

The Implementation of the WEND Concept: The PRIMAR Experience

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This paper describes the practical lessons learned during the establishment of PRIMAR, the first fully operational Regional ENC Coordinating Centre (RENC) under the IHO's Worldwide Electronic Navigational Chart Data Base (WEND) concept. It is hoped that these experiences can help other RENCs when they are established, Hydrographic Offices in their production of Electronic Navigational Charts (ENC), and in the further development of the WEND concept.

The Origins of PRIMAR

One of the fundamental objectives of the International Hydrographic Organisation (IHO) is to bring about 'the greatest possible uniformity in nautical charts and documents', and this is accomplished by the creation and maintenance of standards. All Hydrographic Offices (HO) will be familiar with the INT Standards that give guidance to the producers of paper charts and publications, such as M-4¹ and the associated charts INT 1, 2 and 3². HO's will also know that these standards are important for the chart user, since they ensure that data and information are presented in a standard way, regardless of the origin of the chart. In the transition from a paper to a digital world, the number of standards and regulations has increased and the picture has become more complex and broader-based. There are now more international bodies involved, such as the International Maritime Organisation (IMO) and the International Electrotechnical Commission (IEC). In spite of this, the underlying responsibilities of the HO's have not changed, even though they have new standards controlling their ENC data production – S57 and its associated Product Specification, and S52. HO's must still deliver and maintain their national data sets and they must accept ownership and responsibility for the data they produce. IHO members realised that a new system would be needed to control the production and distribution of ENC data to meet the needs of international shipping. It was from this initiative that the WEND concept was agreed in 1994 and this was described in IHO Circular Letters³. Essentially, the objective is to achieve a com-

¹ M-4: Chart Specifications of the IHO for International (INT) charts

² Chart INT 1: Symbols, Abbreviations, Terms used on Charts
Chart INT 2: Borders, Graduations, Grids and Linear Scales
Chart INT 3: Use of Symbols and Abbreviation

³ IHB Circular Letter 27/1994

mon, standardised, up-to-date, worldwide set of ENC's, comprising national data sets, integrated and distributed through regional centres operating on behalf of HO's in each region. This means working towards common standards in the production, distribution, exchange and provision of ENC related services.

In Europe the North Sea Hydrographic Commission (NSHC) realised the importance of the WEND concept and recognised that the distribution of the ENC product was a separate issue from that of database management. Accordingly, and with the consent of all NSHC members, Norway and the United Kingdom agreed in 1996 to form and operate a RENC for Europe. In September 1996, ten Cooperating Hydrographic Offices (CHO) signed a multinational Memorandum of Understanding known as the Cooperation Arrangement (CoA). These HO's agree to use the RENC as their common instrument for the provision of an integrated, consistent, uniform ENC service to be delivered through a wide network of distributors. The RENC operational responsibilities, provision of staff, and direct operating costs are borne by the United Kingdom and Norway. The details of this arrangement are set out in a Memorandum of Understanding signed by the two parties in 1999. The European RENC operates and provides its ENC Service under the PRIMAR brand name.

Principles Underlying the Operation of PRIMAR

Whilst the originators of the WEND concept held the view that a number of RENC's would be required, with data being transferred between them and then to the end-user, there was no guidance on how each group of HO's – each RENC - should be structured and governed. Additionally there was no detailed indication as to how RENC's should interact and what type of service they must provide to meet the needs of the end-user.

In Europe, the ten CHO's have identified the following critical responsibilities for the European RENC:

- To act on behalf of the cooperating national Hydrographic Offices as their common instrument
- To acquire, quality assure and assemble their national official vector data into a consistent, uniform ENC service
- To protect and secure the commercial interests of HO's when providing the ENC service
- To establish standard procedures and approaches with industry for providing and distributing ENC's
- To make the Service widely available in order to contribute to the safety of navigation, the protection of the environment and the effective operation of maritime activities
- The ENC's distributed by PRIMAR must be the official data provided by the appropriate national hydrographic authority, and must be fully compliant with IHO S57 and its ENC Product Specification, and meet IMO standards under Chapter V/20 of the SOLAS regulations. The ENC's may then be used legally to navigate any ship, including those subject to the IMO SOLAS Convention, when used within a type-approved ECDIS (Electronic Chart Display and Information System)
- The Service must be made available via approved distributors worldwide
- Data integrity must be assured between producing HO and PRIMAR, and between PRIMAR and the ECDIS user
- The Service must be cost and operationally efficient and be perceived as providing high quality in the market
- The Service must be made available in a way that creates maximum competition in the market and provides the best return for the taxpayers in each nation
- To work with other RENC's and individual Hydrographic Offices to provide optimum availability of ENC's worldwide

PRIMAR Development and Functionality

It is never easy to be the first to carry out some task or endeavour: setting-up the first RENC has been no exception. The PRIMAR staff have been breaking new ground every day and an enormous amount of effort was needed to ensure that the Official Service was established, as planned, by the end of 1999. Some of the major accomplishments have been:

- *Data Management.* Many HOs had been producing and quality controlling their own ENC data for some time. When PRIMAR began to receive data from HOs, it was quickly realised that in spite of some commonality of production systems and validation tools, there were many 'flavours' of ENC being produced, partly as a result of differing interpretations of the complex S57 Standard. It was also realised that there were wide variations in the type and number of checks being performed by the validation tools. PRIMAR has striven to achieve higher quality and greater consistency, and has taken the lead in the work needed to define a comprehensive validation checklist that can be adopted and maintained as an International Standard by the IHO
- *Security System.* The WEND Principles indicate that data should carry digital signatures and that the mariner should be protected against 'falsified products'. The PRIMAR security system meets these requirements in full and does so using international standards and protocols and by building on the operational experience from the UKHO's ARCS (Admiralty Raster Chart Service) and the ECHO (European Chart Hub Operations) Project⁴. The system provides users with the ability to confirm data origin and authentication, together with piracy protection and selective access. The specifications of this Security System are being made publicly available and it is hoped that it will receive IHO approval as the Standard to be used for the transmission of ENC data⁵. This move is strongly supported by ECDIS manufacturers who have no wish to implement multiple systems in their equipment
- *PRIMAR Working Groups.* PRIMAR believes that it is very important to consult and work with its ten CHOs on matters of mutual interest and importance. It has therefore created a *Technical Experts Working Group* and a *Marketing Working Group* to enable specific policies and topics to be discussed and developed:
 - *Marketing Working Group.* In addition to standard marketing topics such as pricing and distribution, this group has recently been discussing issues that are fundamental to all HOs and RENCs. Specifically, these are the control of copyright on ENC data and the licensing of companies that wish to use the S57 data within non-ENC applications. These issues affect both the income and the liability of HOs.
 - *The Technical Experts Working Group.* This group addresses issues of practical significance for HOs producing and maintaining ENC datasets. The Group is addressing important issues such as the effects of the introduction of Edition 3.1 of S-57; edge matching of data; the handling of Notes; Warnings and Preliminary and Temporary Notices to Mariners; the synchronisation of ENC updates with other products; data errors; and time variable data.

It is also recognised that some HOs wishing to supply their data to PRIMAR for validation and distribution may not wish to become a member of the RENC. This situation does not present a problem, since PRIMAR would be very happy to sign a bilateral arrangement with a HO. The onus is on PRIMAR to provide the level of service, support and financial return expected by the HO. Such bilaterals may be seen as interim arrangements to be used until such time as the HOs concerned are able to join RENCs in their own regions: RENC to RENC data exchanges will then be established in accordance with the WEND Principles. This would provide HOs with a significant outlet for their ENCs into the global market.

PRIMAR is also interested in receiving information about official ENC coverage from HOs worldwide to inform the market and users about the global build up of ENC coverage. Information will be made available, for example on the Internet, and should be perceived as an active tool for marketing their ENCs.

PRIMAR has always been conscious that it must in no way be in breach of any anti-competitive law or policy. Its role within the WEND framework is to accept data from HOs, to validate the data, to create an integrated database, and then to make the data available as widely as possible using a network of authorised distributors, acting in effect as a sophisticated data warehouse. PRIMAR does not buy data from its cooperating Hydrographic Offices, but is rather the last phase in their ENC production process. The CHOs receive a financial return for their ENC data in the form of royalties on sales achieved, in accordance with the CoA. PRIMAR's aim is to cover its operational costs and to keep these costs to a minimum. Once a

⁴ Part of the European Commission's Transport Telematics Applications Programme

⁵ IHB Circular Letter 38/2000

financially viable operation and cost recovery is achieved, the intention is to disperse any operational surpluses of revenue by adjustments to the CHO royalty levels and/or to prices to distributors.

Current Status of the PRIMAR Service

All of the HOs cooperating in the European RENC are producing ENC's, but not all can produce updates, and PRIMAR is undertaking this task on their behalf as an interim measure. PRIMAR has built up the infrastructure and has, since October 1999, delivered the PRIMAR Official ENC Service by means of:

- CD-ROM distribution comprising base cell CDs and a cumulative weekly update CD
- On-line distribution of the PRIMAR Catalogue, ENC base cells and updates, and security permits to access the ENC information

The ENC services meet all the requirements and principles described in previous paragraphs.

Currently, 31 distributors have been appointed worldwide on a non-exclusive basis and more are in the process of signing up. The distributors include traditional chart agents, ECDIS and ECS manufacturers, marine electronics suppliers and Hydrographic Offices.

PRIMAR is also in close co-operation with ECDIS manufacturers to provide detailed information and assistance in their development to support all aspects of the PRIMAR service. Many well-established manufacturers and smaller marine electronics companies, worldwide have completed their development or are in the process of developing their systems to use the ENC services provided by PRIMAR. There are currently seven ECDIS/ECS systems available that are compatible with the PRIMAR Service, and of these three are fully Type-Approved. A further eight OEMs (Original Equipment Manufacturers) are in the process of implementing the PRIMAR Security System in their ECDIS/ECS.

What Lessons Have Been Learned?

Hindsight is a wonderful gift. Many hard lessons have been learned in the establishment of the European RENC and the development of the PRIMAR Service. In a number of respects, if starting again, many things would be done differently and in some areas, work is in hand to effect such changes: this is seen as a process of evolution. The following sections describe how things might have been done differently in six important areas of work.

Lesson 1 – The RENC Structure

It has been realised for some time that the existing Cooperation Arrangement and the MoU between Norway and the UK need to be replaced by more robust and formal arrangements that will enable individual CHOs to play a greater part in the operation of PRIMAR and contribute more equitably to its running costs. Accordingly, work is now well advanced on a revision of the CoA and in drafting the framework documents necessary to establish PRIMAR as a government-owned limited company under Norwegian law.

Lesson 2 - Range of Activities

Analysis of PRIMAR's activities identifies a whole group relating to technical data standards. These include:

- Data standards (detailed implementation of S57 and the Product Specification in order to ensure consistent, uniform ENC's)
- Change control for standards (so as to ensure safe transition of ECDIS operation)
- Co-ordination of production (so as to facilitate safe ECDIS operation across all geographical areas)
- Production standards (advising HOs and assisting in update production)
- Validation of ENC's against agreed data standards (ongoing)
- Certification that ENC's (base data and updates) meet the agreed data standards (ongoing)

This work has been completed in order to establish the service but it is now recognised that these activities, with the exception of the ongoing processes, are not really appropriate to a RENC. They should rather have been undertaken on a broader international basis on behalf of the IHO as a whole. This could have been a WEND sub-committee or even an individual HO mandated by the IHO. This would have avoid-

ed the still present risk of RENCs developing differing detailed implementation standards and procedures. Overall harmonisation is vital to facilitate the effective and efficient use of ECDIS. In practice, the work has been done by PRIMAR and this is a penalty of being the first RENC. This has made the PRIMAR organisation larger and more costly than it should be ideally. The message for other emerging RENCs is to save time and effort by using the technical standards established by PRIMAR. This would have the further benefit of achieving the greatest possible international standardisation, a principal IHO objective. Indeed, it is possible that the IHO should adopt these standards and charge another body with their future maintenance and further development.

Lesson 3 – ENC Service Standards

Another major task for PRIMAR in developing and establishing a commercial ENC service has been to develop, in collaboration with users and system manufacturers, appropriate service standards, particularly:

- Service standard for ENC distribution using CD-ROM
- Service standard for ENC distribution using Internet based standards for on-line global distribution
- Security standard for the protection and authentication of ENC

The requirements for these service standards have been driven by different HO views on how to protect their ENC products, and by different views of ECDIS/ECS system manufacturers/end-users on how an ENC service shall be provided using both on-line and CD-ROM. It has been a long process to resolve these differing views and to achieve a standardised approach that meets everyone's requirements. The discussions with the OEMs have been very interesting with a good exchange of views, particularly about the technical standards used for the security system, and the on-line service for ENC distribution. PRIMAR is pleased with the wide acknowledgement from the industry in supporting the service standards developed by PRIMAR. Their immediate and crucial feedback is that the IHO must take a position on these issues and adopt relevant IHO standards. As with the technical data standards, adoption of IHO service standards would serve the interests of international standardisation and save time and effort for other RENCs.

Lesson 4 - Data Coverage

In 1994, the WEND Special Committee concluded that 'there is an urgent need for worldwide ENC coverage'. The situation six years later is far from satisfactory and shipping companies, when they are asked about their plans to install ECDIS, always highlight the lack of coverage as a major problem. Part of the delay in creating data was the continuing evolution of the S57 Standard that meant that ENC production system developers were always trying to hit a moving target. The 'freezing' of the Standard in 1996 enabled serious production work to commence but, because of the complexity of the production, verification and validation processes, and the ever present need to remember liability issues, progress has been very slow. At present PRIMAR has over 600 ENCs and 600 updates provided by its CHOs available in its Service. Additionally it is known that over 1500 ENCs have been produced by HOs that do not yet have links with PRIMAR (although many of these ENCs are still in the trial phase). From the user perspective, this is not simply a matter of how many cells are available, but whether they provide sensible, usable coverage without gaps. The ultimate aim is safety of navigation, and this cannot be achieved if the mariner has to swap continuously between paper and digital charts during a voyage. Finding ways to increase coverage is a major challenge for HOs and for PRIMAR. The lessons learned include the need for greater stability of standards, better understanding of requirements and improved, practical level exchanges of experience between HOs. PRIMAR has also started to prepare information to show global ENC coverage in cooperation with the producing HOs.

Lesson 5 - National Responsibility

At the heart of the WEND concept lies the principle that HOs accept full responsibility for the quality of the data that they issue. Each HO must, therefore, have in place procedures and systems that enable them to verify and validate their datasets to ensure that they meet the appropriate international specifications for content and quality. Verification is the process of ensuring the completeness and accuracy of the content of the dataset e.g. depths, positions, navigational aids; validation is the process of ensuring the conformance of the data with the ENC Product Specification of S57. Even the largest HOs have found these tasks to be a major challenge, but they cannot be avoided even if the basic data capture – the digitising – has been performed by another body e.g. under contract. This is because the liability for the data will lie with the issuing HO, not with the organisation that produced it. Whilst each HO may have its own

method of carrying out the verification – and there is no 'right' way – the validation process is well suited to partial automation and several validation tools are available commercially. However, it requires experienced and skilled personnel to analyse and interpret the results of that validation because of the complex and ambiguous nature of the S57 Standard. We now have a clearer view of the responsibilities of both RENCs and cooperating HOs, and of their inter-relationships.

Lesson 6 - Issues Around Production

One of the original WEND concepts was that the RENCs should be able to produce ENC data on behalf of HOs, subject of course to the need for the HO to carry out verification and accept 'ownership' of the data. It was also necessary for a satisfactory financial arrangement to be agreed between the HO and the RENC. Although PRIMAR is currently completing the production of a small number of cells on behalf of certain European HOs, it is not planning to undertake any more production work itself; such work is no longer seen as a core responsibility of a RENC. This mirrors the policy in some major HOs, who are now choosing to out-source their data capture to commercial firms.

So what are the options available for a HO wishing to make ENC data available for its area of responsibility? Firstly, the HO may consider that the cost and complexities of installing a full ENC production system are unacceptable. This would certainly be the case where only small numbers of ENC data are required. It would then be far more sensible for the HO to contract out the data capture and to do its own verification. Such verification is necessary in order for HOs to fulfil their governmental responsibilities. The HO would then need only to purchase an ENC updating system, capable of producing updates, although new editions would need to be produced under contract: this is a far more cost-effective option. The HO would carry out data validation using one or more of the commercially available validation tools, but it would also rely on the expertise of the RENC to ensure total data integration and validation, in line with WEND principles. HOs must be able to use the services that industry can provide but they must not lose sight of their responsibilities as national HOs, particularly with regard to data quality, standards and liability.

It is certain that HOs will need help and advice when entering the ENC world, and it is equally certain that this help must come from within the international hydrographic community; another WEND principle. The first steps in this direction have been taken by the Mediterranean and Black Seas Hydrographic Commission, which has formed a Working Group with the specific objective of helping its members to develop ENC coverage for the region. PRIMAR is a member of this Working Group and is already active in providing advice and assistance.

Lesson 7 – The Concept of a 'Virtual' RENC

The hard-won experience over the last two years has demonstrated that there is a definite need for a centralised validation facility in the early years of a RENC's operation. This is largely because of the complexity of the S-57 Standard, the multiplicity of production and validation software in use, and the overriding necessity to create a uniform, integrated database. It is suggested, therefore, that the true 'Virtual' RENC is an evolutionary stage, building on the standards and experience of a centralised team. In this respect, PRIMAR is planning to migrate from a centralised to a looser, virtual structure. A major new development aims to enhance CHO control, involvement and ownership of their data in the PRIMAR Service. The objective is to move from a centralised to a distributed database service, making use of readily available Virtual Private Network (VPN) technology. The data will still reside on a server in Stavanger but CHOs will be able to access their ENC data securely and manage and manipulate them as easily as with data held in their own premises. The VPN will also facilitate more efficient distributor access to the Service.

Broader Issues Relating to the Implementation of the WEND Concept

The WEND concept envisaged the formation of RENCs as soon as ENC data became available within regions. This has not happened, and there now exist national ENC data sets that are being marketed or made available nationally rather than through a RENC. This raises several questions that the WEND Committee must address, including:

- Do IHO Member States still regard the WEND Principles as valid? The experience in Europe seems to confirm the need for cooperation and collaboration between HOs in order to ensure both a consistent ENC product and a consistent ENC service. These greatly facilitate the use of ECDIS, and are, there

fore, seen as crucial contributions to the safety of navigation

- Do HOs accept the need for detailed IHO standards for the implementation of ENC production, verification and validation? Are they prepared to accept the de facto standards developed by PRIMAR?
- Do HOs have difficulty in forming RENCs? HOs may lack a clear understanding of the role of RENCs: it is hoped that this paper helps in this respect. They may have difficulties in securing the necessary, very substantial, finances and in achieving the necessary agreements with other HOs in the region
- How many RENCs should there be? The original discussions seemed to suggest five or six. Is this still valid? What alternatives are there?
- In the absence of RENCs, how can the general principles behind the WEND concept be implemented? Specifically, the PRIMAR experience begs the question about how ECDIS users can obtain consistent, compatible ENCs worldwide. The key issues are data coverage, consistency of data, consistency of service, and the availability of a worldwide service from a choice of sources

It is believed that many of the answers to these questions are to be found within the WEND Principles that stress the need for uniformity, adherence to standards and the supply of a consistent dataset to the end-user. This consistency, particularly with regard to quality control and updating mechanisms, is being achieved now by PRIMAR as part of its focus on quality, data integrity and safety.

Mention has already been made of the detailed technical standards developed by PRIMAR which it is suggested should become IHO standards. This would ease the tasks of other RENCs. Another way in which PRIMAR might help is to make wider dissemination of its experiences in order to provide more specific advice to HOs. PRIMAR could also provide an interim distribution system for HOs ENCs until such time as RENCs are established in their regions. This raises the question of whether PRIMAR should provide the same level of support to individual HOs as it does for members of the European RENC, particularly with respect to data validation and the creation of a uniform dataset.

Conclusion

Whilst all HOs are familiar with the standards and responsibilities that relate to paper charts, the world of digital data has brought a new set of rules. The WEND Principles must lie at the heart of all operations relating to the production and supply of ENC data, and HOs must not forget that they have a responsibility to provide a maintained dataset that conforms to international standards. PRIMAR's experience as the first RENC, together with the fact that it has established an Official ENC Service, means that it is ideally placed to help other HOs in the further implementation of the WEND concept. However, there remain some fundamental questions concerning this concept and these must be addressed. In doing this, we must all remember the requirements, especially the safety interests, of the users of our products and services.

Biography

Philip Wainwright is a Geography Graduate from University College, Swansea in 1967 and has a Post-Graduate Diploma in Cartography from Swansea in 1976. He was Surveyor and Base Commander with British Antarctic Survey between 1967 and 1972 and was working in Greenland with the Arctic Institute of North America in 1972-73. Mr Wainwright joined the United Kingdom Hydrographic Office in 1976. A varied career in the UKHO covering most aspects of the work of the Office eventually becoming Head of the Chart Branches producing charts for Africa, the Middle East, Indian Ocean and Far East. He moved to Stavanger in 1998 as the senior UKHO staff member in the PRIMAR organisation.

David McPherson graduated in Geography from the University of Bristol in 1967. He joined the United Kingdom Hydrographic Office in 1967, serving in a variety of posts covering most aspects of the work of the Office. He is currently Director of the PRIMAR Programme.