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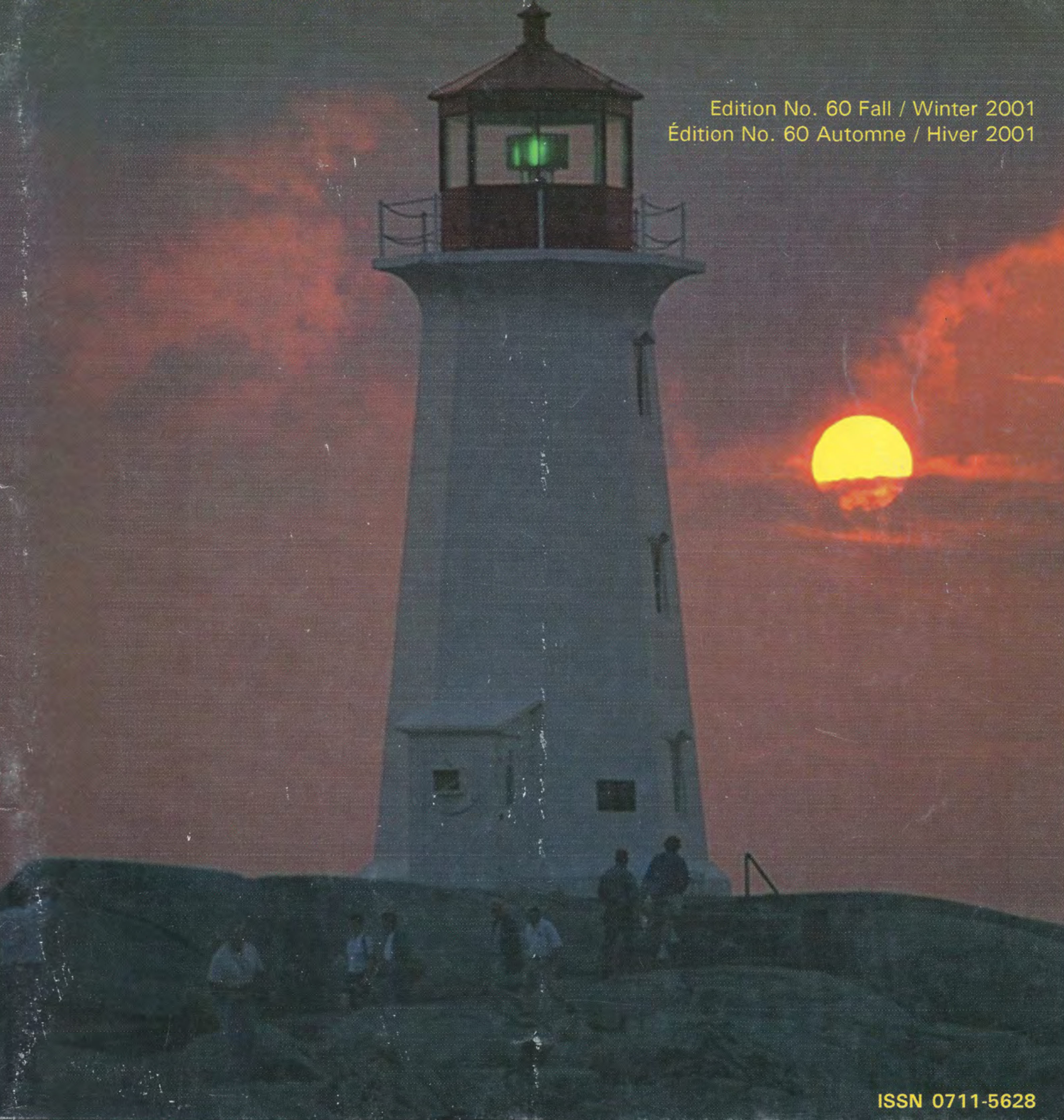

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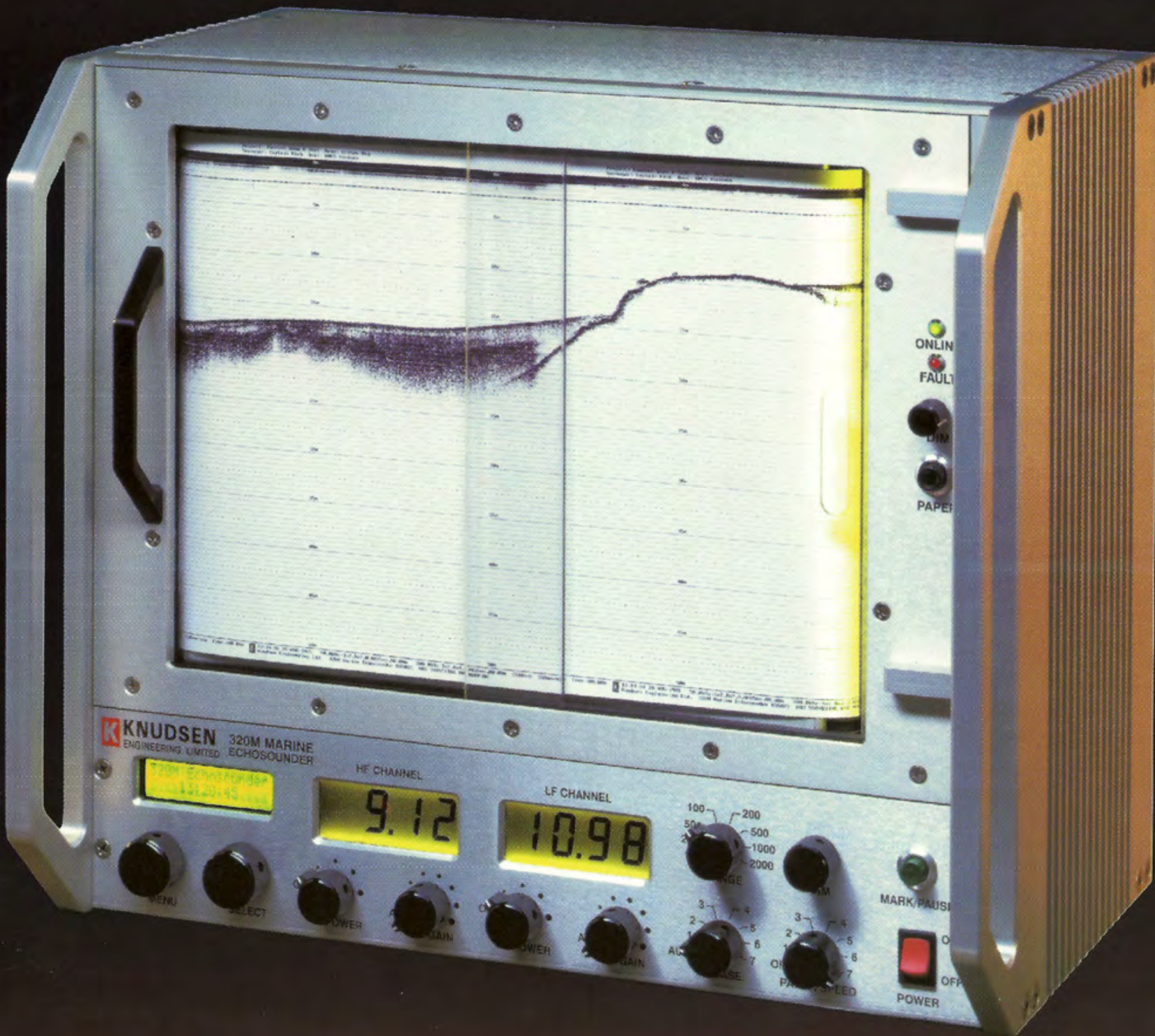
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Every edition also receives much assistance from the Central Branch Lighthouse Committee and other CHA volunteers.

Chaque édition est réalisée grâce à la collaboration du comité Lighthouse de la section Centrale et d'autres volontaires de l'ACH.

Views expressed in articles appearing in this publication are those of the authors and not necessarily those of the Canadian Hydrographic Association.

Les opinions exprimées dans les articles de cette revue ne sont pas nécessairement celles de l'Association canadienne d'hydrographie.

LIGHTHOUSE is published twice yearly by the Canadian Hydrographic Association and is distributed free to its members. A membership application form can be found on page 6 of this issue. Yearly subscription rates for non-members are $20 for Canadian residents and $25 for non-residents. Please make cheque or money order payable in Canadian funds to the Canadian Hydrographic Association.

La revue LIGHTHOUSE est publiée deux fois par année par l'Association canadienne d'hydrographie et distribuée gratuitement à ses membres. Une formule d'adhésion se trouve en page 6 de cette édition. Les tarifs annuels d'abonnement pour les non-membres sont de 20$ au Canada et de 25$ hors Canada, payable par chèque ou mandat-poste en devis-es canadiennes à l'ordre de l'Association canadienne d'hydrographie.

Back issues/Éditions antériures
Back issues of *LIGHTHOUSE*, Editions 24 through 59, are available at a price of $10 per copy. Please write to the Editors.

Les éditions 24 à 59 de la revue LIGHTHOUSE sont disponibles au coût de 10$ par copie en écrivant aux rédacteurs en chef.

Advertising Rates/Tarifs publicitaires
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Pour les tarifs et les spécifications publicitaires, se référer à la page 56 de cette édition.

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Message from the National President
Mot du Président national

The Science of Hydrography has changed radically in the last few years. We have moved into the digital world because of low-cost computing capability combined with multibeam echosounders. Use of a lead line has diminished and single-beam echosounder surveys are being replaced by multibeam surveys. With all this digital data to be processed, the skillset of the Hydrographer has to be constantly upgraded. CHA uses our journal, *LIGHTHOUSE*, as one means of education. Many of our readers are aware of CHA's involvement with the Canadian International Development Agency (CIDA) in the CAT A and CAT B training courses in Malaysia. CHA Central Branch has videotapes available for rental for Hydrographic Training.

Recently, I received information about a new book by Dr. Sylvia Earle, being published by National Geographic Society. One comment stood out in the literature. We have only *seen* (my italics) 5% of the bottom of the oceans once. As we continue to explore the ocean bottom with multibeam echsounders we are seeing the bottom acoustically, and adding to the wealth of information about our planet. Who knows what wonders await us?

Ken McMillan

Editors' Note
Note des redacteurs

You will notice that this edition of *LIGHTHOUSE*, as well as the previous one, has a new look. This new look will continue with every edition. We are very pleased with the positive comments received regarding our decision to feature a different lighthouse on the cover of each edition of the journal. However, the old saying "you can't judge a book by its cover" still applies. Your comments received with respect to the content of our journal have also been positive. Thanks to all of you who took the time to contact us.

It is our intent to continue with the traditional format and balanced content of technical and non-technical articles. We will, however, introduce changes which we believe will enhance the quality of the journal and reflect the interest of CHA members, subscribers, advertisers and others who receive and read this journal.

This edition of *LIGHTHOUSE* includes a short article under the heading of "Soundings" which we hope will be a regular feature of the journal. This article by a retired hydrographer is included, hopefully to stimulate thought, discussion and interest within the hydrographic community. It is called "Soundings" in recognition of a newsletter with that name which was published by the Canadian Hydrographic Service many years ago. We invite your comments on the content or suitability of this sort of article.

We are pleased to announce that *LIGHTHOUSE* will have a prominent role during the 2002 Canadian Hydrographic Conference. This conference will take place in Toronto, Ontario, May 28 to 31, 2002. Planning for the conference is in the advanced stages and all indicators suggest that it will be one of the largest and best in Canadian Hydrographic Conference history. We are delighted that *LIGHTHOUSE* will be able to provide conference exhibitors and sponsors with a special rate to advertise in the Spring 2002 "special" conference edition. A copy of our journal, containing the official program and other information of interest and required by conference attendees, will be provided to all as part of the registration package.

It may be of interest to many of you to note that approximately 900 copies of *LIGHTHOUSE*, edition 59, were circulated to members, subscribers, advertisers and potential advertisers as well as others within the hydrographic and marine community. We are very pleased with our rate of growth and thank you for your support.

Earl Brown and Paola Travaglini

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Cover

Photo courtesy of Mike Crutchlow, CHA

PEGGY'S COVE LIGHTHOUSE,
Nova Scotia

Peggy's Cove lighthouse is probably the most photographed lighthouse in the world. It is situated in the small village of Peggy's Cove, Nova Scotia, population 50.

The original wooden structure was built in 1868 approximately 50 feet from the present hexagonal concrete tower that stands 50 feet above the 415 million-year-old Devonian granite. Completed in 1915, Peggy's Cove lighthouse is now a world-famous tourist attraction and the only lighthouse/post office in North America. Seven lightkeepers manned this site until 1958 when the lighthouse became unwatched.

Throughout its history the light has under-gone a number of changes. It originally started as a red light using a catoptric reflector (round silver plated mirror) lighted by a kerosene oil lamp. The light changed to a white dioptric lens (series of glass prisms) when the new structure was built. There were more changes to the character and colour over the years until 1979 when the present green light was installed.

Thanks to The Nova Scotia Lighthouse Preservation Society for much of this information.

For more information about the lighthouse at Peggy's Cove, N.S. please see :
http://WWW.Ednet.NS.Ca/educ/heritage/nslps/PEGGYS.htm

CHA l'ACH

The Canadian Hydrographic Association (CHA) is a non-profit, scientific and technical group of more than 500 members with the objectives of:

- advancing the development of hydrography, marine cartography and associated activities in Canada;
- furthering the knowledge and professional development of its members;
- enhancing and demonstrating the public need for hydrography;
- assisting in the development of hydrographic sciences in developing countries.

It is the only national hydrographic organization in Canada. It embraces the disciplines of:

- hydrographic surveying;
- marine cartography;
- marine geodesy;
- offshore exploration;
- tidal and tidal current studies.

The Canadian Hydrographic Association is formally affiliated with the Canadian Institute of Geomatics. It is informally associated with The Hydrographic Society.

What the CHA Can Do For You:

- advance your knowledge of hydrography, cartography and associated disciplines, and keep you abreast of the latest development in these disciplines;
- enable you to develop and maintain contacts with others involved with hydrography, nationally and internationally.

These benefits are provided through the publication of *LIGHTHOUSE* (one of only three journals in the world devoted exclusively to hydrography) and through the sponsorship of seminars, colloquiums, training programs, national conferences, and Branch and National meetings.

LIGHTHOUSE

The journal of the Canadian Hydrographic Association, *LIGHTHOUSE*, is published twice yearly and distributed free to its members. Timely scientific, technical and non-technical papers and articles appear in the journal, with authors from national and international academia, industry and government. Present circulation of Lighthouse is approximately 900.

Membership

Membership is open to all hydrographers, those working in associated disciplines, and those interested in hydrography and marine cartography.

Branch & Regional Activities

The Canadian Hydrographic Association has five (5) branches located across Canada. National headquarters is located in Ottawa.

L'Association canadienne d'hydrographie (ACH) est un organisme sans but lucratif réunissant un groupe scientifique et technique de plus de 500 membres ayant des objectifs communs, comme:

- faire progresser le développement de l'hydrographie, de la cartographie marine et de leurs sphères d'activités au Canada
- permettre les échanges d'idées et le développement professionel de ses membres
- rehausser et démontrer l'importance de l'hydrographie auprès de public
- assister au développement des sciences de l'hydrographie dans les pays en voie de développement

Au Canada, l'Association est la seule organisation hydrographique qui embrasse les disciplines suivantes:

- levé hydrographique
- cartographie marine
- géodésie marine
- exploration extra-côtière
- étude des marées et courants

L'Association canadienne d'hydrographie est affiliée à l'Association canadienne des sciences géomatiques, et non-officiellement liée à The Hydrographic Society.

Ce qu'elle L'ACH peut faire pour vous:

- parfaire vos connaissances de l'hydrographie, de la cartographies et des disciplines connexes, tout en vous tenant au courant des nouvelles techniques et des derniers développements réalisés dans ces domaines;
- établir et maintenir des contacts avec ceux qui oeuvrent en hydrographie, au niveau national et international.

Ces avantages sont transmis par l'entremise de *LIGHTHOUSE* (une des trois revues au monde traitant exclusivement d'hydrographie) et par la tenue de séminaires, de colloques, de programmes de formation et d'assemblées régionales et nationales.

LIGHTHOUSE

La revue de l'Association canadienne d'hydrographie, *LIGHTHOUSE*, est publiée deux fois l'an et distribuée gratuitement aux membres. Des articles scientifiques, techniques et non techniques, provenant du milieu de l'industrie ou du gouvernement autant national qu'international, apparaissent dans cette revue. Le tirage actuel de la revue est d'environ 900 copies.

Comment devenir membre

Le statut de membre est offert aux hydrographes et à tout ceux oeuvrant ou ayant un intérêt dans des disciplines associées à hydrographie ou à la cartographie marine.

Sections et activités régionales

L'Association canadienne d'hydrographie possède cinq (5) sections à travers le Canada. L'administration central se trouve à Ottawa.

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Application for Membership / Formule d'adhésion

I hereby make application for membership in the Canadian Hydrographic Association and if accepted agree to abide by the constitution and by-laws of the association.

Je désire devenir membre de l'Association canadienne d'hydrographie en tant que et si ma demande est acceptée je m'engage à respecter la constitution et les règlements de cette association.

- ☐ Member / membre $30.00
- ☐ Sustaining Member / membre de soutien $150.00
- ☐ International Member / membre international $30.00

Canadian Hydrographic Association • Association canadienne d'hydrographie

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First Steps on the Quality Journey

By Sean Hinds, Project Authority for ISO 9000 Implementation, Canadian Hydrographic Service, and
Tony O'Connor, Dominion Hydrographer, Canadian Hydrographic Service

A Quality Decision

When starting out on a quality initiative it is hard not to ask the basic question of just what do we mean by quality. The word 'quality' has been woven into the hydrographic vocabulary forever but are we able to categorically define what it is? Society has embraced the 'quality' phrase and applies it in everything including automobiles, education and health services. If asked to define it very few would be able to, but most would admit to knowing it when they see it. Often quality is taken for granted but it is most notable when there is an absence of quality.

Even the gurus in the quality field have a spectrum of explanations for the term, with the same two fairly distinct paradigms of quality coming out in each of the definitions.

- The first of these is that quality is a simple matter of producing products or delivering services whose measurable characteristics satisfy a fixed set of specifications.
- The second is independent of measurable characteristics, and defines quality products and services as those that simply satisfy customer expectations for their use and consumption. [Hoyer & Hoyer, 'What is Quality', Quality Progress edition. July 2001, pg. 53]

A most comprehensive definition of quality was expressed by Kaoru Ishikawa in his book *What is Total Quality Control? – The Japanese Way.* In this book he states, 'quality means quality of work, quality of service, quality of information, quality of process, quality of division, quality of people, including workers, engineers, managers and executives, quality of company, quality of objectives.'

Apparently, there is unanimous support for the breadth of these definitions of quality but if one is to take these definitions to heart one places 'quality' on a very high plateau within the organizational mission. Quality cannot be looked upon as a function but rather as a basic value system that permeates the entire organization. The revolution in hydrographic technology and the strain on resources within hydrographic offices puts a huge amount of responsibility for quality at the feet of an organization. In days gone-by risk from poor quality was fairly small as hydrographers had tools that surpassed the capability of the end-user. Not so today as the technology available to the mariner and the high expectations of hydrographic data pushes the envelope for quality to new heights.

Very Large and Ultra Large crude carriers (VLCC, ULCC), product tankers, high-speed commuter vessels, congested waterways, cargoes of dangerous goods and increased cruise-line traffic combined with reduced shipboard crews, create increased risk to marine transportation. GPS, ECDIS, aids reductions, minimal keel clearance, and sailing in marginal weather all threaten to push the data and the products to their limits. As the world moves toward data-sharing and linked data-bases, the threat of poor data increases as the management of the data moves from the hands of the hydrographer, who knows the data limitations, into the hands of the operator, who may assume the data is absolutely accurate.

All of these factors culminate in a question of operational excellence and due diligence by the hydrographic office to take 'quality' out of the risk equation and place it into the overall business management for the organization. The Canadian Hydrographic Service (CHS) is committed to the task of implementing and maintaining a Quality Management System as the benchmark principle and tool in its journey of progressive excellence.

Drivers for Change

Real change is most often driven by crisis, and seldom does crisis arise from a single event but often from a series of events. CHS has experienced a series of events over the past ten years that culminated in the decision to embrace a quality management system.

CHS experienced significant changes in capacity triggered by a 30% reduction in resources as a result of the Canadian federal government workforce adjustment initiative called Program Review. Workforce reduction should ideally be accompanied by a similar reduction in workload but this is seldom the case. CHS found itself in this situation when 30% of our staff departed at a time when normal production requirements were increased by the addition of vector and raster electronic charts to the CHS product line. The majority of the workforce adjustment came at the expense of losing some of the senior staff that took with them a vast amount of intellectual capital and corporate memory.

With the loss of the experienced staff came an influx of less experienced temporary staff. The lack of documentation for the digital production processes resulted in greater reliance on the end-of-line inspection process. With this greater reliance, the Quality Control (QC) step was essentially a 3rd party review of the entire production process. CHS realized that this redundant step was not sustainable or appropriate over the long term.

To compound the loss of resources, CHS was still in the midst of a digital revolution that saw all of CHS production shift from principally manual production to fully digital production. This expansion of digital technology in the workplace upset the traditional production sequences that had been refined over time to deliver a consistent product. A lack of documentation and a lack of long-standing experience with digital production raised the risk of errors and increased reliance on software to deliver quality.

Through all of this digital revolution and increase in product lines, CHS had no formal system for process improvement but instead put a heavier reliance on end-of-line inspection and re-work that focussed on making the product meet specifications. It is an accepted principle in industry that organizations with no system for process improvement activities have 10-30% of wasted effort in their production. This is the factory mentality where re-work is accepted as the norm and aggressive attempts at process improvement are not embraced.

The impact of all these changes and pressures had a compounding effect on the morale and health of the workplace. Job satisfaction, teamwork, communication, feedback, purpose, visibility and recognition are all key elements that work together to produce the right attitude and the right environment (win-win culture). Today's business environment is plagued with a revolving door of deadlines and an endless list of pressures, driven by the need to survive in an increasingly competitive world. In this fast-paced environment it takes a strong commitment to quality and systematic feedback to ensure that the fragile human factors of job satisfaction, communication, and recognition are not overlooked or undervalued.

A Quality Management Solution

Quality and management are not thrown together by chance. Quality and excellence can only be achieved when they are managed in a systematic fashion and embraced throughout the organization. This is clearly supported by the numerous criteria for quality systems that exist in the marketplace. Some of the most recognized definitions of a high performance quality management system are the criteria for the Malcolm Baldrige National Quality Award (United States), the Canada Awards for Excellence, the Deming Prize (Japan) and the ISO 9000 International Standard. All of these models describe the same founding principles of leadership, planning, client/market focus, employee focus, process management, supplier/partnering relationships and performance measurement.

When CHS realized it had to address the quality issue with a Quality System it looked at all of these models. Though the Awards criteria are excellent business models they lacked the necessary documentation for guidance, inspection, and maintenance that CHS felt it needed at the early stage of this journey. On the other-hand, the ISO 9000 Standard had some characteristics CHS found compelling:

- ISO 9000 had a long track record, having been established in 1987 with revisions in 1994 and 2000.
- It defined a logical and comprehensive approach to business processes.
- It emphasized customer satisfaction and continuous improvement that meshed well with the goals of CHS.
- It embodied a formal audit process that would ensure short and long-term maintenance of the Quality System.
- There was an accredited registration process that would aid in maintaining focus and bring best-practice guidance via a Registrar with experience across a wide range of organizations.

CHS wanted to evaluate itself against these internationally recognized criteria for quality management to reassure ourselves we were doing business in the right way while conveying to the world, through the international language of ISO 9000, that we were committed to the goal of oganizational excellence.

The CHS Quality Journey

CHS Senior Management Committee decided to build on the success of its Laurentian Region office (located in the province of Quebec, it is one of five CHS offices), which was Registered to ISO 9002:1994 in 1998. A national Quality Management System initiative was authorized in June 1999 with a target date for ISO 9001 certification in June 2001. Unforeseen initiatives of Alternative Service Delivery, Program Integrity II, and general workload managed to delay organizational readiness and the target for Registration was rolled back to November 2001. Each of the four Regional offices across Canada and CHS Headquarters in the National Capital Region will be certified to the ISO 9001:2000 International Standard. This includes a transition of the Laurentian Region's ISO 9002 Quality System to align itself with the national ISO 9001:2000 Quality System. The scope of the certification will cover all aspects of operations from administration to production to distribution. Internal links, especially those between Headquarters and the Regions, will be reinforced where dependencies are critical to optimizing quality and efficiency. External links to agencies with which CHS has moderate dependencies (and yet limited influence) will be reinforced to the best level possible. These links will be a combination of communication protocols and service standards.

To move this project forward, a cross-regional National Coordination Team was formed that reported to the Dominion Hydrographer and the CHS Senior Management Committee. This national team had one representative from each of the five CHS offices who was responsible for coordinating Regional efforts with the national design. A Quality Council was established in each Region to support the national representative and stimulate local understanding and support for the quality system. A Management Consulting firm, BRI International, was contracted to provide guidance in the interpretation and implementation of the ISO 9000 Standard. BRI worked closely with the National Coordination Team and with CHS employees, who were the main contributors in building the Quality System from the ground up.

It was decided at the outset that this would be a national CHS Quality System and not a collection of five quality systems designed for each of the five CHS Regional offices. This meant that the Quality System would have to accommodate the activities in all CHS offices while remaining flexible so any office could opt out of processes that were not applicable. It was a classic multi-site Quality System that had strength in its breadth and flexibility in its design. Critical to mapping the ISO 9000 Standard onto CHS was presenting the organization as a process model.

It was important to the design of the quality system that the nature of CHS business would not be compromised by the ISO 9000 Standard. To this end, it was necessary to integrate the ISO process model into the CHS process model. The founding process of

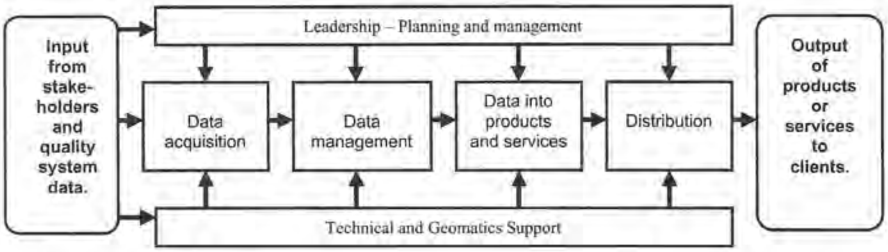

Figure 1. CHS basic process model

ISO 9000 is the simple business model of Plan-Do-Check-Act, which CHS found easy to adopt and drape over CHS operations. The outcome was a Plan-Do-Check-Act model for CHS.

Teamwork

Key to an effective quality system is ownership and usability. The basis for ownership is that all employees need to be involved at one stage or another. Usability comes from the design and the documentation being logical and intuitive for the CHS user. CHS addressed both of these through heavy involvement of teams in the designing of the system and the development of the documentation. It was crucial that the National Coordination Team, responsible for the quality system design, had representation from all CHS offices and worked together to ensure that the Quality System would reflect all of CHS.

Quality Councils were established in each Regional office early in the process to stimulate ideas, generate support and start the ripple effect of ISO 9000 understanding and acceptance. As the Quality System was implemented at each of the sites, the Quality Council members found active roles on writing teams, internal audits teams and performance measurement teams.

Writing teams were assembled and trained in every office for each of the major processes. The writing teams were purposely assembled with varying degrees of expertise to promote learning and development of documentation that would be usable by all staff. At the outset, writing teams were coached by the regional representative on the National Coordination Team and the BRI Quality Specialists. As expertise in documentation evolved, the writing teams turned to supporting themselves; cross-team dynamics took over. This was a critical turning point in the initiative as the ownership factor began to take hold as colleague-to-colleague discussion and collaboration began to take place.

Internal Audit Teams were initiated in each Region during the implementation phase of the project. Training was provided by BRI Consultants rather than an accredited Registrar. The reasoning behind this was to tailor the training for the CHS organization and to evaluate the CHS Internal Audit documentation for completeness and usability. Training of the audit teams took place at each Regional office so that a mock audit could be mounted in familiar surroundings. The Internal Audit Team has become a primary catalyst for encouraging support of the quality system through interviews of work-unit personnel on their procedures and how they fit into the larger system. The Internal Audit function is a key activity for ensuring adherence to the procedures of the Quality System and for helping to identify opportunities for improvement. These audits actually contribute more to the continuous improvement of the Quality Management System than any other one activity, including the Registration Audit. The Registration Audit is significant in terms of having 3rd party certification of the Quality System but the internal auditors are more intimate with and knowledgeable of the organization and its processes. This knowledge means that they probe deeper and stimulate greater discussion on the efficiencies and effectiveness of procedures.

In the later stages of implementation, each CHS office established a Performance Measurement Working Group. These groups gathered input from all levels of the organization to aid in the assembly of a comprehensive Performance Measurement plan for each office. Performance Measurement was relatively new to CHS. It is understood that it will take time, effort and some trials for this new concept to find a synergy with CHS operational philosophy. To nurture and fuel this learning curve it was decided that performance measures would be developed independently at all CHS sites. Just like the writing teams, information exchange was encouraged between Regions so that concepts and best-practice could be adopted. A Quality System procedure for the development of performance measures was documented and included in the Quality Manual as a tool to maintain some consistency in the approach to developing measures based on desired outcomes. This procedure was to be used by all Performance Measurement Working Groups and recorded as a Quality Record as evidence and background on how the Regional measures were established. Each Region had the final say on what measures were to be developed for their workplace as the operational needs, clients and processes differed from Region to Region. A long-term goal of performance measurement is to establish common metrics in Regions to aid in benchmarking and identification of best-practices across all CHS sites.

Once CHS has obtained ISO 9000 Registration, the National Coordination Team will be disbanded and replaced by the Quality System Working Group consisting of the Regional Quality Coordinators from each CHS site. This working group will be active in future enhancements to the Quality Management System as directed by the CHS Senior Management Team or in the spirit of continuous improvement.

The Regional Directors at each of the five CHS offices have assumed the role of Management Representatives for the Quality System. As members of the CHS Senior Management Committee, they are responsible for keeping the Quality System linked to the Goals of the organization and for providing resources for maintenance and continual improvement of the Quality System.

The impact of teamwork and the involvement of many persons from all areas of the organization has been critical to the success of this initiative.

Documentation

One of the starting steps in the design of a quality system is a 'gap assessment'. This 'gap assessment' is an in-depth look at all of the activities within an organization to ascertain what processes are in place and which processes are lacking. During the thorough assessment of CHS it was noted that many of the technical functions of data collection, data management, production and distribution were well entrenched and could be documented 'as is'. The greater gaps were in the less technical areas of the organization that included planning, customer focus and performance measurement. These business processes were based more on the personal management style of the Regional Management Team than on any national guidelines or standards. The result was a range of business processes being used across the Regional offices.

One of the principles of the implementation plan was to use existing processes, unchanged, to develop the necessary documentation. This philosophy was contrary to the idea of improving processes before documentation. The objective of documenting processes 'as is' was to move all documentation to completion in a timely fashion, learn from the process, and begin continuous improvement immediately. For this reason each Region documented the production processes to record what was traditional practice in that Region. The writing teams were put in contact with their counterparts in other Regions; collaboration was encouraged but optional. The processes that were less entrenched, less traditional, and in some cases non-existent, were documented as national processes which would be learned and deployed at all sites. These national processes included planning, design and development, client satisfaction, purchasing, internal auditing and other business type procedures. This approach provided a quality system design that was a combination of region-specific technical processes and national business processes.

A long-term goal of the Quality Management System is to benchmark similar processes across Regions to drive continuous improvement and adopt best-practices. Another opportunity may be to benchmark against external organizations and industry leaders to push the bar to new heights. In the past, the lack of process documentation was a handicap in efforts to share practices across offices. Clear and concise descriptions of work processes should make the transition to best-practice easier and more acceptable. Just the activity of documentation proved invaluable, as improvements and refinements became evident when processes were mapped. The dialogue among team members reinforced the right procedures and initiated discussion over differences in practice.

The current Quality Management System (QMS) is paper-based. CHS intends to move from the paper-based quality system to an on-line documentation management system. The paper-system was created in light of the short timeframe for implementation but also as a learning tool for all staff at the outset of this culture change. As experience grows in administering the quality system so will the knowledge and understanding of the needs and the application of the best-fit solution for an on-line documentation system. The multi-site nature of the documentation adds to the cost and effort of maintaining the paper-based Quality System and also adds a layer of complexity due to the informatics infrastructure that is not always consistent from one office to the next. Both off-the-shelf and custom-designed document management systems are being considered for the next phase of quality system improvements.

The New ISO 9000:2000 Standard

ISO 9000:2000 is a family of three documents. The 9000 document explains fundamentals and vocabulary; 9001 is the actual document that defines the requirements for compliance and 9004 is a guideline document for implementation. ISO 9000 is a common-sense process management model that defines a business environment. CHS used the ISO 9000:2000 International Standard as the core of its Quality Management System. The 2000 version of the Standard was released in December 2000. CHS had designed its Quality Management System based on the draft versions of the Standard. Very little fine-tuning was necessary when the final version was released. The ISO 9000:2000 version came at an opportune time for CHS as it represents a more modern approach to quality management and responds better to the demands of the service industry and public sector. The most important improvements are the re-organization of the Standard to follow the Plan-Do-Check-Act loop that supports process management and continuous improvement. It also promotes a greater emphasis on employee awareness and involvement and incorporates the requirement for increased customer input into the quality system.

Eight Quality Management Principles

- **Customer-focused organization** – organizations depend on their customers and therefore should understand current and future customer needs, meet customer requirements and strive to exceed customer expectations.
- **Leadership** – leaders establish unity of purpose, direction, and the internal environment of the organization. They create the environment in which people can become fully involved in achieving the organization's objectives.
- **Involvement of people** – people at all levels are the essence of an organization and their full involvement enables their abilities to be used for the maximum benefit.
- **Process approach** – a desired result is achieved more efficiently when related resources and activities are managed as a process.
- **System approach to management** – identifying, understanding and managing a system of interrelated processes for a given objective contributes to the effectiveness and efficiency of the organization.
- **Continual improvement** – continual improvement is a permanent objective of the organization
- **Factual approach to decision making** – effective decisions are based on logical and intuitive analysis of data and information
- **Mutually beneficial supplier relationships** – mutual beneficial relationships between the organization and its supplier enhance the ability of both organizations to create value.

Excerpt from ISO9000:2000 Quality management systems- Fundamentals and vocabulary

Figure 2. The ISO 9000:2000 Quality Management Principles

ISO 9000 encourages organizations to harmonize the delicate balance of people and process, recognizing that quality is a result of these components working together. The founding eight quality principles of the ISO 9000 Standard (see Figure 2) are evidence of this balance, expected in a functional quality management system.

A Process Management Approach

A business process model is the logical organization of people, materials, energy, equipment and information into work activities designed to produce the required end result (product or service).

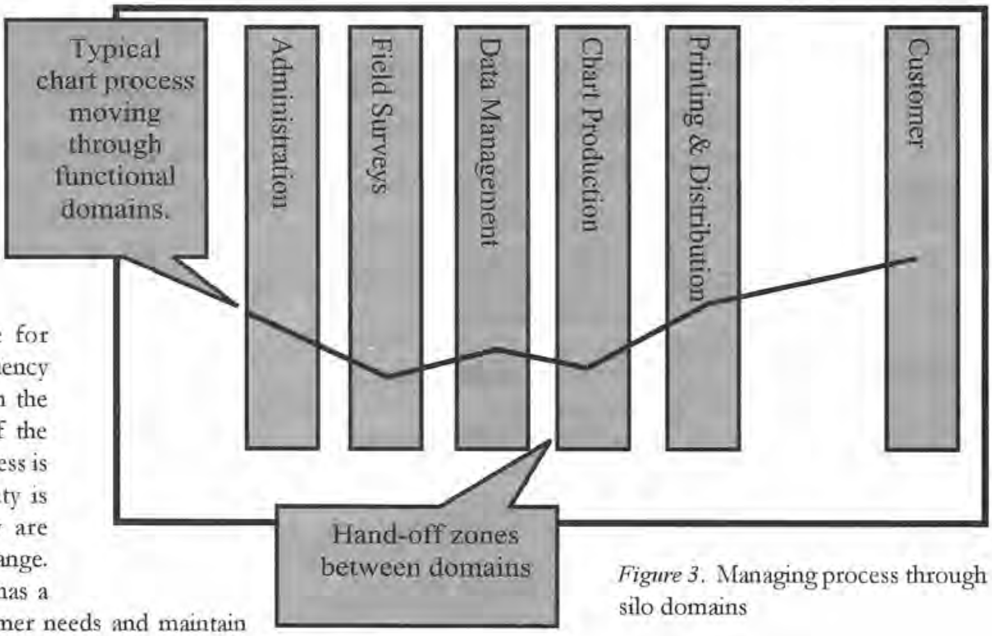

Figure 3. Managing process through silo domains

Three basic principles of measure for process quality are effectiveness, efficiency and adaptability. Effectiveness is when the product or service meets the needs of the customer; efficiency is when effectiveness is achieved at least cost; and adaptability is when effectiveness and efficiency are maintained in the face of constant change. It is imperative that the organization has a processes focus if it is to meet customer needs and maintain organizational health [James F. Riley Jr., Juran, 1999, section 6.1].

Though the concept of process management is relatively easy to grasp, it is harder to implement in the current environment. The CHS business organization model is a hierarchy of functionally specialized divisions; management direction and goals are deployed downward through this vertical hierarchy by divisional managers. However, the products or services that are delivered to the customers are generally a result of processes that flow horizontally through these vertical silos (see Figure 3). Each functional silo is responsible for its own piece of the process and its manager is accountable for the performance of that division. The result of this vertical orientation of functions is that no one is responsible for the entire process. Problems arise when functional demands come into conflict with process demands. Functional demands, functional resources and functional careers may tend to take precedent over cross-functional needs.

The effort to manage processes across traditional functional or vertically managed silos requires highly co-ordinated communication and planning. From the Quality System design perspective it is essential to view the organization as a system of process that can be optimized only when upstream and downstream activities are understood and valued. This systems-thinking approach is a key to the design of an effective quality system that reaps the most value from a finite amount of resources. CHS is moving in this direction as it encourages project teams to carry data collection through to final products.

In the current organizational structure, the hand-off zones between the silos offer the biggest opportunity for gains in production. These are the zones where processes most often fail due to either poor communication or mismatched expectations. In the ISO process model it is imperative to document the links between processes and manage the expectations of each and every hand-off. It is through this rigorous system that improvements are made across the organization and employees see themselves as part of a bigger picture.

Performance Measurement

CHS chose to be proactive in the area of Performance Measurement and go beyond the requirement of the ISO 9001 Standard and to implement a balanced measurement approach that was linked to the Vision, Strategy and Quality Principles of the Canadian Hydrographic Service.

Financial figures have typically been the foundation for measuring an organization's performance but new thinking is to have it on an equal footing with market focus, innovation, productivity, public responsibility and employee satisfaction. More often than not these measures have been observed but they have been for one small enclave of the organization, such as strategic planning being interested in market focus data or the engineering department monitoring innovation. Rarely were these broad-based measures brought to the general management table and utilized for decision making.

For years many organizations relied upon this one financial measure as the sole indicator of performance and this is possibly more harmful than good. The danger of relying on only one measure of performance is that this one measure may be optimized at the expense of the long-term health and vitality of the organization. For example, optimizing the financial bottom line has a danger of hiding the impact on client satisfaction. On the other hand, the numbers in the financial system often fail to clearly support investments in new technologies and innovation that are essential for successful performance and growth.

The CHS balanced approach gives an overall view of organizational performance by combining financial measures with other key performance indicators including client satisfaction, employee growth, workplace health, product quality, effectiveness of internal teams and external partnerships, and the organization's ability to stimulate innovation. As the cornerstone of the CHS Quality Management System, these performance indicators will provide the information for fact-based decisions that guide the organization and optimize production.

In a rudimentary fashion, CHS has begun to collect and report on a spectrum of performance measures and is working to promote this mind-set through the organization to encourage performance measurement as a natural step in the refinement of processes. It is by integrating these steps into procedures that regular performance metrics will be available as leading indicators for all employees to judge the effectiveness of processes as they occur. Key performance metrics need to be at the fingertips of management. Key measures at present focus on the five high-level quality principles of CHS:

- Being responsive to clients' needs
- Maintaining a challenging and rewarding workplace for all employees
- Sustaining teamwork and partnerships
- Consistently achieving high standards for products and services
- Continually improving through innovation in business and best management practices

The ideal is to have these key metrics as composites of a number of operational metrics at the working level.

cost of re-work, the cost of redundant quality control checks, and the cost of after-sales service or updates for poor quality products. But some poor quality costs are hidden from view such as the cost of poor planning, the cost of poor training, the cost of a dissatisfied employee, and the costs of loosing a customer. If all of these seemingly small but significant costs were tracked and tallied their sum and impact would be substantial.

In a practical sense, real quality costs can be measured and then reduced through the proper analysis of cause and effect. As nonconformance or inefficiency is revealed through customer feedback, employee observations or process failures, they are examined for root-cause and eliminated through corrective action. Elimination of root-cause means permanent removal. The further along in the operation process that an error is discovered – that is, the nearer the product is to the customer – the more expensive it is to correct. The optimum point to catch a potential error is in the planning: the cost of poor planning is a significant contributor to the cost of poor quality. Ultimately, if this philosophy and technique of capturing nonconformances and eliminating root-cause is projected far enough, we can expect that a reduction in checking to be possible as the production process becomes a result of highly efficient planning and execution.

The challenge to CHS at this early stage of the quality initiative is to encourage staff to acknowledge these errors and inefficiencies in process and deal with them in a formal and systematic fashion so that they are eliminated at the root-cause.

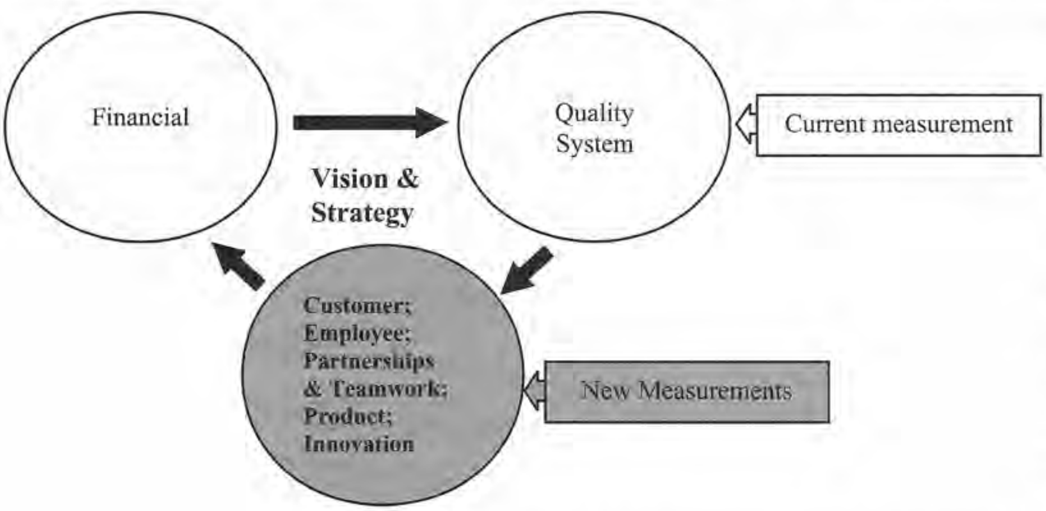

Figure 4. CHS balanced approach to performance measurement

Quality and the Bottom Line

Traditionally, recommendations were made to management that a choice had to be made between quality and cost, the so-called trade-off decision because better quality would somehow cost more and make production difficult. Experience throughout the world has shown differently, and management is beginning to see that this is not true (Campanella 1999). Good quality leads to increased productivity, reduced quality costs, and eventually to increased sales, market penetration and profits.

The focus of a quality management program is more about saving money and increasing operating capacity than it is about spending money on a quality program. The costs of poor quality are truly significant in both the manufacturing and the service environment. Some of these costs are quite obvious, such as the

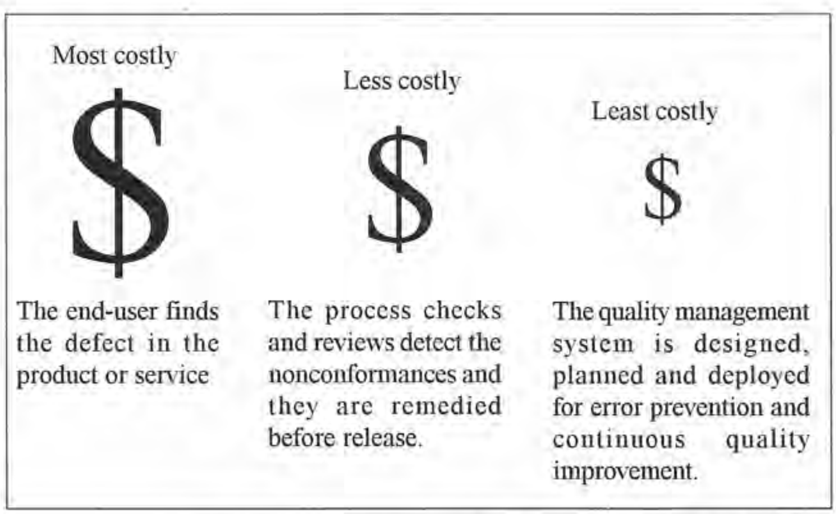

Figure 5. Comparative costs of quality. Adapted from "Principles of Quality Costs" by Jack Campanella.

Challenges

The transformation of an organization into a high-performance organization is a tall order. A quality journey is not just about documentation and a system for process control: it is a culture, a value system, that reaches into all corners of the organization.

Key to success is true leadership by those at the top of the organization. Leaders must be seen to walk the talk. Management must be visible leading the charge if they expect the employees to follow. Management may find it hard to embrace the new environment. By nature, managers have many years of service, and habits or comfort-zones can be difficult to change. Not only do old habits need to be unlearned but they need to be replaced with new procedures and practices. In addition to learning new ways, senior managers must be very outgoing and visible in the whole change initiative. They have to be seen spearheading change and providing reinforcement and encouragement to less senior staff as they struggle to adopt the new laws of the workplace. Eventually these new practices will become second nature but the ongoing role of the leader as coach, motivator and communicator goes on in the spirit of continuous improvement, pushing the organization to even greater heights. Management commitment is one essential ingredient for success that cannot be delegated.

Quality initiatives also need the backing and the participation of employees. Staff need to take an active role in decisions about the change. Today's workforce is the most skilled and talented in all of history; our staff need more than daily work instruction and a paycheck at the end of the week. They need involvement and empowerment to stimulate a workplace charged with energy for continuous improvement and stretching for excellence. Employees need to be free from fear of reprisal to fully participate in the nonconformance process. They need to feel connected and involved in reaching the goals of the organization, and they need to know where they fit in the organizational vision. They need clear understanding and support in their career plan and they need access and involvement in organizational measures and personal performance. More than anything they need effective training and coaching that is often more reliant on peer-to-peer and supervisor guidance than anything formal. Trust and transparency of organizational plans and clearly articulated goals are the pillars upon which to build an effective quality system.

The Goal and the Road Ahead

CHS has chosen the quality journey to put structure to the organization, to instill a quality culture in everything we do, and to establish a systems approach to highlighting poor performance as targets for improvement. It is a journey of progressive excellence that will not be reached in leaps and bounds but rather in small, continuous and insightful steps towards improvement.

CHS Seal of Quality

CHS has really just begun its journey into new waters. We have much to discover about the quality regime and much to discover about our organization. In the words of the Taoist philosopher Lao-Tzu, 'a journey of a thousand miles must begin with a single step'; CHS has taken this first step as a symbol of its commitment to a journey for excellence.

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News flash from November 2, 2001:

The Canadian Hydrographic Service is proud to announce that it has been successful in achieving registration to the ISO9001:2000 International Standard.

SOUNDINGS ...

This short article is being titled "Soundings" in recognition of a newsletter named *"Soundings"* which was produced and promulgated by the Dominion Hydrographer's office many years ago. Coincidentally this article is about real "soundings".

It is our intention to publish, on a regular basis, this column covering a subject which we hope will stimulate interest and discussion within the hydrographic community. We invite your comments.

As co-editor of LIGHTHOUSE, I am pleased to have the opportunity to present some thoughts. Some of the subject matter that you will find in future editions may be new and some you may have heard discussed previously. Each article of "Soundings" will have a discussion on one issue only.

"What is Bottom?"

Over the past decade I have posed this question on numerous occasions but do not recall receiving a satisfactory answer.

This question relates to depths that we show on charts and exactly what the numbers mean. We all know, or perhaps assume, that the numbers show how deep the water is at a particular location and we likely all agree that the depth is the distance from the water surface to the bottom. The number on the chart is also adjusted to the appropriate vertical datum for the area.

When we say "distance to the bottom", what exactly do we mean? What is bottom? In cases where the bottom is composed of soft material and gradually gets harder as depth increases - where are we measuring to? If you were measuring the depth with a measuring tape - where would you place the end of the tape?

There is no debate when the bottom is bedrock or some other hard bottom. The "bottom" in these cases is clear. But when the bottom of the water area is something else, like mud or other material like sawdust or grain, then where is the bottom?

Some decades ago I enjoyed Scuba diving and some of these dives were in areas with a silt bottom. My dictionary defines silt as "A sedimentary material consisting of fine mineral particles found at the bottom of bodies of water". When diving in these areas of silt you can move through the material and as you descend the material becomes more dense, and at some point you can move no further. In this case where is bottom?

Like divers, ships can also move through silt or sawdust covered bottoms but I suspect the ship operators would like to know. I'm sure that most of us have seen ships leave a mud or other coloured wake. In these cases they are quite likely moving through the silty, muddy or sawdust covered "bottom". We have heard of areas where tugs are used to dredge channels for small craft. They are obviously and literally moving the bottom. The question of "What is Bottom" becomes even more relevant.

Most hydrographers, at least those in Canada, know that over the years echo sounders have evolved and the frequency of the sound waves they emit varies considerably.

Many soundings of Canadian waters shown on charts have been collected with sounders having a frequency of 30 Khz and many have been collected with frequencies of 200 Khz. Other soundings were taken with frequencies in between the above two numbers and some at a lower or higher frequency. They are all considered valid depths - the distance from the water surface to the "bottom".

We all are aware that where the bottom is "soft" or silty, the sound waves generated by different frequencies will be reflected by a different "bottom". The high frequency will likely show the bottom as the top of the silt. The lower frequency will likely show no signs of the silt but will show a bottom that is reflected from some denser material. In many cases two bottoms will be shown. In either case, I'm not sure we know how dense the bottom is when a particular sound wave is reflected.

Hydrographers have been aware of this for many years and have even devised solutions to the problem where the depth of the high frequency sounder did not agree with the leadline. In silty waters, it is safe to assume the leadline penetrates the silt and stops at some unknown level of dense material. To resolve this concern, plates were built on the end of the leadline so it would not penetrate as far into the silt. Presumably this resulted in better agreement with the sounder depth. But we still did not know just how dense that material was or if a ship could move through it.

How does the shipping community want the bottom to be shown on charts in cases where the bottom is soft? I suspect, for a variety of valid reasons, they would like to know how deep the silt is. Can we tell them? No, I don't think we can, even in those cases where we have a sounder record with a double bottom. We don't know the hardness of either returned sound wave.

Does the era of digital or multibeam sounding systems resolve this concern? No it does not - but it may make the problem less obvious because only one bottom is recorded. However, we still don't know which bottom!

Over the years, there have been many discussions about the accuracy of soundings. We have heard concerns about water temperature, differing layers within the water column, boat squat and other factors which may affect the accuracy of depth measurements. I do not recall a great deal of discussion about the type of bottom.

Am I way off base? Have I been away too long? I invite your comments and they may be published in the next issue of our journal.

Earl Brown
Hydrographer (retired)

Future Trends In Marine Navigation and Positioning Technology

by Gérard Lachapelle, Department of Geomatics Engineering, University of Calgary, and
Sam Ryan, Canadian Coast Guard, Department of Fisheries and Oceans Canada

Current marine navigation and hydrographic positioning requirements for harbours, harbour approaches and inland waterways are reviewed. Emerging requirements for three-dimensional navigation in constricted navigation channels are then discussed. An analysis of GPS to meet these requirements is then presented. The limitations of the current GPS are illustrated through selected examples. The ability of the forthcoming GPS II and GPS III and the European Union's GALILEO to meet current and emerging requirements is then addressed. It is predicted that the use of a combined GPS/GALILEO system by the end of the decade would have a massive impact on marine navigation and positioning accuracy and reliability. One of the GALILEO services, namely the Control Access System, will provide the integrity function for the signal in space. At the user level, combination of GPS II and GALILEO would provide an excellent receiver autonomous integrity monitoring (RAIM) availability. A cost-effective and reliable real-time kinematic (RTK) service, anchored on the current Canadian Coast Guard DGPS Service, could be made available in inland waterways for three-dimensional, sub-decimetre navigation and positioning.

Introduction

In order to better understand marine navigation and positioning trends, a review of associated performance measures and requirements is in order. Performance measures used in marine navigation are summarized in Table 1. Global satellite navigation systems (GNSS) such as GPS are now and will remain dominant to fulfill marine navigation requirements. These systems have the coverage, fix interval and fix dimension required for all marine applications. This study will focus on the remaining characteristics. The accuracy performance measure is broken down into further categories in Table 2. In the case of GNSS, the repeatable and predictable accuracy is the same and is simply referred to as accuracy.

TABLE 1: NAVIGATION PERFORMANCE MEASURES

Characteristic	Definition
Accuracy/ Precision	Accuracy is the degree of closeness of a position estimate with respect to its true position. Precision reflects a degree of closeness of observations to their mean, which corresponds to a dispersion of observation. In practice, no distinction is made between accuracy and precision.
Availability	Percentage of time that the services are usable by the user
Coverage	Coverage which defines the area in which the system is available
Fix Interval	Fix interval defines a minimum interval between two consecutive position fixes which can be obtained using a particular positioning system
Fix dimension	Fix dimension specifies a dimension of a position fix, e.g., 2D or 3D, provided by a positioning system,
Reliability	Reliability which expresses probability that a specified level of performance is met under specified conditions for a given period of time
Integrity	Integrity or accuracy assurance, which defines the ability of system to provide timely warnings that the system does not meet accuracy or reliability requirements
Continuity	Ability to complete an operation without triggering an alarm

TABLE 2: ACCURACY MEASURES

Predictable accuracy	Defined as the accuracy of a position with respect to a reference coordinate system. It is equivalent to an absolute accuracy measure
Repeatable accuracy	Defined as an accuracy with which one can return to a position having coordinates which have been measured previously with same navigation system
Relative accuracy	Defined as an accuracy of a user's position with respect to that of another user of the same navigation system; or an accuracy of a user's position with respect to a position of the same user in the recent past
DRMS	(Distance Root Mean Squared): DRMS is a single number that expresses two-dimensional accuracy. Its probability is 63 – 68%
2DRMS	2 x DRMS, which corresponds to a probability of 95 - 98%

The most stringent marine navigation requirements are those for the harbour & harbour approach phases and inland waterways phase. The requirements stated in the 1999 U.S. Federal Radionavigation Plan [U.S. DoT/DoD 1999] for the above classes are summarized in Table 3 and 4. All requirements relate to horizontal positions except for the case of engineering and construction vessels where a very stringent vertical accuracy requirement of 10 cm is introduced.

Four categories of operation are dealt with, namely (a) hydrographic surveys, (b) positioning, (c) navigation aids and important features, and (d) depths. The standards pertaining to (a) are given in Table 5. The depth accuracy requirement for special surveys in swallow waters is about 25 cm at the 95% confidence level, which translates in a one-sigma measure of 10 cm. The Laurentian Region of the Canadian Coast Guard (CCG) for instance conducts bathymetric survey operations using acoustic swath systems with 100% bottom coverage on a regular basis in the St. Lawrence River navigation channel as part of a maintenance program to verify under-keel clearance in spring time after ice breakup and to monitor dredging contractors. The standards used are similar or higher than the Special survey standards listed in Table 5. DGPS real-time kinematic (RTK) positioning is often

TABLE 3: MARINE REQUIREMENTS - HARBOUR AND HARBOUR APPRACH PHASE [1,2,3]

REQUIREMENTS	MEASURES OF MINIMUM PERFORMANCE CRITERIA TO MEET REQUIREMENTS					
	ACCURACY (2DRMS)		Coverage	Availability	Reliability	Fix Interval
	Predictable	Repeatable				
SAFETY OF NAVIGATION: LARGE SHIPS & TOWS	8-20 m***	-	harbours & harbour approaches	99.7%	**	6-10 seconds
SAFETY OF NAVIGATION: SMALL SHIPS	8-20 m	8-20 m	harbours & harbour approaches	99.9%	**	***
ENGINEERING & CONSTRUCTION VESSELS	0.1****-5m	0.1****-5 m	Entrance channels, jetties, etc	99%	**	1-2 seconds

1: 2-D (Horizontal) except for River Engineering & construction vessels that have a 3D requirement
2: Unlimited capacity in terms of number of users
3: Ambiguity resolvable with 99.9% confidence
* Based on stated user need
** Depends on mission time
***Varies from one harbour to another.
**** Vertical

TABLE 4: MARINE REQUIREMENTS – INLAND WATERWAYS PHASE [1,2,3]

REQUIREMENTS	MEASURES OF MINIMUM PERFORMANCE CRITERIA TO MEET REQUIREMENTS					
	ACCURACY (2DRMS)		Coverage	Availability-	Reliability	Fix Interval
	Predictable	Repeatable				
SAFETY OF NAVIGATION: LARGE SHIPS & TOWS	2-5 m	2-5 m	Inland Waterway Systems	99.9 %	**	1-2 s
SAFETY OF NAVIGATION: RECREATIONAL BOATS AND SMALLER VESSELS	5-10 m	5-10 m	Inland Waterway Systems	99.9 %	**	5-10 s
RIVER ENGINEERING & CONSTRUCTION VESSELS	0.1*-5 m	0.1*-5 m	Inland Waterway Systems	99 %	**	1-2 s

1: 2-D (Horizontal) except for Engineering & construction vessels that have a 3D requirement
2: Unlimited capacity in terms of number of users
3: Ambiguity resolvable with 99.9 % confidence
* Vertical
** Depends on mission time

Requirements for Hydrographic Surveys

The International Hydrographic Organization (IHO) has developed, with the assistance of numerous national hydrographic offices, including the Canadian Hydrographic Service, standards for hydrographic surveys in coastal areas, harbours and navigation channels [IHO 1998].

used for these operations, but reliability and availability is a concern and maregraph stations combined with Canadian Hydrographic Service SINECO system [SHC 1998] are used to control the vertical component. Seasonal buoy tendering operations and location verifications, which require a high level of positioning accuracy, are also conducted in many areas under the jurisdiction of CCG.

Table 5: IHO STANDARDS FOR HYDROGRAPHIC SURVEYS

Order	Special	1	2	3
Examples of Typical Areas	Harbours, berthing areas, and associated critical channels with minimum under-keel clearance	Harbours, harbour approach channels, recommended tracks and some coastal areas with depths up to 100 m	Areas not described in Special Order and Order 1, or areas up to 200 m water depth	Offshore areas not described in Special Order, Orders 1 and 2
Horizontal Accuracy (95% confidence level)	2 m	5 m + 5% of depth	20 m + 5% of depth	150 m + 5 % of depth
Depth accuracy for reduced depths (95% confidence level) [1]	a = 0.25 m b = 0.0075	a = 0.5 m b = 0.013	a = 1.0 m b = 0.023	Same as Order 2
100% bottom search	Compulsory[2]	Required in selected areas[2]	May be required in selected areas	Not applicable
System detection capability	Cubic features > 1 m	Cubic features > 2 m in depths up to 40 m; 10% of depth beyond 40 m[3]	Same as Order 1	Not applicable
Maximum line spacing[4]	Not applicable, as 100% search is compulsory	3 x average depth or 25 m, whichever is greater	3-4 x average depth or 200, whichever is greater	4 x average depth

1 The error limit for depth accuracy is calculated as $\pm \{[a^2 + (b^*d)^2]\}^{1/2}$ where a is the constant depth error, d the depth and b*d the depth dependent error.

2 For safety of navigation purposes, the use of an accurately specified mechanical sweep to guarantee a minimum safe clearance depth throughout an area may be considered sufficient for Special Order and Order 1 surveys.

3 The value of 40 m has been chosen considering the maximum expected draught of vessels.

4 Maximum line spacing is to be interpreted as "spacing of sounding lines for single beam echosounders"' and "distance between the outer limits of swath sounding systems". The line spacing can be expanded if procedures for ensuring an adequate sounding density are used.

Under-Keel Clearance

The minimum under-keel clearance of a ship in a navigation channel in Canadian waters is currently set at 60 cm, as shown in Figure 1. In shallow navigation channels that require dredging, a high level of vertical accuracy is required in order to conduct and verify dredging operations. The above safety margin constitutes a very significant overhead cost which shipping companies would like to see reduced in order to be more competitive with U.S. ports on the Eastern seaboard. For this to be acceptable without compromising safety, knowledge of the water level is required, together with a much better capability to measure directly the ship's under-keel clearance. GNSS RTK positioning, provided that availability and reliability were adequate, would meet this requirement with a sub-decimetre accuracy via the use of a network of shore-based reference stations.

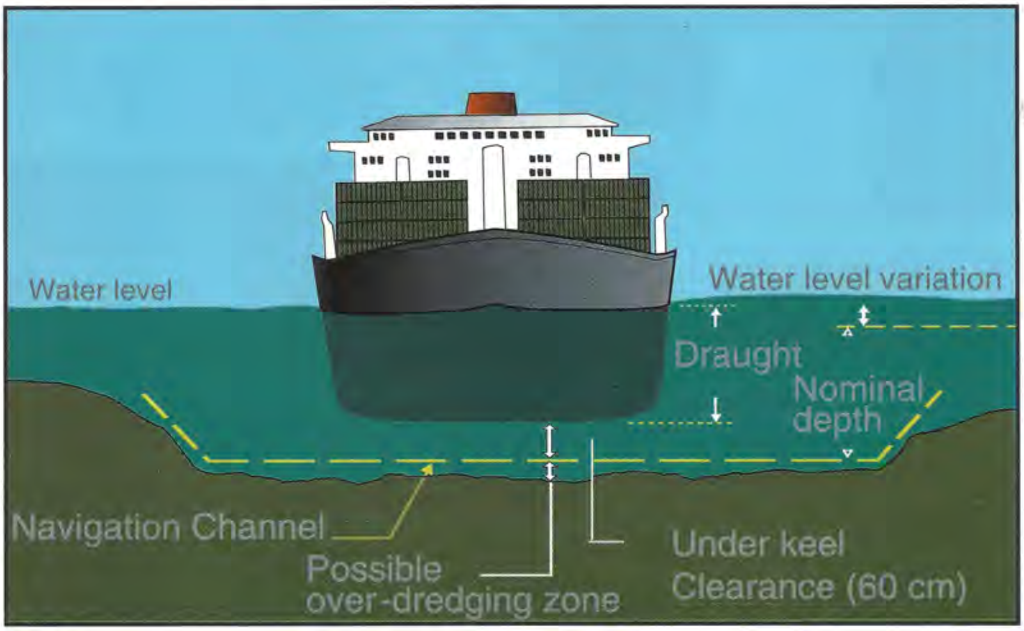

Figure 1: Under-Keel clearance In Navigation Channels

State Of Current Marine Navigation and Positioning Technology

GPS is now by far the most important technology used for marine navigation. The constellation currently consists of 27 operational satellites in six orbital planes, although the nominal constellation is defined as 24 satellites. GPS broadcasts signals on two known frequencies in the upper part of the UHF spectrum, namely L1 (1.575 GHz) and L2 (1.227 GHz). The second frequency, which is used by civilians in an unauthorized manner, is used either to correct for the effect of the ionosphere, which can reach a few tens of metres in extreme cases, or to perform RTK positioning. L1 is the authorized frequency for civilians and forms part of the Standard Positioning Service (SPS). The standalone horizontal accuracy (2DRMS) of the Standard Positioning Service (SPS) is now of the order of 22 m. In practice, this number is conservative and this stated accuracy level is often exceeded. The major limitation for the single frequency SPS user has become the effect of the ionosphere.

GPS user equipment has evolved rapidly during the past two decades, as illustrated in Figure 2. The weight, size, power requirement and cost each has dropped by several orders of magnitude while performance has improved by one order of magnitude. The core of a high quality GPS receiver today typically weighs less than a few hundred grams. Marine users utilize the full range of receivers, from hand-held units for pleasure boating to high performance L1/L2 codeless units for RTK positioning. Many of the low-end units now come with the capability to receive DGPS corrections from the CCG Service.

Figure 2: Evolution Of GPS Equipment, 1980 - 2000

Access to measurements on L2 is in practice necessary for high accuracy (10 cm or better) RTK operations and correction of the ionospheric effect, and manufacturers have been relatively successful in designing equipment based on so-called codeless and semicodeless techniques for unauthorized access to L2. This has been achieved at the expense of less than robust signal tracking, especially under signal interference phenomena such as ionospheric scintillation. The OEM4 engine shown in Figure 2 and manufactured by Calgary-based NovAtel Inc is a state-of-the art dual-frequency (semi-codeless on L2) receiver. In view of the low signal strength of L2 tracking methods, measurements on L2 are not used for safety-of-life applications. However, the success of RTK positioning, which is based on the use of carrier phase measurements and requires resolution of the carrier phase ambiguities on-the-fly (OTF), has resulted in an increasingly large user segment demanding authorized access to at least a second civilian frequency in order to expand the use of such high-accuracy perfomance techniques. This request is partly at the origin of the GPS modernization program, to be discussed in the next section.

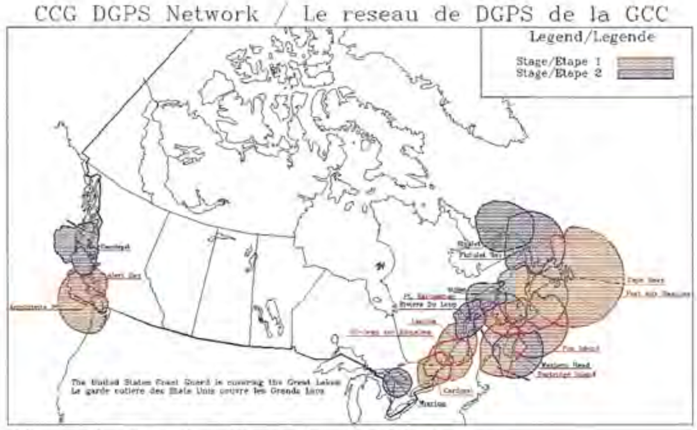

Figure 3: Canadian Coast Guard DGPS System

The accuracy and integrity performance of SPS are still not sufficient for a variety of marine applications. GPS has to be augmented by differential systems. The accuracy is enhanced through eliminating the errors that are correlated between reference stations and users. The CCG DGPS system was deployed in the late 90s and its coverage is shown in Figure 3. Each one of the 20 stations is equipped with redundant receivers to insure a high level of integrity [Ryan & Forbes 1997]. L1 differential corrections are broadcast to users. The corrections are broadcast to the mariner using the 300 kHz marine radiobeacons. Although the system accuracy specification is 10 m, it delivers accuracies at the level of 1 to 2 m to users equipped with sufficiently performing receivers and for reasonable distances to users. The U.S. Coast Guard provides a similar service in the Great Lakes.

Wide Area Augmentation Systems (WAAS) are another type of differential system. They are being deployed for aviation en-route, non-precision approach, and the least stringent category of precision approach. The most advanced system is that being deployed by the U.S. Federal Aviation Administration and consists of 25 WAAS reference stations, two master stations and two uplink stations to geostationary communication satellites that re-broadcast the messages to users via a GPS-like channel, voiding the need for an external communication link. Two to four geostationary satellites are to provide additional ranges to users in order to improve receiver autonomous integrity monitoring (RAIM). The anticipated accuracy of the system is one to a few metres, depending on user equipment performance. The system is due to become operational in 2002. Once this happens, NavCanada might consider extending the system into the southern part of Canada in order to have a seamless service with the United States.

Since the service will be public, marine users equipped with WAAS-compatible receivers could also use the system.

DGPS system reliability is enhanced through signal measurement analysis at the reference stations. This still leaves user equipment reliability to deal with. Measurements made by user receivers can be affected by large blunders that can go undetected unless the receiver firmware is capable of detecting such blunders. This capability is further dependent on measurement redundancy. Investigations have shown that many current receivers do not take advantage of redundant GPS measurements, even when these measurements are available, to detect blunders and erroneous positions [Ryan et al 1999]. The percentage of time during which there are enough GPS satellites available to detect blunders is another issue. Shown in Figure 4 is the average 95% Horizontal Dilution of Precision (HDOP) available with the minimal 24-satellite constellation. A 10-degree mask angle is used, which is reasonable for marine applications. The HDOP is a figure of merit to quantify satellite geometry. A HDOP lower than 5 is generally considered satisfactory for positioning. Figure 4 shows that the average HDOP is better (lower) than 2, which is considered excellent and fully satisfactory for navigation. However, a good HDOP does not necessarily mean adequate reliability.

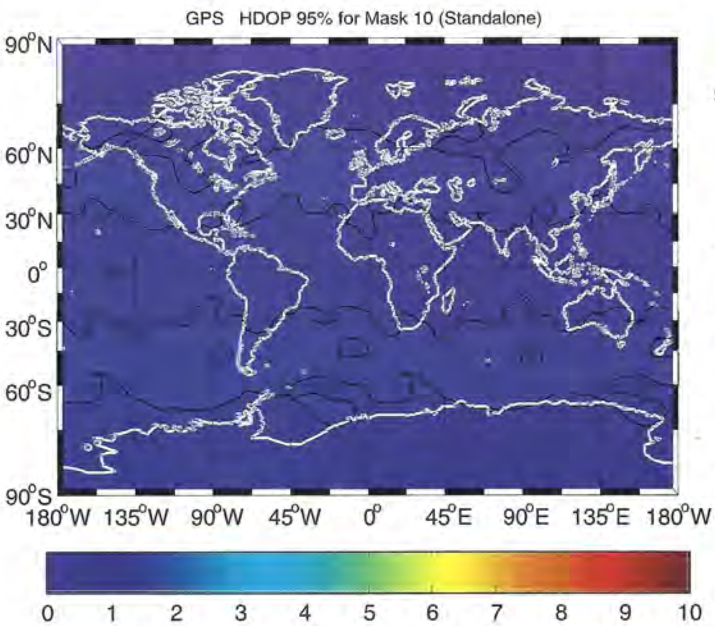

Figure 4: GPS Satellite Geometry, as measured by the HDOP

Internal reliability is the ability of a system to contain sufficient redundant measurements to be able to detect a blunder on any one of them, should such a blunder occur. The internal reliability is expressed in the same unit as the measurements are expressed. The lower the internal reliability number, the better the reliability. If the minimal number of four satellites is available to estimate the position of a ship at a given time, there are no redundant measurements and the internal reliability number would be infinite. This would mean that no blunder could be detected, regardless of its magnitude. External reliability is the effect of a measurement blunder on position. The external reliability is therefore the maximum position error that could occur and go undetected. The probability of occurrence is small but it remains a possibility. This technique or similar techniques form the backbone of RAIM techniques. As mentioned above, few receivers have implemented these techniques at this time, except for civil aviation applications where the reliability/integrity requirements are very stringent and critical. Shown in Figure 5 is the RAIM capability of GPS for horizontal positioning, assuming a constellation of 24 satellites. The values consistently exceed 100 metres over Canada, which shows that GPS alone does not have a good RAIM capability. This capability can be improved by numerous techniques, such as adding satellites, lowering the mask angle to 5 degrees, and using height and/or dynamic constraints [e.g. Ryan & Lachapelle 1999].

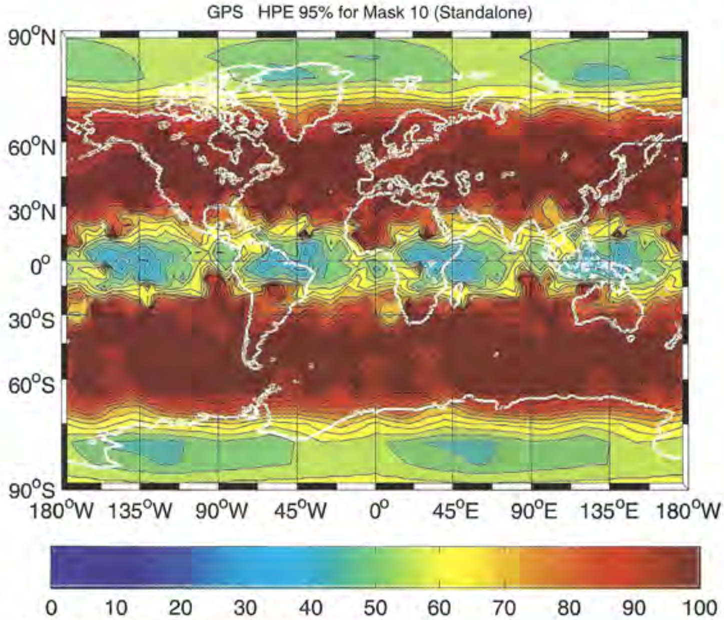

Figure 5: GPS RAIM Capability

RTK Positioning Operations

The Laurentian Region of the Canadian Hydrographic Service has used the RTK positioning mode for its navigation channel maintenance operations since the mid 90s. The CCG DGPS reference station sites are also being used for this purpose. OTF ambiguity resolution was initially successful for inter-station distances of up to several tens of km. Operations were reduced starting in 1998, due to the increased level of solar activity and its impact on the ionosphere. Other field trials conduced in the St. Lawrence region during that period confirmed that the prevailing level of solar activity was a major impediment to OTF ambiguity resolution [Fortes et al 2000]. As the level of solar activity decreases during the next two years, performance will increase to its previous level.

Emerging Systems

The major marine navigation enhancements that will or are likely to occur over the next 10 to 15 years are related to GPS and the European Union's GALILEO, another GNSS that will match the capability of GPS. The use of both systems simultaneously will result in an unprecedented level of performance.

GPS Modernization (GPS II and GPS III)

GPS is being modernized to meet the current and emerging demands of the civil community. The program consists of two phases, namely GPS II and III, as summarized in Table 6. The GPS II definition is well underway and the satellites will be launched between 2003 and 2010. GPS II will consist of improved signals to support safety-of-life applications. Additional authorized frequencies (L2 and L5) and coded signals will be used to improve availability, reliability (GPS II will not have build-in integrity), continuity of service and resistance to jamming. No increase in the number of satellites is planned. However given that the public has grown accustomed to a 27-satellite constellation, one would expect that number to be maintained. Thanks to the availability of multiple frequencies to remove the effect of the ionosphere, the horizontal accuracy (2DRMS) will increase from 22.5 m to 8.5 m in standalone mode. Multiple frequencies will also make the system more or less impervious to ionospheric disturbances encountered under high solar activities, at least from a signal reception point of view. Although the percentage of blunders likely to occur at the users will decrease due to better coding and multiple frequencies, the basic ability of the receiver to detect remaining blunders will not improve since the number of satellites will remain the same as today.

TABLE 6: GPS MODERNIZATION SCHEDULE

Activity	Implementation Date
SA set to zero	May 2000
GPS IIR Enhancements C/A code on L2 M-code on L1 and L2	2003-2006
GPS IIF Enhancements C/A code on L2 M-code on L1 and L2 L5	2005-2010
GPS III Enhancements C/A code on L2 M-code on L1 and L2 with greater power L5 Future capabilities	2010-TBD
Operational Control Segment (OCS) Enhancements	2000-2008

Many of the accuracy requirements described in the Introduction that cannot be met in standalone mode today will be met with GPS II. Current single-frequency user equipment will remain usable. However, new equipment will be required to take advantage of GPS II capabilities. This equipment is expected to be incrementally more expensive than current equipment decade.

Multiple frequencies will substantially improve RTK positioning, in terms of successful OTF ambiguity resolution, time to resolution, accuracy and reliability. The availability of a 3rd frequency is expected to help mitigate differential ionospheric effects on RTK positioning operations. This improvement, together with other improvements to be discussed in the sequel, will likely result in the feasibility of cost-effective RTK services.

Discussions are being initiated regarding GPS III specifications. These may range from yet better signals to additional satellites to real-time integrity monitoring, with the integrity messages being transmitted as part of the navigation message. The plans may be affected by the decision by the European Union to proceed with the deployment of GALILEO.

The consequences of GPS II on marine navigation and positioning are expected to be as follows:

- The current CCG DGPS Service accuracy performance will be enhanced (speculatively, to a consistent 2 m level, horizontally, 2DRMS) if DGPS station equipment is upgraded to GPS II compatible equipment.
- Assuming that current coastal waters and harbour & harbour approach requirements remain the same, the accuracy requirements will be met by GPS II in standalone mode for those users equipped with GPS II compatible equipment. However, GPS II does not contain real-time integrity information, therefore DGPS services such as the CCG DPGS Service will be required to provide real-time integrity. GPS II will mitigate the needs for expanding that Service to northern regions.
- RTK positioning performance improvement will possibly give rise to a demand for a public RTK service in parts of the St.Lawrence Seaway and the Great Lakes for three-dimensional navigation, in order for commercial shipping to better exploit the capacity of navigation channels. This would result in the installation of reference stations additional to those of the current CCG DGPS System and the broadcast of real-time DGPS corrections that would require more bandwidth.

One can speculate that the consequences of GPS III might be as follows:

- The number of satellites may increase substantially, resulting in better RAIM.
- The system will contain some real-time integrity monitoring, transmitted as part of the navigation message.
- The accuracy performance of the system will increase substantially, resulting in routine use of RTK positioning.

GALILEO

GALILEO is the GNSS being considered by the European Union to provide a capability similar to but independent of GPS. Much of the definition work has been done during the past three years. Up-to-date information is available on the GALILEO website (www.galileo-pgm.org). The current plan calls for the deployment of a 30-satellite constellation on three planes inclined at 54° with an orbital radius of 23,000 km. The deployment schedule calls for full operation by 2008. The system will transmit on at least three frequencies very close to the GPS frequencies. The C/A code will likely have a chipping rate of 2.046 Mbits/s, which is twice that of GPS. Several levels of services are planned, namely

- OAS – Open Access Service, available on L1, accessible to anyone
- CAS – Controlled Access Service, likely two levels (e.g. CAS-1 for commercial applications and CAS-2 for safety-of-life applications), multiple frequency, higher density code. Real-time integrity data will be included in the CAS, however, at the current time Europe plans to charge a user fee for the integrity service.

Given the above specifications, the accuracy and other performance of GALILEO are expected to be similar to those of GPS II. The CAS would require the deployment of a Regional Integrity Network, the density of which has yet to be specified. In order to feed back RIN measurements into GALILEO, the host country would have to be a participant. Canada, an associate member of the European Space Agency, has the opportunity to participate in GALILEO and therefore, to be able to use CAS-1 and CAS-2. Canadian participation is being studied by the Canadian Space Agency [e.g. Bastikar et al 2001]. Even with Canadian participation it is not clear at this time if marine users would have to pay in order to use the GALILEO integrity information. Non-participation would result in access to the OAS only, which should be equivalent to the current GPS Standard Positioning Service.

The most interesting aspect of GALILEO, from a user point of view, is the advantage of using it in combination with GPS. Combined GPS/GALILEO user equipment is likely to become available in the same year as the deployment of the initial GALILEO satellites, namely by the middle of the decade. Prices are expected to be incrementally higher than corresponding GPS equipment prices. The introduction of reasonably priced GPS/GLONASS receivers several years ago supports this assumption. The combined GPS II/GALILEO constellation would consist of nearly 60 satellites, as shown in Figure 6, providing a geometry rich environment suitable for effective RAIM, the missing element to increase GPS II reliability. The impact of using a combined GPS/GALILEO receiver on RAIM is illustrated in Figure 7, which corresponds to Figure 5 for the case of GPS only [Ryan 2000]. The addition of GALILEO has a very positive impact on the ability of the receiver to detect blunders and the maximum error that could occur on horizontal positions and go undetected is less than 40 m. When one adds a height constraint, the maximum error possible further decreases.

In addition to the above reliability advantage, there are very significant advantages related to carrier phase ambiguity resolution and RTK positioning service performance, as discussed by Lachapelle et al [2001]. Utilization of both GPS II and GALILEO simultaneously would increase all RTK performance measures very significantly.

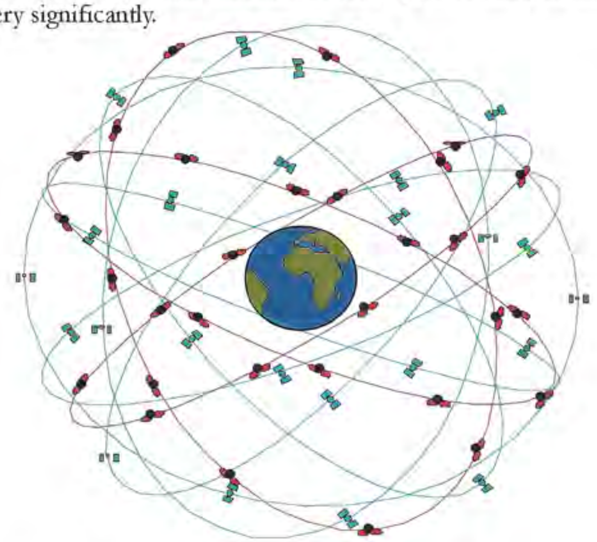

Figure 6: Combined GPS/GALILEO Constellation

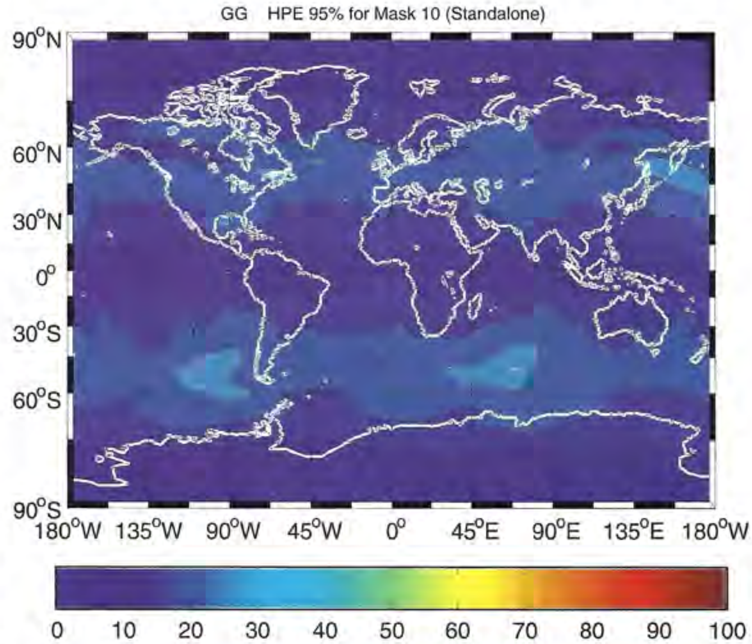

Figure 7: GPS/GALILEO RAIM Capability

The consequences of GALILEO on marine navigation and positioning are even more important that those of GPS II and are expected to be as follows:

- The current accuracy requirements for coastal waters, harbours and harbour approach would be met for users equipped with GPS II/GALILEO (OAS) compatible equipment. Since neither GPS II nor the GALILEO (OAS) service provides real time integrity monitoring, the integrity monitoring must be provided by either a differential service or RAIM. In open areas RAIM-compliant receivers would be able to provide integrity monitoring, however, under signal masking, integrity monitoring might still require a differential service.
- GALILEO would replace the need for a DGPS service in northern areas. AS for GPS II however, the need for a differential service would remain unchanged for users that have kept their current (GPS I) equipment.
- The CCG DGPS Service accuracy performance would be enhanced (possibly to 1 m, 2DRMS) if the current CCG DGPS station receivers were upgraded to GPS II/GALILEO compatible receives. This would be of benefit to some applications, such as the deployment of an integrated vessel traffic system.

Further RTK performance enhancements would result from GPS II/GALILEO, provided that at least two GALILEO frequencies were available. This would further strengthen the case for a public three-dimensional RTK DGPS Service in the St.Lawrence Seaway and other constricted navigation channels.

RTK Positioning Enhancements

Until recently, RTK positioning has been performed with a single reference station at a time. Since the inter-station distance between the reference station and the user is limited to a few tens of km due to the adverse effects of differential errors, a large number of stations is required to cover an area. However, in recent years, investigations have shown that the use of multiple reference stations operating interactively can reduce the number of reference stations required by a factor of 3 to 5 [Raquet & Lachapelle 2001]. Early feasibility studies using some of the CCG DGPS service reference stations in the St. Lawrence River have shown potential with this method [Fortes et al 2000]. The advent of GPS II and GALILEO will make multiple reference stations RTK services cost-effective over large areas.

Conclusions

Performance improvements in GNSS technologies will be so dramatic in the decade ahead that they will possibly result in a revision of current marine navigation requirements. The reasons for more stringent requirements could range from better environmental protection to increasing the capacity of navigation channels. Better GNSS performance will result in the opportunity to tighten requirements without cost escalation. As higher accuracies become available, new applications will emerge that will require these accuracies. Technology, requirements and applications have proven to interact synergistically in many other areas, and there is little doubt that marine navigation will be any different.

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http://www.geomatics.ucalgary.ca/GPSRes/GPSResIndex.html

Lighthouse puzzler

By Beth Weller

	Avro Arrow	Greek slave galley	LaSalle's *Griffen*	Spanish galleon	Halifax	Montreal	Tobermory	Vancouver	Aerial photos	GPS	Loran-C	Radio DF
Biggar												
Labrecque												
O'Reilly												
Wilcox												
Aerial photos												
GPS												
Loran-C												
Radio DF												
Halifax												
Montreal												
Tobermory												
Vancouver												

Lighthouse Puzzler # 20

The hydrographers found interesting wrecks last year. Looking over their briefing notes for the Regional Director, can you tell who found the Spanish treasure galleon off Tobermory?

1. The one working off Halifax was not the one using the antique Radio Direction Finder.
2. Wilcox, being a thoroughly modern person, was using the Global Positioning System but not off Halifax.
3. Loran-C was not used by Biggar's team, nor by the team working from Montreal, nor by the one that made the startling discovery of LaSalle's 17th Century ship *Griffen*.
4. The Greek slave galley was found west of Montreal but was not positioned by RDF.

Solution to Puzzler #19

The sextant is not on *CSS Bayfield* or *Cartier* or *Acadia* [clues 1, 2, 5] so it must be on *CSS Baffin*, so, along with clue 4, Ritchie, with his trusty octant [clue 3], hosted the Prime Minister. So Eaton was the one with the lodestone and must be on *CSS Acadia*. Kerr did not use the sextant [clue 6] so must be navigating by Moon shots. So McCulloch is on *CSS Baffin* using the sextant.

The one with the sextant did not find the seamount [clue 1] so it must have been Eaton on *CSS Acadia*. So McCulloch on *CSS Baffin* was the one sailing across the North Pole.

Canadian Hydrographic Association (CHA) Central Branch *is hosting the* 2002 – Coastal Multibeam Sonar Training Course

We are pleased to announce that during the week prior to the *Canadian Hydrographic Conference 2002*, CHA Central Branch will be hosting a Coastal Multibeam Training Course in Burlington, ON. The course will be held May 22 through 27 at the Travelodge Hotel, downtown Burlington. This course, which will be given by Drs. John Hughes Clarke, Larry Mayer, David Wells and Christian deMoustier, continues what has become one of the best sources for multibeam sonar training worldwide. Although the six-day course will be mostly intensive classroom oriented, time will be allocated for on-the-water demonstrations.

Course fee (includes textbooks, lunches and breaks): $4995 CDN ($4795 before February 28th, 2002). Non-government members of the Canadian Hydrographic Association and The Hydrographic Society of America (THSOA) will benefit from the following discounts on the cost of registration:

Regular Members:	$ 50 reduction
Sustaining/Corporate Members:	10% reduction

Non-member companies or organizations sponsoring two or more registrants will receive a 5% discount on the cost of registration.

To register, please complete this form and send along with applicable payment to:
Paul Davies – CHA Multibeam Course Director
4105 Marcia Place
Burlington, Ontario
L7L 5B6

Name: ______________________ Title: ______________

Company : ______________________________________

Address: ______________________________________

City: ______________ Prov. / State ______________ Country: ______________

Telephone: (   ) ______________ Fax: (   ) ______________ Postal Code: ______________

E-mail: ______________________________

Please circle (if applicable): CHA Regular Member CHA Sustaining Member
THSOA Regular Member THSOA Corporate Member

Payment can be made by cheque or money order, payable to Canadian Hydrographic Association Multibeam Course or by Visa, MasterCard or American Express (The Credit Card debit will appear as McQuest Marine Sciences).

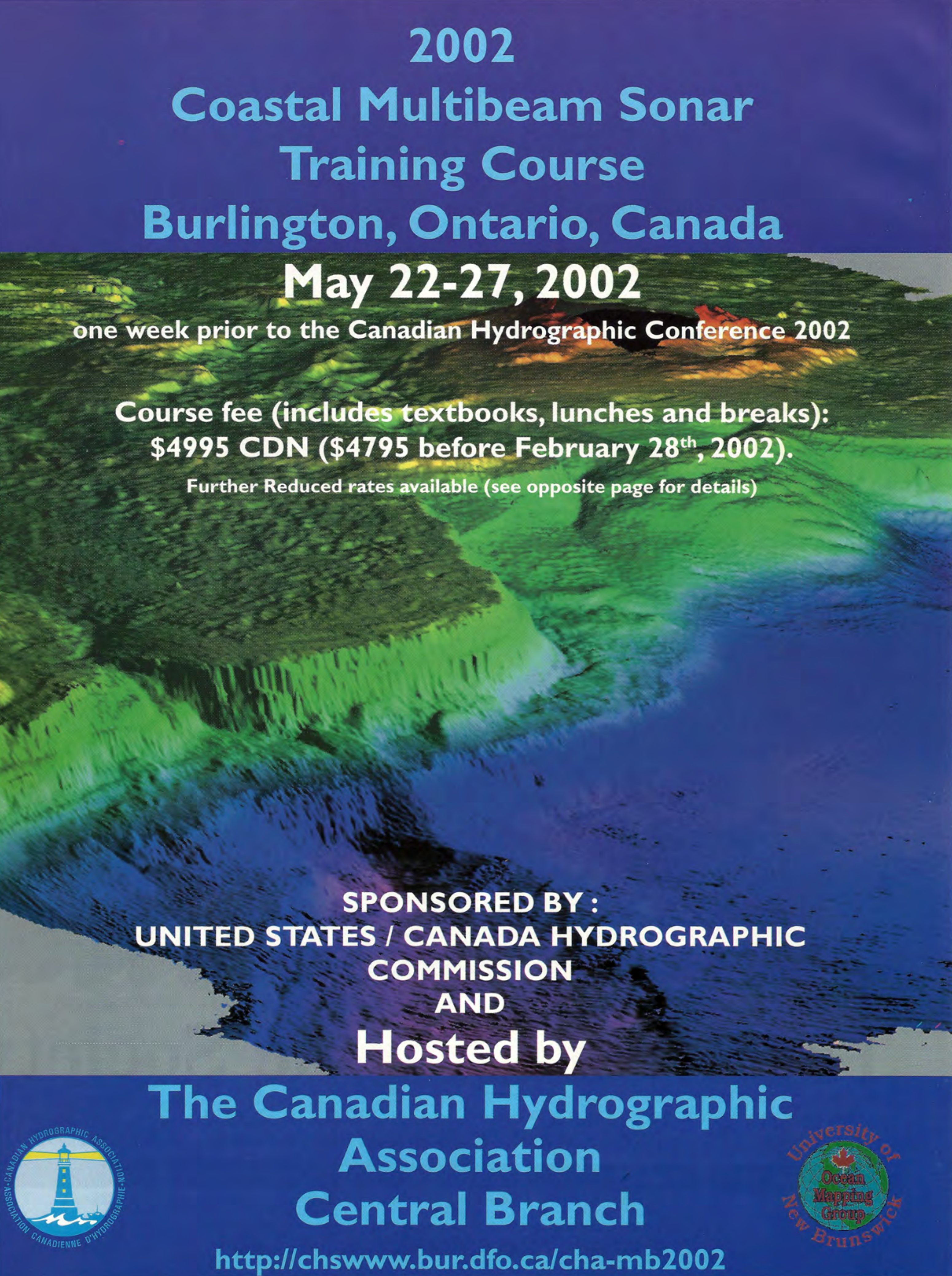
Please circle (if applicable): Visa Mastercard American Express

Credit Card Number: ______________________ Expiry Date: ______________

Signature: ______________________ Amount: ______________

Name of Cardholder: ______________________

Vendors are welcome. For more information on the course or to arrange to demonstrate your equipment please contact:
Paul Davies, Course Director at (905) 336 – 6448 (please leave message) or by email at: daviesp@lara.on.ca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Étudiant(e) – totalité de la conférence				
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			7% *GST (8891 33773-0007)	$ ____________
			Total	$ ____________

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Focusing on client requirements and their changing needs / donner la priorité aux exigences et aux besoins en évolution des clients

The 2002 Canadian Hydrographic Conference (CHC 2002) is presented by the Canadian Hydrographic Association, the Canadian Coast Guard, the Canadian Power and Sail Squadrons, Federation Internationale des Geometres, the International Hydrographic Organization, The Hydrographic Society of America, the Canadian Hydrographic Service, and The Company of Master Mariners of Canada.

The conference alternates each year between the United States and Canada. Recent conferences were in Norfolk, Virginia in 2001 and in Montreal in 2000. This year's conference is on May 28 to 31, 2002 at The Westin Harbour Castle hotel on the Toronto harbourfront; given the focus of the conference, this is the ideal location as visiting ships and survey vessels can be docked nearby. A special feature of this year's conference is that one day of this three-day event has a focus on the needs and concerns of the recreational boater.

This is a major forum for the marine community and appeals to a wide range of businesses and individuals with an interest in marine matters. It is a focus for all stakeholders in hydrography and geomatics, including navigators, inshore and offshore fishers, recreational boaters, engineers, scientists and educators, as well as for government and industry representatives. With 500 delegates from across Canada and around the world, this is a good opportunity to keep up with recent developments and to meet representatives of hydrographic communities from many countries

The theme this year is "Innovation and Excellence: Focusing on client requirements and their needs". This reflects the ever-increasing demand by today's marine clients for new technologies and better ways to use hydrographic data and offers a real opportunity to meet and explore new ideas and technologies in charting. The conference sessions will explore the changing needs and future trends of the maritime community and will encourage discussion between the various scientific communities that share an interest in hydrography and in navigation.

An important feature is the conference tradeshow, where some 60 exhibitors from the commercial and educational environments display their recent developments and technologies. This allows delegates to see the latest tools in hydrography, marine sciences and marine geomatics. Exhibitors that promote the use of charts and related publications will also be showcased, including organizations that promote safety, education and marketing.

The tradeshow will be near the conference rooms and social functions, with poster presentations within and next to the exhibit area, and there will be a stage in the middle of the tradeshow for exhibitors to demonstrate their products or services at scheduled times throughout the conference.

As well as the exhibit halls, there is an opportunity for exhibitors to use Canadian Hydrographic Service survey launches docked beside the conference hotel to demonstrate their equipment on the water. The launch exhibits are intended for practical demonstrations; there will also be an outdoor meeting area with display tables at the harbourfront for ship and launch exhibitors to display materials and to meet other delegates.

The tradeshow and the survey launches offer an opportunity for exhibitors to showcase their products and services to industry decision-makers and to provide them with a great learning experience.

A Canadian Coast Guard Class 1 Icebreaker and a Canadian National Defence Kingston Class Maritime Coastal Defence Vessel are expected to be docked at the same location to demonstrate their world-class navigation systems.

For more information: www.CHC2002.com

IHO S44 Standards for Hydrographic Surveys and The Variety of Requirements for Bathymetric Data

By Dave E. Wells, Ocean Mapping Group, Department of Geodesy and Geomatics Engineering and David Monahan, Canadian Hydrographic Service

In addition to its age-old use of abetting safe and efficient navigation, hydrographic data is increasingly used in an ever-expanding array of marine activities. Many non-hydrographic-office agencies and companies are collecting hydrographic data for intended purposes other than the production of nautical charts. All Hydrographic Offices wish to continue their prime role as providers of navigation products and many aspire to have their data applied to a broader list of intended uses. One of the strong points of hydrographic data is that it generally conforms to a known standard. For the past 40 years, this has usually been the International Hydrographic Organization's S44. However, S44 is strongly biased towards surface navigation, and is inapplicable to many other uses of hydrographic data. In this paper we explain the uncertainty elements in bathymetry data and compare S44 standards with alternatives that have recently emerged.

Introduction

The word "standard" implies something that can be used as a basis for comparison, such as a model or a set of rules, or an authorized measure of some kind. Along these lines, the International Organization for Standards (ISO) defines the term "standards" as :

> *Rules, guidelines, and definitions of characteristics, which ensure that materials, products, processes and services are fit for their intended purposes.*

In this paper we dissect this statement in three steps, as it applies to bathymetric information. First we will consider what characteristics are appropriate to judge whether bathymetric data is "fit". Second we will consider the variety of "intended purposes" for which marine bathymetric data may be fit. Finally, we will consider the status of standards for bathymetric data, in particular those contained in the 4th edition of the International Hydrographic Organization Special Publication No. 44 (IHO, 1998), and some recent alternatives.

Intended Uses for Bathymetric Data

The traditional mandate of hydrography has been to survey, chart and supply all spatial information required to assist in safe navigation and safety of life at sea, primarily for those commercial shipping vessels which fall under the conditions of the Safety of Life at Sea (SOLAS) convention administered by the International Maritime Organization (IMO).

However, driven by technology change, hydrographic needs and capabilities are becoming more broadly concerned with the management of spatial information concerning all marine features, processes, and properties in four dimensions (space and time), including the acquisition, analysis, and visualization of this spatial information (Kenny, 2000; Hecht, 2001; Monahan *et al*, 2001). Bathymetry is that aspect of hydrography that is concerned with delineating the marine floor, including features of both natural origin and those due to human activity. Bathymetric mapping has four broadly defined intended uses: to improve knowledge and understanding, to establish sovereignty and security, for economic purposes (including offshore resource management and shipping), and for environmental management.

Hydrographic information, in particular bathymetric information, is used to make informed decisions of several types: for example vessel navigation decisions; resource management decisions; resource development decisions; marine infrastructure decisions; marine construction decisions; coastal development decisions; tactical and strategic military decisions; and environmental management decisions. The confidence with which such decisions can be made depends on the confidence that can be placed on the hydrographic (and other) information available to assist in making informed decisions. It is consequently critical that users be informed of the uncertainty associated with the data and with products constructed from it. For us as suppliers of bathymetry to provide information about uncertainty, we must first assess it ourselves. We are aided in this assessment by mathematical tools and an international standard, S44 of the International Hydrographic Organisation (IHO, 1998).

Assessment of Uncertainty in Bathymetric Data

The uncertainty associated with bathymetric measurements includes (a) uncertainty in the location of a measured bathymetric data point; (b) uncertainty in the depth associated with a bathymetric data point; and (c) uncertainty in the backscatter strength associated with a bathymetric measurement.

Bathymetric uncertainty management involves both the design of a bathymetric system and the evaluation of results and products derived from bathymetric data. Measurements are always uncertain, to a greater or lesser degree. Uncertainties are of three fundamentally different types: accidental, systematic and random. Each type must be dealt with differently. A common characteristic shared by all three, however, is that the reliability with which we can determine uncertainty is completely dependant upon the degree to which the bathymetric data is redundant (repeated measurements of the same seabed feature, or even footprint, which can be directly compared to ascertain consistency).

"Data cleaning" describes methods used to deal with "accidental" uncertainties (also called mistakes, blunders, or outliers). Comparison of a suspected outlier with its geographical nearest neighboring data points (taking hydrographic judgment into account) is the most powerful data-cleaning tool. A rule of thumb which has emerged for cleaning high-density bathymetric data is that real features are distinguished from points created accidentally according to whether multiple consistent data points (multiple "hits") in close proximity are observed or not.

"Artifact" describes the effect of a systematic uncertainty. "Artifact detection" and, where possible, "artifact removal" describes further steps in the data-cleaning process. Artifacts are most often manifested as identifiable artificial features in a data series, with a strong correlation in time or space with some other data series. Effective artifact detection requires dense data and powerful visualization tools.

Whatever remains after (perhaps incomplete) data cleaning and artifact removal are considered as random uncertainties, or noise, in the data. Sometimes it is appropriate and possible to reduce the noise level by use of suitable filtering and smoothing of the data, but this can be dangerous, re-introducing systematic uncertainties, due to the filtering process itself.

In any case, when we have done our best, if we are fortunate, we will be left with some remaining "random" uncertainties. If we are unfortunate, we will still have residual systematic uncertainties that we cannot remove. If we are really unfortunate, there may still be blunders or outliers which we cannot remove with certainty, because it is impossible to decide whether these data points represent real features, or are accidents of measurement.

To meet the requirements for informed decision-making, we must be able to describe these remaining uncertainties in some standard way. One uncertainty descriptor is "precision" which describes data consistency. Good precision indicates that outliers have been successfully removed, and random uncertainties are small - but large systematic effects may still exist. Another uncertainty descriptor is "accuracy", which in a perfect world indicates agreement of our data with the "truth" (whatever that may be). Good accuracy indicates that the systematic effects have been reduced or eliminated, although occasional outliers may still exist, and the random uncertainties may be large or small.

Both these uncertainty descriptors are based on statistical principles and standards. The "mean" and the "standard deviation" are the two most common statistical descriptors of measurement uncertainties. The mean describes the central tendency of a series of measurements. The standard deviation describes the dispersion of a series of measurements. If we subtract the mean value (or perhaps a "true value" if such is known) from every measurement, we have a series of "residuals" or deviations from the mean. If we calculate the square root of the sum of the squares of these residuals, we obtain the standard deviation for that measurement series.

When discussing measurements that have a number of "dimensions" or time-correlated quantities (as is most certainly the case for a modern bathymetric survey), then these concepts are extended into several dimensions by considering a "mean vector" and a "covariance matrix".

Data-sets containing many measurements tend to have a special statistical character, known as a Gaussian distribution (the familiar "bell-shaped curve"), provided all accidental and systematic uncertainties have been removed, so that the uncertainties are purely random. This Gaussian character is an approximate model of reality, and becomes a better model the larger the number of values which are being considered (something called the Central Limit Theorem) and the more rigorous or successful the data cleaning process. An important descriptor of uncertainty, when the data density permits, is the probability that the data residuals (the random component of uncertainty) obey the Gaussian distribution.

But what does all this have to do with the confidence we can place in our information or measurements? It is another statistical principle that we can predict, under specific statistical conditions, how often our measurement uncertainties (or more specifically our measurement residuals) are likely to exceed a certain value. The value (or values) in question is referred to as the "confidence region", and the likelihood that our measurements lie inside this confidence region is referred to as the "confidence level".

The international standard for confidence level is 95% – in other words 19 times out of 20. 95% is confidence level associated with weather predictions. 95% is the confidence level associated with election outcome predictions or public polling results. And 95% has become the standard for expressing the confidence level for results derived from hydrographic measurements. If data has a Gaussian distribution, the 95% confidence region is related to the standard deviation (in one dimension) or the covariance matrix (in several dimensions) by a simple scale factor.

In summary: Key quality factors in bathymetric survey design are "coverage", "resolution" and "redundancy". The key quality factor in bathymetric data assessment is "uncertainty" – what are the uncertainties in the resulting bathymetric, positioning, and sonar backscatter information, and how do these uncertainties compare with the informed decision-making requirements for the intended uses? Bathymetric uncertainty management requires redundancy, and consists of two or three steps: data cleaning for both outliers and artifact removal, perhaps followed by a noise reduction process, and finally an assessment of the 95% confidence region associated with the remaining residual discrepancies.

Having applied the tools discussed in the previous section, we arrive at numerical values for uncertainty of our bathymetry data, either grouped by adjacent areas, or individually. One way to assess these numbers (decide if they are fit for their intended purpose) is to compare them against a standard.

A standard can be used as a planning document before data are collected, and as an evaluation document after the data are in. The *a priori* approach tries to assess the uncertainty with which each piece of data could or should be collected, before a survey is conducted. This is implemented through an uncertainty prediction estimation process or model. These predicted uncertainties are compared with those required to meet the appropriate standard, and the survey redesigned if they fall short. The *a posteriori* approach attempts to determine what uncertainties actual exist in the collected data, using the data cleaning and assessment tools referred to earlier in this paper. The results of these post-survey checks are then compared with the appropriate standard, to determine whether the survey results are actually "fit for their intended purpose". Sometimes it is claimed that a survey "met" the standard, but if no post-survey check was carried out to verify this claim, it is not supported by evidence. Claiming that surveys were planned to meet the standard is not enough. Planning and realization are not always the same thing.

In the following sections we consider some of the standards that are available for this assessment. We will focus, for simplicity, on just one of the many standard parameters required for assessing hydrographic data: the uncertainty in determination of depth.

S44: IHO Standards for Hydrographic Surveys

The International Hydrographic Organization (IHO) has issued standards for hydrographic surveys (S44) since 1957, and most recently in 1998 (IHO, 1998). These are the standards used by most producers of hydrographic data. Their stated purpose is:

> *To specify minimum standards for hydrographic surveys in order that hydrographic data collected according to these standards is sufficiently accurate and that the spatial uncertainty of data is adequately quantified to be safely used by mariners (commercial, military or recreational) as primary users of this information.*

S44 identifies itself as a "performance standard" and thus contains no instructions on how to evaluate whether a survey meets the standard. Nor does it specifically require the inclusion of redundancy, the most powerful tool for evaluating the uncertainty of any set of measurements. These are left to each agency to implement

> *Equipment and procedures used to achieve the standards laid down in this publication are left to the discretion of the agency responsible for the survey quality.*

Producing a standard like S44 is no easy task. Usual practice is for several member states of the IHO to nominate specialists who not only have a profound knowledge of the theory underlying the subject but also are aware of upcoming improvements in the technology that may impact the standard during its lifetime. The group must also have a strong sense of the pragmatic: there is no value in producing a standard that cannot be achieved or can only be achieved at costs not sustainable by some member states. Finally, the members must possess a thick skin, since their work can never please everyone. The Canadian Hydrographic Service is fortunate in being represented on the S44 working group by Rob Hare of CHS, Pacific Region.

The work of producing the standard is ongoing in a periodic manner, with the published intention of issuing a new edition every five years. An examination of the changes between succeeding editions gives a strong indication of the perceived progress in hydrographic technology and evolution in users' needs. For instance, the current (i.e. 4th) edition:...departs from previous editions by specifying different accuracy requirements for different areas according to their importance for the safety of navigation. The most stringent requirements entail higher accuracies than previously specified, but for areas of less critical nature for navigation the requirements have been relaxed.

Improvements in positioning technology that allow vessels to determine their locations at a level of uncertainty smaller then that required by the previous standard, together with the development of high density bathymetric mapping tools (such as multibeam sonar echosounders and LIDAR), are reasons behind this demand for higher accuracies in certain areas. Future editions will likewise adapt the standard to evolving technology and users' requirements.

S44 4th Edition classifies surveys into four different types (four "intended uses"):

> *Special Order - for specific critical areas with minimum unde- keel clearance and where bottom characteristics are potentially hazardous to vessels (generally less than 40m), such as harbours, berthing areas, and associated critical channels with minimum under keel clearances.*
>
> *Order 1 – for harbours, harbour approach channels, recommended tracks, inland navigation channels, and coastal areas of high commercial traffic density (less than 100m), such as harbours, harbour approach channels, recommended tracks and some coastal areas with depths up to 100 m.*
>
> *Order 2 – for areas with depths less than 200m not covered by Special Order and Order 1.*
>
> *Order 3 – for areas not covered by Special Order, and Orders 1 and 2 and in water depths in excess of 200m*

For each of these it specifies Horizontal Accuracy, Depth Accuracy, 100% Bottom Search, System Detection Capability and Maximum Line Spacing.

S44 4th Edition divides depth uncertainties into two contributing types, fixed and variable. It makes no mention of the primary classification of random, systematic and accidental, within these fixed and variable types. Fixed errors dominate the uncertainty budget in shallow water. Variable (depth-dependent) errors are characterized as a fixed percentage of water depth and thus grow larger with deepening water. The two types are combined in the Root-Sum-of-Squares (RSS) sense to give the 95% uncertainty σ. That

$$\sigma = [a^2+(bd)^2]^{1/2}$$

where a = sum of all depth-independent errors, b = sum of all depth-dependent errors, expressed as a fraction of water depth, and d = depth of water column in metres.

S44 4th Edition draws a distinction between the sampling of the seabed bathymetry represented by the measured depths, and the complete bathymetric model which is presented (in some form) to the end user for informed decision-making. Unless the sampling density is dense enough to delineate all seabed features, this model will be based, either implicitly or explicitly, on some form of interpolation between the sampled depths. Consequently the uncertainty associated with a bathymetric model will include uncertainties introduced by the interpolation process, and will be larger than the depth measurement (sampling) uncertainty.

Table 1: **Summary of Minimum Standards for Depth Uncertainties from S44 4th Edition (IHO, 1998)**

Order	S44 Special	S44 1	S44 2	S44 3
Depth uncertainty for reduced depths (95% Confidence Level)	a = 0.25 m b = 0.75%	a = 0.5 m b = 1.3%	a = 1.0 m b = 2.3%	a = 1.0 m b = 2.3%
Bathymetric model uncertainty (95% Confidence Level)	a = 0.25 m b = 0.75%	a = 1 m b = 2.6%	a = 2 m b = 5%	a = 5 m b = 5%

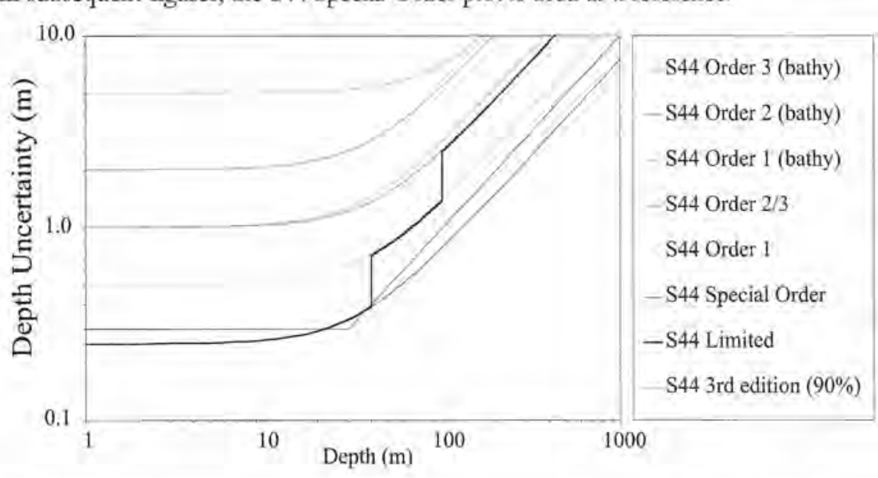
In the case of the Special order, this algorithm is somewhat more demanding than the single depth uncertainty specification from S44 3rd Edition (IHO, 1987), which was

30 cm to the depth of 30 m, and 1% of depth thereafter.

The S44 3rd Edition specification was at the 90% confidence level, and did NOT include uncertainties in water level reduction, which are included in the 4th Edition specifications.

For Orders 1 to 3, this algorithm results in higher permitted uncertainties than did the single 3rd Edition specification.

Figure 1. **Log-log plot of S44 3rd and 4th Editions.**
In subsequent figures, the S44 Special Order plot is used as a reference.



There are two ways in which the S44 4th Edition depth uncertainty standards can be interpreted. In the first interpretation, the word "minimum" standards is taken as the operative word, and the unlimited extension of each of the four S44 orders to deeper depths is permitted, even though not mandatory. In the second, more limited, interpretation, each Order is assigned a maximum depth to which it should be applied (Special Order to 40m, Order 1 to 100 m, Order 2 to 200 m, and Order 3 in deeper water).

Beyond S44: Other Intended Uses, Other Standards

S44 4th Edition broke a lot of new ground. It addresses the use of high-density bathymetric methods, such as multibeam, sweep, and LIDAR. It emphasizes the need to determine and record ("attribute") depth and position uncertainties. It distinguishes between depth measurement uncertainty and bathymetric model uncertainty.

Previous S44 editions were based on the scale of a specified chart, and the draughting skill of experienced marine cartographers. S44 4th Edition is based on uncertainty budgets and (at least nominally) on intended uses. However, despite this nominal objective, the intended use for which S44 4th Edition was created is still almost exclusively nautical charting.

Some of those seeking depth uncertainty standards for other intended uses of bathymetric information have referred to S44 4th Edition, as is (e.g. United Nations, 1999). Others have extended, modified, and replaced the standards embodied in S44 4th Edition.

We will consider four examples of standards that go beyond S44 4th Edition:

- The Exclusive Order introduced by the Swedish Maritime Administration.
- The US Army Corps of Engineers shallow water standards.
- Standards proposed to Land Information New Zealand for deep water multibeam echosounder surveys.
- Standards proposed by The International Marine Contractors Association for offshore construction.

Swedish Implementation of S44

IHO S44 are minimum standards. At least one hydrographic office, the Swedish Maritime Administration, has defined standards which are based on S44 4th Edition, but which are more demanding than those minimum standards (SMA, 2000).

On 1 May 2000, these new standards came into effect for Swedish surveys, and are being considered for adoption by other Baltic hydrographic offices.

SMA extended S44 4th Edition in four ways:

A new Exclusive Order specification was added, intended for the most demanding applications.

100% seafloor coverage is required in all cases by SMA, whereas for S44 4th Edition 100% coverage is specified only for Special Order and, if there is a grounding hazard, for other Orders as well.

Depth uncertainty in the standards refer to both acoustic sounding measurements (topographical reproduction) as well as determinations of the minimum depth by means of mechanical sensors (sweeping bars).

The SMA depth-uncertainty standards include the entire error budget from the surveying uncertainties up to the final result - storage in the digital depth database. In this way, the SMA depth-uncertainty standards are conceptually closer to the S44 4th Edition bathymetric model uncertainties than to the depth measurement uncertainties. However the SMA standards are much tighter than the S44 4th Edition standards, since the numerical values are derived from the S44 4th Edition depth measurement uncertainties.

The SMA established two "intended uses" - "fairway areas" and "other". Fairway areas are defined as

existing, proposed or planned fairways, traffic separations, deepwater routes, ports and areas of anchorage or waiting.

Fairway area surveys require an initial acoustic sounding survey. This is followed by a mechanical bar sweep, when the acoustic soundings indicate that the fairway depths are either

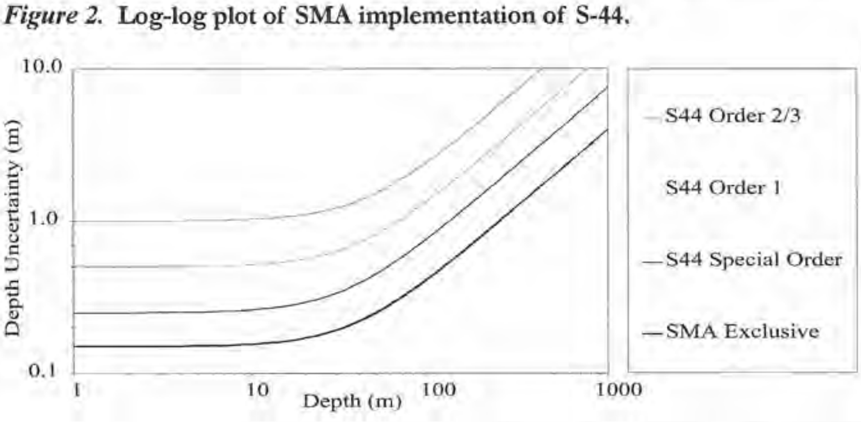
less than 150% of the minimum existing, proposed, or planned underkeel clearance safety margin, including squat, or

the underkeel clearance safety margin is less than 1 m.

Table 2. **The Swedish implementation of S-44**

Order	SMA Exclusive	SMA Special	SMA 1st	SMA 2nd	SMA 3rd
Depth uncertainty for bathymetric models (95% Confidence Level)	a = 0.15 m b = 0.40%	a = 0.25 m b = 0.75%	a = 0.5 m b = 1.3%	a = 1.0 m b = 2.3%	a = 1.0 m b = 2.3%
Depth range to apply order for fairway areas		0 - 20 m	20 - 50 m	50 - 100 m	100 m +
Depth range to apply order for other areas			0 - 6 m	6 - 100 m	100 m +
Maximum depth to apply order	50 m	50 m	100 m	100 m	unlimited

Figure 2. **Log-log plot of SMA implementation of S-44.**



USACE Hydrographic Manual 2001

The United States Army Corps of Engineers has published a Hydrographic Manual since 1991, containing background information, field procedures, and survey standards for Corps hydrographic projects. The latest (2001) version is currently in draft form (USACE, 2001). This document defines two categories of hydrographic surveys (intended uses):

Navigation and dredging support surveys, including project condition surveys of navigation channels, dredging contract plans and specifications surveys, dredging measurement, payment, clearance and acceptance surveys, and river charting surveys.

General surveys and studies, including general reconnaissance or planning surveys/studies, flood control project surveys, reservoir sedimentation surveys, flood plain boundary surveys, hydrological and hydraulic surveys, coastal engineering surveys, beach surveys, environmental investigations, geotechnical investigations, and disposal area surveys.

Based on the following principle:

survey instrumentation requirements, accuracy standards, and quality control procedures vary as a function of bottom type in a navigation channel, as does the required accuracy of dredge measurement and payment.

USACE navigation and dredging support surveys are further divided into three categories:

Hard bottom material and/or new work. Navigation projects where low under-keel clearances are anticipated over potentially hazardous bottom conditions, hazardous cargo is transported, or where bottom sediment could adversely impact naval vessels transiting a project. . . .only a small number of Corps projects fall under this category.

Soft bottom material and/or maintenance dredging. Navigation projects containing soft sand/silt bottoms not judged to be hazardous to vessel hulls; or projects with soft, featureless, and relatively continuous channel bottoms where gaps in coverage between survey lines are unlikely to yield potential hazards/strikes. The vast majority of the Corps deep- and shallow-draft navigation projects . . . fall within this category.

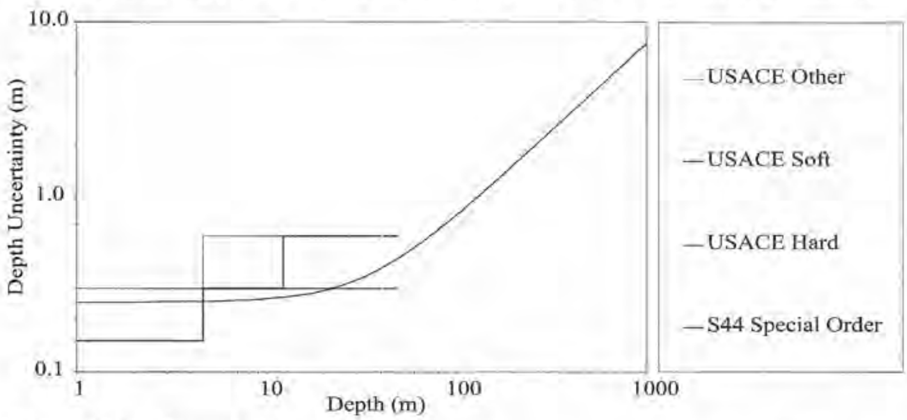
Underwater investigation surveys. Precise investigation surveys of/around locks, dams, power plants, abutments, piers, jetties, bulkheads, and other structures.

The USACE depth uncertainty standards include all uncertainty components that make up a reduced elevation: uncertainties in datum, in tide/stage modeling-extrapolation-interpretation, in dynamic-latency / roll / pitch / heave, in acoustic measurement, sound speed, refraction, and beam forming, and bathymetric mis-modeling through uncertainty in horizontal positioning (depth georeferencing uncertainty). The Manual notes that mechanical and acoustic depth measurement uncertainty increases with increasing depth, that multibeam system uncertainties increase with increasing beam angle, and that tide / stage and water level surface model uncertainties will generally be smaller for shallow (< 5 m) projects than for deeper (> 12 m) projects. The USACE depth uncertainty standards are depth –dependent, but do not follow the S44 4th Edition a / b coefficient model for depth independent and depth dependent uncertainty components.

Table 3. **USACE depth uncertainty standards (2001 draft version)**

Method	Depth	Nav & dredging hard bottom	Nav & dredging soft bottom	Other
Mechanical	< 4.5 m	a = 0.075 m	a = 0.075 m	a = 0.15 m
Acoustic	< 4.5 m	a = 0.15 m	a = 0.15 m	a = 0.30 m
Acoustic	4.5 m to 12 m	a = 0.30 m	a = 0.30 m	a = 0.60 m
Acoustic	> 12 m	a = 0.30 m	a = 0.60 m	a = 0.60 m

Figure 3. **Log-log plot of USACE standards, and S-44 4th Edition Special Order.**



The LINZ Standard, Specifically Addressing MBES Performance

In response to a request from Land Information New Zealand (LINZ), John Hughes Clarke, of the University of New Brunswick, prepared a set of "Provisional Swath Sonar Survey Specifications" (Hughes Clarke, 1999) for surveys involving the use of multibeam sonar echosounders (MBES). The rationale for this project was as follows:

> The [IHO S44 4th Edition] standards unfortunately contain significant ambiguity and are drafted for the sole purpose of data collection for nautical charting (a mandate much narrow than that of LINZ). One example of this broader mandate is that, as of July 1997, LINZ has taken the responsibility for New Zealand's Continental Shelf Delimitation Project. This involves the "measurement and analysis of seabed information according to internationally agreed criteria developed by the United Nations Commission on the Law of the Sea (UNCLOS)". Unfortunately these criteria do not include any specifications for the acquisition or delivery of data that might be acquired by MBES's.

The LINZ report explains that uncertainties associated with MBES depth measurements, expressed as a percentage of water depth (coefficient "b" in S44 4th Edition) are actually <u>smaller</u> in deep water than in shallow water. Depth-independent factors such as tide and heave, and one of the major depth-dependent factors, unstable sound velocity profiles, all have larger magnitudes in shallow (inshore) water than in deep (offshore) water. Consequently the depth uncertainties resulting from imperfect measurement / recovery of these factors, are also far more significant in shallow than in deep water. The report points out that uncertainties as small as 0.2% of water depth have been reported for deep water MBES depths. To demand only 2.3%, as specified in S44 4th Edition Order 3, ignores the capability of MBES, and is less appropriate than S44 3rd Edition, which required 1% for both shallow and deep water depth measurements.

The LINZ report also explains that MBES bottom detection, roll, and refraction uncertainties are all larger for MBES outer beams than for inner (near nadir) beams. Bottom detection uncertainties for the inner beams of a typical MBES are in the range of 40% to 60% of the S44 4th Edition Special Order depth measurement specifications. On the other hand, bottom detection uncertainties alone will exceed the entire Special Order uncertainty limit (from all sources) for outer beams (say those with a grazing angle of less than 30°). Therefore, a MBES survey designed to meet a particular depth uncertainty standard for all beams (out to a certain outer-beam cutoff), will likely outperform that uncertainty standard significantly for the inner beam (near nadir) data.

This MBES beam-angle dependence is not addressed in S44 4th Edition. The LINZ report addresses this dependence head-on by proposing MBES depth uncertainty specifications based on the differences between inner-beam and outer-beam uncertainty performance. Rather than requiring that all depths from a MBES survey meet the same uncertainty standard, inner-beam standards are required to meet something closely related to S44 4th Edition Special Order, while the outer-beam standards are more relaxed. In addition, the permitted balance between inner-beam and outer-beam coverage is allowed to relax as the survey specifications move from LINZ Special Order to LINZ Order 3.

The expected performance of a MBES is divided into several sectors, from the inner-beam sector to the outermost-beam sector. The number of sectors is allowed to increase from one to four, and the specified coverage within each sector is partitioned more generously in favour of the outer-beam sectors, as the survey order descends from Special to Order 3. Since this approach could be quite complex to design, realize, and assess in practice, a simpler approach is also proposed, which is based on the performance of the worst (outer beam) sector. In each case, everything is tied to the S44 4th Edition Special Order specification, and the lower order S44 specifications are ignored. Four uncertainty levels are specified: 1.0, 1.5, 2.0 and 2.5 times the S44 4th Edition Special Order depth uncertainty specification, that is

For 1.0 x SO, a = 0.25 m, b = 0.75% of depth
For 1.5 x SO, a = 0.375 m, b = 1.125% of depth
For 2.0 x SO, a = 0.5 m, b = 1.5% of depth
For 2.5 x SO, a = 0.625 m, b = 1.875% of depth.

Table 4. **Proposed LINZ Depth Uncertainty Specifications**

Order	LINZ Special	LINZ 1st	LINZ 2nd	LINZ 3rd
Depth uncertainty, by sector, for reduced depths (95% Confidence Level)	100% 1.0 x SO	50% 1.0 x SO 50% 1.5 x SO	33% 1.0 x SO 33% 1.5 x SO 33% 2.0 x SO	25% 1.0 x SO 25% 1.5 x SO 25% 2.0 x SO 25% 2.5 x SO
Depth uncertainty for worst-case sector (outer-beams) reduced depths (95% Confidence Level)	1.0 x SO	1.5 x SO	2.0 x SO	2.5 x SO

IMCA offshore construction standards

The International Marine Contractors Association (IMCA) has adopted the S44 and LINZ standards to standards for informed decision making in offshore construction activities (IMCA, 2000). The intended uses associated with each of the four IMCA depth measurement uncertainty orders are:

IMCA First Order - site surveys for offshore engineering, requiring high quality seafloor definition: Template or jacket installations; Detailed route engineering surveys; Route surveys in confined areas; Surveys in ports and harbours; Dredging and inshore engineering surveys

IMCA Second Order – site surveys for offshore engineering, less stringent than First Order: Route reconnaissance surveys; Geo-Hazard and clearance surveys; Coastal engineering surveys; Deepwater geophysical and engineering surveys (conducted by remote vehicle)

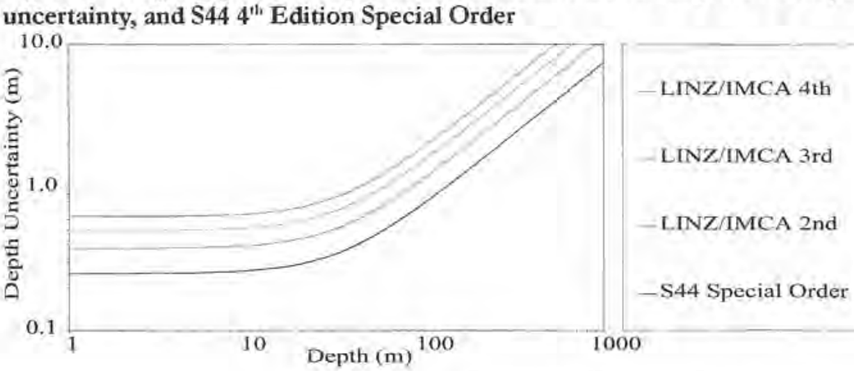
IMCA Third Order – general bathymetric surveys: Continental shelf cable route surveys; Continental shelf charting surveys; Export pipeline route surveys

IMCA Fourth Order – Reconnaissance surveys: Deepwater cable route surveys; Deepwater charting surveys; Surveys for Exclusive Economic Zone assessments and delineation

Table 5. **Proposed IMCA Depth Measurement Uncertainty Standards**

Order	IMCA 1st	IMCA 2nd	IMCA 3rd	IMCA 4th
Depth Accuracy for Reduced Depths (95% Confidence Level)	1 x IHO SO a = 0.25 mb = 0.0075	1.5 x IHO SO a = 0.375 m b = 0.01125	2 x IHO SO a = 0.5 m b = 0.015	2.5 x IHO SO a = 0.625 m b = 0.01875
Maximum depth to apply order	200 m	500 m	750 m	No maximum

Figure 4. **Log-log plot of Proposed LINZ worst-case sector / IMCA depth uncertainty, and S44 4th Edition Special Order**



What's next for S44?

The IHO formally intends to reconsider S44 on a five year schedule, to account for technological and procedural improvements as they occur. Hence work on S44 5th Edition is expected to start soon. To conclude this review, we speculate on the issues to be dealt with by the S44 working group tasked with preparing S44 5th Edition.

Perhaps the most important issue is whether S44 5th Edition should aspire to address all intended uses for hydrographic data, as was hinted at in S44 4th Edition. As we have tried to demonstrate, there are many non-nautical-charting uses for hydrographic data, for which the depth uncertainty standards are quite different (often more demanding) than the standards provided by S44 4th Edition. As well, our brief review is by no means an exhaustive survey of these other intended uses for bathymetric data.

An argument in favour of S44 5th Edition addressing all intended uses for hydrographic data is that many Hydrographic Offices aspire to be suppliers of data / information / products to a broader clientele. It has even been argued that the survival of some HOs may depend upon cultivating a broader user base (Monahan *et al*, 2001). It would be appropriate for the IHO to establish data standards within S44 5th Edition which would facilitate these aspirations.

On the other hand, this approach to a new edition of S44 would require broader representation on the working group. The working group would benefit from inclusion of members involved in specifying the uncertainty requirements for several of the diverse intended uses for hydrographic data, as listed in S44 4th Edition:

Coastal zone management, environmental monitoring, resource development (hydrocarbon and mineral exploitation), legal and jurisdictional issues, ocean and meteorological modelling, engineering and construction planning.

Here are a few ideas for consideration, when work on S44 5th Edition begins:

- Consider moving S44 from a performance standard, to a document that provides guidance on how to apply the performance standard, both *a priori* for planning purposes, and *a posteriori* to determine end use (informed decision making) uncertainty.

- Recognize, as the SMA seems to have done, that the "bathymetric model" introduced in S44 4th Edition is what both navigational and non-navigational clients want and use for informed decision making. Place more emphasis on specifying, on methods for assessing, and on methods for informing end users, of the uncertainty associated with this model, and products based upon it (in contrast to depth measurement uncertainty).

- Consider separating navigational intended uses into use for (a) certified commercial navigation, (b) uncertified commercial navigation, (c) recreational boating, and (d) military operations, with uncertainty management standards specific to each category. Specify the quantity and spatial distribution of redundant measurements, as well as methods of analyzing them.

- Clarify the issue of the maximum depth to which the depth uncertainty associated with a particular order of survey should be applied. Consider removing all limits (essentially stressing that S44 represents minimum standards).

- Consider simplifying the relationship between the various orders of survey, by tying the depth uncertainty definitions for Orders 1, 2 and 3 to multiples of the Special Order uncertainty, as has been done in the proposed LINZ and IMCA standards.

- Reconsider depth of water column as the sole independent quality variable. For work from submerged submarines, Remotely-Operated Vehicles and Autonomous Underwater Vehicles, depth under the sensor would be a more appropriate quality variable than depth of the water column. Accurate high-resolution bathymetry is often required in deep water for marine construction surveys. Bottom slope and roughness, area ensonified, and multibeam beam angle should be considered as additional quality variables

- Consider providing guidelines for managing all three types of uncertainties (accidental, systematic, random) rather than providing a performance standard based on random uncertainties alone.

Conclusion

For simplicity, we have in this paper focused on one quality factor – depth measurement uncertainty – in discussing the status of IHO S44 and other hydrographic survey standards that have recently been proposed and discussed.

However, these standards are more complex than has been represented here, containing many other quality factors, such as target detection uncertainty, georeferencing uncertainty for depths, georeferencing uncertainty for navaids and other features, and tide and tidal stream uncertainty. It would be possible to prepare parallel discussions to this paper, concentrating on each of these other factors in turn (but that is certainly not our intention!).

S44 4th Edition broke new ground and has stimulated the development of several alternative standards. Its impact is still a long way from being fully felt or implemented.

However, there are sufficient challenges that have emerged for useful work to begin on S44 5th Edition. We have tried to identify and describe some of these challenges in this paper. The most important of these by far, is the need to clearly identify in S44 5th Edition whether or not the standards should apply to the broader intended uses of hydrographic data (only partially listed in this paper).

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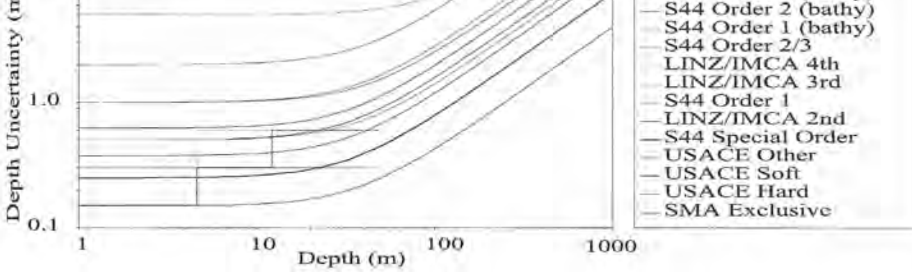
Figure 5. **Compilation of all depth uncertainty standards from Figures 1 to 4.**



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Dave Wells retired from the University of New Brunswick in 1998, after two decades of teaching hydrographic surveying there. He now follows the seasons, and this year taught at four universities: University of Southern Mississippi from January to May; University of New Hampshire in May and June; Universiti Teknologi Malaysia during the summer; and from September to December back to the University of New Brunswick, where he is now Professor Emeritus, and where this fall he introduced three new hydrography courses (on tides, kinematic positioning, and hydrographic data management). Dave and three colleagues teach a short course on multibeam sonar surveying four times each year at various locations around the world (including in Burlington 22-27 May 2002). Since 1990 Dave has been a member of the FIG/IHO International Advisory Board on Standards of Competence in Hydrographic Surveying, which meets for 10 days each year in exotic locations. Dave is exploring the possibility of doing some of his teaching via online (or CD) course delivery, perhaps reducing some of his hectic travel.

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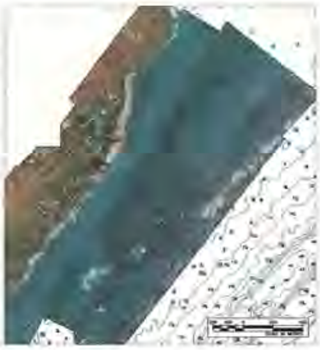
David Monahan is Director, Ocean Mapping, Canadian Hydrographic Service in Ottawa and Hydrographer in Residence with the Department of Geodesy and Geomatics Engineering at the University of New Brunswick. He is Vice-Chairman of the International Hydrographic Organisation's General Bathymetric Chart of the Oceans project, and over the past thirty years has worked in most elements of hydrography.

Dave Monahan enjoying his favourite pass-time.

Terra Remote Sensing Inc.

Terra Maps The World!

Terra Remote Sensing Inc. has been active on a number of fronts using our Larsen scanning laser bathymery/VideoMap system, land LIDAR/digital camera and multibeam data processing capabilities. The work has taken our growing staff to a wide variety of interesting areas of the world (Asia, Central America, Antarctica), and has allowed our company to form very successful collaborative partnerships for ongoing project development.



Our hydrographers, along with the scanning laser bathymetry system, completed a large survey area (2000square kilometres), in South East Asia to provide forty final Field Sheets over the coral reef areas. The LIDAR bathymetry collected provided water depth up to 50 metres and the full color aerial VideoMap imagery was orthomosaiced to clearly delineate all aspects of the complex shoreline and shallow water coral reef areas. The combination of LIDAR bathymetry and VideoMap has proven to be an ideal combination to investigate issues related to coastal zone management (erosion, conservation and sea level rise). This project came on the heels of a similar contract to map the coast of Barbados with our partner, Sir William Halcrow.

Although Terra has close to two decades of hydrographic experience, the firm is finding that land application of aerial mapping technology for linear features is developing rapidly. Terra's Terrain Scanning LIDAR (which provides up to 10,000 elevations per second) has been required by major electrical utilities in Canada, the continental U.S., and in Central America. Typical survey outputs are ground elevations, vegetation encroachment, wire catenary curves and point of attachment determinations for the transmission lines. The crew find themselves in a Bell 206B helicopter instead of a hydrographic sounding launch, both of which seem to be equally dynamic platforms.

The National Institute of Water and Atmospheric Research Ltd. (NIWA)conducted a multibeam hydrographic survey of the Western Ross Sea, Antarctica and the nearby Balleny Islands. From January to April 2001, Terra provided NIWA with hydrographic personnel and support to supervise the survey, process the multibeam data and produce the final deliverables for the contract. A Simrad EM3000 multibeam echo sounder mounted to the 70 metre NIWA Vessel Tangaroa, collected approximately 75 million soundings during the 11 days in the Ross Sea. Just as many soundings were collected during the 15 days surveying the Balleny Islands. This was the first time a multibeam survey has been carried out in Antarctic waters. Terra worked with other survey consultants from Canada, the U.S. and Australia, using CARIS software. In addition to Field Sheets, track maps, oblique and sun illuminated images and drawings were produced - 52 drawings in all. This was Terra's second trip down under. Last year, Terra also provided hydrographic support to survey the Three Kings Islands with NIWA and their client LINZ.

Sustaining membership allows companies closely linked with the hydrographic field to become more involved with the activities of the CHA and to maintain closer contact with users of their products. Through *LIGHTHOUSE* these Sustaining Members are also able to reach a world-wide hydrographic audience. The benefits of Sustaining Membership include:

a certificate suitable for framing / three copies of each issue of Lighthouse / copies of the local Branch newsletters, where available / an invitation to participate in CHA seminars / an annual listing in Lighthouse / an annual 250 word description in Lighthouse / discounted advertising rates in Lighthouse.

Annual dues for CHA Sustaining Membership are $150.00 (Canadian). Current Sustaining Members are listed below.

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contact: Rick Quinn (affiliation - CHA Pacific Branch)

News From Industry

Nouvelles de l'ndustrie

Kongsberg Simrad

Kongsberg, Norway

Kongsberg Simrad, Inc. is pleased to announce the award of a contract worth approximately 1 million USD for delivery of a 1° by 1° EM 300 multibeam echo sounder system to the University of Washington, Seattle, Washington, USA. The EM 300 will be installed on the R/V Thomas G. Thompson (AGOR 23) operated by the University of Washington's School of Oceanography.

This 84-meter multi-purpose research vessel was commissioned in 1991 and conducts research for the US and international oceanographic community. It accommodates 21 crewmembers and up to 38 scientists in cruises lasting up to 50 days. The system will be installed in a shipyard near Seattle and become operational in early 2002. One of the potential uses of the EM 300 system is mapping of the Juan de Fuca tectonic plate off the coast of Oregon, Washington and British Columbia in connection with the proposed NEPTUNE scientific research project. Information about the NEPTUNE project and the R/V Thomas G. Thompson can be found on the web sites www.neptune.washington.edu and www.ocean.washington.edu/ships/manual.html

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HYDRO 2002

ANNOUNCEMENT & PAPERS CALL

The Hydrographic Society, in association with the German Hydrographic Society (Deutsches Hydrographisches Gesellschaft), is to hold its 13th biennial international symposium in Kiel from 8-10 October 2002. The main theme of the proceedings, which will also include a major exhibition of equipment and services as well as anticipated visits by specialist survey vessels, is Sounding The Future.

Co-sponsored by the Canadian Hydrographic Service, the International Association of Lighthouse Authorities (IALA) and FIG Commission 4 for Hydrography, the Symposium will focus on key policy and technical issues affecting future global hydrographic developments and requirements. Planned topics include Bathymetry, Coastal Zone Management & Protection, Data Management, Education & Training, Electronic Charting, GIS, Pollution Monitoring & Control, Port Traffic Control, and Positioning;

250-word English-language abstracts on these or other related subjects are invited for submission by 31 January 2002.

Further details on the event, which will be the fourth Hydrographic Society international Hydro symposium to be held outside the UK following earlier successful stagings in Amsterdam, Copenhagen and Rotterdam, are available via a special event Website at www.hydro2002.org.

Abstracts of proposed papers should be forwarded to:
The Organising Committee, Hydro 2002,
Wischhofstrasse 1-3, Geb.11, 24148
Kiel, Germany
(Tel: +49 431 7207 204 Fax: +49 431 7207 205
Email: info@hydro2002.org)

ADW Software

Vosselaar, Belgium

Pythagoras is an integrated drawing and calculation program for land surveyors, civil engineering companies and utilities. Pythagoras Version 9 adds two important new features to an already impressive list of drawing and calculation functions:

1. Support for the **DWG** (AutoCAD) format: Pythagoras Version 9 imports and exports the AutoCAD DWG format directly, which significantly increases compatibility with AutoCAD.

2. The implementation of **VBA** (Visual Basic for Applications) in Pythagoras. VBA enables users to customize Pythagoras. If you have a specific requirement, a few routines will take care of this in no time at all! The Pythagoras Object Model gives access to Pythagoras objects (Digital Terrain Model (DTM), spirals, coordinate transformations, etc.) that have no access using generic CAD software. The immediate benefit is that this makes Pythagoras drawings ideally suited to build a state-of-the-art GIS. In previous versions of Pythagoras, you were already able to link external databases, but the implementation of VBA significantly enhances the possibilities: bi-directional linking with databases, perform searches, etc.

These 2 new features make Pythagoras very unique: a state-of-the-art and user-friendly stand-alone CAD program that easily meets the needs of the modern Land Surveyor or Civil Engineer.

Pythagoras is a CAD program that has been custom-made for the Land Surveyor and Civil Engineer. In addition to all Coordinate Geometry functions, it contains modules for Digital Terrain Modeling and Road Design. The powerful integration of calculation and drawing functions results in a simple and easy-to-learn software tool.

Pythagoras is available for MS Windows (95, 98, 2000, ME, NT) as well as the Apple Macintosh.

For information please contact:

ADW Software
Osseven 12
B-2350 Vosselaar Tel: +32/14-61.32.70

Klein Associates Inc.
Salem, New Hampshire, USA

Klein Associates, Inc., a leading provider of side scan sonar systems, announced today a five-year, exclusive distribution agreement with Raytheon Marine GmbH of Kiel, Germany. Klein Navigation, a division of Klein Associates, Inc., will be the sole U.S. distributor for the marine navigation and communications equipment manufactured by Raytheon Marine GmbH.

Raytheon Marine GmbH (RMG), a premier supplier of Integrated Bridge Systems (IBS), designs and manufactures a complete line of navigation and communication equipment for the maritime industry including gyros, autopilots, steering systems, radars, ECDIS and GMDSS in their ISO-9001 approved facility in Kiel, Germany.

Klein Associates' sidescan sonar provides underwater imaging using narrow beams of acoustic energy transmitted out to the side of a towfish and across the bottom. Sound is reflected back from the bottom and from objects to the towfish, producing high-resolution images of the seafloor.

"The synergy between Klein and Raytheon is remarkable," said Michael J. Mitchell, General Manager of Klein Navigation. "Klein's underwater technology will augment the Raytheon product line, while Raytheon's ECDIS and INS technology will do likewise for Klein when integrated with their sonar systems."

"We're excited about the opportunity to broaden Klein's product line. The High Seas team that now makes up Klein Navigation brings to Klein long-standing talent and experience in manufacturing and selling products for the ocean-going industry," said William Key, President, Klein Associates, Inc.

All Raytheon Marine High Seas employees have transferred to Klein Navigation. In addition to expanding manpower resources by merging with the existing infrastructure of Klein Associates, positions will be filled to strengthen and enhance support in the technical, purchasing, inventory control, warranty, and shipping/receiving areas of the business.

Technical sales and service will be provided by the existing Raytheon dealer network, while the Klein Navigation Team will be available as technical backup for the dealers, as was done in the past. Customers and potential customers should feel free to contact either their local dealer or Klein Navigation direct at: sales@kleinnavigation.com, telephone 603-890-1304, or fax 603-890-9796. Support is available 24 hours per day by telephone.

An augmented inventory of Raytheon Marine GmbH's High Seas products will be located at the Klein facility in Salem, New Hampshire, for immediate shipment.

For information contact:
Michael J. Mitchell, Klein Navigation
11 Klein Drive; Salem, NH 03079, USA
Tel: (603) 890-1304 E-Mail: mmitchell@kleinnavigation.com

Klein Associates, Inc., of Salem, New Hampshire, USA, announces the return of Jean Schwartz after a 5-year absence. Jean will be involved in the company's new product developments and sonar operations.

For more information please contact Jean Schwartz at:
Klein Associates, Inc.
11 Klein Drive; Salem, NH 03079, USA
Tel: (603) 893-8807; Fax: (603) 893-8807
E-Mail: jschwartz@kleinsonar.com Internet: www.kleinsonar.com

News From Industry
Nouvelles de l'ndustrie

Knudsen Engineering Limited
Perth, Ontario, Canada

The Knudsen 320BR Deep Water Echosounder continues to penetrate the research vessel community. Increased sales confirm this blackbox system is becoming the standard replacement system of choice within the North American UNOLS fleet.

Woods Hole Oceanographic Institution recently took delivery of their third Knudsen 320BR for installation on the R/V Atlantis. Other Woods Hole vessels - the R/V Knorr and the R/V Oceanus - both have a Knudsen 320BR installed. A follow-on order for a second unit will be delivered to Oregon State University in October. Other October deliveries of the 320BR Deep Water Echosounder include the Naval Research Laboratory in California and an integrated hydrographic system to the Hydrographic Office of the Algerian Navy.

The 320BR, developed for full ocean depth requirements that demand chirp and correlation processing, has gained a steady following since its introduction. Its popularity is attributed to the high performance / low cost ratio as well as ease of installation and interface to existing ship-installed low frequency transducers. Since delivery of the first prototype unit to the Scripps Institution of Oceanography, 65% of the North American UNOLS vessel community have now upgraded their vessels with Knudsen 320 echosounder systems. In addition to many UNOLS vessel installations, other North American 320BR customers include NOAA's Pacific Marine Center, Raytheon Polar Services, Clearwater Environmental Inc., and the US Geological Survey. A Knudsen 320BR User Forum will be held at the UNOLS RVTEC meeting at the University of Rhode Island in late October.

The Knudsen 320 series of echosounders is fast becoming known in academic and research communities around the world. All three North American accredited hydrographic survey training centers – the University of New Brunswick, the University of New Hampshire, and the University of Southern Mississippi – have chosen Knudsen echosounders for their hydrographic field training, as well as serious research tools for graduate-level programs.

Using a single beam Knudsen 320BP echosounder with two sidescan transducers, the University of New Brunswick is currently doing some impressive research (visit *www.omg.unb.ca*). The University of New Hampshire, also using a Knudsen 320BP, is currently researching bottom detection and sea floor characterization. The University of Southern Mississippi has just recently purchased a Knudsen 320MP echosounder for use as a training tool in their hydrographic science degree program in the fall.

Other additions to the growing list of Knudsen academic customers include the University of Washington, the University of Arkansas, MIT, East Carolina University, Carleton University, the University of Delaware, the University of Minnesota, Hong Kong Baptist University, HeHai University in China, and the Netherlands Institute for Sea Research.

For information please contact:

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SUBSEA OFFSHORE
Aberdeen, Scotland, UK

Veripos has appointed Seaforth Engineering Group Inc of Dartmouth, Nova Scotia to oversee and maintain its recently-established Canadian Differential GPS service providing Inmarsat-delivered signal corrections facilities for high-accuracy offshore navigation and positioning over ranges up to 2000km.

Seaforth Engineering Group's remit includes provision of user equipment and correction signals from Veripos-operated land-based reference stations in Halifax, Nova Scotia and St. John's, Newfoundland. Each provides rapid correction update rates and low data latency, with data uplinked via Inmarsat's Atlantic West communications satellite for transmission to users. Resulting positional accuracies are between 1 and 3m within 1000km of a reference station and better than 5m when within 2000km. The network, which is compatible with all types of GPS receiver via standard RTCM correction formats, also facilitates computation of multiple reference station position solutions for added reliability and precision.

Seaforth Engineering Group Inc is based at 780 Windmill Road, Suite 302, Dartmouth, Nova Scotia, Canada (Tel: 9020468 3579 Fax: 902-468 6865 Email: rhunter@seafortheng.ca).

For information contact:

David Goodfellow
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London, United Kingdom N12 9PN
Tel: 020 8445 3453 Fax: 020 8446 8986
Email: Dvd.Goodfellow@virgin.net

Triton Elics International

Watsonville, California, USA

Triton Elics International (TEI) recently delivered a combined Isisâ Sonar and Delphâ Seismic acquisition system with two TEI Full Office Suite processing packages to Thales Geosolutions Group Ltd (UK).

Acquisition is performed by a TEI workstation interfaced to Thales GeoSolutions Group Ltd's towed Edgetech chirp sidescan and FSSB sub-bottom, and to a hull-mounted seismic source. All survey information is displayed on three 18-inch TFT flat screens. The acquisition system also includes TEI Mosaic RT which displays sidescan mosaics in real time. The post-processing suite features TEI Delph Map with Seismic GIS, for visualization and interpretation of seismic data geo-referenced with sidescan and bathymetry. The equipment will be commissioned on one of Thales GeoSolutions Group Ltd's specialized cable route survey vessels.

For information contact:
Emmanuel Sgherri at 33 1 44 19 65 80 or at es@tritonelics.com.
Website: www.tritonelics.com

CSUMB selects TEI for Sub-Bottom Profiling

The California State University at Monterey Bay (CSUMB) (Seaside, California) will equip the R/V "MacGinitie" with a Triton Elics International (TEI) (Watsonville, California) Delph Seismic acquisition and processing system to collect sub-bottom data from an Edgetech FSSB. CSUMB will collect sidescan, multibeam, and sub-bottom data, and make sediment grabs along with ROV-video ground-truthing for the Santa Monica Watershed Restoration Foundation. The main focus of the study is to gain insight in the decrease of near shore kelp beds due to changes in the bottom on the Central California coast.

Triton Elics International develops integrated survey systems and advanced survey tools for commercial, academic, and military customers. More information is available on TEI's

For information contact:
Francois Wolf, Director of Marketing
Triton Elics International, Tel: (831) 722-7373
fwolf@tritonelics.com
Website: www.tritonelics.com

C&C Technologies-NavCom Technology Commercial Agreement

September 4, 2001 - C&C Technologies, Inc., an international survey company, and NavCom Technology, Inc., a subsidiary of Deere & Company, announced today that they have entered into a commercial agreement for the supply of StarFire™ differential GPS receivers and signals worldwide. This agreement is exclusive to offshore operations pertaining to satellite navigation positioning on projects for surveying, mapping, geophysics, mining, cable laying and offshore construction, installation, inspection, and maintenance operations.

Commercial marine, land survey, GIS, defense, land seismic, fleet management and all applications not reserved to C&C Technologies or to specific John Deere business units will be managed through value-added resellers, brand-labeling or OEM arrangements by NavCom Technology. NavCom has constructed the StarFire™ system and will maintain the system and continue to improve its performance in both signals and receivers. Various earlier announcements have been made regarding the StarFire™ system and specific technology partnerships. These announcements can be accessed via NavCom's web site at www.navcomtech.com.

C&C Technologies will employ the brand name C-Nav™ for its operations. C-Nav's foundation is the StarFire™ system and receivers; however, C-Nav™ provides many features and functions whose descriptions may be found in C&C Technologies' literature at www.cctechnol.com.

James D. Litton, President of NavCom Technology, and Thomas Chance, President of C&C Technologies, invite current and potential customers to attend product demonstrations and lectures at the ION-GPS 2001 conference in Salt Lake City, Utah on September 12, 2001. This will give prospective clients an opportunity to meet representatives of both companies and view live demonstrations of StarFire™ results and other product demonstrations.

Press Contact: Sandra Zeitzew, PR Department, NavCom Technology, Inc. 310-394-9779 x268 or pr@navcomtech.com

Jeff Fortenberry, PR Coordinator, C&C Technologies, Inc.
337-261-0660 x313 or jef@cctechnol.com

C & C Technologies and Century Subsea form Alliance

C & C Technologies, Inc., headquartered in Lafayette, Louisiana, USA, and Century Subsea, Ltd., headquartered in Aberdeen, Scotland, have formed an alliance to focus on deepwater acoustic construction projects. C&C Technologies and Century Subsea both have extensive experience in the international subsea arena. This alliance will offer customers an unprecedented combination of skills and experience to meet the challenges of the deepwater environment.

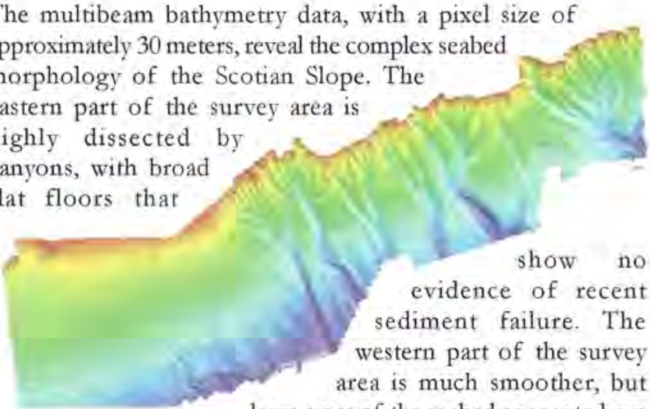
The companies have launched their alliance with a challenging deepwater acoustic positioning project in the Pacific. This project, once completed, will showcase the innovative technologies of both companies.

For more information please send email to info@cctechnol.com.

News From Industry
Nouvelles de l'ndustrie

Scotian Slope Non-exclusive Multibeam Survey Conducted by C & C Technologies

C & C Technologies, Inc. of Lafayette, Louisiana USA completed a multibeam bathymetry and imagery survey of the Canadian Scotian Slope in June of 2000. Marathon, Murphy, Norsk Hydro, and PanCanadian sponsored this non-exclusive survey, which encompassed 28,000 square kilometers of the lease blocks ranging in depth from 600 to 3500 meters. These data are contributing directly to several issues relating to hydrocarbon prospectively, surficial geohazards, and environmental conditions at the seabed.



The multibeam bathymetry data, with a pixel size of approximately 30 meters, reveal the complex seabed morphology of the Scotian Slope. The eastern part of the survey area is highly dissected by canyons, with broad flat floors that show no evidence of recent sediment failure. The western part of the survey area is much smoother, but large areas of the seabed appear to have surficial failures. Many of these failures in deeper water have linear headscarps, developed along faults previously imaged with high-resolution seismic profiles. Such faults are targets for investigation of surface seeps using ROV technology.

The multibeam imagery data are being used to derive a regional assessment of the character of seabed erosion and the distribution of failures throughout the Scotian Slope where little data exist on these issues. They are allowing for the interpretation of the character of sediment failure features at the seabed, the identification of "fresh" failures, the distribution of head scarps and their relationship to sub-surface features known from seismic profiles. Gradients on head scarps allow direct estimation of the strength of seabed sediment. Many of the large failures on the Scotian Slope extend from one lease block to another and therefore their interpretation requires regional information. The spatial resolution of multibeam is higher than 3-D seismic and a more regional coverage is provided.

This multibeam data has also provided precise targeting of seabed features for the sediment-sampling program performed by the Geological Survey of Canada (Atlantic) at the Bedford Institute of Oceanography. As a partner with the industry group, GSCA performed a 30-day confirmation cruise in August 2000 acquiring high-resolution seismic profiles and piston cores. The results are being used to ground-truth the multibeam imagery and to interpret the geohazards including slope stability on the lease block area, the age of past failures, the age of slip features on near surface faults, and the distribution of failure scarps and their relationship to sub-surface features. GSCA is performing the analysis with the collaborating partners in industry and universities including Dalhousie and Saint Mary's.

The high-resolution seabed morphology, together with backscatter data, allow an interpretation of the character of seafloor sediment that is much superior to interpretations made from 3-D seismic data. For example, muddy and sandy canyon floors can be distinguished and the presence of sandy ridge crests and outcropping strata on ridge flanks can be determined. Such data provide a basis for assessing biological habitat and the possible transport of seafloor materials.

For more information please contact:
Art.Kleiner@cctechnol.com or visit http://www.cctechnol.com

Pacific Region

Nautical Publications

The Nautical Publications division within CHS Pacific has been extremely busy this year. The production cycle on paper charts has been such that 33% of our inventory is going out of stock this year which requires us to do some sort of charting action. This has put a huge burden on the staff in this division. The ENC side of production has had similar pressures with producing new products and updating existing files.

This has all come during a year which was full of training demands. Four of the junior MDH staff were on extended rotational assignments for career development and one also returned to university to complete his degree. Throughout the year staff were involved with ISO documentation and training, training on new software for the ENC production and Product Database, and training on PC CARIS as we moved away from UNIX. This all has added to the burden of a heavy production load.

Program Integrity is now becoming a hot issue in Nautical Publications as we are beginning the process of improving our position to produce products. Initially we hired two former staff members under contract to look at the integrity of digital chart files and outstanding unincorporated data. This information will enable us to effectively evaluate the work that is required to improve our inventory. The next step is to get files out to contractors for updating. This will be an ongoing process over the next year and a half.

Also on our agenda this year is the preparation of charts for the new Vessel Traffic Scheme proposed for the Pacific Coast. The new scheme affects 12 charts that will need to be produced as New Editions. We are also looking at the future of Chart 3312, the Cruising Atlas of Desolation Sound/Jervis Inlet. A reprinting of the current edition is underway but we are looking forward to the next New Edition which requires planning. We will be undertaking a market study of focused user groups to determine if this product should be redesigned for today's user. The product was first produced in 1986 and has been a major revenue generator for the CHS.

Our Sailing Directions unit is putting the finishing touches on PAC 200, PAC 205, and PAC 206, which are the replacement booklets for B.C. Sailing Directions (North Coast) Volume 2. These will be released early in the new fiscal year.

Our Graphics Specialist has been busy working on these new Sailing Directions booklets, preparing numerous advertisements and posters for the Sales and Distribution group, producing posters for other CHS projects, most notably multibeam imagery, working on components of our Raster produced charts, and becoming involved with some of the emerging scanning and imagery technologies for the conversion of hardcopy field sheets to a digital file.

The Hand Amendments group has been busy with the summer's peak demands for chart sales and they are also using the HP plotters to plot complicated hand amendments.

Pacific Region has just welcomed an employee from Laurentian Region who is participating in a one-year exchange. Julie Remy has come out west and Shelley Parkhouse will be travelling east. Also added to Pacific Region are four new MDH employees. We welcome Koert Winkel, who is initially assigned to Nautical Publications, Michele Gill, who is working in Geomatics, Brent Seymour and Craig Lessels, who are in Field Surveys.

The Nautical Publications Division is continuing its support of the marine community by hosting evening tours for Power Squadrons and other interested groups. Throughout the fall and winter we average two per month and it gives the users a unique view into the production of a tool they often take for granted. These tours are always well received and we look forward to reaching many more users this coming year.

Atlantic Region

Olà! Brazil

Two CHS representatives are travelling to the Brazilian Hydrographic Office (Directoria De Hidrografia E Navegacao) for two weeks to assist in implementing and improving multibeam technology. The Canadian Hydrographic Service has substantial experience in these areas, having operated multibeam systems for over 12 years. The CHS, as a member of the International Hydrographic Organization (IHO), continues to support international activities in hydrography towards common standards and technology development.

Source Data Base Implementation Project

Michel Therrien is heading up the Source Database Implementation project in the Atlantic Region. Michel is currently identifying and mobilizing resources for the team to begin work on the pilot project, identified as Chart 4013, that will be used in the implementation process.

Internal Communications Working Group (ICWG)

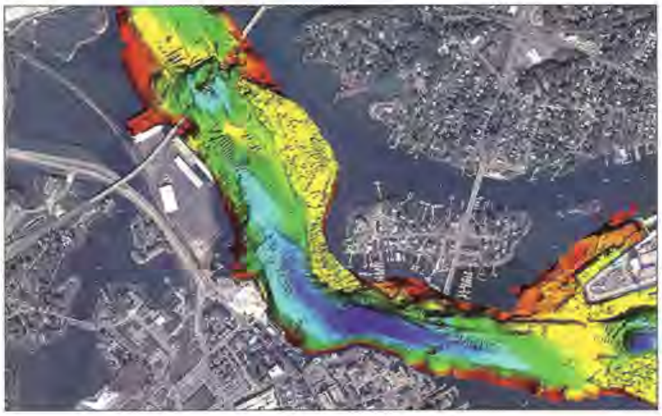
The ICWG has been working effectively in responding to suggestions and we are working hard to promote better internal communication in the workplace.

We would remind everyone to use the Suggestion Box on CHSWEB or approach one of our members with suggestions. All suggestions are considered and reviewed. Responses are posted to CHSWEB.

Shallow Water Conference in New Hampshire

The *2nd International Conference on High-Resolution Surveys in Shallow Water* was held September 24-27 in Portsmouth, New Hampshire. Notable corporate participants included CARIS, Helical Systems, SIMRAD, and RESON.

"Multidimensional Thinking: A Revolutionary Approach to Large Data Set Management and its Application to High-Resolution Bathymetric Surveys", written by Herman Varma in collaboration with Helical Systems and GSC, was presented by Jeff Stockhausen of Helical Systems.



Update from Ireland

In June 2001, the Irish Marine Institute received support from the Newfoundland Labrador Business Partnership to engage in a collaborative project with the Canadian Centre for Marine Communications (CCMC), Newfoundland. The aim of the project is to facilitate the development of expertise in advanced data acquisition, data processing, interpretation, management and dissemination technologies. This will be achieved by facilitating technology transfer and exchange between commercial companies and universities / research institutes and through training / development activities.

The Marine Institute engaged two experts from CCMC including our own Gerard Costello to work on the project.

Gerard is based in the Marine Institute's Technical Support Base in Galway. He is working with the Institute's Seabed Survey Team comprising staff from the Marine Technology Section, the Research Vessel Operations Section, and the Marine Data Centre. His assignment focuses on the transfer of expertise in hydrographic surveying including surveying planning and logistics, data acquisition, data processing, data interpretation, and product development.

Neil Anderson's unfortunate illness has resulted in Gerard's assignment being extended to late October.

Nautical Publications

There are 51 ENC charts scheduled for production this fiscal year. Doug Frizzle is pleased to report that 21 of these have been sent to headquarters. Four cell-based ENC's have also been sent to headquarters. This marks a change in production methodology from overlapping paper charts to non-overlapping cells.

Special thanks go out to the ENC group for pushing ENC 4839 through production in a very efficient and effective manner.

The 7C's evaluation by Alan Smith and Chris Coolen is ongoing. The evaluation period has been extended for a few weeks. No decisions have been made, but initial reports suggest that the software provides very efficient tools for making updates.

Gary Henderson and Walter Burke have been hired to assist in clearing the backlog of Notice to Mariners and also in upgrading to a more efficient process. Dustin Whalen has been hired to work on a cables project in Chart Maintenance.

Tidal

Fred and Carmen have been working to re-establish a permanent tide gauge at Nain, Labrador as part of a five year Arctic Tide Gauge project.

Glen King has collected GPS data at tide stations in Cape Breton and on the Eastern Shore. The office has been busy responding to numerous requests for tidal information for new charts, new editions, and requests from the on-datum chart project.

Charlie O'Reilly traveled to Japan October 9-12 to attend the IHO tidal officer's annual meeting.

Data Incorporation Project

John Ferguson and Wendy Woodford are continuing the data incorporation project that Tammy Waechter had started. In the last month, John and Wendy have completed approximately ten charts, six of which have been completely updated in CHSDIR.

Upon project completion, a CHSDIR maintenance search will only produce data relevant for updates.

Shift Happens

The latest assignment list refers to a crew of 4 (John Rowsell, Jon Griffin, Craig Zeller, Nick Stuifbergen) as "Program Integrity - Off Datum Charts Project". However, this project is initially only concerned with converting NAD27 charts to NAD83, and not true "off-datum" charts. So they dubbed the project On-Datum instead. It was decided that raster was the logical way to go, given the need to do numerous charts during the short two-year Program Integrity period.

To gain some insight, Jon and John traveled to Ottawa, and spent a couple of days meeting with Rick Mehlman and Rob Morrison, trying to better understand their process for raster new editions. Later, Craig and John traveled to NDI to get a handle on what portions of this work might be readily contracted out. Later still, Craig went to PEI to visit Geonet with the aim of possibly contracting some work to them. They also set about trying to prioritize our list of "one hundred and twenty something" charts.

They are presently getting contract work carried out by two companies: NDI and Geonet.

Rick's shop is helping with identifying required work. Dave Roop, John Ferguson, and Wendy Woodford are helping with investigating unincorporated data sources, and hopefully Jon and Craig will do some actual raster updating and QC work. Nick Stuifbergen's work is centered around actual off-datum charts, and should become more of a priority later in the project.

Geomatics

Geomatics has recruited Keith White to assist on the Source Database project. Keith will be primarily involved in loading the data that currently resides on the MSM into the Source Database.

Survey Activities, Fall 2001

MATTHEW Program

Phase two of the *MATTHEW* survey started August 10th under the direction of HIC André Roy.

MATTHEW visited Newfoundland's Notre Dame Bay, St. Anthonys, Pacquet, Snooks Arm, and Red Bay on the Southern Labrador Coast to complete data collection to update chart 4669. The last few stops on the cruise included Harbour Grace and Bay Roberts in Conception Bay and a mussel farm in Fortune Harbour.

The crew returned on October 13 and the *MATTHEW* to BIO on October 17.

CREED Program

A cancelled Herring survey in the Quebec region provided the opportunity for CHS and DND to collaborate on an operational, training, and familiarization survey that gave a number of CHS employees a chance to get their "sea legs".

DND and CHS crew rotated under HIC Mike Lamplugh and LCDR Jim Bradford for two weeks as they collected data from the eastern approaches to Halifax Harbour, Rose Bay in Lunenburg Harbour, and the wreck of H.M.C.S. Saguenay in Lunenburg Marine Park.

The *CREED* will depart again on October 18th for the Bras d'Or Lakes under HIC Ken Paul. This project is being carried out in cooperation with various Aboriginal communities in the area who want to promote conservation and sustainable use of the Lakes. The data will also be available to update the local charts.

The crew is to include Paul Parks, Claudine Fraser, Jon Griffin, Andy Craft, and Jason Pierro of Eskasoni Fish and Wildlife Commission.

Congratulations New Employees!

Chris Leblanc, Andy Craft, Glen King, Mark McCracken, and Tammy Doyle have received their papers!

Chris, Andy, Glen, Tammy, and Craig Zeller attended the Hydro I course at the Sydney Coast Guard College and the Nautical Institute in Port Hawksbury from Oct 15 to Nov 9.

Central and Arctic Region

CHS Staff

Dennis St. Jacques is Central and Arctic Region's new Director. He has been with CHS for many years and brings considerable experience and knowledge to his new position. Best wishes for your continued success!

Special congratulations to Andrew Leyzack and Jacqueline Miles on their marriage which took place on Octobrer 13, 2001.

Roger Cameron, Heather MacArthur, Glenn Macdonald, Mike Read and Scott Youngblut have just completed the month long Hydrographic Training course (Hydro I) in Sydney, Nova Scotia.

ISO Update

CHS has been successful in achieving registration to the ISO9001:2000 International Standard! Thanks are extened to Sean Hinds who is the project leader for ISO Implementation and who provided continual inspiration and motivation for all regions.

Hydrographic Surveys in 2001

CHS Arctic Program in 2001

Central and Arctic Region survey staff were aboard three Canadian Coast Guard ships in the Arctic during 2001 survey season.

In the Western Arctic, Jon Biggar HIC and eight CHS staff were aboard the *CCGS NAHIDIK* from the end of July to late September. The 2001 program was a two-phase operation. The first phase from July 30 to August 20 was a joint CHS/Geological Survey of Canada survey of an area northwest to northeast of Tuktoyaktuk in the Beaufort Sea. The purpose of this surveying project is to evaluate the application of new surveying technologies and the effectiveness in developing a better understanding of seabed morphology, habitat and the impact of ice on the seabed. The program involved multi-beam and single-beam sonar acquisition from the launches *PETREL* and *WOOD* respectively. The Wood was outfitted with sidescan sonar and a towed underwater video camera system. The stability of the Wood on most days was inadequate for sidescan operations. The underwater video camera system proved to be ineffective because of water clarity. The *NAHIDIK* was also outfitted with single beam and sidescan equipment. NRCan provided their real time GPS-C differential service for positioning in the Western Arctic.

On the second phase from August 21 to September 18, CHS continued its program of surveys in the Western Arctic. Surveys were completed at the following locations: Holman, Kugluktuk, and Taloyoak (Spence Bay). Two days of surveying were also accomplished at Storis Passage. The nautical charts of these areas are constructed from 'Turn-of-the-Century' surveys and show large unsurveyed or sparsely surveyed areas. These charts are adequate for visual navigation but often cannot be used with the satellite navigation systems required for modern, precise navigation. The *NAHIDIK* was lifting buoys in Simpson Strait and Cambridge Bay and returned to Inuvik on September 23rd. The 2001 program was a success.

The *CCGS NAHIDIK*

In the Eastern Arctic, Tim Janzen HIC, two hydrographers and one Hourston, single-beam survey launch were aboard the *CCGS PIERRE RADISSON* from mid-July to the end of September. Hydrographic surveys in Hudson Strait and Foxe Basin were conducted on an opportunity basis. Extensive areas were surveyed by survey launch at Killiniq Island (Port Burwell), Igloolik, Kimmirut (Lake Harbour), as well as at Iqaluit and the approaches through Pike-Resor Channel. Surveys were conducted at some other sites (Hall Beach, Radio Island, Button Island) while the ship was in the area.

Arnie Welmers was aboard the *CCGS LOUIS ST. LAURENT* to provide a hydrographic surveying capability to allow the ship to access some uncharted areas in support of a multidisciplinary scientific study in Nares Strait. Arnie then joined the hydrograpchic program under way on the *CCGS PIERRE RADISSON*.

Multibeam Surveys

The newly acquired multibeam system and launch *MERLIN* were kept busy with various projects closer to home while the *PETREL* braved the Arctic waters.

Paola Travaglini ran multibeam surveys in Sarnia, Corwall, three weeks in Lake Ontario just off Toronto Harbour and one week in Hamilton Harbour. These projects, along with the survey programs on board the various Coast Guard ships made for a very successful season for multibeam collection.

New Multibeam launch *MERLIN*

Tides Currents and Water Levels

Funding became available from a program to re-establish some Arctic tide gauge stations to monitor climatic change. Ron Solvason made reconnaissance visits this summer to proposed sites at Cape Parry and Holman in the western Arctic. From a logistical point of view the preferred site would be Holman. Discussions with the oceanographers will have to be held before a final site selection in this area can be made. Ron also visited the previous gauging site at Alert to determine if a gauge could be re-intalled. Under this program, the tide gauge station at Nain on the Labrador coast was re-established in September.

Congratulations! CHA Award Winner Dan Deneau

B.M. Lusk, Manager, CHA Award Program

Dan Deneau is 24 years old and lives in Middleton Nova Scotia. He is attending the College that was once known as College of Geographic Sciences (COGS) but is now known as Centre of Geographic Sciences (COGS). He presently has an educational debt of $35,000 and describes himself in his application as "completely and utterly poor". His combined marks at school are a strong "B+" and I feel a good candidate for this award. He intends on continuing his education at Dalhousie University in future years.

Dear Editor,

I'd like to offer sincere thanks to the Canadian Hydrographic Association for presenting me with this award. I consider this award to be not only a helpful monetary boost, but also a distinct recognition of the effort that I have put into my education/career in the geomatics industry.

At present, I am working with the Applied Geomatics Research Group at the Centre of Geographic Sciences here in Nova Scotia. My work involves GPS Surveying, Processing Imagery, and creating Cartographic products.

In the fall, I will attend the Applied Geomatics Research Program at the Centre of Geographic Sciences. The money from this award will pay my tuition and/or cover expenses for the upcoming year at school.

Once again, thank you for helping me succeed in the geomatics industry!

Yours Sincerely,

Dan Deneau
Research Technician
Applied Geomatics Research Group

THE CANADIAN HYDROGRAPHIC ASSOCIATION AWARD
LA BOURSE DE L'ASSOCIATION CANADIENNE D'HYDROGRAPHIE

(est. 1992 / établie en 1992)

$2,000 for a "Deserving Student" / 2000$ pour un étudiant méritant

1. The applicant must be a full time student registered in an accredited survey science program (the program must have a Geographic Information Systems, Cartographic, Land or Hydrographic Survey component) in a university or technological college anywhere in Canada. The Administrator of this award will determine the eligibility of the program for the award.

2. The award will be available only to students who are in their second year of study in the degree or diploma program (under graduate) that conforms to the basic subject topic. The applicant will be required to submit a transcript of his/her first year marks at the time of application. The marks must indicate an upper level standing in the class and under no condition less than 70%.

3. The award will be presented to an applicant who can demonstrate a bona fide financial need, coupled with an above average academic performance as stated above.

4. The applicant will be required to write a short paragraph explaining his/her financial need in a clear, concise manner on the application form or, if necessary, attached piece of paper. The importance of this aspect of the application is emphasized.

5. The award application will be submitted to the Administrator of Canadian Hydrographic Association Award Program by June 30 each year and to the address in item 11 below.

6. The value of the award is $2,000. There is one award only each calendar year.

7. The successful applicant will be issued with a special Hydrographic Association Certificate, duly framed, at the time the award is made. He/She will also receive a medallion with the Hydrographic Association Crest and have his/her name mounted on a perpetual winner's plaque. A picture of the plaque duly inscribed will be mailed to the winner along with the $2,000 cheque during the second week of July.

8. The applicant must submit one letter of reference from a official of the university or college where the applicant spent the previous year. This letter of reference must include the address and phone number of this official.

9. An individual student may receive the award once only.

10. The successful applicant's letter of appreciation will be published in the next issue of our professional journal "Lighthouse".

11. Application will be made on the form supplied, which is available from your school's awards office, and sent to:

Critères d'admissibilité:

1. Le candidat doit être un étudiant inscrit à plein temps à un programme reconnu en sciences géodésiques (ce programme doit inclure les systèmes d'informations géographiques, la cartographie, les levés terrestres et hydrographiques) dans une université ou un collège au Canada. L'administrateur de cette bourse déterminera l'éligibilité du programme pour la bourse d'études.

2. La bourse s'adresse seulement aux étudiants qui seront à leur deuxième année d'étude dans un programme menant à un diplôme collégial ou de premier cycle universitaire conforme aux sujets de base. Le candidat doit soumettre une copie de son relevé de notes de sa première année avec sa demande. Les notes doivent être supérieures à la moyenne et avoir une moyenne inconditionnelle supérieure à 70 %.

3. La bourse sera remise au candidat qui, de bonne foi, peut démontrer ses besoins financiers et qui respecte les performances académiques exigées ci-haut.

4. Le candidat devra écrire un court texte, d'une manière claire et concise, démontrant ses besoins financiers sur le formulaire de la demande ou, si nécessaire, sur une lettre jointe. Une grande importance est accordée à cet aspect de la demande.

5. La demande doit être soumise à l'administrateur du programme de la bourse de l'Association canadienne d'hydrographie au plus tard le 30 juin de chaque année à l'adresse mentionnée à l'article 11 ci-bas.

6. La valeur de la bourse est de 2000 $. Il n'y a qu'une seule bourse remise à chaque année civile.

7. Le récipiendaire recevra un certificat spécial de l'Association canadienne d'hydrographie, dûment encadré . Il recevra aussi un médaillon à l'effigie de l'Association canadienne d'hydrographie et son nom sera ajouté sur la plaque des gagnants. Une photo de la plaque gravée sera postée au gagnant avec un chèque de 2000 $ au cours de la deuxième semaine de juillet.

8. Le candidat doit soumettre une lettre de référence d'un représentant de l'université ou du collège où il a suivi son cours l'année précédente. Cette lettre de référence doit inclure l'adresse et le numéro de téléphone de ce représentant.

9. Un étudiant peut recevoir la bourse qu'une seule fois.

10. Une lettre d'appréciation du récipiendaire sera publiée dans l'édition suivante de notre revue professionnel "Lighthouse".

11. La demande devra être faite sur le formulaire prescrit, lequel est disponible aux bureaux de vos écoles, et envoyée à :

Barry M. Lusk, Manager / Administrateur

Canadian Hydrographic Association Award Program / Bourse de l'Association canadienne d'hydrographie

4719 Amblewood Drive, Victoria, B.C. V8Y 2S2

email/ courriel luskbm@telus.net Fax : 250 658 2036 Web site: chswww.bur.dfo.ca/dfo/chs/cha

Roy Amero

AMERO, Roy Charles - of Dartmouth, passed away May 30, 2001 at the QEII Camphill Veteran's Building. Born in Doucetteville, NS, on April 8, 1918, he was the son of the late Fred and Isidora (Wagner) Amero. Roy was a veteran of the Second World War, and was a member of the Fourth Canadian Armoured Division, where he was introduced to surveying. The Army surveyors provided coordinates, distances and other topographic information for the artillery. Roy enjoyed this exposure to surveying and following the war, he attended the Lawrencetown Survey School (now the Centre of Geographic Sciences) in Lawrencetown NS. Following graduation, Roy worked for the Maritime Marshlands Reclamation Authority, surveying the dyke lands in the Amherst area of NS. It was during this time that he met his wife, Justine (Gussie). He joined CHS in 1955 and they moved to Ottawa where their sons, Brent and Bruce were born. The family returned to NS in 1960 when the Atlantic Region was created. Roy was involved in surveys too numerous to mention, but notably, he was HIC on the *ACADIA* in 1966, and also in 1969, her last survey season. The *ACADIA* is still "in service" as a major display at the Maritime Museum of the Atlantic on the Halifax waterfront. Roy provided much of the background information for the on board displays. He had the unpleasant experience of being on board the charter vessel MV *MINNA* when it grounded at Resolution Island in the Eastern Arctic in 1974. Fortunately, everyone was evacuated safely. Roy continued to work on a variety of survey projects until his retirement in1983. He was proud of his career with CHS and continued to keep in contact and attend CHS social events, including our 2000 Christmas party. Roy was a kind and gentle man who treated everyone with respect. His friends and colleagues will miss him.

Pacific Branch

Congratulations go out to James and Linda Wilcox on the birth of their second child Nigel, Allan born July 7 2001.

On Wed June 27, members attended a lunchtime seminar held at the Glen Meadows Golf Club. The occasion marked the transfer of Bill Crawford from the CHS to the Ocean Science and Productivity sector of DFO. Bill entertained the diners with a presentation on "Back and Forth with Tides and Currents: Past, Present and Future Research". Bill was presented with a CHA plaque and beer glass as a token of appreciation for his contribution in the past and warm wishes go with him in his new endeavours.

Doug Cartwright was welcomed back for the summer field season after a stint at the University of New Brunswick where he is doing his Masters in Geomatics Engineering with the Ocean Mapping Group. Unfortunately, most members didn't get to see much of Doug as the majority of his time was spent in the field, specifically working with the newly installed Moving Vessel Profiler aboard the Revisor. Doug is now back in Fredericton and we wish him well with his studies.

For the first time in two years there were hirings of new staff in Pacific region. The CHS family welcomes newcomers: Michele Gill, Brent Seymour, Craig Lessels and Koert Winkel, who provide a welcome dose of new blood and plenty of technical "know how". All the newcomers will be attending the planned Hydro 1 course in Nova Scotia this fall in anticipation of their deployment in the coming field season.

Pacific region is again involved in a personnel exchange with Laurentian region. Shelley Parkhouse has left the fold for a one-year secondment in Mont Joli. In her place we are pleased to welcome Julie Remy. Julie brings two years experience of surveying on the St. Lawrence to our office and is looking forward to some new challenges and surveying in a totally new environment.

Kalman Czotter has returned from Malaysia after acting as the CIDA representative offering hydrographic training to members of the Malaysian Navy

Rob Hare has been away since April on a research secondment to the University of Southern Mississippi. We anticipate his return at the beginning of October and look forward to some interesting tales of his time there.

The memorial plaque for the *WILLIAM J STEWART* went through several adventures this spring. Originally it was noticed to be missing from its home in the Inner Harbour wall in Victoria. After an initial all-points bulletin, the plaque was located and it was determined that the first mounting mechanism was faulty and that weathering caused it to come away from the wall. Local member Al Thorn devised a new mounting and it can now be reported that the plaque is safely back in place informing visitors to the Inner Harbour of the history of the "Willie J".

Central Branch

The CHA Central Branch executive is organized into five distinct Committees, each tasked with maintaining certain functions of the Branch.

The **Communications Committee** is responsible for supporting the Branch Newsletter that is published and distributed after each of the Branch General Meetings. The Branch newsletter contains minutes of the meetings as well as messages from Committees and the Branch VP. It is distributed outside the Branch to International Members and the VP's of other CHA Branches. This Committee is also responsible for providing Branch information to *LIGHTHOUSE* as well as distribution of *LIGHTHOUSE* to Branch and International Members. Finally, the Committee is also responsible for the maintenance of the Central Branch website at http://chswww.bur.dfo.ca/dfo/chs/cha/.

The **Membership Committee** is responsible for the annual elections and membership drive in Central Branch. Our current membership stands at 64, including four Sustaining Members: Canadian Centre for Marine Communications, Kongsberg Simrad Mesotech Limited, Knudsen Engineering Limited, and Octopus Marine. Our Central Branch is honoured to include several special people in its membership rolls: Earl Brown, Tom McCulloch and Ab Rogers – Life Members; George Macdonald – Honorary Member and Steve Ritchie – International Life Member. Central Branch is pleased to welcome five new members to its rolls: Patrick Brassard, Ahmed El-Rabbany, Les Reading, Bob Strachan and Scott Youngblut.

On behalf of the National office, Central Branch also administers our International Membership, which totals 19 members in good standing. The Membership Committee helps to maintain contact with the International Members of the CHA, providing a channel for them to voice their opinions and share as much as possible in CHA-sponsored events.

The **Admiralty Launch *SURVEYOR* Committee** is dedicated to maintaining this vessel in working order and providing support at events where the launch is used to promote hydrography in Canada.

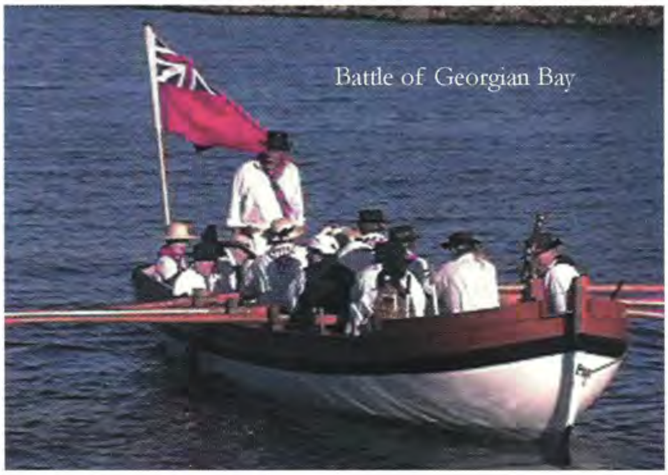
The 2001 season began with the *SURVEYOR* attending the Upper Canada Trade Faire in Odessa on April 28 & 29. This was a static display, which gave us the opportunity to explain the importance of the role of Hydrography in the early settlement of Canada.

Upper Canada Trade Fair

The launch then returned to Burlington to undergo the annual spring maintenance. *SURVEYOR* was then delivered to the Marine Heritage Association (MHA) by mid-June. Due to circumstances beyond our control, the sail training at Discovery Harbour did not make use of the *SURVEYOR*. The next event was a Hydrographic survey demonstration at the waterfront festival in Owen Sound, August 4.

Owen Sound Waterfront Festival

The big event of the year was the *Battle of Georgian Bay*, Aug 23 to 26. The crew started arriving on Wednesday and some stayed until the following Monday. Approximately 2000 re-enactors camped at Discovery Harbour (site of former winter home of Henry Bayfield). The launch participated in several battle scenarios with the larger vessels. When not 'under fire', CHA members and crew looked for opportunities to promote the role of hydrography in Canada to the general public. Brian Power got a break from rowing as he took on the role of 'Skipper' for this event.



Battle of Georgian Bay

Battle of Georgian Bay

The last event of the year was the *Faire of the Forks* in Chatham, September 28 to 30. With close of another busy summer the *SURVEYOR* is back in Burlington to winter in its new shelter until the spring of a new season..

The **Education and Development Committee** is tasked with maintenance and promotion of the *Gerry Wade Memorial Library*. The library has recently acquired a bookcase in which is housed research and historical material owned or loaned to the Branch. It is available for all Branch members to access materials for study or personal interest.

Since January, we have had six general business meetings that include a presentation of interest to the membership. Meetings are generally home hosted by CHA members. This year we have been hosted at the Weller residence, the Power residence and the Duller residence - thank you all for your fine hospitality. Beyond the general business of the Branch, we have had presentations from DFO Central Region Fish Habitat Management group, Research Support Branch of the National Water Research Institute, and CHS presentations on the application of GPS-C and adventures on surveys in the Western Arctic.

In addition to our-home hosted meetings, we have enjoyed one luncheon seminar with speaker Jim Statham, Past President - Association Canada Lands Surveyors, and one evening meeting held at Thirty Bench Winery where we enjoyed the flavours of their fine vintage wines and a tour of the facility.

The **Social Events Committee** is tasked with organizing our annual special events that includes the H2O Bonspiel, the Annual Summer BBQ, and the Annual General Meeting (AGM) and Dinner.

The 2001 CHA Central Branch Barbeque was held July 7th at the lovely residence of Norma and Jon Biggar. The event was attended by a broad spectrum of CHA members and their families. The excellent spread of food was topped-off by a round-robin tournament of croquet that wound its way through lovely landscaped gardens.

The AGM is scheduled for December 6, 2001, at the Mimico Cruising Club located just west of Toronto on the shore of Lake Ontario.

News Flashes:

Julian Goodyear has departed the CHS Central and Arctic Region for a new post as Regional Director of Coast Guard, Central & Arctic Region. We wish Julian and Gayle the best in yet another new home. CHA and CHS look for continued and strengthened ties with Julian in his new career. Thanks Julian for all the support you gave CHA during your stay in Burlington as Director CHS.

Congratulations, Dennis St. Jacques! Dennis is the new Regional Director for CHS Central & Arctic Region. Dennis has been a CHA member for many years and we look forward to his continued participation and support. We wish him all the best in his new position.

Bruce Richards has officially depart the Burlington area for a new posting as the Area Manager DFO in Parry Sound, Ontario. Bruce will manage the delivery of a broad base of Fisheries and Oceans Canada programs in the Parry Sound District. We wish Bruce and his family all the best in their lives and look forward to staying in touch with Bruce as an outhouse member of CHA.

Peter Knight continues to be on of our most prolific International Members. Peter and his family left Central Branch CHA (and CHS) almost four years ago for a post as Lecturer at the University of Otaga in New Zealand. Peter is busy with two primary functions. His involvement in teaching also includes managaerial activities of preparing a submission for Category A certification to the IHO. His research activities complement efforts for formulating a National Oceans Policy for New Zealand. Peter is looking forward to visiting Canada with his family in time to participate in the CHC 2002 in Toronto. We look forward to sharing some time with you then Peter and the best of luck with your engaging endeavours.

Andrew Leyzack and Jacqueline Miles have tied the knot with a sharing of wedding vows on October 13, 2001. Best wishes to you both, from your friends in Central Branch.

Dan Brousseau was scratched from the bachelor roles as he and Christine Boston joined the ranks of married couples in May of 2001. Best wishes to Christine and Dan, from your friends at Central Branch.

Dave Willis has departed Central Branch and has relocated in Victoria B.C. Best wishes in your new home, Dave.

Jim Weedon spent his summer holidays as a deck-hand on the HMS Tecumseh as it toured to special events on the Great Lakes.

HMS Tecumseh

Did You Know...

According to the *Guinness Book of World Records*, the strongest currents in the world are the Natwakto Rapids at Slingsby Channel in British Columbia. The flow rate may reach 16 knots or 18.4 miles per hour.

INTERNATIONAL MEMBERS OF THE CANADIAN HYDROGRAPHIC ASSOCIATION

Membership in the Canadian Hydrographic Association is open to anyone interested in maintaining a link with hydrography in Canada. People who live or work in other countries or who are not conveniently located to existing CHA branches can become International Members with the same rights and privileges as other members.

As authorized under the CHA by-laws, the National President has arranged for Central Branch to continue administering the International section of the CHA membership. Under this arrangement we endeavour to ensure that all International Members receive the same level of service. International Members may also join the branch of their choice.

International Membership is $30.00 (Canadian) per year, or the equivalent in Sterling or US currency. This includes a personal membership certificate suitable for framing along with annual update seals as well as copies of our journal *LIGHTHOUSE* each spring and fall.

Each International Member also receives the Central Branch NewsLetter. This helps our far-flung members keep in touch between issues of our journal and also offers a forum for members to share views and concerns.

Commander Larry Robbins of the Royal New Zealand Navy is our International Correspondent for the Newsletter and writes a regular column with items of interest to International Members. Drop snippets of news to him at: 42 Knights Rd., Rothesay Bay, Auckland 1311, New Zealand, Tel/Fax (+64) 9 410 2626. All scraps are very welcome! And if you have special news or views, you are most welcome to write something longer for the newsletter or Lighthouse. Letters to the Editor are also welcome.

International Members of the Canadian Hydrographic Association

Rhea Metin Alkan	*Turkey*
Peter Barr	*Australia*
Geunter Bellach	*Thailand*
Fosco Bianchetti	*Italy*
Gary Chisholm	*New Zealand*
Luis Leal de Faria	*Portugal*
Ron Dreyer	*Ghanu*
Nick Emerson	*Hong Kong*
Randall J. Franchuk	*U.S.A.*
George Goldsteen	*Australia*
Adam J. Kerr	*United Kingdom*
Karl Kieninger	*U.S.A.*
Peter Knight	*New Zealand*
Charles David Meador	*U.S.A.*
George Pugach	*Azerbaijan*
Rear Admiral Steve Ritchie (Ret'd)	*Scotland*
Cdr. Larry Robbins	*New Zealand*
Kevin Smith	*New Zealand*
Universiti Teknologi Malaysia	*Malaysia*

HINTS TO AUTHORS

LIGHTHOUSE publishes material covering all aspects of hydrography.
Authors submitting manuscripts should bear the following points in mind:

1. A hardcopy complete with graphics including tables, figures, graphs and photos.
2. Digital files, one with text only and a separate file for each graphic (tables, figures, photos, graphs) in its original form or in .tif format (300 DPI). Photos may be submitted separately to be scanned. These may be submitted via E-mail or on CD ROM to the Editor.
3. Papers should be in either English or French and will be published without translation.
4. An abstract, information about the author(s) and contact information should be included.

rates tarifs

POSITIONING / EMPLACEMENTS

The acceptance and positioning of advertising material is under the sole jurisdiction of the publisher. However, requests for a specified position will be considered if the position premium of $25 has been included in the insertion order.

L'approbation et l'emplacement de l'annonce sont à la discrétion de l'éditeur. Cependant, toute demande d'emplacement spécifique sera considérée si une prime de 25 $ est ajoutée à la demande de parution.

MECHANICAL REQUIREMENTS EXIGENCES MÉCANIQUES

Advertising material must be supplied by the closing dates as camera-ready copy or film negatives (Colour ads must be film negatives). Copy preparation, including colour, bleed and photos will be charged at the printer's cost plus 10%. Proofs should be furnished with all ads.

Single-page inserts will be charged at a full page body rate. Material must be supplied by the client. Page size must conform to the single page insert trim size (below).

L'annonce publicitaire doit être un prêt à photographier ou sur film négatif (les couleurs supplémentaires doivent être sur film négatif) et être fournie aux dates de tombée. La préparation de copie couleur, à fond perdu et de photos sera chargée au tarif de l'imprimeur plus 10%.

Les épreuves devraient être fournies avec tous les suppléments. Les insertions d'une page seront chargées au tarif d'une pleine page. Le matériel devra être fourni par le client.

DIGITAL REQUIREMENTS EXIGENCES NUMÉRIQUES

Ad material may be submitted in digital form, if colour .tif format and if black and white .pdf format.

L'annonce publicitaire peut être soumis sous forme numérique en for-mat .tif pour la couleur et en format .pdf pour le noir et blanc.

PUBLICATION SIZE DIMENSIONS DE LA PUBLICITÉ

Publication Trim Size/ Dimension de la revue:	8.5"	x 11.0"
Live Copy Area/ Encart libre:	7.0"	x 10.0"
Bleed Size/ Publicité à fond perdu:	8.75"	x 11.25"
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Full Page/ Pleine page:	7.0"	x 10.0"
1/2 Page/ Demie-page:	6.875"	x 4.75"
or/ ou:	3.375"	x 9.75"

PRINTING / IMPRESSION

Offset screened at 133 lines per inch.
Internégatif tramé à 133 lignes au pouce.

CLOSING DATES / DATE DE TOMBÉE

LIGHTHOUSE is published twice yearly in Spring and Fall. The closing dates are March 15th and September 15th respectively.

LIGHTHOUSE est publiée deux fois par année, au printemps et à l'au-tomne. Les dates de tombée sont le 15 mars et le 15 septembre respectivement.

RATES / TARIFS

All rates are quoted in Canadian Funds. Sustaining Members receive a 10% discount.

Tous les tarifs sont en devises canadiennes. Les membres de sou-tien ont droit à un rabais de 10%.

	B &W/N & B	Colour/Couleur Une/Spot*	Four/Quatre
Outside Back Cover *Couverture arrière*	NA/SO	NA/SO	$1025
Inside Cover *Couverture intérieure*	NA/SO	NA/SO	$825
Body, Full Page *Pleine page*	$275	$375	$675
Half Page Demie-page	$200	$300	$475
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*Spot Colour (Orange, Red, Blue)/Une couleur (orange, rouge, bleu)

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Les tarifs sont assurés aux termes des contrats publicitaires jusqu'à concurrence d'un an. Les annulations ne sont pas acceptées après la date de tombée.

All advertising material should be directed to:
Tout le matériel publicitaire doit être acheminé à:
Advertising Manager/ Directeur de la publicité

LIGHTHOUSE
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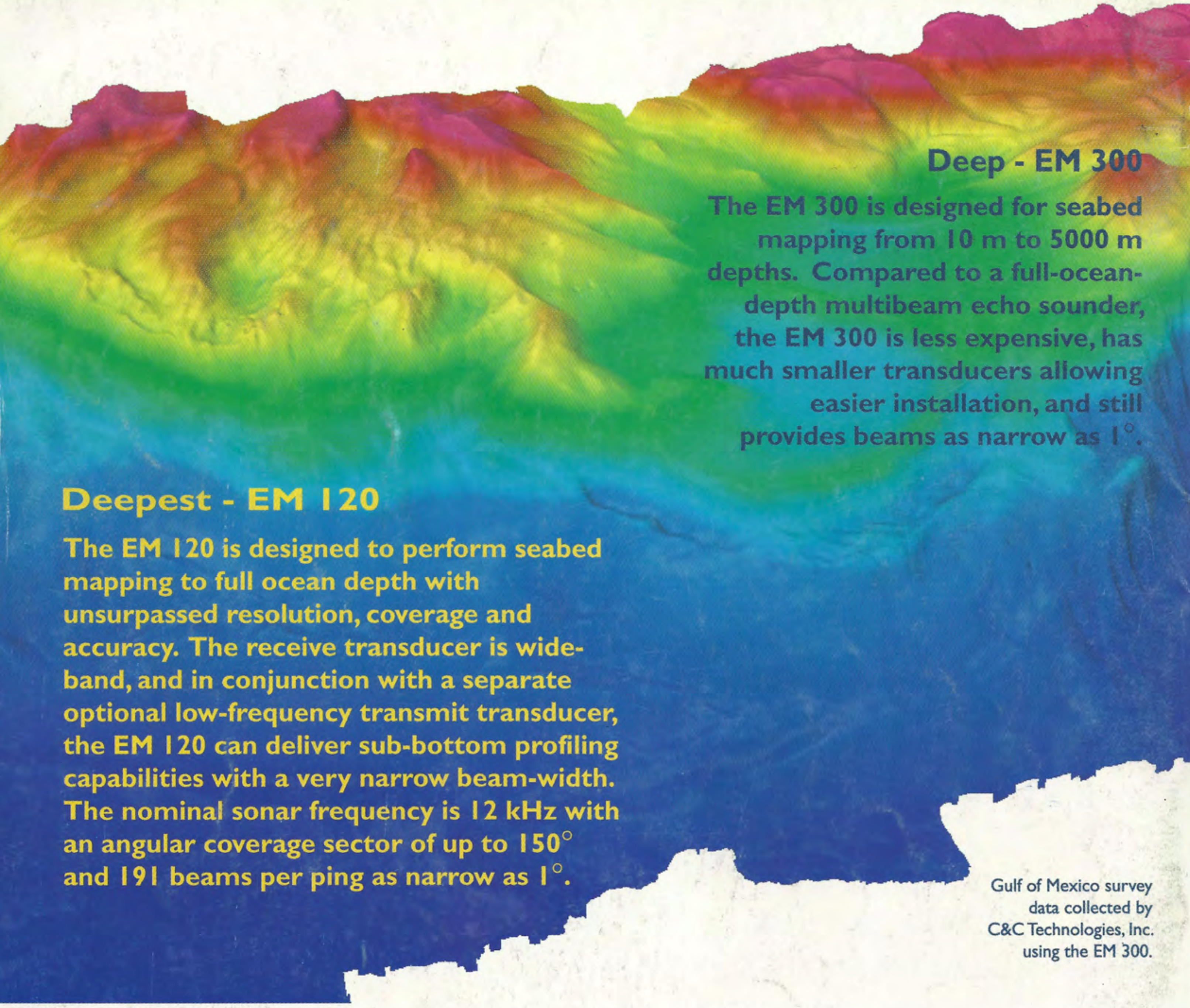

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Gulf of Mexico survey data collected by C&C Technologies, Inc. using the EM 300.

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