

INTERNATIONAL HYDROGRAPHY

by Rear Admiral Sir David HASLAM, KBE, CB, FRIN ¹

Abstract

The fourteenth Duke of Edinburgh Lecture was presented in London on 21 October 1992 to the forty-sixth Annual General Meeting of the Royal Institute of Navigation and published in the Journal of Navigation, Vol. 46, No. 2, May 1993.

It is perhaps appropriate, on this the exact 187th anniversary of the death of Admiral Lord NELSON at Trafalgar and in the year in which so many celebrations have taken place, to commemorate the 500th anniversary of Christopher COLUMBUS's arrival somewhere in the West Indies, to consider the progress which has been made towards international co-operation and achievements in hydrographic surveying and nautical cartography, particularly since the formation of the International Hydrographic Bureau in 1921, and to look at the problems facing international hydrography in the immediate future.

Before doing so, however, it is necessary to look briefly at the earlier advances in hydrography and navigation. Two years after COLUMBUS had reached the West Indies, Spain and Portugal agreed to divide between them those parts of the world which had not then been reached and annexed by Europeans - an agreement which was later approved by His Holiness The Pope. This led to a great flurry of voyages of exploration and annexation of distant lands by the European powers. Within 8 years, the Genoese explorer, John CABOT, sponsored by the English King Henry VII, had visited Newfoundland and Nova Scotia (believing them to be part of Asia) and Vasco da GAMA had rounded the Cape of Good Hope and reached Calicut in India - thanks, it should be noted, to Arabian pilots whom he met in East Africa. Too often, Europeans tend to ignore the voyages made by Asian navigators, notably from the Persian Gulf states and from China, many years before any Europeans reached the Indian and Pacific oceans.

Two of the most important navigational achievements during the next three centuries were the development by the Flemish geographer Gerhard KREMER (whose surname was latinized as Mercator) of his Mercator's Projection and the perfection of a marine chronometer by the Yorkshireman Thomas HARRISON.

¹ President of the Directing Committee, International Hydrographic Bureau, Monaco 1987-1992.

The first charts of British waters were actually produced by a Dutchman, Lukas WAGENHAAR, who, in 1585, produced a fine marine atlas called *Spieghal der Zeevaert*. These came into the hands of a private maps-seller in London and were re-published, with English legends, in 1588 - possibly just in time to be used during the defeat of the Spanish Armada by those of HM Queen ELIZABETH I's warships whose captains could afford to buy them.

It was not until 1681 that a Captain Greenville COLLINS was appointed by King CHARLES I to undertake the first systematic exploration of our own waters. For this enormous task, COLLINS was allocated just one small yacht, THE MERLIN, yet somehow, within seven years, he had produced his *Great Britain's Coasting Pilot*, with 48 charts. These were beautifully drawn and presented, but they contained very few soundings and no attempt was made to supply them to the British Fleet or to keep them up to date.

In 1750, however, the Admiralty appointed a civilian, Professor Murdoch MACKENZIE, to undertake surveys of the Orkneys and the west coasts of Scotland and Ireland. He was superseded as the Admiralty Surveyor, in 1771, by his nephew Lieutenant Murdoch MACKENZIE, Royal Navy, and his cousin, Graeme SPENCE, who together extended the Professor's work around the west and south coasts of Great Britain.

At about the same time, in 1758, Lieutenant James COOK, then the Master of HMS PEMBROKE, happened to meet a former Dutch land surveyor called Samuel HOLLAND, then a major in the British Royal American Regiment of Foot, who was surveying a harbour on the North American Atlantic Coast. COOK and his Captain, SIMCOE, became very interested in HOLLAND's work and the three men spent much of the winter of 1758/59 using captured French charts to construct a chart of the St. Lawrence River.

COOK added to this during the summer of 1759, using his ship's boats, and was then able to pilot the British ships through the intricate section of the River St Lawrence known as the Traverses (despite the removal of the buoyage by the French), allowing General WOLFE to surprise the French by landing his troops behind their defences of Quebec. COOK was then appointed for the next five summers to survey the inhospitable coasts of Newfoundland before being selected to command the first of his three famous voyages to the Southern Ocean and the Pacific. Shortly afterwards, the threat of the War of American Independence led the then First Lord of the Admiralty, Earl HOWE, to recall another army officer serving in the British American Regiment - the Swiss-born engineer DES BARRES - to compile and publish charts of the Atlantic coasts of the North American continent. These were published in 1777, as *The Atlantic Neptune*, which thus became the first series of the British Admiralty charts, although the Admiralty still made no attempt to distribute the series to its Fleet or to set up an organization to keep the series up to date, and only the chart sellers in London profited from the trade.

A different approach was taken both by the French and the East India Company. France established the world's first national hydrographic office - the 'Dépôt des cartes et plans' - in Paris in 1720 and, throughout the 18th century, built up a comprehensive, worldwide archive of the surveys by French 'ingénieurs hydrographes de la marine'. In 1759, whilst COOK was learning about hydrography

in the Gulf of St Lawrence, the East India Company engaged a Scottish civilian, Alexander DALRYMPLE, to survey the routes used by their ships between ports in the Indian sub-continent and those in what are now Malaysia and Indonesia. In 1765, DALRYMPLE was given permission by his employers to use his own and other data held by the company to produce a series of charts, to a common scale. By 1775, the first six of DALRYMPLE's *Collection of Plans of Ports in the East Indies* had been published, with plans of 78 ports and many views of the coast and port approaches.

Eventually, spurred on by complaints from senior naval officers that more British warships and merchant vessels were being lost due to inadequate charts than from enemy action, an Act of Parliament was passed on 12 August 1795, appointing the First Hydrographer of the Navy. But for his murder in 1779, Captain COOK would have been arguably the most suitable candidate, but DALRYMPLE was appointed to the post and was allowed to retain his earlier post with the East India Company.

DALRYMPLE was a perfectionist who was very reluctant to publish a chart until he was personally satisfied with the accuracy of its every detail. Despite his intimate knowledge of the Far East, he knew much less about the areas in which the Napoleonic naval battles were being fought in European, Mediterranean and North American waters. He therefore sought the advice of a small committee of three Royal Naval officers - including a Captain Thomas HURD who had, like COOK, learned his profession from Major HOLLAND in North America. Serious disagreements soon arose between the elderly civilian DALRYMPLE and the younger Royal Naval officers; matters came to a head when a complete set of charts produced by a senior French hydrographer, D'ENTRECASTEAUX, was captured with a French vessel off St Helena. DALRYMPLE, as a Fellow of the Royal Society and scientist, felt that, despite the political situation between Britain and France at that time, he should not make use of the vast amount of new material available from D'ENTRECASTEAUX's surveys until the French Hydrographic Office had made use of it. He therefore had copies made and returned the originals to Paris, keeping the copies locked in his safe custody. The committee demanded the key and the matter came to the attention of the Secretary of the Admiralty who, following an enquiry, dismissed DALRYMPLE and appointed HURD as Hydrographer.

Within a year, HURD was able to provide boxes of charts to Royal Naval ships and make arrangements for these to be routinely returned to the office for updating. Shortly after NAPOLEON's defeat at Waterloo in 1815, HURD, realizing that the Royal Navy's task in peace-time would be to safeguard the British merchant ships increasingly trading round the world, suggested that it would be sensible to make the Admiralty charts available to anybody who needed them. He pointed out that this would not only reduce the risks to merchant shipping and seamen but would also produce revenue to the British tax-payer. This proposal was accepted and, in 1823, some seventy pounds' worth of charts were sold.

Throughout the so-called *Pax Britannica* period of the 19th century, incredibly dedicated teams of Royal Naval hydrographic officers - usually serving in old ships, condemned as fighting ships and bottom of the lists as far as their maintenance in naval dockyards was concerned - worked for very long commissions in almost every corner of the world's oceans. Wherever British trade seemed likely, British Naval surveying ships methodically and meticulously surveyed the coastal

trade routes and approaches to ports and landing places. Bearing in mind the lack of contact, for long periods, with their families, the poor food and living conditions of their crews, many of whom were pressed men snatched from their homes by the Navy's press gangs, the hydrographers in charge of such ships must have been remarkably good leaders as well as experts in their profession.

The countries of the then British empire, and even other countries without their own hydrographic capability, welcomed this activity - even within their own territorial waters - particularly since the British surveying ships had white, rather than grey or black, hulls and, when steam began to replace sail, had buff-coloured funnels to indicate that they were unarmed and were working for the safety of international shipping and trade.

However, with the rapid expansion of international maritime trade during the 19th century, many other countries - appreciating the need for a greater effort in their own waters than Britain could afford to provide - set up their own hydrographic and chart production capabilities. Since many of these countries had common commercial interests, there was often duplication of data collection effort and of chart coverage. Although the techniques employed by each country were similar, different criteria were used as to the scale of the surveys and the resultant charts, and each country developed its own sets of symbols and abbreviations on its chart series - each, of course, using its own language.

Following a preliminary meeting held in Washington in 1899 to discuss the need for some degree of uniformity in hydrographic surveying and nautical charting, a resolution was passed at the International Congress of Navigation held in St Petersburg in 1908 which stated that it would be advantageous if an international conference of seamen and surveyors could be arranged with the object of introducing uniformity in conventional signs and abbreviations on charts, in drawing up sailing directions, regulations for navigation, and the lighting and buoyage of coasts. One of those who attended this conference was the French Ingénieur Hydrographe en Chef M.J.A. RENAUD who recognized the weakness of this rather woolly resolution, which merely endorsed a broad general policy, without making any specific proposals as to how to set about achieving such uniformity.

When an International Maritime Conference was held in 1912, also in St Petersburg (at which, incidentally, Great Britain was not represented), RENAUD spoke up strongly about the great advantages that common agreement on the production of charts and nautical publications would bring to international shipping and mariners. However, the conference was trying to handle too many subjects and RENAUD realized that a special conference, dedicated only to hydrography, was needed. But 1912 was not an auspicious time in which to begin a co-operative international enterprise.

Throughout World War I, RENAUD engaged in frequent discussions and correspondence with the British Hydrographic Office so that, when peace was restored, the British hydrographer, Rear Admiral Sir John PARRY, proposed to the Admiralty that the world's first International Hydrographic Conference should be held in London. Twenty-four countries took part in this conference in June 1919 and, fittingly, M. RENAUD was asked to preside until a President had been elected. The delegates then chose Sir John PARRY as President and M. RENAUD as Vice President.

Most importantly, the conference unanimously agreed with M. RENAUD's proposal that some form of an International Hydrographic Bureau should be formed, and a three-man International Hydrographic Conference Committee was set up, made up of Sir John PARRY, M. RENAUD and Captain Edward SIMPSON Jr., Hydrographer of the USA. Sir John PARRY retired as the British Hydrographer two months after the conference but was appointed by the British Admiralty to work full-time on the IHCC's business, with Commander G.B. SPICER-SIMSON as his secretary, following his work as official interpreter at the June conference and the publication of his report of the conference.

Despite their individual other duties, the committee prepared and circulated monthly reports on their work to the prospective Member States and, on 17 July 1920, circulated the first draft statutes for consideration, including a proposed set of provisional arrangements to allow the proposed organization to start operations. By April 1921, final approval had been obtained from those States considered most likely to join and, on 16 May 1921, the names of 5 candidates for the proposed 3 posts as Directors were circulated for a postal ballot. Very sadly, one of the 5 named candidates, M. RENAUD, the French motivator and inspiration behind the whole concept of an International Hydrographic Bureau, had died three days earlier and it was not possible to obtain another French candidate before the deadline of the ballot of 20 June 1921.

A headquarters site for the Bureau had already been agreed as a result of the generous invitation of the enthusiastic and eminent oceanographer HSH Prince ALBERT of Monaco to make the seat of the Bureau in his Principality. The IHCC had considered the French suggestion that the Bureau should be located in London but had decided that an International Bureau should not be too close to, or dependent on, any one nation's hydrographic office and that Monaco offered not only a neutral hydrographic environment but was also on the coast (unlike Geneva where the League of Nations was then being built up), was centrally located for the majority of the nations likely to become Member States and had all the necessary accommodation needed for hotels and conferences. At the second International Hydrographic Conference in November 1926, Spain generously offered to pay to move the Bureau to Malaga where a new Institute of Oceanography and Marine Biology would be modified to suit the Bureau's needs, without cost to the Bureau. Whilst this offer was being studied, the government of Monaco offered to provide a new building for the free use of the Bureau, provided that the Bureau remained in Monaco. Following a ballot, it was decided to remain in Monaco and the foundation stone of the building now occupied by the Bureau was laid on 20 April 1929, during the First Supplementary Hydrographic Conference. The present prince, Prince RAINIER, has graciously extended the use of this accommodation indefinitely, although at the fourteenth I.H. Conference held in Monaco last May he did tell delegates that a move to a newly-built or refurbished building on the opposite side of the Port of Monaco was being considered.

The first three directors elected by the ballot were Captain S. MULLER of Norway, Vice Admiral Sir John PARRY of the UK and Captain J.M. PHAFF of the Netherlands. Within 2 weeks of the counting of the secret ballot at a meeting in London on 21 June 1921, Admiral PARRY and Captain PHAFF had arrived to start work in Monaco and, when Captain MULLER arrived on 25 July, Admiral PARRY was

elected as the first President and Commander SPICER-SIMSON was confirmed as Secretary-General - a post which he was to fill until 1937.

One of the first matters to be handled was to resolve the relationship between the Bureau and the League of Nations in Geneva. Any international agency formed after the establishment of the League of Nations was automatically incorporated into the League. Following correspondence and a visit to Geneva by Admiral PARRY, the Council of the League of Nations, on 5 October 1921, unanimously adopted a resolution stating that:

Whereas the Secretariat has received detailed information on the final constitution of the International Hydrographic Bureau, its public character and its international utility, the Council decides that this Bureau shall be placed under the direction of the League of Nations, in conformity with Article 24 of the Covenant.

The Bureau thus became the League's first professional agency but escaped being part of the League of Nations' headquarters in Geneva. Following the termination of the League of Nations in April 1946, the statutory nature of the Bureau became unclear but the Bureau became closely linked with the United Nations, without ever becoming a United Nations' organ. However, it does have Memoranda of Understandings and very close links with bodies such as the International Maritime Organization, the Intergovernmental Oceanographic Commission, the World Meteorological Organization, the UN Office for Ocean Affairs and Law of the Sea and the UN Department of Technical Development and Co-operation.

The aim of the first International Hydrographic Conference, held in London in 1919, as stated in the invitation to attend was:

To consider the advisability of all maritime nations adopting similar methods in the preparation, construction and production of their charts and hydrographic publications; of rendering the results in the most convenient form to enable them to be readily used; of instituting a prompt system of mutual exchange of hydrographic information between all countries and of providing an opportunity for consultations and discussions to be carried out on hydrographic subjects generally, by the hydrographic experts of the world.

The new Directing Committee quickly established a pattern of work which has been followed to this day. Circular letters were sent out to all Member States with proposals and requests for comments; these were then circulated, until eventually a postal ballot was carried out and a solution agreed. A Repository of Technical and Administrative Resolutions has been gradually built up to form 'The Bible' for hydrographic offices of the Member States, who endeavour to carry out the instructions in the production of their charts and navigational publications to the maximum degree possible. The Bureau, however, remains the Secretariat of the Member States and cannot compel its Member States to comply with any of the various Resolutions. The Bureau may suggest, promote, encourage and present recommendations and arguments but it is only by the voluntary co-operation and

agreement of the Hydrographic Services of Member States that standardization takes place.

It was originally intended that International Hydrographic Conferences should be held at five-yearly intervals; indeed, with the exception of the war years 1939 to 1945, this pattern has been maintained ever since the third conference in 1932. In order to enable senior officers of Member States' Hydrographic Services to meet together more frequently to discuss mutual problems and their solutions, Regional Hydrographic Commissions have been formed, starting with the North Sea Hydrographic Commission (NSHC) in 1963, although it should be noted that the Scandinavian countries - Denmark, Finland, Iceland, Norway and Sweden - had formed a Northern Hydrographic Group in 1928. Regional Hydrographic Commissions were formed for the Mediterranean and Black Seas in 1978; US/Canada in 1977; East Asia in 1981; the Baltic in 1983; the Eastern Atlantic in 1984 and the South-East Pacific in 1991. Others are planned.

As mentioned earlier, the statutory position of the Bureau had become unclear with the demise of the League of Nations, and a new convention was prepared by legal experts for consideration by the delegates who attended the ninth I.H. Conference in 1967, with plenipotentiary powers to sign on behalf of their governments. The convention was then officially ratified by the necessary two-thirds majority of Member States by 22 June 1970, and came into force three months later on 22 September 1970. On that date, the worldwide organization became the International Hydrographic Organization (or IHO), rather than the IHB, whilst the Bureau remained in existence as the Headquarters Secretariat of the IHO.

In order to fulfil the objectives of the Organization, the work of the Bureau is now undertaken by a staff of 21 people (8 ladies and 13 males - of 9 different nationalities) including the 3 members of the Directing Committee, the four professional assistants (to deal with hydrographic, cartographic, editorial and financial matters) and 14 secretarial, translation, printing and administrative personnel. The official languages are English and French but Spanish is being increasingly used. The aims of the Bureau are:

- (i) *to bring about a close and permanent association between national hydrographic offices;*
- (ii) *to study any matters relating to hydrography and its allied sciences and techniques and to collect the necessary papers;*
- (iii) *to further the exchange of nautical charts and publications between hydrographic offices of Member States;*
- (iv) *to circulate the appropriate documents;*
- (v) *to tender guidance and advice, upon request, in particular to countries engaged in setting up or expanding their hydrographic services;*
- (vi) *to encourage co-ordination of hydrographic surveys with relevant oceanographic activities;*
- (vii) *to extend and facilitate the application of oceanographic knowledge for the benefit of navigators;*
- (viii) *to co-operate with international organizations and scientific institutions with related objectives.*

The ninth conference, in 1967, was also significant as it set up a commission to study the creation of a common, worldwide, International chart (INT Chart) series, initially confined to small-scale charts. Two worldwide series, at 1:3.5 M and 1:10 M scales were planned, with a total of 79 charts to provide cover for the world's main shipping routes. Sixteen national Hydrographic Offices agreed to produce a number of this new series and to make the four sheets of reproduction material, representing the four basic colours to be used (black, blue, magenta and buff) available to any other Member State that wished to reproduce the chart in its own national series. This represented an enormous saving of chart compilation effort and has ensured that all shipping can use identical charts - except for some changes of titles and other printed information. Both series are now complete. Instead of there being seven different small-scale charts of the Mediterranean - all on different scales, with slightly different limits and very different sounding details - there is now one standard version produced by the various Member States.

Five years later, at the tenth conference, a further commission was set up to consider how to extend the INT chart concept to medium and large scale charts, so that mariners could navigate along all the major sea routes and enter all the major ports of any country using standardized INT charts. Initially, the study was handed to the North Sea International Chart Commission (NSICC) to plan a series covering the North Sea and its immediately adjacent waters. The NSICC Report was accepted by the eleventh conference, in 1977, which recommended that it should be considered as a guide for extending INT charting at medium and large scales to other world regions.

Such schemes have now been agreed by 8 of a total of 12 IHO regional charting groups or commissions and, by the end of 1991, almost 800 medium and large scale INT charts had been planned and some 240 had actually been produced.

One of the difficulties highlighted by the NSICC Report in 1977 was the lack of a full set of chart specifications. Despite all the efforts to achieve standardization of such chart symbols and abbreviations at previous conferences and by circular letters between conferences, less than a third of all symbols used on charts had been agreed upon by Member States up till 1977. The 1977 conference established a Chart Specifications Committee (CSC) to adapt and extend the set of specifications drawn up by the NSICC for the small-scale INT chart series. By the time of the 12th conference in 1982, the CSC had produced a comprehensive list of chart specifications of the IHO, recommended for use by all Member States on all their charts, both international and national. The CSC's name was changed to the Chart Standardization Committee, which was charged with keeping the list under review and up-to-date for any new symbols found necessary and as approved by Member States voting by circular letters.

Associated with MP-004 *Chart Specifications of the IHO* - which is now available in English, French and Spanish (thanks to translation work by Chile) - are three INT Charts: INT 1, produced by Germany, which lists all the symbols and abbreviations contained in MP-004; INT 2, produced by the Netherlands, shows the 'borders, graduations, grids and linear scales' to be used; and INT 3, produced by the UK, showing a chart of a fictitious harbour on which almost all of the recommended symbols and abbreviations are shown.

It must be stressed that it is a major undertaking for any national hydrographic office to convert all the symbology and abbreviations on all of its set of charts. Many compromises also have to be made. As an indication of the task, my illustrious predecessor as Hydrographer of the Navy, Rear Admiral Steve RITCHIE, boldly decided, in 1967, to modernize the whole 3500 individual British Admiralty navigational charts and some 600 latticed versions so as to introduce a more uniform range of scales, to provide better overlap between adjoining charts, to provide for the modern patterns of trade routes and new ports and, most significantly, to comply with one of the first Technical Resolutions of the IHO which was that the units used for depths should be metric rather than the Imperial ones of fathoms and feet. Despite enormous efforts by all concerned in the Hydrographic Office at Taunton, I understand that this huge task is only just beyond the half-way stage.

But even these newly compiled British Admiralty charts and the new INT charts will only be as accurate as the data on which they are based. Until quite recently, titles of most charts contained a line saying: *'From the latest information available to such-and-such a date.'* This looked fine, but often disguised the fact that the latest -or only - information available was well over 100 years old. The IHO had, for some time, recommended that all charts should have source data diagrams or reliability diagrams so that mariners might have some guidance as to how much trust they can put on their charted data. These are gradually being used on most charts.

The recent grounding of the QUEEN ELIZABETH II off the approaches to Boston highlights the position. Although I do not know any more details than have appeared in the press, it would seem that the area in question had been surveyed, in the early 1940s, using the latest techniques then available.

Prior to the start of World War I, hydrographers had used hand- lead and line to measure the depth of water and hand-held sextants to measure the horizontal angles between fixed marks on land or between floating beacons moored off-shore, in order to plot the positions of their soundings using station-pointers. Experiments with anti-submarine detecting instruments during WWI had led, during the 1930s, to the introduction of the echo-sounder. But this only gave the depth of water almost immediately below the transducers and, unless the lines of soundings were run extremely close together, there would inevitably have been gaps between the lines, in which might have lurked undetected wrecks or other natural dangers, such as spikes of coral-heads, pinnacles of rock or large boulders - some of which might have been rolled along the seabed by the tidal streams or currents.

Experiments during World War II to fix the position of aircraft over hostile territory (including the sea), led, during the 1950s, to radio electronic fixing systems becoming available, which enabled hydrographers to position their soundings more accurately; visibility ceased to be a limiting factor as surveys could be continued in darkness or in rainy or foggy conditions and to increasing distances off-shore. More recently, satellite navigation systems have given even greater accuracy and provided worldwide cover - not only to hydrographers but also to mariners, even in small yachts. The positions of many charted land and off-shore submerged dangers are still based on old 19th-century (or even earlier) positioning methods so that present-day mariners must be made aware of the need to relate their satellite positions to the datums used for their charts. At the recent fourteenth conference in Monaco, a new

committee was formed to study how to resolve this new situation. The old 'thumb-nail' maxim that a mariner should never plan to pass closer to a charted danger than the width of his thumb on the largest scale chart of the area is now even more valid.

Although, following the adoption of the IHO Chart Specifications, cautions are now being included on all charts to allow mariners to relate their satellite-derived positions on a World Geodetic datum to that used in compiling the chart, the positions of many off-shore charted dangers are less accurately known and, as I mentioned earlier, there are many areas still surveyed only by echo-sounding methods and an even greater area which has not been surveyed at all.

Even with the echo-sounder, errors could occur due to the vertical movement of the sounding platform due to sea or swell, or to the inaccurate calibration of the echo-sounder due to changes in the velocity of sound in water. More use can now be made of heave compensators, or vertical accelerometers, to level out the pitch of the sounding platform. Modern calibration techniques and a better understanding and knowledge of tidal heights off-shore are also improving the accuracy of charted depths.

To ensure that no hidden dangers exist in the gaps between lines of soundings, various side-scan sonars have been introduced increasingly since the mid-1960s. A set of transducers, mounted in a small cylinder - or 'fish' - towed astern of the surveying vessel, close to the sea-bed, sends acoustic pulses sideways to either side of the track, for several hundred metres; the echoes returned from any solid object are shown as a picture on the recording roll of paper in the surveying vessel. Careful study and advanced interpretation expertise are needed to ensure that no potential dangers are missed and then each potential danger must be investigated by individual searches by echo-sounder or wire drag-sweeping; a very time-consuming and expensive business, but obviously vital if ships are to use the minimal underwater clearances now accepted by ship-owners or operators.

In order to speed up such routine coastal surveys and to carry out surveys in greater depths, multi-beam or swath survey systems have been developed to give up to 25 slant-range soundings on either side of a ship's track, from a swath of the sea-bed about 2.5 times as wide as the vertical depth of water below the transducers. Even more powerful systems - such as the British GLORIA systems - are now available, but these modern developments have made such a mass of data available that it was not possible for the old, human, methods to handle it.

Concurrently with the rapid introduction of automated data acquisition systems for hydrographers - including digital echo-sounders, swath systems, multiple radio and satellite positioning systems, plotters and visual display systems - navigators and mariners have also become aware of the need to integrate the various data becoming available on the bridges of merchant ships and in the cockpits of yachts and other, increasingly sophisticated and expensive, recreational craft.

One of the original aims of the Bureau was to encourage the unrestricted exchange of data between Member States' hydrographic offices. By an early Technical Resolution, all Member States are required to supply a copy of each new chart or new edition of a chart or publication to the Bureau. The Bureau at present holds a unique collection of some 21 000 charts published by its Member States and,

each month, publishes a list of such new documents announced by its Member States so that all other Member States may write to obtain copies. There are many bilateral arrangements in existence whereby new material is automatically exchanged between offices.

When several offices began to adopt the rendering of original survey data in digital form and to adopt automated chart drawing techniques - originally for the construction of the geographic grid but moving quickly on to the plotting of coastlines and point data (such as lighthouses, buoys and eventually soundings) - it became desirable to develop standards for the formatting of digital data exchanged between hydrographic offices and a Committee on the Exchange of Digital Data (CEDD) was established following the twelfth conference. Its most recent achievement was the publication, in August 1991, by the Bureau, of the CEDD's Feature Code Working Group's *IHO Transfer Standard for Digital Hydrographic Data* as SP-57. This important publication is the first IHB product to include floppy discs and, as with all such standards, it must be kept continuously under review and updated as more experience is gained in this rapidly expanding field.

One of the most significant developments in the IHO's recent requirements has been the introduction of Electronic Chart Display and Information Systems (or ECDIS) for merchant ships and recreational craft. Economic pressures and new measures to improve the safety of shipping have led to the reduction in the crewing levels of merchant ships, whilst increasing the work load of the remaining crew. The hand correction of paper charts has always been a thankless but vital task for navigators, whilst the need to plot a ship's position on a paper chart, on a chart-table some distance away from a radar display, has always been difficult - even with several officers on the bridge; with a 'one-man' bridge situation, some integrated system, combining own ship's position with those of shipping in the immediate vicinity and of charted dangers, is increasingly attractive. Manufacturers of ECDIS variations have not been slow to appreciate the potential market, but they need to have the contents of the traditional paper chart available in digital form to include in the databases of their systems.

Working very closely with the joint IMO/IHO Harmonizing Group on ECDIS (the HGE), the IHO's Committee on ECDIS (or COE) has produced SP-52 *Provisional Specifications for Chart Content and Display of Electronic Chart Display and Information Systems* together with its Appendix I *Up-dating the Electronic Chart*, Appendix II *Provisional Presentation Standards for ECDIS* and Appendix III *Glossary of ECDIS-related terms*. These were all designed to give guidance to those world manufacturers of ECDIS working on systems which could be accepted by the IMO's Safety of Life at Sea (SOLAS) Convention.

One of the most vital inputs to any ECDIS is the content of the navigational database. Very little is yet available in digital format from Member States' hydrographic offices. The COE has set up six working groups to study the various problems involved. Work by the Group of Experts on Specifications enabled the Bureau to publish a second edition of SP-52 in September 1992. The Updating Group is working on a second edition of Appendix I of SP-52, whilst the Data-Base Group is working on an Appendix IV *Guidelines for the Production of Data-Bases*. The Colours and Symbols Group has done extensive work with perception psychology institutes in Germany, the Netherlands and Canada, so as to recommend colours and symbols

suitable for use, by day and night, on visual display units. The Glossary Group and Data Quality Group have also been very active.

The Norwegian Government, with very significant merchant shipping tonnage on its register, has played a very prominent role in the development of ECDIS, particularly in the creation of an official navigational data base and the testing of prototype ECDIS. Following their offer to contribute very significant financial support for the establishment of a Worldwide Electronic Navigational Chart Data Base (WEND), a seminar was held in the Bureau in October 1991. This attracted a large number of experts, including 11 national hydrographers, and resulted in two proposals being made to the fourteenth conference in May 1992 and the publication of the proceedings of the seminar, as SP-58 in February 1992.

The fourteenth conference devoted much time to the subject and has established a new committee to study the matter and to report on the need to have an extraordinary conference, devoted solely to the subject, before the scheduled fifteenth conference in 1997. Amongst the problems to be resolved are: the legal implications for commercial manufacturers regarding their handling of material used in their navigational database (whether this is produced by themselves or provided by a national or international governmental agency); the legal implications for the navigator when updating or manipulating data in his ECDIS; and the financial and other implications for national offices, whether the data is provided by them directly to the world database or input from their national charts by an international or other national agency. Norway has been asked to work, with other hydrographic offices, to produce a database of North-West European waters. Several countries are now carrying out extensive tests of various ECDIS in order that both the new systems and the performance standards may be tested before the date by which it is proposed that ECDIS equipment can be accepted by IMO for use in merchant vessels. A matter yet to be tackled - either by IMO or IHO - is the development of the so-called non-equivalent electronic charts for use on recreational craft.

Closely linked with both the introduction of INT charts and the development of ECDIS is the transmission of maritime safety information to mariners, whether in harbour or anywhere at sea in the world. Jointly with IMO, the IHO, in 1977, established a worldwide Navigational Warning Service to promulgate, by radio, important information affecting the safety of navigation of ocean-going and coastal shipping. The service divides the world into 16 NAVAREAS, each with a volunteer area co-ordinator responsible for collecting, analysing and broadcasting information. Each NAVAREA is divided into regions, placed under the authority of national co-ordinators.

The IHO is at present working closely with IMO, the World Meteorological Office (WMO) and the International Maritime Satellite Organization (INMARSAT) in connection with the details of the two systems - SafetyNET and NAVTEX - which are now being introduced to broadcast maritime safety information in the Global Maritime Distress and Safety System (GMDSS). The Chairman of the IHO Commission on Promulgation of Radio Navigational Warnings was tasked, in July 1992, with exploring the possibility of setting up an interim service to provide basic navigational warning coverage in those areas in which broadcasts via SafetyNET are not yet possible.

As was mentioned earlier, even the new INT and new national charts are all too often based on very old data, totally inadequate to ensure the safe navigation of today's vessels, which are very much larger and of much deeper draught than when the surveys were carried out. As long as ships remained at fairly constant draught and marine trade kept to its traditional routes, the data built up by successive generations of surveyors and navigators was reasonably adequate. Within the last 35 years however, there have been dramatic changes: the closure of the Suez Canal in 1956 led to the draughts of VLCCs more than doubling, from 38 to 80 ft; the introduction of very deep-diving nuclear submarines diverted much surveying effort from traditional surveying areas around the world, in order to provide the new data which these vessels required; the ability to extract hydrocarbons at ever-increasing depths and distances offshore placed a new burden on hydrographers and led to the formation of highly-skilled commercial surveying companies to collect the data which over-stretched and under-funded national offices could not provide; and finally the many countries colonized by mainly European powers in the 19th century were left with no hydrographic capability when they obtained independent status; having always relied on their Imperial power to undertake the surveys needed, their governments had little or no understanding of the requirements.

Although the UN Law of the Sea Convention has not yet entered into force, many of its aspects have already been adopted. Many countries are now extracting, or looking for, hydrocarbons and minerals and are developing fishing industries within their Exclusive Economic Zones. A United Nations group of experts in December 1977 stated that: *'Those responsible at the highest level of government should recognize that, in the marine environment, there can be no exploitation of resources without exploration and there can be no exploration without hydrography'*.

Unfortunately, of the more than 120 maritime states, only 57 yet belong to the IHO - although, encouragingly, 9 more have applied to join within the last 18 months and are either awaiting approval of the necessary two-third majority of Member States or have to deposit their Instrument of Accession to the Convention on the IHO. In order to improve the situation, the thirteenth and fourteenth conferences approved the expenditure of quite significant funds to pay for experts to visit any maritime state which requested assistance to form or expand its own hydrographic capability. Obviously, the IHO cannot force its advice on any country, but every opportunity has been taken by the Bureau to encourage such requests to be made to it.

Experience over the last five years has shown that, whilst much enthusiasm and support were given during the visit of the IHO expert, all too often this momentum was lost once he had left and made his report, which remained in the 'Too Difficult' in-tray. Hydrography is not likely to attract support - or votes - when compared with projects such as building hospitals, houses, schools, roads, etc.; and a hydrographic project seldom attracts sufficient priority for funding by UNDP, the World Bank or bilateral aid from a donor country. It is hoped that support may soon be given to the establishment of regional hydrographic offices, each with a permanent regional hydrographic adviser and, eventually, with a capability to maintain the specialist hydrographic equipment (such as tide gauges, echo-sounders, current meters, etc.) for countries in the region, in order to avoid the expense and time wasted in returning the equipment to a far-distant manufacturer. In order to avoid duplication of aid projects, a joint Technical Assistance Co-ordination

Committee has been formed with the International Federation of Surveyors (FIG) to build up a databank of information about technical assistance projects involving hydrography and oceanography. To be effective, this needs to be expanded to include the IOC, IMO and other agencies.

Perhaps one of the most successful achievements of the Bureau in recent years has been in the dissemination of information. Four different types of publications are produced for free distribution to IHO Member States and for sale to anybody interested. Twenty-seven such publications were distributed in 1991. Amongst the more important ones are: the *Periodical Publications* which include the twice yearly *IH Review*, available in March and October, each with some 12 technical articles; the monthly *IH Bulletin*; and the annual *IHO Year Book and Catalogue of IHO Publications*.

Miscellaneous Publications, apart from those already mentioned, include: MP-005 *Standards of Competence for Hydrographic Surveyors*; MP-006 *Reference Texts and Journals for Hydrographic Surveyors*; MP-009 *Catalogue of Member States' Chart Agents*; MP-011 *Catalogue of INT Charts at Small, Medium and Large Scales*. *Special Publications*, which include SP-32 *Hydrographic Dictionary*; SP-39 *Precise Positioning Systems - including satellite systems and evaluation reports by users (as opposed to manufacturers' claims)*; SP-47 *Lists of Training Courses Available for Hydrographic Surveyors*; SP-50 *Catalogue of Tidal Stations' Constituents*; SP-55 *Status of Hydrographic Surveying and Nautical Charting Worldwide*, with its Appendix I dealing only with Antarctica. *Bathymetric Publications* which include BP-0008 *Gazetteer of Geographical Names and Standardization of Undersea Feature Names*.

I hope that I have given the correct impression that the IHO, with its small headquarters staff in the Bureau, is both alive and active. For comparatively small national annual contributions (the largest amount paid is around £40 000) and with a remarkably small Bureau staff, a great deal has been achieved. This is largely due to an almost complete lack of political involvement and the most enthusiastic support and co-operation of all Member States. Much has been achieved but much remains to be done. However I am very confident that the IHO has a healthy future.

References

- MOITORET, Captain Victor A. (1971): *Fifty Years of Progress, 1921 to 1971*, IHB, Monaco.
- RITCHIE, Rear Admiral G.S. (1967): Great Britain's contribution to hydrography during the nineteenth century. *Journal of Navigation*, Vol. 20, No. 1.
- RITCHIE, Rear Admiral G.S. (1983): The future of hydrography. *Interdisciplinary Science Review*, 8, No. 4, pp. 345-357.
- RITCHIE, Rear Admiral G.S. (1992): *No Day Too Long - An Hydrographer's Tale*. The Pentland Press Ltd.
- HASLAM, Rear Admiral D.W. (1977): Hydrographic Services - basic charting vital to all sea users. *Marine Policy*, I, No. 1 (Jan. 1977), pp. 3-15.
- HASLAM, Rear Admiral Sir David (1985): The Development of Hydrography in support of the Mercantile Marine. *Royal Society of Arts' Thomas Gray Memorial Lecture*, 8 May 1985.
- IHB Annual Report (1991). Part I - General, IHB, April 1992.