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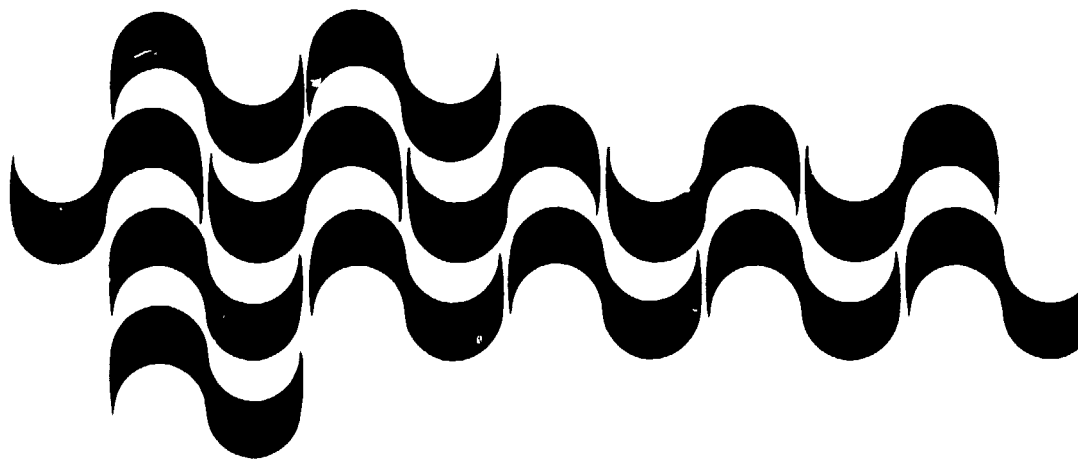
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MARINE INDUSTRIAL TECHNOLOGY MONITOR



ECDIS: Electronic Chart Display and Information System

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1. Introduction

The Electronic Chart Display and Information System, ECDIS, is a new development in the field of at-sea navigation. It may support utilities such as alarms to prevent grounding, accurate track-steering and choice of necessary information for various tasks. It is assumed that ECDIS will in future replace the traditional paper charts.

Most of the preconditions already exist for the production and sale of a comprehensive ECDIS. Rules and regulations have almost been completed by two United Nations bodies, the International Maritime Organization (IMO) and the International Hydrographic Organization (IHO). An accurate and global positioning system, GPS, is available. In addition, commercial IHO-approved databases will be made available in the near future.

Minimum elements in ECDIS include a database, connections to at least one accurate positioning device, gyro and speed-log. Optional are satellite communications equipment, an autopilot system, radar interface, depth sounder and other systems essential for an integrated bridge. IMO and IHO are currently working on rules and regulations for ECDIS. The utility of the system has been demonstrated in several test projects. ECDIS is currently available in the commercial market. A medium-size ECDIS for a merchant vessel can be purchased for US\$ 50,000.

The first part of this article introduces the motivation behind ECDIS and brings an overview of its possible uses, while the most characteristic elements of the system will be briefly discussed. There follows a summary of the work by various organizations on establishing standards and specifications. Specific functions, both existing and potential, are listed and the findings from two completed projects on ECDIS in the Netherlands and Norway are presented at the end of the article.

2. Motivation behind ECDIS

Throughout the past 40 years, mariners have adopted a host of various electronic navigation and positioning aids in order to make navigation at sea safer and more efficient. Collision avoidance systems have predominantly been radar-based and enroute navigation systems have been focussed on the use of, for instance, Loran-c and Decca. The newcomer to the field of navigation, the Global Positioning System (GPS), is currently under development and deployment. The catch is, however, that the manual position plotting methods, which are still the most common methods used for representing and displaying this information, frequently cause significant time-lags between measurement and use and have high frequencies of human error. As a result, the position shown on the paper chart represents the historical position of the vessel rather than the current position and is not as reliable as it might have been. In effect, these problems have compromised efforts to enhance the safety of vessels through electronic navigational aids. Such efforts have traditionally aimed at providing accurate position data through the use of microwave transponders, radar-assisted precise navigation systems and GPS.

The principal idea behind ECDIS is to quickly integrate hydrographic chart data with position and navigation information obtained from the gyrocompass and other navigational aids, and represent the information graphically. The result is a regular and automated update of current position, course and track of the vessel relative to the nearby coastline, navigational hazards and the intended track. Thus the ECDIS permits mariners to make optimal use of modern precise vessel positioning systems and the bridge personnel can devote more time and attention to other activities to secure a safe voyage.

ECDIS has two primary roles: it

replaces the traditional paper chart and is an additional aid to navigation. The first generations of ECDIS were intended as a mere substitute to the traditional papercharts. By replacing the approximately 2,000 such charts necessary for a world-wide journey, the owner of a vessel could save investments exceeding US\$ 30,000. ECDIS would also be automatically updated and thus render unnecessary the boring and time-consuming work involved in the manual updating of these charts. ECDIS should, according to Regulation 5, chapter I, of the International Maritime Organization (IMO) Safety of Life at Sea (SOLAS) Convention of 1974 [SOLAS, 1974], be the legal paper chart equivalent. However, the development of the second generation ECDIS also focussed on its virtue as an active aid to navigation and thus as a safety enhancing system.

At MARINTEK we feel that the success of ECDIS is contingent upon establishing it as a new aid to navigation, similar to what happened to radar in the period from 1950 to 1960, and developing additional functions that can aid the bridge personnel. Among these are anti-grounding control, track-steering, access to an appropriate level of information display and at-a-glance observation of vessel position. All this makes ECDIS an extremely useful tool on the bridge. As an illustration of its entry as a bridge system, we mention that several classification societies now explicitly introduce ECDIS as a vital new aid to navigation and mandatory in one-man bridge solutions.

The cost of a single mishap, whether a vessel is simply damaged and temporarily taken out of service or catastrophically damaged, is high and growing. The replacement costs of larger vessels can range from US\$ 50 million for a small passenger ferry to more than US\$ 200 million for a liquefied natural gas (LNG) carrier. Dry-dock and repair bills for less serious accidents usually range from US\$ 500

thousand to well above US\$ 1 million dollars.

Recent accidents, such as the grounding in March 1989 of the Very Large Crude Carrier *Exxon Valdez* in Prince William Sound in Alaska, have shown that as the sizes and numbers of vessels transporting hazardous cargoes grows, the hazard to the environment caused by groundings or collisions grows dramatically. It has been estimated that Exxon Corporation will spend almost US\$ 2 billion in the attempt to clean up the mess caused by the costliest vessel grounding in history.

It seems clear that the *Exxon Valdez* accident could have been prevented if appropriate technology had been used. This can be concluded through simulations done with ECDIS in the *Exxon Valdez* scenario. ECDIS would, if installed, have plotted the vessel according to a pre-planned route. When the deviation occurred from the pre-planned route an off-track alarm would have sounded. Then if no action were taken, an off-course alarm would sound and if there were still no correcting measures, a grounding alarm would sound. All these alarm signals would be directed to the general alarm system of the vessel, and if the ECDIS was designed appropriately the automatic steering system on board the vessel would take corrective action to avoid the disaster. In this context an investment of US\$ 50,000, which is the average cost of a commercial ECDIS, is a cheap insurance.

3. Pre-conditions for a successful ECDIS

The successful operation of ECDIS is contingent upon several factors, where the major ones are:

- (1) effective rules and regulations;
- (2) an accurate positioning system; and
- (3) a chart database.

Pre-condition 1: Rules and regulations

Rules and regulations distinguish ECDIS from conventional chart plotters. The Provisional Performance Standards for ECDIS, developed by the IMO and the IHO, can be named as an example of such regulations. They are provisional standards that are valid

until 1 January 1993. These sets of standards are necessary as guidelines for approving systems by port and flag state of the vessel and give classification societies a foundation for their own rules. When complete standards are established, ECDIS has all the chances of becoming part of an integrated modern bridge, both as a replacement of the old paper charts and as a new and promising navigational aid.

Pre-condition 2: Accurate position device

Positioning devices vary greatly in the range of area covered and accuracy. In experiments performed by MARINTEK, we experienced that the required position accuracy is within less than half the length of the vessel. The success of ECDIS also depends on the device being available for 24 hours a day and to be accessible at any location along the journey. The system that most closely conforms to these requirements is currently GPS.

Pre-condition 3: Chart database

The Electronic Navigational Chart (ENC), the chart database in ECDIS, must

be supplied by an authorized official supplier. In effect this means a supplier authorized by the IHO. For this purpose IHO is currently developing international standards for the formatting of data organization and exchange. One of the main requirements before

authorization is that the suppliers regularly update the database. The ENCs are currently in limited supply, but several hydrographic services, notably in Canada, Norway and the USA, are working with technical and administrative procedures needed to supply users with ENCs.

Today, pre-conditions 1 and 2 are satisfied or will become so in the near future. The major problem is, as mentioned, to supply the users with authorized databases. One possible concept, put forth by the IHO, suggests resolving this supply problem by organizing the oceans into four or five geographical regions and establishing organizations that will supply the database for each of these. It has been proposed that these regions be the American, the Far Eastern, the European, the African and the Australian regions. However, several experimental databases covering small areas are available today. The largest of these, developed by the Norwegian Hydrographic Services (NHS) in cooperation with other countries surrounding the North Sea, covers the North Sea and adjacent shorelines.

4. Elements of ECDIS

Figure 1 illustrates the connections between the sub-systems in an operating ECDIS. It consists of several elements, the basis of which are a chart data base (ENC), position device(s), com-

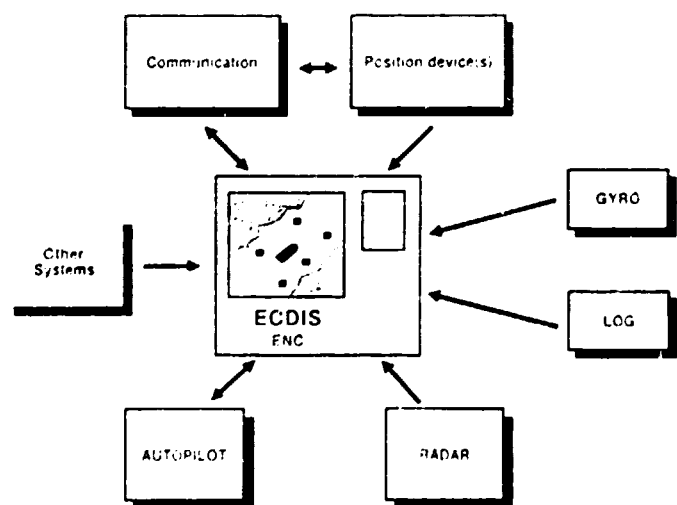


Figure 1: ECDIS sub-system.

munication device(s), radar interface, autopilot interface, and gyro-compass and log.

The Electronic Navigational Chart (ENC)

The ENC, which is standardized with regard to content, structure and format, is specifically designed for use with ECDIS. The ENC is equivalent to new editions of paper charts, and several ENCs contain supplementary nautical information to that included in traditional paper charts. An example of such additional information is sailing directions.

Position devices)

Among the positioning devices or methods are GPS, Decca, Loran-C and dead reckoning. The system will be able to automatically select the positioning device that provides the best information at any time and location.

The position information supplied by the Decca system is not precise enough for navigation in restricted waters and the system has an insufficient area coverage. It is thus of limited utility to ECDIS.

The position given by the Loran-C has an accuracy in the range 100 to 300 metres and is therefore not precise enough for navigation in restricted waters. Loran-C also has limited coverage.

GPS is a military, satellite-based navigation system currently under development by the United States Department of Defense. The principal idea behind GPS is to accurately measure the propagation time of electromagnetic signals between satellites and recipients. Through access to at least three satellites the user receives two-dimensional position parameters at a typical frequency of one update per second. When the system is fully developed and deployed in 1992 or 1993, 24 orbiting satellites will give global, all-day and all-weather accuracy of 100 metres.

Since the 100-metre accuracy of GPS is insufficient for many applications, differential GPS has been developed to improve accuracy. The idea behind a differential GPS is to use data from an additional GPS receiver located at a

point with fixed co-ordinates to calculate range measurement errors for every observed satellite. These errors will be grossly constant over wide areas (100 to 1,000 kilometres distance). Such differential corrections are transmitted to and applied by the users to allow corrections of local measurements, thus improving accuracy from 2 to 10 metres.

Dead reckoning means to estimate the vessel position by using information from the gyro-compass and the log. In principle it may be possible to develop the method to become a useful aid in the event that GPS positions are unavailable.

Communications

ECDIS requires that the user is able to receive chart updates from the vessel's chart supplier. Updates will be automatically transferred to the system and stored separate from the ENC. The International Maritime Satellite Organization (INMARSAT) provides a system for such communications.

INMARSAT is a 54-member state, commercially managed organization that operates a system of satellites for world-wide communication, and INMARSAT Standard-C is a service provided by the organization to transfer data and text. Both the service itself and the equipment required by the user are designed to give relatively low-cost communication solutions.

Radar interface

A radar interface can be designed for several purposes. Among these are corrections and checks on the vessel's position. This can be done by plotting Automatic Radar Plotting Aid (ARPA) targets and comparing them with chart objects, for instance small islands, buoys and beacons. ECDIS may also superimpose the radar image on the electronic chart, which makes all vital information available to the navigator. This makes it possible for the navigator to quickly evaluate whether the actual position of the vessel is the one indicated in the charts, or whether there is an error in the system.

Autopilot interface

An autopilot may be connected directly

to ECDIS. By using information of the preplanned route and accurate position data, the autopilot may be able to steer the vessel, even in narrow passages.

An autopilot may operate together with ECDIS in two different modes: Xross Track Error (XTE) and Course To Steer (CTS). XTE corrects the vessel course according to registered deviation from a line between two en-route points, and is meant to keep the vessel precisely on track from one way-point to the next. CTS, on the other hand, sets the course to the next way-point and may in some cases cause a significant deviation from the straight line between two way-points.

Gyro and log

Gyro-compass and log are predominantly used to estimate the vessel's position by dead reckoning.

5. Functions in ECDIS

The following is a list of the various utilities that a fully developed ECDIS will accommodate:

- Option to display the electronic chart in different scales
- Planning of the voyage route prior to departure of the vessel
- Display vessel position on a video display
- Use of radar targets to correct or confirm the vessel's position information
- Display depths on a video display
- The display of electronic lines and range markers, which may be used for measurement of distances
- Display historical and future voyage route of the vessel
- Grounding alarm connected to vessel safety contour information.

New opportunities:

- Black-box, or voyage recorder, function
- Weather routing system to avoid bad weather
- Registering restricted areas
- Register and display position and redirect the vessel in cases of man overboard
- Ice edge information
- Displaying information on sailing procedures
- Registering of particular water char-

acteristics such as temperatures, to be used in, for instance, fishing activities

- Tidal water modelling
- Local pilot information.

6. Status on activities of the IMO and IHO

Rules and regulations are developed in working groups and committees under IHO and IMO, and these are briefly introduced here. Figure 2 illustrates the connections between the most active groups in these two organizations in work related to ECDIS.

The International Hydrographic Organization (IHO)

The Committee on ECDIS (COE) under the IHO is an administrative umbrella comprising at present six working groups. These are as follows:

- Group of Experts on Specifications for ECDIS
- Working Group on Updating ECDIS
- Working Group on Regional Data Bases
- Working Group on ECDIS Glossary
- Working Group on Colors and Symbols
- Working Group on Data Quality.

The working groups meet whenever deemed appropriate, and the results of their work are made public in various papers and reports. Central publications are the International Hydrographic Bureau's report SP-52 *Draft Specifications for Electronic Chart Display and Information Systems* and its appendix *Updating the Electronic Chart* [IHB, 1988]. Important unpublished or draft stage documents include the report of the *Colors and Symbols Working Group Meeting* and the *Draft ECDIS Glossary*.

Group of Experts on Specifications for ECDIS

The Group of Experts on Specifications for ECDIS was the first group to be formed, and its initial report covered all aspects of ECDIS Standards. This report was the basis whereupon the publication of SP-52 was based. This

Group of Experts still exists and carries out continuous updating of the specifications as more experience is gained and comments are received from ECDIS users.

Working Group on Updating ECDIS

The need to update charts is recognized in the SOLAS Convention. Regulation 20 of Chapter V in this convention states that all vessels are required to carry up-to-date charts. Thus if the electronic charts are to be considered equivalent to the paper charts they must be maintained and updated regularly. A major difficulty to be resolved is the issue of updating the database contain-

therefore established this group in order to develop a complete glossary of ECDIS terms to be used by the IMO.

Working Group on Colors and Symbols

The need to standardize colours and symbols used for electronic display was early on appreciated by the Group of Experts on ECDIS Specifications. As the ECDIS integrates navigational and chart information, it became necessary to develop colours and symbols for both the charted information and the navigator's electronic annotations so that they became distinguishable. The Working Group on Colors and Symbols was established to design the colours

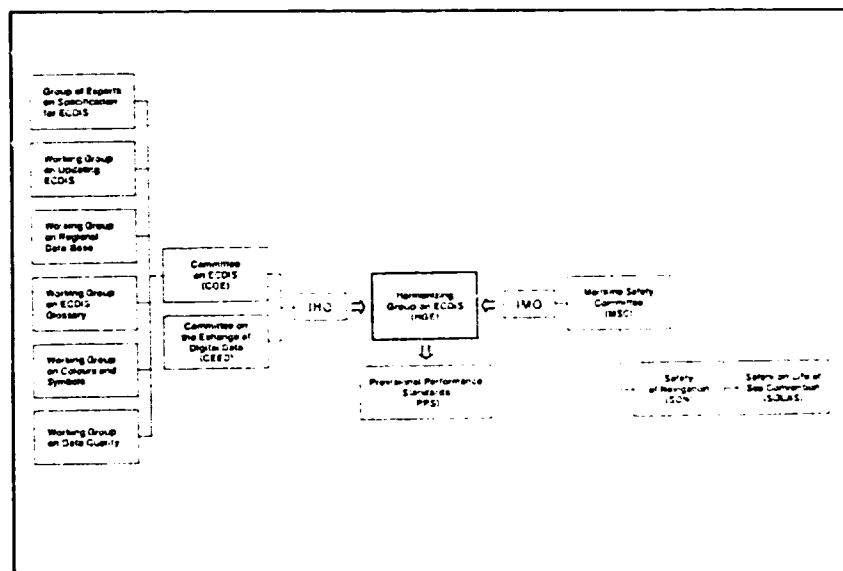


Figure 2: IHO and IMO working groups in ECDIS

ing the information required to produce the electronic charts.

Working Group on Regional Databases

The Committee on ECDIS quite early realized the importance of developing data bases for ECDIS users, and the aim of this working group is thus to establish methods that can be used for this purpose. The group focusses on both technical and administrative aspects of the problem.

Working Group on ECDIS Glossary

It is important in any technological development to have an agreed terminology. A large number of acronyms and other terms quickly emerge and their meaning is often subjected to individual interpretation. The COE has

and symbols for chart information, while a non-IHO group, the *Comité International Radio Maritime* (CIRM) works with establishing non-chart symbols.

Working Group on Data Quality

The Working Group on Data Quality aims to establish criteria whereby the required quality in chart compilation and chart information display can be determined.

Committee on the Exchange of Digital Data (CEDD)

The Committee on the Exchange of Digital Data is working to develop standard formats to be used in exchanging digital data [IHO, 1986].

The International Maritime Organization (IMO)

Safety of Life at Sea Convention (SOLAS)

Of particular importance for ECDIS developers is the carriage requirements for nautical publications. Regulation 20 of Chapter V reads as follows [IMO, 1986]:

"All ships shall carry adequate and up-to-date charts, sailing directions, list of lights, notices to mariners, tide tables and all other nautical publications necessary for the intended voyage"

Another SOLAS regulation of particular importance is Regulation 5 of Chapter I: *Equivalent*s. This regulation is central because it makes possible the approval of substitutes, subject to adequate tests of equivalence, of other nautical documents than the ones required according to Regulation 20 of Chapter V.

Harmonizing Group on ECDIS (HGE)

The task of the HGE is to prepare Provisional Performance Standards. This group aims at finalizing the Performance Standards on ECDIS by 1993. This will make it possible for ECDIS designers to use these standards to make the system 'equivalent' to the paper charts.

7. Review of trial plans and results

Work on ECDIS, including tests and sea-trials of the system, has been undertaken by several countries. Among the more matured projects are those completed in the Netherlands and Norway, but other countries, for instance the USA, the USSR, Germany and Canada, are also vesting efforts into work on ECDIS. The results from the work in the Netherlands and Norway are reported to the IMO and the IHO working groups and their findings will be summarized in detail here.

The Netherlands

Objectives:

The project in the Netherlands was in-

itiated in 1989 with the objective of designing and building an ECDIS prototype according to IMO and IHO specifications, and carrying out subsequent at-sea tests of the system. The project centred on the following activities:

- Investigate to what degree the system design was in harmony with the provisional specifications of the IHO and the IMO
- Report to the IMO Sub-Committee on Safety of Navigation the findings and other relevant information needed to evaluate the quality of the provisional Performance Standards
- Report to the IHO Committee on ECDIS the findings and other relevant information needed to evaluate the quality of the provisional Specifications on Chart Content and Display
- Report to the Netherlands Hydrographic Office the findings related to the digitalized paper charts used during the sea trials
- Report to the industrial partners the findings relating to the overall performance of the system and possible improvements involved in the project
- Study the quality of the interface between ECDIS and the human operator.

Organization:

Design and manufacture of the ECDIS prototype and the completion of at-sea trials included participation from the following organizations:

- Netherlands Hydrographic Office
- van Rietschoten & Houwens, b.v.
- Radio Holland Group
- Ministry of Transportation and Public Works, Directorate for General Shipping and Maritime Affairs
- National Foundation for the Coordination of Maritime Research
- Royal Shell Tankers and Nedlloyd Lines, b.v.
- The Netherlands Organization for Applied Scientific Research, Institute for Perception
- The Royal Netherlands Naval Academy.

Experiences from sea trials:

Among the important conclusions regarding improvements in ECDIS were [Netherlands Hydrographic Service, 1991]:

- Software was too sensitive to *operator errors*
- The interface between ECDIS and the operator lacked a *logical structure*
- ECDIS spent *too much time building backup charts*. This was due to the amount of data involved, and thus an improved ECDIS software is required. A compression of the digital chart data used for establishing an ENC is probably necessary
- More work was needed to increase the *quality of way-point establishment and editing*
- The vessel was displayed at the centre of the screen, giving too short a time on the display before redraw. *Initial vessel display* should be about 30 per cent from the after end of the display, i.e., with 70 per cent of the screen ahead of the ship after screen refresh
- *Wrong input* should be quickly and easily scrapped
- A good *on-line help* is required
- Possible *cautions or notes* should be visible on the screen at all times. Such messages should be displayed both for currently displayed areas and for adjacent areas not shown on the screen
- More emphasis on *user-friendly software*
- A *look-ahead capability* in operational mode outside the displayed area
- The *built-in high resolution colour screen-dump* at a graphics printer proved very useful
- The decision to keep *symbols* at a constant size after zooming should be re-examined
- There was a need for a *second large display* for plan-ahead action. This screen might also be used for alphanumeric, or text, display
- *Alphanumeric display* should be possible on the area now devoted to chart display - not only in a window at the base of the large primary screen as now
- Legible display of *navigator's notes* is important
- A clear representation of the *display*

scale is required

- 99 per cent of the preliminary *IHO* and *IMO*-recommended colours and symbols were deemed excellent
- Preparation of an *ENC* was one of the most complex and time-consuming tasks.

Norway

Objectives:

The Norwegian project was a joint venture with primary objectives to:

- Establish *ENC*'s for experimental use along an extensive voyage
- Get practical experience in operating a prototype Electronic Navigational Chart Data Base (*ENCDB*)
- Get practical experiences on the operational requirements and the performance of *ECDIS* in order to improve the safety of marine navigation
- Explore how to automatically broadcast chart corrections by using the recommended maritime satellite communications
- Evaluate the effects on workload and operational safety when using *ECDIS* in confined waters and under different weather conditions
- Analyze the impact of integrating *Navstar GPS* and *ECDIS*
- Contribute to the development and use of approved navigational systems that utilize electronic navigational charts.

Organization:

The project was managed by the Norwegian Hydrographic Service and included ten other private and public Norwegian institutions. The project was supported financially by the Royal Norwegian Council for Scientific and Industrial Research and the Norwegian Maritime Directorate. The main participants in the project were:

- The Norwegian Hydrographic Service (*NHS*)
- Det norske Veritas (*DnV*)
- The Norwegian Maritime Directorate
- The Norwegian Marine Technology Research Institute A.S. (*MARINTEK*)
- Seatrans ANS and Norske Skog A.S.
- Robertson Tritech A.S.

A reference group was organized to give technical support and advice on *GPS* and *INMARSAT Standard-C*. This group included:

Satellite based reference system (SATREF) differential GPS service:

- The Norwegian Mapping Authority, Geodesy division
- The Norwegian Coast Directorate
- Seatex A.S.

Maritime satellite communication - INMARSAT Standard-C:

- The Norwegian Telecom Satcom Division

At-sea trial case:

The paper carrier *M/V Nornevy Express*, build in 1987, of Seatrans ANS and Norske Skog A.S. has regular voyages between the ports of Skogn near Trondheim in Norway, Hamburg and Amsterdam. A major part of the voyage takes place in extremely narrow and irregular waters along the Norwegian west coast between the towns of Stavaanger and Trondheim. The depth clearances are marginal and the route is heavily trafficked.

The vessel's bridge is laid out with a view to these conditions. It is designed in accordance with specifications in the *DnV* Nautical Safety Class and will, when electronic charts are made commercially available, support one-man bridge operation (*W1*) in inshore waters. The key navigational instruments are grouped in one central console, and the navigator has a 360° view from the bridge. The vessel's length is 110 metres, the draught is 6.3 metres, the deadweight 4,500 tonnes, and the journey speed is approximately 15 knots. The functions onboard the vessel are highly automated, and the crew is thus as low as six.

The *NHS* was responsible for supplying the operational Electronic Navigational Chart Database for the extended voyage of 1,000 nautical miles. The *ENC* was to comply with international regulations.

Approximately 35 charts were digitalized and processed. The chart corrections were broadcast from *NHS* using recommended *INMARSAT Std C* satellite communication.

Experiences from the sea-trials:

After three months of testing the project concluded that the navigators were very satisfied with the *ECDIS* and could see several advantages and new opportunities with this new navigational aid.

Among the conclusions to be drawn from the project were the following [*NHS*, 1991 and *MARINTEK*, 1991]:

- It was easy to locate vessel position at a glance. This was helpful in ensuring safe and efficient navigation
- The system depended on an accurate positioning device. For a vessel on such a voyage, *GPS* was, and still is, the only solution since positioning using radar, *Decca* and dead reckoning proved inefficient. Thus, *GPS* is satisfactory provided it can support the same accuracy as in this project on other routes
- The vessel could automatically steer from a preplanned route in *ECDIS* by transferring steering information to the autopilot. Nevertheless, the navigators tended to use *ECDIS* track-steering only in open waters, and used manual control over the traditional autopilot in close waters.
- The accuracy of *GPS*, even without differential *GPS*, was impressive. In several charts, the accuracy in the chart database was too poor to utilize the positioning system optimally. An accurate positioning device requires an accurate chart database.
- The most useful functions proved to be:
 - Route monitoring
 - Route planning
 - Steaming according to the preplanned route
 - Display of safe waters
 - Choice of level of details to be displayed, such as optional display of lighthouses, with corresponding sectors
 - Selection of relevant information on the display.
- The navigators had the paper chart ready as backup. As the project proceeded, they relied increasingly on the *ECDIS* and used the paper chart less often
- The navigators saw the electronic chart as a helpful aid to navigation. In their opinion the safety was in-

creased when the ECDIS was on-board

- The power of ECDIS was clearly demonstrated in areas where radar was unreliable. The position of the vessel according to hydrographic information, such as vessel safety contours and navigational information like lighthouse sectors, was useful when the radar could not supply accurate information
- The most useful hydrographic information from ECDIS was vessel safety contours and lighthouse sectors. The safety contours were essential in the ECDIS grounding warning function. The lighthouse sectors were more frequently used as a decision criterion for course adjustment than was the case without ECDIS.

USSR

Three independent industry initiatives are involved with electronic charts. The Government is working to coordinate these efforts and aims to proceed with sea-trials using a database of 40 Baltic Sea charts. The positioning systems will be domestic GLONASS or the GPS.

USA

The US project, which is still at the planning stage, will involve DX-90 formatted digital charts of six harbour approach areas. These areas are Valdez, San Francisco, Long Beach, Narragansett Bay, New York and Norfolk as well as certain connecting transits between those harbours. The prime activities will be to test IMO and IHO preliminary standards and specifications and other such specifications, for instance those suggested by the Technical Commission for Maritime Services (RTCM), and will also test updating techniques. The ultimate goal is a complete evaluation of user options. The vessels to be used include a Coast Guard cutter, one tanker, one ferry and one tug. A report from the project is expected by May 1993 and will include publications of computer (UNIX operative system) software development. The National Ocean Service will supply the database, while private in-

dustry, governmental agencies and private institutions are co-operating in completing the other activities.

Germany

A trial using a container ship on a single round trip between Germany and the east coast of Canada USA is at its planning stage, with an enroute ENC between the North Sea and Halifax in development. The objective is to test IMO and IHO Preliminary Performance Standards and Specifications. Due to available resources, no chart updates will take place.

Canada

The Canadian Hydrographic Services has, in co-operation with the Colors and Symbols Working Group of the IHO, developed an ECDIS testbed, also called "Electronic Chart Testbed". The purpose of the project was to initially develop a good chart design for the ECDIS. Several tests and sea-trials have been conducted to gain practical experience with the chart database in ECDIS.

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General Information

Over the horizon

Inmarsat may soon experience problems serving its rapidly growing number of customers. At present, there are about 15,000 civilian users of the satellite communication services provided by the organization. However, some predictions of future use put the number at 100,000 users in 1995 and at more than a million by the year 2005. While some of the problems caused by such an expansion of traffic are thought to be alleviated by new technological developments providing more efficient means to transmit messages, there are fears that the Inmarsat satellite communication services may become severely overloaded if the forecasts turn out to become reality. Part of the congestion problem arises from the fact

that current communication takes place within two small frequency bands: between 1,530 and 1,550 Mhz and between 1,626 and 1,660.5 Mhz. (**Ship & Boat International**, May 1991)

Conferences

Energy-sources Technology Conference & Exhibition, ETCE '91, is to be held in Houston, Texas, in the period 26-30 January 1992. Information can be received from: Frank Demarest, ASME Petroleum Division, 1950 Stemmons Freeway, Suite 5037C, Dallas, TX 75207, USA.

Oceanology International 92; exhibition and conference is to be arranged in Brighton, UK, in the period 10-13 March 1992. Information can be received from: Spearhead Exhibitions Ltd., Rowe House, 55-59 Fife Road, Kingston-upon-Thames, Surrey, KT1 1TA, United Kingdom.

The SingaPort '92 Conference is an international exhibition and conference for the maritime industry, and will be arranged in Singapore in the period 25-28 March 1992. The conference will cover the latest innovations and state-of-the-art technologies in ship operations, systems and management; shipbuilding and repair; marine and offshore equipment; and port operations and maritime services. Information can be received from: Times Conference & Exhibitions Pte. Ltd., Times Centre, 1 New Industrial Road, Singapore 1953.

The 5th Safety at Sea and Marine Electronics Exhibition and Conference (SASMEX '92) is to be arranged in London in the period 7-9 April 1992. The conference and exhibition, which cover a wide range of safety-related topics, are supported by the International Maritime Organisation (IMO) and other maritime organizations. Information can be received from: SASMEX 1992, Queensway House, 2 Queensway, Redhill, Surrey, RH1 1QS, United Kingdom.

The 10th Annual Intervention/ROV '92 Conference and Exposition is to be ar-

ranged in San Diego, California, in the period 10-12 June 1992. The conference and exposition covers technological issues and advances on undersea vehicles, manned diving and submersibles, and combined technologies and operations. Information can be received from: The ROV Committee of the Marine Technology Society, P.O. Box 261149, San Diego, CA 92196, USA.

The 2nd International Congress on Energy, Environment and Technological Innovation is to be held in Rome, Italy, in the period 12-16 October 1992. Among the topics covered by the congress are technological innovation in the production, conversion and transport of energy, such as raw materials for energy and electrical, thermal and mechanical energy from various sources. The other main topic is technological innovation and environment, such as productive processes, land use and habitation. Information can be received from: Studio EGA, Viale Tiziano 19, 00196 Rome, Italy.

New products

British Aerospace has developed a weather monitoring system called Dartcom. The system is claimed to be of great use to mariners in need of detailed weather pattern information to increase the quality and efficiency of routing decisions. It utilizes an IBM compatible personal computer in conjunction with satellite images transmitted from meteorological satellites and received through two small externally mounted antennas. It is possible to zoom in on weather pictures in areas of concern and to study actual weather development through animation of up to 16 stored images. Images are updated every half-hour from the Meteosat satellite system. (**Safety at Sea**, August 1991, page 10)

Kelvin Hughes has presented a new line of radars - the *Nucleus 5000* and *6000* series. One of the most significant achievements of the new developments is the user interface, with all required information located at the same display, and all functions performed

through operating a tracker ball and three push buttons. The colours on the display correspond to the configuration as recommended by IMO/IHO (see lead article). The radars are presented as parts of an integrated bridge system, which aims to improve the efficiency of information processing and vessel control. (**Safety at Sea**, August 1991, pp. 12-13; **Marine Engineers Review**, August 1991, page 22)

A new sonar, EM12 from Simrad Subsea of Norway, is said to be "the most efficient ever produced because of its ultra wide swath capacity of up to 20 kilometres." The essence of the product is its high resolution - facilitated by 1° beam spacing. The system can be delivered in two different configurations, one with a 90° mapping sector (single system) and another with a 150° sector (dual system). Both of the systems operate on a frequency of 13 KHz and can use two pulse lengths; 2 milliseconds (shallow mode) and 10 milliseconds (deep mode), and give a range resolution of 0.6 and 2.4 metres, respectively. In shallow mode, the single system has a maximum operating depth of 700 metres while the dual system can function in depths of up to 2,000 metres. In deep mode, the range will be larger due to particular filters that reduce noise level. The maximum swath width of the EM12 for the dual system is in the order 15-20 kilometres at all depths below 2,000 metres, while for the single system the swath width is twice the range for all depths. (**Sea Technology**, June 1991, pp. 19-25)

Navigational aids and maritime communications

Integrated bridge systems are receiving increased attention as an option for commercial vessels. There are two primary reasons for their development: the need for more efficient operation of traditional merchant vessels and the need for safer and quicker operation of high speed vessels. In the prior case, the aim is to fit the vessel with a bridge that can be operated with a minimum of personnel, in some cases one-man bridges. Thus the question becomes one of balancing investment costs with

the operational savings, while maintaining or improving safety. In the latter case, with high speeds, higher passenger load factors and high traffic density at sea, the chief goal is to quickly make the operator aware of new information, and to make possible quick and safe operation of important vessel functions. In such situations it becomes important to efficiently combine information regarding vessel speed and position, as well as information from the technical systems aboard the craft. Most of the integrated bridge systems are modular, leaving the purchaser more free to choose components with a view to the particular needs of the vessel. Three major new integrated bridge concepts were introduced in 1991 from Kelvin Hughes, Norcontrol and Kvaerner Eureka. The latter is particularly intended for high speed vessels and is to be installed on-board a new vessel - a Foil-Cat - to be launched by the end of 1991. (*Marine Engineers Review*, August 1991, pp. 16-17)

The Kelvin Hughes integrated bridge system mentioned above has a basic structure composed of seven units: (1) Electronic Chart Workstation, which gives the operator the inputs required for route planning and database handling operations; (2) Navigation Display Workstation, which contains all the navigation software and interfaces to necessary sensors; (3) Navigation Monitor, giving information such as speed, heading, depths, wind speed and status on propulsion systems; (4) Ship Control Station, which houses the autopilot, manual steering equipment, internal and external communication systems and other controls; (5) Vessel Monitoring Workstation, which controls information from selected sensors placed at various locations aboard the ship, such as cargo control sensors; (6) Communication Workstation, which is the interface with radio and satellite communication systems; and (7) Electronic Chart Table, which is the area where the operator can input new route information. (*Safety at Sea*, September 1991, page 16)

The Global Positioning System (GPS) has always been subjected to Selective

Availability (SA) - a term used to denote the policy of the United States' Department of Defence of limiting the ability of commercial GPS receivers to provide accurate positioning data. The main purpose of SA is to avoid giving hostile forces all the benefits of GPS - originally a system developed to give position data to the US military. SA currently reduces GPS accuracy to 50 metres, while Differential GPS (described in *Monitor No. 3*) can attain approximately 15 metres accuracy. In lieu of an on-going discussion in the Pentagon regarding further reduction in accuracy to 200-300 metres, Stephen Colwell of Colwell-Kirtland International Corporation and founder of the Global Positioning Systems Association, warns that too extensive use of SA may diminish its utility to commercial users. GPS has frequently been quoted as a major contributor to safe passage of marine vessels, but this depends on whether the users receive position data sufficient to aid passage in inland waters and narrow passages. Thus, wide acceptance of GPS in the commercial market - both at land, sea and air - depends on the degree to which SA is used in the future. (*Sea Technology*, March 1991, page 97)

Inmarsat is gradually improving the quality and expanding the extent of its user services as well as availability. There are currently approximately 15,000 maritime users of the communication services and this number is expected to experience significant growth in the future. For this reason Inmarsat deployed three new-generation satellites in 1990 and 1991 and expects to deploy a fourth in 1992. These satellites will triple the current capacity of the global maritime communication system. In addition, new coast earth stations (CESS) gradually increase the quality and number of services offered to maritime users. Such services now include commercial telephone calls, facsimile and telextransmission, digital data exchange, and even television transmission. From this, several specialized services have emerged, including efficient weather reporting, news summary distribution services and credit card services aboard cruise ships.

Additional specialized services offered through CESS in conjunction with Inmarsat are technical guidance and advice for vessels and navigational hazards and warnings. One service connects the caller to hospitals where medical advice is provided to help treat ill or injured crew members or passengers. It is expected that as services become more efficient and cheap, and on-board units become smaller, satellite communication will emerge as a viable option even to owners of smaller leisure vessels. (*Sea Technology*, May 1991, pp. 19-25; *Ocean Voice Guide*, July 1987, pp. 1-8)

Research and educational opportunities

The Transportation Development Centre (TDC), Transport Canada's central research and development organization, is looking for ideas and project proposals from companies that could contribute towards the safety of marine transportation. Among the projects that are currently being undertaken by the TDC are: (1) a project aimed at tracking and predicting the movement of objects (primarily life boats) drifting in the sea; (2) further development of NAVIFRANATM to improve all-weather, inshore navigation; and (3) development of SINADSTM (Shipboard Integrated Navigation And Display Systems) to improve capabilities to navigate in confined waters. Further information can be received from: Office of the Executive Director, Transportation Development Centre, 200 Rene Levesque Boulevard West, Suite 601, Montreal, PQ H2Z 1X4, Canada.

CEI-Europe/Elsevier arranges annual short-term courses in various technological matters. Of courses offered in 1992 are: *Underwater Acoustics: Applications of Neural Networks and Expert Systems* (course 276) to be held in Singapore in the period 3-6 August and in Sweden in the period 16-18 November; *Underwater Acoustics: System Analysis* (course 213) to be held in Sweden in the period 16-19 November; and *Aspects of Modern Military Commercial Radar* (course 233) to be held

in Germany in the period 3-7 February and in Singapore in the period 13-17 July. Information can be received from: CEI-Europe Elsevier, P.O. Box 910, S-612 25 Finspong, Sweden.

Penn State University arranges short educational programmes in *Acoustics and Signals Processing* in 1992. In the period 4-8 November there will be a course designed to give the participants an introduction to the current R&D in the field. A summer graduate programme will be offered during the period 27 May to 26 June. Ten courses are offered under the programme, including sonar engineering and underwater sound behaviour. Information can be received from: Kathy Karcher, The Pennsylvania State University, 410 Keller Conference Center, University Park, PA 16802-1304, USA.

Notebook

Professor Walter Munk at the Scripps Institute of Oceanography was the initiator of an experiment, undertaken in January 1991, that aimed at testing a theory regarding underwater acoustics. A low-frequency underwater acoustic signal was sent from a ship in the southern Indian Ocean and was received at various locations around the world, including the East and the West coasts of the USA. The farthest location was 11,000 miles (17,700 kilometres) away from the source of the signal. Professor Munk expects that over a testing period of ten years, researchers should be able to gain, amongst others, a significant knowledge of acoustics and ocean temperatures. Such experiments may be a means of assessing the correctness of theories predicting global warming and how global warming affects the oceans. (*Sea Technology*, March 1991, page 9)

A **Remotely Operated Vehicle (ROV)** was used by Eastport International to solve a 14-year-old mystery. The company was contracted by an Austrian court to locate and investigate the wreckage of the cargo vessel *Lucona*, which sank in the Indian Ocean on 23 January 1977. There were frequent al-

legations that the ship was sunk as part of an insurance fraud, but no efforts were made to investigate the ship partly due to lack of necessary technology. On 1 February 1991, the search vessel crew located the ship at 14,600 feet (4,400 metres) and managed to photograph the wreckage. These photographs evidenced that the *Lucona* was sunk by an explosion caused by a bomb on board, and were used in the criminal court proceedings against the Austrian owner. The same company was contracted by an Italian court to locate and recover a flight data recorder missing in the Tyrrhenian Sea. The flight recorder was aboard an Italian airliner that crashed on 27 June 1980, and was not found at the time. It was recovered from a depth of 10,800 feet (3,200 metres). (*Waves*, September/October 1991, pp. 18-20)

Shipboard Environmental data Acquisition System (SEAS) is a system in continual development by the US National Oceanographic and Atmospheric Association (NOAA). The development started in the 1970s in order to establish an efficient means of receiving and analyzing weather information from the oceans. The next generation (the third) of SEAS will be available by autumn 1992. The key problem to address through SEAS III is that shipboard personnel is steadily decreasing in number, so that each crew member is given more tasks to perform and they must consequently allocate less resources to each of them. Thus, the system is intended to be efficient and user friendly so that an on-board weather observer can perform the task significantly faster than before. For instance, the system incorporates the use of sensors that are simply dropped in the sea, and which will relay information to NOAA without the on-board observer needing to process the information first. NOAA is currently looking for vessels to participate in the programme. The contact at NOAA is: Christopher Noe, NOAA Code N O51, 6010 Executive Boulevard, Room 925, Rockville, MD 29852, USA. (*Marine Weather Log*, Summer 1991, pp. 24-27)

Experiences from the Seatrans project on ECDIS, referred to in the lead article, are reported in the publication **The Seatrans Project—Summary of Experiences and Conclusions**. The report lists the main conclusions on ECDIS and the experiences from the sea trials, as well as comments and proposed amendments to IMO standards on ECDIS. The report is available from The Norwegian Hydrographic Service, Fervigsveien 30, P.O. Box 60, N-4001 Stavanger, Norway.

A Danish project on new vessel concepts, **Project Ship**, was commenced in January 1987 and had as a primary objective to "create opportunities for reducing operating expenses through increased flexibility, efficiency, low maintenance and reduced manning." A main activity of the project was the establishment of an integrated bridge system, with the possibility of manning the bridge with only one crew member. The design was implemented on four container vessels built by Danyard in 1990 and 1991 for J. Lauritzen A/S of Denmark. The project description and experiences are published in the report **Building and operating the world's first one-man operated reefer in practice**. For details contact Ole Rendbæk, Danyard A/S, P.O. Box 719, DK-9900 Frederikshavn, Denmark.