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**EMERGING
TECHNOLOGY
SERIES**

1 and 2/1999

***Marine Industrial
Technology***



**UNITED NATIONS
INDUSTRIAL DEVELOPMENT
ORGANIZATION**

Vienna, 1999

MARINE INDUSTRIAL TECHNOLOGY

Nos. 1 & 2/1999

CONTENTS

SPECIAL ARTICLES

Prawn and shrimp: Attributes that command premium price

UNCTAD Summary of Transport Info Networks

INDUSTRY NEWS

TECHNOLOGY

OCEAN RESEARCH

ENVIRONMENT

COUNTRY NEWS

INTERNATIONAL NEWS

SOFTWARE

PUBLICATIONS

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CONTENTS

	<i>Page</i>		<i>Page</i>
A. SPECIAL ARTICLES	1	Electric screen to prevent stray fish entry into water intakes	16
Prawn and shrimp—attributes that command premium price	1	Flagship seismic vessel launched	16
Conclusion	2	Two bows	16
UNCTAD summary of transport info networks	3	INDIGO uses drill data for foundation design	16
B. INDUSTRY NEWS	5	Space launch planned for floater before year-end	16
The cost-effective methanol transport solution	5	Guide frame provides safer ROV deployment in stormy weather	17
Shipshape	6	High-speed energy-conserving oceangoing ship	17
Excess oil, flat economic growth battle on two fronts for offshore industry	6	D. OCEAN RESEARCH	18
Lead levels from leaded gasoline in Atlantic reduced	7	Down to the summit	18
Floating wave power device, Mighty Whale, completed	7	New mariculture technology	18
Emerging legal and ethical issues in advanced remote sensing technology	7	First seismic centre on the deep sea floor	18
Oil boom junk will not be sunk	8	Hand-held sonar displays near photographic images	18
Marine transport—Houston Ship Channel dredging to begin	8	Fish feed from natural gas?	19
Out of the blue	8	Mussel proteins inhibit bacterial growth	19
Double blow for chemical tankers	9	Unique thermostable enzymes in hydrothermal vent worm	19
Evaluation of methodology for QRA in offshore operations	9	ODP pursues history of Antarctic ice sheet	20
Underbalance perforation in long horizontal wells in the Andrew field	10	Licensing agreement signed for development of discodermolide	20
Ports are racing to satisfy the needs of new megaships	10	Newly discovered molecule will aid cell study	20
Multi-modular system intended for re-use	10	Ocean Drilling Program extends global network to deep oceans	20
MURCS under test	11	Methane hydrate research—energy resources for the future	21
Production systems moving subsea and downhole	11	MIT laser sheds light on pollution	21
Three enabling technologies	12	Ocean jigsaw nears completion at conference	21
C. TECHNOLOGY UPDATE	13	Active sulphide chimneys retrieved for first time	22
Marine industrial technology	13	SubSea International sets new depth record	22
New uses for seaweed	13	Study finds group of marine bacteria off US	22
Damming in the Dutch	13	Surprising picture emerges of sub-sea floor magma formation	22
Composite materials investigated for weight and maintenance savings	13	Evidence of further global warming	23
First offshore use of new drillstring inspection system	14	High-performance system for removing marine organisms	23
ODP testing new technology for deep ocean drilling	14	The research vessel MIRAI—ocean observations and research on a global scale targeted for the 21st century	23
Innovative petroleum industry	14	New ultra-water-repellent material	24
Port of London: new VTS system launched	14	Wireless in water	24
ECS system for tracking container movements	15	Tainted catch	25
Lidar in-space technology experiment measurements of sea surface directional reflectance and the link to surface wind speed	15	Sounding out	25
New technology of mechanical treatment of dredged material from Hamburg harbour	15	How to beat corrosion bacteria	25
		As large as life	26
		Ocean drilling floats ambitious plans for growth	26
		The big break	26
		Short-term bets	27
		Sensing the sea without breaking the bank	27

CONTENTS (continued)

	<i>Page</i>		<i>Page</i>
E. ENVIRONMENT	28	<i>Canada</i>	43
Coastal ships to go biocide free?	28	Moratorium under review	43
Shrimp on the cob	28	From Commission to Port Authority—	
Sea mounts protected?	28	Nanaimo	43
Exotic species threaten the fragile balance		<i>China</i>	44
of the Baltic	28	Offshore discoveries	44
Foreign species	29	Joint venture to redevelop Dalian Port	
Reefs at Risk: improving our knowledge		eastern sector	44
base	29	<i>Denmark</i>	44
Sustainable marine resource management	30	Maritime advances	44
Programmes to monitor air pollution from		<i>European Union</i>	44
ships agreed	31	Future of marine technology	44
Unsafe practices associated with the traffick-		<i>Finland</i>	45
ing or transport of migrants by sea	32	Marine science and technology	45
Mandatory ship reporting system to protect		<i>India</i>	45
northern right whale off United States		Reliability prime factor in hub port selection .	45
adopted	32	Ennore coal port	45
ISM Code deadline highlighted	32	<i>Ireland</i>	46
Do carbon sinks absorb fossil fuel output?	33	Gateway to the north-east Atlantic	46
First El Niño observed and forecast from the		<i>Italy</i>	47
start	33	Marine sciences	47
Rockfish population declining	33	Development of Leghorn	47
Antarctic ozone hole sets new record	34	<i>Japan</i>	48
Scientist says 20th century global warming		“Kuzzoko” culture a success	48
unprecedented	34	In the name of science	48
Disruption of coastal ecosystems in Alaska ...	34	<i>Republic of Korea</i>	48
IMO approves US mandatory ship reporting		Access to Russian port may shorten trade route	
system for right whales	34	with China	48
Emergency research to clarify the mechanism		<i>Malaysia</i>	49
of coral bleaching	35	Norwegians help set up farm	49
Ban proposed for TBT-based ship paint	35	<i>Malta</i>	49
North American land mass soaking up carbon		Valetta cruise terminal development initiated	49
dioxide	35	<i>Myanmar</i>	49
Oil spill prevention	36	Overview of fisheries resources	49
Muddy waters	36	<i>The Netherlands</i>	50
All at sea	36	Dutch water policy	50
Grave impact of trawling	37	<i>Norway</i>	51
Marine diamond mining and the environ-		Norway: marine technology and ocean	
ment	37	engineering	51
Aquaculture	38	Fabricator eyes coming phase of gas, deep-	
F. COUNTRY NEWS	42	water developments	52
<i>Australia</i>	42	<i>Oman</i>	52
Aquaculture course by correspondence	42	Oman opens major container hub terminal ...	52
Research into pearl culture	42	<i>Poland</i>	53
Brisbane adopts IMS to improve operation ...	42	Outline of activities in marine sciences	53
Thumbs up for marine servicing facility	42	<i>Portugal</i>	53
New ballast water rules now in force	43	Marine-related activities	53
<i>Azerbaijan</i>	43	<i>Sri Lanka</i>	54
Largest fish farm planned	43	New rules for processors and shrimp	
<i>Belgium</i>	43	farming regulated	54
Antwerp found to be fourth largest port in		<i>United Kingdom</i>	54
the world	43	Marine science and technology	54
		<i>United States of America</i>	55
		NSF invests in new engineering research	
		centres	55

CONTENTS (continued)

	<i>Page</i>		
G. INTERNATIONAL NEWS	56	H. SOFTWARE	65
Satellite launch has success out at sea	56	Information technology—electronic charting ..	65
Appellate decision on turtle excluder issue	56	Clearer picture of ocean bottom possible	66
Partnership for development between IAPH and UNCTAD	57	New software package launched for Aquarius GPS receivers	67
West and Central African States agree draft regional port State control regime	57	Earth observation helps develop new maritime information products	67
More Than 25,000 raster topographic maps now available on the Web	57	New, low-cost GPS monitors	67
Locating data	58	VTS and the role of information technology ..	67
Sinking fast	58	Electronic communication for routine reporting	68
Bilateral fishery accord at risk	58	“Virtual ocean” computer simulation	70
Field development rate dropping	59	I. PUBLICATIONS	71
Global FPSO fleet growing annually	59	Model Ballast Water Management Plan	71
FAO consultation concludes with global plans of action	59	Safeguarding the health of oceans	71
Equal treatment?	60	Opportunities for Ports	71
NOAA-K weather satellite successfully launched	60	Lloyds Ports of the World 1999	72
Non-living resource development work- shop	60	The impact of changes in ship design on trans- portation infrastructure and operations	72
The Arrest of Sea-Going Ships Position Paper adopted by IAPH	61	Living Resources of India’s Exclusive Economic Zone	73
Resolution adopted on 30 July 1998 in Cape Town, South Africa	61	Port and Harbour Engineering	73
The redevelopment of derelict port areas	61	The Asian Crisis: Implications for Regional Containerisation	73
Implications of oil spills	63	Forest Products Shipping: Looking to the Upturn?	73
Cautious progress on disputes affecting China seas exploration	64	Associated British Ports’ handbook now available	74
		ICS publishes guidelines on garbage management	74

A. SPECIAL ARTICLES

PRAWN AND SHRIMP—ATTRIBUTES THAT COMMAND PREMIUM PRICE

Quality in prawn and shrimp relate to having optimum “quantities” of attributes such as freshness, size, colour, texture, taste and other aesthetic and eating characteristics. These attributes or characteristics may either be positively or negatively-valued traits present or absent in a product in varying quantities. In spite of the generally accepted relationship between price and quality, no attempt has been made to estimate the functional linkages between product price and such quality attributes.

Using prawn and shrimp samples purchased from selected markets in the Philippines, we developed a hedonic price model (HPM) that explains and quantifies the relationship between price and attributes defining quality in a domestic market. The use of HPM for prawn and shrimp is relevant since improving quality is a major issue in the global seafood market.

There is increasing consciousness among buyers, who are becoming “quality consumers” rather than “quantity consumers” (INFOFISH 1994). That is, consumers desire optimum quantities of positively-valued product attributes or minimum quantities of negatively-valued characteristics rather than consuming optimum quantities or units of the product per se.

With the current fluctuation in prawn and shrimp production due to depleting marine resources and the disease problem that plague the aquaculture industry, hedonic analysis could help identify value-adding processes that either increases the quantity of desired attributes of a product, adds a new desirable attribute to a product, or minimizes, if not eliminates, the attributes unwanted by consumers. To counter revenue loss due to a decline in the volume of production, processing and marketing, products worthy of price premiums could increase returns from investment in the industry.

Profit maximizing producers and middlemen are therefore expected to identify the attributes desired by consumers and offer the optimum quantities of attributes that would receive price premiums and minimize those

attributes that are expected to be unfavourable. The framework of HPM caters to identify the market price at which the consumers and sellers are satisfied with the attributes of the product.

Given the existing diversity in prawn and shrimp attributes in the domestic market, it is necessary to appropriately address the attributes preferred. The wide range of attributes can be noted on the variety of species, marketable sizes, product forms and preparations, degree of freshness, methods of preservation, colour, packaging and other physically observable characteristics. The diversity of product attributes is encouraged in the Philippines domestic market to meet various consumer groups. An estimate of price premiums relevant to the different attributes desired by consumers, rather than standardization, seems to be a more relevant objective in the domestic setting.

The relevant HPM for prawn and shrimp in the Philippines domestic market is one with combined quantitative and qualitative attributes whose impact on price is conveniently presented in percentages relative to a chosen benchmark characteristic. The model shows that significant price premiums are associated with attributes such as the tail length, product form, freshness, species, colour, size, ease of preparation, discoloration, protein and carbohydrate content.

Tail length: Length and weight-related attributes seem to influence price but the length of the tail matters most, being the edible portion, and is readily observable, unlike weight-related traits. The estimated 107 per cent impact on price due to tail length suggests that prawns with longer tails get a price premium, holding other factors constant.

Product form: Headless peeled prawns with or without tails, create the biggest influence on price at 219 per cent relative to the benchmark head-on shell-on form which does not require processing. Headless breaded forms follow with 197 per cent effect on price.

Although the headless shell-on form incurs some level of processing, it is nevertheless associated with a 33 per cent

price discount as deheading does not substantially create additional desirable attributes. Processing of headless shell-on or peeled products are often done, using lower grade raw material with discolorations on the carapace, broken antennae and appendages, or drooping heads.

Value-added breaded products, however, fetch price premiums because breading requires fresh raw prawn to avoid contamination and spoilage. Investing in value-adding processes to obtain such products that receive a price premium is encouraged when such processes are cost-effective.

Freshness: Live prawn is preferred while all other levels of freshness are discounted. Chilled raw prawn and dried/cooked get 50 and 58 per cent respectively. Frozen prawn is linked with an 80 per cent discount. Once prawns and shrimps cannot be marketed live to obtain a premium price, the alternatives are either to market them as chilled, or by cooking or to process and prolong their shell-life by drying.

Freezing without value adding is the last recommended option as this showed an implicit price reduction. Nevertheless, freezing remains the most common practice as this prolongs storage at least cost-due to advanced freezing technology compared to other preservation methods. Cooking and drying requires substantial labour and other resources and hence is not as popular as freezing. Furthermore, cooked prawn, either boiled or steamed, are more susceptible to contamination and spoilage than frozen prawn.

Species or type: While all species are highly valued relative to the abundant aquacultured black tiger, sea-caught banana prawns received the highest premium at 142 per cent followed by endeavour prawns at 104 per cent and freshwater prawns at 98 per cent. Though assorted species received low ratings they are not in fact inferior.

Banana prawns with easier-to-remove shells than black tiger are generally harvested from off-shore deep waters and linked with the concept of purity, being void of chemicals used in aquaculture. The small-sized species are common in local markets either fresh or prepared as dried, cooked or salted paste. Freshwater prawn with disproportionately big head and less edible meat is not commercially abundant in the Philippines. This species is generally intended for use in soups implying limited preparation styles.

Colour during purchase: With black as the benchmark, all other colours are rated as inferior. Grey receives the least price discount of 43 per cent. White and orange are associated with 66 and 65 per cent discounts respectively. Orange discolorations that appear on the shell and meat of deteriorating uncooked prawn is associated with discounts.

With the high value imputed for raw black coloured prawns, black tiger may, therefore, be marketed raw with its shell since its colour gets a price premium. The premium on black-coloured prawn is linked with the popularity and acceptability of the black tiger species in the Philippines,

which comprise 75 per cent of the total prawn and shrimp production in the country (BAS).

Size or number of prawn pieces per kilogram: The domestic market is not particularly size-discriminating, so that large sizes (15 pieces/kg), and average sizes (36-100 pieces/kg) receive almost equal premiums at 49 and 48 per cent respectively, relative to the benchmark medium-sized prawn (16-35 pieces/kg). Very small shrimp is still positively valued, but secondary to the larger sizes.

The trend in the export market, where medium-sized prawns are most preferred, has reduced the volume of medium-sized prawns in the local market. As a result, local buyers tend to value any available size.

Ease of preparation: Prawns and shrimps with moderately textured shells or those that have been cleaned and prepared receive premiums 48 per cent higher than those that require preparation. This shows the benefits derived from processing, such as ease and reduced preparation time. Timing of harvest, when shells are moderately textured and easy to detach, but not during the moulting stage, could reduce labour costs for processors.

Discolorations: Prawns with discolorations on the carapace and tail shell obtained 30 per cent price discounts. Discolorations appear after some time if the proper temperature is not maintained. Producers and middlemen should therefore prevent the products from reaching discoloration ratings from 3 to 5 (in a scale of 0 to 5 where 0 means no discoloration) to avoid price discounts. However, the lack of standard ratings defining the extent of discoloration associated with each scaled rating needs attention from the industry.

Proximate component analysis: Although nutrient contents are important reasons for consuming gourmet seafood, the HPM showed that protein content greater than or equal to 15 per cent, as per proximate content analysis, is associated with a 37 per cent price discount. Similarly, carbohydrate content greater than or equal to 1.5 per cent is linked with a 24 per cent price discount. Prawn consumers seem to value the observable attributes of prawns, such as freshness and eating quality, but seem to be moderate on protein and carbohydrate intake.

Conclusion

Overall, the HPM derived for prawns and shrimps in the Philippines domestic market identified the attributes desired by today's consumers. The premiums and discounts relevant to each attribute reflect the consumers' willingness to pay for attributes and their quality standards.

With the understanding of the consumers' valuation of attributes, producers, processors and researchers could focus their efforts and investment on relevant alternative value-adding procedures. In the lucrative, yet high-investment domestic prawn and shrimp industry in the Philippines and elsewhere, identifying consumers' demand for product attributes would facilitate efficiency in resource use. (Reprinted with permission from *INFOFISH International*, March 1998)

UNCTAD SUMMARY OF TRANSPORT INFO NETWORKS

There are numerous port community systems which exist and allow the various actors involved in the movement of goods to exchange information electronically. The advantage of such systems is that all authorized partners have access to the same information which can be updated before the goods arrive and then as they move through the port area. However to speed the movement of goods, it is essential that these systems can communicate with one another, particularly for goods that move internationally. The UNCTAD Monograph on Electronic Data Interchange Concerning Ports provides valuable material on data interchanges for transport operations.

The following is a brief summary of a number of port community systems with their associated Internet Web site.

DAKOSY (Data Communication System—Hamburg)

The function of DAKOSY is to act as a "data junction" linking together all the companies and institutions involved in the handling processes, by means of EDI. Standardized interfaces ensure that each company needs to set up its EDI interface only once, and then can reach all subscribers. All transport documents can be exchanged via DAKOSY which currently has 480 subscribers. (www.dakosy.de)

PORTNET (Port of Singapore Corporation—Singapore)

PORTNET provides a single user-friendly interface by which information regarding port documentation, planning, operations and finances can be obtained and sent by the local and overseas maritime community. PORTNET on Windows is a new version moving from an intranet-based to an Internet-based electronic commerce framework. The new system will be Windows-based, graphical, point and click environment to allow shipping lines to improve their business processes with PSA and among themselves. (www.psa.com.sg/portnet)

Seagha (Antwerp)

Seagha is the electronic commerce services provider for transport within the Antwerp logistic community, providing EDI, e-mail and Internet services and supporting the complete logistic chain from producers to end-consumers on a worldwide scale. Seagha offers multimodal electronic commerce services and supports all standard UN/EDIFACT messages. There are 341 companies directly connected to the Seagha network. (www.seagha.com)

INTIS (International Transport Information System—Rotterdam)

INTIS was established in 1985 to develop an electronic data network for the Rotterdam trading community. The company was a result of the Strategic Automation of Rotterdam project which called for the development of a data communication infrastructure which would be an open

system. Thus the objective was to provide data interchange amongst companies rather than a port system. The approach adopted was to use the PC as the interface and make use of the Dutch PTT mailbox system using standard EDI messages and free text. (www.pcr-info.nl/en/home/main.htm)

PACE (Port Automated Cargo Environment—Port of London)

London's community information system is a secure computer network for its port users. The reason for PACE is to provide a system that makes it easy and cheap for users to access and deal with the commercial and statutory information flows in a uniform and integrated way, using electronic transfers to the greatest possible extent. A cargo information database, containing an inventory of manifest records forms the hub of the system. Customs clearance is one of many functions provided. Interfaces with terminal operators' systems have eliminated paper documents and the associated clerical effort. The present aim is to move towards an open systems environment. (www.portoflondon.co.uk)

ORION (Port of Charleston)

ORION is a one-stop-shop for document clearing and processing systems and a host of EDI services. It provides access to US customs' Automated Commercial System (ACS), Automated Manifest System (AMS) and Automated Broker Interface (ABI). Charleston is perhaps the most automated port in the US and its computer system allows accurate information exchange and control of freight movements while speeding cargo flows. All brokers and all steamship lines use ABI and AMS respectively. There are currently more than 380 subscribers to the system, including brokers and forwarders, steamship agents and lines, warehouses, non-vessel operating common carriers and motor carriers. ORION went into service in 1982. US customs chose Charleston as the pilot location for their Automated Export System (AES). (www.port-of-charleston.com/orion.htm)

Tradegate ECA (Sydney, Australia)

Tradegate ECA is a non-profit, non-governmental user funded organization headquartered in Sydney. Its foremost role is to facilitate the use of electronic commerce techniques for the exchange of information between customers and their suppliers. Tradegate ECA acts as a user service facilitator for the international trade and transport community by allowing them to connect via the user service with their trading partners using telex, fax, electronic mail, EDI or EFT (electronic file transfer). As well as managing the user service facilitation arrangements with technology suppliers, Tradegate ECA provides information, education and training services. Tradegate put in place a service contract with AT&T Easylink Services which covered the supply of a generic set of technology services to the trade

and transport community. Also Tradegate has the exclusive distribution and marketing rights to all the electronic commerce services offered by Australian customs. Over 600 organizations use the Tradegate ECA User Service to deal with the Australian Customs Service for importing and exporting procedures and for commercial messaging. (www.tradegate.org.au)

ADEMAR+ (Automated Customs Clearance of Goods—Le Havre, France)

The ADEMAR+ system was designed and implemented as a global information system for the large number of operations concerning the passage of goods and containers through the port. The system is connected to the French customs administration system SOFI, consignees, shipping agents, shipping companies, ship brokers, forwarding agents, stores managers and container terminal operators. The main functions of the system are to allow the flow and processing of information needed in the commercial and customs chain for import and export containers. ADEMAR+ is evolving from a centralized system to an open network that will ensure information exchanges and ensure interconnection of users to the various systems of the port community. (www.hps.tm.fr)

Portis/Escale 2 (Port of Marseilles Authority, France)

The two systems are networks which provide confidential and secure data exchanges between port authorities and users. Portis is a value-added telecommunication system which allows port professionals, the Port of Marseilles Authority and customs to exchange data and messages. Accessed via computer terminals or minitels, it covers cargo tracking, administration and customs documentation which ensures export procedures completed with maximum reliability while reducing transit times. Escale manages vessel calls and links agents, refineries, support services, customs, pilots, tug operators, fire service and the port's operations, administrative and commercial departments. Via an e-mail system, Escale informs clients in real time of ships' status within the port and oversees arrivals. Billing for services and statistics is also integrated into the system. (www.marseilles-port.fr/presenta/presang/antic.htm)

From the description of these port community systems we see that there is a clear trend to make these systems more open to facilitate the exchange of information with those outside the local port community. Closely related to the port community systems are systems that provide communication

facilities amongst the various organizations involved in maritime transportation.

Bolero (TT Club and SWIFT)

Paperless trading is moving only very slowly into the trade environment as key pieces are missing including a global operational capability, a secure legal framework, harmonized standards, comprehensive data security and the potential for value added services. Bolero, a commercial organization, seeks to provide a service structure that will facilitate the development of the electronic trade documentation market. As such, Bolero will provide guaranteed and secure delivery, in electronic form, of trade documentation, globally, based on a binding legal environment and common procedures. It will also provide a platform for provision of neutral cross-industry services. Bolero is thus a communication and document management service with a corresponding legal framework, security and support services. (www.bolero-project.com)

Maris Cargo Document Exchange

In August 1998, General Electric (GE) Information Services and OceanWide Marine Network offered an Internet EDI solution that allows ocean transport companies to exchange cargo documents electronically over the Internet. This is the first product to provide Internet EDI capabilities to smaller companies. Ocean carriers and their trading partners can exchange bill of lading instructions, freight invoices, container status messages, trucker carrier shipment instructions and other documents.

Maris Cargo Document Exchange is based on GE TradeWeb technology, tailored to meet the needs of the ocean shipping community. Small and medium-sized companies can begin using the system almost immediately by registering on the OceanWide Web site. The new service will enable shippers, freight forwarders and suppliers to electronically exchange cargo documents with ocean carriers by simply using a personal computer, an Internet Web browser and the tools accessed via the OceanWide Web site. Carriers can use their existing GE Information Services mailbox and EDI*EXPRESS (TM) to exchange messages with their trading partners. The Exchange seeks to give small and medium-sized companies the power of EDI without expensive set-up or extensive training. For the pilot phase, there will be three forms available: shipping instructions, motor carrier shipment information and motor carrier freight details and invoice. (www.oceanwide.com/edi.htm). (Source: PORTS AND HARBORS, May 1999)

B. INDUSTRY NEWS

The cost-effective methanol transport solution

Siting new methanol production generally involves balancing the benefits of low gas costs with the problems of geographic remoteness of these cheap feedstocks from methanol's industrial markets. Low transportation costs are therefore the key to profitable exploitation of these reserves.

If gas is available in heavily populated areas, it will already have a variety of alternative uses, including as a domestic energy source. These alternative uses attract higher prices than methanol producers can afford to pay. However, there is no shortage of cheap gas available globally.

Companies are therefore exploring transportation and distribution options that will allow them to minimize the transport costs of moving methanol produced from current remote locations. Methanol production is a way of making money from something that was previously flared or re-injected. It has no alternative value at the site. Indeed, disposal could even be considered as a cost.

This could be taken a stage further in future, with flaring increasingly frowned upon, companies must seek alternative solutions for the gas. They may not yet actually pay for a methanol producer to move in and solve their gas disposal problem, but very low prices have been agreed for the West African methanol project. With world markets awash with methanol and a question mark over MTBE use, methanol producers are unwilling to invest. A role for methanol in fuel cells could change things completely but not for several years.

For the methanol industry therefore, the challenge in current very low-priced methanol markets is to move methanol from remote areas of the world to the industrial markets at the lowest possible cost. If methanol has to be moved from Chile to Europe or Asia, it is not surprising that the cost advantage of the very low-priced gas can be eaten up by transport costs.

The solution is increasingly seen to be running a dedicated tanker fleet, according to Mitch Silver of Distribution Consulting Services in Texas, US. In the mid-1980s Sabic and its partners developed a methanol transport strategy that encompassed both parcel tankers and dedicated

vessels. This was followed by the very successful Cape Horn Methanol project, now owned by Methanex, which acquired two 45,000-tonne tankers for the Atlantic basin trade.

These successes set the trend for others to follow. Today there are 24 purpose-built dedicated methanol tankers in service or on order from shipyards, with four or five additional vessels likely to be committed this year. In addition, there are other vessels time-chartered to the methanol trade although not specifically built for carrying methanol.

Cost savings are, of course, the prime driver for using dedicated tonnage—the most cost-effective way of transporting methanol over long distances while at the same time allowing a producer to lock in shipping costs up to 10-15 years in advance. It also allows its operators to maintain flexibility and make last minute destination changes that would not be possible with a parcel tanker with several producers' product to move on a pre-set route. In addition, producers have greater inventory control. The use of dedicated vessels also minimizes the chances of contamination and increases the speed with which cargoes can be loaded and offloaded.

Shipowners are willing to negotiate long-term deals at lower rates of return than the charterers themselves would be willing to accept. Couple this with the owners' economies of scale with regard to ship acquisition, vessel management and vessel operations, and it is easy to understand why time chartering became the overwhelming choice of producers.

Where the market goes from here is still unclear, says Silver. One possibility is to continue with more 30,000 and 45,000 dwt dedicated tankers servicing new methanol plants around the world. Another bolder vision is of methanol plants clustered in production hubs in gas rich areas of the world.

"Product would be moved to distribution hubs like Houston and Rotterdam in ever larger oil-type tankers. The product would be discharged in bulk and then be redistributed in smaller tankers and barges," predicts Silver. If

methanol has a future role in powering fuel cells then the chances of this happening must be very high. (Source: *European Chemical News*, 24-30 May 1999)

Shipshape

Coastal and port zones represent the most hazardous areas of operation for tankers. Of the 20 largest oil spills over the past 30 years, all but five occurred within sight of land. Of the 2.4 m tonnes of oil lost in these accidents, 1.7 m tonnes escaped in near-shore waters and damaged coastal environments.

Tanker accidents in near-shore waters continue to occur, as highlighted by the *Sea Empress*, *Nissos Amorgos* and *Diamond Grace* groundings and the collision between *Evoikos* and *Orapin Global* in recent years.

During the 1980s oil tanker operational standards slipped due to the parlour state of the market and the preponderance of asset-playing shipowners with little concern for quality or maritime tradition. The decade climaxed with the *Exxon Valdez* grounding, a defining moment in the history of tanker shipping.

Faced with a barrage of regulations, tanker owners realized that a proactive stance was needed to deflect further debilitating rules. The International Safety Management (ISM) code, with its concept of continuous improvement, was embraced, as was an upgraded crew training regime which reflects ship practices.

The success of the post-*Exxon Valdez* regime, including the requirement for tankers carrying oil to have double hulls, is shown by the fact that the safety record of oil tankers has improved markedly. The amount of oil pollution from tankers has been reduced by approximately 80 per cent over the past 20 years.

Today, public expectations as regards safe and environment-friendly industrial activities are greater than ever before. In an attempt to minimize the risk of accidents, and to complement the regulatory regime governing vessel design and operations, the tanker industry has taken the lead by introducing two international ship inspection systems during the past five years to assist in the process of ship vetting.

The initiatives, Sire and CDI, have been developed cooperatively by charterers and shipowners to enable inspections to be carried out to an industry-wide standard and the number of duplicative inspections to be reduced.

The Ship Inspection Report (Sire) system for oil tankers is coordinated by the Oil Companies' International Marine Forum (OCIMF), while the Chemical Distribution Institute's (CDI) scheme for chemical and chemical gas tankers was developed under the auspices of the European Chemical Industries Council (Cefic) as part of the chemical industry's commitment to the worldwide Responsible Care programme.

CDI is widely used in the chemical tanker sector, but there is still quite some way to go until all oil tanker charterers and brokers use Sire.

Tanker owners are now looking outside their own ranks for the next major leap forward in maritime safety. They point out that the regulatory regimes governing activities such as pilotage, vessel traffic services, waterway maintenance, hydrography and terminal operations need to be

harmonized and made more rigorous in order to measure up to the global controls in place for tanker shipping.

The International Association of Independent Tanker Owners (Intertanko) has introduced its "chain of responsibility" concept to formalize the notion that all parties in the transport chain must bear some share of the responsibility for ensuring maritime safety.

The idea has been welcomed by the US Coast Guard and the European Commission, the latter by incorporating it as an integral part of its new Quality Shipping Campaign.

In the US, the Department of Transportation (DOT) is taking the tanker owners' concerns about the weaknesses in the US waterway management system, as highlighted in Intertanko's Port and Terminal Safety Study, as one of the starting points for its Marine Transportation System (MTS) initiative.

Whilst applauding the MTS initiative and the EU Quality Shipping Campaign as important breakthroughs, tanker owners point out that the areas of concern in US and European waterway management systems are mirrored, to a greater or lesser extent, in many other countries worldwide.

They will continue to push for an equitable sharing of responsibility amongst all the stakeholders concerned with the safe passage of ships. (Source: *European Chemical News*, 24-30 May 1999)

Excess oil, flat economic growth battle on two fronts for offshore industry

For the offshore petroleum industry, 1999 will be one of transition between growing weakness in 1998 and growing recovery in 2000. Two major challenges confront the industry as 1999 looms—low oil prices and flat economic activity—that will keep producers and service companies from taking anything but a defensive business posture. Low oil prices are a direct result of overproduction by all segments of the business while reduced economic activity is a direct result of the financial problems in south-east Asia.

Among the most significant driving issues during 1999 are the following:

- Continued engagement of non-OPEC producers by Saudi Arabia to boost its market share;
- Possibility of a global economic recession, largely dependent upon the speed of economic recovery in Asia/Pacific;
- Privatization of national oil companies, a consequence of continuing low oil prices;
- Multinationals remain the key reservoirs of exploration and production investment capital, with countries competing to offer stability and good licensing terms.

OPEC is the largest crude oil producer, but was forced to accept reductions in produced volumes in 1998, which will likely continue into 1999. The global organization failed internally to generate production restraint. Only when Saudi Arabia engaged non-OPEC producers did a consensus develop to restrain production. Once a critical mass of producers, Mexico and Norway along with Venezuela, agreed to reduce volumes, then the remainder of OPEC accepted the necessary painful cuts.

Reductions are slowly bringing the market back to balance. Many countries earlier in 1998 planned to expand

oil production in 1999 but those plans are being tempered by slow global economic growth.

A supply overhang will continue to depress oil prices through much of 1999 into the winter heating season. Much will depend on two factors:

- Economic recovery in south-east Asia;
- Recession prevention by reserve banks.

(Source: *Offshore*, December 1998)

Lead levels from leaded gasoline in Atlantic reduced

Concentrations of lead in the Atlantic Ocean have dropped dramatically 18 years after the Clean Air Act banned lead from gasoline, an MIT scientist said at the 1998 ocean sciences meeting of the American Geophysical Union and the American Society of Limnology and Oceanography. The bad news is that since those measurements were made in the 1980s, the decline slowed in the 1990s, leaving present lead concentrations more than twice their pre-industrial levels.

In a recent study, the first to document the decline in ocean lead over the past two decades, MIT professor of chemical oceanography Edward A. Boyle, provided scientific proof that lead in the ocean comes from people's use of substances such as leaded gasoline. Since unleaded gasoline was first introduced in the early 1980s, the use of leaded gas in the US has dropped, hitting a low point at the end of the decade. Europe began slowly phasing out leaded gasoline in the 1980s and mandated elimination in the 1990s, but a lot of the lead that is in the Atlantic Ocean now is suspected to come from high-temperature industrial activities, such as smelting, coal combustion, and cement production.

While researchers have argued for years that ocean-borne lead is tied to human activities because levels are highest in waters close to emission sources, there has been no data to definitively link the time dependence of the two. Metals such as aluminium have the same distribution patterns in the oceans but occur naturally. By understanding how trace metals in shells and sediments weave their way through moving water, researchers can use that knowledge as a tool to study how ocean circulation has changed over time.

The data show that lead levels peaked when the US reported peak emissions, and dipped in the years following the phasing out of leaded gasoline. Even before Boyle collected samples of surface and subsurface seawater near Bermuda, a student provided him with a novel way to track Atlantic lead levels. Glen Shen, who received his doctorate from MIT in 1986, found that analysing the composition of Bermudian coral, which grows a new layer each year, provides an accurate record of its environment. The coral provides an environmental record that dates back to the 1880s. The effects of the Industrial Revolution in its layers can be seen, as well as the subsequent imposition of leaded gas, which was invented in the 1920s.

Lead from gasoline gets into seawater when lead in automobile exhaust attaches fine particles in the atmosphere. About 10 per cent of the particles, which include lead from the smokestacks of industrial countries, catch a ride on the

wind to remote regions of the ocean and polar ice cores. While lead from industrialized countries moves all around the oceans, the Atlantic in particular receives lead from the US on westerlies and from Europe on the trade winds. After it falls into surface ocean water, lead is converted into soluble form. It then falls to deeper water on sinking biological particles, such as fecal pellets. Lead remains in surface waters for about two years, and up to a few hundred years in deep water. (Source: *Sea Technology*, May 1998)

Floating wave power device, Mighty Whale, completed

Ishikawajima-Harima Heavy Industries Co. Ltd. has delivered the offshore floating wave power device, Mighty Whale, to the Japan Marine Science and Technology Center. The Mighty Whale was developed jointly by JAMSTEC and IHI, constructed at the IHI Aioi Works, and recently moored at the test site off Gokasho Bay, Mie Prefecture. The device is 50 m long and 30 m wide, which is the world's largest wave power device.

The appearance resembles a whale, hence the name Mighty Whale. It transforms wave motion into high-velocity airflow, which is achieved by three chambers provided at the mouth. Waves that enter and leave the chambers generate high-velocity oscillating airflow through ducts on the top of the chambers. In the ducts, air turbines are installed to drive electric power generators. Electricity is used to drive the air compressors. The unit carries one each 10 and 50 kilowatt generators and two 30 kilowatt generators. (Source: *Sea Technology*, November 1998)

Emerging legal and ethical issues in advanced remote sensing technology

Fundamental changes are taking place in the world of remote sensing with respect to three primary developments. First, a new generation of space-borne sensors will be able to deliver high spatial and spectral resolution imagery on a global basis. Technical advances are making previous restrictions on data scale, resolution, location and availability largely irrelevant. Second, economic restructuring of the remote sensing community will transform the control and distribution of imagery and imagery-derived information generally, away from government and into the private sector. Third, the development of a digital, global information infrastructure, such as the Internet, will allow for rapid global distribution of information to a worldwide user community. The combined effects of these developments could have significant legal and ethical consequences for all remote sensing professionals. For example, remote sensing technology could soon develop the capability to generate and deliver a level of information detail that could violate common societal perceptions of individual privacy, and a number of direct legal and ethical consequences could result.

This paper reviews the legal background of remote sensing and current developments in satellite surveillance and information technology and outlines a number of legal and ethical issues that could be of future concern to the remote sensing community. Self regulation of the profession is central to maintaining the appropriate balance between the

rights of the individual and the economic interests of the remote sensing community and the nation as a whole. (Source: *Photogrammetric Engineering & Remote Sensing*, 64(6):589-595, June 1988)

Oil boom junk will not be sunk

Drilling platforms in the North Sea will no longer be dumped or toppled where they stand, thanks to an agreement reached by OSPAR. Though it means the most difficult pieces of oil-platform junk can still be left at sea for now, the move has been hailed as a victory by Greenpeace, which began a campaign against the dumping of oil platforms in 1995.

Many old rigs will have to be removed completely, but giant concrete platforms and the "footings", the bottom 25 per cent of steel platforms that weigh more than 10,000 tonnes, will be allowed to remain in place. The agreement says these structures should be brought ashore where it is safe and practical to do so.

Environmentalists believe that the technology to remove these large platforms will exist by the time they are decommissioned.

The next conflict in the North Sea is likely to be over the fate of more than a million tonnes of contaminated waste "cuttings" from oil drilling. An OSPAR working group will hear Britain's proposals in February 1999. (Source: *New Scientist*, 1 August 1998) www.newscientist.com

Marine transport—Houston Ship Channel dredging to begin

After 30 years, a plan to dredge the Houston Ship Channel is being put into motion. Work is to begin mid-August 1998. The four-year project at the second-largest port in total tonnage in the US is expected to cost a total of \$508 million.

Chemical producers and marine operators have been pushing in recent years to deepen the channel from 40 feet to 45 feet and to widen it from 400 feet to 530 feet to accommodate larger ships, reduce congestion, and increase safety.

Eleven companies—including Union Carbide, Shell, Exxon, Texas Houston Pipeline, Mobil, Chevron, Enron and Enterprise Products—are still negotiating with the port over who should pay for moving the companies' 130 pipelines that run beneath the channel. (Source: *Chemical Week*, 5 August 1998)

Out of the blue

At noon on Friday 3 July 1998 the 35 m motor yacht *Cable & Wireless Adventurer* arrived in Gibraltar after a journey of some 26,000 nautical miles in 74 days, 20 hours and 58 minutes. The vessel had just broken the world record for circumnavigation of the globe in a powered vessel, a record that had stood for over 30 years since the US nuclear submarine *USS Triton* completed the same journey in just over 83 days.

While the record obviously brought much pleasing publicity for the sponsors of the voyage, for its designers it provided a powerful demonstration of a new form of boat design that they hope will have a profound effect on the nature of high-speed water travel in the next century. Nigel

Irens Design is a small company that has been working on efficient, high-speed-powered vessels since the mid 1980s.

Like several other modern boat designers Irens has been taken up with the concept of the very slender vessel (VSV) as a method of improving boat performance.

These VSV designs are more than twice as slim as traditional boat hulls, having an aspect ratio of between 18 and 20:1, compared with 6 or 8:1 for conventional high-drag designs. There are problems associated with the approach, however. The trade-off for a hull that cuts through the water very efficiently is the loss of the inherent stability provided by a wider, slower shape. In the quest for optimal efficiency, however, Irens elected to stay with a single hull and use two small stabilizing floats on outriggers to keep the boat upright.

A further advantage of the trimaran design, according to Irens, is that the long hull improves stability in rough sea conditions and is capable of slicing through some waves rather than riding over them.

Iren's first experiment with the three-hulled concept was a 21 m boat, the *Ilan Voyager*, which was built in 1988 and used to break the record for travelling around Britain in a speedboat. Although the record has been broken several times in the ten years since the *Ilan Voyager's* construction, the vessel still holds the record for completing the trip without needing to stop for refuelling, consuming only 2,000 litres of fuel in the 1,568 mile journey.

After her record-breaking venture, *Ilan Voyager* has proven her worth in a variety of commercial applications, working first as a camera boat for the filming of yacht races, where the combination of high speed and stability provided by the triple hull design made an ideal platform for the collection of steady images and currently as a tourist transfer vessel in the Cape Verde islands where there is a requirement for a small, economical vessel capable of operating in rough sea conditions.

While the *Ilan Voyager* proved Iren's concept, he realized that to try and find commercial applications for his boats at a larger scale he would need more publicity and a more visible demonstration of the abilities of the design. "We worked with Jock Wishart during the round-Britain trip", explains Irens, "and when the idea of trying to break the round-the-world record came up, we were happy to work with him again". Wishart, who was project leader for the *Cable & Wireless Adventurer* project, was able to organize the sponsorship and publicity required to get the project off the ground.

To go around the world requires a larger vessel than the 12 passenger *Ilan Voyager*, however, with more sophisticated equipment and power plant on-board. *Cable & Wireless Adventurer* is 35 m long and has a displacement of 53 tonnes fully loaded, ten times that of her predecessor.

The design proved to be remarkably successful during the circumnavigation of the globe, mechanical problems were on the whole, minor and apart from an emergency repair upon leaving New York when one engine was contaminated with sea water which entered through an exhaust riser and some hull damage caused by the vessel striking a submerged object, the whole voyage ran largely to schedule.

Record-breaking boats do not make money, however, and Nigel Irens Design is actively seeking commercial applications for the trimaran design. The first applications Irens would like to see adopted are for passenger transport vessels intended to carry relatively small numbers of people in areas of rough sea.

Construction methods would have to change, however, as Irens points out that the composite construction methods used on *Cable & Wireless Adventurer* and *Ilan Voyager* would probably not remain viable for larger vessels. Instead, a more conventional aluminium alloy building technique would be used.

So while *Cable & Wireless Adventurer* has certainly made one of the most unusual journeys expected of Irens' designs, it is quite possible that in the near future vessels of the same type may be carrying thousands of passengers every day. (Source: *Engineering*, July/August 1998)

Double blow for chemical tankers

Like many segments of the tanker shipping industry, chemical tankers have suffered a double blow as a result of the Asian economic crisis. Not only is the demand for tonnage down due to significant reductions in the volume of Asian imports over the past year, but also owners have the task of trying to assimilate into their fleets all the new ships that were ordered during the halcyon days of two or three years ago when the belief in strong, steady chemical trade growth was universally accepted.

The order book swelled to such an extent that it will still be some time before it is cleared. It is estimated that around 1.9 m dwt of deep-sea chemical parcel tanker new building tonnage, equivalent to 21 per cent of the existing fleet, will have been delivered during the 1998-2000 period. The fact that the contracted delivery date for several of these new buildings has been delayed due to technical problems encountered by the shipyards has played into the hands of the owners concerned. They are only too pleased to accept late delivery penalty payments while hoping that the actual handover date will coincide with a strengthening market and fuller employment for their new vessels.

Despite the attractive new building prices being quoted by Far Eastern shipyards, the number of new orders has dropped to a trickle since the Asian economies began to catch cold in July 1997, as shipowners have no desire to prolong the agony of a depressed market. In any case, Asian shipyard prices are not a factor when considering the fully stainless steel parcel tankers which carry speciality chemicals on the deep-sea routes, as these sophisticated ships are still built only in Europe.

Forecasters predict that the longer-term effects of the Asian crisis will knock, on average, a couple of percentage points off the annual growth rate in the demand for chemical tanker tonnage, pushing it down to 3 per cent through 2001. With the steady flow of new ship deliveries at least until 2000, the current tonnage surplus in the deep-sea fleet is likely to prevail at similar levels for another three years.

Average spot rates for a typical 3,000-tonne commodity chemical cargo on the transatlantic eastbound route declined from around \$45/tonne in the first quarter of 1997 to \$30/tonne in the fourth. Rates in the first quarter of 1998

declined only marginally from fourth quarter 1997 figures, but a further significant drop occurred in the second quarter of 1998 as ships surplus to the Far East trades gravitated to the Atlantic Basin. Rates below \$20/tonne were reported for some 5,000-tonne parcels, the lowest level since the early 1990s. In 1997 spot rates for a typical 3,000 tonne commodity chemical cargo transpacific eastbound declined even more dramatically, from around \$65/tonne at the start of the year to \$40/tonne in the fourth quarter. Rates slipped further during the first two quarters of 1998, touching \$35/tonne. On average, vessel earnings from transpacific spot cargoes are more than 40 per cent lower this year compared with 1997 levels.

In general, spot rates for speciality chemicals have stood up to market pressures better than those for commodity chemicals. For example, transatlantic eastbound rates for 1,000-tonne parcels of speciality chemicals declined about 15-20 per cent between the start of 1997 and early 1998, from around \$65/tonne to \$50-55/tonne.

The buildup of chemical plant capacity in many Asian countries in recent years, however, coupled with depreciated prices for locally produced chemicals and the need to earn hard currency, has brought some additional new business to the ship operators in the form of Asian exports, albeit nothing to match the volume that has been lost.

The new building programmes upon which several of the deep-sea operators are currently embarked are aimed, to a great extent, at replacing first-generation chemical tankers built in the early to mid-1970s. However, a significant part of the new tonnage was ordered to meet the forecast strong trade growth. The fact that the new tankers have greater capacities and cargo handling efficiencies than the ships they are replacing also serves to exacerbate the tonnage surplus.

That the road to recovery in Asia is likely to be a long and difficult one is something all chemical tanker owners, no matter where in the world their ships are operating, have had to reckon with over the past 12 months. The greatest challenge facing the major chemical tanker owners is to earn a satisfactory return on their huge investment in the new tonnage currently being delivered. For owners of smaller fleets, the principal concern is one of maintaining a viable operation. (Source: *ECN Chemscope*, October 1998)

Evaluation of methodology for QRA in offshore operations

A brief summary is presented of the development of Quantified Risk Analysis in the offshore oil and gas industry for nearly 20 years. From a modest start in Norway as a research activity, QRA has today become one of the focal points of oil and gas management in all countries around the North Sea, and also in other areas. This was mainly initiated by authority regulations and requirements, but has now for some time been driven by the industry itself, as it sees the QRA as a vehicle to gain extended flexibility with respect to optimization of offshore safety standards. This article discusses how QRAs are used, and examines in this light how methodology developments that are and should be carried out by R&D institutions and the industry. Recommendations with respect to how and where knowledge should be

developed are expressed and discussed. Lastly, visions for future use and developments within the QRA technology are outlined. (Source: *Reliability Engineering & System Safety*, 61(1-2):39-52, July-August 1998)

Underbalance perforation in long horizontal wells in the Andrew field

Andrew field in the UK Continental Shelf, which is operated by British Petroleum (BP) Exploration, is being developed using horizontal oil producers and completed with cemented liners. The main challenges of perforating these wells are maximizing well productivity by avoiding formation damage, minimizing the possibility of sanding, maximizing ultimate hydrocarbon recovery, perforating long horizontal sections safely and efficiently, optimizing the economic value of perforating, and minimizing perforating debris.

In general, to avoid impairing well productivity, it is best to perforate the underbalance. However, the advantage is compromised, because of the fluid invasion and loss-control material, if a well will be killed when the tubing-conveyed perforating (TCP) guns are removed. Existing deployment methods with coiled tubing (CT) enable perforation and subsequent gun removal in an underbalance condition. Unfortunately, various limitations would require multiple runs with CT for perforating each horizontal well in the Andrew field, which would result in significant time and on-balance perforation for each subsequent run.

The combination of the newly developed mechanical ball valve and the deployment of TCP guns with hydraulic workover units enables long horizontal wells to be perforated in one run in underbalance, and enables the guns to be removed without killing the well. Specially engineered guns and perforating charges are used to minimize sanding and gun debris.

This paper describes how these new technologies, used for perforating operations, meet many challenges. The same technologies can be used readily for perforating other long horizontal wells with similar problems.

To date, three horizontal wells in the Andrew field were perforated successfully with the method described in this paper. The initial results indicate that the combination of the cemented Liner completion, the engineered perforation systems, and the correct TCP gun deployment method using the mechanical deployment valve have contributed to improve well performance, to reduce cost, and to improve operability and safety in long horizontal wells. (Source: *Spe Drilling & Completion*, 13(2):73-77, June 1998)

Ports are racing to satisfy the needs of new megaships

Large cargo ships that are generating an upheaval in the maritime industry, especially in the North Atlantic, where outdated ports cannot meet the needs of the new vessels. With their contracts at the Port Authority of New York & New Jersey set to expire, two of the world's biggest container shippers—Sea-Land Services Inc. and Maersk Inc.—are seeking an East Coast port that can host the big ships. Roads and rails would then be used to deliver goods throughout the Northeast and Midwest.

Sea-Land and Maersk, which account for 20 per cent of the global market, have set off a bidding war between New York and ports from Halifax, Nova Scotia, to Norfolk, VA., each of which is trying to offer a better-equipped port.

The stakes are enormous—not just for the East Coast but for the shipping industry worldwide. With booming exports expected to lead to a surge in North Atlantic maritime traffic from Europe and south-east Asia, bagging Sea-Land and Maersk would cement the winning port's position as the premier North Atlantic hub. A downside for the winning port is that it will have to take the costly and environmentally sensitive step of dredging its channels for the new ships.

In 1986, Congress authorized dredging to deepen the New York channel. The Army Corps of Engineers is set to being the dredging this winter, in a project that will cost \$732 million and take five to nine years to complete. When it is finished, the harbour's channels will be 45 feet deep—still too shallow for the new megaships, which will require a 50-foot draw.

When Congress authorized the dredging 12 years ago, no one could guess that container ships would require such depths. By the time the studies, permits, and funding for the dredging were in place, the project had already become obsolete. With at least a 10-year lead time on any dredging project, the corps is now fast-tracking a study to determine whether it can take some New York Harbour channels to 50 feet.

The Port of Virginia in Norfolk, the top contender for Sea-Land and Maersk's business, has main channels already 50 feet deep, and berthside dredging is in the works. Rail comes right into the terminal, which is undergoing a \$400 million expansion and already has the big cranes needed to unload big ships.

In the meantime, carriers have already begun diverting some of their business north to the deeper waters of Halifax. (Source: *Business Week*, 21 September 1998)

Multi-modular system intended for re-use

If all goes to plan, the modular subsea processing system Alpha Prime could be in service on a live field by the end of next year. The technology, which can be configured to include separation on the seabed, is targeted at:

- Marginal field developments, due to the low capex involved;
- Longer distance satellite tiebacks, avoiding multiphase flow and hydrate formation problems;
- Reactivation of decommissioned fields;
- Late field life retrofit, to defer abandonment of infrastructure replacement of FPSOs in shallow or remote deep-water applications.

Alpha Prime is a modular seabed system, designed for diverless installation and subsequent retrieval for re-use on another field. The system's modules can be configured to suit the requirements of the field using either manifolding or subsea separation. Modules can be inserted and removed without the need to shut in wells, and can also be designed for 100 per cent availability while one system component undergoes maintenance or reconfiguration, brought on by changes in the reservoir's characteristics.

The technology has been developed over several years by London-based Alpha Thames Engineering, but progress has been speeded up of late through the acquisition of the company by Sweden's Kockums Group.

At Alpha Prime's heart is the Aesop all-electrically-powered seabed processing system, the prototype for which has been sponsored by a joint team including Conoco, Shell, Hardy and Statoil. A completed version should undergo tests in mid-1999. Other important modules include:

- HWC, a subsea mateable electrical connector rated up to 11 kV and 1 MW currently, although a newer version is under development with 22 kV capability;
- REAct, a fail-safe electric valve actuator, ROV operable in remote and deep locations, and also integrated easily with high integrity pressure protection systems. This has already been designed, patented, and certified;
- MATE, a multiple pipework connector allowing simultaneous connection and disconnection of up to six, 8-in. and four, 4-in. flowlines, with both halves of the connector internally valved to contain process fluids when separated. A version was recently built and then tested at Kockums' site in Malmö;
- CUSP, a tool for tie-in or pull-in of rigid or flexible flowlines, bundles, electro-hydraulic umbilicals, plus valve retrieval and pipeline repairs. This can be operated from a surface vessel or an ROV. Again, testing has been completed at Malmö, with certification already granted by DNV.

The next step for Hardy is to prove Alpha Prime on a live field installation. A longer-term aim is to progress the processing to handle problematic hydrocarbons, for instance, with high hydrogen sulphide or carbon monoxide content.

MURCS under test

Another new subsea system suited for marginal fields was demonstrated for the first time at British Gas' British Auckland test site in northern England. MURCS (minimum umbilical remote control systems) is a subsea power generation and well control system designed partly to minimize requirements for umbilicals, which are seen as one of the higher cost components of very long distance well tiebacks.

The \$1.6 million project, conducted by Caltec in the UK with European Union support, is also sponsored by Amerada Hess, Enterprise Oil, Mobil and Kongsberg Offshore, with participation from Camco, British Gas, ECS, Honhinco and W.D. Loth.

MURCS is not limited by water depths or offset. The subsea production/injection system is linked to surface facilities via a standard telecommunications fibre optic umbilical and, optionally, by a small-diameter chemical injection conduit piggy-backed to a flowline. This conduit should cater for increased chemical demands as subsea processing systems become proven.

The project team took into account the likelihood that total severance of subsea control from the surface will not be practicable for a while yet. But umbilical size and cost

can be restrained by dedicating it to vital telemetry and chemical supply functions.

MURCS supports this objective in two ways: control system power requirements are provided by a local power supply driven by produced fluids, and hydraulic needs are furnished by untreated seawater. A local power supply needs to be robust, with a significant amount of power (electric and hydraulic) available rapidly to support multiple re-starts. There must also be a contingency method for recharging faced with successive shutdowns in quick succession.

Use of seawater hydraulics helps bring down overall costs. Actuated components are simple, relatively inexpensive, and mimic operating characteristics of conventional units. Direct acting pilot valves consume more power than the multi-stage units in conventional electrohydraulic systems, but they also eliminate the need for costly, lean hydraulic practices. (Source: *Offshore*, August 1998)

Production systems moving subsea and downhole

Offshore oil and gas exploration and development operations are the earthly equivalent of deep space exploration. The oceans are equally hostile and remote. All supplies and equipment must be transported to sites far offshore. Contingency planning must account for many hazards, and built-in redundancies in deeper depths must rely on intervention by remotely controlled devices.

Like space exploration, contingencies are costly, but unlike space, technology cost is the primary driver for profit-driven companies. Technology innovation is supported to the extent that it can lower costs. As costs associated with offshore E&P continue to rise, driven by a tight market, the industry is re-assessing such major costs as rig day rates, facilities construction, facilities emplacement, logistical servicing and labour. Technology that can drive down any of these costs can quickly increase returns and allow more development.

Automation of routine processes can add efficiencies while reducing reliance on a limited number of trained workers. Day rate and some installation costs can be lowered, or eventually eliminated by moving surface processes to the seabed or into the borehole.

Advancements in drilling technology and extended rig capabilities have led to exploration projects in deepwater and ultra-deepwater. While these technologies have extended the range of exploration, development and production costs are much higher. Deeper water columns and attendant current-profile complexity are straining production riser technologies and reducing the economic viability of many deepwater projects.

To justify development in ultra-deepwater, either the reserves must be very large or the cost of development must be reduced dramatically. Field life-cycle cost-of-operation could fall dramatically with the deployment of integrated "smart" production systems that are self-sustaining and self-regulating, positioned either on the seabed or downhole.

A recent announcement by alliance partners Baker Hughes, Inc. and Sensor Highway, articulated a vision shared to a greater or lesser extent by the entire industry—moving surface production functions to the seabed or

downhole. While the details of how this future will develop vary widely from company to company, the core goal of eliminating the surface facility is shared by all. Baker Hughes named this concept the "Downhole Factory", reflecting the objective of their technical pursuit and the next step in the evolution of downhole technology.

The Downhole Factory concept achieves a major aesthetic/political goal: placing oil and gas operations out-of-site and out-of-mind:

- The system can control environmentally-objectionable flows and emissions at the source, preventing releases rather than forcing the industry to respond with containment strategies.
- Stranded natural gas production or flaring can be stopped. The gas will be used for electrical power generation downhole using fuel cell technology or turbines. The electricity produced will be used to power the downhole factory or could be routed onshore and fed into power grids on land.

Several countries and US states along the Gulf of Mexico and Pacific Ocean forbid development within sight of land, often for the simple reason that a platform or rig might spoil the view from beachfront property. A more serious concern centres around pollution and seabed damage. The downhole factory attempts to address these concerns and might open some environmentally sensitive areas to future development.

Three enabling technologies

Fibre optics

Smart downhole tools will require instructions from both on-board computers and from human handlers off site. Fibre optic cables provide a way to send instructions to many different smart tools on a single glass fibre, just by altering the frequency (colour) of light employed.

The fibre optic cable will become a "spinal cord" for the well, relaying directed instructions as well as passively monitoring the status and condition of the wellbore. Automated pre-programmed responses, similar to the human body's autonomic reflex system, will deal with expected problems before they become a major danger.

Alerts will be sent by light cable to the surface telemetry system, which will relay data and conditions by satellite to the field control operation on-shore. Additional instructions can then be sent to the in-bore tools to effect repairs.

Mankind has achieved similar things before, most recently in the NASA Mars Sojourner space programmes. Unmanned probes could become an operational norm for the next century.

Artificial intelligence

Smart production systems will need to be able to respond to changing conditions in the well. To do this, the collective wisdom of production engineers will be encoded

into software, artificial intelligence (AI), that can take the monitoring data from sensors within the wellbore and respond in necessary ways to control pressures or modify treatment programmes.

The petroleum industry AI system of the future will have the ability to learn and adjust to the specific characteristic of unique production flows. In addition, the system will control all the tool systems operating in the well.

Robotic devices

The wellbore designed around such technologies as the Downhole Factory will be larger than that for conventional oil wells, at least the upper sections. Lateral holes will be drilled as storage bays for tools and supplies, keeping them out of the way until they are needed.

These active elements within the wellbore will be robotic devices that can adjust or tune the hydrocones and other specialized production equipment in the factory. They will be able to move freely within the borehole and will receive instruction by fibre optic cable and internal telemetry. The systems will be equipped with sonar/radar imaging systems to provide visual data to distant human field controllers.

The artificial intelligence (AI) stored in the "brain" of the well will instruct these devices as to their tasks. At first, the devices will be task-specific, similar to today's dedicated electro-mechanical systems. As these robotic tool systems evolve a more general programmable tool, they will be able to handle multiple tasks.

Well servicing by wire

For subsea wells 300 or 400 miles from shore, routine well servicing will become a logistical nightmare. "Smart" wells should change the conventional service approach. Routine service can be remotely controlled.

Even consumables, such as corrosion inhibitors, could be delivered by a powered airplane, not ship or helicopter. Unmanned drone airplanes could deliver necessities, saving the cost and danger of sending air crews to the wellsite. The drones would fly to the well location and drop modules with transponder beacons. A dedicated remotely operated vehicle (ROV), attached to the mudline module above the borehole and routinely charged by downhole power systems, will locate the dropped supplies and return them to the wellhead.

A second approach would be to include a motorized delivery that would guide the consumable module to the wellsite, where the ROV would then take control. Automated systems will then take the supplies downhole. Spent modules will be returned to the mudline where the ROV will bundle them for surface delivery.

Nitrogen cartridges will fill lift balloons to return the modules to the surface where retrieval can be made by air with a snatch-hook. Such an approach would be simple, economic, and fully controllable by satellite link. (Source: *Offshore*, June 1998)

C. TECHNOLOGY UPDATE

Marine industrial technology

New uses for seaweed

Louis Druehl runs *Canadian KelpResources*, a small company in British Columbia. It has three functions: a product line of wild sea vegetables, consulting services, and producing seed for people who farm kelp. The company also helps people in coastal villages develop uses for seaweed.

Druehl says he sees a number of opportunities: firstly, herring-roe-on-kelp. At present it is a \$22 million-a-year industry shared among approximately 40 licence holders. The process relies on herring laying their eggs on kelp, "which produces a very, very expensive product", says Druehl. The herring, however, do not always choose the best kelp, so Druehl took this opportunity to help establish four west coast farms to produce suitable kelp. What he particularly likes is that it is a sustainable industry. "You don't have to kill the goose to get the egg," he says. Killing herring for its roe wastes 5/6ths of the fish.

Druehl would also like to develop similar products using different seaweed to fit market niches that do not compete directly with herring-roe-on-kelp. Druehl advocates growing kelp in order to ranch sea urchins. He notes that urchins often appear in barren waters with no visible food. By feeding them kelp, urchins' roe can be increased to bring them to marketable quality. The kelp is grown on a grid of ropes about two metres below the water's surface, then individual ropes are dragged to the urchin site. The animals are allowed to eat the kelp until only the base of the plant remains. The rope is removed to allow the kelp to regrow. "It's like taking your lawn to the cow," says Druehl. It is cheaper than prepared feed and does not have to be stored or transported. And it is what urchins like. (Source: *INFOFISH International*, January 1999)

Damming in the Dutch

After the flooding of 1953, during which 1,850 people died, the Netherlands launched a massive Delta Project. The last link, completed last year, consists of two enormous gates. The two 22 m high and 210 m long curved barriers are the final defence against the sort of stormy events which

are only expected to occur once every 10,000 years. Together the double wall barriers weigh 30,000 tonnes, which is almost seven times greater than the Eiffel Tower. The giant gates swivel on the world's largest ball joints. Each ball has a diameter of 10 m, is as high as a three-storey house, and weighs 680 tonnes.

On such a scale smoothing the movement was not a job for conventional lubricants. Oil, for example, would be squeezed out, so a dry alternative containing molybdenum disulphide was developed by OKS Spezialschmierstoff GmbH in Munich, based on DuPont's product Krytox.

DuPont explained that just 30 µm of this special lubricant is sufficient for the ball joints to keep moving freely, even in the worst possible circumstances. Naturally the Dutch, after spending 960 million guilders on the gates would like to be absolutely sure that they will always close when needed, and not just now, but in fifty years time. The formula for the lubricant is a trade secret, so as part of the deal, the exact composition and an account of how it is made, have been deposited with a public notary at The Hague. After fifty years this information will be transferred to the Dutch government archives.

While designed for events which may never occur, normal conditions can become bad enough for the gates to close. About once in every ten years tides and winds combine to create problems and the gates will be used to help regulate water levels for a huge area behind the dikes. At all other times the passage will remain open for an average of 140 large vessels which pass through to Rotterdam and back every day. (Source: *Technology Ireland*, January 1999)

Composite materials investigated for weight and maintenance savings

With the continuing demand for lightweight materials to be used on offshore structures, modular living and service modules specialist Emtunga, has launched a development programme to research the use of composite materials in the construction of offshore modules. Now in the first of three phases, the programme has been initiated in response to customer demand to not only reduce weight but also to

develop virtually maintenance-free materials which could be used for service as well as accommodation modules.

Emtunga already believes that it will be possible to find a suitable composite that will weigh less than aluminium and will need no maintenance other than external painting. With none of its competitors as yet looking into this area, Emtunga hopes to attract support from the major offshore players during the third stage of development. The problem with aluminium is that it has to be treated in a different way to steel in order to make it fireproof whilst still retaining good insulation properties. The benefit of a composite material is that it could have fireproofing and insulation built in.

Emtunga is also enhancing its international profile by stepping up its marketing efforts away from its home market to include new areas for the company such as the Gulf of Mexico, Asia and South America. (Source: *Offshore*, October 1998)

First offshore use of new drillstring inspection system

Under normal operating conditions fatigue cracking can occur in drillstring threads. If left undetected this can lead to downhole failures which can be extremely costly. Conventional drillstring thread inspection methods rely on visual identification of defects using magnetic particle inspection (MPI) for standard connections or dye penetrants for non-magnetic components. Both rely on skilled operators and can be unreliable when applied to threaded connections.

Technical Software Consultants (TSC) Ltd. has developed a semi-automated drillstring thread inspection system as a replacement for conventional MPI and penetrant inspections. ATI uses TSC's novel ACFM inspection technology and provides simple pass/fail reporting, thereby reducing the reliance on operators.

The ATI system was developed with support from Shell Expo, British Gas, BP, Statoil, and OSO and is now available commercially. According to a spokesperson, successful pipe yard trials have demonstrated the effectiveness of the system and reliability improvement over conventional MPI. Shell Expo has successfully used it offshore during drillstring operations in the Barque field where there was a requirement to confirm the integrity of important drillstring components. (Source: *Sea Technology*, September 1998)

ODP testing new technology for deep ocean drilling

Researchers with the Ocean Drilling Program (ODP) will test a new drilling system designed to drill large-diameter casing into hard fractured rock on the seafloor. The new drilling system, called water hammer drilling, uses a percussion drill similar to a jack hammer but is driven by fluid rather than air. The new drilling system will create a 375 mm borehole while simultaneously inserting a 340 mm casing into the borehole, immediately behind the drill bit. Drilling in a casing in this way is an attempt to stabilize the borehole as it is being drilled. This is accomplished by isolating the fractured rock from the borehole with the casing.

Three test sites have been selected on the Southwest Indian Ridge in the Indian Ocean. The water depths at the test sites range from 700 to 3,000 m. If the tests are successful, re-entry systems will be placed in the stable borehole on the ridge. These systems will allow scientists to return to these locations to conduct future experiments.

The water hammer drilling system may also be used to establish scientific boreholes on the mid-ocean ridges and other hard fractured rock formations around the world, which would allow scientists to study parts of Earth currently inaccessible because of technical limitations. (Source: *Sea Technology*, July 1998)

Innovative petroleum industry

The offshore petroleum industry seems to have no bounds when it comes to technical innovation.

The 1990s have seen important new developments with horizontal drilling, concrete gravity structures, floating petroleum storage and offtake (FPSO) vessels and unmanned navigation, control and communication buoys.

Now, Apache Energy has come up with a world first by "sinking" a delivery ship to offload the jacket and topsides for the Stag oil project off the North West coast of Western Australia.

After being fabricated, the jacket and topsides were brought to the site of the Stag oil field, 65 km north-west of Dampier, aboard a transport vessel. There the vessel was submerged, allowing the jacket and topside structures to be floated off separately.

In water 47 m deep, the jacket was then lowered into position over a pre-drilled template on the sea bed. On completion of piling operations, the 5,000-tonne self-floating topside structure was then positioned over the jacket and "stabbed" into place. The next manoeuvre involved jacking up the topside over the legs of the jacket to allow a 20-m gap between the bottom of the structure and sea level.

The Stag project will make an important new contribution to oil production in Western Australia. The oil field is planned to produce an average of 27,000 barrels of crude oil per day over the first 12 months. This will be about 15 per cent of WA's total oil production (which amounted to 65.8 million bbl, worth over \$1.9 billion in 1996/1997). (Source: *Prospect*, March-May 1998)

Port of London: new VTS system launched

State-of-the-art vessel traffic monitoring equipment is to be inaugurated in the UK's largest port, the Port of London.

The new Vessel Traffic Services (VTS) system, manufactured by the French company Sofrelog, will permit navigation within the Port of London limits to be monitored with even greater accuracy and reliability than before, enhancing the already high standards of safety achieved by the Port.

Replacing 12-year-old equipment, the commercially available, "off-the-shelf" hardware, comprises five two-screen workstations, each using wide-screen format for added clarity and coverage.

Radar data is fed from seven transceivers via microwave links, which together provide seamless radar surveillance of the Thames estuary and lower river.

Two further radar sites are shortly to be introduced, which will complement existing coverage and ensure that in all areas critical to navigation, every vessel is tracked by at least two independent radar sites. The system, which integrates an electronic navigational chart, is also capable of using ship transponder technology and will track vessels suitably equipped to an accuracy of 10 m or better.

At the heart of the new VTS system is its highly flexible and powerful software, which has been fully integrated with the PLA's computerized ship information database (POLARIS), and will enable rapid transfer of information between the two systems. The VTS system is also capable of being observed live in real time, but remotely by Sofrelog at their headquarters in France, permitting the rapid diagnosis and remote rectification of any fault, as well as the easy introduction of software updates. (Source: *Ports and Harbors*, December 1998)

ECS system for tracking container movements

Witness a major breakthrough in the world of technology with the introduction of a revolutionary wireless container tracking and monitoring system. Electronics firm, P-Serv Technologies Pte Ltd. developed the Electronic Container Seal (ECS) System specifically for port users to improve the efficiency of port operations worldwide.

The ECS system consisting of 3 peripheral's modules—base reader (BR), interfacing software (IS) and the handheld reader (HHR)—is an active wireless transmitter powered by battery and equipped with an embedded seal number, with an optional key-in of information.

The system is designed with a radio frequency (RF) of 315 MHz using the frequency shift key technique (FSK), and an effective communication range of 3 to 5 m with transmitting power of 1 mW or less. The ECS consists of a radio frequency identification (RFID) unit incorporated into the present container seals.

The "brain" of the entire ECS System is the integrated circuit (IC), a transmitter of FSK that can be fitted on all different models of seals, thereby increasing its range of usage. There is a huge market potential for ECS due to its distinct advantages and wide applications. "The seal can be easily adapted to other applications such as air cargo and luggage tags, further boosting its market potential," said Mr. Ronald Teo, PSA's Senior Regional Manager of International Business Division.

The newly developed ECS enables checks to be done electronically on every container with an electronic seal, thereby ensuring 100 per cent seal checks phasing out the old process whereby checks are carried out manually on randomly selected containers at the gates.

This new technology will save manpower costs, time and improve operational safety as physical checking at port's entrance or exit is eliminated. Security is enhanced, as ECS is tamper-proof and equipped to track container movements and to detect any tamper. (Source: *Ports and Harbors*, June 1998)

Lidar in-space technology experiment measurements of sea surface directional reflectance and the link to surface wind speed

The dependence of sea surface directional reflectance on surface wind stress suggests a method for deriving surface wind speed from space-based lidar measurements of sea surface backscatter. In particular, lidar measurements in the nadir angle ranging from 10 degrees to 30 degrees appear to be most sensitive to surface wind-speed variability in the regime below 10 m/s. The Lidar In-space Technology Experiment (LITE) shuttle Lidar mission of September 1994 provided a unique opportunity to measure directional backscatter at selected locations by use of the landmark track manoeuvre and to measure fixed-angle backscatter from the ocean surfaces on a global scale. During the landmark track manoeuvre the shuttle orbiter orientation and roll axis are adjusted continuously to maintain the lidar footprint at a fixed location for a duration of 1 minute. Several data sets were converted to calibrated reflectance units and compared with a surface reflectance model to deduce surface wind speeds. Comparisons were made with ERS-1 scatterometer data and surface measurements. (Source: *Applied Optics*, 37(24):5550-5559, 20 August 1998)

New technology of mechanical treatment of dredged material from Hamburg harbour

Harbours and water ways can only fulfil their commercial task if there is always sufficient water depth for navigation. Environmental problems have started to influence dredging methods in recent decades. As a logical consequence of a policy giving high priority to environmental protection, Hamburg built the METHA plant (Mechanical Treatment of Harbour Sediments). METHA produces a clean sand product (grain size $>63 \mu\text{m}$) which is reused and a contaminated silt fraction (grain size $<150 \mu\text{m}$) which is disposed presently. Previous investigations showed that the content of heavy metals and organic contaminants are primarily governed by the grain size. In 1995 Strom- and Hafengebäude started a new investigation to produce a further fraction from the METHA silt which can be reused.

The result of laboratory- and pilot-scale research showed the possibility of a further separation at $20 \mu\text{m}$ grain size. The best result was reached through a two-step separation made by hydrocyclons and spirals. The produced fraction ($20\text{-}150 \mu\text{m}$) is mainly quartz material with a low level of contamination. In February 1996 Strom- and Hafengebäude decided to build a test plant on a technical scale. The capacity of the test-plant is 50 t/h based on dry substance. The technical concept is integrated into the METHA concept. All aspects of technical feasibility, economy, environment and product reuse will be investigated in the test plant. (Source: *Water Science & Technology*, 37(6-7):337-343, 1998)

Electric screen to prevent stray fish entry into water intakes

Hitachi Zosen Corp. has installed and started operating an electric screen system at a water purification plant in Kanagawa Prefecture to prevent the entry of stray fish into the water intake. When stray fish enter the water intake, an invisible net (electric field) provides a weak electric stimulus to scare and cause these fish to turn around, preventing them from entering the water intake.

The company commercialized the electric screen to prevent fish entry about seven years ago. The system involves a parallel type electric screen in which the water intake concrete walls were lined with an iron wall (anode side) and a lead wall (cathode side). A voltage of 0.2 V/cm is impressed that can be sensed by a 5-cm fish.

Methods to prevent entry of fish into water intakes include the water bubble type, coloured panel type, acoustic type and optical type, but these systems lose their effect with time since the fish get accustomed to these systems. With the electric screen, an invisible electric barrier is created by impressing an AC voltage on the electrodes installed in the water. The entry of fish into the water intake is prevented by a weak electric stimulation. The system is effective for most type of fish and does not exert any adverse influence on their growth. Further details from Hitachi Zosen Corporation, Public Relation Section, 1-1-1, Hitotsubashi, Chiyoda-ku, Tokyo, 100-8121, Japan. Tel.: +81-3-3217-8418, Fax.: +81-3-3217-8534. (Source: *Jetro*, October 1998)

Flagship seismic vessel launched

Veritas DGC has launched its new flagship seismic acquisition vessel, the *SRV Veritas Viking*, in Bergen, Norway. The *Viking* is the newest multi-element vessel in the company's fleet. The *Viking* will be initially equipped to deploy with dual sources and eight, 24-bit RDA streamers, but was designed to deploy in excess of 12.

The vessel can also handle and tow 12,000-m streamers in order to meet the latest requirements for extra-long recording offsets. The *Viking* is also equipped with the latest Syntak data acquisition systems, Spectra integrated navigation, advanced on-board data processing systems, and full quality assurance capabilities.

The *Viking* is undergoing sea trials prior to beginning data production in the North Sea. The vessel was built by Mjellam & Karlssen in Bergen, Norway and was reportedly delivered on time and on budget. (Source: *Offshore*, August 1998)

Two bows

Aker Maritime has developed a new drilling and production ship concept which features a bow at both ends which allows for the ship to turn the bows into the waves without the use of a turret. This design allows for the risers and mooring systems to be attached directly to the hull. The design also features the drilling deck on the same level as the rest of the deck, allowing for increased efficiency, a higher level of safety, and better working environment.

The lack of turret also allows the ship to install several drilling systems which can work in parallel or together, reducing lag time between operations. The design has been

given the DPS (drilling production storage) designation and has confirmed good characteristics in model tank tests. Aker has stated that a great deal of interest in the ship has already been received. Aker has also developed a pure drillship concept for the international market based on the design offering the same qualities as the DPS. (Source: *Offshore*, August 1998)

INDIGO uses drill data for foundation design

An Australian geotechnical consultancy has developed a method for using routine exploration data in platform foundation concept designs. The data used, mainly preliminary geotechnical engineering data, is processed and interpreted by engineers looking for information on the soil stratigraphy and the indicative strengths in the first 100-150 m beneath the sea floor. Using this information, the geotechnical engineers can identify viable foundation options.

The approach is called Interpretation of Drilling Information with Geotechnical Objectives (INDIGO). In addition to being cost-effective, the information-gathering technique does not disturb normal exploration well drilling time.

The INDIGO approach has been successfully used offshore Western Australia in the Timor Sea, according to Brian Ims, a Senior Geotechnical Engineer with Douglas Partners, the system developers.

Other useful information that can be gathered offshore includes the collection of sea floor samples of the seabed returns using an ROV, and the collection of samples of material adhering to the drill bit on its return. These data provide a range of information including micro-palaentological dating and establishment of the geological and dispositional characteristics of the strata, and the soil types at discrete depths. (Source: *Offshore*, August 1998)

Space launch planned for floater before year-end

The much-doubted Sea Launch floating rocket launching facility is becoming a reality. The international partnership expects to launch a satellite into space from a converted semisubmersible later this year.

The mission control ship *Sea Launch Commander* has reached its home port in Long Beach, CA, after a month-long trip from a shipyard in St. Petersburg, Russian Federation, where it had been refitted with more than 600 tons of electronic and mechanical support equipment. The vessel is carrying the first of two Sea Launch rockets, which are modified versions of the Ukrainian-built Zenit.

In addition to serving as mission control for Sea Launch operations, the vessel is also a rocket assembly plant. Designed by Kvaerner Maritime and built at the company's Govan Shipyard, the vessel, called an Assembly and Command Ship (ACS) is the first of its kind, according to Sea Launch President and General Manager Allen B. Ashby.

The 667-ft, 34,000-ton vessel, can accommodate up to 250 crew members, launch technicians, and customers. It features a roll-on, roll-off cargo vessel design for the assembly and transportation of launch vehicles, and the integration of their satellite payloads.

The second Sea Launch vessel, *Odyssey*, is a self-propelled semisubmersible launch platform converted from

the mobile offshore drilling unit *Ocean Odyssey* by Kvaerner Maritime at its Rosenberg Shipyard in Stavanger, Norway.

With this conversion, the *Odyssey* is among the largest semisubmersible, self-propelled vessels in the world, measuring 456 ft in length and 220 ft in breadth.

The vessel has accommodations for 68 crew members and spacecraft personnel and is equipped with a large, environmentally controlled hangar for storage of the rocket during transit. It also has mobile transporter/erector equipment on board. The vessel has storage capacity for rocket fuels (kerosene and liquid oxygen) sufficient for each mission.

According to engineers connected with the project, the cheapest place on Earth from which to reach outer space is the equator. Unfortunately, land is scarce at zero latitude, and what land does exist is covered by thick jungle which does not lend itself well to such projects. What is at the equator is water, millions of acres of it.

With a better angle on orbital positioning, it makes economic sense to launch as close to the equator as possible. There also are safety and environmental concerns. Land-based launches can endanger human populations, disturb animal and plant life, and cause noise pollution.

Sea Launch is a project that began about six years ago on the premise that the growing backlog of satellite traffic could be relieved with a floating mobile launch base. The Sea Launch platform has been designed so that it can be used to launch a payload into any orbit, which is a key performance advantage, according to Boeing.

In addition to the two new vessels, Sea Launch has completed work on a 16-acre home port. Converted from a former US Navy installation, this satellite processing centre features a payload-processing facility that includes two state-of-the-art spacecraft preparation areas and an encapsulation facility. This port is near the satellite manufacturing region of California and includes a warehouse that can store up to three of the Zenit launch vehicles. There is a 1,000-ft wharf for berthing the two vessels and offices for Sea Launch customers.

Sea Launch should be able to complete between 6 and 8 launches a year and has 17 scheduled between now and 2000, 12 more with Hughes and five with Space Systems/Loral. (Source: *Offshore*, August 1998)

Guide frame provides safer ROV deployment in stormy weather

Odim Offshore of Ulsteinvik, Norway, believes that the safe launch and recovery of ROVs will be possible in force 7 winds and sea state 10 conditions if operators use its new guide frame system. The system is claimed to limit significantly the risk of damage to ships, ROV, and crew by restraining vehicles as they pass through the hazardous splash zone.

Mating or releasing the ROV from the ship while it is still under water will guard against the expensive risk of the ROV being smashed against the ship's side or being damaged by the extreme suction that can be caused by certain wave conditions.

The Odim design features a guide frame that is suspended within an A-frame. The guide frame is deployed over the side of the ship by the A-frame and lowered until it reaches below the hull. The ROV and its tether management system is held securely by a trolley that runs inside the guide frame and is lowered through the splash zone without experiencing any uncontrolled movement. Heave compensation can be hydraulically applied, and when the ROV and its TMS reach a depth that takes them clear of the hull, they can be released and deployed in the normal way.

Recovery of the ROV and its TMS is largely the reverse of the launch procedure. Efficient design of the docking station or turntable has been essential to ensure that mating is secure and easily achieved. Once fixed inside the frame it should be possible to raise them without difficulty and without their being exposed to risk through extreme movements of the ship. (Source: *Offshore*, August 1998)

High-speed energy-conserving oceangoing ship

Kanazaki Trading Co., Ltd. has designed a high-speed, energy-conserving oceangoing ship that reduces fuel consumption by as much as 30 per cent and improves the cruising speed by about 20 per cent.

With conventional types of ships, the rudder is installed just beyond the screw to permit easy steering when cruising at low speeds, making the rudder larger than is actually necessary, leading to large energy loss due to water resistance when cruising at high speeds.

With the high-speed, energy-conservation type of ship designed by Kanazaki, the rudder positioned behind the screw is lifted at right angles by a hydraulic cylinder to eliminate rudder wave resistance when the ship cruises at high speed. Also, to secure reliable steering at high speeds, a small rudder is installed forward of the screw. When cruising at slow speed inside ports/harbours or at fishing sites, the rear rudder is lowered into the water to operate in tandem with the fore rudder. Using the rudders in this manner enables fuel consumption to be reduced by 30 per cent and the speed increased by 20 per cent.

The company acquired patents in 1995 and is presently planning to engage in a commercial experiment with the cooperation of Oita University and other enterprises interested in the joint commercialization of the newly designed ship. Further details from Kanazaki Trading Co., Ltd., 8, Honcho, Usuki City, Oita Pref. 875-0041, Japan. Tel.: +81-972-62-3212; fax.: +81-972-63-0076. (Source: *Jetro*, July 1998)

D. OCEAN RESEARCH

Down to the summit

Marine scientists are cruising toward their goal of building an observatory at the tip of a massive underwater volcano. More than two dozen researchers recently boarded a University of Washington research vessel bound for the Axial volcano, 400 km off the Oregon coast. Once there, they hope to complete the second phase of the year-old U.S.-Canadian observatory project, which plans to assemble a suite of instruments focused on the geology and biology of the Juan de Fuca Ridge, where microbes and other sea life thrive around sea-floor vents of superheated water.

During 1998 researchers installed the first instruments—including water chemistry and earthquake monitors—at the New Millennium Observatory (NeMO), which sits more than 1,000 m above the sea floor and 1,400 m under the surface. On this year's cruise they plan to drill rock cores and deploy new equipment at the observatory, which has no firm completion date.

Hopes for neat science are high, as NeMO rests on "the most volcanically active site" in the region, says oceanographer Stephen Hammond of the Marine Environmental Laboratory in New Port, OR. To follow the action, check out newport.pmel.noaa.gov/nemo (Source: *Science*, vol. 284, 18 June 1999)

New mariculture technology

Indian scientists have developed a unique multi-crop sea bottom farming technology for cultivating pearls, mussels, finfish and shellfish in shallow waters throughout the year. According to the Indian Council of Agricultural Research (ICAR) sources, scientists at the Centre for Marine Fisheries Research Institute (CMFRI), part of the Vizhinjam Research Centre, have developed this technology for the coastal States.

They said the technology would help to promote marine farming in shallow water areas, including the lagoons of Lak-shadweep and the Andaman and Nicobar Islands, with minimum investment. The special cages designed and developed for this purpose would need an initial investment of Rs 4,000 and could generate an income of Rs 50,000 for the farmers after six to nine months, at the rate of a 25 per cent yield of pearls from oysters.

It is also understood that these cages are like artificial reefs and act as fish-attracting devices. The fishermen would be able to exploit the various species of marine life forms, using the two-in-one trap cages, which also act as substrata for the settlement of pearl oysters. (Source: *TECHMONITOR*, May-June 1999)

First seismic centre on the deep sea floor

Seismologists from the Incorporated Research Institutions for Seismology (IRIS), a consortium of research institutions funded by NSF, are examining earthquake data from the world's first permanent sea floor seismic centre, the Hawaii-2 Observatory (H20). Built by scientists from the University of Hawaii, the H20 seismic system is linked to a junction box built by researchers at the Woods Hole Oceanographic Institution and attached to the retired Hawaii-2 telephone cable five km beneath the surface of the Pacific Ocean midway between Hawaii and California.

Recently, H20's seismographs recorded their first earthquake, a tremor from Papua New Guinea measuring 5.7 on the Richter scale.

Seismic data from H20 is expected to enable researchers to gain a complete picture of seismic events on the Pacific Rim. "Until now, the ocean floor—which comprises most of the surface of the earth's crust—represented a large gap in our available data," said Rhett Butler, global seismic network manager at IRIS. According to Butler, H20 will provide scientists with a previously unavailable way of witnessing seismic events in places such as Hawaii, Alaska and California. (Source: *Sea Technology*, January 1999)

Hand-held sonar displays near photographic images

The Applied Physics Laboratory (APL) of the University of Washington has developed a small imaging sonar that allows a diver or ROV operator to visualize small objects despite zero-visibility conditions. The sonar provides almost-photographic quality images at 12 frames per second. The prototype was sponsored by the Department of the Navy Office of Special Technology (OST) and managed by the Naval Explosive Ordnance Disposal

Technology Division (NAVEODTECHDIV). The sonar is called limpet mine imaging sonar (LIMIS) for its primary function is to search for and identify limpet mines attached to the hulls of ships.

Divers are extremely conscious of size. If it is too large, they will not use it. LIMIS is small—only 7 in. wide, 8 in. high, and 14 in. long (including a 4-in. handle). It weighs 17 pounds in air and is slightly buoyant in water. Sonar images often require a good imagination for the user to determine what is being imaged. Divers do not want to guess the identity of the object, they want the image as clear as possible. LIMIS was designed to allow quick, accurate identification. The acoustic images are converted to NTSC video and displayed on a mask-mounted display. This allows the diver to see an image in zero-visibility water. The mask-mounted display was developed by Dennis Gallagher, Diving and Life Support Division of the Navy Coastal Systems Station, Panama City Beach, FL. Video can also be sent up a cable and viewed/recorded topside. The sonar can record "snapshots". The image frames shown in this article were saved by divers and stored in the sonar. After the dive, the stored frames are transferred to a PC through the COM port.

At present there is only one prototype at the EOD Training and Evaluation Unit Two at Fort Story, VA. A second prototype with 6 dB more transmit power and wider beamwidths in elevation is scheduled for testing in March 1999. APL submitted a proposal to EOD, EODTECHDIV and OST to design and build a dual-frequency version that will detect objects at 60 yards using a 750 kHz operating frequency and automatically switch to 2 MHz for ranges less than 25 ft. This dual-frequency system should also have commercial applications when a larger search area is required.

The two prototypes are hand-made by engineers and instrument makers and cost \$80 million to duplicate one at a time. If there is sufficient military and market interest, APL will find a way to mass-produce the units at a significantly lower cost. (Source: *Sea Technology*, December 1998)

Fish feed from natural gas?

A new high-quality single-cell protein based on natural gas has been developed by Norwegian biochemist Dr. Gunnar Kleppe of Norferm DA. A basic production process has been developed for the "feed" which has been tested for use in Atlantic salmon. The commercial production of this protein is based on the use of a natural methanotropic bacteria which is able to utilize methane as the energy and carbon source in a fermentation process. According to a report in *Scottish Fish Farmer*, the process is carried out by a unique loop reactor, specially developed for the process.

The bacteria, *methylic capsulatus*, normally found in freshwater lakes, is in fact already a part of the food chain. The final product, called "BioProtein", contains around 70 per cent protein of high quality in terms of its amino acid profile. In comparison, it is reported that fish meal has 63.8 per cent protein, soya bean meal 45.8 per cent and skimmed milk powder 36.1 per cent. The percentage of amino acid is

23. According to Dr. Kleppe it also tastes neutral, making it easy to formulate in feed.

Through a very extensive documentation of its nutritional properties as a feed stuff, BioProtein was approved by the EU for use in feed for Atlantic salmon and domestic animals in 1995 and feeding trials with salmon have been conducted. The trials show that BioProtein performs very well as a salmon feed up to an inclusion level of 25 per cent of the total dietary amino acids resulting in improved feed conversion rates.

Norferm believes there is a market for such a product and plans to begin commercial production this year, producing around 10,000 mt and increasing to 40,000, once the product is proven in the marketplace and a bigger plant is built. The company also believes BioProtein to have acceptable digestibility and palatability in inclusion volumes up to 50 per cent of the total protein. It is a stable product with no seasonal variations and can be produced in unlimited quantities. (Source: *INFOFISH International*, June 1998).

Mussel proteins inhibit bacterial growth

The observation, that mussels live in heavily polluted waters where most fauna and flora do not survive, made by Swedish researcher Johan de Faire in the mid-1980s has led to some interesting discoveries on the ability of mussels to act as a "disinfectant". Subsequent studies have shown that mussels have a substance which seems to inactivate microorganisms, by putting them into a deep "sleep". With this new discovery, the Swedish marine biology company MAP AB who has the Swedish Institute for Food and Biotechnology (SIK) to support its research, is on the threshold of almost incredible potential in terms of areas of application for mussels.

Bjorn Strandwitz, Managing Director of MAP AB is hoping to start manufacturing the first commercial MAP product within a year, in a factory in the Lysekil area, where there are plenty of mussel farms. Initially, the product will be tested in greenhouses and fish farms to keep the bacterial concentrations under check.

Initial production will use mussels rejected for consumption due to damage or size. Pending the construction of the factory, a pilot version has been set up at SIK. Different production methods have given different results from very high anti-microbial activity to cases where the growth of bacteria was promoted rather than inhibited. This is explained by the fact that some extracts are in fact bacterial stimulants. Studies so far have completely inactivated bacteria such as *Listeria seeligeri*, *Bacillus pumilus* and *E. coli*. Yeasts, viruses and moulds have not been tested yet. (Source: *INFOFISH International*, May 1998)

Unique thermostable enzymes in hydrothermal vent worm

Diversa Corp. (San Diego, CA) has discovered unique, thermostable enzymes located in the symbiotic bacteria associated with the Pompeii hydrothermal vent worm (*Alvinella pompejana*). Scientists at Diversa, the University of Delaware, and Rutgers University reported data showing the Pompeii worm to be the most eurythermal (thriving in all

temperatures) organism and thermotolerant metazoan yet discovered. Some of the symbiotic bacteria residing on the worm appear to be closely related to a human pathogenic bacterium called *Helicobacter*, known to cause ulcers in humans. Study of these bacteria could lead to the development of more effective pharmaceuticals. In an effort to determine what enables the Pompeii worm and its associated microflora to survive at such extreme conditions, Diversa has created DNA libraries and sequenced and screened thousands of clones from the symbiont samples.

Diversa went 1.5 miles deep to locate unique enzymes with utility in commercial processes and pharmaceutical development. One of the most intriguing enzymes discovered from these micro-organisms is an esterase capable of functioning throughout a range of temperature conditions including a high temperature capability reaching up to 176° F. The organism can survive with a 140° F-temperature range in its body at one particular time.

The symbiotic proteobacteria, which survive along the dorsal surface of the animal, are unique in their ability to survive in this extreme environment. Diversa is studying the enzymes of these symbionts because of their high activity over extended temperature ranges, making them potentially useful as biocatalysts. Heat-tolerant enzymes offer endless biocatalyst possibilities for the advancement of textile, detergent, and other industrial processes worldwide. But it is the potential to increase knowledge in the health care arena that is of great interest.

Diversa believes that the enzymes of the Pompeii worm and its symbionts may provide clues as to how these organisms can survive in such an extreme environment. It will be useful to see how a bacteria with known pathogenic relatives can co-exist with a higher organism like the Pompeii worm. (Source: *Sea Technology*, May 1998)

ODP pursues history of Antarctic ice sheet

The Ocean Drilling Program (ODP) is conducting a two-month expedition near the edge of the Antarctic continent, the first of a series to probe the historical development of the Antarctic ice sheet and its consequences for the Earth's climate.

The Antarctic ice sheet, the world's largest, is 35 million years old and has waxed and waned through glacial cycles compared to the ice sheets in the Northern Hemisphere which are relatively young (about 3 million years old). The waxing and waning of the Northern Hemisphere ice sheets changed sea levels by about 110 m. ODP programme results show that these ice sheets are very sensitive to climate change. The expedition should help to answer the question as to how sensitive is the Antarctic ice sheet.

Ice sheets grow from an accumulation of snow. Growth is balanced by drainage—by rapid ice flow in narrow channels. Here the ice is not frozen to the underlying rock, but is lubricated by unsorted wet sediment called till. The till is carried by the ice streams to the ice sheet edge and deposited there as the ice breaks off. Till deposits on the Antarctic margin contain a record of past behaviour of the ice sheet. (Source: *Sea Technology*, May 1998)

Licensing agreement signed for development of discodermolide

Harbor Branch Oceanographic Institution (HBOI) Inc., Fort Pierce, FL, has entered into an agreement to license its marine-derived, anti-cancer agent, discodermolide, to Novartis Pharma Ag., Basel, Switzerland, on an exclusive worldwide basis.

Discodermolide is an anti-cancer compound derived from the marine sponge, *Discodermia dissoluta*, first collected in 1987 by Dr. Shirley A. Pomponi, Director of HBOI's Division of Biomedical Marine Research. The compound was isolated from the sponge and characterized by Dr. Sarath P. Gunasekera and Dr. Ross E. Longley at HBOI in 1990. Subsequent studies by the HBOI team and collaborators revealed the compound to be a potent, anti-tumour agent that is effective in killing human cancer cells *in vitro* with a mechanism of action similar to that of the clinical anti-cancer agent Taxol. (Source: *Sea Technology*, June 1998).

Newly discovered molecule will aid cell study

Researchers at the University of California/San Diego have discovered a new inhibitor molecule derived from a species of Pacific Ocean sponge called *Haliclona* (also known as *Adocia*). The molecule, called *adociasulfate-2* (AS-2), is the first inhibitor molecule to target kinesins, a family of proteins that play a crucial role in intracellular transport and cell division. In addition to helping biologists better understand how cells divide and move materials, AS-2 may also lead to improved cancer drugs.

The discovery, funded in part by California Sea Grant, is published in the 10 April 1998 issue of the journal *Science* and is one of the latest in the rapid emerging field of marine biomedicine.

According to John Faulkner, California Sea Grant researcher and co-author of the paper, scientists study marine sponges because of their natural chemical protection.

While scientists know that kinesins move chromosomes into new cells during cell division, much of the process is poorly understood. Inhibitor molecules, such as AS-2, are valuable because of their ability to stop the cell division at various points, allowing scientists to study the process in detail. The researchers hope to better assess the clinical possibilities of AS-2 once they develop a more detailed understanding of the compound's mechanism of action. (Source: *Sea Technology*, June 1998)

Ocean Drilling Program extends global network to deep oceans

The global network of on-land seismic stations provides sufficient earthquake monitoring capabilities for large parts of the Earth's surface in continental regions and some islands. However, oceanic regions that cover approximately 70 per cent of the Earth's surface remain largely unmonitored, creating large "holes" in the worldwide data coverage for low magnitude earthquakes and for the Earth's deep interior. Scientists with the Ocean Drilling Program (ODP) will install one of many planned geophysical ocean bottom observatories (GOBO).

Representing seven countries, scientists aboard the *JOIDES Resolution* will drill into the oceanic basement of the Indian Ocean, a region of the world where there is a lack of ocean-bottom seismograph stations. The drill hole will be located on the Ninetyeast Ridge between India and Australia. In addition to this installation, a series of seismic experiments involving the drill ship, as well as the German research vessel *Sonne*, are also planned to completely characterize the site.

Earthquakes, which are the results of sudden and rapid movements along faults, can be detected by seismographs. These movements are associated with the motion of seismic waves which can be detected by seismograph stations even when the sources of these waves occur at great distances from the stations. Data collected from the network of existing seismic stations can be studied by geologists and provide remarkable seismic tomographic images.

A global network of on-land seismic stations called the Worldwide Standard Seismograph Network, used for monitoring earthquake activity, was established in 1962. Seismic data from this network accelerated advances in seismology and were a great source of new discoveries up to the 1970s. These discoveries enabled seismologists to understand the distribution and patterns of moderate to strong earthquakes in the regions of the world that were subject to significant earthquake risk. (Source: *Sea Technology*, June 1998).

Methane hydrate research—energy resources for the future

Recent photographs of large rocks burning on the deck of an oceanographic research vessel have spurred renewed interest in these fascinating and ubiquitous minerals consisting of frozen crystals of methane gas. Recent claims that the global resources of methane hydrates may contain more than twice the recoverable energy of all other fossil fuel resources combined have raised them from the status of nuisance to a potentially important source of energy for the future.

Appropriately, a bill proposed to US Congress provides for the awards of grants, contracts, or cooperative agreements coordinated by the Secretaries of Energy, Defense and Interior, the latter two acting through the Navy and the Geological Survey. The work proposed will include basic and applied research to identify, explore, assess and develop methane hydrates as a source of energy; technologies required for efficient and environmentally sound development of methane hydrate resources; research to provide safe means of transport and storage of production; education and training in hydrate research and resource development; basic and applied research to assess and mitigate the environmental impacts of hydrate degassing, both natural and associated with commercial development; and technologies to reduce the risks of drilling through methane hydrates.

In the US, extensive deposits have been noted in the Arctic seas, on the Blake Plateau, and in the Gulf of Mexico. Those in the Gulf are not distinguishable by standard reflection methods that depend on the recognition of a bottom simulating reflector but are nevertheless prolific, if unstable. In the deep oceans, hydrates have been recovered

from a number of cores from the Ocean Drilling Project and the extent and thickness of the deposits have been greater than expected. The instability of near-surface hydrates in the Gulf has presented a cause for concern for those companies engaged in deep drilling for oil. Sudden change of phase can result in massive discharges of gas or can cause landslides on steep slopes.

Both India and Japan have initiated substantial research and development work on the nature and potential development of methane hydrates in their EEZs. (Source: *Sea Technology*, June 1998)

MIT laser sheds light on pollution

Massachusetts Institute of Technology (MIT) Sea Grant researchers have developed a new pollution-detecting tool that may help state and federal regulators identify and quantify which organic materials in the Boston Harbour are detrimental to the ecosystem.

Conventional fluorescence spectroscopy instruments can measure PAHs in water, but the signal becomes swamped by natural dissolved organic matter. This new instrument is able to separate the signals of the organic materials from those of PAHs.

Besides providing more precise measurements, the new instrument is also easy to deploy. The tip of the spectrofluorometer mounts on the chassis of a conventional CTD.

The new tool is a portable, fibre-optic spectrofluorometer that guides a laser beam into the water. When hit with the laser, harmful organic compounds such as polycyclic aromatic hydrocarbons (PAHs) absorb specific wavelengths of the light and fluoresce them back. The more fluorescence detected, the more pollution in the water. In the future, Robert Chen and his fellow colleagues from the University of Massachusetts (Boston) will be collaborating with MIT scientists to miniaturize the spectrofluorometer and fit it onto an AUV that could traverse Boston Harbour and other estuaries surveying for pollution. (Source: *Sea Technology*, June 1998)

Ocean jigsaw nears completion at conference

At a unique Ocean Circulation and Climate Conference in Canada more than 360 scientists from all over the world marked a new phase in a research programme linking changes in the ocean to changes in the atmosphere. When finished they will have put together the pieces of the ocean jigsaw puzzle revealing a complex global picture of how the oceans affect the Earth's climate. The researchers are part of the World Ocean Circulation Experiment (WOCE)—an unprecedented collaboration to measure and model the contribution of the oceans and their currents to the global climate system.

During the past eight years, researchers from 30 nations have used satellites, research ships, and new robotic instruments to collect data from all over the world's oceans. This conference marked the completion of the first ever global survey of the ocean's circulation.

The Kyoto Conference in 1997 served to highlight the need for greater understanding of the many complex factors that affect climate. The oceans represent a major component in the climate equation and the WOCE data will be used to

develop, test, and improve predictive models of ocean circulation. (Source: *Sea Technology*, September 1998)

Active sulphide chimneys retrieved for first time

The University of Washington (Seattle) and the American Museum of Natural History (New York) have announced that actively forming sulphide chimneys—informally known as “black smokers”—have been raised for the first time from the depths of the ocean complete with the extraordinary microbial communities that live in their interiors. Sulphide chimneys are fascinating because they harbour exotic life forms far below the reach of sunlight, in the most extreme environments in which living things can exist.

Sulphide chimneys are remarkable tower-like structures that grow where hot water flows from the sea floor in areas where new oceanic crust is being created by the forces of plate tectonics. These regions, known as mid-ocean ridges, are in effect a 50,000-mile long chain of volcanoes on the ocean floor. These ridges act as a gigantic heat engine that drives the circulation of water through the ocean crust. That water dissolves minerals in the crust and deposits them when it re-emerges into the cold ocean water, eventually forming the sulphide chimneys.

The black smokers were retrieved by the expedition team from a depth of more than one mile beneath the surface of the ocean, from the Juan De Fuca Ridge, approximately 180 miles off the coast of Washington and British Columbia.

While small sulphide structures have been recovered in the past, no one had ever before attempted to raise a large, actively growing structure. On this expedition, scientists were able to raise four 5-foot chimneys, ranging in weight from 1,200 to more than 4,000 pounds. (Source: *Sea Technology*, September 1998)

SubSea International sets new depth record

A SubSea International Inc. (Houston, TX) spokesperson reported the company has broken its own previously recorded ROV depth record. The feat was accomplished by completing a successful dive to 16,405 ft during sea trials in the Cayman Trench in the Caribbean. The dive was recorded by SubSea's Hammerhead ROV, a 150-horsepower, advanced work-class vehicle designed, built, and operated by SubSea.

The firm currently operates two Hammerhead vehicles that are semi-permanently maintained aboard the 197-ft dive support vessel *Cambridge Service* and are available to support demanding deep water construction and remote intervention activity through the Americas region. The Hammerhead's extremely high payload of 2,000 pounds, on-board navigation system, and computer diagnosis make it one of the world's premier ultra deep water ROVs. (Source: *Sea Technology*, September 1998)

Study finds group of marine bacteria off US

Georgia Sea Grant researchers Mary Ann Moran and Jose Gonzalez have discovered that as much as 30 per cent of the bacteria in the salty near-shore waters and estuaries of the Georgia coast belong to a single group named marine

alpha bacteria which could have a future industry application.

“Right now, an important goal in marine microbiology is understanding the connection between the structure of bacterial communities and their ecological function”, said Moran. “We are studying a group of bacteria that are closely related but which may be very diverse functionally.”

With funding from Georgia Sea Grant and the NSF, researchers designed a “probe” to seek out the 16S ribosomal RNA (rRNA) gene of marine alpha bacteria in sea water. The genes coding for rRNA are an essential component of the genetic material of all bacteria, but they vary enough to give each species a unique name tag. The researchers used the key rRNA gene to quantify just how abundant the marine alpha bacteria may be.

To ensure that the probe was correctly targeting marine alpha bacteria, the researchers used a technique called polymerase chain reaction (PCR) to greatly amplify the genetic sequences of the 16S rRNA genes. Researchers at the same time successfully cultured the bacteria in low-nutrient sea water agar medium. The PCR technique confirmed their preliminary results.

The researchers plan to continue to study the bacteria to better understand their role in the marine ecosystem as well as their potential industrial applications. (Source: *Sea Technology*, July 1998)

Surprising picture emerges of sub-sea floor magma formation

For the first time, seismologists have captured detailed images of the deep underground processes that give birth to most of the planet's new surface along the mid-ocean ridges where the sea floor pulls apart. Some of the underground patterns confirm predictions. Others are a surprise. The new data is major for understanding crust formation, convection in the planet's interior, and the source of the most abundant volcanic activity on Earth. Funded by the National Science Foundation (NSF), the \$7 million project is called the mantle electromagnetic and tomography experiment, also known as MELT. One of the largest marine geophysical experiments ever conducted, its main goal is to find where magma is formed and how it moves to the ridge crest to form new oceanic crust.

In a recent issue of *Science*, geophysicists from Brown University and six other institutions report that melting rock flows up in a broad zone in the Earth's upper mantle rather than in the narrower plume that some researchers had predicted. Under the separating sea floor, magma starts forming nearly twice as deep as scientists had expected and, surprisingly, wells up slightly off centre, not directly beneath the ridge where most of the magma eventually erupts and cools to form new oceanic crust.

The results show that melt is generated over a much larger region than many scientists had expected. Some of the surprising observations may lead to the development of a new generation of models of mantle flow and magma generation beneath mid-ocean ridges. Scientists have debated mantle activity and it turns out that their predictions were at least partly wrong. One model described a broad, shallow region of passive up welling and a second model

predicted a narrow, shallow, and active upwelling zone. Neither model predicted the asymmetry of the upwelling magma or the depth at which melting occurs. (Source: *Sea Technology*, July 1998)

Evidence of further global warming

National Science Foundation-funded climatologists have reconstructed global temperature over the past 600 years and determined that 1997, 1995, and 1990 were the warmest years since at least 1400 A.D. The study, conducted by Michael Mann and Raymond Bradley of the University of Massachusetts at Amherst, along with University of Arizona colleague Malcolm Hughes, is detailed in the July issue of the journal *Nature*.

The researchers were able to estimate temperatures over more than half the surface of the globe, pinpointing northern hemisphere yearly temperatures to a fraction of a degree back to 1400 A.D. The study places in a new context the long-standing controversy over the relative roles of human and natural changes in the climate of past centuries. Scientists were particularly interested in natural "forcings", that is, factors that can affect climate significantly, but which are not part of the climate system itself. Based on statistical comparisons of reconstructed northern hemisphere temperatures, the best estimates indicate that natural changes in the brightness of the sun and volcanic emissions both played an important role in governing climate variations over the period studied.

Climatologists are also concerned about the degrees of uncertainty surrounding increased or accelerated global warming. (Source: *Sea Technology*, July 1998)

High-performance system for removing marine organisms

Kuribayashi & Co., Ltd. has developed a high-performance system for removing marine organisms (shell removing system). The floating system can remove marine organisms even from the curved surfaces of walls.

A wire is fixed in position at the tip of a flight, and scrapers mounted vertically on the upward and downward moving flights. The flight, wire and scrapers are assembled in a unit construction, so revolving the flight shaft causes the scrapers to come into contact with the wall surfaces to enable cleaning and shell removal reliably and with ease.

The wire fixed on the flight tip has an appropriate elasticity, to enable the scrapers to come into contact uniformly on the wall surfaces to perform cleaning and shell removal operations most efficiently. The scraper material is changeable depending on the wall material. At the central part of the system is a jet water outlet and a propeller-type thruster. The system bottoming and lateral shift speeds are adjusted by changing the angle of the propeller type thruster, and since the shell removing system minimizes underwater operations, various conventional problems are resolved (shortening of project schedules, reduction of costs, etc.).

In addition, since the flight is of the extendable type, the number of flights can be adjusted and changed in conformance with the water depth where the system will be used. The system, in addition to wall cleaning can be used for special types of cleaning and shell removal operations by

placing an oil fence or a shielding fence between the left and right flights and cleaning the hulls of ships. The system can remove marine organisms from inlet channels and quay walls of atomic power plants and thermal power plants. Further details from Kuribayashi & Co., Ltd., International Trading Team, 2-13-16, Motonakano-cho, Tomakomai City, Hokkaido 053-0005, Japan. Tel.: (+81) 144-32-5161; fax: (+81) 144-36-6839, e-mail: kuri_col@ains.tomakomai.or.jp (Source: *JETRO*, December 1998)

The research vessel MIRAI—ocean observations and research on a global scale targeted for the 21st century

The new oceanographic research vessel MIRAI is equipped with many high-accuracy observation tools and equipment, and will engage in marine meteorological and oceanic observations and research on global scales for extended periods. MIRAI, with its exceptionally large size and its anti-rolling device of special design, is capable of undertaking observation missions at high latitudes and polar regions exposed to the extremely severe meteorological conditions that have until now prevented the adequate assembly of this much needed data for climate change research. MIRAI is also equipped to deploy a batch of ocean observation buoys for the TRITON array, another feature not possessed by conventional oceanographic research vessels.

Samples and data gathered on board the MIRAI can be processed and analysed immediately at the various shipboard laboratories. Also, through the shipboard data management system, the data can be communicated without delay between the shipboard laboratories or linked via satellite with other laboratories on land. The researchers can subsequently work in a similar environment as in laboratories on land.

The Japan Marine Science and Technology Center (JAMSTEC) will operate MIRAI beginning in the autumn of 1998 in a collaboration between international organizations and foreign institutions. JAMSTEC expects many marine research organizations and institutions throughout the world to utilize the MIRAI. Since MIRAI means "future" in Japanese, it will represent the future in ocean research. It will be a comfortable and functional platform for the world's scientists to jointly conduct their research and establish cultural bridges. In this paper, these functions and capabilities of MIRAI are introduced and the principle for the operation is described. By making use of the functions introduced in the following sections, MIRAI will be operated to perform the following missions:

- Deployment, maintenance and recovery of the ocean observation buoys for TRITON and TAO;
- Contribution for the international observations of worldwide scale considering the collaboration under the bi/multi-international framework for ocean science to elucidate and predict the ocean phenomena;
- Acquisition of data where there is a present shortage because of rough seas and in the Arctic Ocean; and
- Observations to obtain large quantities and high precision data and samples, and quick and accurate on-board analysis.

(Source: *Marine Technology Society Journal*, 31(4):8-15, windows 1997.)

New ultra-water-repellent material

Mitsui Engineering & Ship-building Co., Ltd. has developed an ultra-water-repellent material, and succeeded in a basic study on a completely new technique to significantly improve the propulsive performance of ships by using this material to reduce their frictional drag by 50 per cent or even more. This study is covered by a grant-in-aid from the technological development fund managed by the Ship & Ocean Foundation with the financial assistance of the Nippon Foundation and funds derived from proceeds of motorboat racing.

Any conventional water-repellent material cannot form a surface that is completely free from wetting in water. The surface coated with a water-repellent paint using the ultra-water-repellent material developed by MES can form, when immersed in water, a thin air film over the surface to keep the surface completely free from wetting. The technique forms a thin air film over the surface of the hull bottom by letting a small quantity of air flow from the bow section, thereby reducing frictional drag.

Drags exerted against the propulsive force of a ship can be generally broken down into a wave-making drag consisting in the generation of waves from the hull, an eddy making resistance and a frictional drag due to the contact between the hull and water. Out of these drags, the frictional drag accounts for more than 80 per cent of the total drags for low-speed squat hull forms typical of tankers, or nearly 70 per cent for non-tanker cargo ships. How to reduce this frictional drag poses a major technical challenge. For this reason, many different methods have been tried to reduce frictional drag, and those previously proposed and studied include a riblet method, a polymer blow-in method and a micro-bubble method, but none proved useful for practical purposes because more energy is consumed than the reduction in drag.

Of these previous attempts, the micro-bubble method, which is similar to the technique recently developed by MES, involves the problems of requiring a large quantity of energy to generate sufficient micro-bubbles and the tendency of the generated bubbles to disperse away from the hull surface. The recently developed water-repellent surface, because of the air film that is formed, serves to reduce the needed air supply substantially, and consumes much less power to supply air.

In addition, NO_x and SO_x emissions from the ship engines in maritime transport are claimed to account for 7 and 4 per cent respectively of the total world NO_x and SO_x contaminants, which is posing an increasingly serious problem. Development of an effective method to reduce the drag of ships is called for not only to improve the operational economy of fleets but also to protect the environment and conserve energy.

MES has carried out tests on pressure losses in rectangular pipes and resistances on flat plates using this technique, and confirmed that the frictional drag can be reduced by about 50 per cent in the speed range of around 15 knots (about 28 km/H), the actual service speed range for tankers. It has been further found that the fractional drag can

be reduced by 80 per cent or more in the low speed range of below 7 knots or by almost 40 per cent in the high speed range of around 20 knots. If this method is applied only to the bottom of a tanker, the frictional drag, which accounts for some 80 per cent of the total drag, can be reduced by one quarter. In other words, the total drag is reduced by about 20 per cent, because the bottom area represents half of the whole water-immersed area, though the proportion may vary according to the way cargo is stowed. The energy consumed to supply the air needed for the purpose is one tenth or less of the propulsive power saving achieved by the drag reduction.

MES will undertake research for practical use of this technique with a view to its commercial application at an early opportunity.

For further information: Technical Coordination Department, Technical Headquarters, Mitsui Engineering & Shipbuilding Co., Ltd., 6-4, Tsukiji 5-chome, Chuo-ku, Tokyo, Japan. Tel.: (+81) 3-3544-3246; fax: (+81) 3-3544-3033. (Source: *Science & Technology in Japan*)

Wireless in water

Video pictures and high-speed data can be sent through the murky depths of the North Sea—using sound waves instead of cables.

The system, inspired by dolphins and the Internet, has been developed by researchers from Newcastle University to allow remotely operated undersea craft to inspect and maintain oil rigs. It could also be used to hunt for shipwrecks or mines, or prospect for new oil and gas fields. It uses the frequency band preferred by dolphins to transmit data coded in much the same way as the modems that squeeze extra data capacity out of phone lines.

Only very low-frequency radio waves can travel through water, and their long wave-length limits data capacity to a few bits of digital information per second. This is the method used by nuclear submarines, which may spend many months submerged. Blue-green lasers can penetrate 100 m of clear water, but in the murky waters of the North Sea this falls to a few metres.

So far, animals have done better than humans at communicating in water. Whales keep in touch over very long distances using low-frequency sound waves, while dolphins use higher-frequency sounds. Attempts to use sound waves to carry digital data have failed, however, because such waves are easily corrupted by random reflections from the sea floor, surface waves or underwater objects. These make the signal power fluctuate, randomly adding or removing data bits.

But after eight years of research, the Department of Electrical and Electronic Engineering at Newcastle University claims it can now send data through several kilometres of seawater at up to 16 kilobits per second.

Previous attempts to make this kind of technology work have used ultrasound. Such high frequencies are directional, so the transmitter and receiver must be kept in alignment, which is difficult when the underwater vehicle and the boat on the surface are out in the open sea. The Doppler shift, caused by the relative movement of the tow craft, corrupts the data, as do the echoes caused by spurious reflections.

Instead, the new system uses relatively low frequencies, between 10 and 20 kilohertz. These are omnidirectional, so alignment is not necessary. A high data rate is squeezed from the low frequency by modulating a 15-kilohertz carrier wave using a technique called phase shift keying, the same method the latest modems use to send data along conventional phone lines at high speed. The carrier is switched through four states, and the pattern of switching conveys the data bits.

The system also uses "diversity reception", in which several receivers are arranged in a ring. Each picks up the sound signal from a different angle, which means that even if the sound reaching some receivers is weak, others pick up stronger signals.

The data stream includes reference markers that let the receiver identify the strongest and cleanest signal, and strip out distortion caused by echoes and by the Doppler shift—significant because the speed of sound is so low.

The Newcastle team recently tested the system in the Royal Quay docks on Tyneside and is now confident enough to try it out in the North Sea. (Source: *New Scientist*, 27 June 1998).

Tainted catch

A simple test for toxins in fish may be a step closer now that researchers have pinned down the structure of a compound responsible for food poisoning in the Caribbean. A test could help poor economies by allowing fishermen to catch fish from toxin "hot spots" they have avoided up till now.

Ciguatera is an illness that affects up to 50,000 people worldwide every year, including around 20,000 in the Caribbean. It is caused by ciguatoxins, compounds produced by dinoflagellate algae. These toxins have been found in the tissues of over 400 species of coral reef fish. Cooking does not break down the toxins, and affected fish taste normal.

Symptoms of ciguatera include nausea, vomiting and neurological effects such as temperature sensory reversal, where cold is perceived as hot and vice versa. The symptoms can persist for months, and around 1 per cent of cases are fatal, usually through respiratory paralysis. In the US, ciguatera is the most frequently reported food-borne illness associated with a natural poison. The problem is so common in the seas near Puerto Rico that the country imports 85 per cent of its fish.

Richard Lewis of the University of Queensland in Brisbane and Jean-Paul Vernoux of the University of Caen in France extracted ciguatoxins from the horse-eye jack, *Caranx latus*, from the Caribbean. Using nuclear-magnetic resonance, they worked out the structure of the main ciguatoxin molecule.

The structure of the main ciguatoxin in fish from the Pacific is already known. "The structure of ciguatoxin in the Pacific is the same between Japan, Hawaii and Polynesia," says Vernoux. But to his surprise, the Caribbean structure turned out to be different. Vernoux speculates that the micro-organism producing the toxin in the Caribbean may be a different strain to that in the Pacific.

There is no quick and easy way to test for ciguatoxins in fish. But now that scientists know the structure of the

Caribbean toxin, they may be able to find antibodies that would bind to it and betray its presence in a simple field test kit.

Antibodies that recognize Pacific ciguatoxins are available, but they can react with other compounds as well.

A simple test could allow fishermen to return to the sites of ciguatera outbreaks, as the problem may be transient. Pollution, fishing with dynamite and military activity may also spread ciguatera to new areas, as the dinoflagellates responsible are early colonists of reef surfaces cleared by disturbance. (Source: *New Scientist*, 18 July 1998)

Sounding out

The US Office of Naval Research (ONR) wants to continue the once controversial Acoustic Thermometry of Ocean Climate (ATOC) project, which measures sea temperatures by clocking underwater sound pulses.

In 1994, activists stalled the installation of ATOC emitters off California and Hawaii, worrying that the pulses would deafen whales; that fear proved unfounded. But ATOC's \$40 million seed grant ran out last year and the California station is being dismantled. However, ONR signalled its desire to keep the Hawaii source running for at least a few more years, saying it will sponsor an environmental study necessary for obtaining new operating permits. (Source: *Science*, vol. 284, 25 June 1999)

How to beat corrosion bacteria

Bacteria growing in bilge water can eat through the steel hull of a ship in a matter of months. But a team based in Wales has now devised a simple method of detecting and killing the corrosive bugs.

Ships regularly empty their bilges at sea, but are not allowed to do so within 3 miles of land because bilge water often contains oil and other pollutants. Instead, inshore vessels such as tugs have to pump bilge water into tankers for specialist treatment. This is expensive and time-consuming, so crews tend to let bilge water accumulate—providing ideal conditions for ship-eating bacteria.

Aerobic bacteria use up all the oxygen in bilge water, paving the way for anaerobic sulphate-reducing bacteria (SRBs) such as *Desulfovibrio desulfuricans*. These bugs convert the sulphates in sea water into corrosive sulphides that attack metal. Left to themselves, the microbes form a sludge that can eat through 10 mm steel plate in a year.

Edward Hill of Echa Microbiology in Cardiff and his son Graham have invented a simple test to detect the sulphate-reducing bacteria. All a deck hand has to do is pour a sample of bilge water into a glass bottle containing a suitable growth medium for SRBs. Ferrous salts in the medium turn black overnight if there are large numbers of sulphide-producing SRBs in the sample.

If found, the bugs could be killed with disinfectants such as bleach, but that means the water has to be detoxified afterwards. Instead, the Hills have come up with a way of knocking out the SRBs by wrecking their metabolism. The treatment uses a chemical to block the flow of electrons in the anaerobic respiration of the SRBs. This effectively

unplugs the power source that drives the bacteria, and they die off. As this specifically targets the sulphate-reducing microbes, there is less risk of environmental damage.

Double-hulled oil tankers may be particularly at risk, as some warmth-loving bacteria thrive in the insulated space between the two hulls. (Source: *New Scientist*, 10 October 1998)

As large as life

Scottish researchers working a kilometre beneath the surface of the North Atlantic have recovered what they believe to be the largest single-celled organism ever seen. The sponge-like protozoan, a xenophyophore of the species *Syringammina fragilissima*, is 10 cm in diameter and was brought to the surface during a research trip near Rockall in July 1998 by the Scottish Association for Marine Science in Oban.

As its name suggests, *S. fragilissima* is extremely delicate and disintegrates if vibrated. The recovered specimen is being examined by a xenophyophore expert, Andrew Gooday of the Southampton Oceanography Centre. (Source: *New Scientist*, 24 October 1998)

Ocean drilling floats ambitious plans for growth

For 15 years, a vessel that looks like a cross between a freighter and an oil derrick has been roaming the oceans, boring holes in sea floor sediments and crust. Its team of roughnecks and scientists has sampled ancient muds beneath the ice-infested waters of Antarctica and rocky crust off the Galapagos Islands. However, some of the most tempting scientific targets on the ocean floor, including unstable sediments, oil- and gas-rich regions, and the deepest reaches of the crust, have been off limits to the *JOIDES Resolution* and the Ocean Drilling Program (ODP), the 22-nation scientific consortium that operates it. Next year, Japan hopes to begin building a \$350 million drill ship that could open up these forbidden zones. But researchers do not know if their Governments will be willing to spend the extra money needed to operated that country's generous gift to the ocean drilling community.

Japan's plans, expected to be approved early next year by the Diet, call for up to \$40 million to start construction of a ship equipped with a riser that extends from the ship to the sea floor. Risers, which are standard on deep-sea oil platforms, allow drillers to flush heavy debris from deep holes and shore up unstable sediments. They also help provide a safeguard against blowouts when the bit penetrates oil or gas deposits. Japan intends to fund the building of the ship, which should be completed by 2003, just when the ODP's lease on the *JOIDES Resolution* will end. The timing seems perfect, and many ocean drillers would welcome the riser ship's capabilities.

Although the ocean drilling community identified the need for a riser in the early 1990s, the original idea was to lease such a ship from the oil industry as needed. But then the Japanese Government, in particular its Science and Technology Agency (STA), stepped into the picture. STA's Marine Science and Technology Center (JAMSTEC), which is overseeing the design and construction of the vessel, saw a riser ship both as a key component of an increasing

emphasis on basic research and as a project that might have technological spin-offs for Japan's shipbuilding industry.

Scientists are already thinking up missions for the riser ship. JAMSTEC, for example, has sponsored workshops on its scientific objectives, and a mission to study the ocean floor just east of Japan has received priority. There drilling would approach its depth limits to penetrate a fault that generates large earthquakes off Japan. Kinoshita says this target will also allow officials to keep a close eye on the vessel during its shakedown cruises.

The riser ship could also enable marine geophysicists to reach a long-sought goal: the Mohorovičić discontinuity, or Moho, the presumed boundary between the crust and the mantle. Although seismic waves bounce off the Moho, geophysicists are not sure whether it is the boundary between the crust and the underlying mantle, an intrusion of rock into either layer, or something else.

Although the initial funds for the riser driller are included in next year's JAMSTEC budget, completion of the ship will depend on continuing appropriations over the next five years.

The bigger problem will be finding money to keep it at sea. At an estimated \$85 million a year, the riser ship would be expensive to operate on its own. (Source: *Science*, vol. 282, 13 November 1998) www.sciencemag.org

The big break

Today, the prospects for wave power have never looked better. For the first time, independent analysts reckon that the electricity it could produce will cost less than that from new nuclear and coal-fired stations.

At least 15 wave power generators are planned across the globe: nine in Europe, four in the Far East, one in the US and one in India. Eight of them should be producing energy in 1999. All are robust, realistic designs, shaped by years of trial and error. Five of them are backed by private investors. Public funds are also pouring in. The European Union (EU), which has already put 2 million ecus into a wave generator in the Azores, is about to invest more—perhaps as much again. The Danish Government, which invested early in wind power and opened the way for Danish companies to dominate what is now a fast-growing market, has committed £3.6 million to wave power over the next three years.

Tom Thorpe, an international expert on wave power, thinks it could eventually supply more than 10 per cent of the world's electricity and help to solve shortages of drinking water by desalinating seawater. "These uses represent a potential market in excess of £100 billion", he says.

Thorpe, the British Government's main adviser on wave power since 1989, estimates that waves in British waters could be tapped for 10,000 megawatts of electricity, more than 20 per cent of its needs. Waves in waters off the Irish Republic could generate nearly 75 per cent of its electricity, he says. Enticed by this prospect, researchers in Britain have been in the vanguard of wave power research since the oil crisis in 1973. For much of that time, they have had to work without help from Government. The British Government withdrew most of its funding in 1982. Nevertheless, teams in Edinburgh, Inverness and Belfast scraped together enough money from universities, industry

and EU to continue their research. They are now trying to push the technology to the point of commercial reality.

The teams' progress has been such that the British Government could now be about to change its mind. The Scottish Office has already taken the lead by saying that it will consider wave power plants under its scheme for encouraging renewable energy, the Scottish Renewables Obligation. This, says Thomson, is "a tremendous step forward. Wave energy is already economically competitive in niche markets", he concluded, "and has good prospects of being commercially competitive with further research and development." (Source: *New Scientist*, 3 October 1998) www.newscientists.com

Short-term bets

- The Limpet, a 500-kilowatt oscillating water column (OWC) device from Queen's University of Belfast and Applied Research & Technology in Inverness, is due to be installed on the shore of Islay, Scotland, next year.
 - A 500-kilowatt OWC device developed by the Technical Institute in Lisbon and the University of Edinburgh is due to be installed on the shore of Pico in the Azores later this month.
 - WPT-375, a 375-kilowatt "bending spine" generator developed by Richard Yemm, an Edinburgh engineer, is planned for Islay in Scotland next year.
 - The McCabe Wave Pump, a 140-kilowatt pontoon device developed by Peter McCabe of Hydam Technology in Killarney, Ireland, is due to be tested off the southwest coast of Ireland next year.
 - Ten 30-kilowatt IPS buoys, built by the Swedish firm Technocean are due to be moored off the Greek island of Amorgos next year.
 - Osprey is a 2-megawatt OWC device developed by Applied Research & Technology planned for the sea off Kilkee on the west coast of Ireland next year.
 - The Mighty Whale, a 110-kilowatt OWC device developed by the Japanese Marine Science and Technology Centre in Yokohama, is being tested in Goyasho Bay, south of Nagoya in central Japan
 - A 100-kilowatt OWC generator, developed by the Chinese Academy of Sciences, is being installed on the south coast of China at Zhelang near Hong Kong
- (Source: *New Scientist*, 3 October 1998)

Sensing the sea without breaking the bank

Innovative tools at relatively low cost are surfacing throughout the US, as researchers develop technology that their colleagues elsewhere can adapt and use.

One example of oceanography on the cheap is the \$5,000 "OsmaAnalyzer", a compact device that, from a buoy, measures concentrations of dissolved nitrate for up to three months developed by Hans Jannasch of the Monterey Bay Aquarium Research Institute (MBARI). The instrument requires little power, as osmotic pressure pumps sea water droplets into a detection chamber every 15 minutes. Newer models will test for phosphate, iron, and other nutrients. A companion tool, the "OsmaSampler", slowly draws a year's worth of water samples into a single tube a mm wide and up to 2 km long, allowing researchers to gauge chemical changes at one site over time without returning to collect many separate batches. Ultraslow collection rates prevent the samples from diffusing into each other.

Also in the pennies-per-kilobyte category is a sensor for spotting harmful algae blooms in their earliest stages. MBARI molecular biologist Chris Scholin and colleagues at Saigene Corp., in Redmond, WA, have devised a \$7,500 "dipstick" test that identifies RNA sequences unique to each toxic species. In a small water sample, detergents and heat break open cells. Fluorescent molecules latch onto particular phytoplankton RNA strands to identify killer species. Last May, the probe spotted a nascent diatom bloom near Santa Cruz, CA. The same diatom had killed hundreds of Monterey Bay seabirds in 1991; this time health officials were able to track the bloom down the coast, where it apparently killed birds and sickened sea lions. Although researchers still do not know what drives these blooms, says Scholin, "early warnings can go a long way toward mitigating potential problems".

University of Maryland scientists use the \$150,000 "ScanFish", a towed, batlike fin crammed with instruments, to monitor the Chesapeake Bay's ecology, and a team at Johns Hopkins University and the University of Rhode Island (URI), Narragansett, has developed a submersible "holocamera" that uses holography to image all particles in a cylinder of water about the size of a can of spray paint. The camera yields precise three-dimensional positions and velocities for hundreds of thousands of particles. "Holography is the only tool that gives us both of those measures at scales from centimetres to microns," says URI's Percy Donaghay. A better grasp of how plankton and other particles move in response to small-scale turbulence, he says, will help researchers understand the base of the sea's vast food web. (Source: *Science*, vol. 281, 10 July 1998) www.sciencemag.org

E. ENVIRONMENT

Coastal ships to go biocide free?

Certain types of coastal ships could use biocide-free antifouling paints without losing any performance, according to a report by independent marine institute Limnomar. The report, funded by the Worldwide Fund for Nature (WWF) and the environment ministry of Germany's lower Saxony region, measured the amount of fouling on ships coated with a series of biocide-free alternatives available.

Limnomar has been campaigning against the use of paints containing biocides such as toxic tributyl tin (TBT). The group hopes the report findings will contribute to hastening a worldwide ban on TBT-containing antifouling paints, but acknowledged alternative coatings had yet to be tested on ocean-going vessels.

Jim Brown of Akzo Nobel's marine coatings division said the International Maritime Organization will adopt a resolution this year or next that application of TBT-containing antifoulings will be banned worldwide from 1 January 2003 and their presence on ships' hulls should be banned from 1 January 2008. (Source: *European Chemical News*, 21-27 June 1999)

Shrimp on the cob

A new kind of shrimp has begun to appear along the coast of Ecuador. Known as the "corn shrimp", its arrival is linked to El Niño, which produced a proliferation of sweet algae. Shrimp that eat this algae give a sweet taste, similar to sweetcorn.

The taste has not proved popular and the new species is only commanding a lower price than its traditional counterpart. Any attempts to modify the taste would result in additional costs, which are passed on to the consumer in the form of higher-than-average retail prices. The taste of the shrimp does change over time, but while the farmers wait for the shrimp to mature and the taste to change, the harvest is being delayed and farmers are losing money (Source: *INFOFISH International*, January 1999)

Sea mounts protected?

Unique marine life on undersea mountains south of Tasmania may be conserved in Australia's first deep sea

marine protected area. The seamounts, remnants of extinct volcanoes, rise up to several hundred metres above the sea floor at depths of 1,000 and 2,000 m. A three-year study by the CSIRO shows they contain a diversity of life forms, many new to science and highly vulnerable to trawling.

According to a report in the official newsletter of the Fisheries Research and Development Corporation, Deakin, Australia, a single research cruise found 259 species of invertebrates, such as corals, seastars and crabs; and 37 species of fish. "We found deep-sea coral reefs dominated by filter feeders such as colonial corals including bamboo corals that live for 100 years," says research leader Tony Koslow.

About a third of the invertebrates were new to science and up to 40 of the new species are thought to occur on these seamounts only. Since they were discovered in 1995, Australia's deep sea trawl fishery has voluntarily observed an interim closure of a 370 km² zone, about 100 km south of Tasmania. The CSIRO recommends that this area, containing 15 of the 70 known seamounts, be permanently protected. (Source: *INFOFISH International*, January 1999)

Exotic species threaten the fragile balance of the Baltic

The fishermen of St. Petersburg realized something was wrong when their nets started coming up clogged with stinking, grey sludge. At first they suspected pollution. But the true culprit was revealed only under the microscope. It was *Cercopagis pengoi*—a water flea that is native to the Black Sea. The crustacean arrived at St. Petersburg in 1995. It found few predators and there was a population explosion. In some parts of the Baltic Sea, masses of the creatures—their tails hooked together to form clumps—can make it impossible to pull a fishing net through the water.

The incident is the most visible example yet of a threat that is increasingly alarming marine scientists. The Baltic ecosystem, home to an important fishery and to a huge coastal population, is experiencing a massive invasion of foreign organisms. Alien invaders have already wrought havoc in the Black Sea. By 1990, an introduced American comb jelly, *Mnemiopsis*, had eaten so much of the zooplankton in the Black Sea that fish fry starved. Combined with

pollution and overfishing, this has led to the collapse of Black Sea fisheries. Biologists have warned that the Baltic could suffer the same devastation as the Black Sea.

Most of the invaders hitch a lift in the ballast water of ships. While the US and Australia have now clamped down on dumping ballast water in their ports, dumping in the Baltic is largely unregulated.

So far, around 70 alien non-microscopic species have set up house in the Baltic, alongside the 400 natives. Only 25 non-microscopic species successfully invaded the Black Sea before *Mnemiopsis* struck.

But the impact on the Baltic so far seems small. No native species has become extinct. And some aliens are longtime residents. *Mya arenaria*, a North American bivalve, arrived in the 11th century, clinging to the bottom of Viking longboats. Others were introduced deliberately. In the 1960s, Soviet planners brought in *Pontogammarus*, a Caspian shrimp, for local fish to eat. The shrimps have done well, and fish have changed their diet. Little else changed.

If most of the invasions have so far been benign, their scale is still troubling. Piotr Czgruszka of the Agricultural University of Szczecin in Poland estimates that 97 per cent of the bottom dwellers in the Oder estuary and 95 per cent in the Vistula estuary are now *Marenzelleria*. This bristly polychaete worm from Chesapeake Bay on the east coast of the US arrived in 1985, probably in ballast water. The worm seems to have displaced a few aquatic midge larvae. And it has certainly taken over. But has it done any real harm? The answer is still not clear.

Its burrows are several times longer than any native species make, which may liberate more nutrients from sediment. This could add to eutrophication: excessive nutrients cause an explosion of algae, which die, rot and deplete the oxygen in the water. On the other hand, the worm's larvae are a new food source for fish, says Stephan Gollash of the Institute for Marine Research in Kiel, Germany.

Other invaders also have good and bad sides. Besides fouling nets, *Cercopagis* feeds the economically important herring, says Gollash. And although round gobies from the Black Sea (*Neogobius melanostomus*) are competing with native flounder of Gdansk, they taste just as good and might be controllable if people would start eating them, says Krzysztof Stóra of Gdansk University. But scientists are wary of suggestions that some introductions might be beneficial.

Some species have already surprised scientists. The shipworm *Teredo navalis*, a native of the tropics, started reaching the Baltic on ships in the 1730s. But it did not breed in the chilly northern waters. At least, not then: this year, larvae have been found off Kiel. The species has adapted. No risk assessment model would have predicted that.

Some newcomers are undeniably dangerous. In a study for the Nordic Council, Gollash and Erkki Leppäkoski of the University of Åbo Akademi in Turku, Finland, list the invaders that can travel in ballast, but have not hit the Baltic yet. They include toxic algal blooms; cholera, thought to have reached Peru in 1991 in ballast; *Pfiesteria*, a North American alga that kills fish and causes human disease; a Japanese seastar that has rampaged through shellfish beds in

Australia and a Japanese snail that destroyed Black Sea mussel beds.

In 1996, a study of German ports found that each incoming ship carries on average four million specimens of macrofauna—everything from zooplankton to fish—and as many as 110 million phytoplankton per cubic metre. Some 7,000 ships a year dock in Klaipeda in the Baltic, Lithuania's only port, dumping two to four million cubic metres of ballast water a year.

Yet there are almost no controls on dumping ballast water in European ports. In 1997, the United Nations International Maritime Organization (IMO) recommended that when ships reach mid-ocean they exchange the ballast water they took on in harbours—which is typically full of organisms—for relatively lifeless water. The recommendation is enforced in the US and Australia by inspectors who check the salinity of ballast water. Similar controls are planned for some British ports and all Swedish ones.

The IMO's guidelines are voluntary, and captains may ignore them if they feel that the weather makes ballast exchange at sea too dangerous. Captains may also be swayed by the knowledge that frequent exchanges wear out expensive ballast pumps faster.

But foreign invasions are also expensive. The Australian Government calculates that the accidental introduction of toxic dinoflagellate algae in its waters would cost as much as £80 million. The Caspian zebra mussels that now foul waterways throughout North America have so far cost £300 million to clean up. (Source: *New Scientist*, 24 April 1999)

Foreign species

A new report from marine researchers has some practical advice for ship captains seeking to prevent exotic stowaways hidden in ballast tanks from invading other waters. The study mandated by the US Congress and prepared by a government-appointed task force, tackles a growing ecological threat: introduced species that displace native organisms. In the US, for instance, experts believe the Asian zebra mussel slipped into the Great Lakes decades ago in ballast tanks. It has since caused billions of dollars in damage by clogging pipes, disrupting fisheries, and driving out native shellfish.

To prevent similar invasions, US officials now ask captains to exchange their ballast waters in mid-ocean, where they are unlikely to pick up organisms that can survive in harbour waters. But in case they do not, the report concludes that ships can safely flush their ballast tanks almost anywhere more than 200 km offshore. (Source: *Science*, vol. 284, 7 May 1999)

Reefs at Risk: improving our knowledge base

The Reefs at Risk indicator presents the best estimate of likely threats to coral reefs from human activities, but it is only an estimate. Results confirm that there is a critical need for detailed monitoring and assessment of reef habitats in order to better document where and how coral reefs are threatened and to understand what measures are needed to safeguard them. Scientists and managers have only rudimentary, incomplete data on the status and health of coral reef

ecosystems. For example, there is still a lack of a complete global map depicting reef location, and the vast majority of coral reefs are unassessed. This and other basic information is essential for informed decision making by resource management agencies, fishers, the tourism industry and other sectors economically dependent on reef resources. The public, non-governmental organizations and scientists need such data to better understand and fight for the protection and stewardship of coral reefs.

These data gaps are not for lack of tools. There are a range of techniques for assessing and monitoring coral reefs, each with advantages and limitations. Generally, these entail tradeoffs between cost and detail, and range from the use of satellite imagery to map reef location (relatively low cost, but low detail) to running underwater transects to measure reef health (high cost, high detail). The optimal approach is through multilevel sampling, where information obtained from limited, detailed high-resolution sampling is extrapolated to large areas based on low-resolution data of wide coverage. The goal is to use as much information as possible and available to improve assessments at national, regional and global scales.

As of 1998, several major new initiatives were underway to collect new data and synthesize existing information so as to build a picture of the status of reefs worldwide. These include:

Global Coral Reef Monitoring Network (GCRMN): GCRMN will rely on governments and local communities to regularly assess the health of coral reefs and their fish populations in about 80 countries of the world. Permanent transects are to be established on many reefs. The data will be fed into ReefBase (see below). GCRMN is coordinated by the Australian Institute for Marine Sciences and the International Center for Living Aquatic Resources Management and is a joint programme of the International Oceanographic Commission, the World Conservation Union (IUCN), and the United Nations Environment Programme.

Reef Check Programme: Through this volunteer effort, hundreds of diving groups around the world are organizing annual field trips to gather transect data on selected coral reefs. The Reef Check protocol (methodology) is simple, requiring only a few hours to explain, but is dependent on the involvement of coral reef scientists to supervise site selection and data gathering. Three hundred reefs in 30 countries were surveyed between June and August 1997.

ReefBase Aquanaut Method: The ReefBase Aquanaut Method has been developed to empower divers to conduct highly reliable surveys independent of scientists. Professional scuba instructors teach the four-day training course as an advanced specialty course. In addition to volunteers, park rangers and members of governmental and private sector groups tasked with coral reef management also use the training. In the Reef Check and Aquanaut systems, data exchange and dissemination are facilitated through ReefBase (see below).

Other volunteer programmes: Throughout the world, increasing numbers of volunteers are conducting coral reef surveys with Organizations such as Reef Watch, Reef Keeper, REEF, Frontier and Coral Cay Conservation. Efforts are underway to coordinate this work. In many cases,

volunteer surveys have had substantial impact on coral reef management and public awareness.

ReefBase: ReefBase was initiated in late 1993 to consolidate and disseminate information useful in managing coral reefs. This database, produced by ICLARM, is the most comprehensive source of information on reefs available, providing ecological and socio-economic data on sites around the world. It includes digital maps of coral reefs provided by the World Conservation Monitoring Centre (WCMC), space shuttle and satellite images contributed by the National Atmospheric and Space Administration (NASA) and others, and photographs of reefs contributed by volunteers. ReefBase is currently distributed yearly on CD-ROMs, and major portions are available through a Web site (www.reefbase.org).

Bringing scientists together: The International Coral Reef Symposia (ICRS) are held approximately every four years, and serve as a primary focal point for the analysis and official release of information on coral reef status (the next session will be held in 2000 in Bali, Indonesia). In November 1998, a new series of conferences will be initiated, focused particularly on management concerns. The first International Tropical Marine Ecosystem Management Symposium, to be held in Australia, will provide a forum for the evaluation of the success of the International Coral Reef Initiative in the three-and-a-half years since the first global workshop. Other periodic conferences of importance in the release and critical evaluation of reef information include the regional meetings of the International Society for Reef Studies, the Pacific Science Congresses, the West-Pacific Conferences and many others.

Most available data collection is focused on the biological and physical dimensions of reefs: species found within these ecosystems, the location of these habitats, degree of degradation, etc. Socio-economic and political information can help managers, scientists, and others better understand the direct and underlying factors that result in changes in reef condition (for example, subsidies and laws that result in overfishing). Information that can be used to quantify the direct and indirect values derived from coral reef ecosystems is important input for weighing development and management options. Collection of such policy-relevant data should be a priority in future monitoring and assessment efforts. (Source: *World Resource Institute*, 9 April 1999)

Sustainable marine resource management

There are many causes of the loss during recent decades of marine biodiversity, especially in the coastal waters of industrialized countries. Among the most important are direct habitat destruction through the erection of engineering and drainage works that disturb the physical integrity of coastal and marine systems; poor fisheries management; the uncontrolled exploitation of corals and molluscs; the "by-catch" of large numbers of non-target species in fisheries; the introduction of alien species; and the overall lack of an integrated approach to coastal zone management. As a consequence, the productivity of fisheries and such important ecosystems as mangroves and coral reefs has been depressed, and local communities have suffered.

Four basic kinds of policy change are needed to put resource management on a sustainable footing.

- First, governments should review all the activities within their jurisdiction that affect the coastal zones and oceans, including activities on land and within river catchments. They should then develop integrated policies that coordinate the allocation of uses in the coastal zone, especially to safeguard the rights and interests of local communities. They should also regulate activities—like the over-cutting of mangroves or inappropriate extension of mariculture—that have destroyed coastal ecosystems or increased the vulnerability of coasts to erosion and storm surges.
- Second, pollutant discharge into coastal seas and via inflowing rivers should be strictly controlled. About 70 to 80 per cent of marine pollution comes from land-based sources. Governments should adopt the “precautionary principle” to minimize inputs of potentially damaging substances and draw up plans for rehabilitating degraded coastal ecosystems.
- Third, fishery policies should be reviewed. Small-scale, community-based fisheries account for almost half the world food catch, employ more than 95 per cent of the people engaged in fishing, and use only 10 per cent of the energy of large-scale corporate fisheries. They are also vital to the livelihood of local communities. Governments should reverse policies that discriminate against such fisheries, especially policies that invalidate local common property systems for managing fisheries. Governments should also adopt an ecosystem approach to the management of fishery resources in both coastal and nearshore seas and ensure that catches are kept within maximum sustainable yields. They should also ban the use of unselective and destructive fishing systems (such a monofilament drift nets) by their nationals and in their coastal waters and Exclusive Economic Zones. Governments should base fisheries policy primarily on ecological assessments of sustainable harvest levels, rather than on political and economic considerations.
- Fourth, governments should support international legal instruments for protecting the seas against pollution and misuse. The United Nations Law of the Sea, which entered into force on 16 November 1994, is the globally recognized regime dealing with all matters relating to the law of the sea. International cooperation, especially within UNEP’s Regional Seas Programme, should be extended. Research collaboration under international agreements should also be strengthened. All states that have not done so should ratify the conventions controlling pollution from ships and from the dumping of wastes. (Source: *World Resources Institute*, 9 April 1999)

Programmes to monitor air pollution from ships agreed

The Marine Environment Protection Committee (MEPC) of IMO agreed at its 42nd Session to begin a programme to monitor the average sulphur content of residual fuels worldwide, as part of a programme of action

towards implementation of Annex VI of MARPOL 73/78, on the Prevention of Air Pollution from Ships, which was adopted at a conference in September 1997.

Annex VI, when it comes into force, will set limits on sulphur oxide and nitrogen oxide emissions from ship exhausts and prohibit deliberate emissions of ozone-depleting substances.

The monitoring scheme will be based on guidelines which were approved at the session. The guidelines set out a formula for calculating the yearly average sulphur content, based on sampling and testing of residual fuel.

Currently, average worldwide sulphur contents are in the order of 3 per cent mass for mass—while Annex V sets a cap of 4.5 per cent m/m. The aim of the monitoring programme is to ensure that action can be taken if the average sulphur content is seen to be rising.

The MEPC also agreed that IMO should begin a study on greenhouse gas emissions from ships, including carbon dioxide emissions from ships worldwide, to assess what controls may be necessary.* Papers presented to the committee suggest that shipping contributes between two and three per cent of worldwide carbon dioxide emissions—a small, but significant, proportion.

The principal purpose of the study would be to examine reductions in greenhouse gas emissions that would be possible through different technical, operational and market-based approaches. Specific pollutants to be studied include carbon dioxide, nitrogen oxides, particulate matter and hydrocarbons.

The study would also consider possible technical and operational controls which could reduce emissions. These include improved propeller maintenance, weather and current routing, slow-steaming, new hull/propulsive system and propeller designs, and supplemental propulsion systems.

Interim guidelines on NO_x technique code approved

The MEPC approved an MEPC circular on interim guidelines for the application of the NO_x Technical Code. The purpose of the NO_x (nitrogen oxides) Technical Code is to establish mandatory procedures for the testing, survey and certification of marine diesel engines, in order to enable engine manufacturers, shipowners and administrations to ensure that all applicable marine diesel engines comply with the relevant limits for emission values of NO_x as specified in MARPOL Annex VI (regulation 13).

Although the regulation will not enter into force until the Annex enters into force, Administrations are encouraged to issue interim certificates confirming conformity with the NO_x Technical Code for engines installed on ships on or after 1 January 2000, or for engines undergoing a major conversion on or after 1 January 2000. The aim is to ensure

*Resolution 8, adopted by the conference of Parties to MARPOL 73/78 which adopted Annex VI, called for work in this area. In addition, the Kyoto Protocol to the United Nations Framework Convention on Climate Change, in article 2.2, states that: “Parties included in Annex I [of that Protocol] shall pursue limitation or reduction of emissions of greenhouse gases not controlled by the Montreal Protocol from aviation and marine bunker fuels, working through the International Civil Aviation Organization and the International Maritime Organization, respectively.”

that new or modified engines will already be compliant with the NO_x Code once it enters into force.

Particularly sensitive sea areas

The MEPC began reviewing guidelines on designating a "particularly sensitive sea area" (PSSA), and agreed to continue its work on this issue at the next session (schedule for June-July 1999).

The current guidelines, in resolution A.720(17) (adopted in 1991), allow areas to be designated a PSSA if they fulfil a number of criteria, including ecological criteria, such as unique or rare ecosystems, diversity of the ecosystem, or vulnerability to degradation by natural events or human activities; social, cultural and economic criteria, such as significance of the area for recreation or tourism; and scientific and educational criteria, such as biological research or historical value.

Some delegations felt that the guidelines could be improved by making the procedures simpler, while environmental, ship safety and navigational aspects needed to be considered further.

When an area is approved as a particularly sensitive sea area, specific measures can be used to control the maritime activities in that area, such as routing measures, strict application of MARPOL discharge and equipment requirements for ships such as oil tankers, and installation of Vessel Traffic Services (VTS). There are currently two designated PSSAs: the Great Barrier Reef, Australia, and the Sabana-Camagüey Archipelago in Cuba. The Sabana-Camagüey Archipelago was designated a PSSA in September 1997. (Source: *IMO News*, April 1998)

Unsafe practices associated with the trafficking or transport of migrants by sea

The Maritime Safety Committee of the IMO (MSC) approved an advisory circular outlining interim measures for combating unsafe practices associated with the trafficking or transport of migrants by sea, which is intended to supplement work by the United Nations Commission on Crime Prevention and Criminal Justice to develop and adopt a United Nations instrument against transnational organized crime, to include provisions against illegal trafficking of migrants by sea.

The advisory circular notes that experience has shown that migrants often are transported on ships that are not properly manned, equipped or licensed for carrying passengers on international voyages. States should take steps relating to maritime safety, in accordance with domestic and international law, to eliminate these unsafe practices associated with the trafficking or transport of migrants by sea, including:

- Ensuring compliance with SOLAS;
- Collecting and disseminating information on ships believed to be engaged in unsafe practices associated with trafficking or transporting migrants;
- Taking appropriate action against masters, officers and crew members engaged in such unsafe practices; and
- Preventing any such ship:
 - From again engaging in unsafe practices; and
 - If in port, from sailing.

The circular contains a proposed format for reporting any incidents to IMO, so that the circular can be updated

and revised on the basis of experience. (Source: *IMO News*, April 1998)

Mandatory ship reporting system to protect northern right whale off United States adopted

The MSC adopted a mandatory ship reporting system, off the north-eastern coast and the south-eastern coast of the United States, covering an area inhabited by the endangered northern right whale. This is the first time a mandatory ship reporting system has been implemented for the protection of one particular marine species from direct physical impact with ships, rather than for protection of the marine environment from ships.

The aim of the reporting system is to provide important protection for endangered large whale species, in particular the critically endangered northern right whale. Ship strikes are the species' largest known source of human-related mortality. Since 1991, approximately 50 per cent of the recorded right whale mortalities have been attributed to ship strikes.

The mandatory ship reporting system off the south-eastern coast of the United States will operate from 15 November to 15 April, which includes the calving season for right whales in this area; whilst the system off the north-eastern coast will operate throughout the year, as right whales have been sighted in this area throughout the year. The scheme will be implemented from 0000 hours UTC on 1 July 1999. (Source: *IMO News*, April 1999)

ISM Code deadline highlighted

The MSC approved a circular to highlight the deadline of 1 July 2002, when all ships and mobile offshore units on international voyages will have to comply with the International Safety Management (ISM) Code. The Code, which is mandatory under chapter IX of SOLAS, was adopted in 1994 and entered into force on 1 July 1998 for all oil tankers, chemical tankers, bulk carriers, gas carriers, passenger ships and cargo high-speed craft of 500 gt and above on international voyages. It is extended to other ships on international voyages in 2002.

The Code requires a safety management system (SMS) to be established by "the Company", which is described as the shipowner or any person, such as the manager or bareboat charterer, who has assumed responsibility for operating the ship. Administrations must issue a Document of Compliance (DOC) to every company that meets the standards laid down in the Code, a copy of which is required to be carried on board every ship of the company, while ships must also be issued with a Safety Management Certificate (SMC). Verification of compliance with the Code—such as checking the DOCs and SMCs—may be carried out during port State control inspections.

The MSC agreed in principle to proposed draft amendments to SOLAS chapter IX and to the ISM Code, which are intended to be approved and adopted in time for them to enter into force on 1 July 2002.

The proposed draft amendments concern provisions relating to periods of validity of certificates, interim certification and forms of certificates, currently included in Assembly resolution A.788(19) on guidelines on imple-

mentation of the International Safety Management (ISM) Code by Administrations.*

The relevant provisions of resolution A.788(19) could be included in SOLAS chapter IX or section 13 "Certification, verification and control" of the ISM Code or in both. Adding these provisions to chapter IX or to the Code itself would make them mandatory, rather than recommendatory. (Source: *IMO News*, April 1998)

Do carbon sinks absorb fossil fuel output?

Environmental policy makers are operating ahead of reasonable scientific knowledge and setting policies of dubious value. More importantly, they are attempting to "solve a problem" (global warming) by imposing penalties (taxes) and controls (usage of fossil fuels) on producers and consumers without sufficient knowledge.

New evidence places the global warming/carbon dioxide debate in a different light. Published in a recent issue of *Science*, a study by the Carbon Modeling consortium at Princeton University presents evidence of a major "carbon-sink" in North America.

Up to 1.7 petagrams (1.7×10^{15}) of carbon is absorbed in North America, according to the study. This is enough to overcome the carbon dioxide (CO_2) produced by burning fossil fuels in both the US and Canada. Other studies dispute the results of this work.

The Princeton study also points out the limited number of monitoring stations worldwide, the complexities of the carbon cycle, and the need to assess the effect of plant growth on carbon absorption.

The article quotes Steven Crookshank of the American Petroleum Institute: "(The study) calls into question the scientific basis on which we are making these (global warming) decisions, when we still do not know if the US is even emitting any carbon in the net." Much more work is needed before governments can understand the atmosphere, much less control it.

- **Cooling costs:** The Energy Information Agency has concluded that compliance with the Kyoto accords will cost the average US household US\$ 355 to US\$ 1,740 annually. Prices for gasoline would increase US\$ 0.14 to US\$ 0.66 per gallon while natural gas prices would rise 25 per cent to 147 per cent. Such an increase would cost the gross national product between US\$ 60 and US\$ 387 billion. The estimates are based on greenhouse gas reductions of 7 per cent from 1990 figures. The estimates are significantly higher than those projected by the Clinton Administration.
- **OPEC view:** OPEC does not want to lower its current production levels. The Saudis favour extending the present levels for an additional six months beyond the current agreement.

This would hold output steady through all of 1999, providing time for the winter 1998 heating and summer 1999 driving seasons to rebalance the market. Demand is

not expected to grow strongly in the coming year. (Source: *Offshore*, December 1998)

First El Niño observed and forecast from the start

For the first time in history, scientists around the world were able to observe a major climate event from the earliest stages of development through its decline. These observations have brought unprecedented insight into El Niño—years of research data to analyse and the opportunity to issue valuable predictions.

The 1997-1998 El Niño "event of the century" was the best monitored and first ever predicted El Niño on record, according to NASA and NOAA scientists reporting from the AGU meeting in San Francisco. Following the last strong El Niño in 1982-1983, the international science community deployed an extensive surface observing system in the tropical Pacific Ocean in support of monitoring and predicting El Niño.

In addition, within the last 10 years, a series of ocean and atmospheric remote sensing satellites have been launched that supplement and enhance the observations being taken at the surface, and at depth, of the equatorial Pacific Ocean. These global observations have provided unprecedented information on sea surface temperature, sea surface topography, sea surface winds, ocean colour, and precipitation. According to Dr. Antonio Busalacchi, NASA Goddard Space Flight Center scientist, the observations of the marine environment for the first time have shown how the physical climate system during El Niño obliterated the lowest levels of the marine ecosystem and subsequent impacts at higher levels in the food chain.

"The observations of the climate system, combined with sophisticated ocean-atmosphere prediction models, and the science communities increased understanding of the atmospheric response, led to an incredibly bold forecast of El Niño nearly six months prior to the onset of the major impacts," said Dr. Ants Leetmaa, NOAA scientist. "Working with the emergency management community and other users we were able to start applying the forecasts for practical use and widespread education about climate variability. With this event, we were light years ahead of the last major El Niño."

NOAA's Climate Prediction Center monitors, analyses, and predicts climate events for the entire nation—from weeks to seasons. NOAA operates the network of data buoys and satellites that provide vital information about the ocean and initiates research projects to improve future climate forecasts. (Source: *Sea Technology*, January 1999)

Rockfish population declining

According to researchers at the University of California, Santa Barbara, rockfish population off the southern and central California coast have severely declined in recent years. A study headed by biologist Milton Love of the Marine Science Institute is using several techniques to examine the status of the economically important bottom fish. The study is part of a cooperative research project being conducted with the US Geological Survey's Biological Resources Division.

*A.788(19), section 3, "Issuance and validity of DOC and SMC", and appendix 2, "Forms of DOC, SMC and Interim DOC and SMC".

While the number of many rockfish species has declined precipitously, one in particular—bocaccio—might be listed as an endangered species if it were a land animal, since the population of bocaccio has dropped down to 8 to 10 per cent of their 1960 numbers, explained Love.

Love also analysed rockfish data compiled by coastal electrical power generating stations that corroborated his submarine research. He explained that these results are particularly useful because they are based on unbiased samples of water taken in by the power plants. (Source: *Sea Technology*, January 1999)

Antarctic ozone hole sets new record

Scientists at NOAA have announced that the observations of this year's "ozone hole" over Antarctica show an area greater at this time of the season than those previously observed. The "hole", a region of ozone depletion over Antarctica, is the result of complex chemical and meteorological processes occurring in the stratosphere. This year's ozone hole is the largest observed since it first developed in the early 1980s.

NOAA scientists use satellite instruments and balloons to measure the ozone hole. The satellite measurements were made with the solar Backscatter Ultra-Violet instrument on the NOAA-14 environmental satellite. NASA scientists obtained their data from the total ozone mapping spectrometer (TOMS) instrument aboard NASA's Earth probe satellite. (Source: *Sea Technology*, January 1999)

Scientist says 20th century global warming unprecedented

Palaeoclimatologists, using a compilation of available data from around the Northern Hemisphere, have confirmed that 20th century global warming is unprecedented relative to the last 1,200 years. Jonathan Overpeck, head of NOAA's Palaeoclimatology Program in Boulder, CO, says that research has failed to identify any known natural climate-forcing mechanism that could have generated all of the unprecedented warming that has led to 1998 being, most likely, the warmest year in at least 1,200 years.

Overpeck also said that the so-called mediaeval warm period, a period from the 9th and 14th centuries that is commonly thought to be as warm or warmer than today, may not have been what it seemed after all. He reported his findings at the fall meeting of the American Geophysical Union in San Francisco.

Overpeck's work, building on that of others, suggests that there was no global mediaeval warm period, and that the patterns of climate change during that time indicate that changes in North Atlantic circulation might have been the cause of observed regional warming.

"Over the past year, a number of studies have shown that 20th century arctic and hemispheric warming are unprecedented relative to the last six centuries", said Overpeck. "Now, high-resolution palaeoclimate records stretching back 1,200 years confirm that the so-called mediaeval warm period did not exist in the form of a globally synchronous period as warm, or warmer, than today. Thus, recent record high hemispheric temperatures are probably unprecedented in at least 1,200 years. In addition, our study of the mediaeval warm period supports the likelihood that no

known natural phenomenon can explain the record 20th century warmth. Twentieth century global warming is a reality and should be taken seriously." (Source: *Sea Technology*, January 1999)

Disruption of coastal ecosystems in Alaska

During the 1990s, throughout large areas of western Alaska, the sea otter population has seen an abrupt decline by about 25 per cent. With seals and sea lions in short supply in the North Pacific, killer whales are now feeding on sea otters according to researchers studying the area's marine ecosystem. The decline in sea otters has allowed their primary prey, sea urchins, to increase in number and strip coastal kelp forests over large areas, said James Estes, a marine ecologist with the US Geological Survey and the University of California, Santa Cruz.

Where sea otter populations have dropped, the kelp forest ecosystem is collapsing, said Estes, who has spent years documenting the central role of otters in the ecology of the kelp forests. Exploding sea urchin populations have decreased kelp densities by a factor of 12 since the sea otters began to disappear.

According to Estes, the researcher ruled out other possible causes of the sea otter decline, such as disease, toxins, and starvation.

One of the important implications of the current study, as far as ecologists are concerned, is the linkage between the coastal ecosystem and events and species seemingly far removed from it. The transient presence of killer whales, driven to prey on sea otters by changes in the open ocean, has affected the entire structure of the coastal ecosystem. (Source: *Sea Technology*, December 1998)

IMO approves US mandatory ship reporting system for right whales

Endangered North Atlantic right whales received timely protection from ship strikes from the United Nations International Maritime Organization. The body voted unanimously for July 1999 implementation of a mandatory ship reporting system in two critical habitat areas off Massachusetts and coastal Florida and Georgia, key feeding and nursery areas for right whales. Adults are 45-55 feet long. The proposal was initially developed by NOAA in conjunction with the Marine Mammal Commission. Reporting will act in the same manner as a road sign in a school zone area in that it will warn transiting ships about the presence of right whales. The ship reporting system requires ships weighing more than 300 gross tons entering these areas to notify the US Coast Guard. In return, the mariner will be provided with automated information about the last known locations of any right whales. The data will be regularly updated by the Coast Guard and private spotters scouting the area from aircraft. Implementation of the mandatory reporting system will not begin until 1 July 1999, in order to provide sufficient notice to mariners operating in the areas. Several thousand right whales once existed in the North Atlantic Ocean. Years of commercial hunting at the turn of the century severely depleted the stocks. Whalers considered the animal the "right whale" to hunt because they were slow moving, migrated close to shore, and stayed afloat after being killed. Today, despite more than 60 years

of protection, right whales have not fully recovered. (Source, *Sea Technology*, December 1998)

Emergency research to clarify the mechanism of coral bleaching

The Policy Committee of the Council for Science and Technology has decided to conduct emergency research funded by the Coordination Funds for Promoting Science and Technology to clarify the cause of coral bleaching at the coral reefs around the Ryukyu islands since summer 1998.

The research will be carried out by the Japan Marine Science and Technology Center (JAMSTEC), the Geological Survey of Japan of the Ministry of International Trade and Industry, and the Establishment of Tropical Marine Ecological Research. They will conduct a survey in the Kerama island chain in Okinawa Prefecture to examine and study the relationship between coral bleaching and marine environment changes.

Coral bleaching is a phenomenon where symbiotic algae come out of the coral due to the abnormal rise in sea water temperature or other reasons, often resulting in the death of the coral. The phenomenon is thought to have a great cause-and-effect relationship with climatic changes because it occurs at coral reefs all over the world, interlocking with displacement to the south of El Niño and Southern Oscillation.

The actual research contents will be: (1) research of topographical effects on coral bleaching; (2) survey and research on the distribution of coral bleaching using remote sensing; (3) analytical research on coral bleaching and marine climate changes; (4) coral bleaching environments and recovery prediction simulation; (5) research on skeleton record analysis concerning bleaching and long-term climatic changes.

(For further information, contact the Ocean and Earth Division, Research and Development Bureau, STA. Tel.: 03- 3581-5271, ext. 485). (Source: *STA Today*, January 1999)

Ban proposed for TBT-based ship paint

The International Maritime Organization has taken the first step towards possibly banning the use of a chemical that has been linked to marine animal kills throughout the Atlantic and Pacific oceans.

The IMO's marine environmental protection committee, which met in London in November 1998, is recommending that the use of antifouling paint containing tributyltin (TBT) be banned on ship hulls by 2008.

Since the 1970s, TBT has been added to paint to prevent tube worms, algae and barnacles from growing on ship hulls. But after alarms were raised that TBT was killing shellfish and other marine species, France and other European nations began restricting the use of organotin-based antifouling paints in the mid-1980s.

In 1988, US Congress passed legislation forbidding the use of TBT paints on vessels less than 25 metres long, effectively banning their use on yachts and pleasure boats. Regulations implementing the law also limit the level of TBT in discharge waters from dry docks and repair

facilities, making it difficult to use the paints on larger vessels in the US.

Next year, the IMO general assembly will consider the recommendation for a global ban on TBT. The marine environment protection committee is proposing that ship owners stop using the paint by 1 January 2003, with a complete global ban on TBT in marine paints by 2008.

If the recommendation passes, member nations will still have to ratify the resolution, a lengthy process. Some nations, such as Japan, have already banned TBT completely and are pressing other countries to follow suit.

Environmentalists say the use of TBT-based antifouling paints should be banned as soon as possible. (Source: *Chemical Market Reporter*, 11 January 1999)

North American land mass soaking up carbon dioxide

A study by government and university scientists indicates that the land mass in North America is absorbing a large amount of carbon dioxide from the atmosphere. During the past decade, evidence had already suggested the existence of a large land "sink" of atmospheric carbon dioxide at temperate latitudes in the northern hemisphere. Carbon dioxide is a greenhouse gas that is closely associated with global warming. The term "sink" refers to areas where greenhouse gases are absorbed either by land or ocean processes.

In an article appearing in *Science* magazine, scientists from NOAA, Princeton University, and Columbia University say that they have now tentatively identified that sink as being mostly North America, at least during the period studies, from 1988-1992.

Pieter Tans, an atmospheric chemist at NOAA's Climate Monitoring & Diagnostics Laboratory in Boulder, CO, and a co-author of the paper, says that "the North American land surface appears to be absorbing possibly as much as between one and two billion tons of carbon annually, or a sizeable fraction of global emissions of carbon dioxide from fossil fuel burning". The data used in the study were obtained from 63 atmospheric sampling stations taken from the Globalview database. Globalview includes stations from NOAA's Climate Monitoring & Diagnostics Laboratory, and 12 other laboratories located around the world. The ocean and atmospheric models used were developed at NOAA's Geophysical Fluid Dynamics Laboratory located at Princeton University, and the air-sea fluxes were developed at Columbia's Lamont-Doherty Earth Observatory. The study was funded by NOAA's Office of Global Programs.

According to the *Science* article, the researchers developed a three-dimensional grid of the earth to model the flow of carbon dioxide. The expectation was that the gas would increase over North America as the winds moved from west to east, due to the large amounts of carbon dioxide produced by fossil fuel burning. Instead, carbon dioxide tended to decline slightly in crossing North America from the Pacific to the Atlantic oceans during the period of the study. The researchers are not sure what is causing this decline of carbon dioxide. But they theorize that it is partly due to the regrowth of plants and vegetation on abandoned

farmland and previously logged forests in North America and may be enhanced by human-induced nitrogen deposition—a diluted form of acid rain—and increasing carbon dioxide levels, which can act as fertilizers for plants. However, the actual cause remains unknown.

The researchers believe that plants and soils are a major factor in carbon dioxide absorption and will continue to exert considerable influence on atmospheric carbon dioxide in the future. (Source: *Sea Technology*, November 1998)

Oil spill prevention

After the *Exxon Valdez* ran aground in Prince William Sound, spilling more than 11 million gallons of oil into Alaska waters, the Oil Pollution Act of 1990 was enacted. This law—along with the international maritime regulations that followed—calls for nearly all oil-transporting vessels to have double hulls by the year 2020 to help protect against spills caused by punctures. Punctures cause some 70 per cent of maritime oil disasters.

If properly designed, double-hull tankers and barges can significantly lower the risk of large oil spills and offer more protection to the marine environment, says a new report by a committee of Canada's National Research Council. Replacing all single-hull tankers with correctly designed double-hull vessels could prevent a large number of spills attributed to collisions and groundings, and reduce by as much as two-thirds the total volume of oil spilled in such accidents.

The US Coast Guard should quickly take the lead in developing design standards to ensure that all double-hull vessels will prevent spills and operate safely, the committee said. Some of the new double-hull ships—particularly those without a centre bulkhead partition—are less effective than other double-hull designs in preventing spills. They also are not as stable during loading and unloading.

The Coast Guard also should develop a surveillance programme to monitor the physical condition, maintenance and operational procedures of older, single-hull vessels that are still permitted in US waters, the committee said. An exemption to US law until the year 2015 allows single-hull vessels with less than 30 years' service to use deep-water ports and offshore areas designated for transferring cargo from vessel to vessel.

In addition, the impact of the double-hull requirement on the US domestic shipping industry should be assessed further, the committee said. An independent panel should be appointed to examine policy options that would ensure that enough US-built vessels will be available when needed.

Double-Hull Tanker Legislation: An Assessment of the Oil Pollution Act of 1990. Committee on the Oil Pollution Act of 1990 (Section 4115) Implementation Review, Marine Board, Commission on Engineering and Technical Systems (1998, 288 pp.; ISBN 0-309-06730-1; available from National Academy Press. Tel.: 1-800-624-6242; \$45.00 plus \$4.00 shipping for single copies; also online at www.nap.edu/bookstore/isbn/0309063701.html). (Source: *NRC News Report*, vol. XLVIII, No. 1, Winter 1998)

Muddy waters

At a meeting of the member nations of the Oslo-Paris (OSPAR) convention on marine pollution in the northeast Atlantic last July, Britain's Deputy Prime Minister, John Prescott, pledged to reduce radioactive emissions into the sea around Britain to near zero by 2020.

But "near zero" was not defined in the agreement reached at OSPAR, and this has allowed the nuclear industry, the Government and the environmental lobby all to claim victory. Greenpeace claimed that the OSPAR agreement "signals the beginning of the end of the nuclear reprocessing industry".

The Government and British Nuclear Fuels (BNFL) have agreed that over the next 18 months they will draw up a strategy for meeting the target. This will centre round plans to clean up the two most highly radioactive discharges into the Irish Sea, both of which are from BNFL's Sellafield plant in Cumbria, which handles spent fuel from the nuclear industry's first-generation Magnox reactors. The eight reactors still in service in Britain are all more than 30 years old.

The first target for a cleanup will be chemical waste from the reprocessing of irradiated Magnox fuel. These discharges contain increasing amounts of technetium-99, a radionuclide which is appearing in lobsters off the coast of Norway. Levels of the radionuclide are increasing because Sellafield has been dealing with a backlog of waste that was previously stored. For the past three years it has been using its Enhanced Actinide Recovery Plant to treat this waste.

The new plant discharges technetium into the sea, even though a similar plant that handles the spent fuel from reactors younger than the Magnox generation seals technetium in inert glass. Colin Partington, BNFL's principal safety officer, says that it will take five years to design and build the technology needed to seal technetium from Magnox fuel. It will take at least as long, therefore, for Magnox discharges to be significantly reduced, he says.

The second form of waste that is causing a problem is the contaminated water used to cool the stored Magnox spent fuel before it goes to be reprocessed. Though an ion-exchange plant removes 99 per cent of its radioactivity, the water remains seriously contaminated. BNFL accepts that such levels of contamination will probably become illegal in 2020. So, the Magnox reactors will have to close in time to allow Sellafield to finish reprocessing all their waste by 2020. The date for their closure could be as late as 2015. (Source: *New Scientist*, 1 August 1998)

All at sea

Toxic wastes are leaching into the North Sea from piles of debris heaped up beneath oil rigs, a new survey has found. Levels of heavy metals dissolved in water immediately above the dumps exceed environmental safety limits, say scientists at the Dunstaffnage Marine Laboratory near Oban, Scotland.

Drilling for oil has left seven million cubic metres of cuttings, including metals, lubricants and rock, beneath some 1,500 North Sea rigs. For the past two years European Governments have been trying to decide how best to deal with this waste.

Until now, scientists assumed that metals would remain trapped within the piles, but a study managed by Britain's Natural Environment Research Council and the oil industry has found high concentrations of metals in the water around cuttings piles at two wells operated by the US oil company Amoco. Levels of arsenic and nickel in the sea water above piles at the wells Northwest Hutton and Wellhead 1523b exceeded British environmental quality standards. These limit the concentration of arsenic in sea water to 25 parts per billion and that of nickel to 30 ppb. At Wellhead 1523b, water immediately above the cuttings contained 38 ppb of arsenic and 44 ppb of nickel.

Concentrations of metals were even higher in water samples taken from pores within the cuttings piles, reaching 90 ppb for arsenic and 70 ppb for nickel. The study's authors, Eric Breuer and Graham Shimmield of the Dunstaffnage Laboratory, argue that other cuttings piles under other North Sea rigs are also likely to be leaking and call for further investigations to find out if the toxic leakage is harming marine life.

In June, the UK Offshore Operators Association (UKOOA) launched a two-year research programme to determine what should be done with the piles. At a seminar in London, the Norwegian consulting firm Rogaland Research, came up with seven options. These included dredging the cuttings piles to the surface, reinjecting them into the wells, covering them with gravel and simply doing nothing.

If the waste piles are not touched, they will continue to leach toxic waste, but attempting to move the piles with existing technologies might release more heavy metals into the water. (Source: *New Scientist*, 28 November 1998)

Grave impact of trawling

In a press conference a group of marine scientists lobbied a rhetorical warning shot across the bows of the world's trawling fleets. They presented evidence that dragging heavy nets across the sea floor causes far more environmental damage than does the more visible clearing of forests. Some trawlers are returning fire, however, saying that the scientists have overstated their case and that some fishing grounds have remained productive despite more than a century of trawling. Caught in the crossfire are government fisheries officials, who believe the new findings will fuel but not settle an increasingly rancorous debate over whether to curtail trawling in some heavily fished waters.

The latest battle over sustainable fishing was triggered by papers and results discussed at a conference in the UK. Some sea floor researchers and the American Oceans Campaign, a Washington, D.C.-based environmental group, hope the findings will prompt an outcry against the largely invisible impact of trawling, a technique traditionally confined to shallow coastal seas that has recently extended its reach into waters up to 2 km deep. At the press conference, scientists and environmentalists called on governments to establish more marine reserves where trawling—but not all fishing—is banned.

The most controversial paper, by Les Watling, a biologist at the University of Maine, Orono, and Elliott Norse of the Redmond, Washington-based Marine Conservation

Biology Institute, equates the habitat damage caused by trawling with forest clearcutting—long denounced by biologists as a major threat to biodiversity. Both techniques, the researchers argue, transform structurally complex habitats supporting many kinds of life into relatively flat, uniform environments that shelter fewer species. But trawlers cover far more ground than loggers, say Watling and Norse. Their estimate, based on scanty industry records, is that the worldwide fleet of trawlers drag up to 15 million km² annually—an area 150 times greater than the forest cleared each year. Unlike loggers, however, some trawlers may sweep the same sea floor patches many times in a single year, leaving little time for slow-growing organisms to regain their toeholds. Trawling's long reach "was not previously appreciated", they conclude. "With the possible exception of agriculture, we doubt that any other human activity physically disturbs the biosphere to this degree."

Another study, led by Jonna Engel of the Moss Landing Marine Laboratory in California, is among the first to document the change in biodiversity from trawling. Using sonar, video images taken from submarines, and samples of sea floor life, it compared a repeatedly trawled seabed 180 km off the central California coast with a nearby swathe that was dragged less often. Engel's team found that the heavily trawled area was flatter and harboured fewer species than the lightly fished stretch. They also found that increased trawling reshuffled sea life communities: smaller, rapidly reproducing creatures—such as nematode worms—tended to replace larger, longer-lived organisms, such as some shellfish. Other studies suggest the ecological changes can persist for months or longer after trawling ends.

The idea that trawling produces undersea winners and losers also surfaced at the conference in Wales, which featured work in European waters. Dutch researchers, for instance, found that a century of trawling may have reshaped parts of the North Sea's floor into perfect habitat for Dover sole, a sought-after catch, and swept away less adaptable creatures, such as delicate anemones.

Fishing industry officials point to such results in arguing that policy makers need more information before establishing trawl-free zones. Trawlers and marine biologists agree that "some gear does impact some bottom types during some fishing operations", but "there is nothing approaching a consensus on the effects, positive or negative".

The US has already taken limited steps toward protecting reefs and some nursing grounds, notes National Marine Fisheries Service deputy director Andy Rosenberg. But he says policy makers will want more specific information before closing more waters to trawling. (Source: *Science*, vol. 282, 18 December 1998)

Marine diamond mining and the environment

Coastal areas worldwide sustain some of the most productive and biologically diverse ecosystems in the world, and due to their riches, these areas are often threatened by human activities, which in turn often lead to environmental degradation and loss of biodiversity. As throughout the world pressures on the coastal zone are increasing, the need for wise management is now urgent.

The Namaqualand coast is situated in the North-western part of South Africa, and although sparsely populated, the area sustains a fishery as well as a diamond mining industry, both of great importance for the South African economy. Diamond mining has long been an important industry in South Africa, and the first finds in Kimberley in 1868 and 1869 started what became a rapid development of the country's economy. In 1993, South Africa produced approximately 10.3 million carats of diamonds, to a value of more than US\$ 1,000 million, representing 14 per cent by value of the world's total diamond production.

On the Namaqualand coast, diamonds have been mined from raised marine gravel-deposits since early this century. The two largest ore deposits are situated at the mouth of the Orange River in the North, and at the Buffels River mouth 140 km further south. Until recently, offshore mining in South Africa was limited to shallow waters and the annual production was then approximately only 100,000 carats. Lately, with the availability of new technology, the scale and depths at which offshore operations can operate economically have increased, and at present, marine diamond exploration and mining is experiencing something of a bonanza. The total offshore diamond resource has been estimated at more than 1.5 billion carats, and the yearly production is predicted to possibly reach 2 million carats, representing 10 per cent of the global production of gem diamonds, as early as by the year 2000.

According to Agenda 21, the most elaborate and far-reaching document produced at the United Nations Conference on Environment and Development in Rio (1992), coastal states should commit themselves to the wise use and the sustainable development of coastal areas and resources. Along the Namaqualand coast, onshore diamond mining has often been done with scant regard for the environment as mined out areas have generally not been rehabilitated, leaving the coastal landscape riddled with scars which may remain for generations. Furthermore, in the last few decades fisheries off the South African west coast have experienced a dramatic decline due to severe over-fishing. The pilchard catch dwindled from a peak of 400,000 tons in 1962 to 16,000 tons in 1974, and off Namaqualand, the crayfish industry experienced reduction in the catch, from 2,000 tons in the mid-1960s to an all-time low of 40 tons in 1984. Clearly, the need for careful management of future developments along the Namaqualand coast is pressing. Environmental Impact Assessments (EIAs) are not mandatory under South African law and consequently the environmental impact of large-scale diamond mining on South African waters still remains to be scientifically assessed. Marine diamond mining is an industry with a lifespan in the order of a few decades. The mining itself may, however, have significant impacts on sustainable marine resources, which may, if managed wisely, yield substantial benefits for many generations. As the Namaqualand coast is in serious need of economic development brought by the diamond mining industry, it is important that the environmental impact of marine mining is thoroughly investigated in order to assess the potential conflict of interest between mining and fisheries. Furthermore, as mining may impact on the ecological

balance of the coastal zone it is important to optimize the environmental management of the offshore diamond mining industry, as wise management may lessen the extent of habitat destruction that is an inevitable consequence of any mining operations. (Source: *Journal of Mineral Policy, Business and Environment Raw Materials Report*, vol. 13, No. 1)

Aquaculture

by Claude E. Boyd, Laurence Massaut and Lee J. Weddig

Rapid growth of aquaculture in the past two decades has enabled the world fisheries supply to keep pace with population growth despite the fact that catch from the oceans and inland waters has reached a plateau. It is generally recognized that continued growth of aquaculture is essential if the need for annual increase of world fisheries production of 2-3 million mt is to be met. While the rapid growth of aquaculture has been the cause of environmental damage in some areas, such damage need not be a routine consequence of aquaculture. The scientific base for aquaculture is well established. Fish, shrimp, and other aquatic species can be and are being produced in an "environmentally friendly" manner.

The negative environmental impacts attributed to aquaculture most often have resulted from poor planning, inappropriate site selection and management procedures, and lack of attention to environmental protection. While much of the blame may be placed on rapid expansion, very often, practical aquaculturists did not understand the consequences of their actions. Lately, aquaculturists have been learning from their mistakes, just as pioneers in other new industries learned from theirs. Aquaculturists throughout the world recognize that they must take positive steps towards environmental protection, both in the interest of maintaining productivity within their farms and as good citizens and neighbours.

Techniques for preventing and mitigating adverse impacts of pond aquaculture in various areas of environmental concern are discussed below.

Conversion of mangroves and other wetlands

Mangrove forests and other wetlands are not optimal sites for aquaculture ponds. Soils in such locations often are highly acidic and may contain large amounts of organic matter. It is difficult to drain and dry soil to permit use of standard construction techniques. Water exchange by tidal flow in the creeks and channels of mangrove swamps is incomplete and pond effluents may not be washed completely away when discharged. As a result, it is difficult to prevent cross-contamination of intake water and discharge water on farms located in the intertidal zone. Wetlands are located in lowland areas and pond drainage in such areas may not be complete.

Wetlands and mangrove forests are fragile ecosystems playing an important role in nutrient cycling and supporting large biodiversity. They serve as essential buffer zones between terrestrial areas and water bodies. Mangroves are breeding and nursery grounds for many important species of fish, crustaceans, and molluscs. There is evidence that a decline in mangrove areas can diminish production of coastal fisheries. Most governments are now regulating the cutting of mangrove forests and protecting other wetland

areas. Controlled and sustainable use of such resources is desirable, and it is evident that no type of development will be permitted to clear huge tracts of a wetland in the future.

There is another important inducement for aquaculturists not to destroy wetland areas. Recent research has shown that mangrove forests and wetlands are highly efficient in enhancing the removal of solids and nutrients from aquaculture effluents. The discharge from aquaculture farms can be directed through mangrove stands and other wetlands to effect water treatment. For coastal aquaculture, this has the combined benefits of stimulating the productivity of the mangrove areas and enhancing coastal fisheries, minimizing pollution of the coastal environment, and providing a higher quality water supply for aquaculture. Aquaculturists should initiate mangrove reforestation and wetland construction projects to provide additional areas for water treatment.

In some circumstances, parts of aquaculture operations need to be established in wetland areas, e.g. inlet canals bringing brackish water to coastal shrimp farms, drainage canals discharging treated effluents in nearby rivers, and pumping stations. In these situations, careful planning needs to be done before construction. Disturbance caused by construction should be kept to a minimum. The canals or other infrastructure should not restrict natural water flow nor interfere with wildlife migration and ranging. Equally important, a management plan should be prepared to prevent further disturbance of mangrove and wetland during the life of the aquaculture project.

Eutrophication of natural waters

Feeds and fertilizers are used in most aquaculture ponds to stimulate production. Fertilizers increase nitrogen and phosphorus concentrations in pond waters and stimulate the growth of plankton. Photosynthesis by phytoplankton is the major source of dissolved oxygen necessary to maintain aerobic conditions in pond waters and superficial sediment. Feeds are consumed by fish, shrimp and other aquatic animals, but some uneaten feed reaches the pond bottom to be decomposed by micro-organisms and converted to inorganic nutrients such as ammonia, phosphate, and carbon dioxide. Cultured aquatic animals convert part of the feed they eat to flesh, but they excrete faeces, ammonia, carbon dioxide, and other metabolites. It is not possible to increase production with fertilizers and feeds without causing eutrophication of pond waters. Organic matter from uneaten feed, faeces, and dead phytoplankton serves as substrate for microbial activity. Micro-organisms can assimilate much of the waste load in ponds. They convert organic matter to carbon dioxide and water, nitrify ammonia to nitrate, and denitrify nitrate to gaseous nitrogen. Phosphate is strongly adsorbed and retained by pond bottom soils.

Ponds are efficient in assimilating organic matter and nutrients if the average hydraulic residence time in ponds is several weeks, and if ponds are not stocked and fed excessively. Nevertheless, water discharged from aquaculture ponds during water exchange or a draining for harvest may be enriched with nutrients and suspended and soluble organic matter when compared with receiving water bodies. Organic matter also settles to pond bottoms, and when ponds are drained, sediment particles may be resuspended. Receiving water bodies have the ability to dilute and

assimilate the pollutants entering them, and if that capacity is not exceeded, the discharges from aquaculture farms will not cause eutrophication. When discharged into large bodies of water, pollutants from ponds will be diluted, and currents will carry them offshore or downstream. At the same time the pollutants are being assimilated and rendered harmless. Therefore, to prevent pollution, site selection and infrastructure design should be done with consideration for efficient effluent disposal and prevention of eutrophication. When eutrophication occurs, water available for use in aquaculture farms will be negatively impacted because many water bodies are both the water supply and the effluent recipient for aquaculture farms. Methods to reduce the pollution potentials of outflows from aquaculture farms are essential both to diminish eutrophication of receiving waters and to protect the water supply of aquatic farms.

A number of techniques are now employed to reduce the concentration of nutrients, organic matter, and suspended solids in aquaculture farm waters. These include improvements in feed quality that enhance digestibility and reduce nitrogen and phosphorus content. Small quantities of feed placed on strategically-located underwater trays in ponds (feeding trays) or demand feeders allow farmers to determine how much feed aquatic animals will eat on a particular day to prevent overfeeding. Better aeration methods help maintain dissolved oxygen concentrations throughout the pond volume and in surface layers of bottom soils to enhance the assimilative capacities of ponds and reduce the pollution load in discharges. Better feeding methods and aeration technology have also reduced the need to exchange large volumes of water in coastal ponds with the result that less waste is discharged from ponds than in the past. Some farmers even use static water systems or water-recirculating systems that do not employ water exchange. Water is released mainly after heavy rains or when the ponds are drained for harvest. By holding water in ponds longer, more of the potential pollutants can be assimilated within ponds instead of being released to the outside. However, for this system to be effective, shrimp ponds should not be stocked with more than 30-40 animals /m². In channel catfish farming in the US, fish are harvested with seines without draining the ponds. It may eventually be possible to develop such techniques for shrimp farming and other types of coastal aquaculture.

Government regulations, discharge permits, and water quality standards could set criteria for maximum limits and ranges for effluent quality. However, it is probably more practical in tropical nations for the shrimp farmers to adopt codes of practice with best management procedures that provide environmental protection without need for intensive monitoring programmes for effluents. Such techniques have been used successfully in agriculture in the US, and afford both environmental protection and improved efficiency of production.

Sedimentation in natural water bodies

During pond construction there is potential for soil erosion because of exposure to rain and wind action. The risk of erosion can be reduced if construction takes place during the dry season. Precise cut and fill calculations prevent any excess soil material from being scraped and

disposed of in spoil piles. Good compaction of pond levees and canals are necessary, as well as embankment slopes that will prevent erosion from runoff. Canals should be designed so that water currents will not reach a scouring velocity and suspend soil particles through erosion of bottoms and sides of canals. Erosion-sensitive sites in canals should be lined. Embankments should be covered by grass species tolerant to the prevailing environmental conditions. During operation of aquaculture farms, proper attention should be given to maintenance of embankments and canals in order to reduce suspended solid concentrations in outflowing water.

Recent studies have shown that 50 per cent of the settleable solids discharged when channel catfish ponds were drained were released in the last 5 per cent of the effluent volume. These findings suggest that the best way to minimize suspended solids in aquaculture pond effluents is to harvest ponds by seining without complete draining, holding the remaining water for 2-3 days to permit sedimentation, and slowly discharging it. Alternatively, the water can be passed through a settling basin. Mangrove and other wetlands offer a potential option to settling basins for removal of nutrients, organic matter, and suspended solids from pond effluents.

The accumulation of organic matter, soil particles, and other sediments in the bottom of ponds is a common phenomenon during the aquaculture production cycle. In south-east Asia, farmers think that the sediment contains excessive amounts of organic matter and often remove the surface 510 cm layer from pond bottoms after each crop. Research shows that it is not necessary to remove sediment after each crop, and the practice is declining in popularity. Where aquatic animals are harvested after completely draining a pond, the pond bottom should be dried (sun-baked) for 2-3 weeks to increase microbial degradation of accumulated organic matter. Microbial decomposition can be stimulated by tilling the bottom of an empty pond with a disk harrow to encourage soil aeration. Small amounts of sediment that accumulate in the deeper areas of ponds can be excavated periodically, placed in areas of the ponds that have suffered erosion, and compacted. If larger amounts of sediment must be removed, the excavated material could be applied to specified areas that do not drain into freshwater bodies and that are not in contact with underground aquifers. Special care needs to be taken where such sediments come from brackish water ponds to avoid salt leaching into freshwater supplies.

Salinization of freshwater

Seepage through pond bottoms, discharge of pond waters into freshwater areas, and leaching of salt from sediment disposal sites can salinize freshwater. If ponds are built on sites with soils of adequate clay content, seepage usually will not be a major factor. It is not necessary to discharge pond water into freshwater bodies, and this practice should be prohibited, but when it is necessary, sediment should be disposed of in a manner to prevent leachates from entering freshwater.

Use of chemicals

The most common substances added to aquaculture ponds are fertilizers, liming materials and feeds. These materials can cause nutrient and organic enrichment, but they are not toxic. Zeolite is widely used in ponds in Asia

for ammonia removal. Zeolite is a natural mineral and has no real benefits to pond water quality, but it is not toxic or bioaccumulative. Chlorination is sometimes used to disinfect pond waters and bottom soils suspected of containing disease vectors. The common form of chlorine used in ponds is calcium hypochlorite. It is the same compound widely used to disinfect public water supplies and swimming pools, and it quickly degrades to non-toxic calcium and chloride ions.

Many Asian shrimp farmers use a variety of bactericides, enzyme products, bacterial amendments and other products in ponds. The benefits of these products to aquaculture are unproven. The products are not popular outside of Asia and their use is even declining there because benefits are not obvious. Nevertheless, all of these products have been used in other types of agriculture and they have a history of safe use.

Antibiotics are often used in shrimp farming. They are administered in the food or applied directly to the water. Overexposure of larvae to antibiotics in hatcheries may result in poor natural resistance and survival in production settings. Excessive use of some antibiotics during the grow-out period could lead to the development of resistant disease organisms. Persistence of tissue residues in marketable animals sometimes causes them to be rejected in the international market. It is also known that significant levels of antibiotic-resistant bacteria that are human pathogens can occur in aquaculture ponds where antibiotics are routinely incorporated into animal feeds. Antibiotic therapy is often the last line of defence for aquaculturists in attempts to control bacterial infections. However, regular use of antibiotics should be minimized, and serious consideration should be given to alternative methods of disease control.

Various insecticides have been used in shrimp and fish ponds to eliminate wild fish and to destroy potential carriers of disease. Many insecticides are bioaccumulative and can contaminate aquaculture products. Thus, general insecticide use in ponds should be prohibited. The only situation where it has proven necessary to use insecticides is for the control of a burrowing species of shrimp (locally known as ghost shrimp) in shrimp ponds in Central and South America. Control of the burrowing shrimp is effected with the carbamate insecticide Sevin. Sevin degrades quickly, so it can be used for this purpose without posing a risk.

Because it is necessary to use some chemicals in aquaculture management, all chemicals cannot be prohibited. The most effective approach would be one of government regulation in which governments make a list of chemicals approved for aquaculture and specify the use for which each chemical is approved. Such a system is currently used in the US, and is controlled by the Food and Drug Administration.

Conversion of crop land to aquaculture

In some countries, aquaculturists have obtained permission from the government to use land that had formerly been used by landless people for home sites, agriculture, gathering of wood for fuel and construction, hunting, fishing, and other purposes. The conversion of the land to aquaculture farms can restrict resources for local users and can sometimes force them from the land. Thus, there have been conflicts between aquaculturists and local people. These are social issues and cannot be solely addressed by

environmental scientists. The decision on how to best use land for maximum benefit needs to come from a broad consensus, involving aquaculturists, sociologists, environmentalists, representatives of local interests and local activist groups, economists, policy makers, etc.

Excessive use of resources

Freshwater resources are limited and they should be conserved. Freshwater aquaculture ponds should be operated without water exchange, and they should only be drained every few years for pond repairs and fish inventory adjustment. Instead of draining ponds for harvest, water can also be pumped to adjacent ponds and then reused in the same or other ponds.

In the early days of shrimp farming, it was a common practice in Taiwan and some other Asian countries to mix freshwater and brackish water to provide a salinity in production ponds of 15 ppt. Excessive use of freshwater from wells occasionally caused local land subsidence and salt water intrusion into freshwater aquifers. Shrimp have been successfully cultured over a salinity range from less than 5 ppt to about 40 ppt. Farmers outside Asia seldom use freshwater in ponds, and today, the practice is rare even in Asia.

Aquaculture feeds are made primarily from plant and animal meals, such as soybean meal, rice bran, fish meal, shrimp head meal, squid meal, etc. Vitamin and mineral supplements and other additives are also put in feeds. Some of these ingredients are by-products from other industries and their use in aquaculture feeds is a wise use.

Aquaculture, like any other type of agriculture, requires inputs of energy and other resources. Wise use of natural resources should be encouraged by sound management, conservation, use of alternative sources of energy, and recycling, but use of natural resources is necessary to meet the needs of the population.

Negative effects on fisheries and biodiversity

As already mentioned, mangroves and other wetlands are not good sites for aquaculture farms, and their protection is highly recommended. Eutrophication of water in aquaculture ponds is desirable to achieve good production, but aquaculture effluents may be more concentrated in nutrients and organic matter than many waters into which they are discharged. Discharge of such effluents should be kept to a minimum and effluent quality should be maintained within acceptable ranges for potential pollutants, because eutrophication reduces biodiversity. In coastal aquaculture, when water is pumped into the farm, various animals may be pulled into the pumps and killed. Impingement by pumps should be prevented by the use of intake screens.

Some kinds of aquaculture, mainly shrimp farming, have relied heavily on wild-caught broodstock and larvae to supply animals for stocking. Aquaculturists now prefer to produce or acquire larvae or fingerlings from hatcheries for stocking in production ponds. Hatchery animals can be

certified disease-free, or they may be the result of an enhancement programme where traits beneficial for growth and disease resistance were selected. If sufficient hatchery capacity is available, it guarantees that aquaculturists can stock ponds at any time desirable and makes production more efficient.

Scientific literature abounds with examples of problems resulting from the introduction of non-native species to certain regions of the world. Strict international regulations should be applied to aquaculture.

A proactive approach

A growing number of aquaculturists realize that denial of the environmental impacts of aquaculture is not to the benefit of industry. Industry must face the problem squarely and cooperate with governmental and non-governmental groups to protect the environment. It is apparent that much better management practices are being adopted in aquaculture and that farmers are more aware of the value of environmental protection than in the past. For example, most recent aquaculture conferences at local, national, and international levels have had sessions dealing with the environment, and several symposia have been convened specifically for aquaculture and the environment.

The alternative to a proactive approach by industry with development of production methods compatible with environmental protection is probably more governmental regulations. Regulations would probably take the form of zoning, restrictions on areas in which ponds can be constructed, limits of production or feed use, effluent water quality standards, and restrictions on discharge volume. Industry would have to develop food management methods in order to comply with such regulations, and considerable environmental monitoring would be required to show compliance with regulations. Thus, it seems highly beneficial for the aquaculture industry to be proactive and continue to provide solutions to environmental issues before solutions are mandated by others.

A number of aquaculture associations are trying to develop environmental guidelines for aquaculture. The Global Aquaculture Alliance (GAA), a new multinational consortium of aquaculture producers and marketers, is dedicated to the development and promotion of improved practices to enhance the efficiency of aquaculture and to reduce or overcome completely negative environmental impacts. The GAA believes these dual objectives are complementary. The GAA is in the process of developing codes of good practice and will emphasize their implementation in coming months.

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F. COUNTRY NEWS

Australia

Aquaculture course by correspondence

The National Fishing Industry Education Centre of TAFE at Grafton, New South Wales, Australia, is helping to develop Australia's aquaculture industry through training by correspondence, with about 400 people currently enrolled. The centre delivers its courses through the post, with the Internet increasingly utilized to share resources and exchange information.

The range of practical electives covers many aspects of commercial operations including fish biology, engineering, management, finance, and government regulations. The centre also offers specialized short courses, including Recirculation Technology Fish Farming which teaches indoor intensive tank fish farming using minimal water. (Source: *INFOFISH International*, June 1998)

Research into pearl culture

Scientists from James Cook University, Queensland, Australia, are in the Cook Islands researching new ways of stimulating the growth of pearls in farmed oysters. The joint project between the university, the Queensland Department of Primary Industries, and several Pacific countries is trying to increase the number of perfect pearls through various techniques including sedating the oysters before inserting beads and sealing the wounds after the operation using sterile methods to cut down on infection. At present, only a small proportion of pearl oysters produces quality gems, because some animals die after bead insertion and others reject the beads. (Source: *INFOFISH International*, June 1998)

Brisbane adopts IMS to improve operation

The Port of Brisbane Corporation (PBC) will introduce an Integrated Management System (IMS) during 1998/99, to ensure the Corporation is achieving world-class standards in its management and operation of the Port of Brisbane.

The IMS will consist of the International Safety Rating System (ISRS) and the International Environmental Rating System (IERS). PBC has been granted a licence to use both

systems by the world renowned company, Det Norske Veritas (DNV). DNV provides risk assessment and loss control management services, and has developed international rating systems for health, safety, environment and quality to measure loss control performance.

The benefits of the IMS include:

- Elimination of management inefficiencies to reduce the operating costs of accidents and other losses;
- Techniques to appraise group and organizational performance;
- Techniques to meet regulatory requirements and standards for occupational health and safety, and environmental management.

ISRS is a management tool used to objectively evaluate and quantify a company's health and safety efforts against the world's best management practices. ISRS was developed in 1978, and has been adopted by many national and international businesses such as Western Mining Company, Fremantle Port Authority, BP Oil, Queensland Rail and 20 per cent of the Fortune 500 companies. To drive the process of implementation, PBC has established its own Loss Control Unit.

IERS is an integrated, proactive approach to environmental management. The primary goal of the IERS is to provide an organization's management with the early warnings that are critical to the prevention and control of loss. Every PBC activity, including the operation of workshops, dredging, storm-water management, project development and management of contractors, will be assessed for environmental risk. IERS will also enable the Corporation to comply with current and future legislation, demonstrating a responsible approach to its workforce, neighbours and customers. (Source: *Ports and Harbors*, October 1998)

Thumbs up for marine servicing facility

Industry has given the "thumbs up" to government plans to establish a major new marine servicing facility at Jervoise Bay, south of Fremantle. A recent independent survey asked 42 of Australia's leading manufacturing and engineering companies about their attitude towards the project.

Jointly sponsored by the Western Australian and Commonwealth Governments, the \$200 million Jervoise Bay project will be spread over about 65 ha, providing engineering, fabrication, load-out facilities and a full range of technical support services. Its development, which is expected to take up to three years to complete and create more than 1,600 new jobs, will benefit numerous support industries particularly those linked to the offshore oil and gas industries.

Of special importance is the fact that the facility will be competitive on an international basis, against dockyards in Singapore, Korea, Japan and ports further abroad.

Despite uncertainty caused by the Asian economic crisis, Australian companies indicated their support for the facility and believed it had a strong long-term future. (Source: *Prospect*, December 1998-February 1999)

New ballast water rules now in force

All ships arriving in Australian ports now have to comply with tough new requirements to minimize the risk of introducing exotic marine species into the country's coastal waters.

Denis Patterson, AQIS National Manager, Animal and Plant Programmes, said that the new ballast water reporting and inspection procedures became effective on 1 August 1998 and that vessels must now provide an accurate report of their ballast water management arrangements.

The new requirements will become mandatory on 1 October 1998. Ships providing false reports from that date could be prosecuted and will be targeted on future visits to Australian ports.

The new rules foreshadow the expected adoption by the International Maritime Organization of a compulsory regulatory framework for ballast management in the year 2000.

AQIS estimates that more than 150 million tonnes of ballast water are discharged in Australia's territorial waters each year, by 10,000 ships in the country's 64 international ports. The number of exotic marine species in Australia currently exceeds 200. (Source: *Ports and Harbors*, December 1998)

Azerbaijan

Largest fish farm planned

According to the newspaper *Azadlyg*, Azerbaijan plans to build the biggest fish farm in the world by the first quarter of the year 2000. The US\$ 5 million farm, to be sited on the Kura river, will reportedly produce some 15 million sturgeon per year. If approved, an international tender will be called. The Azerbaijani Government is believed to have already held talks with the World Bank on this. (Source: *INFOFISH*, June 1998)

Belgium

Antwerp found to be fourth largest port in the world

The Antwerp Municipal Port Authority's think-tank has calculated that Antwerp is currently the fourth largest port in the world. In order to estimate the importance of a port within international trade flows, figures for seaborne inter-

national goods traffic were used, while excluding national maritime traffic.

As a result, ports with a great deal of internal traffic had a much lower score than expected. The base year is 1996, whereas the sources included the Navigation Data Center of the US Army Corps of Engineers, the *Journal de la Marine Marchande* ("Les trafics des ports du monde", December 1997), as well as a variety of other publications, Web sites, and questionnaires sent out to various port authorities.

One of the problems centred on the discrepancy in the units used by ports in their goods handling figures, viz. metric tons, long tons, short tons, harbour tons, freight tons, and revenue tons. In order to obtain an unbiased result, conversions were made based on tested methods. But what about the result? In terms of international traffic, Rotterdam is still the world's largest port, with Singapore being a close second.

At a small distance we find Hong Kong and Antwerp in third and fourth positions, respectively. For the purpose of the study goods handling quality was disregarded since it is impossible to distinguish bulk traffic flows (with a low added value) from unitized traffic and conventional general cargo (with a high added value) for a sufficient number of ports.

Anyhow, together with the volume of its seaborne goods traffic it is Antwerp's uniquely balanced mixture of traffic flows which makes it a major player in international trade. (Source: *Ports and Harbors*, July-August 1998)

Canada

Moratorium under review

Officials are beginning to take a second look at a 26-year-old moratorium on drilling off Canada's Pacific coast. A recent preliminary geological report stated that the region could possibly hold up to 9.8 billion bbl of oil and 1,228 bcm of gas. The moratorium was enacted in 1972, and officials have not announced any plans on ending it. However, Western Canadian businesses eager to make up for the severe decline in the fishing, mining, and timber industries with oil and gas exploration are beginning to put pressure on the Government for a change. (Source: *Offshore*, December 1998)

From Commission to Port Authority—Nanaimo

With effect from 1 January 1999 the Nanaimo Harbour Commission will become one of Canada's new Port Authorities and be officially renamed Nanaimo Port Authority.

With the passing of Canada Marine Act Bill C-9 in May 1998 the Nanaimo Harbour Commission is now in the process of undertaking all the necessary restructuring required to comply with the guidelines of the new Act.

The changes implemented in the Canada Marine Act will impact the Nanaimo Harbour Commission by requiring payment of a stipend to Ottawa and grant-in-lieu of taxes to the City, increases in the Board size from five to seven directors, compliance with the Official Languages Act and more public disclosure. (Source: *Ports and Harbors*, October 1998)

China

Offshore discoveries

China has discovered three oil and gas fields in the northeastern area of Bohai Bay with proven reserves of 60 million tons of oil and 8 bcm of gas. The discoveries are in Shijiutuo, an area 100 km off the port of Tanggu covering 600 km². Testing showed daily production levels of 31 MMcf/d of gas and an estimated 190 tons of oil per day, making Shijiutuo China's largest offshore oil producer. (Source: *Offshore*, December 1998)

Joint venture to redevelop Dalian Port eastern sector

PSA Corporation signed an agreement for the formation of an equity joint venture with the Port of Dalian Authority (PDA), on 16 October 1998, to promote the redevelopment of the eastern port area of Dalian Port (Donggang) into a modern business hub. The agreement gives PSA a 50 per cent equity in the joint venture company.

Situated next to Dalian city's busiest business district, the Donggang area has the potential to be further developed into a centre for tourism, waterfront and commercial activities. The agreement will allow both PDA and PSA to explore cooperation in promoting the redevelopment of Donggang. PDA and PSA will form an equity joint-venture company to take charge of the overall planning, marketing and implementation of the plan for the development of the Donggang area. (Source: *Ports and Harbors*, December 1998).

Denmark

Maritime advances

A variety of remarkable engineering projects have been carried out in Danish waters. Current projects include construction of bridges and tunnels (on the agenda for many years) in order to improve the infrastructure within Denmark and in relation to neighbouring countries. In recent years the construction of the Great Belt Bridge (opened June 1998) and the Sound Bridge between Copenhagen, Denmark, and Malmö, Sweden, have been the dominant marine engineering projects. In connection with the construction of these two bridges, comprehensive oceanographic research has been performed for the purpose of identification and reduction of possible effects on the environment of the Baltic Sea. This work was primarily conducted by the Danish Hydraulic Institute, which has also started preliminary environmental investigations for a bridge between Denmark and Germany.

Coastal protection is an important issue along the relative long coastline of Denmark. The Danish Coastal Authority is responsible for the construction and maintenance of coastal protection activities in Danish waters and, together with the Danish Meteorological Institute, operates a storm surge warning system.

The marine environment of Danish waters, being an exchange area for water flowing in and out of the Baltic Sea, is very sensitive to imported and local environmental effects. These conditions often result in anoxic conditions and subsequent fish deaths. The Danish Environmental Research

Institute and the local country authorities are responsible for monitoring and assessment of the marine environment. The national marine environmental monitoring programme was revised, upgraded in 1997, and now includes advanced automatic measuring stations securing a real-time retrieval of important data.

The Danish Navy operates units in Danish, Faeroes, and Greenland waters and, in addition to military tasks, also performs fisheries inspection, prescription of sovereignty, rescues, hydrographic surveying, etc.

In Greenland waters, sea ice constitutes a severe problem to all maritime activities and the Greenland Ice Service under the Danish Meteorological Institute has for more than 40 years prepared ice maps based on visual observations from aeroplanes and helicopters. In recent years, the production of ice maps is increasingly based on satellite images.

The Danish marine research community is rather fragmented with a relatively small amount of marine scientists employed by many small institutions. Despite this disadvantage, Danish research groups are active in many international marine research projects funded, for instance, by the European Union. Danish marine scientists within recent decades have played a leading role in disciplines including marine optics, remote sensing, underwater acoustics, turbulent mixing, numeric modelling, marine biology, etc. Denmark, together with the other Nordic nations, participated in large ocean climate programmes like the Greenland Sea Project and World Ocean Circulation Experiment (WOCE) and is now playing an active role in EuroGOOS—the European component of the global ocean observing system (GOOS) (Source: *Sea Technology*, August 1998)

European Union

Future of marine technology

Marine science and technology, in the next European Union framework programme on research (FP-V), will not be addressed in a single thematic programme but rather will be integrated into distinct but complementary parts of the European Union research portfolio. Within the new philosophy and the new structure of FP-V (1998-2002), as proposed by the Commission [OJ No. C106 of 6.4.1998 + COM(98) 305], there will be several "key actions" that will touch upon marine research and technologies. The problem-oriented, interdisciplinary, and focused key actions have been selected on the basis of a number of criteria that reflect society's needs. Hence socio-economic research will also be integrated into these key actions.

In order to achieve concentration, the key actions have been regrouped into four thematic programmes (as compared to the 15 thematic programmes for FP-IV), which are complemented by generic activities and support for infrastructures. In addition to the thematic programmes, there are three special horizontal programmes for international cooperation, small and medium enterprises and innovation and training of researchers.

Marine research itself and the development of marine technologies will now be integrated into the key actions—"Sustainable agriculture, fisheries and forestry, including

integrated development of rural areas"; "Land transport and marine technologies"; "Global change, climate and biodiversity"; and "Sustainable marine ecosystems". Although the specific details can be found on the Commission server at <http://www.cordis.lu/fifth/home.html>, it is worth noting that the marine technologies related to navigation or exploitation of resources will be in the key action Land Transport and Marine Technologies while the technologies needed for ecosystem research are integrated into the two key actions of the programme Preserving the Ecosystem, which will also include energy-related marine research in two other key actions.

These key actions will substantially profit from the experience gained and groundwork laid in the three MAST programmes. The networks of scientists and engineers, the interactions between European Union-funded R&D projects, and the other R&D activities (like those of EUREKA or those at the international level) will substantially contribute to the further success of marine and oceanographic European R&D. The new wind of FP-V should give a strong impetus to the sector, eliminating on one side outdated activities and concentrating on the other side on the needs of today and of the future. (Source: *Sea Technology*, August 1998)

Finland

Marine science and technology

Finland is the only country in the world which is surrounded by sea ice every winter, leading to a substantial emphasis on tackling sea ice problems. The Finnish shipbuilding industry has focused on specialized vessels, in particular those capable of operating in severe ice conditions. Marine research has contributed through a variety of studies of sea ice, its modelling and detection by remote sensing. These research themes are still very relevant, not only for the local problems of the Baltic Sea but for developing tools for sustaining activities in other ice-covered regions, such as the Arctic Ocean.

The development of marine science in Finland during the last decade can be characterized by moderate expansion, increased focusing of targets, and increased internationalization. Marine research is carried out at five universities and six governmental research institutes. Public funding of the latter dominates. Yet, basic research forms more than one third of the activities due to a tradition of using basic research as a tool for developing improved methods for applications.

The Finnish Institute of Marine Research is responsible for half of the national marine research. Its research fields consist of physical, chemical, and biological oceanography; monitoring of the Baltic Sea environment; and services for maritime safety. Main focus is on the Baltic Sea with basic research on other cold seas: the Northern Atlantic, Barents Sea, and Weddell Sea.

The institute has developed numerical models for ice forecasting and is developing coupled ice-ocean models for the Baltic Sea and satellite remote sensing applications for customers. The 10 national ice-breakers obtain daily ERS-1 and RADARSAT images for their use, processed and interpreted for ice types. These services smooth the operations of

more than 20,000 port visits during the ice-covered winter period. For maritime safety, forecasts and reports on wind waves are given daily, by broadcast and by Internet. In the long term, this activity will be merged in a multinational EuroGOOS subprogramme, called BOOS. (Source: *Sea Technology*, August 1998)

India

Reliability prime factor in hub port selection

Shippers in India consider hub port reliability and efficiency to be the most important criteria in their selection of hub ports, a survey of 200 exporters, freight forwarders and shipping lines/agencies in India has shown. The survey was conducted by PSA Corporation during marketing seminars held in the four Indian cities of Madras, Bombay, Chennai and New Delhi in 1998.

The survey asked seminar participants from the four major Indian cities to rank, in terms of importance, eight criteria used in hub port selection: hub port charges, reliability of hub ports, efficiency of hub ports, feeder freight rates, frequency of feeder services, concentration of main-haul services, services at hub ports and total transit time.

A majority (58 per cent) of Indian shippers ranked hub port reliability and efficiency as their most important criteria in hub port selection. Of the two, reliability was more important than efficiency, with a third of Indian shippers voting for the former and a quarter for the latter.

Hub port charges ranked only third in the Indian shippers' list of most important criteria in hub port selection, with 12 per cent of exporters citing it as an important factor in their choice of hub port.

The findings explain the upward trend of Indian shippers trans-shipping at Singapore, which has seen a more than 20 per cent increase in annual container traffic to and from India in the last five years.

The survey also revealed differing trends among shippers in different parts of India. While shippers in Calcutta, Madras and New Delhi rated efficiency and reliability as critical factors in hub port selection, for shippers in Bombay it was freight rates. (Source: *Ports and Harbors*, October 1998)

Ennore coal port

Following feasibility studies of the coal transport chain from the coal fields of Paradip to the coal-fired power plant of Ennore near Madras, HASKONING Consulting Engineers and Architects (the Netherlands) were commissioned for preliminary and detailed design, tender procedures and supervision of construction of the complete new coal port at Ennore. The services comprise all aspects of port planning, design and construction supervision of breakwaters, entrance channel, harbour basin, wharfs, port infrastructure, etc. For the designs, a wide range of investigations and studies were carried out: offshore and onshore soil investigations, wave data collection, numerical modelling of waves, currents, cyclonic conditions and nautical characteristics of the design alternatives (fast-time), physical modelling of breakwater design and nautical characteristics (real-time) and environmental studies. Construction of the port is progressing to schedule.

The coastal regime at Ennore is affected by a significant littoral drift from south to north. The impact of the new port protruding into the sea in this respect has been studied extensively. As initial measures, three small groynes and one larger groyne will be constructed together with 2.5 mm³ sand nourishment. The coastal regime is also influenced by a creek outlet south of the port.

Some technical details:

- Total breakwater length: 4.2 km;
- Total dredging volume: 13 mm³;
- Total rock volume: 3.3 mt;
- Wharf length: 550 m.

Major civil engineering contracts:

- Rock quarrying and transportation: Hindustan Construction Company (HCC), India;
- Breakwater construction: HCC (India)/Van Oord ACZ (the Netherlands) Joint Venture;
- Wharf construction: Afcons (India);
- Dredging: Jan de Nul N.V. (Belgium);
- Onshore Port Infrastructure: various Indian contractors.

The work was financed by the Madras Port Trust and a loan from the Asian Development Bank through the Government of India. (Source: *The Dock & Harbor Authority*, vol. 79, No. 886, 1988)

Ireland

Gateway to the north-east Atlantic

Irish marine renaissance

The 1990s have seen the beginnings of a marine renaissance in Ireland. In 1987, the Irish Government established a Department of the Marine to "achieve the full potential of Ireland's marine resources" followed, in 1991, by the formation of a specialist R&D body, the Marine Institute. Its brief is to: "Undertake, to coordinate, to promote, and to assist in marine research and development and to provide such services related to marine research and development that in the opinion of the institute will promote economic development and create employment and protect the marine environment".

In 1994, the board of the Institute initiated a development plan aimed at the core priorities of drawing up a national marine R&D strategy, building the capacity to carry it out, and raising the awareness of the Irish people to their marine heritage. The key areas for development were targeted as:

- Marine food (including fisheries, aquaculture, and food processing);
- Water-based tourism and leisure;
- Seaweed-based industry (including food-based and chemical/pharmaceutical-based activities);
- Marine technology and instrumentation;
- Ocean energy (including wind and wave energy);
- Seabed resources (including oil, gas and mineral deposits);
- Ports and intermodal maritime transport;
- Offshore industries and ocean engineering.

Marine environmental quality and sustainable development strategies are identified as essential issues underpinning each of these sectors.

National marine R&D strategy

The Institute's approach to marine resource development has always been "demand-led" through identification of profitable and self-sustaining industry niches in consultation with the business community. Following an intensive 18-month assessment, the institute prepared a draft strategy document, *A Marine Research, Technology, Development and Innovation Strategy for Ireland—A National Team Approach*, which identifies the barriers to development that can be addressed by research.

With the assistance of European Union Regional Development Fund (ERDF) aid, Ireland has made great strides in upgrading its marine research infrastructure. This includes a major extension to the Marine Institute's Fisheries Research Centre, a new purpose-built multi-disciplinary research vessel Celtic Voyager, and a wide range of cooperative initiatives. These involve both research institutes and private enterprises to the tune of Ir3.8 million in the areas of fisheries, aquaculture, marine food processing, marine survey, and technology. A recent initiative between the Irish Government and the oil industry is encouraging geological, environmental, and metocean studies in the Rockall Trough.

High quality data

The Irish Marine Data Centre is a core operational element of the Marine Institute, managing and providing high quality marine data and information services to both the Institute itself and to the national and international communities. Products include the Extended EDMED Database (an electronic directory of marine environmental data holdings) and EDAP, a guideline document on marine electronic data management and publishing.

With respect to the marine environment, the Marine Institute is currently finalizing a detailed assessment on the environmental quality of waters surrounding Ireland. The report will not only provide an assessment of current conditions and gaps that need to be addressed, but it will also provide Ireland's input to the Convention on the Protection of the Marine Environment of the Northeast Atlantic (OSPAR Convention 1992) and the proposed Ministerial Conference in 2000.

Ireland provides a unique location from which to direct cooperative research and survey projects in the north-east Atlantic. Irish marine research institutions are already involved in more than 60 cooperative research projects funded under the European Union's fourth Framework Programme (1994-1998). The new Framework Programme (1998-2002) will support cooperative research in fisheries and aquaculture, sustainable marine ecosystems (processes, coastal zone management, operational forecasting), marine technologies, climate change, biodiversity, ocean energy, information technology and food, and nutrition and health. It offers increased opportunities for focused and competitive cooperative R&D initiatives. Participation in this programme is not confined to European Union member States but includes a number of other countries that have signed cooperative research agreements.

In addition to facilities provided by the Marine Institute, Ireland has six national universities and a number of institutes of technology, many of which have specialized

marine interests. The National University of Ireland (Galway) Marine Science Institute (MRI) supports research in oceanography, marine botany, zoology, microbiology, and atmospheric physics and hosts a very useful Web site reference guide to marine algae (<http://www.seaweed.nvigoalway.ie/botany/botany>). The National University of Ireland (Cork) is home to the Coastal Zone Institute (CZI), comprising the Aquaculture Development Centre, the Coastal Resources Centre, and the Hydraulics and Maritime Research Laboratory (<http://www.ucc.ie/research/czi>). Foreign research vessels are increasingly using Ireland as a port of call for the embarkation-disembarkation of scientific and ship personnel because of its excellent port facilities, good communications infrastructure, and no doubt the renowned hospitality of Irish people. (Source: *Sea Technology*, August 1998)

Docklands revival

For years, much of Dublin's docklands area has been run down and semi-derelict, but all that is set to change with the new Dublin Docklands Development Authority, which is mandated to oversee the redevelopment of the area over the next 15 years at a cost of £1.6 billion. Some of the development envisaged will include high tech industries and state-of-the-art business, including e-commerce. A digital park is among the measures being proposed. The aim of the authority is to create between 30,000 and 40,000 new jobs in the area and to increase the number of people living here by 25,000 by 2012. At present, 17,000 people live in docklands, often in depressed and deprived communities.

The area covered by the new authority's remit extends to 526 hectares (1,300 acres) and is on both sides of the River Liffey, stretching from the corner of the East Wall Road and North Strand Road on the north side of the river right across to Ringsend, Irishtown and the Poolbeg peninsula on the south. (Source: *Technology Ireland*, June 1998)

Italy

Marine sciences

In 1994, the Interuniversity National Consortium for Marine Sciences (CONISMA) was founded, with the main office in S. Margherita Ligure at the Institute of Marine Environmental Sciences. To CONISMA 23 universities are associated with 544 scientists and technicians and its activity mainly develops five objectives:

- Organization;
- Promotion;
- Planning and carrying out research, education and training;
- Transfer of the results to applied and technological scientific sectors;
- Setting up meetings, seminars, and coordinating assemblies at national and international levels.

Each university of the consortium has its own research unit working alone or in connection with other units, according to programmes and contracts. The scientific theme areas into which the research units converge for a common cultural and scientific background are:

- Brackish, coastal and oceanic environments;
- Marine protected areas;

- Fisheries, aquaculture and mariculture;
- Marine technology and biotechnology.

CONISMA is very active in various programmes at the EC level. Among the others: Eurorock (physical and biological interactions on the European rocky shores) and Codepass (community complexity and the decomposition process in aquatic system—an ecosystem approach to manage biodiversity).

Since 1996, the National Research Council (CNR) has established the National Institute for the Coordination of Marine Sciences (ISMARE) with its main office temporarily in Ancona at the Research Institute for Marine Fisheries (IRPEM) of the CNR. ISMARE has as scientific references the National Committee for Science and Technologies of the Environment and Habitat, the National Committee for Physical Sciences, and the National Committee for Geological and Mining Sciences of the CNR.

ISMARE, to which belong 15 institutes with a scientific manpower exceeding 300 units, is planning the research project SINAPSI (seasonal, inter-annual, and decadal variability of the atmosphere, ocean, and related marine ecosystems), which will be developed in four directions:

- Observational and modelling studies of the global climate system;
- Climate variability in the Mediterranean area;
- Climate variability of the Mediterranean marine ecosystem;
- Climate variability of the past climate regimes.

This programme will be financed by the CNR and will also involve research units of the national agency ENEA, universities, and the Zoological Station of Naples.

It is worthwhile noting that ISMARE, being an institution of the national agency CNR, is pursuing the goal of becoming the reference point for the coordination of marine research, according to the main objectives of the national policy, as well as those of international bodies such as the EC and the IOC. (Source: *Sea Technology*, August 1998)

Development of Leghorn

Plans for a "chemical bay" to rival Porto Marghera and Gela on Sicily are developing in Italy. A three-year government project to improve Italy's port infrastructure has now borne fruit. The province of Leghorn at the mouth of the river Arno on Italy's west coast is determined to become a leader in chemicals "as we were in the last century", say the region's promoters.

Once the headquarters of former Italian chemicals giant Montedison, the port of Leghorn has weathered a period of deep industrial recession and has embarked on a reindustrialization drive. Still home to three chemical majors—Solvay, RhodiaChem and Dow Chemical—the region is now seeking new chemical investors, particularly SMEs, to occupy the more than 1.8 km² of land set aside for industrial development.

The port is the 14th most active in Europe, handling more than 20 m tonne/year of goods and competing for container traffic with Rotterdam and Marseilles. The reforming of Italian labour laws has meant the cost of handling each container has halved since 1989.

The driving force behind the development of the port of Leghorn is the Port Authority. It serves as a reference

point for clients from around the world and is responsible for the direction, programming, control, promotion and coordination of port activities.

In addition, the authority is currently helping several operators, including Dow Chemical, seek joint venture partners to occupy part of its existing site; Dow uses only a third of its 100,000 m² property. Within the port area itself, developments can only take place on existing property. This should change at the end of February 1999 when a government safety audit is expected to give the go-ahead for outward expansion.

"The port boasts ideal nautical and meteorological conditions, a mild climate with no fog, winds of no more than 90 km/h and minimal tide changes," according to local shipbuilder, Luigi Orlando. The port is connected by rail and motorway to the "Amerigo Vespucci" intermodal centre, and the international airports of Pisa and Florence are 15 km and 90 km away respectively.

Two waste disposal plants operate in the area. According to the Leghorn industrial association, these treat about 250,000 tonne/year of hazardous industrial waste such as sludges, waste water, emulsions and hydrocarbon wastes using physical and biological treatments.

The wealth of university graduates (10 per cent of the population) has led to the establishment of many university-driven research centres such as the Leghorn science and technology park, the bioelectronic science and technology park of Elba; the Magona di Cecina technological park and the University of Pisa's 19 research centres.

The Leghorn Industrial Port Company (Spil) is a public/private agency which serves as a central clearing house for new investors. Spil was set up in 1928 to promote industrial start-ups in the area and distributes bank and government funds for new projects in areas with existing infrastructure. The agency calls itself the "privileged channel" between new investors and institutions because it can help speed up bureaucracy.

Spil helps new investors seek financing in the form of public grants to typical venture capital investments. For example, under European Union law, Leghorn is classified as a depressed area and therefore eligible for special European Union or national grants. Conditions for seeking bank financing are "particularly favourable" for new production start-ups. Spil also operates as the local office for Italinvest, a government-owned company which acquires temporary and minority shareholdings in SMEs.

The port of Leghorn is distinguished by the large amount of services it provides in shipbuilding and repair. The Luigi Orlando shipyard in the southern port area monopolizes the construction and repair market for mid-tonnage ships, ship repairs and conversion. It is assisted by several private shipyards. (Source: *European Chemical News*, 14-27 December 1998)

Japan

"Kuzzoko" culture a success

The Fukuoka Fisheries and Marine Technology Research Centre has been able to produce juvenile kuzzoko (three-lined tongue-sole), a fish of the Cynoglosidae family. This fish is the main species of the Ariake Sea and is highly prized in Japan, where it is served raw, cut into slices, or

cooked in consommé or "murriel". Kuzzoko is considered a species of great commercial value among the fishermen working in the Ariake Sea, who have repeatedly called on the Government to increase stocks to compensate for the decline in catches. The Ariakekai laboratory and the marine institute developed a farming system for producing kuzzoko juveniles and obtained about 200 fish up to 50 cm long in July 1998. They selected 83,000 eggs of good quality between April and May, but only 78,000 hatched. (Source: *INFOFISH International*, January 1999)

In the name of science

The country that introduced "scientific whaling" has now started "research fishing". In defiance of an agreement with Australia and New Zealand, Japan's Fisheries Agency has begun catching southern bluefin tuna outside the normal fishing season and outside the normal quota, ostensibly to gather data on stocks of the prized delicacy.

The Commission for the Conservation of Southern Bluefin Tuna allows Japan to catch 6,065 tons of southern bluefin in the Indian Ocean each year. But the fourth annual meeting of the Commission adjourned without reaching agreement. Japan wanted to increase its quota by 25 per cent, but fisheries experts from Australia and New Zealand argued that such an increase could make the southern bluefin extinct by 2020. The fish is classified as "critically endangered" by the IUCN, the World Conservation Union.

"We expect to sample around 1,400 tonnes", says Joji Morishita, a senior official at the agency. "This tuna will be utilized in the same way as commercial tuna in order not to waste this precious resource." In other words, it will be sent back to Japan, sold at the market price of £15 to £30 a kilogram and eaten.

The normal fishing season begins in September, but the Japanese vessels are going out seven weeks early to do their "research". They will catch tuna using lines several kilometres long, with up to 3,000 hooks each. "The boats' licences as commercial vessels will be frozen and they will be licensed by the Government temporarily as research vessels", says Morishita. "At the end of August the sample tuna will be inspected." The same boats will then return to the fishing grounds to take their normal commercial catches. Japan says it wants to show that bluefin tuna are more widespread than Australia claims. The research boats will be fishing in an area of the Indian Ocean that has not been recently fished.

The Australian Government is incensed by what it sees as a cynical move to increase commercial catches under the pretence of doing science.

Australia has already taken action against Japan. It banned Japanese long-line vessels from its ports after the collapse of the talks in February 1998 and has also excluded these boats from its 320-kilometre offshore economic zone. (Source: *New Scientist*, 18 July 1998)

Republic of Korea

Access to Russian port may shorten trade route with China

As early as August, the existing trade route between the Republic of Korea and north-eastern China may be shortened by over 1,000 km.

The shortening of the trade route depends upon Russia's acceptance of a proposal by Seoul to utilize a port city located near Vladivostok, according to the Ministry of Maritime Affairs and Fisheries of the Republic of Korea.

Until now, Korea's sole access to China has been through maritime routes on the West Sea, requiring long voyages in order to reach China's north-eastern provinces of Jilin and Heilungjiang. However, the distances could be cut in half if Korea gains access to the Russian port city of Poshtet about 100 km south of Vladivostok on the East Sea. The port city is located on a narrow strip of land touching the north-eastern border of North Korea, thereby allowing access to China through the East Sea.

"The opening of the new maritime route will lead to the economic development of Kangwon Province and create an additional \$1 billion in trade between Korea and north-eastern China, whose market is scaled at \$440 million annually", a Ministry spokesman said. (Source: *Newsreview*, 19 June 1999)

Malaysia

Norwegians help set up farm

An offshore fish farm is being built in the northern Penang state of West Malaysia, with the help of Norwegian aquaculture experts. The Malaysian and Norwegian Governments signed a record of discussion to develop marine cage culture in July 1997, and in March 1998 a memorandum of understanding between the Halim Mazmin Group and Marine Farms of Norway was signed. A Norwegian researcher from Marintek in Trondheim, is now stationed at the Fisheries Research Institute in Penang with the aim of establishing the farm. According to the Malaysia Norway Business Council, the Governments hope that the combination of Malaysian expertise in dealing with tropical species and Norwegian experience in offshore aquaculture methods and technology will produce 600,000 mt of fish by 2010 through the introduction of more offshore aquaculture systems. (Source: *INFOFISH International*, January 1999)

Malta

Valletta cruise terminal development initiated

This is one of a number of projects which were initiated by the Prime Minister intended to bring about the complete rehabilitation of historical sites particularly those along the waterfronts in Valletta and Cottonera. These projects include the yacht marina and related development at Cottonera, the cruise terminal and ancillary activities at Valletta, the restoration and rehabilitation of a number of areas in Valletta, and a new lift system intended to link the capital centre with the waterfront.

These projects, although separate, are in fact part of an overall plan aimed at enhancing the economic prosperity and social conditions of the citizens of the area through private sector investment in commercial activities. Certain linkages are already evident, for example through the planned waterborne connections between Cottonera and Valletta quays and into the city centre via the new lift system.

The main highlights of the Valletta Terminal Project include:

- The building of a major cruise terminal capable of handling a number of cruise liners simultaneously;
- The setting up of large duty-free facilities;
- The embellishment and landscaping of the public promenade;
- The setting up of retail, catering and other commercial establishments;
- The rehabilitation and re-use of the historic Pinto Stores and its environs; and
- The construction of a tunnel for vehicular traffic.

Overall the Mediterranean has witnessed unprecedented growth as a major cruise destination, second only to the Caribbean both in terms of the number of cruise passengers as well as in the number of cruise liners calling in the region.

The port of Valletta, strategically situated in the centre of the Mediterranean, has been a major player in this development. In recent years, cruise lining activity has increased considerably. In 1997 over 129,000 cruise passengers visited the port, representing a 78 per cent increase over the previous year's figures. Forecasts for 1998 indicate an even better performance.

The project is similar and complementary to that across the harbour where another maritime-related leisure development based on the construction of an international yacht marina and linking the waterfront along the Three Cities, is due to start. Both projects will serve to revive waterborne links between Valletta and the Three Cities. (Source: *Ports and Harbors*, May 1998)

Myanmar

Overview of fisheries resources

Myanmar, an agrarian country, is endowed with equitable climatic conditions and vested with an abundance of land, water, fishery and forestry resources. The agriculture sector which includes agriculture, forest, livestock and fishery subsectors, is the most important sector in Myanmar's economy, accounting for about 46 per cent of GDP and about 79 per cent of export earnings as of 1995-1996. Three quarters of Myanmar's population is rural, and the agricultural sector directly and indirectly engages two thirds of Myanmar's 45 million inhabitants.

Marine environment

Myanmar has a long coastline of 2,832 km with a continental shelf area of 225,000 km². The continental shelf is relatively wider in the central and southern parts. The estuarine area covers most of the central part of the coastal area where the Irrawaddy and Salween rivers empty their freshwater. The exclusive Economic Zone extends seawards to a distance of 200 nautical miles from the baseline.

Types of fisheries

Fisheries in Myanmar are divided into freshwater fisheries and marine fisheries. The marine fisheries are classified into onshore fisheries, inshore fisheries and offshore fisheries.

Marine fishery

Marine fishery activities in Myanmar are concentrated in three distinct fishing zones (i.e., onshore, inshore and offshore). The onshore area is characterized by extensive intertidal mud flats. The use of fixed gears such as traps, stake nets, and cast nets are the most common methods of fishing in the onshore area. The inshore area starts from the lowest tide level to the 8-fathom line (approximately 5-10 miles from shore) wherein gears such as gill-nets, drift nets, shore-seine, small longlines, handlines and cast nets are commonly used. The active gear popularly used in the capture of hilsa is the encircling gill-net. The offshore area is described as the zone that starts from the 8-fathom line and beyond. The fishing methods used in offshore areas are similar to those used in inshore areas. Their respective share of the total marine fisheries production is as follows: onshore fishery contributed 209,200 mt, inshore fishery contributed 215,500 mt and offshore fisheries contributed 100,600 mt.

The species of fish landed are pelagic species such as sardine, anchovies, mackerel, etc. while demersal catches consist mainly of chub mackerel, bartail flathead and threadfin bream, while the deep sea catches are mainly shark, shrimp and lobster.

Total production

Total fish production shows an increasing trend over the years. In 1995-1996 total fish production reached 0.83 million mt, made up of 0.22 and 0.61 million mt of freshwater and marine fish respectively. Production from marine resources accounted for 73 per cent of the catch. The fishery resources, in particular marine resources, still remain under-exploited, with the maximum sustainable yield (MSY) around 1.05 million mt.

Legal aspects of fisheries

To make legal provisions for investment in Myanmar, the Government enacted the Foreign Investment Law on 30 November 1988. The State has promulgated four relevant fisheries laws to manage the industry and to protect the environment.

Issues and constraints

Several issues and constraints have been identified that hinder the development of the sector. Amongst the major constraints are:

(i) *Insufficient information on fisheries resources*

There is a lack of scientific information including resource status and insufficient or inaccurate statistics.

(ii) *Infrastructure*

There is lack of fish processing facilities both onshore and on-board fishing vessels.

(iii) *Fisheries harbour*

There is a need for better harbours with necessary facilities such as ice supply, engine repair facilities, fuel supply etc., at the major fishing centres.

(iv) *Research*

Facilities are lacking in the marine sector in terms of trained manpower, equipment and funds for research activities. Assistance and cooperation from international and regional bodies are required to achieve optimum exploitation of marine resources in Myanmar.

(v) *Training*

Marine training institutions/centres need to be established to upgrade technical skills of the fishing populace, in areas of fishing skills, navigation and engine maintenance.

Outlook

The fisheries sector is of vital importance to the economy of Myanmar. Its contribution to the nation's animal protein requirements remains substantially high, and has been on the increase. The per capita consumption of fish for the year 1995-1996 was 17.4 kg.

It has been some years since gear studies or resource surveys were conducted in Myanmar waters and there may be significant changes in biomass and the distribution of the marine resources. Studies on fishing gear suitable for harvesting these resources should be given priority.

Areas that require attention in the fishery sector are conservation of resources, provision of more modern facilities, expansion of investments in offshore and inshore fishing and improved technologies for fishing.

Myanmar has been endowed with an abundance of natural resources and food insecurity is not expected to be an issue. However, as a country economically dependent on agriculture (including fisheries), the Government has given high priority to its development and, *inter alia*, food security. The past decade witnessed impressive progress and the next decade also looks promising for further growth.

Export potential of fisheries products is rather limited due to lack of capital, market, insufficient onshore facilities such as ice plants, cold storage, canning factories and fish-meal plants. In order to increase fisheries production and export, construction of cold storage facilities, fish meal plants, canning plants and also establishment of marine as well as freshwater hatcheries along the entire coast has been included in the sectorial development plans of Fisheries Department of Myanmar. (Source: *INFOFISH International*, May 1998)

The Netherlands

Dutch water policy

In the Netherlands, the Ministry of Transport, Public Works and Water Management is responsible for water and shipping policies. The Directorate-General for Public Works and Water Management (Rijkswaterstaat), as part of this ministry, is initiator for new policies and is responsible for the execution of plans and measures. RIKZ is a research and advisory body attached to Rijkswaterstaat.

Policy-making for fish stock management is performed by the Ministry of Agriculture, Nature Management and Fisheries. The Ministry of Economic Affairs issues permits for development of gas/oil fields and is responsible for the development and implementation of measures for the offshore mining industry to meet national environmental goals.

Sustainable use, beside flood protection, is the basic idea behind the Dutch water policy. No longer are technical solutions to control water systems seen as the only opportunity. Recent civil engineering work has shown that maintenance costs are high and natural values are diminishing. Hence, the creation of a resilient coastline

based on managing natural processes, instead of blocking them, is now the concept behind a nourishment programme to restore coastal erosion.

Another example of the new look at coastal zone management is a plan to reopen outlet sluices south-west of Rotterdam. The challenge is to bring back the original estuary characteristics of this area (which disappeared with the closure three decades ago).

Marine monitoring programmes

Rijkswaterstaat is responsible for a national monitoring programme for coastal and inland waters, containing a large amount of physical, chemical and biological parameters. The monitoring objectives include actual status assessment of the aquatic environment by regular testing for compliance with standards, trend monitoring, and the early warning for accidents and storm surges. For the execution of this monitoring programme, Rijkswaterstaat possesses 62 vessels, one aircraft, and about 350 monitoring stations.

To provide integral water management, information products are needed with sufficient aggregation of multi-disciplinary data, with short turn-around times and accurate temporal and spatial resolutions. To deal with these specifications it is believed that monitoring systems should be based on an optimal integration of data from *in situ* measurements, remote sensing, and modelling. An example of this concept is the RWSBAS system. This system gives a synoptic description of the bathymetry using satellite SAR images, models for radar backscattering by wave-current interactions, and sonar data.

To stimulate the development of such integrated monitoring systems, the Dutch Remote Sensing Board was established in 1985. This government board will provide a total investment of NLG85 million to be spent by 2001. To implement new integrated monitoring systems within the Rijkswaterstaat organization, a special programme was started in 1996. This programme, called Monitoring Strategy 2000+, has funding for five years.

The land water environment information technology programme was started in 1994 in order to explore the possibilities of information technology. The main objective was to create synergy between the Dutch civil engineering sector and the ICT sector. The development of decision support systems, using various data resources including *in situ* and remote sensing data, is an important activity.

The unification of monitoring programmes in the North Sea region, similar to the unification of Europe, is a major challenge. Water systems do not stop at individual boundaries. That is why Dutch contributions were given to:

- The European programme to foster the exploitation of advanced marine technology (EUROMAR);
- The Environmental Assessment and Monitoring Committee (ASMO) of the Oslo and Paris Commission (OSPARCOM);
- The European component of the Global Ocean Observation System (EuroGOOS);
- A concerted action by monitoring network authorities (Seanet). (Source: *Sea Technology*, August 1998)

Norway

Norway: marine technology and ocean engineering

By Dr. Ing. Carl Trygve Stansberg

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The national Institute of Marine Research in Bergen carries out a broad range of long-term oceanographic research activities, particularly within biology, seafood, ocean dynamics, environmental aspects, etc. In addition to general scientific purposes, its work also supports governmental regulations and the control of fisheries. The institute operates advanced research vessels and also has activities in the arctic and antarctic areas. There are biological and physical oceanographic activities carried out at the national universities in Oslo, Bergen, Trondheim and Tromsø. The meteorological institutes in Oslo and Bergen also cover physical oceanography. A commercial company in Trondheim, OCEANOR (the Oceanographic Company of Norway), has specialized in ocean monitoring services for authorities and industry including measurements of waves, currents, temperature, salinity, pollution, etc. Underwater robot and ROV technologies are significant fields of research and development at the Norwegian University of Science and Technology in Trondheim as well as at the neighbouring SINTEF research group. Advanced underwater technology services are also carried out by commercial companies including NUTEC (Bergen) and Kongsberg Simrad A/S (Horten).

A governmental office, with a marine laboratory in Horten, supervises coastal protection from pollution, including oil spills from ships and the oil industry.

The Norwegian Marine Technology Research Institute (MARINTEK) in Trondheim is a commercial research company serving national authorities, domestic and international ships, oil/gas, and fishery industries. It is one of the largest of its kind in the world. Its main activities cover research and development on ship and offshore platform design; theoretical and experimental verification studies, including model testing in large laboratories with wave, current, and wind modelling; and R&D on machinery, technical operations, fisheries, and aquaculture. MARINTEK is affiliated with the SINTEF research group, which covers a broad range of technology research activities, also including such as structural engineering, coastal and ocean engineering, theoretical hydrodynamics, etc.

SINTEF works in close contact with the Norwegian Institute of Science and Technology research activities within the same areas. Another centre for marine technology research is Det Norske Veritas in Oslo. This group works in particular fields such as the performance and classification of ships and offshore platforms; design loads and responses; guidelines for the industry; and hazards, safety, and reliability. Research and development are also carried out within the Norwegian oil companies Statoil, Norsk Hydro, and Saga Petroleum. The oil industry rules and regulations are supervised by the Norwegian Petroleum Directorate in Stavanger and for the ship industry by the Norwegian Directorate of Shipping in Oslo.

The various ships produced include special cargo vessels, advanced fishing vessels, passenger ferries, fast-going vessels for coastal transport, navy vessels, and others. Recently a new concept for efficient ocean transport of fresh water by flexible, floating textile water bags has been introduced. There is also a considerable number of equipment companies delivering a broad range of advanced products and services for the marine and fishing industries.

Coastal transportation is a key challenge in the national infrastructure (due to all the fjords and islands) and it covers a relatively large part of the population. The technology for more efficient (faster) and environmentally friendly local car and passenger ferries, developed in cooperation with research institutes, plays an important role. The ferries in many places are now being replaced with sub-sea tunnels or conventional and floating type bridges. Norwegian fjords are typically several hundred metres deep. A submerged floating tube tunnel is now also being considered at one site.

Since the 1960s, starting from zero, the offshore oil and gas industries have had a remarkable growth in Norway. Today, a dominating factor in the nation's economy, Norway is one of the world's largest oil and gas exporters. Until the 1980s the production was limited to the North Sea; today it has expanded further north to include the Norwegian Sea.

Foreign companies, especially from the United States, originally operated the oil activities. However, the Norwegian oil companies Statoil, Norsk Hydro, and Saga Petroleum now operate a substantial portion. However, the foreign companies still play an important role.

The main Norwegian platform construction companies are Kvaerner and Aker with several production sites across the country. Foreign companies also deliver some installations.

In the earlier fields most production platforms were fixed on the bottom, including steel jacket and concrete gravity-based types. In the recent and future fields, with water depths from 350 to 2,000 m, floating production ships and platforms are developed, with mooring, positioning, and riser technology essential.

The industry and research institutes, to improve technology, are currently carrying out extensive research and development projects. Another important and related field is the sub-sea bottom pipeline technology.

Traditional small fishing vessels are now being replaced more and more by larger ocean-going advanced ships produced by Norwegian yards. These ships are equipped with modern technology manufactured mainly by Norwegian companies.

The fisheries technology is a result of considerable research throughout many years. There have been large variations in Norwegian ocean fish resources throughout the years with several types of fish caught, with cod as the most important. Therefore government authorities are more or less strongly regulating the fisheries and its market in collaboration with the unions of fishermen, vessel owners, and other countries such as Iceland, Russia, and the European Union. The resource situation has been quite positive the last few years, but the Government and ocean researchers are constantly watching it. In addition to "wild

fish" catching, there has been a rapidly growing volume in aquaculture during the last 20 years, and Norway is now one of the largest fish farm product exporters in the world. The export markets are in Europe, United States and Asia (salmon is most common).

The fish farms are distributed along most of the Norwegian coastline from south to north.

The rapid development of the production volume has itself provided considerable experience and has also been followed by research and development of technology and biological aspects of the industry (carried out as national projects at research institutes and universities). (Source: *Sea Technology*, August 1998)

Fabricator eyes coming phase of gas, deep-water developments

Aker Verdal, one of Aker Maritime's two major fabrication yards in Norway, is positioning itself for the 21st century. The yard has a diverse portfolio of products and some unique fabrication technology, which can also be delivered as part of a turnkey package involving other Aker Maritime companies.

Located at the northern end of the Trondheim Fjord, Aker Verdal is situated to participate in projects in the Norwegian Sea off mid-Norway. Here, the development of massive gas resources through the Åsgard and Haltenbank South projects has prompted proposals for using some of the gas locally for industrial development.

If the "age of gas deliveries" in the Trondheim region comes about, Aker Verdal intends to be in on the act, according to marketing director Kjell Eggen. The yard recently applied for permission to expand into an adjacent area of 175,000 m², on which work related to such developments could be undertaken. (Source: *Offshore*, August 1998)

Oman

Oman opens major container hub terminal

With the arrival of two main-line container ships, Sealand Lightning and Dragge Maersk, in Salalah, Sultanate of Oman, the first two berths of the new, high-capacity Port Raysut container trans-shipment terminal commenced operations on schedule on 1 November 1998, less than 18 months after the start of construction. The new facility, also known by its Arabic name Mina Raysut, puts Oman among the leading Middle East container ports, linking the fast-growing Europe-Far East trade route directly to eastern Africa, Indian Ocean, and Gulf services and potentially improving transit times by as much as eight days.

The port has a draft of 16 m (52.2 ft) to accommodate the largest megacontainer vessels now afloat. When completed, it will have four berths with a total length of 1,227 m (4,000 ft) and a capacity of over 1 million lifts or 1.5 million TEUs a year. Dockside facilities will include: 12 high-speed, 65-ton-capacity container cranes, designed to load ships up to 22 containers wide at an average rate of 40 moves per hour per crane; 24 rubber-tyred gantry cranes; and four toploaders. (Source: *Ports and Harbors*, April 1999)

Poland

Outline of activities in marine sciences

Oceanographic and nautical sciences are long-established in Poland as are coastal management, sea fisheries, the shipbuilding industry, maritime transport and shipping, the exploration of the sea bed and the extraction of raw materials therefrom, and seaboard recreation.

Marine research programmes

The first marine research laboratory in Poland was established on the Hel peninsula on the Gulf of Gdansk in 1923 to serve the needs of the fishing industry. It carried out a programme of biological research into fisheries in the Baltic, which after World War II was continued by the Sea Fisheries Institute in Gdynia. Today this is one of Poland's leading marine research centres, conducting comprehensive studies on the ecology, technology, and economy of fisheries.

At the same time, a number of other research institutions came into being to monitor and study the marine environment. The earliest of these was the Marine Branch of the Hydro-Meteorological Institute—today called the Institute of Meteorology and Water Management (IMWM), which was founded in 1921 and has been based in Gdynia since 1927. INWM carries out research and monitoring programmes in line with the Helsinki Convention (HELCOM) and provides hydrometeorological services for shipping. The Maritime Institute in Gdansk provides comprehensive scientific backup for the shipping and coastal management sectors of the Polish maritime economy.

In the post-war period, the Polish Academy of Sciences (PAS) established the Institute of Oceanology in Sopot (IOPAS) and the Institute of Hydraulic Engineering (IHPAS) in Gdansk. Both have become important research centres, the former dealing with fundamental oceanological research, the latter carrying out basic studies in hydraulic and maritime engineering. In addition, the Marine Geology Branch of the Polish Geological Institute at Sopot has long been responsible for investigating geological, geomorphologic, and geodynamic aspects of the coastal zone, in particular detailed geological mapping of the sea floor. Finally, a recent newcomer is the Marine Biology Centre in Gdynia, established by PAS.

Besides the work done by these autonomous research institutes, Polish universities have made a significant contribution to the development of research and maritime technology. The leaders in this field are the Technical University of Gdansk, and the University of Gdansk, founded in 1970.

International research programmes

At present Poland is involved in a large number of international marine research programmes coordinated by IOC/UNESCO, WMO, and the European Union, to name a few organizations. These programmes cover climate studies in northern Europe and the arctic (WCRP/GEWEX/BALTEX, VEINS, ACSYS), biodiversity studies (BIODIVERSITY), and Baltic studies (LOICZ, BASYS, Coastal Management Research, GOOS, etc.). PAS is a member of the European Marine and Polar Science boards (EMaPS) at the European Science Foundation and is to a

large extent adapting its national marine research programmes to the needs of the EMaPS-initiated European research programmes.

The Polish National SCOR recently compiled a new "National Strategy for Marine Research until 2010". The principal objective of this programme is the rational utilization of the resources of the Baltic and selected regions of the oceans and the creation of a basis for the balanced development and integrated administration of the Baltic coastal region.

The principal investor in scientific research in Poland is the Polish Government, which is represented by a quasi-ministry, the State Committee for Scientific Research. Funds for research from other sources have so far been infinitesimal by comparison. (Source: *Sea Technology*, August 1998)

Portugal

Marine-related activities

The connection of Portugal to sea activities was emphasized with the hosting in Lisbon of the EXPO 98, the 1998 world exhibition that had as its theme "The Oceans our Heritage for the Future", commemorating the 500-year anniversary of the voyage of Vasco da Gama to India.

The Portuguese Exclusive Economic Zone has an area of 319,500 km² around the continent, 984,300 km² around the Azores and 411,000 km² at Madeira, a total that represents more than 50 per cent of the total exclusive economic zone of the European Union, which is about 3,000,000 km².

The sea-related industries in Portugal consist of the generally known maritime industries, which deal with shipbuilding and repair, maritime transportation, the fishing and aquaculture industry, and the recreation industry.

Responsibility for marine activities in Portugal is spread among different ministries. Maritime transportation and recreation is under the Ministry of Regional Planning, the shipbuilding and repair industry under the Ministry of the Economy, and the fisheries are under the Ministry of Agriculture and Fisheries. The research activities related to all fields are under the Ministry of Science and Technology.

Portugal has had a major role in the world market of ship repair, having until a few years ago two ship repair yards that were within the five largest in the world. The activity has reduced drastically in the last few years and the two yards merged. In addition to the continued activity of repair of large ships, they have moved into the market of conversion of tankers into drilling vessels and floating production and storage offshore (FPSO) units.

There is another shipyard that builds medium-size ships such as container ships and chemical tankers, which has kept a steady activity along the years. In the next segment of the market, there are several small yards that build fishing vessels, tugs and other small vessels. Several small and traditional shipyards keep the coastal fishing fleet made basically of wooden ships.

During the last few years, there have been important changes in the legislation that governs the operation of ports, which have been perceived as the main bottlenecks in the maritime transportation chain. The sector is being restructured so as to make ship loading and unloading as well as cargo processing a quicker and more competitive process.

During the last 10 years, fishing has been severely reduced as a result of the international acceptance of the principles of the EEZ, which has limited the fishing mainly to the Portuguese area. As a consequence, the fishing fleet has lost some of its largest vessels aimed at long-distance fishing and is basing its activity on the coastal fishing fleet made of relatively small vessels.

Fisheries that are presently more important are the purse-seine fishing of sardine and mackerel; the long-line catch of tuna a swordfish; the bottom trawl, long-line and gill-nets catch of monkfish, sea bream, hake, and sea bass; as well as the trawl of shrimp and other crustaceans.

Governmental laboratories and academic groups undertake the research work. The first have, in general, a heavier infrastructure including research ships and one can mention IPIMAR, the institute whose scope is fisheries, and the Hydrographic Institute, which deals with hydrography.

The research activity of the university groups is related to their teaching activity. In the fields of marine biology, there are active groups at the universities of Porto, Lisbon, Algarve, and more recently in the Azores. Some aspects of coastal zone management are dealt with at the Technical University of Lisbon (Instituto Superior Tecnico) and the Universities of Porto, Coimbra and Aveiro.

The different aspects of maritime technology are concentrated at the Technical University of Lisbon, which deals with shipbuilding and repair, maritime transportation, fishing vessels, underwater vehicles, and marine environmental modelling. Research activities are mainly financed by the Portuguese Ministry of Science and Technology, by the European Commission, and on a much smaller scale by industry. (Source: *Sea Technology*, August 1998)

Sri Lanka

New rules for processors and shrimp farming regulated

As a result of pressure from the European Union, the Minister of Fisheries and Aquatic Resources Development, Mahinda Rajapakse, has introduced new regulations for processing fish. The European Union contends that some consignments of fish from Sri Lanka have been substandard.

All fish exporters will have to obtain a special licence from the Department of Fisheries and Aquatic Resources and a certificate from the Sri Lanka Standards Institution.

New permits to develop shrimp farms along the coastal belt of North Western Province of Sri Lanka has been suspended by the Fisheries and Aquatic Resources Development Ministry. The decision to ban development of new farms was due to the large number of farms that already exist in the province. There are already about 1,000 farms in the province mostly established illegally and the proliferation of illegal farms has caused environmental degradation of coastal areas.

Minister Mahinda Rajapakse has urged for an integrated plan to be formulated to prevent illegal farms and require farm owners to register with the ministry in order to provide technical and financial assistance to develop shrimp farming without destroying the environment. (Source: *INFOFISH International*, January 1999)

United Kingdom

Marine science and technology

The United Kingdom Government's Technology Foresight Programme (TFP), with a remit to prioritize future research funding by liaison between industry, universities, and government, has recently examined non-living marine resources. Three growth markets were identified as: (a) offshore information and forecasting, (b) seabed surveys, and (c) exploitation at oceanic depths. This report is entirely attributable to the authors of the Marine Technology Foresight Panel (MTFP) working group's report on the Marine Technology Foresight Panel on "Exploitation of Non-Living Marine Resources", *J. Soc. Underwater Technology*, vol. 22:3, pp. 103-122, 1997.

Background and priorities

In 1993, 15 TFP panels started a national consultation with the major market sectors. In 1995, the Government added the MTFP with five working groups: energy, living resources, transport, coastal zone and leisure, and non-living marine resources. The challenge now is to exploit the potential resources of the continental shelf around the United Kingdom and adjacent oceanic areas. The MTFP prioritized technologies for United Kingdom investment in science, engineering, and technology with relevant markets as: environmental forecasting (A), continuous monitoring and real-time global information (A), sensors (A), acoustics (B, C), automation and robotics (A, B, C), miniaturization (A, B, C), optics (B, C), continuous monitoring and real-time local information (A, B), energy (C), and waste disposal (C). The MTFP also identified priority policy issues, emphasizing a need for a national marine technology strategy; more collaboration between research councils, universities, industry and government departments; influence over legislation by acceding to the Law of the Sea Convention; supporting United Kingdom marine businesses; supporting the Global International Waters Assessment proposed by the World Bank through its global environment facility (GEF); capitalizing on the GEF budget; developing an oceanographic infrastructure and contributing to the Global Ocean Observing System (GOOS); and revising education to widen appreciation of the oceans and marine markets.

The MTFP identified potential market application sectors as general offshore business opportunities, seabed mining (including resource assessment, reserve evaluation, exploration, and extraction), communications, and waste disposal. The main activities in these sectors include bathymetric, seismic, geological and geophysical surveying; seabed imaging and mapping; monitoring the marine environment and its resources at all depths; resource assessment and reserve evaluation; administering and managing offshore economic activities; predicting environmental conditions; sub-sea inspection and maintenance; remote sensing; laying cables; mining; hydrographic surveying for military, transport and telecommunications applications; wreck searches; and underwater navigation, object detection and obstacle avoidance.

Trends will continue towards unmanned and remote activities. Improvements in seabed survey, characterization,

and underwater intervention will be made by increasing use of autonomous underwater vehicles (AUVs), remotely operated vehicles (ROVs), and remotely operated towed vehicles (ROTVs). "Smart" vehicles like AUVs, which provide safer operation than divers, are needed to help develop oil fields in deep water and eventually to reduce costs. The 1,000-km AUV mission is already in sight for Southampton Oceanographic Centre's Autosub. Further trends will include advances in active sonar using multiple beams, adaptive beam-forming, broad-band transmissions, and synthetic aperture techniques. For sub-bottom investigations, high resolution, shallow-penetration seismic profiling will be extremely important for engineering or mining surveys. Other advances will be the use of digital communications systems and information control, the development of deep ocean industries, and the control of exploitation. (Source: *Sea Technology*, August 1998)

United States of America

NSF invests in new engineering research centres

The National Science Foundation (NSF) has invested \$10 million to fund the first year of new engineering

research centres (ERCs) in Georgia, Hawaii, Maryland, South Carolina, and Virginia. The five new centres are pioneering fields such as tissue engineering, computer-assisted surgery, computer modelling and visualization of industrial materials, power electronics, and marine bioproducts.

Each of the five new centres will receive \$2 million in the first year from NSF, leveraged by support from industry, state governments, and partnering universities. NSF will support the centres for five years, after which the support agreement is subject to renewal. NSF has established 34 ERCs nationwide since 1985.

Dr. Oskar R. Zaborsky directs the Marine Bioproducts Engineering Center (MarBEC) at the University of Hawaii. MarBEC's mission is to lay the groundwork for future use of marine biotechnology products in the chemical, pharmaceutical, nutraceutical, and life sciences industries. MarBEC will incorporate expertise from many different fields of ocean science and engineering to develop the basis of a working marine biotechnology industry. Priority marine bioproducts include carotenoid pigments, polyunsaturated fatty acids, biocatalysts, and UV-absorbing agents. (Source: *Sea Technology*, January 1999)

G. INTERNATIONAL NEWS

Satellite launch has success out at sea

Sea Launch, which seemed the most unlikely of the up-and-coming satellite launch vehicles, has successfully completed its maiden flight.

The concept, taking a second-hand oil rig and firing Russian/Ukrainian-made rockets from it, was met with some scepticism when it was announced.

There is a big shortage of reliable launch capacity for satellites. Launcher confidence has been made worse by the destruction of the first Ariane 5, a prototype Zenit (not the Sea Launch version) carrying 12 communication satellites and several Chinese Long March rockets.

Due to nervousness on the part of satellite companies, there was no satellite on board the first Sea Launch. Instead it carried an instrumented dummy load similar to a Hughes 702 satellite chassis.

This was successfully delivered into a geostationary orbit.

The first launch, of a real Hughes 702, was due in August 1999 and the next 15 launch slots are all booked.

Sea Launch gets over the problem of non-optimal launch sites.

The equator is the best (cheapest) place to launch geostationary satellites from, because the rocket gains maximum energy from the Earth's rotation, reducing fuel requirements. But the take-off site has to have a lot of empty sea or land down-range—just in case the launch goes wrong and the rocket falls out of the sky. This limits the choice of sites.

The European Space Agency's site in South America comes closest to the ideal, and can also launch to polar orbits, but Sea Launch can be moved to a nominally perfect position.

Sea Launch is actually two vessels, a rocket and a home port.

The vessels are the Sea Launch Commander (also called the Assembly and Command Ship, or ACS), a floating mission control centre and rocket assembly factory, and Odyssey, the converted oil rig.

Home port is at Long Beach, CA, and the rockets are three-stage type Z-3SL Zenits, modified for extra strength, reliability and guidance performance.

These rockets have the advantage that they burn kerosene and liquid oxygen, a low-tech fuel that makes them less of an environmental problem than launchers like Ariane 5, which produce tonnes of corrosive chemicals when fired. Z-3-SLs can also be transported horizontally, unlike most US-made rockets.

For the first launches, rockets will be transferred to Odyssey at the home port. The intention is eventually to leave Odyssey out in the ocean and ferry Zenits, up to three at a time, out to it in the ACS.

The ACS was built at the Govan Shipyard in Glasgow and is 200 m long displacing 34,000 tonnes and has a range of 18,000 nautical miles. Odyssey is claimed to be the largest semi-submersible self-propelled vehicle in the world and is 134 m by 67 m, displacing 50,000 tonnes when most deeply submerged. The rocket is 60 m tall and 4.3 m wide at the base. (Source: *Electronics Weekly*, 21 April 1999)

Appellate decision on turtle excluder issue

In a recent meeting, the World Trade Organization's appellate body concluded that nations had a right to establish trade accords based on sustainable development and environmental protection, such as the US ban on shrimp imports from countries where turtle excluder devices are not in use. However, it found fault with the US implementation of the ban which required Thailand, Malaysia, Pakistan and India to fit the devices within four months, whereas 14 countries from the Caribbean and South America had been given a much longer compliance period of three years. The US policy was said to "constitute arbitrary and unjustifiable discrimination" against the four complainant countries. Although the decision was welcomed by the four countries, Thailand remained worried that environmental rules could be used in future to restrict imports of selected products. On the other hand, the World Wide Fund for Nature felt that the ruling had set a wrong precedent. (Source: *INFOFISH International*, January 1999)

Partnership for development between IAPH and UNCTAD

The International Association of Ports and Harbours (IAPH) is a worldwide association of port authorities with more than 400 regular and associate members from 85 countries. The principal objective of IAPH is to develop and foster good relations and cooperation among ports and harbours of the world. One of its activities is to promote greater efficiency of all ports through the exchange of information about new techniques and technology relating to port development, organization, administration and management.

Cargo moving through ports in some developing countries is often delayed because of missing or insufficient information which prevents the planning of operations and blocks the clearance of cargo. The quality of port services can be greatly improved through the use of information technology and modern communication methods. However, certain ports in developing countries lack the revenue base that would allow them to make major investments for sophisticated software solutions. With the availability of high-performance computing power at low cost, what is required is appropriate software that is international, multi-modal and open. UNCTAD, through its work on improving port performance and its work on the development of low-cost software for transport systems, has expertise enabling it to assist in the development of information technology making use of international standards that can be used by such ports.

The UNCTAD secretariat and members of IAPH will work together to identify those areas where information technology would be of the greatest benefit to ports and particularly small ports in developing countries. The UNCTAD secretariat would prepare a work plan and with IAPH establish a small discussion group to define systems and also more importantly to identify ways management in developing countries can be assisted in the implementation of these systems. IAPH provides an international network of members who could be available to provide guidance and assistance. The first priority for such systems should be to reduce the time cargo is immobilized in ports, and a second priority should be to reduce the turnaround time of ships in port. Systems would be defined and funding sought to develop standard software packages that could initially be aimed at ports in the least developed countries. The UNCTAD secretariat and IAPH could jointly disseminate information on these systems through their existing publications such as the UNCTAD's Monographs on Port Management and IAPH's Ports & Harbors Magazine. (Source: *PORTS AND HARBORS*, January-February, 1999)

West and Central African States agree draft regional port State control regime

Eighteen West and Central African States have agreed a draft memorandum of understanding (MOU) on port State control (PSC), at a meeting in Conakry (Guinea) which ended on 22 January 1999. The meeting was jointly organized by the Guinean Government and the International Maritime Organization and was supported by the Ministerial Conference of West and Central African States on Maritime Transport (MINCONMAR).

The aim is to hold a further meeting to adopt the MOU in Nigeria during October 1999.

The countries participating in the meeting were Angola, Benin, Cape Verde, Congo, Côte d'Ivoire, Gabon, Gambia, Ghana, Guinea, Liberia, Mali, Mauritania, Namibia, Nigeria, Sao Tomé and Principe, Senegal, South Africa and Togo.

The Conakry meeting was also attended by representatives of IMO, the United Nations Development Programme (UNDP), the Economic Commission for Africa (ECA), MINCONMAR, the Communauté économique et monétaire de l'Afrique centrale (CEMAC) and other regional organizations.

The meeting at Conakry followed an initial preparatory meeting of the States in Accra, Ghana, in February 1998.

Participants continued work on developing a set of training measures to improve the maritime administration infrastructure and human resource capability of the participating States. The aim is to develop a regional training programme for flag State surveyors and PSC inspectors for the West and Central African region.

The meeting agreed, in principle, that the regional secretariat would be established in Nigeria while a regional information centre would be set up at MINCONMAR headquarters in Côte d'Ivoire.

The draft MOU that was agreed in Conakry is similar to other regional PSC agreements already established around the world. All countries have the right to inspect ships visiting their ports to ensure they meet IMO requirements regarding safety and marine pollution-prevention standards, and experience has shown that PSC works best when it is organized on a regional basis.

However, the West and Central African MOU will also be expected to cover PSC inspections on smaller ships (below 500 gross tonnage) which are not generally covered by most IMO regulations. These ships tend to trade inter-regionally.

Like the other agreements, the draft West and Central African MOU requires each maritime authority which is a signatory to the agreement to establish and maintain an effective system of PSC and sets for the region's maritime Administrations an annual required total of inspections of at least 15 per cent of the estimated total number of foreign merchant ships entering the region's ports during the year, within a period of three years after the MOU becomes effective.

The MOU encourages exchange of information so that substandard ships can be identified and targeted. On the other hand, ships inspected by one port State and found to be complying with all safety and marine pollution-prevention rules will not be subject to too frequent inspections. (Source: *IMO News*, January 1999)

More Than 25,000 raster topographic maps now available on the Web

California-based Horizons Technology Inc. reports it has made its more than 25,000 industry standard topographic maps available for purchase and download over the Internet from the HTI Web site (<http://tango.horizons.com/quadstore>). In addition, the Sure!MAPS(r) raster seamless map data can now be purchased by standard US

Geological Survey (USGS) quadrangle as well as by custom, user-defined areas online.

Horizons marketing manager Tiffany Hawkins said visitors to HTI's Web site can now access a seamless, georeferenced, 1:24,000-scale Sure!MAPS raster topographic quadrangle map in just minutes from the new Download-A-Quad Store, which is open 24 hours a day. When users select their maps, they are not limited to purchasing by standard USGS-defined quadrangle sheets. Instead, they have a choice of selecting their maps either by USGS quad or by a custom area that they define. The raster map server interface allows users to choose the precise size and area they need from HTI's seamless database of topographic maps. (Source: *SEA TECHNOLOGY*, January 1999)

Locating data

Marine Informatics, set up in 1996 by John Wallace, recently completed a study of how scientists across Europe gather and exchange data. The European Commission commissioned the study so that future programmes such as MAST could be more effective. Over 500 scientists responded to a questionnaire, and by answering 41 questions they identified major weaknesses in gaining access to shared data. Some 11 per cent said that obtaining extra data is too expensive, 23 per cent said that owners were unwilling to part with data, and 40 per cent said that they have difficulties locating relevant data. According to Marine Informatics 90 per cent of the scientists who responded to the survey depend on data sources other than their own. (Source: *Technology Ireland*, January 1999)

Sinking fast

Despite the central role of water transport in the spread of civilization, the sea, seamen and their ships have been neglected by those concerned with conservation. In 1972, when the UNESCO Convention on World Heritage provided international protection for historical sites and opened a list of World Heritage "monuments", none of them was maritime. For example, neither the Swedish warship *Wasa* nor Henry VIII's *Mary Rose* were on it. Yet for most of history and some of prehistory, ships were the most elaborate and advanced technical machines in existence.

Now there are moves to make our marine cultural heritage part of the World Heritage regime, but they face a difficult passage. In October, a UNESCO Charter (a consultative document) that was ratified in 1966 will become a legally binding International Convention for the Protection of the Underwater Cultural Heritage. Protection will be extended to inland waters, shallow seas and the ocean deeps, and archaeologists will be allowed to unlock the evidence of past civilizations and present this material and knowledge for all humankind. With an estimated 3 million "heritage" wrecks worldwide, ratifying the charter will surely be a worthy way to usher in the new millennium.

The moves towards a convention have been given added urgency by the technological advances that enable remote working at greater depths than divers and crewed submarines can go. These tools are already being used by commercial companies to exploit wrecks in international waters at depths of several thousand metres.

In addition, new harbours and marinas, oil pipelines and undersea cables all affect the archaeological potential of coasts, river banks and even the deep-sea floor.

Some traditions of the sea are not helpful. Fishermen and sports divers hunting for souvenirs shelter behind the "finders keepers" custom. So cannons, porcelain, early instruments and amphorae end up in homes as decorations. The story that they could have told in context is lost forever, while prising these artefacts loose does untold damage to what is left behind. Some salvage operations even use dynamite to free treasures. Archaeology involves the interpretation of objects in their context, not simply displaying them in a glass case. On-site procedures are crucial, but archaeology also relies on painstaking work in the lab—recording, conserving and analysing.

These archaeological requirements are catered for by the proposals, but for the convention to have full effect more specialist archaeologists and divers must be recruited, conservation facilities must be expanded and developed, and new "heritage" finance found. Most important of all, sea-blind governments will have to be convinced and national laws changed.

One of the more distasteful features of the present situation is the way developing countries with weak economies are offered a cut of the proceeds, possibly amounting to millions of dollars, by foreign salvage companies in exchange for rights to rich historical wrecks in local waters.

So far, the negotiations surrounding the convention have been driven by lawyers. The input from archaeologists—marine or otherwise—has been muted.

UNESCO has made a direct appeal to archaeologists to play their part in the deliberations. They are, after all, the practitioners with experience and knowledge of what is involved. The convention opens up wonderful possibilities for them and their science. (Source: *New Scientist*, 16 January 1999)

Bilateral fishery accord at risk

The Korean and Japanese Governments, faced with angry protests from their respective fishing industries, are rushing to resume stalled working-level talks for the full implementation of the new fisheries accord.

However, industry sources say chances appear slim for an early and mutually satisfactory conclusion.

Replacing a 1965 bilateral fisheries agreement, Seoul and Tokyo exchanged ratification letters on a new fisheries accord, but the two countries failed to fully implement the new pact because of differences over details concerning fishing methods and quotas.

To narrow the differences over details on fishing boundaries and quotas, Seoul and Tokyo have held nine rounds of bilateral talks since October 1998.

Citing depleting fishing stock and obstruction of fishing operations, Japanese negotiators have strongly opposed the Korean methods of gill-net and trap fishing in its waters.

Japan says the fishing method of gill-nets are illegal under Japanese law and is calling for a complete ban on the fishing methods within its waters.

Under the new accord, which will be automatically renewed after three years without objections from each side,

Korea and Japan agreed to reduce their fishing catches in each other's waters.

The new accord allows Korean and Japanese fishing boats to operate within each country's exclusive economic zones, normally 35 nautical miles, and a joint fishing zone which stretches from 131.66 to 135.5 degrees east longitude. (Source: *Newsreview*, 30 January 1999)

Field development rate dropping

Oil and gas producers around the globe currently have 390 fields in development or in some stage of planning for future development. This figure is a 24 per cent drop from the 1997 survey, which showed over 500 fields in some stage of development.

There are several explanations for the decrease. The key driver is the decrease in oil prices and perceived oil demand from 1997 at this time, which has affected the number of new fields proposed for development. With dwindling cash flow from low oil prices, producers have raised the reserve requirements and lowered cost hurdle rates for development, basically trimming off 10-24 per cent of their developable prospects.

Without the stable, higher oil price experienced at this time last year, many projects that seemed feasible at the time are now entirely unprofitable. That threshold of minimal reserve requirements for development had been on the decline for many years before 1998.

At the same time, a large number of fields scheduled to go on stream in 1997 and 1998 have done so, and have been removed from the 1998 survey. In 1997 alone, a total of 235 fields were expected to start up.

Exploration levels are also down compared with last year. Companies have withdrawn from many exploration programmes, especially in shallow water, decreasing worldwide discovery rates.

Deep-water exploration remains strong due to longer-term commitments for necessary resources, but discoveries are still not as high as last year.

Discovery-to-development time is expected to rise again, after being on the decline for some years.

Another possible reason for the drop is that higher risk, and underdeveloped areas are not nearly as attractive as they once were. The risk involved with moving resources into politically unstable and underdeveloped regions of the world is not justifiable at a depressed oil price. This has resulted in operators sticking to what they know and continuing activities in stable, proven and developed regions.

Unitization of fields may have also influenced the decrease as well.

If the production threshold has been raised, then unitizing these smaller fields is the only other avenue for an operator besides full abandonment or producing in a weak market. Tying these smaller fields to one field listing further decreases the world's total figures. (Source: *Offshore*, November 1998)

Global FPSO fleet growing annually

With no projection for future growth, the floating production, storage, and offloading (FPSO) vessel fleet will consist of 71 vessels by the year 2001. According to Bluewater Offshore, 47 FPSOs are now in operation around

the world. An additional 24 units are on order or currently under construction.

Bluewater has released information tracking the existing and committed-for-construction FPSO fleet as of September 1998. Seventy-one vessels are listed as entering the FPSO fleet by 2001. Forty-seven are in operation, and 24 were committed for construction, as of September 1998.

The Asia-Pacific region is by far the most active FPSO region with 26 vessels. Twenty-two FPSOs are in operation and four are planned or under construction. The East China Sea area is the most active in the region, with 10 in operation.

The North Sea follows closely, with 22 vessels. Thirteen of the FPSOs are in operation and nine are planned or under construction. West Africa holds third place, with 10 (six in operation and four planned), and Brazil follows with eight (four in operation and four planned).

Oil companies own a majority of the world's fleet. Forty-two vessels are owned by oil companies, with the remaining 29 contractor-owned. In a comparison between the North Sea and the rest of the world, North Sea contractors own 12 vessels, compared with 17 in the rest of the world. As far as oil companies are concerned, North Sea oil companies own 10 vessels, compared to 32 in the rest of the world.

Based on this information, the FPSO fleet is growing at an annual rate of 34 per cent. The FPSO fleet has been on the rise since 1992, and has climbed quickly in the period from 1996 to the present.

It is expected that the FPSO fleet will continue to grow with the expanding number of deep-water fields being discovered and the need of an FPSO for production.

Another factor, not included in the information, is the number of deep-water drill-ships being built that can be easily converted for FPSO usage. This will allow a quick shift in the market if needed.

A third factor that may also boost construction will be the growing pressure on the Gulf of Mexico for FPSO usage. If FPSOs do enter US Gulf waters, a strong growth rate in the fleet is sure to follow. (Source: *Offshore*, November 1998)

FAO consultation concludes with global plans of action

Member countries of the Food and Agriculture Organization of the United Nations, after a week-long meeting in Rome, agreed to international plans of action for the conservation and management of sharks and for reducing incidental catch of sea birds in long-line fisheries. The plans describe concrete and specific steps to improve the conservation of sharks and sea birds at the national, regional and global levels, calling for national plans by 2001. Countries are to conduct assessments of sharks and sea birds by catch and, if necessary, develop national plans of action.

These international plans of action should establish sound management practices worldwide for the conservation of sharks and reducing incidental by-catch.

The meeting agreed to a document entitled "Elements of an International Instrument for the Management of Fishing Capacity". Although the United States had hoped that it could have amended the document to become an

international plan of action, participants did agree on the need for all FAO members to regularly assess their levels of harvesting capacity; maintain national records of fishing fleets; develop and implement national capacity management plans; and within the context of these national plans, reduce and progressively eliminate subsidies that contribute to the build-up of fishing capacity.

Although both plans are voluntary in nature, the process of their development is designed to lead to their endorsement by consensus at the FAO Committee on Fisheries meeting in February 1999 and adoption by the FAO Conference in November 1999. (Source: *Sea Technology*, December 1998)

Equal treatment?

Will biomass and other hydrocarbon substitutes be subject to the same taxes based on their "greenhouse" gas contribution? The European Community is strongly in favour of neutralizing the effect of "greenhouse" gases and is strongly in favour of developing alternative energy sources. Some of these alternative sources also produce "greenhouse" gases, carbon dioxide among others. Most governments in the region are in favour of increasing taxes on petroleum or creating new taxes on combustion by-products. Sweden already has taxes on carbon dioxide production. Britain's development of biomass for electrical power generation makes an interesting point (*Financial Times*, 16 April 1998). Chicken waste is combined as a "fuel" with fluidized bed combustion. According to the report, chicken waste is a "clean" fuel, cleaner than coal, and generates useful phosphate fertilizer as a by-product. However, the questions remain:

- Will biomass and other hydrocarbon substitutes be subjected to the same taxes based on their "greenhouse" gas contribution?
- Will uncontained methane releases from chicken waste be taxed in addition to the carbon dioxide and other by-products, that burning produces? (Source: *Offshore*, June 1998)

NOAA-K weather satellite successfully launched

A new satellite that will improve weather forecasting and monitor environmental events around the world was successfully launched, according to NOAA and NASA officials. All deployments were confirmed 30 minutes after the launch. NOAA-K, a joint project of the ocean and space agencies, was launched from Vandenberg Air Force Base, CA, into a near-polar orbit 516 miles above the Earth on a US Air Force Titan II rocket. It will circle the Earth every 102 minutes.

NASA's Goddard Space Flight Center in Greenbelt, MD, is responsible for the construction, integration and verification testing of the satellite, instruments and ground equipment. NASA arranges launch of the satellites with the US Air Force. Following the launch, NASA turns operational control of the satellite over to NOAA after a comprehensive on-orbit verification period, which is expected to last about 60 days. NOAA operates the satellites from the Satellite Operations Control Center of the National Environmental Satellite, Data and Information Service in Suitland, MD. Information on the polar satellites is available

on the World Wide Web at: <http://poes2.gsfc.nasa.gov> and at <http://www2.ncdc.noaa.gov/docs/intro.htm>. (Source: *Sea Technology*, June 1998)

Non-living resource development workshop

Convened to promote the Regional Action Programme (RAP) plan, a workshop in Bangkok, Thailand, was based on a review of the past 10 years' activities and was expected to identify existing conflicts and their resolution.

The identified issue of greatest concern was sustainable development and use of marine and coastal resources coupled with environmental protection. Within that context the priorities for action included institutional arrangements and management planning at the national, rather than regional, level; the protection of coastal resources with more attention to resource assessment and ecosystem accounting; better regional cooperation on transboundary disasters including the development of an adequate database; and increased use of satellite data and geographical information systems (GIS).

Priority subprogrammes and integrated coastal zone management (ICZM) identified at the workshop included integration of ICZM plans with national development goals; public participation to ensure that action is taken at the grass roots level; the implementation of site specific demonstration projects in key coastal areas; strengthening of co-operation and coordination among international programmes and agencies; and enhancement of the role of NGOs.

In general it was concluded that capacity building and institutional strengthening is needed in many countries that lack expertise or capability in such fields as environmental impact assessment, coastal engineering, environmental law, or economic valuation and monitoring of resources. In a flurry of new buzzwords, stakeholder participation, consensus building, and conflict resolution were also deemed necessary elements in ICZM and emphasis put on interdisciplinary efforts of policy makers, management, and natural, engineering, social, and marine scientists.

In that respect the scientific community was admonished that they must be aware of their responsibilities in the decision-making process.

In accordance with the tenets of Agenda 21, Ch. 17, of the United Nations Conference on Environment and Development, the workshop acknowledged the international aspects of ICZM and recommended that non-living resources, being as important as living resources, be managed within an integrated framework.

Some informal discussion at the workshop centred on the formal implementation of the IOMAC, dedicated to the integrated management of the Indian Ocean, and further progress is likely in the near future.

CCOP, the marine minerals coordinating body in East Asia, has been focusing more on coastal sand problems, which are becoming recognized as an important issue throughout the region and have become major issues in such countries as the Maldives and Viet Nam.

These same issues are paramount throughout many of the Pacific island nations and have been the subject of considerable activity in the region as indicated at the SOPAC annual meeting held in Fiji, 23 September to 3 October 1998. They were also the theme of some

discussion at the Pacific Exploration Technology 98 conference held in Nadi during the first two days.

Other mineral issues of interest at these series of meetings have been the planned development of mineral leases for gold-bearing metal sulphides within the territorial waters formed by the archipelagic boundary of Papua New Guinea. The deposits are of considerable interest and occur in water depths less than 2,000 m. In Thailand rediscovery of diamonds among the tin fields in the area of Phuket has sparked new interest in the possibility of further resources offshore, though no leases have been reported. Offshore gold and diamonds are also the theme subject of the next Underwater Mining Institute. (Source: *Sea Technology*, October 1998)

The Arrest of Sea-Going Ships Position Paper adopted by IAPH

A diplomatic conference has been convened to consider the review of the International Convention on the Arrest of Sea-Going Ships of 10 May 1952.

It will conclude the session held by the IMO and UNCTAD with the JIGE (Joint Intergovernmental Group of Experts).

The issue is of particular importance to Port Authorities.

Throughout the world, ports are unwilling hosts of arrested vessels, which can block major berths for months and even years. Their operations are impeded and they can suffer heavy commercial losses. At the same time, the activities of port users and the traffic flows can be affected, with consequential detrimental impact on the economy.

Furthermore, because ships' agents quite often resign from their office, safety and protection measures for the vessels and the environment depend upon the initiatives of the Port Authority alone.

Unfortunately the draft convention, which is to be submitted to the diplomatic conference, deals with the issue as if it were a commercial agreement between the claimants and the sued parties. It does not mention the fact that the detention of an arrested ship cannot take place elsewhere than within the domain of a third party, the host port.

The draft text is incomplete when it leaves major points to be settled without mention by national and procedural legislation. This is not consistent with the universality aimed at by maritime law.

The members of the diplomatic conference should be aware of the expectations of ports:

- The convention should mention that the arrest and detention of a ship take place in a port.
- The competent authorities (ports, governmental agencies, responsible for navigation and safety ...) should be in a position to settle all safety measures to be taken—location of the ship, crew to be kept on board, unloading of HNS or perishable cargo, maintenance of moorings, lights, etc.
- In the event of default by the shipowner, the claimant should bear port dues and costs incurred by the arrest and detention of the ship.
- Following arrest, detention should be limited in time, before release, renewal or conclusion by the forced sale of the ship.

It would be most useful if the preamble of the convention includes a reference to the needs of further legislation at national level, in order to protect the interests, not only of the ports but also those of all other parties involved at local or regional levels.

Such legislation exists in certain national laws, but it should be generalized by a proposal within the Preamble of the convention in order to fill the gaps left by the convention itself, before the closure of the diplomatic conference. (Source: *Ports and Harbors*, October 1998)

Resolution adopted on 30 July 1998 in Cape Town, South Africa

The Steering Committee on Ballast Water Management, established under the UNDP/IMO/GEF project "Removal of Barriers to the Effective Implementation of Ballast Water Control and Management Measures in Developing Countries" at its meeting in Cape Town, South Africa, on 29 and 30 July 1998, RECOGNIZING that the marine environment and the living resources which it supports are of vital importance to mankind, particularly for the coastal pollution, RECOGNIZING FURTHER that invasions of non-indigenous harmful aquatic organisms and pathogens in new regions are occurring at increasing rates, threatening the conservation and sustainable use of aquatic biodiversity, NOTING that besides ecological consequences, severe economic losses and threats to human health are being faced in many countries resulting in national unilateral actions to avoid further threats, BEING AWARE that the transfer of harmful aquatic organisms and pathogens with ships' ballast water constitutes a main vector of unintentional introduction of organisms, BEING FURTHER AWARE that the safety of a ship and its crew is of paramount importance, NOTING that action to minimize the risk of new introductions of non-indigenous species with ballast water is being taken in several regions of the world, NOTING FURTHER the support for this GEF project as expressed by the representatives of the six participating countries, the International Maritime Organization (IMO) and interested non-governmental organizations, including those of shipping and port industries, HAVING CONSIDERED the draft GEF project brief entitled "Removal of Barriers to the Effective Implementation of Ballast Water Control and Management Measures in Developing Countries" presented at this meeting:

1. ENDORSES the draft GEF project brief as amended at this meeting;
2. INVITES governments from both industrial and developing countries, international and national organizations and the private sector to support the project;
3. REQUESTS the Marine Environment Protection Committee (MEPC) to cooperate with the Project Coordinating Unit (PCU) as appropriate; and
4. URGES the GEF Council to approve the project brief. (Source: *Ports and Harbors*, November, 1998)

The redevelopment of derelict port areas

The regeneration of inner cities, now widespread in many parts of the world and of particular relevance in the context of port cities, normally involves waterfront redevelopment as one element among others in a complex

process of urban restructuring. Redesigning the morphology and functions of sensitive urban areas is closely associated with the spatial diffusion of the phenomenon of waterfront redevelopment. Port cities around the world illustrate basic principles involved, contrasted perceptions, and in practice a variety of socio-economic and environmental issues.

In recent decades the revitalization of urban waterfronts has spread from North America to Europe and Australasia, and to newly industrializing and developing countries. In the US, Baltimore is one of the best known examples from the older-established city ports of the east coast, as well as one of the most successful in terms of city-port integration. On the west coast, San Francisco displays other aspects of the same phenomenon as old commercial waterfronts around the urban core have achieved a virtual resurrection in the context of tourism and water-related recreation. Canada, similarly, displays many examples of new waterfronts in old port cities and the problems with which they are associated: Toronto, Vancouver and Montreal are among the more instructive cases.

In a European context, there are now many interesting and some controversial examples of the process—London, Genoa, Marseilles and Barcelona are well-known examples of port cities where not every example of waterfront revitalization has met with unadulterated acclaim. In the newly industrializing countries of South-East Asia, the port cities of Hong Kong and Singapore present spectacular examples of changing waterfronts; and in the less advanced developing countries, such as India, Cuba and Tanzania, a lot of effort is now being put into urban conservation including waterfront development, as for example in the old stone town of Zanzibar where some remarkable 19th century buildings are being renovated.

Waterfront development is thus not just a local phenomenon, wherever it is observed, planned or studied. It is not something that reflects only local circumstances in Britain, or in Europe, or in the Mediterranean world, or in advanced countries. It is a global phenomenon now, and has become so quite recently, during the past two or three decades. In examining waterfront redevelopment what we are looking at is a set of trends that are in the process of changing once more the face of port cities, and other cities on water, all around the world, not of course for the first time. This time around, port cities are responding to late 20th century changes in the technology of maritime transport and in concepts of urban design. Derelict port areas are being renewed and transformed into attractive urban water-related environments for the 21st century. The waterfront is normally and essentially a water-orientated urban zone, and the water surface involved may be the sea, a river, a lake, or some artificial water body. Most commonly, however, waterfront revitalization is associated with the renewal of inner areas of port cities where the migration of the port function to alternative sites has produced redundant urban space available for revitalization. The phases of waterfront redevelopment and enhanced port-city proximity are today associated with urban renewal programmes in innumerable cities around the world. Waterfront redevelopment has the effect of removing barriers between a city and the sea, bringing people back to the waterfront once again—as

individuals, groups, organizations, observers and participants in sporting events, customers, residents, and people who just enjoy being near or on the water.

The original rationale that underpins the waterfront redevelopment phenomenon is basically fairly clear, although complex in the ways it is worked out in practice, in actual cases. As maritime technology advanced, and required ever larger land and water areas to discharge the port function, that port function has been forced to migrate towards deeper water and more extensive land sites. For ports located on rivers and estuaries, this usually (although not invariably) means downstream migration, and for many such ports this is an acceleration of that downstream movement, not an innovation.

In urban terms the result is a vacuum, an abandoned doorstep, a problematic planning zone often in or very close to the traditional heart of a port city, a zone of dereliction and decay where once all was bustle and interchange and activity. What to do about this problem zone becomes a major planning issue, but is also soon perceived as an opportunity—to make money, to replan and redevelop, and to bring the city back to the waterfront once more, in a new and updated context. The challenge presented by this process is quite considerable, because it involves major adjustments for both ports and cities. On the one hand there are new locational requirements for ports, and on the other the redesigning of substantial areas of cities. Urban renewal involves, of course, not just physical infrastructures but also communities. The impact of revitalization on society goes hand in hand with the impact on the environment. Both are almost invariably controversial.

The attractiveness of the idea of waterfront redevelopment is such that it has become an element in the late 20th century revival of settlements of all kinds, not just port cities, and indeed has extended to rural waterfront locations as well, along riverbanks, in wetlands, and in water-based conservation areas. So though in many contexts the discussion of waterfront redevelopment concerns ports and port cities, we need to be aware that for many people the origins of waterfront redevelopment lie for all practical purposes in the field of urban planning, design and renewal, not in the sphere of changing maritime technology and its effects.

The geographical diffusion of the phenomenon is also interesting because it has taken place in several dimensions: around the globe; from larger to smaller urban places; and, in a sense, down the international development ladder from the more advanced towards the less developed countries. Traditionally, a port city's waterfront has been its commercial front door, and its relative efficiency, attractiveness and competitiveness have long underpinned its trading fortunes.

Today an increasing number of locations outside the traditional Euro-American and Australasian advanced country group are actively becoming involved in the waterfront revitalization movement. Singapore has completed a clean-up of its formerly characterful old harbour; Havana (Cuba) is planning to spend a lot of money on renovating some substantial and architecturally interesting old waterfront buildings before they collapse. In South Africa, Cape Town is firmly on this bandwagon with the redevelopment

of the Victoria and Alfred waterfront—the first major development of this sort on the African continent. In East Africa, however, substantial efforts are now being made to save and revitalize waterfront buildings in several Kenyan and Tanzanian port cities—Mombasa, Lamu, Dar es Salaam and Zanzibar—in the context of urban conservation. (Source: *The Dock and Harbour Authority*, June 1998)

Implications of oil spills

In the United Kingdom, the Marine Pollution Control Unit (MPCU) maintains the Government's National Contingency Plan for dealing with spillages from ships at sea and provides guidance to local authorities for their contingency plans and for the establishment of Joint Response Centres. In a major spillage, MPCU directs operations offshore and helps to coordinate shoreline operations, particularly the identification of the most appropriate methods of shore protection and clean-up. The first part of any pollution control strategy must be to try to prevent the accident happening. If that fails, the second must be to try to prevent a spillage occurring.

More than half of major oil spills are caused by grounding. This means that by definition the majority of major spills are likely to occur relatively close to shore. They will thus pose a threat of major coastal pollution. Grounding can be caused only by navigational error or loss of control of the vessel, generally by failure either of propulsion or steering.

Collision is the second largest cause of major spills. The reasons for collision are the same as for grounding. Collisions will also tend to occur not far from the coast. Accidents highlight the importance of safety management. A tanker's most vital safety and prevention system is the crew. As well as being properly trained, they have to have their responsibilities and the procedures under which they operate clearly defined. In fact, the International Maritime Organization (IMO) has introduced its new International Safety Management (ISM) code. This is an international standard for the safe management and operation of ships and for the prevention of pollution.

While allowing considerable scope for individual organizations to draw up their own plans, it will apply to ships and shipping companies from various dates, regardless of their date of construction. For tankers, it will apply from July 1998.

The code requires all shipping companies to develop and maintain a Safety Management System (SMS) to ensure that mandatory standards of safety and environmental protection are maintained.

Modern vessels are very well equipped with nav aids. However, the possibility of human error always exists. It has been recommended that, as an additional back-up and checking process, the port radar surveillance system be provided with a continuous recording facility and be continuously monitored by a trained operator who would be kept informed of a vessel's intended track. This puts the tanker into a somewhat similar situation to an aircraft approaching an airport under the eye of an air traffic controller.

The concept of the typical VLCC being single-engined has long caused concern, largely due to the prospect of

helplessness in case of engine failure. One of the responses to this problem is to provide escort tugs, capable of exerting the very high dynamic forces that may be required, to accompany tankers on the approaches to their terminals. These, however, only address the problem over a fairly short distance.

Schottel has proposed the use of two of their PumpJet units as an auxiliary propulsion system, one in the bow and the other towards the stern. These can thrust in any direction. Schottel cite various incidents in which their units, if fitted to the vessels in question, would have developed sufficient thrust to have prevented groundings. Another auxiliary system is one offered by Wartsila in which an electrical generator mounted on the propeller shaft can be used as an emergency propulsion system by running the generator as an electric motor, powered by the ship's separate gensets.

Arco has really broken the mould. Its new Millennium Class tankers will each be powered by two engines. Each engine will be in its own separate engine room and fuelled by its own independent fuel system.

This really is a significant step forward.

The double-hulled tanker is the major advance towards keeping the oil in the ship. In minor accidents, it can prevent all spillage; in more serious incidents it can at least delay and reduce the problem: apart from its benefits in oil containment, a double hull in the area of the ship's pump room can mean that it remains operational, enabling the ship to be lightened if required, by transferring cargo to another tanker. In addition, the double-hulled vessel demonstrated better damaged stability. The argument for double hulled tankers has, in fact, been won. Such construction has been mandatory on all VLCCs ordered since 1993 and the last single-hulled vessel was delivered in 1995. It will, however, be a considerable time before double-hulled VLCCs form a major part of the world fleet.

In the Netherlands, TNO Building and Construction Research is engaged on an investigative programme on collisions at sea. They are soon to start on a series of collision tests in which a fully instrumented tanker will be made to collide with another ship under carefully controlled conditions. This is the third series of tests, ultimately aimed towards the production of better ship designs. As well as the collision tests, experiments are made to simulate running aground on rocks using dummy bows with different plating and stiffener configurations. At the same time testing has been carried out on the impact resistance of a new high-strength steel which may be considered for tanker hulls. If the worst happens—the incident occurs and the oil escapes—the response depends upon the type of oil being lost and also on the environment.

In some respects, the spillage of oil at sea is of little consequence. In open ocean, a slick can simply be left to disperse and degrade naturally. In deep water offshore the slick can often be sprayed with dispersants to help it break up and then simply kept under observation while it progressively biodegrades and disappears. However, in an inshore location there is no way that a major spillage will not impact the shore.

Operators are taking on board the concept of safety management, twin engines and redundancy of equipment are

coming in, all to reduce the risk of accident. Double hulls and better damage resistance will help to keep the oil aboard. The clean-up industry is developing its forward planning and its skills in case the worst happens. As well as this, the atmosphere is becoming more litigious. In the UK, the Environment Agency has instituted criminal prosecutions against Milford Haven Port Authority and the Harbour Master of Milford Haven Port following the grounding of the *Sea Empress*. In the US, a coalition of environmental groups is suing the US Coast Guard, claiming that the agency has failed in its duty of requiring improvements and structural changes to tankers to reduce the risk of oil spills. (Source: *The Dock and Harbour Authority*, January/February 1999)

Cautious progress on disputes affecting China seas exploration

Sovereignty issues continue to fester

Economic events in the Far East have put the region's continuing territorial disputes into the shade. However, two of these disputes are significant, as they have hampered exploration in parts of the East China Sea and South China Sea.

Diplomatic attempts to break the impasse of late have not been entirely futile. Progress was outlined this summer at the "Borderlands Under Stress" conference at the UK's Durham University organized by the International Boundaries Research Unit.

Both sovereignty issues centre around a group of small, uninhabited islands of which the Spratlys have been more

publicized. This is due to the brief naval conflict in the area between Viet Nam and China in 1988, followed by China's award of hydrocarbon exploration rights in these waters to Crestone Energy.

Others contending ownership of the Spratlys are Brunei, Malaysia and the Philippines. Their strategy seems to have oscillated between occupation and negotiation.

However, a framework for a new security order in the Spratlys region is unfolding. Whether this will lead to multilateral oil and gas exploration remains to be seen.

The surrounding maritime space is what is most sought after, not just for its unknown quantities of oil, gas and minerals, but because the sea lanes west of the islands link the Indian and Pacific Oceans. Jurisdiction over this space is regulated by the United Nations Convention on the Law of the Sea (UNCLOS).

But UNCLOS' application assumes that a particular state has undisputed title over territory from which the maritime zone is claimed. However, territorial sovereignty merely requires that state to demonstrate an ability to administer the territory. This interpretation has led to the claimant states effectively embarking on a policy of occupation of the Spratlys.

An UNCLOS definition of a semi-enclosed sea can be loosely applied to the South China Sea. Article 123 requires bordering States of such a sea to "cooperate with each other in the exercise of their rights and in the performance of their duties under this Convention". Using UNCLOS provisions may provide a breakthrough for cooperation in the Spratlys. (Source: *Offshore*, October 1998)

H. SOFTWARE

Information technology—electronic charting

By Robert Lennox

While paper charts are still required to be carried, the introduction of electronic charting some years ago showed the way ahead. There is an obvious advantage in having the appropriate chart on screen and seeing the vessel's position plotted accurately and instantaneously on it from information supplied by the global positioning system (GPS) receiver. Just this could be seen as advantage enough in the case of high-speed vessels, where the craft could perhaps have travelled a mile in the time it would take to put a manual position fix on a paper chart.

Electronic charting (ECS) is, however, more than that. Beyond ECS are the Electronic Chart Display and Information Systems (ECDIS) which are intended to gather, and make accessible to the navigator, the most comprehensive set of useful information which is available.

In 1986, the International Hydrographic Organization (IHO) and International Maritime Organization (IMO) agreed to establish a harmonization group on ECDIS. In 1995, IMO adopted performance standards for ECDIS. This was a fundamental step in that the ECDIS performance standards clearly state that an ECDIS with adequate back-up arrangement can be accepted as providing the up-to-date chart required by the 1974 SOLAS Convention. This would make the carriage of paper charts unnecessary. There remains, however, some difficulty in achieving this. The electronic navigation charts (ENCs) used in ECDIS have to be up-to-date vector charts issued on the authority of government hydrographic offices. It is likely to be several years before officially approved vector charts achieve worldwide coverage.

The base of the electronic chart is the official Admiralty or Hydrographic Office paper chart. This is scanned electronically to produce a raster chart. The Admiralty Raster Chart Service (ARCS) provides high quality digital reproductions of the paper charts. They retain the same standards of accuracy, clarity and reliability as the charts from which they were made. The electronic charts are provided on CD. Schemes can be joined so that the

navigator receives an update CD, either on request (the ARCS Skipper Service) or on a weekly basis under licence (the ARCS Navigator Service). Electronic chart plotting systems are available based on the ARCS charts. As an example, Meridian Chartware offers Oceantrak. This is a Windows95/Windows NT fully featured system aimed at the professional mariner who may need access to a large chart portfolio requiring weekly correction, and it supports the ARCS Navigator Service. This system can be customized to individual requirements to interface with a wide range of instruments—ARPS, gyro, autopilot and other NMEA 0183 compatible equipment.

Meridian also offer Proudman Oceanographic Tidal Stream Atlases covering the UK and the Continental Shelf in nine separate regions, each on floppy disc. Used in conjunction with Oceantrak, this software allows tides to be shown for any date/time as an overlay on the chart. It enables full tidal passage calculations. Another product, Tidetrak, is supplied as an integral part of Meridian's chart-plotting systems. This simple harmonic tidal calculator carries licenced Hydrographic Office data for over 600 ports. It shows a permanent display of tidal curve, current height, time and tidal range and printouts of 24-hour/monthly predictions can be obtained.

As already mentioned, the base for the electronic chart is the official paper chart. This is electronically scanned to create a computer file which contains the visual information from the chart stored as a series of dots of varying colour and intensity. To preserve the detail requires scanning at high resolution, which makes for a large computer file. More important, zooming in to look closely at an area reveals the dots of the image. The closer the zoom, the bigger the dots. The vector chart overcomes this, turning the exact positions of all the features of the scanned raster chart into a series of mathematical representations (vectors). Based at Port Solent, Portsmouth, Euronav is a leading and innovative navigational software house that produces vector charts under its name of "Livecharts".

Working from the raster chart, Euronav's digitizing technicians accurately trace the exact positions of features

to produce the vector chart. As vectorization is performed by experienced humans rather than machine, features are stored onto many separate "layers" of information—for example, one for spot depths, one for navigational marks, one for isolated dangers and so on.

Because the information is stored in layers, the layers can be switched on or off as required at any time. For example, when using a chart as an overview, the picture would be very cluttered if it showed every charted feature. The layers are thus switched off at this stage and then progressively switched on when zooming in for a closer view. This is done automatically by the chart-plotting software.

Livecharts are either digitized by Euronav in-house or are supplied to the company in digital format by the relevant hydrographic office. Either way, they faithfully reproduce the original charts in their entirety.

Euronav is not solely a producer of vector charts. The company's SeaPro 2000 is a unique and revolutionary electronic charting system designed to offer seamless zooming and selection of both raster and vector charts. In standard form, it features multiple chart windows and on-screen display of navigational data, all in a 32-bit program taking advantage of Windows95/Windows NT multitasking. Passages can be planned and monitored in different windows at different scales, or monitored in one window while planning a different passage in another.

The system gives access to the world's largest range of fully detailed top quality charts and is automatically ready for the new S-57 official vector chart data. The ARCS Skipper service is supported in the standard version. The SeaPro system interfaces with a wide variety of navigational instruments and can give full control of an NMEA 0183 autopilot. It includes an electronic tidal atlas as standard and thus provides full tidal passage planning and optimization capabilities.

The Plus version of SeaPro 2000 offers, in addition, multiple overlays, overzoom, ARPA radar overlay with facilities for enhanced logging, fuel calculations and Great Circle planning. The ARCS Navigator Service is supported in this Plus version. The SeaPro 2000 Professional offers turnkey or ECDIS compatible systems.

Transas offers a considerable range of products aimed largely towards navigation. Among these is Navi-Sailor. The Navi-Sailor system from Transas provides the user with access to the complete world collection of over 3,500 fully vector-digitized Transas TX-97 format charts (the Transas World Folio), as well as to other IMO recommended raster chart databases such as ARCS, NOAA and the DX-90 (S-57) official vector digitized charts. Navi-Sailor will load and display raster charts from other official chart producers in compatible formats.

When used in the Multiple Chart Loading Mode, several charts can be displayed simultaneously on the screen. The displayed chart collection may use any combination of available raster scan and vectorized data.

Charts from the Transas World Folio may be acquired separately, or as collections of any number up to the World Collection which is supplied on CD-ROM. Charts included in the World Folio are kept corrected to date by using the Notices to Mariners distributed by the national authorities. Users can receive a single updating service for Transas

charts using individual disks or on an annual subscription basis using either a CD-ROM issued quarterly or remotely via a satellite communication link. Additional charts can be purchased separately through a local agent or simply by receiving a new PIN code which allows access to the required collections on CD-ROM.

Functional capacity has been enhanced by various modules. These permit, among other things, the simultaneous display of radar information on the chart screen, a simulator for manoeuvring and collision avoidance training, alarms to warn of number of hazards, port information, Navtex management and also voyage playback.

Turning to Raytheon, electronic charting is a part of their hardware product range. Raychart combines Raytheon technology with C-Map NT cartography to provide fully featured electronic charting combined with the power to integrate with Raytheon GPS, autopilots and also instrument data to provide one central navigational unit.

Raychart 620 has a 10-inch supertwist LCD screen which delivers crisp resolution and autocompensates to maintain readability, even in bright sunlight. Orientation of the display can be North Up, Head Up, Course Up, true or magnetic. Four levels of greyscale are used to communicate water and land mass detail. Chart presentation can be as detailed or uncluttered as required. Chart boundaries, names, coastal features, restrictions, depth contours and spot soundings can be switched on or off, while there is the capability to display tidal and port information at the touch of a button.

Cartography details are stored on C-Map micro cartridges which combine compact size with high capacity. The system is user-friendly and incorporates fully configurable SeaTalk data boxes, turning the Raychart 620 into a fully-fledged information centre. Full waterproofing means that the Raychart can be mounted externally if required.

The large memory capacity allows the storage of up to 1,000 waypoints/events, 1,000 marks and 5,000 trackpoints. Tracks and marks can be saved to a memory cartridge. Active route information is shared between the Raychart 620 and other units on the Raytheon SeaTalk bus. Further details from: Meridian Chartware Ltd. Tel.: +44 1603 441 026; fax: +44 1603 765 253; Euronav Navigation. Tel.: +44 1705 373 855; fax: +44 1705 325 800; Transas Marine (UK) Ltd. Tel.: +44 1703 332 730; fax: +44 1703 233 439; Raytheon Marine Company (USA). Tel.: +1 603 634 4868; fax: +1 603 634 4756. (Source: *The Dock and Harbour Authority*, January/February 1999)

Clearer picture of ocean bottom possible

According to a spokesperson, John E. Chance & Associates Inc. (Chance) of Lafayette, LA, have developed an innovative process to capture a clearer picture of the ocean bottom for better planning of drilling and construction near a structure. This process was developed to meet the challenges that oil companies are facing as they exceed the capabilities of surface positioning systems used to position vessels during redevelopment of existing fields.

Chance incorporates a Sonavision 4000 scanning sonar system to collect data of sea-floor features along with a proprietary image enhancement and analysis software. The combination is used to create a greater definition and

resolution of sea-floor features and hazards that is beneficial during preparation of maintenance or redevelopment work at a well site or structure. The image of the sea floor is manipulated and matched to known geographical points (such as the legs of a structure). The sea-floor features observed with the scanning sonar are then mapped into an AutoCad drawing of the preliminary base map of the site. A final base map of the site is then produced along with a report and any pertinent frame prints of the sonar image.

According to a spokesperson, this technique is also ideal for underwater pipeline construction and well-site clearance. The safety of positioning jack-up drilling rigs and lifeboats near structures, wells and sub-sea wells is also enhanced through this process. (Source: *Sea Technology*, January 1999)

New software package launched for Aquarius GPS receivers

Confpack is the new software package designed for users of the Dassault Sercel NP high-precision DGPS/GNSS Aquarius 5000 range receiver. According to a DSNP spokeswoman, the new software allows users to "get the most optimized GPS receiver configuration, thus contributing to each project's best return on investment".

Global positioning system (GPS) manufacturers quite commonly offer only a fixed set of pre-defined configurations with their GPS receivers. In cases where the receiver configuration cannot be matched to local work conditions, this brings considerable limitation and leads to poor survey efficiency. By allowing the user to customize the GPS receiver configuration as far as required, DSNP's approach is quite original. Confpack's Windows®-based friendly interface sets the user free to select or create the adequate functions such as complete configuration of radio links, programming of any geodetic coordinate system, design of specific output messages, and definition of customized quality control parameters. (Source: *Sea Technology*, December 1998)

Earth observation helps develop new maritime information products

Earth observation (EO) refers to information obtained about the planet's surface from sensors on satellites orbiting in space, some of which have been operating for many years, allowing a global coverage of historical observations to be built up. A new generation of microwave sensors, which has only come into practical use for commercial applications this decade, has produced data that British Maritime Technology Ltd. (BMT), working with its Dutch partner ARGOSS, has identified for conversion into two new global information products for the maritime sector.

In operational terms, the satellite-mounted sensors measure the electromagnetic energy radiated naturally from the Earth's surface or reflected back from pulsed energy signals. Different sensors operate in the visible, thermal or microwave parts of the electromagnetic spectrum. Their observations are transmitted to a ground station where they are used to interpret changes on land, at sea and in the air. It is now possible to monitor and map the mean sea level, the wave climate and water depths in coastal zones.

The EO products developed by BMT are an integrated wave climate database and bathymetric charts based on EO data for coastal waters. Both products meet a need for high-level primary information among a number of strategic groups of customers, including port terminal designers, and arose from a research evaluation programme for the maritime industry funded by the European Commission's Centre for Earth Observation (CEO) based at the Commission's Joint Research Centre in Italy.

Jerzy Graff, the BMT coordinator of the CEO Maritime Study Programme, said "Earth observation data promises to provide some important benefits for the maritime community. We are confident that within two years we will see the first products coming through that will allow practical exploitation of this important global data resource. Both BMT and ARGOSS have expertise in making complex maritime information products accessible to the market place through interpretation tools and easy-to-use software interface." (Source: *The Dock and Harbour Authority*, July/August, 1998)

New, low-cost GPS monitors

The global positioning system (GPS), which gives geologists the ability to measure ground motions of less than an inch, has proven to be an important tool for both geophysical and atmospheric research. The high cost (about \$20,000) of GPS installations, however, has limited their number, making it harder to study rapidly changing phenomena such as volcanoes, faults and weather.

Now researchers at the University Navstar Consortium (UNAVCO), an international organization of more than 80 universities and other research institutions, have developed a new high-precision GPS system. The system's cost is low enough for it to be deployed in large numbers. Dense arrays of 15 to 30 instruments will be used to investigate features such as volcanoes and faults. Researchers have installed the first such network in the Long Valley, CA, volcanic region and will install others next year at volcanoes like Popocatepetl near Mexico City.

Receivers continuously transmit GPS data through a radio modem/repeater network to a base station. Hence even if some sites are destroyed by a volcano or earthquake, other sites will transmit data, according to Charles Meertens of UNAVCO, lead scientist on the project. (Source: *Sea Technology*, December 1998)

VTS and the role of information technology

by Dipl.-Ing. Jürgen Meine, Senior Sales Manager—VTS Systems, STN Atlas Elektronik, Bremen, Germany

With the adoption of the very latest data acquisition and processing techniques, vessel traffic service (VTS) systems have become the equivalent of an integrated information network enabling port authorities to exercise almost total supervision of vessels and their cargoes—and much more besides. It is a trend which has largely been dictated by advances in electronics and computing technologies in response to demands for improved levels of safety and efficiency. Both these demands and their attendant decision-making processes are therefore increasingly reliant upon the best that information technology can offer.

So, too, is the design and performance of open-architecture assemblies which can be readily modified or expanded to meet changing needs and expectations. At its most simplistic level, a modern VTS assembly is little more than a modular information processing and display system usually interfaced to commercially available radars and other sensors. As such, modular configurations allow much greater flexibility and ease of installation and can be conveniently assembled to meet specific operational requirements by using the equivalent of standardized building blocks at comparatively low cost. In this way, systems can be variously configured for single radar and display operations or to meet multi-radar or multi-sector surveillance and monitoring requirements.

Broadly, VTS systems are essentially designed for comprehensive surveillance and control of shipping traffic over specified areas. Typically embodying a range of sensor components including radar, radio, satellite navigation and CCTV, they are supported by integral computerized processing and display functions housed in a main control centre from which unmanned remote sites can be accessed for information. The sites themselves may be some distance from the control centre, with data usually being relayed via microwave radio, fibre optic links, private landline or public telecommunications networks.

Current advances in technology are primarily concerned with improvements in information transmission, display, processing and data management functions. Latest display systems, for example, now use high-resolution monitors and feature Windows-style presentation as part of ergonomically designed workstations. With them, a much more diverse volume of meaningful data can be accessed with presentations typically comprising overlays of raw radar data together with synthetically-generated information such as track data, VHF direction-finder bearing lines, operating alerts, symbols and electronic charts.

Another area where there have been notable technical advances is the synchronization of signal transmissions from remotely distributed sensors of different types and bandwidths for relay to control centres. Variations in sensor outputs can be considerable and have until recently necessitated separate relay and recording functions. Raw radar signals, for example, have data output rates of more than 20 Mbit/s while those for, say, CCTV signals are much lower, at 2 Mbit/s. These and other signals therefore have to be compressed and the most economical way of doing this is at an output level of precisely 2.048 Mbit/s. But this in turn is conditional upon a compressed, loss-free signal which does not in any way compromise integrity of data.

As part of its 9730 series of VTS configurations, STN ATLAS Elektronik has recently developed a common interface which makes it possible to combine raw radar, CCTV signals, voice communications, serial data streams and single event data such as relay contacts or similar information. Using separate data compression and reduction algorithms for each type of signal, the interface has a particularly high processing power of several hundred MegaFlops in order to carry out all necessary calculations in real-time.

With this VTS multimedia signal transmission development, a complete range of differing sensor data can

now be relayed digitally via just one line using standard transmission equipment. Thus raw radar, tracks, voice channels, direction-finding information, weather data, equipment status and remote-control signals are all compressed within a single duplex transmission channel which can also be recorded in compressed form and subsequently stored for reference on high-capacity hard disks. Multi-channelling and separate logging of event data is no longer necessary.

Digital signal transmission of this type is now a standard feature of latest VTS configurations, along with the dynamic linking between radar and computerized vessel databases as well as movements logs of a port's management information system. This extends equally to growing use of Wide Area Networks (WAN's) which effectively link multiple VTS centres and distribute information to all interested parties within a port's own overall sphere of interest.

Complementary advances in information and telecommunications technologies have thus reached a stage where large amounts of data can now be acquired, sorted and processed by a VTS and so provide any number of value-added services either in real-time or at specified periods. That is, with a database typically containing details of all past, present and predicted traffic data, a system can also become a lucrative source of revenue with its ability to provide valuable banks of data to third parties. These typically include, for example, those engaged in berth and harbour planning, traffic handling and forecasting as well as agents, customs authorities, shipowners and others. For a growing number of ports, this value-added potential is already a reality.

Proponents of the concept, which is presently being examined under the EC Framework Programme, point to a number of benefits. Not least of these is that by sharing traffic information between various VTS users such as coastguard, emergency service, port, customs and pilot authorities, the safety of traffic within predetermined areas, is considerably enhanced. Similarly, detailed knowledge of coastlines, tidal movements, shipping and port conditions will be readily available to shared users of a vessel traffic information system (VTMIS) and will provide them with, for example, much better means of countering threats of pollution or environmental damage arising from ever-increasing shipments of hazardous and dangerous cargoes.

At the same time, repeated ship-to-shore communications could be significantly reduced once initial contact had been established centrally, since all subsequent relays of data from vessels to individual VTS systems could be more efficiently handled by integral VTMIS user dial-in links. (Source: *The Dock and Harbour Authority*, July/August 1998)

Electronic communication for routine reporting by Sue Garstone, Community Network Services Limited

As a node in the transport chain, where goods pause briefly before changing their mode of transport, ports play a vital role in the efficient turn-around of cargo and ships. The daily routine operations of every port around the globe are based on an efficient communications network. Today, electronic data interchange (EDI) is the favoured structured

method to provide faster transmission of information between ports, ship operators and cargo agents, and has been implemented by large and small companies in the logistics chain. Just as the ships and cargo pause in the port, so the electronic information pauses, is updated and moves on, before arriving at the next location in the logistics chain.

Efficiency

The players in the port business around the port authority itself have developed electronic communities where information is shared in the port community system (PCS) in order to facilitate the rapid movement of goods through the port. Electronic links from one PCS to another, to shipping lines and other operators worldwide, mean that data is keyed into a computer system once only and then passed from party to party, as ships and goods move around the world. This practice has increased the speed of communications between relevant parties while eliminating the vast amounts of paperwork previously involved.

Ease of use

The extent of today's computer technology means applications can be presented in a familiar PC format, so that anyone subscribing to a port community network system has instant, desktop access to vital freight logistics.

Interconnectivity

Port community systems, such as those connected to CNSNet 2000, exploit the significant advantages of today's Internet technology. CNSNet 2000 represents a closed intranet for port communities, providing greater interconnectivity. It provides access to information for those with a need to obtain details of a ship, a container or a package of goods, its content, its whereabouts, its port of origin, etc. Based on Internet standard protocol, TCP/IP, and utilizing "Windows"-based software, CNSNet 2000 gives users the ability to access its network information from a PC situated on their desks.

Small harbour ports

Traditionally, the community has relied on the harbour master, stevedore or ship operator for traffic and cargo information via telephone or fax. This is now changing, with information accessible to all community members via an electronic communications network.

Manifests

Manifests are created by shipping companies when a port utilizes data of cargo bookings to produce a load list, and sends back a list of cargo loaded. When this process has been completed in the loading ports, the shipping company can then create a list of cargo to be unloaded at each of the unloading ports in advance of the arrival of the ship. These manifests are then sent to the ports to allow the community there to plan the various operations necessary.

Bayplans

In the special case of container ships, where one vessel can carry as many as 8,000 containers (or TEU), a special EDI message is now universally used. This is the "bayplan" which is sent between port terminals and vessel operators,

and reflects the position of each container on the ship. The use of electronic bayplans has significantly benefited port operations, ensuring the swift turnaround of a ship in port. However, in its EDI format, the bayplan is unintelligible to all but a computer and requires translation into a format which can be understood by personnel who require it. An essential component in the success of EDI bayplanning is the specifically designed PC software, which provides a graphical front end to those working with the information.

It is probably true to say that, in the major trades, container ships have reached such a size that it would be impossible to handle them efficiently and quickly in the absence of such sophisticated electronic communications networks which have grown up around the ports.

Dangerous goods

Following a European Union (EU) ruling, instant access to all ship manifests is now required in order to establish the nature of a vessel's cargo in the case of an emergency. These documents highlighting a vessel's inventory of dangerous goods had previously been sent to the harbour masters on the vessel's departure towards his port. Now the information is also required by the search and rescue organizations (SAR).

Current legislation requires competent authorities in each EU member State to hold details of the hazardous goods on board vessels leaving their ports. It is not however, compulsory for all countries to hold information in electronic format. Indeed, there are many existing methods of holding the required details which are rarely linked and with no coordinated planning. Furthermore, there are a large number of small ports in Europe which have little or no computer facilities for what is essential operational data.

Plans are afoot to implement a modular integrated system to satisfy the regulations and which will allow any national competent authority to access the latest information available. CNS will shortly be providing access to this information for harbour masters and also to SAR via CNSNet 2000.

VTS links

Electronic links have also been established with the vessel traffic services (VTS). In the Port of London, CNSNet 2000 provides access to the POLARIS VTS system and will shortly be implemented in the Port of Southampton. This enables agents to establish the exact arrival of a ship in port. Local community network users such as Port Health, the Ministry of Agriculture and Fisheries, and the Trading Standards Authority, can also access the data from their desktops, enabling them to identify particular containers for clearance or those which require closer scrutiny.

Conclusion

The electronic transmission of data within port community systems is a vital component in the efficient movement of goods across the globe. EDI has provided an electronic platform on which these port community systems operate, without which cargoes would simply remain in port until cleared manually. This would be quite a daunting task considering that today's container ships have the capacity

to carry up to 8,000 containers! (Source: *The Dock & Harbour Authority*, July/August 1998)

"Virtual ocean" computer simulation

Engineers working on a project for the United States Navy at an advanced simulation-based design centre are using a mathematical "virtual ocean" to test a computer-generated prototype of the largest floating structure ever envisioned—a self-propelled military base bigger than 10 aircraft carriers. Consisting of five separate modules joined by a series of hinged connectors, the proposed mobile offshore base (MOB) would provide the United States with a mobile, sea-based alternative to fixed land bases on foreign soil. Operating on the high seas, it would partially submerge when on location, providing a stable platform for launching and logistical support of troop deployments, common and control operations, and humanitarian efforts such as disaster relief and evacuation.

Over a mile long, the structure measures 500 ft wide by 250 ft high and includes a runway long enough to land fully loaded C-130 and C-17 cargo planes, interior quarters for up to 20,000 troops, and 85 acres of storage space for up to 150 aircraft, 5,000 cargo containers, and 3,500 trucks, tanks and other vehicles.

Studies on the feasibility of the mobile base are being performed by McDermott Technology Inc. (Lynchburg, VA), a supplier and operator of semi-submersible vessels for the offshore oil industry. Simulations visualizations, and analyses for these studies are being performed at the Simulation-Based Design Office of the Gulf Coast Regional Maritime Technology Center (Orange, TX), established by

the University of New Orleans in cooperation with the Office of Naval Research.

Because such a large complex structure has never been attempted before, engineers at the technology centre are using computer simulation to determine how the MOB will operate in various sea states. Given its primary mission of logistical supply, operations of the MOB's cargo systems are of particular interest, especially during the heavy wave action that could limit the ability to transfer cargo to and from adjacent supply ships.

Cargo ships react to wave action differently than the comparatively stable MOB so knowing their relative motion is critical in determining if cranes on the MOB can lift cargo containers from ships without the containers swaying too much and if vehicles can be driven safely over ramps between ships and the MOB.

Using ADAMS (automatic dynamic analysis of mechanical systems) mechanical simulation software from Mechanical Dynamics Inc. (Ann Arbor, MI), engineers verified that these operations could be performed normally during sea state 4, corresponding to significant wave heights of six feet. Simulations also revealed that the lift cranes could continue to move cargo in the nine-foot waves of sea state 5, which was unexpected good news for program managers.

According to Dave Johnson, coordinator of digital media at the centre, computer simulation was necessary because building a physical model of such an enormous structure is impractical, testing it on the open sea would be dangerous, and wave-tank scale models would not be sufficiently accurate. (Source: *Sea Technology*, November 1998)

I. PUBLICATIONS

Model Ballast Water Management Plan

The International Chamber of Shipping (ICS) and INTERTANKO have jointly produced a *Model Ballast Water Management Plan*. Price: £40.00 per copy inclusive of airmail postage.

The model plan complements resolution A.868(20) "Guidelines for the control and management of ships' ballast water to minimize the transfer of harmful aquatic organisms and pathogens" adopted at the twentieth session of the International Maritime Organization Assembly in November 1997.

The resolution recommends, *inter alia*, that "every ship that carries ballast water should be provided with a ballast water management plan". The plan should be specific to each ship, and be included in the ship's operational documentation.

The ICS/INTERTANKO model plan is accompanied by a PC diskette containing outline data designed to assist shipowners, managers and others who may be responsible for creating individual ballast water management plans for ships. This comprehensive package provides advice and information on:

- The need for ballast water management;
- Reporting to port States;
- Safety considerations;
- Procedures for managing ballast water, including exchange methods;
- Crew training and familiarization;
- Quarantine issues;
- Record keeping.

Some countries have already established controls on the discharge of ships' ballast water to minimize the potential for colonization of their rivers and estuaries by non-native species. Summaries of existing national and local quarantine requirements are provided in the plan.

For further information, please contact: Marisec Publications, 12 Carthusian Street, London EC1M 6EZ, United Kingdom. Tel.: +44 171 417 8844; fax: +44 171 417 8877. (Source: *PORTS AND HARBORS*, April 1999).

Safeguarding the health of oceans

Worldwatch Paper 145

For much of history, humanity has treated oceans as inexhaustible both in terms of what they could produce and in terms of what they could absorb. But humanity has pushed the world's oceans close to—and in some cases past—their natural limits. In this thorough review of the challenges facing us in managing oceans, author Anne Platt McGinn examines the threats to our oceans and prescribes the steps we must take quickly to protect ocean health.

The problems afflicting oceans are growing, from relentless overfishing by government-subsidized fleets to the insidious accumulation of thousands of chemicals in marine food chains. And too many international institutions working on oceanic issues were created to promote economic growth and development.

In the light of these threats, McGinn argues that we are poised at the edge of an explosion of information about oceans because of recent scientific and technological advances. The key question at this critical juncture is whether this new knowledge will be bent to the service of the old, increasingly destructive view of oceans as limitless, or to the new awareness of their fragility and importance to all life on the planet.

The fundamental challenge in protecting oceans is to make them more visible to people and communities who may not realize that they have a stake in the health of oceans. Better public understanding and political support are essential for carrying out the detailed programme McGinn proposes for advancing ocean protection.

Further information from: Worldwatch Institute, 1776 Massachusetts Ave., NW, Washington, D.C., 20036-1904, USA.

Opportunities for Ports

Opportunities for Ports, published by Cargo Systems, is the world's first in depth report on port business strategies and effect of shipping trends on ports and terminals.

Containing selected case studies and regional analysis, *Opportunities for Ports* discovers and explores winning port strategies. Handling technology, IT systems and marketing are all discussed and evaluated. *Opportunities for Ports* is an ideal planning document, allowing any port or terminal to remain competitive and react to changes in the market.

IIR Publications, 5th Floor, 29 Bressenden Place, London SW1 5DR, United Kingdom. Tel.: Subscriptions +44 171 976 4001; fax: +44 171 931 0516. (Source: *PORTS AND HARBORS*, July-August 1998)

Lloyds Ports of the World 1999

LLP (formerly Lloyd's of London Press) has published the 17th edition of *Lloyds Ports of the World*, its award-winning guide to the world's commercial ports.

Contained in a single volume, *Lloyd's Ports of the World* is a comprehensive reference source, listing ports and their facilities by region and then in a geographic listing encompassing all major facilities in the global port industry. A comprehensive index complements the data section.

Lloyd's Ports of the World is the only ports guide to utilize the information-gathering resources of the Lloyd's Agency Network and as such has been expanded to include additional information on key port locations and up-to-date intelligence on vital shipping areas including the Suez and Panama canals.

The 1999 edition of *Lloyd's Ports of the World* features an expanded front section to complement its comprehensive port data. A review of port developments and activities at the world's ports has been compiled from the Lloyd's List archive and two port organizations with which LLP is affiliated, the International Harbor Masters' Association and the International Association of Ports and Harbors present information on their current work and future plans.

Again included is a guide to the world's free trade zones, listing some 300 facilities around the world. A 68-page colour map section of the world's ports and shipping places completes the package, bringing together commercial and geographical information in one convenient volume.

Port users, port authorities, suppliers of goods and services to ports, indeed all those needing details of the world's ports for their work at sea or ashore, will find *Lloyd's Ports of the World* an essential reference work, enabling them to stay up to date with port development, throughputs and facilities worldwide.

Port data includes: latitude and longitude, approach and pilotage requirements, port authority contact data, pilotage and radio-frequency information, admiralty chart and admiralty pilot numbers, UNCTAD Locode, anchorages, weather conditions, key to principal facilities, port and terminal facilities, berth descriptions, shipping agents, Lloyd's agents, ship repair facilities, cranes, tide information, berth capacity (largest vessel), bunker suppliers, towage services.

Published September 1998—Annual/Soft cover—ISBN 1 85978 849 1; Price: £230/US\$ 391/HK\$ 3,050.

For more information, please contact Neville Smith, Managing Editor, on: +44 171 553 1000. For order information, please call: +44 1206 772 800. (Source: *PORTS AND HARBORS*, December 1998)

The impact of changes in ship design on transportation infrastructure and operations

By the US Department of Transportation, Office of Intermodalism (Washington, D.C., February 1998). 46 pages. Executive Summary. Tables. Figures). Order from: US Department of Transportation, Office of Intermodalism, 400 Seventh Street, SW, Washington, D.C., 20590. Fax: (202) 366-0263. Limited copies available. No charge.

This report focuses on the potential impact of so-called megacontainer ships on the US freight transportation network. It is based on input received by the US Department of Transportation from four regional meetings conducted last year on the need to improve infrastructure links to ports to cope with the expected growth in container traffic volume.

For example, the report finds that:

- Containerized sea trade is growing at annual rates of 9.9 per cent worldwide and 9.5 per cent and 1.5 per cent, respectively, at US and Canadian ports.
- 90 per cent of world liner general cargo trade will be containerized by the year 2010, compared to just 55 per cent at present.
- Every major container port is projected to double or triple its throughput by 2020.
- In 1990, less than 6 per cent of US containerized cargo was carried on vessels of 4,000 TEUs or more. By 2010, 30 per cent is projected to be handled on ships in the 4,000 to 6,000 TEU class, and more than 9 per cent in those in the 6,000 to 8,000 TEU range.
- Megaships of 4,500+ TEU capacity and/or fully-loaded drafts of 40 to 46 ft cannot be handled at "some major US ports".
- Ships in the 6,000 to 9,000 TEU capacity range will account for about 9.5 per cent of the world containership fleet by 2010.

Based on a survey of technical data, the report identifies these "parameters for an optimized megaship terminal":

- Minimum of 2,500 linear ft of berthing (two megaship berths @ 1,250 ft each).
- Up to 3,000 linear ft of berthing (three postPanamax berths @ 1,000 linear ft) to accommodate a mix of vessels.
- 50-ft water depths at berth.
- High berth occupancy rates (with 50 per cent as the target).
- A minimum of three "Beyond PostPanamax (BPP) cranes (outreach of more than 158 ft) per berth.
- Upgraded wharf load-bearing capacity to support the BPP cranes.
- Up to 75 terminal acres per megaship berth or 50 acres per standard berth (150 acres for 2,500 to 3,000 linear ft of berthing).
- State-of-the-art gate complex and on-dock rail.

Such a terminal could achieve throughput of between 450,000 and 900,000 TEUs annually, "depending on operation factors such as storage density, working hours, use of advanced in-terminal equipment, intermodal rail utilization and degree of trans-shipment to/from the terminal".

The report examines the issues of trans-shipment terminals and especially the capacity of landside rail and truck systems to accommodate the huge volumes of traffic that would be generated by even a single megaship.

It also discusses how various technologies and modified labour practices could improve container terminal productivity, citing as examples the impressive efficiencies already achieved at "the best Asian ports". (Source: *PORTS AND HARBOURS*, June 1998)

Living Resources of India's Exclusive Economic Zone

Compiled and edited by S. Z. Qasim and G. S. Roonwal
Hardcover. 140 pp. Omega Scientific Publisher. \$60.

This book synthesizes, through the various contributions, information on the living resources in India's Exclusive Economic Zones as well as pointing to the type of assessment studies required to be undertaken in the future. In addition, it brings out the importance of the ocean in order to plan for long- and short-term sustainable use of the sea. Many of the papers included in this volume were presented at the two-day international seminar on "Exclusive Economic Zones, International Law, and Fishing in the Indian Ocean". (Source: *SEA TECHNOLOGY*, November 1998)

Port and Harbour Engineering

Edited by Adrian Jarvis

Hardcover. 416 pp. Ashgate Variorum. \$153. (Cloth)

This book presents an invaluable reference collection for the study of civil engineering. This series encompasses many different branches of engineering from early times to the beginning of this century; its perspective is global, and the chosen articles have an international authorship, to the extent that this can be achieved for an essentially English language series. The volume editors were chosen for their particular knowledge and expertise in the field. The learned journals are represented, as also are conference proceedings, and essay chapters contributed to books. (Source: *SEA TECHNOLOGY*, November 1998)

The Asian Crisis: Implications for Regional Containerisation

This highly topical report provides a detailed analysis of the effect of currency and stock market uncertainties on the underlying trade growth in East Asia and with the rest of the world. The demand outlook for regional container ports is fully re-evaluated by national and port region. This reappraisal highlights the differences within the region, identifying and assessing the severity of the crisis on a national basis.

The report provides a full revision of earlier Ocean Shipping Consultants' forecasts, which are also shown for purposes of comparison.

Container terminal handling capabilities and planned investments are reviewed and future investment needs are re-evaluated in the light of current and forecast future capacity utilization levels. Areas of likely over-investment are identified.

The evolution and future development of the regional container trades and shipping capacity are also examined, including the deteriorating imbalances in trade flows which are a consequence of recent currency devaluations.

Ocean Shipping Consultants Limited, Ocean House,
60 Guildford Street, Chertsey, Surrey KT16 9BE,

United Kingdom. Tel.: +44 1932 560 332; fax: +44 1932 567 084; e-mail: oceanshipping@compuserve.com
(Source: *PORTS AND HARBORS*, October 1998)

Forest Products Shipping: Looking to the Upturn?

The global market for forest products has expanded considerably since the mid-1980s to the extent that demand growth in some sectors even appears to overcome economic reversals. The growth of forest products trade (from 125-130 million tonnes/year in the mid-1980s to around 150-155 million tonnes/year at the start of the 1990s and some 170-175 million tonnes/year at present) has been driven by two principal forces—construction activity and demand for paper products, both of which are highly sensitive economic indicators. These in turn gain their impetus from population growth, improving living standards and higher literacy levels. The last 20 years have also seen the industry undergoing a gradual process of modernization as the diversified operations of the 1970s have been forced by shareholder pressure to sell off underperforming units, seek partners, accept bankruptcy or simply become more market oriented.

In the past, forest products trades have focused on the relatively low value end of the spectrum—but this is steadily changing. These changes have impacted on the nature of forest products companies, resulting in the divesting of peripheral interests and focus on adding more value at source. So, instead of logs, the cargoes are increasingly sawn woods, panels and boards; instead of pulpwoods, they are pulp or paper. In fact the high value and extreme price volatility of market pulp makes it a crucial sector. Not only has it come to be seen as a "commodity" in its own right, but 1997 has seen the introduction of pulp futures! The high cargo values—by bulk/breakbulk standards at least—make service quality and reliability particularly high priorities for shippers. Consequently, nil or minimum damage "cargo care" is a key factor in an increasingly competitive market which utilizes almost all dry cargo ship types—including open hatch bulk carriers, woodchip carriers, box hold and conventional cargo ships, container ships, ro-ro, sto-ro, pallet carriers, conventional bulk/lumber carriers, log/bulk carriers and log carriers.

It is not only the fleet which faces the challenge of cargo care. The ports themselves need to address the crucial logistics question: does the cargo get moved to a central consolidation point or does the vessel come to load/discharge at individual mill facilities? Increasingly their response has been to develop innovative cargo handling systems. These enable some ports to become logistical hubs where a wide mix of cargoes are drawn in due to the presence of specialist agents' sites within the port—an operation analogous with that of a supermarket, where the truck takes the role of the supermarket trolley. This adds significantly to the port's portion of services—adding a new "unique selling proposition", attracting shipping lines on a "must call" basis and enticing other subsidiary products to the port to take advantage of the distribution facilities there.

The combined effect of all these factors is encouraging a more innovative, dynamic outlook in all areas of the trade—and this, in turn, has implications for new port

investment. The medium-term outlook, therefore, is optimistic but also highly competitive.

This report details all the key elements for success in this dynamic trade—such as the nature of competition and an analysis of port infrastructure and new investment in port facilities. It is, therefore, of vital importance to anyone hoping to benefit from the anticipated upturn in this mature but changing market.

Drewry Shipping Consultants Ltd. £415 including postage. Publication Dept., Drewry Shipping Consultants Ltd., Drewry House, Meridian Gate—South Quay, 213 Marsh Wall, London E14 9FJ, United Kingdom. Tel.: +44 171 538 0191; fax: +44 171 987 9396. (Source: *PORTS AND HARBORS*, April 1998)

Associated British Ports' handbook now available

Associated British Ports (ABP) has published its 1998 ports handbook *PORTS '98*. The 152-page guide to ABP's 23 ports around Great Britain is now available either from ABP Head Office, or from the ports themselves, which include Southampton, Hull, Grimsby and Immingham and the recently acquired Port of Ipswich.

PORTS '98 is a comprehensive reference guide to the services and facilities available at ABP's ports, its subsidiaries and two associated companies in the container-handling business. The book features profiles of each port, port maps, listings of port service companies, waste-

management facilities, and a liner-services section detailing the services operated by shipping companies between ABP ports and more than 100 countries around the world. (Source: *PORTS AND HARBORS*, April 1998)

ICS publishes guidelines on garbage management

The International Chamber of Shipping (ICS) has published Guidelines on the Preparation of Garbage Management Plans to assist shipping companies meet new IMO requirements. ICS Marine Director, Captain John Joyce, explained:

"From 1 July 1998, every ship will be required to have on board a Garbage Management Plan. The new regulation is an amendment to Annex V of the MARPOL Convention. The Garbage Management Plans will very probably be inspected by both flag and port state control authorities and will be expected to be an integral part of a ship's Safety Management System under the ISM Code."

The ICS Guidelines incorporate a model plan to facilitate the development of ship-specific plans and take full account of IMO guidance on the contents of Garbage Management Plans and should serve as a valuable reference document for personnel who are required to be aware of the current regulatory requirements and technical aspects relating to garbage storage and disposal. Copies of the Guidelines can be obtained direct from ICS for £25 including postage. (Source: *PORTS AND HARBORS*, May 1998)