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THE IHO, ELECTRONIC CHARTING AND THE CHANGING RELATIONSHIP TO PORTS

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BACKGROUND

The International Hydrographic Bureau (IHB), the headquarters of the International Hydrographic Organization (IHO), is located in the Principality of Monaco and has been in existence since 1921. The IHO is an intergovernmental organization, which currently consists of 59 Member Governments with another 10 nations pending. Normally governments are represented within the IHO by their national Hydrographic Offices.

The mission of the IHO is principally to coordinate the activities of national Hydrographic Offices throughout the world, foster the unencumbered exchange of marine information between nations, seek standardization throughout the system of information exchange and foster training and technical assistance to build on worldwide hydrographic capability. IHO serves to enhance international cooperation in the collection and publication of marine geographic information principally for marine mapping (bathymetric maps used to advance our scientific understanding of the oceans) and for charting (nautical charts essential for safe marine navigation to enhance the safety of lives, property and to protect the marine environment).

The 59 IHO Member Governments operate over 300 surveying and oceanographic ships of greater than 20 tons and several more hundreds of small boats to collect data in support of marine charting. Thus, the IHO Membership contributes significantly to the collection of geographic and oceanographic information related to the marine environment. In addition to the basic survey data collected by these ships, the national charting authorities depend on information from a wide variety of sources for maintenance of nautical charts and related publications such that mariners are continually provided with the needed information to insure safe marine operations. Information must continuously come from Coast Guard agencies concerning aids to navigation, from waterway

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maintenance authorities concerning dredge surveys, from port authorities about construction and status of harbor areas, from mariners who voluntarily provide significant information based on direct observations, and many others. In the United States, the national Hydrographic Office is faced with between 60,000 and 80,000 inputs annually which result in the immediate transmission of about 25,000 Notices to Mariners annually.

At the International Hydrographic Bureau in Monaco, we maintain copies of the publicly available charts issued by the IHO Member States and have over 20,000 different charts of varying coverage and differing languages that support marine activity throughout the world. A principal reason for the Bureau's maintenance of this archive is to comment on variances in chart construction. The IHO has a Chart Standardization Committee, promulgates standards for survey measurement in its publication S-44 "IHO Standards for Hydrographic Surveys" and consistently works towards maximum standardization in the specifications, symbols, style and formats used for nautical charts and related publications, which are governed by IHO publication M-4 "Chart Specifications of the IHO and Regulations of the IHO for International (INT) Charts." The INT Chart concept is an attempt by IHO to develop a common, worldwide chart series produced to a single set of agreed specifications for use by international shipping. Progress is being made towards increased standardization of worldwide charting. With the adoption of the metre as the basis for charting by the United States in 1990, virtually all nations are in the process of converting their charts to the meter as the common unit of depth measurement. The IHO Member States have agreed to convert their charts to a common horizontal datum, the WGS-84 datum. In 1992, the IHO Member States agreed to a common format for exchange of digital chart data. These are just a few examples of the progress being made and, although it will take many years to accomplish the various tasks, the important point is that agreement is being reached and Hydrographic Offices are progressing towards a common goal.

The majority of work by the IHO is done through a multitude of Working Groups (15), Committees (9) and regional Hydrographic Commissions (8). Their activities range from adoption of undersea feature names, to defining terminology for the Hydrographic Dictionary, to establishing Standards of Competence for Hydrographic Surveyors, to detailing Technical Aspects of the Law of the Sea, etc. Regional IHO Hydrographic Commissions meet at regular intervals and deal with mutual hydrographic and chart production problems, plan joint survey operations, coordinate regional chart schemes, and deal with all types of problems of local interest. Representatives of the IHB try to attend each of these meetings to provide an interface for exchange of information between the various Commissions.

The advances of modern survey technologies, the development of powerful low cost computer systems, progress towards increased standardization, improved digital information exchange and the development of powerful software to handle digital graphics data are rapidly changing the working environment of the hydrographer, the chartmaker and the mariner. As a result, national Hydrographic Offices throughout the world, in cooperation with many public and private groups, are contributing to what will ultimately be a completely new approach to marine navigation, one which will be as revolutionary as was the introduction of radar for marine navigation, that is, the Electronic Navigational Chart (ENC). The era of

digital data handling, digital data communications and the electronic chart clearly has arrived.

TECHNICAL DEVELOPMENT OF ECDIS STANDARDS

Hydrographic Offices have been collecting data digitally and have worked on many aspects of digital cartographic systems since the 1960's, followed by serious attempts to develop a digital chart production system in the 1970's. Although a few Hydrographic Offices reached digital production for some charts, the systems then used were too slow and graphics software was lacking. By the 1980's technology had advanced such that new efforts were underway to not only consider digital methods for production of paper charts, but also there now was the possibility of producing the Electronic Navigational Chart.

In 1982, Canada proposed that the IHO establish a committee to develop an international format for data storage and to exchange digital data between Hydrographic Offices. Thus, the Committee for the Exchange of Digital Data (CEDD) was formed. This effort has resulted in adoption of the IHO DX-90 digital exchange format, IHO publication S-57 "IHO Transfer Standard for Digital Hydrographic Data", by the IHO Member States in 1992. As work progressed on the exchange standard, it became evident that standards needed to be developed for the eventual ENC and, thus, the IHO Committee on Electronic Chart Display and Information Systems (ECDIS)-(COE) was formed.

The COE has been very active and has developed the IHO Publication S-52, "Provisional Specifications for Chart Content and Display of Electronic Chart Display and Information Systems". This effort is quite complex and as Hydrographic Offices gained experience with the handling of digital data, commercial companies began to develop various kinds of electronic chart systems and nations began to conduct electronic chart test beds, the Committee divided its effort amongst a series of Working Groups. There are Working Groups on: Colors and Symbols for ECDIS, Data Base structure (regional or worldwide), Updating of the Electronic Navigational Chart, the ECDIS Glossary, and Data Quality plus a Group of Experts on Specifications, which addresses proposed amendments to the S-52 Provisional Specifications.

Norway has from the start been a strong supporter of ECDIS and has initiated two of the major field test programs, the North Sea Project and the SEATRANS Project. Other test beds have been conducted by Germany, Canada, Netherlands, U.K. and the U.S. Such test bed projects provide essential information as to whether or not ECDIS will improve the safety of navigation and provides basic information as to what changes should be made concerning the application of ECDIS for the mariner. Such tests are likely to continue for several years as ECDIS evolves as a new tool for the mariner.

IHO publication S-52 is the reference document for the International Maritime Organization (IMO) formulation of international regulations for carriage and use of ECDIS by ships. To coordinate this activity between IHO and IMO and

maintain an awareness of the various sea trials being conducted and their possible impact on regulation of ECDIS, an IMO/IHO Harmonization Group on Electronic Chart Display and Information System (HGE) was formed which is presently under the Chairmanship of Mr. Oyvind STENE of Norway.

Finally, a Change Control Procedures Working Group was established to coordinate the changes being proposed to S-52 and S-57. This Group is chaired by Dr. Chris DRINKWATER of the U.K. Hydrographic Office.

ADVANTAGES OF AN ECDIS

As a result of the various ECDIS Test Beds that have been conducted and experience gained through the commercial availability of interim electronic chart systems, it has become clear that the ENC can, when properly supported and used, provide a number of capabilities that improve marine navigation and safety.

It must be recognized that continual availability of accurate marine positioning data is an important element of any ECDIS system since this provides the relationship between the ECDIS digital display and the ship's position. The deployment of differential GPS coverage for coastal waters, providing better than 10 metres accuracy provides essential input to ECDIS for marine navigation as well as for vessel traffic control and marine surveying. For those few areas where GPS coverage may not be adequate, the Canadians have been using a system of passive radar reflectors which act as ARPA targets for computation of ship position; another option is to use short-range electronic positioning systems. As we proceed with the deployment of DGPS and ECDIS, it will be important to identify those areas where satellite signal is obscured such as in fjords, port areas with tall structures, mountainous areas, etc. These may be few, but it is desirable that they be known. An underway mariner using ECDIS encountering such an area will know there is a navigation problem because the radar and ECDIS displays will separate, but obviously it would be best to know of such problem areas in advance. ECDIS will be a powerful tool of the mariner, but it does require the availability accurate positioning without major interruption.

SOME ADVANTAGES OF ECDIS

* Continuous position display. The navigator always has the ships position in view. There are no distractions from maintaining the watch due to the traditional taking of bearings and plotting of fixes. Constant knowledge of the ships position during turns and other close quarters maneuvering allows more precise navigation.

* Combined display of both radar and chart information. Since the radar display is depicted relative to the ship's position and the electronic chart display is positioned externally by GPS, etc., when a navigation aid such as a buoy

is not in its charted position, the combined display will show any difference between the charted and actual positions. Also, the display of selected information with the radar image such as channel limits, aids to navigation, land areas, etc. will very likely enhance the decision making capability of a navigator.

* Information alerts. Navigators and route planners could be automatically advised when the route being planned or navigator underway is about to enter designated or regulated areas. That is, a Traffic Separation Scheme; an Economic Zone or Territorial Sea where fishing, dumping or other activities are prohibited or otherwise controlled; Sensitive Areas which are not to be transited at certain times due to marine mammals, sensitive fisheries, military operations, etc.; and when approaching ports can be provided Customs clearance/regulatory information; etc.

* Hazardous warnings. An ENC supported by a vector data base can include expert systems applications which, when provided with certain ship characteristics information--stopping distance, turning radius, etc., can warn the route planner prior to the voyage and the navigator while underway of approaching hazards, i.e., shoal waters, underwater obstructions, etc.

* Automatic computation of route information. The route planner and the underway navigator can have automatic computation of route information. Great circle routes can be automatically displayed for efficient navigation and fuel savings, distances to chart objects can be easily obtained using a cursor, etc.

* Automatic chart updating. Chart information can be automatically updated, thereby eliminating a burdensome and time consuming task. Since only major shipping is typically required to maintain up to date charts, many mariners do not do so and accept the associated risks. The electronic chart with automatic updating will improve safety for a large number of mariners, particularly the private boaters. Plotters that print out electronic chart data bases will make current information available for hard copy use and provide a backup to the ECDIS.

* Use as a marine Geographic Information System (GIS). Multiple layers of information which could not be shown on the paper chart due to chart clutter and the limitations of scale may now be included in the data available from an ECDIS. It will now be possible to provide a mariner with access to significant information that previously was not possible to display or even include in the Sailing Directions. Access to information will improve through the ability to search for information by digital methods. Details about pipelines and cables in an area planned for anchoring might now be displayed, berthing information, including large scale depiction of the berth and details such as facilities available, i.e., port reception/waste disposal, water, fuel, etc. might be shown, as well as a multitude of other important information.

ECDIS AND VTS

The United States has been evaluating the possibility of combining the traditional radar display of VTS and the digital chart display of ECDIS. In doing so, the U.S. Coast Guard has recognized the potential use of ECDIS as a marine GIS. They plan to use ECDIS as a tool to identify hazardous situations and, with vector rather than raster data, to have the option to display all or only a part of the nautical chart as the graphic reference on the VTS display, thereby avoiding having the display cluttered with unnecessary information at any one time yet at the same time having any information that might be needed readily available. By using ECDIS as a reference graphic, the VTS information display and the shipboard paper chart or ECDIS display have a common basis for information exchanges between the mariner and the VTS center.

In the United States, VTS installations in the ports of New York, Puget Sound and San Francisco are being modernized and the decision has been made to use an advanced radar processor to provide digital radar images that permit automatic tracking of vessel positions and movements. The system will also provide the ability to overlay multiple radar images that are scaled and geographically matched to a navigation-quality electronic chart. The first system has already been installed in New York. Based on the needs of the VTS operator, it will be possible to vary the display in terms of the amount of chart data, vessel icons and corresponding radar images. In doing so, the decision has been made to use the IHO's DX-90 data format. By using ENC data from the Hydrographic Office, information such as depth curves, soundings, shorelines, shoal waters, underwater obstructions, traffic separation lanes, buoys, bridges, etc. are reliably determined and updating information can be quickly and reliably integrated into the display data.

At some time in the future, it may be possible for the VTS center to share the updated ENC data with international vessels using IMO-compliant ECDIS in the VTS operational area. In the future, it is expected that VTS will evolve a digital Navigation Safety Broadcast service. Often referred to as a "silent VTS", the location and movement of vessels within the VTS area of operation will be communicated to all participating vessels via a digital communications link.

This information, along with other navigation safety-related matters then would be displayed at the VTS center as well as onboard the ECDIS of participating vessels. It is expected that an ECDIS updating and automated Notices to Mariners will be provided as a digital VTS Navigation Safety Broadcast. This ideally, would be in a format, protocol and means of broadcast that is standardized throughout the world's VTS centers.

The U.S. Coast Guard has called for the IALA (International Association of Lighthouse Authorities) to address the standardization issues through the IALA Committee on VTS. This would involve an international standard for vessel position/movement reporting to VTS. With a standard format and protocol (e.g., vessel identification, location, course, speed and time), it would be possible for each vessel to display on ECDIS the location, identification and movement of other vessels

within the VTS area through receipt of broadcasts from the VTS center. Since there is need to develop additional characters and symbols for display at both VTS centers and vessels using ECDIS, IHO which already has several areas of cooperation with IALA will cooperate in the development of needed symbology, implementation internationally, etc.

INLAND NAVIGATION

Many of the ports and harbors throughout the world are in estuarine areas and on rivers. Ships transiting to these areas may encounter a wide variety of formats for charts and related information. In the United States, the U.S. Army Corps of Engineers is responsible for maintenance of inland waterways and the issuance of chart information is divided between the national Hydrographic Office and certain COE districts. Along the Mississippi River system, one can encounter significant changes in display, i.e., different color schemes, contour intervals, etc., as transit is made from one district to another.

Recently, the COE has been looking into the application of ECDIS including the use of a common chart display and the IHO DX-90 digital exchange format. Expansion of ECDIS inland will surely occur when one considers: increased transits by cruise ships from offshore areas into inland areas, the volume of commercial traffic that transits inland areas, the volume of recreational traffic in inland areas and the deployment of DGPS into such areas providing for accurate navigation of the waterways. This expansion of ECDIS, like the application of VTS, will require the addition of new symbols, etc. to supplement the present ECDIS chart coding. IHO would be willing to cooperate with the international aspects of any such a development.

PORTS

The availability of accurate positioning for navigation in port areas is making possible many new applications of ECDIS, particularly related to harbor maneuvering and docking. To do so will require larger scale chart information than has been available in the past and an expanded system of updating. In Canada, use of ECDIS on one of their ferries in an extremely restricted area, has shown the value of such a system in an area where it is difficult to maneuver, where weather is often severe and visibility often restricted.

Because of the perceived need to develop an information system using ECDIS as a GIS, the IHO Member States will be asked to consider an expanded role in relation to ports. Although Member States have their individual methods of accessing data from port areas, there appears to be a need for IHO to take a more active role in relation to port surveyors and to build the awareness of port managers concerning chart related issues.

IHO sets standards of accuracy for hydrographic surveys and is in the process of reviewing the standards at this time. A number of changes will be made as a result of technology available (perhaps the standard will no longer have a relationship to the scale of chart or line spacing of hydrographic surveys) and the accuracy standard itself may become more stringent in port areas.

There is a need for survey data for charting to be on common datums, including ports. Even within the existing chart series of the IHO Member States there currently are hundreds of different chart datums and this is becoming a serious problem. Many mariners fail to realize that in the past as they approached a harbor and began navigating visually or with regional navigation systems, that they had automatically shifted to navigation using the local chart datum. Now with GPS navigation which is on a single worldwide datum it is essential that they be aware that positions derived from GPS cannot be plotted on the chart without giving consideration to adjusting them to the local chart datum. The latitude and longitude value of the GPS and that on the chart typically differ by some datum adjustment value. Unfortunately, in many cases the adjustment information from the WGS-84 datum to the local datum is unknown. This same problem will arise with local datums used to conduct dredge surveys, etc. in port areas.

One of the Professional Assistants within the IHO in cooperation with the Port of Hamburg, Germany, wrote a manual for port surveys some years ago. Because there are so many ports, so many types of port management and so many ports that are left to their own devices, it is perhaps time for the IHO to consider the possibility of updating this manual for worldwide distribution as an aid to the safety of port operations. This will be made part of the proposed expansion of IHO's involvement with ports.

As noted for the application of ECDIS to VTS above, there is need for additional standards and symbols to be developed with regard to port information. Port and Harbormaster Associations might consider working with IHO and IALA towards standardization of the information that would be valuable as additional layers within an ECDIS-GIS. Perhaps some designated port area might be used as a test area to prototype such a development. Options for doing so need to be considered and, within the IHO, Member States must consider their level of involvement.

Information exchange is a major part of IHO's work and it may be necessary to improve the linkages between IHO and the Ports. One possibility would be for IHO to establish a secondary type of membership, such as Port Associate, at a nominal fee such that routine information exchange occurs between port surveyors or port managers with responsibility for contracted port surveys and the IHO. The IHO is also involved with training and certification and should perhaps be more active in developing modules to support courses being given to port managers, by both national authorities and IMO.

There are many possibilities brought on by the evolution of ECDIS, and we must be careful to select the things which are most important to maritime safety and operating efficiencies such that the marine transportation system is the best one possible within available resources.

REGULATION OF ECDIS

Great progress has been made through the work of the various groups and committees associated with ECDIS standards development and implementation of the regulatory process has begun. In September 1993, the Safety of Navigation Subcommittee of the IMO, Maritime Safety Committee approved the latest draft of the ECDIS Performance Standards and forwarded them to the IMO Maritime Safety Committee for consideration. The Maritime Safety Committee is in the process of doing so this week, 16-20 May 1994. If approved as expected, the IMO Assembly will consider the ECDIS Standards for final approval in November 1995.

ECDIS DATA BASES

It is essential that commercial companies develop the hardware systems to display the Electronic Navigational Chart. Hydrographic Offices are not equipment manufacturers. However, a major question concerning the prospect of the ENC has been, "Where will the electronic chart data base come from and how will it get updated?"

Hydrographic Offices, being government organizations, typically are staffed to produce charts in the traditional way, i.e., maintain their suites of paper charts and compile Notices to Mariners but have little "capacity" for building the needed electronic chart data base. This has created a problem with how to get from "here to there".

Commercial manufacturers that develop electronic chart hardware must have digital chart data or sales are not possible. As a result, commercial firms have been building electronic chart data bases at varying levels of detail and accuracy. Users are warned that use is only to be made in conjunction with authorized paper charts. This warning is important in that Hydrographic Offices typically are held liable for the content of their nautical chart products and for anyone else to assume the role of official chartmaker would also entail assumption of significant liability. IMO has warned shipping about the use of non-equivalent (to the paper charts of national Hydrographic Offices) electronic chart data bases.

Additionally, there are numerous manufacturers of electronic chart systems and they use varying methods for the presentation of their digital displays. While the IHO has developed the DX-90 standard for exchange of digital data between Hydrographic Offices, this has not been designed as an efficient display format. To specify a display format might give advantage to some specific manufacturer and could stymie open market place development. Thus, IHO has not developed an ENC display standard and, in view of the number of system manufacturers, it is not likely that systems could be granted certifications by the national Hydrographic Offices wherein the Hydrographic Offices would assume liability. However, IHO is producing a Presentation Standard for voluntary usage and eventually regulatory agencies such as Coast Guards will issue ECDIS type certifications. Rather than

having Hydrographic Offices certify commercial hardware and software, it is more likely that manufacturers will have to show that they follow proper quality control procedures in their manufacturing processes by obtaining something like ISO 9000 certification. If the manufacture of pacemakers for one's heart can be controlled by such a process, then certainly ENC systems for shipping could also follow such a system. As experience is gained, regulatory actions will mandate backup features for the ENC as necessary.

While countries may specify national standards for their internal use, as the United States recently has recently done, to support GIS operations, it must be recognized that the mariners of the world are quite mobile and their systems must be able to operate on a truly international basis. Commercial firms have already sold tens of thousands of electronic chart systems worldwide and each must be supported by an electronic chart data base.

Another issue relating to the establishment of an ENC data base is that nations hold copyright for their map and nautical chart products and there is a need for arrangements to be made for access to these data both between individual Hydrographic Offices and between Hydrographic Offices and commercial manufacturers. The IHO has adopted a requirement that bilateral arrangements be sought before the Hydrographic Office of one nation utilizes the digital product of another. Between Hydrographic Offices, this may or may not involve payment of royalties since sometimes mutual exchange arrangements can be made. With regard to commercial firms, initially, there has been a reluctance by Hydrographic Offices to release their data probably partly due to their position of liability and the question of where liability begins and ends. Could an Hydrographic Office be held liable for data somehow altered by a private company, and could an Hydrographic Office be held liable for malfunctioning of a commercial firm's hardware and display software? A workshop on liability related to the ENC was held in Canada in 1990, but many questions are unanswerable because law is traditionally based on historic precedent of which there is little to go on for the ENC. A follow-on workshop is planned for 1995 in the U.S. at Tulane University in New Orleans, Louisiana.

It is unrealistic to expect that ECDIS coverage of the entire world will be available in the near term. Because of the variance in capability to conduct hydrographic surveys, systematic surveys have not been conducted for many areas of the world, and of those areas that have been surveyed, many have been conducted with out of date technology and cannot meet current IHO standards or needs of the mariners. Government reductions have reduced the capability of many Hydrographic Offices to respond to the needs. Thus, it will be necessary for Hydrographic Offices to concentrate on priority areas with available resources, for Hydrographic Offices to cooperate with one another by transferring technologies and cooperatively producing needed data, for Hydrographic Offices and the commercial sector to cooperate by perhaps having the commercial firms initially digitize the data with the Hydrographic Offices doing the quality control and accepting the liability, and there is need to rebuild the capability of Hydrographic Offices to conduct surveys such that chart data are of an accuracy comparable to that of the navigator and to provide Hydrographic Offices with the resources to convert data bases in support of ECDIS.

It is important to recognize that accurate positioning from satellite navigation is of little use if the positions of charted objects are not known accurately. That is, many surveys only a short distance from shore were positioned by astronomic fixes that were only accurate to within 1 or 2 nautical miles. Electronic positioning did not come available until the 1960's so most surveys do not meet current standards. Until the advent of satellites, it was not possible to conduct surveys in anything but local or regional datums, and new survey data needs to be acquired to determine the datum shifts. Additionally, echo sounders were not brought into use until about the 1930's, thus resurveys are needed for many areas that were covered with old survey technology. Hydrographic Offices throughout the world need to have a basic level of survey capability such that continuous progress is being made in resurveying areas that do not meet standards. Such surveys and the building of ECDIS data need to be given priority in port approach areas, particularly areas with VTS.

ECDIS DATA BASE FORMATION

How then will a worldwide ENC data base which can be automatically updated be reached? In 1990, Norway kindly offered to develop a worldwide electronic chart data base to support the needs of international shipping. This proposal has been under consideration within IHO for some time and, as one might expect, has involved some rather complex interrelationships and technical issues. Excellent progress has been made in overcoming technical issues. During the 1992 International Hydrographic Conference, Norway was encouraged to form a regional ENC data base for the northern European area and to include others countries as can be agreed bilaterally. The development of this data base is in progress at this time for priority areas and has a target date for completion of 1995, which fits well with the IMO regulatory schedule.

Also, during the I.H. Conference the IHO Member Governments agreed to form a Special Committee to address the establishment of a Worldwide Electronic Chart Data Base by studying administrative matters related to ECDIS. This WEND Committee is under the Chairmanship of Dr. Peter EHLERS of Germany. At this time, the approach seems to be toward the establishment of several regional data bases throughout the world, and it is yet to be determined if there is a need for a Worldwide Electronic Chart Data Base. The question becomes one of whether or not there is a need for a central body to resolve differences or problems that occur at the junctions between regional data bases, and does international shipping have need for "one stop shopping", i.e., a central source for all charts and updates? This is yet to be decided.

THE FUTURE

It is clear that there is a need for an ENC data base updated by national Hydrographic Offices in the relatively near future, i.e., within the next decade. To do so, requires that the various parties involved come to certain accommodations, which is being done, but the pace of accomplishment will depend as always on the amount of effort or resources applied to the task. It is important for people to be made aware of the tremendous possibilities available for improvement of the marine transportation system so important to all our daily living.

Continually up to date charts will make things safer for all mariners, both large and small operators; the ENC will be replicated in Vessel Traffic Control centers so the mariner and the VTS operator are working from the same data; and the ENC data base will form the basis of a marine GIS. Once the chart becomes digital, there are numerous possibilities for additional layers of information to be made available through Hydrographic Offices and commercial firms. For example, touch screen might provide the local tide and current information; touch screen might provide details about the port, including traditional Sailing Direction information; touch screen might provide a picture of specified navigation aids for proper identification of landmarks, etc.; there might be layers to show the best fishing spots, archeological sites, areas of marine vegetation, special protected areas, recreational zones, etc.; a marina information layer to provide a listing of the availability of boat slips, groceries, water, fuel, sanitary tank dumping, etc.; a meteorological layer for selecting the best route rather than using traditional paper facsimile weather transmissions; a layer to show satellite derived temperature distribution data for fishing and ice forecasts for vessel routing; a side-scan sonar image might be depicted of wrecks for use by divers or fishermen; etc. The possibilities are tremendous and will serve to both increase safety and improve our environment.

Because of the advances in data acquisition capability the data base will continually improve. Hydrographic Offices now use multibeam survey systems that provide total bottom coverage and give high resolution data of interest to many users other than just the mariner. Airborne laser sounding systems are now coming into use which for the first time make it possible to monitor the shallow inshore areas which in the past have taken so long to survey. This will provide more current information for the small boat navigator, data for use in modelling storm surge and making predictions in the coastal areas and data for scientific use such as sediment transport/coastal erosion studies important to coastal construction and facility siting. Multibeam side-scan sonars are now beginning to be marketed which markedly increase the speed at which high resolution side-scan imagery can be acquired to allow depiction of objects and backscatter data from multibeam systems is being recorded to depict the character of the seafloor in detail never before available.

Much of the data collected by Hydrographic Offices will serve as the basis for a marine GIS. Recently, the IHO has questioned its Member Governments, in cooperation with a study being conducted by the International Cartographic

Association, about their involvement with GIS. From this it is evident that a number of the Hydrographic Offices now recognize a need to be responsive to GIS needs, but many are resource constrained and overwhelmed by the need to simply convert existing chart information into the ECDIS data base. Hydrographic Offices have much to offer related to the safety of not only shipping but also the entire coastal region, and can provide data essential for use of the marine GIS to improve our coastal and marine environment. The tasks of ECDIS data base development and establishment of the marine GIS are opportunities that should be taken advantage of and be supported.