International Hydrographic Review, Monaco, LXXVI(2), September 1999

THE ROLE OF THE HYDROGRAPHIC OFFICE

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Abstract

The paper which follows was written by a member of staff of the UK Hydrographic Office following a request by the President of the Directing Committee to the UK Hydrographer. While the International Hydrographic Review contains many papers dealing with specific and detailed aspects of the world of Hydrography and associated areas, few papers attempt to cover the broader canvas. It was felt that as we approach the millennium, this would be an appropriate time to set out the continuing rationale for the distinctive work of National Hydrographic Offices as well as their developing relationships with other interested groups, not the least being publishers of commercial chart products.

INTRODUCTION

In seeking to define the role of a national Hydrographic Office (HO), it is as well to establish the present baseline and pose the question "what is the present purpose of a Hydrographic Office?" Many national governments are signatories to the International Maritime Organization's International Convention for the Safety of Life at Sea (SOLAS), reflecting their acceptance of responsibilities under it as well as their intent to execute these through the publication of national charts, supporting publications and services.

It may therefore be said that the principal raison d'être of any national Hydrographic Office is the desire of a national government to execute in a safe and professional manner its responsibilities with regard to the safety of life at sea within its own waters.

But the task does not end there. The existence of a national inventory of current charts, publications and related services also affords considerable support to many other activities: the exploitation and protection of the marine environment, the facilitation of national and international trade, defence, national planning, coastal zone management and environmental measures, to name but a few.

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This paper will examine the degree to which national Hydrographic Offices are succeeding in meeting their present commitments while attempting to point to the ways in which they are refocusing their energies for the future.

BACKGROUND

National governments' responsibilities for hydrography arise principally from Chapter V of SOLAS. The first version of SOLAS was adopted at a conference in London in 1914, following the sinking of the *"Titanic"* on her maiden voyage with huge loss of life. Further versions were adopted in 1929, 1948, 1960 and 1974.

The Inter-Governmental Maritime Consultative Organization (IMCO) was created by a convention drawn up at a United Nations conference in 1948, primarily to improve safety at sea. The Convention came into force 10 years later and, at the first Assembly in 1959, it was decided to assume responsibility for SOLAS from the UK Government which had formerly carried out the associated duties and functions. (IMCO was subsequently renamed the International Maritime Organization (IMO) in 1982.)

Despite the long history of SOLAS, it was not until 1968 that Regulation 20 was added to Chapter V requiring all ships to carry adequate and up-to-date charts and publications necessary for the intended voyage. This amendment was incorporated in the current 1974 SOLAS Convention which came into force in 1980.

As the hydrographic world has become increasingly digital, there have been two important developments. Firstly, IMO approved a Performance Standard for Electronic Chart Display and Information Systems (ECDIS) in 1995. Secondly, Chapter V of SOLAS is currently under revision, though it is not expected to enter into force until 2002.

Three important additions to Chapter V have implications as far as Hydrographic Offices are concerned:

- the definition of a chart, both paper and digital, in a new Regulation 2;
- requirements for signatory Governments to support safe navigation by providing hydrographic services including navigational warning services, hydrographic surveying, preparation and issuing of official charts and publications, promulgation of Notices to Mariners and the provision of the associated data management arrangements in a new Regulation 9;
- the expansion of the existing Regulation 20 to accommodate digital solutions.

THE NATIONAL HYDROGRAPHIC OFFICE (NHO)

The continuing importance to national economies of ship-borne trade will ensure that Hydrographic Offices should form a fundamental part of national infrastructures throughout the 21st century. The primary function of a Hydrographic Office in its own national waters is to ensure that data are collected, processed and promulgated to navigators in a way which can easily inform the navigator's decision making process. It is also common for national Hydrographic Offices to have ancillary responsibilities related to lights and buoyage or military data requirements.

The national hydrographic data banks that have been developed over time, in some cases centuries, are valuable assets which NHOs maintain and run on behalf of their Governments and taxpayers. These data have formed the basis upon which NHOs produce "official" charts of the waters of their national responsibility; the standards and accuracy of these products is a direct responsibility of the NHO and Government.

During the 21st century we can expect the medium by which this information reaches the navigator to change from the essentially paper based environment with a growing number of digital products to one where digital products are the norm. However, the basic principles remain the same: source data particularly from multibeam and subsequent generations of survey systems will continue to need interpretation and selection.

Navigators are far from the only users of hydrographic products. They are often used for reference by legislators, planners and researchers and as the definitive documents for issues relating to national sea boundaries limits and jurisdiction and such issues as the introduction of routeing measures at sea. Hydrographic survey involves the collection of a range of information including the texture of the seabed and its mobility. Such information may be of value for research and the development of national plans for resource utilisation as well as development of joint cost-effective resurvey policy in mobile areas. The frequency required for the survey of all offshore areas can be assessed and Hydrographic Offices have also developed the capability to process and assess photogrammetric and satellite imagery which can be used to reposition major features such as isolated islands or offshore shoals. These can also be expected to allow better and more accurate depiction of the intertidal zone of interest to small craft and to assist national and regional disaster and contingency planning.

Hydrographic Offices need to hold large amounts of source data to fulfil their function and they have frequently become the repository not only for current but also historic sources which even now may still be the only source for some navigational information. They have thus become the national archive for hydrographic data. This involves them in all the disciplines of cataloguing, maintaining and storing millions of sources. Increasingly the data are being received in digital form but paper sources from the past will still need to be retained.

Paper charts are now produced by many Hydrographic Offices from digital masters and copy for publications such as Sailing Directions and Lists of Lights have long been produced digitally. The paper product inventories form an integrated package of products where none stand alone. The paper chart must be used alongside Tide Tables, Sailing Directions, Lists of Lights, and Lists of Radio Signals

and other products such as Tidal Stream Atlases. In the future the digital production environment offers the opportunity for the integration of these navigational products into linked databases. The full development of the Electronic Navigational Chart (ENC) concept allows for this, including the possibility, for example, of the depiction of real time depth information.

The core task of producing documents to assist safe navigation involves a continuous process of data receipt, cataloguing, assessment for its immediate impact on navigation, promulgation of information to meet the need for immediate change of products, and the longer term updating of products through the compilation, printing and distribution of new products and new editions. The skills required for this detailed compilation process are not readily available "off the shelf", so considerable investment is placed in recruitment, training and retention of highly skilled staff to interpret the data received and ensure that the "right" information is included in navigational products. This means that most Hydrographic Offices bear a continuous hidden training load as staff gain experience. Marine geodesy is of major importance in chart construction and therefore some Hydrographic Offices house experts in this field also.

At present, the production of paper products underpins the operation of all national Hydrographic Offices. However, most are now grappling with the implications of developing digital navigational products. Digital chart data are likely to be the norm within 10 to 15 years and there will probably be a consequent change in focus from selective updating, with new editions at longer intervals, to more complete updating on a frequent basis. The massive development of communications systems at the end of the 20th century offers the prospect that new information might be transmitted directly from a Hydrographic Office to its data users.

Internal methods are in a process of considerable change. For smaller Hydrographic Offices it has been easier to replace manual processes by end to end digital systems in a relatively short space of time. One smaller office is in the enviable position of having fully digital chart databases to support all their paper charts. On the other hand the high investment involved has led some governments to adopt an incremental approach to the development of digital source assessment, production and compilation systems. In the future we may expect most Hydrographic Offices to have multi-product generation systems capable of delivering most navigational products from one basic set of rigorously verified databases.

THE INTERNATIONAL HYDROGRAPHIC ORGANIZATION (IHO)

The IHO presently consists of some 67 Member States most of which chart only their own waters. However, a number have assumed wider responsibilities, with three nations supplying world chart folios, while two others have extensive coverage outside their own national waters. The Member States fund the IHO to meet the four objectives stated in the IHO Convention, which are:

a. the co-ordination of the activities of national Hydrographic Offices;

b. the greatest possible uniformity in nautical charts and documents;

c. the adoption of reliable and efficient methods of carrying out and exploiting hydrographic surveys;

d. the development of the sciences in the field of hydrography and the techniques employed in descriptive oceanography.

As an Organisation it works through consultation and discussion, though unlike the IMO, it has no prescriptive capacity.

The Organisation is, however, a potent force for good as it monitors change and assists nations to develop uniform methods of dealing with problems. Information is exchanged routinely on international chart schemes for instance, allowing the sharing of expertise and production capacity over large geographical areas. More progress in completing schemes and altering them to suit changing needs can be expected in future. Hydrographic Offices will also be closely involved as the IHO re-energises the programme to effect world-wide International Chart coverage.

World-wide chart standardisation has been furthered by the efforts of nations through the IHO's Chart Standardization Committee, bringing benefits to both users and producers. This important work will continue with its benefits to digital production systems. In addition the IHO's Technical Resolutions (TRs) provide an agreed set of guidelines within which all chart producing nations can operate. Recent changes relating to the recognition within the TRs of data ownership will have profound consequences for relationships between all types of hydrographic data providers well into the next century.

Common standards are also agreed between nations for hydrographic surveying and the handling of resulting data. A number of working groups and committees dealing with all aspects of digital cartographic data requirements, producing internationally accepted standards, have been a major success of the organisation over the last ten years.

The IHO has ensured the involvement of the largest possible numbers of Member States through its 12 Regional Hydrographic Commissions, responsible for the International Chart schemes and co-ordination of surveying, exchanges of information and the discussion of developing policy within the organisation. One region of the world in which this has been particularly successful is Antarctica, where many nations have interests and where the common pooling of hydrographic surveying effort and charting capacity have led to the development of charting which would not otherwise have been possible.

Lastly, the Organisation is presently undertaking a critical re-examination of its functions and future strategies to maximise its support for Member States. As we enter the next century a refocused IHB will be operating within the framework of a Strategic Plan and will measure its effectiveness against performance indicators agreed with the Member States. Through these mechanisms all national Hydrographic Offices must expect to have a more influential role in determining the direction and thrust of the organisation and will be obliged to take a continuing active interest in the work of the Bureau.

DATA OWNERSHIP

A growing awareness among Member States of the value of their hydrographic data and the significant cost that their taxpayers had historically borne led to the current situation regarding the use of one nation's data by another being challenged. At the 1997 Conference the situation was resolved with a change to the relevant Technical Resolution acknowledging copyright and encouraging the establishment of arrangements between states to formally permit the use of their data by the other with adequate recompense.

During the same period a situation was developing whereby commercial chart producers were taking "official" charts and were repackaging them for sale. Again the IHO led by work undertaken in the North Sea Hydrographic Commission is increasingly seeking to establish proper business relationships with these commercial organisations that adequately recompense the taxpayer.

INTERNATIONAL STANDARDS

The late 20th century has seen the advent of electronic navigation, first by means of Electronic Chart Systems (ECS), and now, at long last, by the imminent use of ECDIS and their associated ENCs.

The concept of the Electronic Chart was first mooted in the 1970s. By the mid 1980s a number of Member States had taken the work in hand within the ambit of the IHO (and subsequently the IMO), to develop the necessary standards to enable these electronic charts to meet the mariner's chart carrying obligations under the SOLAS Convention. The need for objectivity and independence in these fora has been important in obtaining general agreement to their proposals for world standards.

The standards in question were in support of ECDIS and the associated ENC. In parallel with the development of these standards, increasing use was being made of ECSs. These are equipments possessing a wide range of functionality, from the very simple to the complex. ECSs are merely an aid to navigation and, by definition, their use does not satisfy a vessel's legal chart-carriage requirements. The ECSs in the main use commercial charts based on the paper charts produced by the NHOs, but responsibility for these charts is not accepted by either NHOs or their Governments.

Because of the needs of maritime safety and the requirement to reach international agreement, the requisite IMO ECDIS Performance Standards were not agreed until late 1995. This was the culmination of several years' work by the IMO/IHO Harmonization Group on ECDIS (HGE). IMO performance standards are high-level documents. But there is also a need for a detailed type-approval standard for ECDIS. This was developed by the International Electrotechnical Commission and the results (IEC61174) made available in 1998. Type approval authorities will now be able to certify ECDIS equipment as being IMO compliant and, subject to the availability of the ENC data, it will be possible for vessels to use ECDIS to meet their chart carriage obligations, provided the ECDIS has adequate backup.

The associated ENC standard, the ENC Product Specification contained in Edition 3 of the IHO's Data Transfer Standard, S57, was agreed by the IHO in late 1996.

To produce properly conformant ENC is posing a major challenge to NHOs. Not only are the technical requirements advanced, but NHOs often with limited resources are having to embrace completely new production and delivery techniques. Nevertheless many NHOs are slowly delivering ENCs and a number of pilot services are now available. One of the most significant barriers to progress is the need to ensure beyond reasonable doubt the quality and accuracy of the product to allow the Government to take the necessary responsibility. The requirement to take responsibility is a very powerful safeguard which Governments are well placed to take given the consequences of the attendant liability.

Thus while a comprehensive range of ENCs are awaited the technically innovative part of the marine market has sought alternatives. While paper charts remain the legal standard many are seeking alternative solutions by using ECSs employing electronic charts produced by commercial organisations. This spread of ECSs is not only uncontrolled but threatens a plethora of standards which will eventually undermine the mechanisms that have controlled the quality of charts.

Several HOs sought to find alternatives to this predicament and this brought raster to the fore. A relatively simple technical solution, raster is capable of quick production and is one in which Governments can place reliance due to the ease of the Quality Assurance. This initiative resulted in the IMO recently adopting an amendment to the ECDIS Performance Standard which permits ECDIS to operate in a Raster Chart Display System (RCDS) mode using official raster charts when ENCs are not available. When operated in this optional mode, ECDIS must be used together with an appropriate folio of paper charts.

CHANGING FINANCIAL EMPHASIS

NHOs in fulfilling their statutory contribution to safe navigation have traditionally been totally funded by their Governments. The evolving role of Government in many countries is leading to a re-appraisal and greater questioning of how NHOs are funded. In parallel with the growing appreciation of the value of their data, NHOs are increasingly looking for methods of cost recovery. This raises two serious issues.

Firstly, the prime motivation for the existence of an NHO is the safety of navigation. However, the effort to cost recover introduces a commercial element. While it is not possible to recover all the costs of surveying, some elements can be recovered which is why many NHOs are examining more closely the value of national data bases.

It is generally accepted that the existence of a national Hydrographic Office supports the wider public good. It is therefore, something for which the public should pay; though that approach is increasingly coming under intense scrutiny.

National governments are increasingly looking for ways in which they might offset these costs at a time when unprecedented change is occurring in hydrography. New methods of production, electronic charts, digital products and changed means of delivery, increasing numbers of commercial product suppliers and many others, combined with increasing financial pressures from governments make it important to examine all possible future means of financial support.

However, national offices must be alert to their ability to raise revenue from exploitation of the Intellectual Property Rights they hold. These monies may then be employed to further the prime objectives of the offices increasing rather than interrupting the flow of data directly to the commercial shipping market or to others through derived producers.

HOs will have to keep informing their governments of the benefits of allowing the profits from volume sales of their products to offset the expensive production of low-selling but equally important charts and data sets which together support national trading and infrastructure development. Only by convincing national treasuries that surpluses should be left with HOs for them to invest in their futures will progress continue to be made.

But there is a danger that in seeking to maximise cost recovery, national offices may metaphorically "lose their way", and increasingly be seen by those on the outside as purely commercial in outlook. Such an approach will blur the definition of a national office as compared to a commercial company and will not be helpful. The primary duty of a national office must continue to be safety rather than profit related.

PRODUCT DISTRIBUTION

Hydrographic Offices have traditionally reproduced their products using their own printing facilities, other government printing capacity or under contracts with commercial printers. They have used chart agents to distribute their paper charts, publications and Notices to mariners. There are many hundreds of such agents world-wide. Some are large specialised businesses handling charts from many HOs and operating globally. Some are shipping companies, others shipping agents; some are small ships' chandlers serving local marinas. Chart agents usually provide a range of services to shipping beyond the simple supply of charts and other HO products, e.g. the supply of NM tracings, IMO publications and chart correction.

Agents are commercial businesses and receive reimbursements on charts and other publications in the form of a discount from HOs or more correctly a margin between the wholesale price paid to HOs and the retail price paid by their customers. While most HOs set recommended end user prices for their products, the actual prices vary considerably depending on location, volume and several other factors over which HOs have little or no control.

However, most HOs manage directly or indirectly the supply of charts and related publications to their national navies. In some instances this work may be contracted to commercial chart agents, in others the HO concerned may act as the navy's chart agent.

The advent of digital products has been very significant in respect of data distribution. The navigator can use the paper chart directly, but to use a digital chart he requires a hardware and software system. The HO thus becomes a component supplier together with the manufacturer of the ECDIS system.

Most digital charts produced so far have been unofficial, that is they have been produced by commercial companies, extracting information from HOs' products on payment of royalties. These commercial companies usually undertake distribution themselves using an equally wide variety of agents; some are also systems manufacturers. With the publication of the ENC Product Specification in S57 edition 3, a number of Hydrographic Offices have now begun to produce trial data sets followed by full ENCs. The relatively slow initial production and the overcoming of associated teething problems will shortly be followed by significant production capable of meeting SOLAS requirements. For the majority of national offices the capability to produce and distribute ENCs will be a marker closely associated with the start of the new century.

With respect to ENCs, the IHO recommends their distribution via Regional Electronic Navigational Chart Co-ordinating Centres or RENCs, in accordance with the IHO's agreed Worldwide Electronic Navigation Chart Database principles. The overall aim is to ensure that users of digital chart systems in any HO's waters are using that HO's ENCs. Over ten European HOs have already decided to distribute their ENCs through what was originally called the Northern Europe RENC and is now called PRIMAR. In turn PRIMAR will support a series of distributors/service providers, HOs, shipping companies, etc. This is seen as the best way to maximise the availability of ENCs in the marketplace.

Thus the roles of both the HOs and traditional chart agents are changing. Some agents are having to acquire new skills while others are forging new relationships with system manufacturers. HOs are also having to build new relationships with each other, with systems manufacturers or with potential distributors/service providers.

OFFICIAL VS UNOFFICIAL DATA

Hydrographic Offices, being government agencies, accept legal liability for the quality of their products, be they paper or digital. It is also their responsibility to issue updates to their charts in order to satisfy the SOLAS requirement that charts should be "adequate and up-to-date for the intended voyage".

Hydrographic Offices may see attempts made to blur the distinction between official and unofficial data with the aim of suggesting that all sources and products are equally valid and safe irrespective of their origins. For HOs, and more importantly governments, to succumb to such blandishments would be to do a major disservice to consumers as well as flying in the face of movements throughout the world to enforce higher rather than lower standards on product manufacturers. Nowhere is it truer than in hydrography that the product cannot be better than the data on which it is based. The need for HOs to "hold the line" on this issue is not a protectionist reaction to the threat of competition, though it will no doubt be attacked as such. It is simply a reflection of the fact that the primary motivation of the world's

hydrographers is not profit but the safety of life at sea. With safety comes world-wide economic benefit in the widest sense which is therefore to everyone's benefit.

The danger is that in the next century HOs will be left as the producers of the non-profitable products in their waters leaving taxpayers across the world to pay for services which might otherwise be self-sustaining. It will be essential to convince governments that the guarantee of "official" data quality, backed by IMO and other safeguards, is an essential pre-requisite both for economic development and long term safety at sea. It is difficult to see how once this distinction is lost it will be possible to regain the advantages to the user inherent in the present system. Standards and assumptions with respect to content are presently guaranteed. HOs will have to assert these advantages to governments and the market place if the next century is not to see the undermining of standards which have taken nearly a century to establish.

It has already been noted that the IHO is a non-prescriptive body. However, when dealing with computer systems, rigid adherence to standards is a necessity if equipment is to function correctly and it is for that reason that the IMO requires ENCs to conform to the IHO's ENC Product Specification.

The work done by the members of the IHO over the last decade on official standards for the digital products which will dominate the 21st century are a testimony to the importance and advantages of official data. The IMO-adopted definition of ENC calls for them to be "issued on the authority of a government authorised Hydrographic Office". This definition means that it is perfectly legitimate for commercial data producers to play a role in both the production and distribution of ENC providing they do so as agents for a Hydrographic Office. This emphasis on the role of Hydrographic Offices is in recognition of the fact that it is only they who have access to the latest information and it is they who have the skills to take raw, and often conflicting, archive and other data and compile it into a safe nautical chart.

The IMO's ECDIS Performance Standards state that the ENCs should conform to IHO standards. As maritime trade is an international activity, it would not be well served if different Hydrographic Offices used their own ENC standards. The result is the ENC product Specification contained in Edition 3 of S57, the IHO's Transfer Standard for Digital Hydrographic Data. There was very early agreement that it was not possible to develop an ENC display, or direct access format, which was optimum for all ECDIS equipment. S57 was developed to deliver a single transfer format in which ENCs and their updates would be supplied to the ECDIS. On receipt, the data is then transformed into a display format optimised fore that particular manufacturer's ECDIS.

PRIVATE PUBLISHERS

While, until recently, NHOs were the principal providers of navigational products, with a limited number of private publishers producing derivative products mainly aimed at the leisure marker, this is now altering very quickly. The digital era has brought increasing demand from customers for digital products in both the commercial shipping and leisure markets. This has, and will, create greater opportunities for the development of further derived products, and should bring with

it an expansion in the number of private publishers wishing to develop and expand the market.

Hydrographic Offices have responded to these new demands by giving a high priority to the conversion of source materials and products into a digital form for dissemination to both the user and to private publishers for their use within derived products. This trend will continue.

The shift towards digital product flowlines over recent years will increasingly make access to this data easier. Hydrographic Offices will have the option of producing data bases which can be exploited by commercial producers. Increasing income can be expected from such sources because these official databases can be relied upon by derived producers who are becoming more alive to the dangers posed for them by producer liability. Using government produced data will always give them a sure foundation upon which to create their own derived products without relieving them of their share of responsibility for the quality of their final market offerings.

There is a perception that there exists in the market place a greater degree of competition between Hydrographic Offices and private publishers than before and that this will increase. In reality there is no reason why they cannot co-exist in the future, exploring new relationships presented by technology to produce derived products. HOs will continue to license use of their copyright material to private publishers in an increasing number of countries, using simplified application procedures, common licensing conditions and standardised contract documentation. This freedom of access to data allows product diversification with companies meeting the market place requirement. New relationships establishing joint production or publishing arrangements can also be expected, with HOs increasingly operating as "official data warehouses" using the undoubted skills of the commercial publishers to effect rapid and cheap distribution, particularly to leisure market users.

On the other hand, HOs will have to examine options to use the skills they learn from working with the commercial publishers to reduce the costs of their SOLAS market products. If they do not do so, they may find that commercial producers begin to attempt to supply that market as well as those they already serve. Pressure from Governments will force HOs to be seen to operate with decreasing subsidies through diversification of their products and implementation of commercial practices tailoring production to specific market requirements.

None of this should lead to a deterioration in the relationship between HOs and private publishers. They have much to give each other and will increasingly work together rather than viewing each other with suspicion. The professional relationship between the two is governed by a number of international laws and treaties. Copyright law establishes that the copyright holder has the exclusive right to copy, adapt and distribute any copies of their work. Competition law, both domestic and international, prevents the abuse of a dominant position within particular markets and to some extent balances the exclusive rights of a copyright holder. Thus while establishing the rights of Hydrographic Offices, those of private publishers of derivative products are also clearly established, verifiable and safeguarded.

THE FUTURE

The national Hydrographic Office of the next century will have a continuing demand for its traditional services, but these will change at an increasingly fast rate as new technologies are exploited, putting a high premium on the development of IT related skills at all levels.

The timescales over which the present paper chart is to be supplanted by print on demand or fully digital products is by no means clear. It may be that analogue products will be demanded for a considerable time to come, requiring HOs to maintain duplicate product lines or moving production to remote centres closer to users.

Speed of response using the Internet, e-mail, satellites, etc is going to be an essential element in meeting developing needs and just as importantly, delivery expectations. Output diversification will lead to demanding trialing and testing of the product with an enhanced importance given to meeting the customers' stated needs, as well as the legislative requirements imposed by the IMO.

Electronic Docking Charts represent a specific type of product which may become common, particularly for major terminals covered by DGPS fixing systems either inside or outside large ports. Demand for their production using ENC data may increase, as port operators and shippers seek the means to dock vessels with the tide, irrespective of visibility, in order to reduce delay and costs; but the critical factor which will determine whether Hydrographic Offices supply these products will be their ability to assess the data and deliver it as fast as possible. This will require careful planning and control.

In addition, HOs will have to take even more seriously those liability issues arising from failures to handle data and issue products sufficiently quickly, as well as ensuring that outgoing products are entirely accurate. Allied to this will be the need for fast, often IT-based, Quality Assurance carried out on their digital seamless datasets.

These data sets will also increase greatly in size as multibeam survey systems become common. This will bring growing data handling overheads, though near real-time data assessment methods on survey ships will help to reduce the workload. Such systems will also bring with them questions about the advisability of resurveying the whole area of a nation's seabed area. HOs will have to examine their priorities and liabilities very carefully before committing themselves to these or more wide-ranging co-operative surveying ventures.

Increasing accuracy in navigation systems and their availability to commercial shipping have ensured that ENCs are all to be based on the WGS84 datum. But HOs, particularly those with large chart inventories, will probably not be able to determine WGS84 shifts for all of their products. Some charts are not positioned on a defined datum, others are internally inconsistent or shift parameters cannot be determined which are accurate enough for the chart. This will mean increasing pressure on HOs in the early years of the next century to determine chart datum shifts with consequent costs in data collection, resurvey and production.

National HOs will also find themselves co-operating even more closely in order to allow bodies such as RENCs to function effectively. Business arrangements between the HOs and value adders and data distributors have the potential to become complex. HOs must try, wherever possible, to use standardised contract and copyright agreements, sharing through custodianship arrangements the resulting revenue. This will benefit the commercial sector just as much as the HOs themselves.

Governments can also be expected to be given more rather than fewer responsibilities for safety through IMO regulation. The amendments to SOLAS Chapter V, which may come into force in 2002, contain carriage requirement changes exemplifying these. These must have implications for charting and more particularly the accuracy of the content and positioning of chart detail. This will result in pressure to resurvey areas last visited in some cases only relatively recently. With this may well come more routeing prescription and the need to include more territorial limits and associated information on charts as UNCLOS and inter-governmental agreements on boundaries become more common. In many parts of the world governments will have to address the requirement to establish national organisations which are suitably funded to gather necessary data to full modern standards and be enabled to deliver it to the user. This will bring with it demands on established HOs to assist with training and technology transfer.

Lastly the demand for Freedom of Information on the US model will increasingly be heard, principally from derived product suppliers. The response to this on the part of national Hydrographic Offices may be to increasingly question the retention of their data distribution function allowing them to concentrate on being data warehouses constantly updating their databases supported directly by government funds. The choice for many countries will not be easy.

CONCLUSIONS

The world's Hydrographic Offices have been subject to unparalleled changes in the closing years of this century. These have affected data types, the product requirements that must be met, the technologies they must master and their relationships with their governments and the commercial world. Relationships and understandings, which have lasted for generations, are being challenged, altered and rewritten.

However, the Offices of the future must remain clear in their determination to uphold the safety standards to which they work and the control over these which comes from the involvement and support of Governments. Without this governmental linkage it is difficult to see how an increasingly profit-led commercial sector can sustain the assurance of the origins of data and its characteristics which we presently take so much for granted. Today's position has been arrived at after more than two centuries of endeavour. What we have should not lightly be discarded in the next century. Retention of this role will sustain HOs and ensure their continued existence.