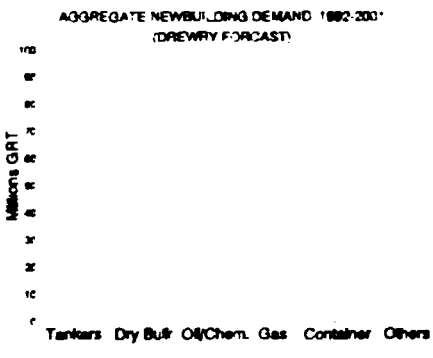
committed to the LR scheme. There is some scope for business from ageing VLCC tonnage whose owners must decide in the next year or so whether to scrap or maintain them in trade. In the end, says LR, the market place will decide the future of condition assessment/hull renovation schemes. (Source: **MER**, July 1993).

LAY-UP AND SCRAPPING GROW

The number of vessels in lay-up increased sharply in 1992 to over 7million gt of ships of all types by year end, according to Lloyd's Register, which reported 95 tankers totaling 4.6 million gt in lay-up at the end of 1992, "three times above 1991 levels, but significantly lower than in the early '80s". Lloyd's Register notes that its figures "do not include tonnage classed as in semi-lay-up – a status that became increasingly popular in 1992. The vessels concerned are not actually laid-up by definition, but simply at anchor (with crew aboard) unable to find employment; some tankers in the Arabian Gulf had been in semi-lay-up for months." In addition to lay-up and semi-lay-up, other capacity has been blotted up by slow-steaming, ballasting of VLCCs around the Cape of Good Hope and the fact that, with an aging fleet, repairs mean more time in dry dock. In these market circumstances, tanker owners can wait a little longer in the hopes of an economic upturn – or they can scrap capacity. According to Intertanko, 13.1 million dwt of tanker-capacity went to the breakers in 1992. Lloyd's Register notes in its annual report that in 1992, tanker scrapping reached its highest level in six years and included demolition of 20 VLCCs. The trend appears to be continuing and may well accelerate, given that the average age of the tanker fleet is approaching 14 years and more than 60 per cent of the fleet is over 15 years old. The likelihood of large numbers of ships being scrapped in the next few years, generally depressed second hand tanker prices and some tempting new building prices can be expected. Some owners may see an opportunity for fleet renewal. (Source: **Marine Log**, June 1993).

$350 BILLION NEW BUILDING DEMAND

Driven by an insatiable appetite for replacement tonnage, the new building demand over the remainder of this decade is expected to climb to a total of 300 million dwt, with capital expenditures eclipsing the $350 billion mark. According to a report by Drewry Shipping Consultants Ltd., London, based on the current age structure of the world fleet, replacement demand up to the year 2001 is estimated at about 14,000 vessels totaling over 153 million gross registered tons (grt), or 230 million dwt. An additional 2,000 vessels are expected to be built, mainly due to the expansion of world trade.



Source: Drewry Shipping Consultants

The study forecasts that the lion's share of replacement tonnage will be ordered during the period from 1996-2001. The report projects 110.81 million grt to be contracted for during the five-year period studied. In terms of compensated gross registered tons (cgrt), the study sees the aggregate new building demand for 1992-2001 as about 158 million cgrt, with nearly 120 million cgrt expected to be delivered between 1996-2001. Drewry predicts, however, that existing facilities should be adequate enough to handle the surge in construction. In its assessment of the world shipbuilding outlook, the working group on the market and forecast of the Association of Western European Shipbuilders (AWES) expects the annual demand to average 15.4 million cgrt between 1995-2000 and increase to 18.7 million cgrt between 2000-2005. (Source: **Marine Log**, June 1993)

DOUBLE HULLS THE NORM

For all tankers ordered from now on, double hull construction will be the norm. While the mid-deck design promoted strongly by Mitsubishi is acceptable as an alternative to double hull construction under the MARPOL regulations, it is not acceptable under OPA '90. Few owners are likely to order tankers that cannot enter USA waters in the foreseeable future. The double hull requirements of OPA and MARPOL 13F are only a part of the tanker design story. New buildings now on order or joining the world fleet also incorporate a number of other significant technological advances. It is no longer realistic to think of tankers as "simple, basic ships". Today they are much more sophisticated and energy efficient than their predecessors and are likely to have a longer life span. Owners and classification societies have become wary of over-extensive use of high tensile steel and pay much closer attention to the need to protect ballast tanks against corrosion. By the end of 1992, Japanese tankers had already delivered 20 double-hulled tankers, including the first to be completed following enactment of OPA '90: the 96,733 dwt *Aframax Olympic Serenity*. USA shipyards are also anxious to re-enter the tanker market and at least two innovative designs are being offered. One is the Skarhar design from Ole Skaarup's US Shipbuilding Consortium, which aims to greatly simplify double hull construction by building up hulls from blocks of just two different configurations. Another is the Marc Guardian Tanker from Marinex International and Metro Marine, based on forming a double hull from "cubicles" incorporated into 50-foot long, fully coated curved plate modules manufactured

to close tolerances in a highly automated, climate controlled facility. Ingalls Shipbuilding has contacted Marinex International to prepare a contract design package for the bow and stern sections of a 1,100 ft long 324,000 dwt twin-screw Marc Guardian VLCC. This follows an earlier announcement that Ingalls would team with Marinex and Metro Marine in the international VLCC market. (Source: **Marine Log**, May 1993)

THE LARGEST DOUBLE-HULL DESIGN FROM NKK

Not long after delivery by Hitachi of *Arosa*, NKK Corporation completed what is believed to be the largest double-hull design yet built at its Tsu yard. this is the 306,430 dwt *Berge Sigval*, ordered by the Norwegian owner Bergesen d. A/S. She is the first of two sister ships for this company. *Berge Sigval* has tar-epoxy-coated ballast tanks and pipes for the ballast system (inside tanks) are made of FRP. Ladders and walkways are fitted for ballast tank inspections. Cargo oil and residual oil pipes are of highly corrosion-resistant cast iron containing chromium. The cargo pumping system includes radar-type level equipment, automatic stripping and special bellmouths to improve discharge performance. All cargo systems plus the auxiliary engines and generators can be controlled by keyboards and CRT screens in the engine control room and cargo office. Emergency towing winches are included in anticipation of requirements at the Louisiana offshore oil loading pier (LOOP). (Source: **The Naval Architect**, June 1993)

JAPAN: NIPPON STEEL LAUNCHES COMPUTERIZED SHIPPING

As part of its three-year programme begun in 1991 to streamline domestic shipping operations, Nippon Steel Corporation has inaugurated Triton, a computer network that links all of its nine steel works, seven branch offices, five shipping companies and 50 berths spread all over Japan. Triton, an acronym for Totally Regulated and Integrated Transport Operation Network System, is expected to save the company one billion Yen ($8.7 million) or more per year in domestic marine transportation costs. At the push of a key, shipment supervisors at any terminal are able to access all shipment data covering movements, operations at berths, shipping assignments and scheduling of loading or unloading operations. Another feature of the program is building all-weather berths at mill sites and receiving ports. This enables all steel products coming from the mill to be loaded on to ships in any type of weather and unloaded at receiving ports in any weather. Streamlining of marine transportation is becoming increasingly imporant because of the growing trend of division of work between "mother" mills and processing mills. Raw or semi-finished products are made at mother mills, then are transported to processing mills for cold-rolling and other processing. (Source: **American Metal Market**, 16 April 1993)

EUREKA PROJECT (EU 353 FASP): AUTOMATION IN THE SHIPBUILDING INDUSTRY

Since there is an enormous over-capacity in the shipbuildingindustry and since several shipyards have already had to close down production or change over to other products, great importance is now being attached to automation and standardization. Ships are basically a one-off product and differ greatly in their construction. In the past, these aspects alone were an insuperable obstacle for the economic use of robots in the welding of ship components. For this reason the research project FASP (Flexible Automation in Ship Prefabrication) was started with the intention of increasing the competitiveness of shipyards on the world market. The aim of this project is the realization of a flexible production line for the automatic prefabrication of ship components in the Italian shipyard Fincantieri under the project management of Fincantieri (Trieste-Monfalcone). Well-known European companies in the automation industry, including IGM, have been invited to cooperate in this high-tech project. The production sequence begins with the welding of single pre-formed plates, thereafter this section of the hull plating is cut to size. The stiffening profile and prefabricated structural sections are put in the marked positions using a manipulator and crane, and then welded into the hull by robots. The production line has been designed in such a way that one complete section can be welded per working day. (Source: **Machinery & Steel Austria**, 1 May 1993).

PROPELLER SHAFT OF ADVANCED COMPOSITE MATERIAL

Sumitomo Heavy Industries Ltd., jointly with the Ship and Ocean Foundation and others, has developed a low-vibration, low-noise marine propeller shaft made of an advanced composite fibre-reinforced plastic (FRP) material. The new propeller shaft has functions comparable to or better than the high-elasticity joint type propeller shaft now used to prevent hull vibration, and the cost is 20 to 30 per cent less. Good results have already been acquired in design, forming and commercialization, so the plan is to market the propeller shaft for use on small and medium-sized vessels. Further information is available from: Sumitomo Heavy Industries Ltd. Public Relations, 2-2-1 Otemachi, Chiyoda-ku, Tokyo 100. Tel: +81-3-3245-4079. Fax: +81-3-3245-4337. (Source: **JETRO**, May 1993)

JAPAN LOOKS FOR GREEN MARINE COATINGS

Japan's Ministry of Transport has initiated a three-year project to develop environmentally friendly anti-fouling coatings. The project will be carried

out by the country's Maritime Technology and Safety Bureau. Separately Mitsubishi Heavy Industries has developed an anti-fouling system based on conductive coatings, which will be made by Chugoku Marine Paints (Source: **Chemical Week**, 10 March1993).

PREVENTION OF MARINE ORGANISM ADHESION WITH THERMALLY SENSITIVE POLYMER

Japan's National Institute of Materials and Chemical Research ofthe Agency of Industrial Science and Technology has developed a newtechnology to prevent the adhesion of marine organisms on marine structures through the use of thermally sensitive polymers at a fixed temperature.The polymer is poly-n-isopropxypropyl-acrylamide, which has a transition temperature in seawater of 9^0 C, so is dissolvedat lower temperatures. The polymer is syntnesized from isopropoxylpropylamine and acryloylchloride triethyiamine. In experiments, a transparent acryl plate (polymethyl methacrylate (PMMA) plate) coated with this thermally sensitive polymer was submerged in the sea for one month at a seawater temperature of 18 to 20^0 C. Marine organisms adhered to the entire surface of this acryl plate. However, when the plate was left for 14 hours in seawater at a constant temperature of 6^0 C, the adhering marine organisms and the polymer were completely removed.The seawater temperature will differ with the region, so the research team plans to develop various thermally sensitive polymerswith different transision temperatures. Further information is available from The National Institute of Materials and Chemical Research, AIST, 1-1, Higashi, Tsukuba City, Ibaraki Pref. 305, Tel:+81-298-54-6228; Fax: +81-298-54-6233. (Source: JETRO, October1993).

CONCRETE INHIBITS ADHESION OF MARINE ORGANISMS

Taisei Corporation has developed a new type of concrete that inhibits marine organisms adhering to marine structures. A repellent is mixed into the concrete, which is applied to the surfaces of marine structures. The new concrete uses a safe repellent extracted from plants and marine organisms and prevents marine organism adhesion without killing them. It does not pollute seawater and can be used readily in civil engineering works. The repellent is assimilated on the surface of a polymer impregnated concrete panel featuring excellent airtightness and strength, which is then applied to the outer walls of marine structures. Maintenance involves simply replacing the panel when its effect wears out after 5 to 10 years. Further information is available from Taisei Corporation, Public Relations Section, 1-25-1, Nishi-Shinjuku, Shinjuku-ku, Tokyo 163; Tel:+81-3-5381-5011; Fax: +81-3-3345-1386. (Source: **JETRO**, May 1993).

ELECTRICAL CONDUCTIVE COATING PREVENTS MARINE ORGANISMS FROM FOULING SHIPS' HULLS

Mitsubishi Heavy Industries Ltd (MHI), in collaboration with the Ship and Ocean Foundation, has succeeded in the commercialization of an anti-fouling system for ships' hulls using an electrical conductive coating. Since it is non-polluting and long-lasting, this system has attracted attention internationally. The system for small coastal ships up to 500 tons has been commercialized under the brand name MGPET-200 (Marine Growth Prevention System by Electrolysis Technology).The new system prevents marine organisms from adhering by temporarily ionizing seawater. Using electrolysis of only a fewvolts, the system covers the hull's surface with hypochiorous acid ions that repel marine organisms. As these ions are used to treat the public water supply and the amount of ions generated is very small, the system does not harm marine organisms. Moreover, as the ions are immediately decomposed in seawater, there is no problem of accumulation of substances in the sea. The system is applicable to both newly built and existing ships and is effective duringcruising and while in harbour, especially for ships moored for long periods. Application of the system of large ocean-going ships and to marine facilities such as seawater iniet channels at power plants is under development. Further information is available from Mitsubishi Heavy Industries Ltd., Public Relations Section, 2-5-1, Marunouchi, Chiyoda-ku, Tokyo 100; Tel: +81-3-3212-3111; Fax: +81-3-3201-4517.(Source: **JETRO**, May 1993).

GPS TAKES NAVIGATION FROM THE 18TH INTO THE 21ST CENTURY

By the turn of the century, no fewer than 51 satellites will be available for navigation at any one time. Only three are required for two dimensional positioning, so there will be a very high redundancy factor for users with integrated receivers, with a minimum of 12 satellites in view. In a paper prepared for the Maritime Technology 21st Century Conference, R.I.S. Nijjer, Head of the Department of Marine Transport at Australia's Royal Melbourne Institute of Technology, estimates that at the turn of the century, the nav.sat count will include 21 GPS satellites, plusthree active spares, 21 Glonass satellites, plus three active spares and three new-generation Inmarsat satellites with a navigation function overlaid on the main communication role. (A navigation overlay may also be a feature of future local communications satellites.)The first of these systems to come fully on line is GPS, taking us into "an era of accurate position and velocity information available on demand 24 hours a day,

365 days a year, from any location in the world, in any weather. It will enable port to port navigation with an accuracy and precision unimaginable even a decade ago." "Dithering" of the GPS signal for security purposes by the USA Department of Defense will make the unprocessed GPS signal unsuitable for use in marine navigation where accuracy and position are critical, such as harbour navigation. However, accuracy at the local level will be recovered initially by the use of DGPS (differential GPS), giving an accuracy of five metres and later by carrier wave measurement, which is expected to result in decimeter level accuracy. Nijjer feels that there is a need to make a reappraisal of the basics of marine navigation. The broad definition of navigation has four elements, which he identifies as being the following: (1) Planning a safe and expeditious track for the ship; (2) Manoeuvering the ship to follow the safe pre-planned track; (3) Position fixing to monitor the movement of the ship on the track; and (4) Avoidance of collision. In practice, it is the first and third elements that are implied when the term navigation is used (manoeuvering and collision avoidance being basic elements of seamanship). When fully developed, GPS will make the position fixing element redundant. This is a very significant change and represents a very big advance on the present port to port navigation model. That model, based on visual techniques, consists of four stages: (1) Offshore; (2) Coastal; (3) Harbour, and (4) Berthing. GPS makes all this redundant as the same level of high positioning accuracy is available and suitable for use in any stage of the port to port navigation, with the possible exception of berthing. Before the full potential of GPS can be realized, chartmakers face thechallenge of improving the accuracy of charts to be better than, or at least equivalent to, that of the positioning system (GPS) and, additionally, referencing all coordinates to the same World Geodetic System (WGS-84) as GPS. Most GPS receivers can carry out the transformation of WGS-84 to most local datums, but the problem of chart accuracy remains. If GPS-assisted groundings are to be avoided, cautions the study, the issue of chart reliability will have to be addressed and given the widest circulation. At present there are few coastal and harbour charts that meet the accuracy requirements necessary to use GPS confidently. (Source: **Marine Log**, July 1993).

ECDIS RESEARCH IN CHINA

In accordance with the requirements of the third draft specification for electronic chart display and information systems (ECDIS) produced by the International Hydrographic Organization (IHO), the Research Group on ECDIS (RGE) of the Dalian Maritime University (DMU) developed an ECDIS consisting of three subsystems, for chart generation, electronic chart display and electronic chart information respectively. During September 1991, experiments were conducted on the *Yu Long*, the training vessel of the DMU. The system performance was tested on the route from Dalian to Hong Kong. In compliance with the minimum requirements of the IHO draft specification, the group constructed their ECDIS with a hardware structure. The central processing unit was an IBM-compatible 386 microcomputer. The system output included two high-resolution graphic displays and an alpha-numeric VGA display. The input system comprised a digitiser and scanner or an electronic database (ECDB) connected to the central processing unit and which generated electronic charts in different ways. To obtain positional and radar information, the central processing unit was connected to navigational instruments and, separately, to the radar by means of suitable interfaces. Apart from the radar, navigational inputs were available from GPS, NNSS, Loran C, gyro compass and echo sounder. The system could display information from any of these sources after processing. Testing was carried out over a one-month period following completion of the ECDIS research programme in the laboratory. The object was to test and verify the performance of the system and its operational reliability in a practical application. The results confirm that the system can meet the user's basic requirements, that the interfaces to the external devices are stable and reliable, and that the overall system operates satisfactorily. With the steady development of navigation technology and computers, the utility of ECDIS is close to or in some areas, superior to that of the paper chart. Presently, ECDIS is mainly applied to fishing boats, small offshore vessels, survey ships, ferries and research vessels. However, ECDIS offers not only a great deal of navigational information, but it also supplies integrated management data. It can be used both as a terminal to display the navigational situation and supporting information, and as a dynamic surveillance terminal for vessel traffic services. (Source: **The Journal of Navigation**, Vol. 46, No 2, May 1993)

SENSORS IN SPACE TRAIL MARINE TRAFFIC ON EARTH

Using the Japanese satellite JERS-1, the Remote Sensing Technology Center has developed a new technique to observe marine traffic from 350 miles in space. The new technique makes it possible to measure the speed of a ship by utilizing a time difference between two near-infrared-ray images taken by a pair of optical sensors on the satellite, according to a spokesman. He said the technology can be applied to observe marine traffic on Earth and noted that marine traffic conditions in Tokyo Bay and the Straits of Dover, for instance, could be studied and compared. The sensors are able to capture images of all ships in a range of 75 kms. The centre released a photograph of Tokyo Bay with images of 400 moving ships, 240 ships at anchor and two

airliners landing at Tokyo International Airport. Ships of 50 metres or more in length could be clearly recognised. (Source: **American Metal Market**, 18 June 1993).

FAST FERRIES: FULL SPEED AHEAD

At a time of continuing recession, there is a rising demand for faster ferries. The fast ferry industry is poised to make some important inroads into the established arena for ferry operators. Fast ferry operators and builders have been viewed with considerable scepticism by some, but as more ferry operators seek to maximise their revenue and increase market share against competition from air, road and rail transportation, fast ferries are now offering a real alternative. Advanced Multi-Hull Designs in Australia says "1991 and 1992 were tough years for the fast ferry industry worldwide with the world economy in recession and the promised prosperous future of the high speed ferry market under question. In 1993, however, there appears to be a new optimism within the industry with the economies of many countries starting to grow again and the realisation by many conventional ferry operators that large high speed car ferries can operate reliably and profitably. Furthermore, new markets in Asia are being realised with extraordinary growth being predicted." The varying types of fast ferry design include catamarans, monohulls, hovercraft, hydrofoils, surface effect ships, swaths, foil assisted catamarans and foil assisted monohulls and range in size from 22 to 120 metres. The style of craft is dependent on its area of operation. Many of those destined for the Far East and Asia are passenger-only configuration, while the vehicle carriers are concentrated on more developed routes. Construction also varies with some of the larger ships now consisting of steel hulls and aluminium superstructure. Even speed is not quite so crucial to some operators, who prefer to sail at a more leasurely pace to allow their passengers the opportunity to enjoy the on-board atmosphere, while spending their money in a casino-style environment. (Source: **Seatrade Review**, July 1993).

RACE TO SUPPLY EUROPE'S GROWING FAST FERRIES MARKET

Shipbuilders are fighting for a slice of the huge new market in large high-speed ferries, such as catamarans, water jet powered vesseis and hovercraft. Experts believe the emerging market could be worth about one billion US dollars over the next decade. Leading the race to supply Europe's 300-plus ferry companies are two Italian yards – Rodriguez in Messina and SEC in Viareggio – both of which are hoping to complete 100-metre high-speed ferries. When complete, Rodriguez intends to hand its fast-ferry, the Aquastrada, to its Aliscafi high-speed vessel division. SEC is to start a joint venture with Italy's State ferry company and put theship on the busy routes to Sardinia. Competition is hotting up – German shipbuilder Blohm & Voss has entered the fray by launching its fast-ferry prototype, the 60 metre long Corsair 600. Manufacturers believe that large high-speed ships will eventually dominate any ferry route of more tham 50 kms where time saving is justified. Perhaps the biggest latent market is in fast cargo ferries. Finnish shipyard Kvaerner Masa has produced a futuristic design of a pencil-slim cargo vessel, EuroExpress, which they hope will halve journey times on Europe's "sail-boat slow" primary freight routes. On the busy Travemünde/Helsinki link – a 36-hour crossing for conventional ships – EuroExpress's 225-metre monohull will make the crossing in just 18 hours, carrying 2,000 to 3,000 tonnes of freight at 35 knots. This means shipping companies will need only two ships instead of four to provide a daily service on the route, bringing massive cost savings to shipping operators and knock-on reductions in cargo rates. The unique side doors could halve the loading time to six hours. In addition to eliminating thousands of slow and expensive lorry journeys overland, the fast cargo-passenger ferry should also cut delivery times and reduce freight costs. (Source: **The European**, 21 July 1993).

NEW TECHNOLOGY IMPROVES PERFORMANCE OF HIGH SPEED FERRIES

Schichau Seebeckwerft AG, a member of the Vulkan Group shipyards of Germany, claims recent modifications to its high speed SWATH car/passengers ferry has improved passenger accommodation, payload and operating performance. In particular, the company notes that the weight of the 90 car and 600 passenger SSW 320 has been reduced through the application of advanced aluminium technology. Studies were made using the same technology as developed for theGerman high speed ICE train. These developments have increased the stiffness and considerably reduced stress fatigue in the craft, says the yard, which also states that the problems associated with welds in areas of high cyclical stress have been eliminated. In view of the increasing demand for fast ferries Blohm & Voss in Hamburg says that it has started a large-scale development of a complete family of fast monohull ferries. Detailed model tests have been conducted, comprising manoeuvering, sea keeping and propeller cavitation tests as well as resistance and propulsion tests for various displacement trims and speeds. Of the many other designs currently available one of the more interesting types is offered by Ateliers et Chantiers du Havre (ACH). This monohull design is extremely slender with two lateral wings providing added stability, allowing the vessel to cut through the waves while transverse wings offer superior comfort levels without movement control systems. Ranging from 25 to 150 metres, the ship can be used in passenger

only mode, or for vehicle and light freight applications.Netherlands-based Royal Schelde has extended its range of Seaswift Surface Effect Ships to include both low-wash and standard catamarans, as well as high-speed monohulls. The main reason is the flexibility required to meet an operator's requirements in both size and layout. Royal Schelde s designs range from a 26 metre SES to a 135 metre monohull. Additional designs are being prepared to meet market demand. One of the largest designs currently on the market is produced by Westamarin of Norway. With a passenger capacity of 1,200 and a car capacity of 275, this 120 metre craft will operate at speeds of up to 50 knots. While most of the current designs concentrate on passenger-only and car and passenger type vessels, builders do not rule out the possibility of cargo carrying craft in future and some have suggested that fast Atlantic sea crossing is not outside the bounds of reality leading to the interesting spectre of new fast ferry companies setting *Blue Riband* records every day of the week. (Source: **Seatrade Review**, July 1993).

CONSTRUCTION OF TWO TECHNO-SUPERLINER MODELS

Construction of two large-scale models of the Techno-Superliner (TSL), which is envisioned as a super-high-speed cargo ship with excellent cruising performance, has started following completion of basic research. The Techno-Superliner Research and Development Project, a six-year Japanese project, was inaugurated in 1989 under the supervision of the Ministry of Transport. To cope with worldwide economic changes, a new high-speed, high-volume cargo vessel is needed. Conventional air and marine cargo carriers differ widely in speed and capacity and an intermediate mode of transportation with a speed and capacity midway between those of aircraft and ships has long been sought.The features of TSL include the ability to cruise at 50 knots; a cargo capacity of 1,000 tons; a range exceeding 500 nautical miles; and a seaworthiness that allows the ship to navigate safely even in high seas.The R&D effort for TSL focused on the three forces that support theship – buoyancy, dynamic lift and air pressure – to derive two new ship designs: a hydrofoil-type hybrid hull, which combines buoyancy and dynamic lift, and an air cushion-type hybrid hull, which combines buoyancy and air pressure. Once established, the basic design and construction technology of the Techno Superliner will permit the production of suitable super-high-speed ships to serve various needs. Further information is available from Technological Research Association of Techno-Superliner, 1-3-8, Mejiro, Toshima-ku, Tokyo 171; Tel.+81-3-3985-3841; Fax: +81-3-3985-3740. (Source: **JETRO**, August 1993).

CARIBBEAN SERVICE

A 49 metre long OA catamaran ferry has been delivered to theSwedish builder Orkarshams Varv AB to Brudey Freres in Guadeloupe. *Madikera* has been built in alumium to a design by Westamarin of Norway. The ship, which carries 352 passengers and 35 cars at a service speed of 31.5 knots, is powered by four MTU 2,000kW engines driving KaMeWa waterjets. (Source: **The Motor Ship**, May 1993)

ALL UNDER ONE ROOF

Capitalising on the current interest from the Chinese market, the Australian naval architect, Advanced Multi-Hull Designs, formed a joint venture company with the Guangzhou Marine Engineering Corporation (GUMECO), a subsidiary of the China State Shipbuilding Corporation, at the beginning of 1993.The joint venture company, SeaBus International Co. Ltd., has been formed to promote the development of high speed vessels in China and South East Asia. According to AMD, this is the first company that is able to offer all types of high performance vessels under one roof. Currently building a series of 24 metre and 28 metre designs in Hong Kong for Chinese interests, AMD has also released details of its new 71 metre all-passenger (AMD 1000P) 950 capacity, wave-piercing catamaran design. The development is in response to the considerable demand shown by Chinese operators requiring ferries for operation on coastal routes in the South China Sea and Taiwan Strait. (Source: **Seatrade Review**, July 1993).

MARINE INDUSTRY AND ENVIRONMENT

PROTECTING THE MARINE ENVIRONMENT

The commonest forms of pollution are the discharge of industrial waste and untreated sewage into rivers and the open sea, oil spills as a result of collision or grounding, pumping-out contaminated ballast water, and emissions into the atmosphere from main and auxiliary machinery. Such national/local measures as have been introduced only embrace territorial waters, which is the legal limit of national jurisdiction. There is basically no provision to cater for pollution on the high seas. Contribution to the problem of pollution are the generally declining standards of merchant shipping. Technical advances can also be counter productive for exam-

ple, the provision of an autopilot has resulted in a marked decline in manual steering skill, and radar has contributed to not keeping a proper lookout. Nowhere in the world has any country established a single authority to monitor and provide clearance forces for environmental pollution. The responsibilities have been assumed in piecemeal fashion by navies, coast guards (where they exist), non-marine and unrelated government departments, harbour boards, the offshore oil industries, salvage associations, and private contractors; and it would appear rash to assume that they would necessarily act in concert, or even in a seaman-like manner, in an emergency situation. Many small countries with limited maritime assets may have little choice other than to allocate the responsibility to their navies. Such an organization could be easily integrated into a well-established coast guard as an extension of its maritime law-enforcement duties, and some compromise arranged with the Police and Customs where there is an overlap of judicial authority. This proliferation of responsibility is not as meaningless as it would appear, as governments naturally wish to offload as much of the financial burden as possible. The offshore oil industry, for example, is expected to make its own commercial arrangements to cope with an emergency situation by the provision of privately-owned and/or chartered vessels and aircraft. This is particularly noticeable where foreign nationals are operating within the exclusive economic zone (EEZ). Where governments have failed, or are dilatory, in drafting legislation self-interest has compelled harbour authorities to make emergency arrangements so that commercial operations can be maintained, or resumed as quickly as possible, otherwise cargo will be diverted to other ports. In some instances draconian regulations on the emissions from machinery prevent ships using their main engines while entering or leaving harbour; or operating their generator sets while alongside. This compels the use of tugs and connection to a shore supply for electricity; and is little short of exploitation. The very varied harbour regulations drafted for port users further compounds the difficulties faced by the international shipping industry, who are confronted by mounting legislation from all quarters. As any casualty is a potential environmental hazard, the salvage associations have a major role in ensuring that any damaged vessel is towed to a repair yard as expeditiously as possible. The cost of maintaining powerful salvage tugs at strategic locations worldwide is proving to be such a financial burden that their numbers are steadily declining, and is a matter for international concern. Although oil pollution from whatever cause is the major hazard to the marine environment, it is not the only one. Dangerous cargoes such as LNG/LPG/ammonia/ asphalt/bitumen/chemicals/nuclear waste/etc., whether carried in bulk or deck-stowed, can be equally devastating as a result of spillage and/or fire. However, the sheer volume of oil, transported in relatively large ships, makes it the highest risk cargo. It will be readily apparent from the above that any listing of environmental units cannot be complete owing to the facts that their ownership is so diverse, and many are small craft well under the minimum tonnage that excludes them from the registers of the classification societies. Added to this, practically any vessel can be readily equipped to spray dispersants and/or deploy booms to contain a spill. The types that can be best utilised for this purpose include patrol vessels/boats/craft, minesweepers/hunters, minor landing craft, lighthouse/buoy/navaid tenders, pilot boats/craft, tugs, fishing vessels, etc; and in many instances their knowledge of local waters would prove extremely valuable. The examples listed are not necessarily naval, and many would willingly participate because of self-interest (e.g. fishing vessels). The task of clearing pollution from the surface of the water has to be undertaken by dedicated vessels, which vary considerably in size depending on their intended deployment within harbour confines, in estuarial waters, or the open sea. Firefighting facilities also have to be built-in; and are normally possessed by all salvage vessels, many tugs and offshore support vessels, and dedicated firefighting units. Aircraft can be used for surveillance (their primary role); and also to distribute dispersants and for firefighting; while the ubiquitous helicopter -- whether shore-based or shipborne – is a virtual maid-of-all-work. In fact, any helicopter-carrying vessel is an asset in an emergency situation. (Extracted from **Navy International**, January/February 1993).

CONTAMINATION OF COASTAL VERSUS OPEN OCEAN SURFACE WATERS

The relative contamination of coastal and open ocean surface waters by several classes of marine pollutants is compared by re-analysis of data published by the authoritative Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP) 1990 on the state of the oceans. This re-evaluation, together with analysis of recent IAEA data, suggests that marine pollutants can be divided into three broad categories:

- those that are more concentrated in the open ocean environment than in coastal waters, including PCBs and (arguably) radioactive wastes;
- those that are equally concentrated in open ocean and coastal waters, including DDT and its metabolites;
- and those that are somewhat more concentrated in coastal waters than the open ocean, including chlorinated hydrocarbons and the heavy metals.

The data do not support the conclusion drawn by GESAMP that although coastal waters are contaminated, the open sea is still relatively clean. Instead the data support the general conclusion that, with respect to the contaminants exam-

ined here, open ocean waters are approximately as contaminated as coastal waters. The GESAMP report on the state of the oceans acknowledges the general inadequacy of the available database, and especially the paucity of data available for the open ocean. The GESAMP report also warns of the need for concerted international action within the next decade if serious and potentially irreversible degradation of the oceans is to be averted. The present re-examination of available data supports that recommendation, but suggests further that the oceanic ecosystem may presently be more vulnerable than suggested by GESAMP's summary conclusions. (Source: **Marine Pollution Bulletin**, Vol. 26, No. 3, March 1993).

RECOVERY OF MANGROVE ECOSYSTEMS AFTER CATASTROPHIC OIL SPILLS

Most oil spills are unplanned events involving tankers, oil rigs, storage tanks, pipelines, barges and other vessels. Between 1978-90, the largest sources of spilled oil worldwide were (1) tankers and (2) oil rigs or storage tanks. In the tropics, there were at least 157 major spills from ships and barges between January 1974 and 15 June 1990. Of these, 26 occurred on the high seas, 99 in coastal or restricted waters, 12 in harbours and 20 at dock. A conservative estimate, made by adding spills in restricted waters involving groundings to those in harbours or at dock, is that 54 per cent of the major spills caused by shipping occurred near such potentially vulnerable ecosystems as coral reefs and reef flats, seagrass meadows, sand beaches and mangrove forests. Despite the frequency and continued probability of spills in nearshore tropical waters, little work has been done on the effects of oiling on shoreline communities at low latitudes. In particular, although there is general agreement on the biological and economic value of mangrove forests, and on the vulnerability of mangroves and their biota to oiling, knowledge of the effects of oil on mangroves and associated species is extremely limited. Hydrocarbon chemistry has confirmed the long-term persistence of crude oil residues in the deep muds of mangrove ecosystems. Pools of trapped oil maintain surprising consistency in composition measured by UVF, GC and SIM-GC/MS analyses. Trapped oil continually leach from mangrove sediments into coastal waters and bioaccumulate by encrusting bivalves for years after a spill. Reoiling associated with erosion of heavily oiled sediments cause chronic oil pollution in coastal waters. The most residual aromatic fractions appear to be the dibenzothiophene, chrysene and phenanthrene series. Continued high concentrations of these relatively toxic fractions, even in sediment residues that appear highly weathered by GC, indicates their life span in mangroves is much longer than five years. Even with the large database we have acquired, many questions remain unanswered, and ecosystem recovery is far from complete. We know nothing about transmission of possible long term effects up the food chain or on local fisheries dependent in part on the species of the mangrove fringe community. The interactions between the effects of structural changes to the habitat and continued toxic effects of hydrocarbons and related oxidation products will be critical in understanding recovery processes over the long term. For example, oil hydrocarbons were detectable in mangrove sediments in Puerto Rico for at least 20 years after a tanker grounding. In previously reported studies of oil spills, biological and chemical measurements were not made more than five to seven years post-spill. The time period between five and twenty years post-spill is when the effects of oiling in muddy coastal habitats grade from acute and severe toxicity into sublethal stress and eventually into nearly non-detectable effects. The long time scale of these impacts accentuates the need for careful protection of these important habitats. (Extracted from **Marine Pollution Bulletin**, Vol. 26, pp. 239-248, May 1993).

RENEWABLE OCEAN ENERGY AND DESALINATION

DEMONSTRATION TEST OF VARIABLE SPEED SEAWATER PUMPED-STORAGE POWERPLANT

A project to construct a variable speed seawater pumped-storage powerplant (output 30 MW) is presently underway in Okinawa Prefecture, Japan, by the Electric Power Development Company Ltd. under consignment from the Ministry of International Trade and Industry (MITI). Seawater pumped-storage powerplants have several advantages over freshwater pumped-storage powerplants in current use. Costs for dam construction are lower since the sea is used as the lower reservoir. Furthermore, power transmission is more efficient since the powerplants can be built near electric power consumption areas or base-load powerplants. However, several technical and environmental concerns caused by using seawater will have to be

solved. Metal corrosion and marine organism growth is accelerated in seawater as compared to freshwater, requiring the development of new technology. Since seawater will be pumped to the upper reservoir, the environment will have to be protected from seawater seepage and spray caused by strong winds. Before such powerplants can be put to practical use, the applicability must be proven through extensive testing. After six years of technical and environmental investigations on seawater pumped-storage power generation, MITI decided to start construction of a demonstration model pilot plant in 1987. The pilot plant has an output capacity of 30 MW and is the first seawater pumped-storage power generation facility. The powerplant operates by releasing water at a rate of 26 cubic metres per second from the intake located on the bottom of the upper reservoir (area of 250 by 250 metres). The released water travels down a tunnel to an underground power-house housing a turbine/generator that can generate 30 megawatts of electricity. The spent water then travels through an outlet to the ocean. The upper reservoir is located 600 metres from the coast and 150 metres above sea level. During the recharging cycle, seawater will be pumped from the ocean back up to the upper reservoir using the turbine in the reverse direction as a pump. The pumped-storage system that is planned will be a variable speed system allowing an increase in efficiency over the traditional constant speed pumped-storage powerplants. New power lines will be installed to transmit power that is generated and to receive power needed to pump seawater to the upper reservoir. After construction on the pilot plant is completed, it will be operated for five years, during which time the plant will be checked for metal corrosion and marine life growth. Environmental monitoring data will be collected and total verification will be obtained for the use of seawater pumped-storage technology for electric power generation. Further information is available from the Electric Power Development Co. Ltd., Public Relations Department, 6-15-1, Ginza, Chou-ku, Tokyo 104; Tel: +81-3-3546-2211; Fax: +81-3-3546-9532. (Source: **JETRO**, August 1993)

OCEAN THERMAL ENERGY

Ocean thermal energy conversion technology can be viable in certain parts of the world if additional uses are found for water pumped from the ocean bottom, according to Alistair Johnson, technical director of the United Kingdom's GEC Marconi research centre. For example, cold water from the deep ocean, which is rich in nutrients, could provide water for fish farms in addition to electricity. The additional uses for the cold water, coupled with technical improvements in heat exchanges for electricity generation, could make OTEC a realistic project in some areas. (Source: **International Solar Energy Intelligence Report**, 5 October 1992)

MARSHALL ISLANDS SEEK PROPOSALS TO STUDY OCEAN THERMAL ENERGY

The Republic of the Marshall Islands is inviting engineering companies to bid on a contract to conduct a $200,000 study of the feasibility of building and operating a 5-10 megawatt ocean thermal energy conversion (OTEC) power plant at Majuro. The study is being funded under a grant from the US Trade and Development Programme. The study would examine the optimum sizing, siting and cost; preliminary design, construction, transfer and operations plan; the impact of ocean thermal energy conversion's multi-product capability on the economics of the facility and on the needs of Majuro atoll; and project financing, planning and assessment, including the potential for private investment and a framework for a mutually satisfactory power and water purchase agreement between the operator and the utility agencies. Included in the study will be the power system; the cold, warm and discharge seawater pipes; the containment housing; a freshwater subsystem and the appropriate interconnect with the existing electrical grid and water systems on Majuro. (Source: **International Solar Energy Intelligence Report**, 5 October 1992)

GREENHOUSE PLANS TO REAP THE SEA WIND

Researchers from the UK, Portugal, Spain and Greece have joined forces to develop the first greenhouses in the world to be irrigated with seawater as part of a £750,000 project supported through the pan-European Framework Programme of collaborative research. The goal is to develop and demonstrate a cost-effective means to provide water for agriculture from the sea. Light Works, the London-based company coordinating the project believes that if it succeeds, communities living along barren coastlines will be able to grow vegetables instead of importing them. Essentially, the greenhouse will act as a funnel for warm, moisture-rich air blowing in from the sea. A wall of evaporative filters facing into the wind traps the moisture and acts as a windblock to protect the plants. Condensed water drips down the filters and is transferred into the greenhouse, raising the humidity. The double-layered roof serves a dual function, shielding the vegetables below from scorching heat, yet admitting the wavelengths of solar radiation vital for photosynthesis. Light Works is experimenting with cheap materials for the filters, as they seem to have the best effect. The best candidate is a mixture of a well-known British blackcurrant syrup and an equally well-known bright-red Italian aperitif bonded with salt and sugar. A shallow cavity dividing the upper, transparent roof layer from the solar filter layer below traps heat and raises the moisture of the air sucked inside. The humid air swirls down to

a heat exchanger at the rear of the greenhouse. Humid air arriving both from the roof cavity and the greenhouse itself condenses on aluminium pipes carrying cold seawater piped in from three kilometres offshore. The system also allows for capture and recycling of the water vapour discharged by plants as they transpire, so virtually no water is wasted. Any surplus freshwater from the heat exchanger is used to irrigate plants and trees grown on the leeward side of the greenhouse, sheltered from the wind. The company says that most of the energy for pumping up the cold seawater would be harvested by windmills mounted on the roof of the greenhouse at the front, and supplemented by the energy from solar cells. Another slightly more ambitious objective is to isolate plant nutrients and fertilizers such as nitrogen, phosphorus and potassium from the cooling water. The seawater for cooling would be piped from depths of around 100 metres. Sunlight cannot reach such depths, meaning that sinking organic matter is not digested by light-dependent organisms. This leaves the water at these depths richer in nutrients. (Source: **New Scientist**, 29 May 1993)

SOLAR ENERGY FOR SEAWATER DESALINATION

With the deteriorating water supply situation in the entire Middle East, serious considerations have been given to large-scale desalination processes. Seawater desalination utilizing non-polluting solar energy appears to be an ideal solution for the region. Climatic conditions in the Middle East are conducive to solar heat collection and large water consuming population centres are located near the Mediterranean and Red seas, which would supply the saline "raw material." ADAN Technical and Economic Services Ltd. was commissioned by the Israeli Ministry of Energy Infrastructure (MOEI) to review and study the technical potential and resultant economics of solar desalination on a regional scale. The study was guided by such considerations as competitiveness with conventional sources, financial structure of the project, balanced approach between proven and advanced design concerning technologies based on economies of scale, and space requirements for the projects. Various solar desalination systems were studied and after a comparative study based on a number of criteria, the LT-MED combination appeared to be the most economical. It required the lowest overall investment and results in the lowest water cost. The system is completely solar operated and does not require fuel-fired heat backup. LT-MED technology is developed and proven, but design improvement for the plant can still be significant. Strong institutional considerations such as environmental cleaness and safety also favour the solar desalination technology. (Source: "The Application of Solar Energy for Large-scale Seawater Desalination" by Dan Hoffman (ADAN Technical and Economic Services Ltd., Tel Aviv), **Israel Energy News**, Winter 1991/1992, p.5)

SOLAR TOWER FOR POWER GENERATION AND DESALINATION

A group of experts led by Dr. Dan Zaslavsky, dean of the Agricultural Engineering Faculty at the Haifa Technion, has been working on a project to use the desert's heat to generate power and desalinate seawater. Water is pumped to the top of a high tower and sprayed into the centre where it rapidly evaporates in the dry desert heat. The air is cooled by evaporation, becomes denser and falls downwards. Its moving speed accelerates under gravity and achieves 80 kms per hour by the time it reaches the bottom. This downdraught is used to drive turbines that generate electricity. The target is to generate power from the dry desert air and brackish or seawater at a cost of 2.5 to 3.5 cents per kWh. A by-product of the process will be desalinated water at a cost of about half the current price. A typical full-sized SNAP plant would have a generating capacity of 500 MW. It would also desalinate 100 x 10^6 m^3 of water annually. (Source: **RERIC News**, December 1993)