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# INTERNATIONAL COOPERATION IN HYDROGRAPHY AND MODERN TECHNIQUES IN HYDROGRAPHIC SURVEYING

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## ABSTRACT

There is nothing more timely and urgent than the need for promoting international cooperation in hydrography and for considering the development, uses and need for employing modern techniques in hydrographic surveying. The International Hydrographic Organization has always given particular attention to international cooperation in hydrography in the widest sense. The role played by IHO and the manner in which FIG could possibly assist IHO in promoting international cooperation in hydrography are explained in the address.

The period since World War II has probably seen more changes than any similar period in the history of the world. The impact of these changes has been such that charts of many of the world's economically strategic waterways were made obsolete and inadequate, while maritime trade developed in many new areas where existing charts were found hopelessly inadequate. While regional or sub-regional cooperative efforts are a means by which hydrographic surveying and nautical charting programmes could lead to more adequate and up-to-date charts, the problems of developing countries that have little or no hydrographic capability need very special attention. As in other fields, hydrographic surveying has witnessed spectacular technological advances in recent years. This technology and future developments must be exploited to the full and their benefits must not be limited to the few.

The establishment and strengthening of hydrographic capabilities of developing countries through international cooperation are vital to the attainment of the

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IHO's objective of providing up-to-date charts, based on internationally accepted standards, which in turn would benefit the international maritime community in an increasingly interdependent world.

## INTRODUCTION

There is nothing more timely and urgent than the need for promoting international cooperation in hydrography and for considering the development, uses and need for employing modern techniques in hydrographic surveying.

The International Hydrographic Organization has always given particular attention to international cooperation in hydrography in the widest sense, arising out of its main objectives to bring about the greatest possible uniformity in nautical charts and documents, to establish global standards for hydrographic surveying and nautical charting, and to promote the development of the sciences in the field of hydrography. This address speaks of how the IHO is dealing with these complex issues and how FIG cooperation would help in promoting the IHO objectives, and also touches upon the work of other international organizations.

## BACKGROUND

The period since World War II has probably seen more changes than any similar period in the history of the world. The greatest of these changes, perhaps, have been the spectacular advances in science and technology, and the emergence of newly independent nations in many parts of the world.

The changes have had a dramatic impact on charting the seas, creating serious problems for developed and developing countries alike, whether they operate national or international merchant fleets. The impact was such that charts of many of the world's economically strategic waterways were made obsolete and inadequate, while maritime trade developed in many new areas where existing charts were found hopelessly inadequate. Never before had the world's hydrographic community, as indeed the maritime community, been faced with such a challenge, since, until that time, the adequacy of the navigational chart was taken for granted, and the mariner placed implicit trust, much as he still does, in this basic navigational tool. This challenge affected the needs of national and international shipping of the industrialized and third world countries and calls for a global effort on the part of all coastal states by the process of international cooperation, through international organizations such as the IHO, to meet the needs of shipping. This inevitably will be a gradual process but nevertheless a start has already been made to resolve these world-wide problems, as we shall see later.

## IMPACT OF SHIPPING

In order to appreciate the extent of the inadequacy of charts, it is necessary to review the changes in shipping that have impacted on charting the seas. Up to the period including the Second World War, the major areas of maritime trade relied on charts suitable for draughts of ships prevalent at that time, which was a maximum of 36 feet, generally, or about 11 metres. The closing of the Suez Canal in the 1950's, however, necessitated using a longer route round the Cape of Good Hope, thereby greatly increasing the cost of transportation. Economy of ship size came to be appreciated for long-haul traffic, resulting in the birth of the supertanker and, with it, the development of deep-water oil terminals to receive these enormous ships. Their huge size necessitated a great increase in draught, nearing 30 metres. The underkeel clearance of these ships in many of the important waterways of the world, such as the Malacca Straits, the North Sea, and others, was often critical, requiring charts based on "precise" surveys and calling for the provision of special routeing guides. Charts were found inadequate both qualitatively and quantitatively. The growth of shipping continued to diversify, motivated by economic considerations, in the form of large oil/bulk/ore carriers of considerable size and fast container ships, each bringing with them their special problems related to charting. The needs of the mariner went beyond qualitative and quantitative requirements and these could be summarized as follows :

1. The provision of adequate and up-to-date charts.
2. A single standard international series of charts.
3. The availability of these charts on a world-wide basis.

## ACTION BY IHO

The IHO, as a first step towards providing a standard world-wide series of charts, at its IXth International Hydrographic Conference in 1967, established a Commission to study the constitution of an international set of charts on small scales (1/10 M and 1/3.5 M). This was the most significant step so far taken towards the time-honoured IHO objective of achieving the greatest possible uniformity in nautical charts and documents.

Following the Commission's Report in 1971 on the International Chart at small scales, the Xth I.H. Conference in 1972 established a Commission to study the problem of producing International Charts at medium and large scales, initially for a representative area, for facsimile reproduction by any chart-producing nation. The concept of the international chart was to meet the needs of international shipping and envisaged facilitating the maintenance and correction of only one series, instead of different series of charts produced by over 30 chart-producing nations. Moreover, the International Chart would ameliorate the distribution problem, since chart agents would have only the one series of charts to stock and

maintain. The Report of this International Chart Commission, which consisted mainly of a comprehensive set of chart specifications, was adopted, in 1977, by the XIth International Hydrographic Conference which decided to extend its application to other regions of the world. For this purpose a permanent Chart Specifications Committee was established by IHO to draw up a single standard international list of specifications to cover all navigational charts. The XIIth International Hydrographic Conference, held in April 1982, adopted the Chart Specifications of the IHO drawn up by the Specifications Committee, while renaming that Committee the Chart Standardization Committee. This Committee is charged with keeping the Specifications of the IHO under continuous review in order to advise on their updating.

This done, the question then arises as to how to achieve world-wide coverage by international charts at medium and large scales in an integrated manner, when hardly 50 % of the coastal States of the world are members of the IHO and the remaining States have little or no hydrographic resources of their own.

The IHO considers that implementation of the plan for the International Chart can only be achieved through close cooperation on a regional basis by member and non-member coastal States. It therefore resolved to initiate action for the formation of regional charting commissions or geographical groups for developing integrated schemes of charts for their areas. Such groups already exist for the Baltic Sea, the North Sea, the Mediterranean, East Asia, and North America, and are emerging in the S.W. Pacific. But that still leaves the whole of South Asia, Africa, South America and large areas in the Pacific, Atlantic and Indian Oceans.

The need to form additional groups to cover these areas is pressing. The need for all coastal States who are not members of the IHO to cooperate with these groups is vitally important to the success of the plan for developing integrated schemes of International Charts on medium and large scales. At the same time, it must be remembered that no charting scheme or international series will meet the needs of safety of shipping until and unless surveys to internationally-accepted standards are made. This brings us to the first question of providing adequate and up-to-date charts, which is how to ensure that charted content is based on survey data acquired to internationally-accepted standards and the prompt availability of such data on a world-wide basis.

The IHO has set standards for the conduct of hydrographic surveys and, together with FIG, minimum international standards of competence for hydrographic surveyors have been developed. But the difficulty IHO faces is in approaching non-member States, particularly in developing countries who have little or no hydrographic capacity of their own. We cannot go to a country uninvited and it is difficult to identify whom to approach and whom to convince. This is a role FIG members may be able to assume by endeavouring to convince their administrations of the need for cooperating in developing integrated chart schemes within their regions or geographical areas under the auspices of IHO, and for acquiring new survey data according to the minimum acceptable international standards for the updating of charts. It is realised that hydrographic surveying is capital-intensive and takes a long time, but a start must be made. In the meantime, international cooperation should be explored for carrying out cooperative hydrographic survey programmes on a regional or sub-regional basis. An excellent example of such

cooperation is the programme of technical cooperation among the four participating countries for the joint surveys of the Malacca and Singapore Straits. In both cases, namely to promote the development of integrated chart schemes and cooperative hydrographic surveying programmes, the International Hydrographic Bureau is prepared to actively assist in the formation of regional commissions or geographic groups for these purposes. FIG members should advise their National Administrations accordingly and, in turn, the IHB would positively respond to requests for such assistance. For certain regions of the world the IHB has already taken the initiative to establish such groups and commissions, but we would welcome FIG support through its participants at this Congress.

## TECHNICAL ASSISTANCE

While regional or sub-regional cooperative efforts are a means by which hydrographic surveying and nautical charting programmes could lead to more adequate and up-to-date charts, the problems of developing countries that have little or no hydrographic capability need very special attention. There is an ever-increasing interdependence among countries in a world of steady technological advances in the maritime field, creating an urgent requirement in developing countries for the establishment or strengthening of their hydrographic facilities. Lack of development in this field results both in weakening the links of these countries with the world system of maritime trade and the loss of their ability to explore and exploit their marine resources. Projects connected with the development of ports and harbours, coastal zone management, the development of marine resources and environmental concerns must have, as a pre-requisite, the relevant hydrographic data acquired by means of hydrographic surveys. The question of hydrographic surveying and nautical charting for developing countries was examined by the United Nations Group of Experts in 1977, who, in relation to marine resources, stated thus : "... in the marine environment there can be no exploitation of resources without exploration and there can be no exploration without hydrography". Developing countries lacking hydrographic capability would therefore be deprived of the exploitation of these resources, leading inevitably to widening of the gap between them and the industrialized countries. Furthermore, in order to deposit with the Secretary General of U.N. claims to seaward limits of national jurisdiction, countries must have hydrographic capability. Equally, this capability is necessary for the delimitation of maritime boundaries between adjacent or opposite coastal States.

The IHO has naturally viewed with concern the level of hydrography in many developing coastal States where a need exists to establish or strengthen hydrographic capabilities. At its XIIth International Hydrographic Conference, the IHO considered that the IHB should play a more dynamic role in the field of technical assistance and approved funding to promote this role. Accordingly, the IHB has taken the initiative to approach developing coastal States for arranging visits by its Directors or Professional Staff to review, advise and assist them in the formulation, development and implementation of hydrographic projects or the upgrading of existing infrastructures. It is foreseen that these visits will result in projects

requiring funding by bilateral and/or multilateral international sources. The IHB will coordinate such proposals within the IHO membership and thereafter follow the development of the project. Delegates from developing coastal States, on returning to their countries, should advise their Administrations of the services that the IHB can provide in the field of technical assistance, and urge their Administrations to positively respond to IHB initiatives. In this manner, FIG could co-operate with IHO and thereby give meaning to this discussion on international cooperation in hydrography. In promoting technical assistance to developing countries, the IHB is seeking the cooperation of other international organizations and has already negotiated an agreement with the International Maritime Organization for promoting hydrography in developing countries through its advisory services. An informal arrangement exists with the Commonwealth Fund for Technical Cooperation to provide assistance in hydrography including such matters as delimitation of maritime boundaries and the determination of seaward limits of national jurisdiction.

This will give some idea of the extent of international cooperation in hydrography required on an urgent basis, and of the efforts of the IHO to meet the needs of national and international shipping and the maritime development of third world countries.

## MODERN TECHNIQUES

And now, a few words on modern techniques in hydrographic surveying. It is not proposed to go into the state-of-the-art of modern techniques, but only to express a few thoughts that might be useful as points for discussion in this rapidly advancing field.

As in other fields, hydrographic surveying has witnessed spectacular technological advances in recent years. Electronic innovations, micro-processor techniques in surveying instruments and computer-assisted hydrographic data gathering, processing and plotting systems, have all sought to enhance the work of the surveyor qualitatively and quantitatively. The availability of these techniques and their performance capabilities have motivated the surveyor to exploit them for just these purposes.

The hydrographer whose main task is to undertake a detailed examination of the seabed would like to spend the minimum time on establishing his shore control. With the use of well-proven EDMs and the theodolite, in favourable weather conditions, but working day and night, his time and effort on establishing shore control is considerably reduced while achieving enhanced accuracy in his work. The adjustment of his field observations using handy programmable calculators at base ashore or onboard is also considerably facilitated. These advantages are particularly of value where existing land survey planimetric control is not easily available. Tying the hydrographer's shore control with the land mapping system is also greatly facilitated.

The advantages gained ashore by the use of modern techniques are more predominantly felt in the main body of the surveying operation at sea. One of the

greatest advantages of modern techniques for the hydrographic surveyor has been his ability to position himself with very high precision out of sight of land. Radio positioning systems of varying ranges and accuracies have also provided an almost all-weather day and night capability for the conduct of surveying operations. There is a large range of systems available in the world to choose from, starting with the short-range line-of-sight systems and extending to the medium-range ones in excess of 200 nautical miles' capability. The short-range systems have been even further developed to extend their ranges over the horizon, employing UHF frequencies which enable the user to extend his range beyond the line-of-sight system, as well as overcome difficulties experienced in the X-band frequencies, which are susceptible to interference, such as from ships' radars.

However, whatever radio positioning systems are to be used, before they are operationally employed for hydrographic surveying, they should always be tested and calibrated to obtain the maximum accuracy possible within the environmental conditions prevailing at the time. To help users of such systems, FIG established a Working Group to provide users with a comparative guide of the capabilities and characteristics of the various positioning systems. Commodore A.H. COOPER(*), Head of the Technical Section of the IHB, acted as Chairman of the Working Group and submitted the resultant document, "Standard Test Procedures", to the XVIth Congress of FIG in Montreux, in August 1981. The basis of this document was the excellent Report, by Rear Admiral MUNSON submitted to Commission IV, on "Positioning Systems". It was the difficulties experienced by Admiral MUNSON in assessing the capabilities of systems due to the disparity in Test Procedures which caused FIG to charge the Working Group with a study of Standard Test Procedures.

The IHB has published this document in its Special Publications series, where it is entitled "Precise Positioning Systems for Hydrographic Surveying — Standard Test Procedures", SP No. 39-1-5. All users of radio positioning systems are urged to carry out trials of their systems in general conformity with the Standard Test Procedures and to report the results to the IHB using the Trial Record Forms attached thereto. The IHB will publicize the receipt of trials records and provide copies upon request; furthermore, users' comments and suggestions on the Standard Test Procedures and Trials Record Forms will be welcomed and taken into consideration in improving both. By so doing, the experience of various users will be shared and the techniques of employing positioning systems could be further refined by hydrographic surveyors, and manufacturers could design modifications to their systems on the recommendations of users.

The growing use of computer-assisted techniques in hydrographic surveying has now reached a stage where it seems necessary for hydrographic organizations to develop a universal approach. At present, hydrographic organizations are individually developing systems to meet their own needs based on criteria developed within their offices, but no doubt taking into account the well-established norms and practices of hydrographic surveying. As a result, these systems are beginning to proliferate, some based on mini-computer technology and others using the more sophisticated host computers. Moreover, systems are being adapted to the methods of data gathering and processing and data manipulation adopted

(*) Retired since August 1983.

by different organizations — in one case undertaking the entire operation onboard ship and, in the other, using the ships and their boats for logging purposes and despatching the logged data to shore processing centres. Whichever method for logging, processing and plotting is adopted, there are, however, various parameters which should have a common standard to ensure that the acquisition of hydrographic data is adequately logged for both position and depth.

In this regard, the digitizing and filtering parameters for depth are a matter of major concern to all hydrographers interested in automation. It is, therefore, very encouraging to find hydrographic surveyors such as MACDONALD of Canada, and others, who are particularly applying their minds to ensure that data quality is enhanced and not degraded by the use of computer-assisted technology. In certain national hydrographic organizations, the use of automated hydrography has come to be a standard procedure and therefore one must assume that automation has come to stay, which is all the more reason why a common approach should be developed by establishing a Working Group to examine basic specifications as guidelines to those entering the field. The IHB would be fully prepared to cooperate in such a Working Group with a view to preparing a document that could serve as a guide for the preparation of specifications for automated hydrographic data acquisition and processing systems, and elaborating on the minimum filtering parameters necessary with regard to depth and position. It is known that there is already a Working Group 416, which is cataloguing data acquisition systems, and which could possibly be in a good position to consider such specifications, as well as make a cost-effectiveness study of automated hydrographic surveying systems.

One of the things that has always bothered hydrographers is what lies between their sounding lines. The introduction of the side scan sonar has helped to detect anomalies between lines but has not provided the perfect solution, since these anomalies need to be subsequently examined by echo sounder. The ability to continuously insonify, transverse to the ship's track, the strip of seabed existing between lines of soundings to obtain depth profiles, in the same way the conventional echo sounder does for vertical depth, will largely solve this vexing problem. The development of the bathymetric swath system might just provide the answer to the hydrographer's dream. The Sea Beam and $BS^3$ are two such systems which, I believe, are operational in France and the United States, respectively. The Sea Beam obtains depth values which are digitized and plotted in real time in the form of contour lines over a width of seabed 0.8 times the depth of water and has a maximum operational range of 12,000 m. The $BS^3$ generates real time plots displaying corrected vertical soundings plus contoured relief of those features detected by the other slant beams which are shoaler than the vertical soundings over a width of seabed 2.6 times the depth of water and having vertical and slant ranges up to 610 and 1,200 metres respectively.

Undoubtedly these systems have the capacity to acquire vast amounts of depth data which can only be handled by automation. The criteria applicable to data logging, processing and plotting, using conventional echo-sounders and precise positioning systems, will be similarly applicable to the bathymetric swath survey systems but to a far greater extent and in a much more complex manner. It is hoped that technologically and cost-wise the availability to those systems will be made exploitable by countries in need of them, including developing countries.

In addition, there are the laser airborne depth sounders and sensors mounted in space orbiting platforms, both of which can provide information of shallow water areas useful for reconnaissance surveys. Such information would be most valuable in planning hydrographic surveying programmes and avoiding wasteful effort by surveying ships employed on searching for passages through large areas of shoal waters, particularly those waters of low turbidity where the effectiveness of laser and remote sensing techniques is greatest.

## CONCLUSION

The advance of hydrographic surveying techniques benefits the surveyor in many ways, making his task more efficient, accurate, speedier and more cost effective. While these are exciting developments, they should not become limited to the few. There is a compelling need for better access to advanced technology and greater self-reliance for developing countries. An important factor determining the pace of economic and social development in developing countries is their ability to accelerate the pace of their maritime development, including their hydrographic infrastructures. The establishment and strengthening of hydrographic capabilities of developing countries through international cooperation is vital to the attainment of the IHO's objective of providing up-to-date charts based on internationally accepted standards, which in turn would benefit the international maritime community in an increasingly interdependent world.