LIGHTHOUSE

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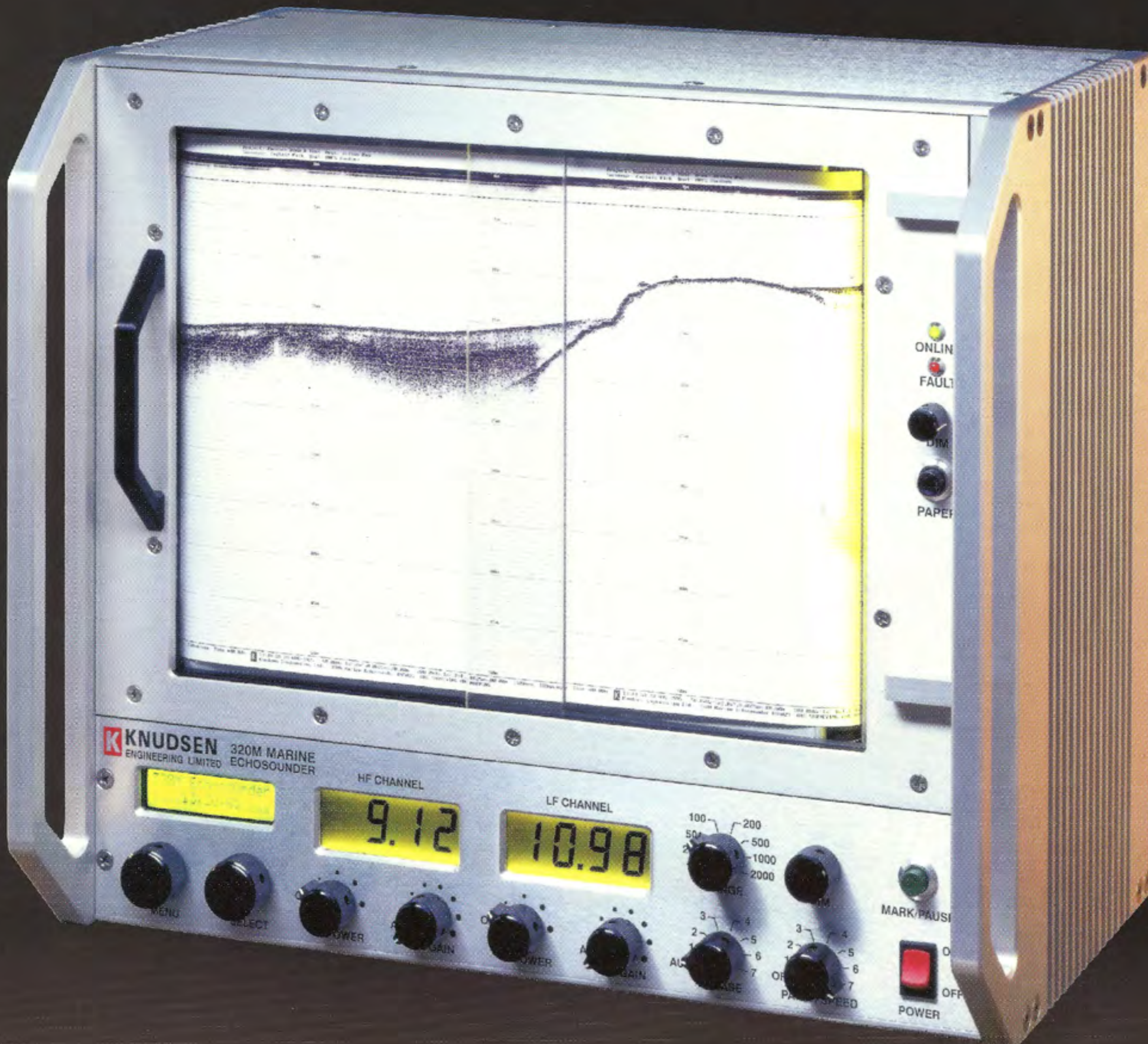

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PICTOU BAR LIGHTHOUSE
Pictou, Nova Scotia

Photograph Courtesy of Janet Francis of the Pictou Landing First Nations Community

Originally built in 1843, Pictou Bar Lighthouse was destroyed by fire on July 5, 2004. Soon after, residents of the Pictou Landing First Nations, the town of Pictou and surrounding area formed the Pictou Bar Lighthouse Restoration Group with the intention of restoring this landmark.

Rod Desborough, a resident of Braeshore on Pictou Harbour, has written an article on the light which appears in this edition of *Lighthouse*.

More information on the restoration project may be found at:

http://www.pictoubarlighthouse.piczo.com

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Editors' Note / Note des rédacteurs

True to the diversity of information which our Journal delivers to its readers, this 66^{th} edition of *Lighthouse* combines leading edge research and solutions with lighter reading of a historical nature. Many a conference has treated recognition of our past with future themes. Perhaps this is not due to a lack of creativity when choosing a theme but merely a simple yet necessary message to all that, while we continue to develop practical tools and technology for safe and efficient navigation, we must constantly be reminded of how things were, so as to stay on track with our progress. Initiatives such as the FIG Permanent Institution for the History of Surveying and Measurement and Steve Ritchie's "As it Was" are valuable contributions to the development of our understanding of marine geomatics today.

This edition talks about the Pictou Bar Lighthouse, its value as an aid to navigation and its intrinsic value to the communities of people who knew the light. You'll also read about the circumstances leading up to the wreck of *BAYFIELD II* and then leap forward to the development of electronic tools to aid in safe navigation through ice-covered waters. El-Rabbany and El-Diasty present a continuation (albeit more technical treatment) of this topic, first introduced in *Lighthouse 65*. We also present an article which describes how both a traditional paper chart and ENC could be produced from a common data structure. An article from NOAA on the Navigation Surface Approach for Archiving and Charting Shallow Survey Data examines its impact on traditional charting "rules". Finally, we look at UNB's Ocean Mapping Group's use of GPS elevation measurements as a means for developing a seamless vertical reference datum. We would like to acknowledge the assistance of Ruth Adams of the United Kingdom Hydrographic Office for her review of this paper.

Speaking about "As it Was", on behalf of the Canadian Hydrographic Association, the editors would like to offer belated best wishes to the "Old Hydrographer", Rear Admiral Steve Ritchie who celebrated his 90^{th} birthday this year(2004).

Andrew Leyzack

CANADIAN HYDROGRAPHIC ASSOCIATION • ASSOCIATION CANADIENNE D'HYDROGRAPHIE •

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Message from the National President
Mot du Président national

The CHA has long been affiliated with the The Hydrographic Society (UK) and our members may be aware that in recent years, the Hydrographic Society has been in process of transforming itself into a Federation of national hydrographic societies. The existing regional branches of the Hydrographic Society have become autonomous national organizations and in turn have joined the International Federation of Hydrographic Societies (IFHS). The *Hydrographic Journal* has also undergone some changes for the better, boasting a new full-colour layout and apparently lower production costs. Benefits of membership in the IFHS include a quarterly subscription to the Hydrographic Journal and the IFHS annual *Diary*.

I became aware of the Hydrographic Society's restructuring plans two years ago while attending Hydro2002 and have since communicated with our directors the potential benefits and opportunities for CHA if we were to join the Federation. As I write this message, Hydro2004, which is to be held in Galway, Ireland, is less than one month away. I have been informed that the IFHS intend to legally formalize their transition from The Hydrographic Society by then. I believe the timing of this event to be a key incentive for CHA and other national hydrographic societies to seriously consider joining the Federation.

Hydrography is international in scope and personally I see more benefit for our members from tapping into an international network of like-minded organizations. I believe, that through our Association's membership in the International Federation of Hydrographic Societies, our members will enjoy increased access to educational resources and career opportunities as well as a better awareness of current events, technology and leading edge developments within the field of hydrography.

L'ACH est depuis longtemps affiliée à la Société hydrographique (RU) et nos membres sont sans doute conscients que depuis quelques années, la Société hydrographique est dans le processus de transformation en une Fédération des sociétés hydrographiques nationales. Les sections régionales existantes de la Société hydrographique sont devenues des organisations nationales autonomes et ainsi, ont joint la fédération internationale des sociétés hydrographique (FISH). Le *Journal Hydrographique* a aussi entrepris quelques changements afin de s'améliorer, arborisant une nouvelle mise en pages tout en couleur et apparemment à moindre coût de production. Les avantages d'une adhésion avec FISH incluent une souscription trimestrielle au Journal Hydrographique et à l'agenda annuelle de FISH.

J'ai pris conscience du plan de restructuration de la Société hydrographique il y a de cela deux ans lorsque j'ai assisté à Hydro2002 et depuis, j'ai parlé avec nos directeurs des avantages potentiels et des opportunités pour l'ACH si nous joignons à la Fédération. Au moment d'écrire ce message, Hydro2004, lequel se tiendra dans un peu moins d'un mois à Galway, Irlande. J'ai été informé que FISH a l'intention de formaliser légalement leur transition de la Société hydrographique d'ici là. Je crois que le moment choisi pour cet événement sera un incitatif primordial pour l'ACH et les autres sociétés hydrographiques nationales de considérer sérieusement de se joindre à la Fédération.

L'hydrographie est d'envergure internationale et personnellement, je vois plus d'avantages pour nos membres à s'affilier à un réseau international d'organisations ayant les mêmes intérêts. Je crois qu'avec l'adhésion de notre Association à la Fédération internationale des sociétés hydrographiques, nos membres apprécieront l'accès accru aux ressources en formation et aux opportunités de carrière offertes ainsi qu'à une meilleure information des événements en cours, de la technologie et des développements de pointe dans le domaine de l'hydrographie.

Andrew Leyzack

Pictou Bar Lighthouse: Destroyed by Fire July 5, 2004

By: Rod Desborough

Some things and people in life you take too much for granted. The Pictou Bar Lighthouse was one of the things I took for granted for most of my life, firmly believing it would always be there doing the job as an important navigational aid and as a key historic landmark for residents and visitors on both sides of Pictou Harbour, Nova Scotia.

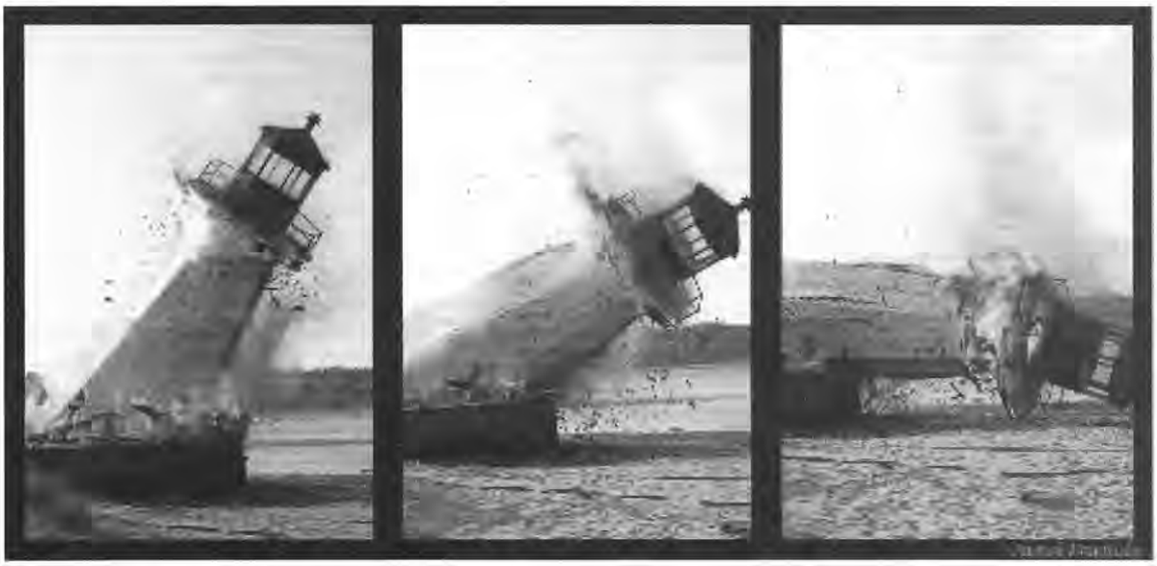

Photo by permission of Janet Francis.

As a child on the beach at Braeshore in 1946, the Pictou Bar Lighthouse loomed large and important but seemed inaccessible across the Harbour entrance. In those days the Lighthouse was attended and the keeper's house was part of the landmark. Eventually the lighthouse had increased in significance for me as a navigational aid: initially, as I sailed in and out of Pictou Harbour in the summers of 1960 and 1962 on the Canadian Hydrographic Ship *CSS ACADIA*, or on one of her survey launches, and later, in 1978, when I started recreational sailing on my own boat, in and out of the harbour. From our property at Braeshore, the lighthouse continued as a very important landmark and "friend". Until my retirement in 2001, most of my time spent at Braeshore was during the summer. The lighthouse and its beacon became an entirely new landmark and experience during the winter months when the harbour entrance and approaches are choked with ice. There was always a feeling of comfort to look out at the lighthouse during a raging blizzard, or late on a frosty winter night, or first thing in the early morning dawn and see the never faltering flashing beacon from the lighthouse. The reflection of the flashing beacon on the walls of our home was something that was always there, and something I was used to during the nighttime hours. It was the absence of the beacon's reflections that provided one of the strongest reminders of our loss after the tragic fire on July 5, 2004.

For over 170 years there was a Lighthouse on Pictou Bar helping to guide ships into Pictou Harbour as well as becoming a very familiar and well-loved landmark. The original 55 foot Lighthouse was constructed in 1834 but was destroyed by fire in May 1903. Construction of a replacement was started immediately and a new light was operational by the end of the year. The new structure was constructed at a cost of $3471.99 and had an increased light range with a tower that was 10 feet shorter than the original. Improvements were made over the years, including raising the tower to 60 feet and conversion to unattended [automated] operation in 1960, thus ending decades of service by a succession of 8 lighthouse keepers. It was the quick action by one of the keepers, Mr. William MacFarlane, that prevented a fire in the lantern room on July 16, 1931 from spreading and burning the structure to the ground. Pictou Bar Lighthouse was electrified in 1975, two years after the Canadian Coast Guard assumed operational responsibility.

Shortly before 6pm on July 5, 2004, smoke was noticed coming from the top of the Pictou Bar Lighthouse. For a second time in the history of a lighthouse in this location, the structure burned to the ground. Many residents, including the author, watched with dismay as the fire spread through this historic landmark. The tower was totally destroyed in less than an hour. An impressive series of pictures of the fire were recorded by Janet Francis and are available for viewing on the Pictou Landing First Nations' website: *http://plfn.com/ipw-web/gallery/*. Fire fighting efforts were hampered due to no access for large fire trucks on the Pictou Bar. Several fire departments responded but only portable pumps were available to fight the fire. These pumps had to be taken to the fire by 4 wheel drive vehicles that were able to travel across a tidal sand bar that was dry due to a low tide. Unfortunately, the water from the portable pumps arrived too late to save any of the structure. A police investigation has been unable to determine the cause of the fire. There is no evidence that vandalism was involved and, although the light was out for a time during the day of the fire, there is also no evidence supporting a theory that an electrical problem was the source of the fire.

The Lighthouse was located on Federal Land and the Canadian Coast Guard was responsible for its operation and maintenance. Temporary navigation marks have been placed in the harbour approaches until a decision is made on the type of replacement light to be installed.

Within days after the fire, area residents and visitors alike were asking about the plans for the replacement of the well-known and much admired Pictou Bar Light. Some also advocated its replacement in order to provide an important navigational aid for area fishermen and recreational boaters. Fortunately, the Pictou Bar Lighthouse Restoration Group (PBLRG), a group of Pictou County volunteers, has been established to raise funds and rebuild the lighthouse. A copy of the original plan is available and the old foundation is apparently adequate for a new structure. Fundraising plans and a construction schedule are under development, with the objective of constructing a replacement lighthouse as quickly as possible, hopefully within the next 12 months. An excellent web site has been established by the PBLRG and can be found at: *www.pictoubarlighthouse.piczo.com*

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Irwin, E.H. Rip, "Lighthouses and Lights of Nova Scotia"; Nimbus Publishing, 2003; ISBN 1-55109-426-6

The Pictou Bar Lighthouse Restoration Group (PBLRG) website at: *www.pictoubarlighthouse.piczo.com*

Pictures by Janet Francis, website at: *http://plfn.com/ipw-web/gallery/*

About the author...

Rod Desborough worked as a summer student for the Canadian Hydrographic Service from 1959 to 1962. After a 30 year project management career with Imperial Oil/ExxonMobil, Rod is now retired and he and his wife Kay spend their time between their homes in Halifax and Braeshore on Pictou Harbour, Nova Scotia. Rod is a volunteer helping with preservation/restoration work, as well as providing below deck tours for visitors, on the *CSS ACADIA*, the largest artifact at The Maritime Museum of the Atlantic in Halifax.

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Bayfield Cottage, Bic, QC

By: Ronald Jackson

Seigneur Archibald Campbell, a Quebec lawyer, had Bayfield Cottage constructed in 1850. It was built on land purchased from Isidore Coté, who farmed the area called *Pointe du Vieux Bic*. The region subsequently gained the name *Pointe aux Anglaise*. The cottage looks out on a bay (*Havre du Bic*) connecting to the St. Lawrence River. Although Bayfield Cottage is not directly on the water, Seigneur Campbell had the foresight to purchase the "scenic rites" to the land in front of the cottage. Thus, all subsequent owners have retained the right to an unobstructed view of the bay and the adjacent mountains.

Cottage Facade

Archibald Campbell named the cottage in honor of a visit from Henry Wolsey Bayfield. A pioneering hydrographer for the Royal Navy from 1816-1856, Admiral Bayfield was one of Archibald Campbell's relatives. Other distinguished visitors to the cottage have been Sir John A. MacDonald (1873) and Admiral Douglas (Archibald Campbell's son-in-law) who paid several visits to the cottage when he was young. In one of his last visits, he commanded the frigate *ARIADNE*, which he anchored adjacent to Massacre Island in the bay. The Campbells held the cottage until 1898, when it was purchased by William McNab. He was chief engineer for the Grand Trunk Railway. The property remained in his family's hands until one of his sons, Stewart McNab, sold it to the present owners in 1979. They have done several renovations to the structure, including a basement under the original building and extensions to the kitchen and second floor.

The cottage possesses a curved roof line, typical of the time in "Lower Canada." The cottage is built *piece sur piece* - that is, the walls are composed of solid planks stacked one on top of the other. These are held together by wooden pegs. In the case of Bayfield Cottage, the wood is red pine and the planks are 3" X 13". The outside of the cottage is still covered with the original tongue-and-grove planks about 10" wide. The cottage still retains much of its original character, including its pine flooring, ceilings, stair case, etc. The French doors that now open out of the kitchen possess a plaque that celebrates the hydrographic connection of Bayfield Cottage. Andrew Leyzack (a Hydrographer employed at the Bayfield Institute in Burlington, ON) helped provide the owners with a copy of a period Admiralty Hydrographic crest, current to the era when Bayfield himself was surveying the Great Lakes, the St. Lawrence River and the Gulf of St. Lawrence. Yves Desrosiers (*Atelier Fine Touche*) used the crest to sculpt the plaque shown in the accompanying photograph. LH

Cottage Plaque

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Michaud, J. D. (1925, 1926). Le Bic. Les Etapes d'une Paroisse. 1ere & 2eme Partie. Ernst Tremblay, Quebec.

About the Author...

Ronald Jackson is an Adjunct Professor, Cool Climate Oenology and Viticulture Institute, Brock University, St. Catharines, Ontario. He and his wife have owned the cottage since 1979 and over the years have contributed to its restoration.

The Last Years of *BAYFIELD (II)* Remembered

By: Andrew Leyzack

Henry Wolseley Bayfield, recognised as one of the grandfathers of Canadian hydrography, left his mark on many a chart from the Great Lakes through the St. Lawrence River to the Maritimes. Since 1884, there have been three scientific ships named in dedication of Bayfield. Recently, I had the pleasure of meeting a gentleman who served as an ordinary seaman aboard the second *BAYFIELD* after the ship had been retired from the Canadian Hydrographic Service (1903-1930) as *CGS BAYFIELD (II)*. Louis DeVillers, now in his seventies, was a young man when he served aboard *BAYFIELD*. His father purchased *BAYFIELD* in 1944, after the ship had been partially converted into a coaster trader. *BAYFIELD* was refit and put into service carrying pulpwood between Gaspé and Trois Rivières. Louis and his daughter Caroline, who live in Trois Rivières, paid a visit to the Bayfield Laboratory in Burlington when he discovered that *BAYFIELD'S* wheel, the wheel which he had first learned to steer a ship by, had been preserved and was on display in the hall within the Hydrographic Office.

The SS Lord Stanley *was a 140-foot ocean going tug when she was purchased by the government in 1901 to replace the aging CGS* Bayfield. *Refitted at Toronto as a survey vessel she entered Canadian hydrographic service in 1903 as CGS* Bayfield *(II) and remained in active service until 1930.*

Newly Commissioned CGS BAYFIELD (II)
Photo taken from The Chartmakers

BAYFIELD Converted for the Coastal Trade
Photo courtesy DeVillers Family

Along with a wealth of memories, Louis brought with him a copy of the ship's registry, a scale model which he built of the converted *BAYFIELD* and a number of photographs which described the ship's career as a cargo-carrying vessel. In addition to the pulpwood trade, *BAYFIELD* hauled bananas from Mexico to Miami and coal from Cape Breton Island. Her final voyage was from Sydney Mines, Nova Scotia with coal bound for Newfoundland. Two days out and fog-bound all the way with only a magnetic compass and sextant to navigate by, captain Paul DeVillers (who was Louis' brother) took a sextant sighting when the sun made a brief appearance. The resulting position put them 30 miles off the desired track. Given that the horizon was poor and doubting his initial measured position, the captain took a second sighting. On his way below

November 9, 1949, Cape Pine, Newfoundland
Photo courtesy DeVillers Family

Captain Paul DeVillers** (middle bottom), **Officers and Crew Ashore at Cape Pine
Photo courtesy DeVillers Family

to calculate a second position, *BAYFIELD* struck the sands off Cape Pine, Newfoundland. By chance, in the thick fog they had made their way between two drying rocks off the beach and wound up ashore within reach of the cliffs of Cape Pine.

With a lifeline to shore, all eight hands were able to get off safely, and among other items *BAYFIELD'S* wheel was salvaged. The following day, November 9, 1949[1], the leading seas of a late season hurricane on its way north sent *BAYFIELD* into the cliffs at Cape Pine where she was destroyed. Louis DeVilliers wasn't aboard *BAYFIELD* during her final voyage but had joined CN Ships where he continued his sea-going career as a vessel pilot until his retirement. LH

Louis DeVillers
Photo by Andrew Leyzack

[1] According to Louis DeVillers, the date shown on the plaque affixed to the wheel within the Hydrographic Office is incorrect.

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Prediction of Ice Concentration in the Gulf of St. Lawrence Using Modular Neural Networks

By: M. El-Diasty and A. El-Rabbany, Ryerson University

Comprehensive and timely information on sea ice conditions are essential for supporting various marine operations in ice-infested waters. These include optimal selection of navigation routes, deployment of icebreakers, offshore oil exploration, and others. In supporting these operations, the Canadian Ice Service produces and distributes sea ice information to mariners operating in the Canadian waters in the form of daily and weekly ice charts. Although highly useful in providing comprehensive ice information, ice charts may not fulfil the requirements for safe and efficient marine navigation, even if they are used side-by-side with Electronic Chart Display and Information System (ECDIS). This suggests that, in ice-infested waters, an integrated navigational chart system combining the ice information and ECDIS is vital. To successfully carry out this task, however, a model for reliable prediction of the ice condition, particularly ice concentration, over time must be developed.

Examining the weekly ice charts for the period 1987 to 1998 showed that the variations in the sea ice condition (concentration) follow a regular pattern, to a high degree of approximation. Consequently, a neural network function approximation system could model, and hence predict, these variations when trained using multiple-year ice concentration readings. This paper proposes a modular neural network structure for this purpose. The training was carried out using the ice charts of the Gulf of St. Lawrence over 11 years. Initially, the training was carried out using a batch model, which predicts future ice concentration values over a full year in a batch mode. However, this model was found to be inefficient when abrupt changes in the values of the ice concentration were encountered. Therefore, a second model was developed, which predicts the ice conditions sequentially. It is shown that the sequential model, which uses a modular neural network, is capable of predicting the ice concentration reliably; even when abrupt changes in the values of the ice concentration were encountered.

Une information détaillée et opportune sur les conditions de la glace sont essentielles pour supporter différentes opérations marines dans les eaux couvertes de glace. Celles-ci doivent inclure une sélection optimale des routes de navigation, du déploiement des brises-glaces, de la prospection du pétrole et d'autres. En supportant ces opérations, le Service canadien des glaces produit et distribue des informations sur les glaces aux navigateurs opérant dans les eaux canadiennes sous forme de cartes des glaces journalières et hebdomadaires. Bien que fort utile pour fournir une information détaillée des glaces, les cartes des glaces ne peuvent pas satisfaire aux exigences d'une navigation marine sécuritaire et efficace, même si elles sont utilisées en parallèle avec un système électronique de visualisation de carte Marine (SEVCM) Ceci laisse supposer que, dans des eaux couvertes de glace, un système intégré de cartes de navigation combinant l'information sur la glace et SEVCM est vital. Cependant pour bien accomplir cette tâche, un modèle de prédiction fiable sur la condition de la glace, particulièrement la concentration de la glace, doit être développé dans le futur.

Lorsque l'on examine les cartes des glaces hebdomadaires pour la période de 1987 à 1998 on voit que les variations dans la condition (concentration) de la glace de mer suivent une structure régulière, avec un haut degré d'approximation. En conséquence, un système d'approximation d'un réseau de fonction neuronal peut modeler, et de là, prédire ces variations lorsque formé à utiliser les données de concentration de la glace sur plusieurs années. Cet article propose la structure d'un réseau modulaire neuronal à cet effet. La préparation s'est poursuivi en utilisant les cartes des glaces du golfe du Saint-Laurent sur onze ans. Initialement, la préparation s'est poursuivi en se servant d'un modèle en lots, lequel prédit la valeur future de la concentration de la glace sur une année complète en temps différé. Cependant, ce modèle s'est avéré inefficace quand des écarts abruptes dans les valeurs de la concentration de la glace se présentaient. Pour cette raison, un second modèle a été développé, lequel prédit les conditions de la glace séquentiellement. Il est démontré qu'un modèle séquentiel qui se sert d'un réseau modulaire neuronal, est capable de prédire avec fiabilité la concentration de la glace; même lorsque des écarts abruptes dans les valeurs de la concentration de la glace se présentaient.

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1. Introduction

Sea ice affects over 90% of the Canadian maritime shoreline for some part of the year (Haykin et al., 1994). This creates hazardous conditions to marine operations; including marine navigation, offshore development, fisheries operations, and others. To maintain the safety and efficiency of marine operations, comprehensive and timely information on sea ice conditions is required (El-Rabbany, 2000). The Canadian Ice Service (CIS) is a governmental agency responsible for providing marine operators with ice information in the Canadian waters (Ramsay et al., 1998). To extract the ice information, CIS integrates ice data from various sources, including satellite remote sensing, airborne remote sensing, shore-station observations and ship reports. The integration process allows for the inter-comparison of the various data sets (Haykin et al., 1994). Data analysis follows the integration process, which results in the extraction of the various ice features and parameters. The extracted ice information is then presented in a standard form of daily ice charts, which represent the primary data products of the Canadian Ice Service. The ice charts include information such as ice concentration and type, ice edge location, icebergs and open leads. The total concentration of sea ice is the most important element of the ice information to support vessels with no ice capability (Haykin et al., 1994).

Ice charts, although highly useful in providing comprehensive ice information, may not fulfil the requirements for safe and efficient marine navigation, even if they are used side-by-side with ECDIS. For example, a route may be identified as ice-free or least hazardous through an ice chart, while it may not necessarily be a suitable route for marine navigation due to, e.g. shallow water depth. This suggests that in ice-infested waters, an integrated navigational chart system combining the ice information and ECDIS is vital. To successfully carry out this task, however, a model for reliable prediction of the ice condition, particularly ice concentration, over time must be developed. Inspecting the weekly ice charts of the Gulf of St. Lawrence over 11 years showed that the sea ice conditions change according to a regular pattern to some extent. As such, a neural network-based model could effectively be used to model and predict the variations in the ice conditions over time. A supervised, three-layer feedforward neural network, trained using the back-propagation algorithm is used for this purpose. The design parameters of this model are the number of neural network inputs, outputs, and hidden nodes, as well as the structure of the network itself. The training was carried out using weekly ice charts of the Gulf of St. Lawrence for the period 1987 to 1998. Initially, the training was carried out using a batch model, which predicts future ice concentration values over a full year in a batch mode. However, this model was found to be inefficient when abrupt changes in the values of the ice concentration were encountered. Therefore, a second model was developed, which predicts the ice conditions sequentially. It is shown that the sequential model, which uses a modular neural network, is capable of predicting the ice concentration reliably, even when abrupt changes in the values of the ice concentration were encountered.

2. Canadian Ice Service Ice Charts

The Canadian Ice Service is responsible for providing the ice information in Canadian waters, mainly through its daily ice charts (Figure 1). To do this, the CIS uses various space-borne and airborne remote sensing sensors, shore station

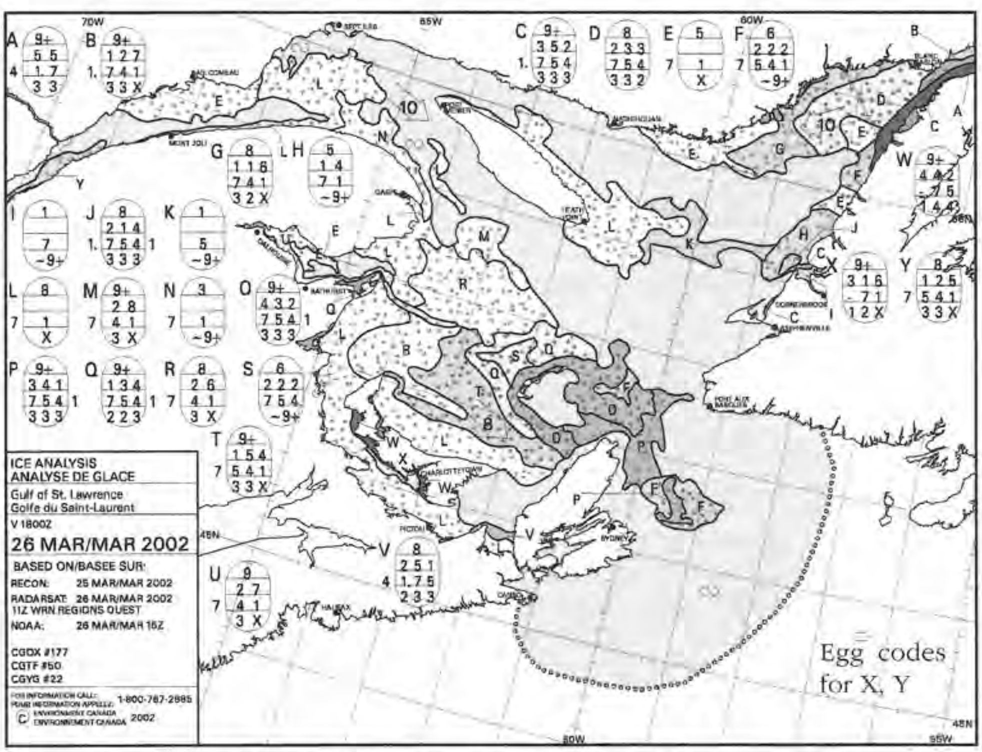

Figure 1: An example of CIS ice chart for the Gulf of St. Lawrence

observations and shipboard ice observations (Canadian Ice Service, 2002). The charts use the North American Datum 1927 (NAD 27) and the Lambert conical projection. The World Meteorological Organization (WMO) symbolization for ice information, frequently referred to as the "Egg Code", is used to describe the ice conditions (Figure 1). Boundaries are drawn around the ice areas with different concentrations; each is represented by an egg code (Canadian Ice Service, 2002).

An egg code is an oval shaped symbol, which contains three parts that describe the concentration of the ice, the stage of development (age) of the ice concentration and the predominant form of ice (floe size). These are expressed by up to 12 numerical values. The concentration of the ice represents the ratio between the area of the water surface covered by ice and the total area, and is expressed in tenths. The value of the ice concentration varies from 10/10 for consolidated ice to 1/10 for open water. The single uppermost parameter in the egg code represents the total concentration, which includes all stages of development. The second row in the egg code matrix contains the partial concentration for the thickest (left), the second thickest (middle) and the third thickest (right) ice types. The partial concentration field may contain two numbers if only two ice types are present in the area (see Figure 1). If there is one ice type only, the partial concentration field will be left blank, as the concentration of the one type will be presented by the total concentration (Figure 1).

The third field in the ice code contains the stages of development (age) for the ice types reported in the partial concentration field. Thicker ice refers to older ice, and vice versa. Various codes are used, depending of the stage of development. For example, a code of "1" is a assigned to the *new ice* (less than 10 cm in thickness), while a code of "9" is assigned to the *second stage thin first-year ice* (50-70 cm in thickness). Medium/thick first-year ice as well as old ice are assigned a dot (•) as part of their code. The last field in the code represents the predominant forms of the sea ice (floe sizes) corresponding to the stages of development identified in the previous field. Various codes are given to various floe size, which vary from "0" for the *pancake ice* to "7" for the *giant floe* (width greater than 10 km). Fast ice and icebergs are given the codes of "8" and "9", respectively. Undetermined ice form, unknown or no form is assigned the code of "X".

3. ANN Model Development

Artificial Neural Networks (ANN), or simply neural networks, are computational models that imitate the human brain in performing a particular task (Haykin, 1999). They have the capability to solve complex problems through learning, or training, and then generalizing the network outputs for other inputs. A neural network consists of processing elements, or neurons, that are massively interconnected. Each of the connecting links is characterized by its own weight, or strength. Figure 2 represents a block diagram of a simple model of a neuron showing the weights of the various links. An activation function, such as a sigmoid function or a hyperbolic tangent function, is applied to limit the amplitude of the neuron. The sigmoid function is an s-shaped function, which is used widely in the construction of the neural networks (Haykin, 1999). The logistic function represents an example of the sigmoid function, which is defined as:

$$\varphi(v) = [1 + \exp(-av)]^{-1} \tag{1}$$

where the parameter a represents the slope of the sigmoid function. Finally, an external bias, b_k, is applied to increase or lower the net input of the activation function. The neural network is trained to find the optimal values for the weights and the biases.

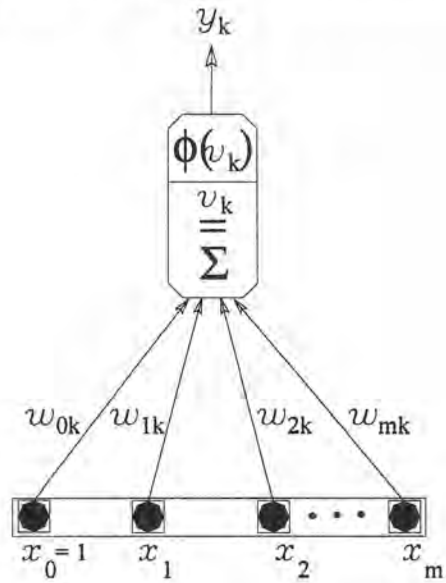

Figure 2: Simple neuron model

The above structure for a neuron k can be represented mathematically as:

$$v_k = \sum_{j=1}^{m} w_{kj} x_j + b_k = \sum_{j=0}^{m} w_{kj} x_j \tag{2}$$

$$y_k = \varphi(v_k) \tag{3}$$

where $x_0, x_1, x_2, ..., x_m$ are the input signals; v_k is the activation potential of neuron k; y_k is the output signal, and $w_{k0}, w_{k1}, w_{k2}, ..., w_{km}$ are the weights of neuron k. It should be noted in (2) that the values of $x_0 = +1$ and $w_{k0} = b_k$, respectively.

3.1 Neural Network Structures and Training

Artificial neural networks can be designed in various ways, depending on how the neurons are structured and the learning algorithms, or rules, used. Network architectures may be classified as single-layer feedforward, multi-layer feedforward, and recurrent networks (Haykin, 1999). Single-layer network is the simplest form of a layered network, which consists of an input layer of source neurons that are mapped onto an output layer of neurons. The computations are performed at the output layer only, which is why it is referred to as single-layer. Multi-layer feedforward networks, on the other hand, are characterized by the existence of additional one or more hidden layers containing a number of hidden neurons. The hidden layers help the network in extracting higher-order statistics (Haykin, 1999). Figure 3 shows an example of a fully connected three-layer feedforward network, which is referred to as m-s-c [*m* source neurons, *s* hidden neurons, and *c* output neurons]. With this architecture, the source neurons in the input layer (i.e., first layer) provide the input vector to the hidden layer (i.e., second layer). The output vector of the hidden layer is then used as input to the third layer (i.e., output layer), which outputs the overall network solution.

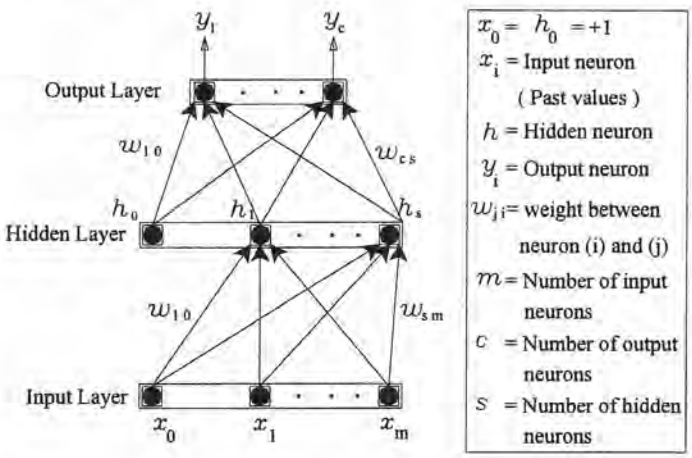

Figure 3: Three-Layer feedforward neural network with the structure [m-s-c]

Recurrent neural networks are similar to the feedforward networks, except that the former have at least one feedback loop. According to Schuh et al. (2002), feedforward networks have better prediction capabilities than recurrent networks. In our prediction model, we used the feedforward neural networks. In this case, the output signal at a neuron *j* (either a hidden neuron or an output node) can be written as:

$$y_j(n) = \varphi(v_j(n)) \qquad (4)$$

where $v_j(n)$ is the activation potential of neuron *j*, which is defined by:

$$v_j(n) = \sum_{i=0}^{m} w_{ji}(n) y_i(n) \qquad (5)$$

where *m* is the total number of inputs (without the bias) applied to neuron *j*; $w_{ji}(n)$ represents the weight connecting the output of neuron *i* to the input of neuron *j* at iteration *n* (n^{th} training example); and $y_i(n)$ is the output signal of neuron *i* (i.e., the input signal of neuron *j*). It should be clear that $y_i(n) = x_i(n)$, the i^{th} element in the input vector, if neuron *j* is in the first hidden layer.

3.2 The Learning Process (back-propagation algorithm)

As stated above, neural networks solve complex problems through learning (i.e., training) and then generalizing the network outputs for other inputs. Training the neural network is accomplished through iterative adjustments of the free parameters, i.e., the weights and bias, of the network until we obtain the optimal values. There exist various learning algorithms, which are fundamental to the design of neural networks. Of these, the back-propagation -learning algorithm is the most widely used for feedforward neural networks (Schuh et al., 2002), which is discussed with the back-propagation-learning algorithm, the output signal of a neuron *j*, $y_j(n)$, is compared to a desired (target) output, $d_j(n)$. The error signal at the output of neuron *j*, $e_j(n)$, is defined as:

$$e_j(n) = d_j(n) - y_j(n) \qquad (6)$$

where *n* represents the n^{th} training example (i.e., n^{th} pattern). The objective of the iterative adjustments is to make $y_j(n)$ as close as possible to $d_j(n)$, which can be achieved by minimizing a cost function (total instantaneous error energy over all neurons in the output layer) defined as:

$$\mathrm{E}(n) = \frac{1}{2} \sum_{j \in C} e_j^2(n) \qquad (7)$$

where *C* represents all neurons in the output layer. The weight correction $\Delta w_{ji}(n)$ can now be defined according to the delta rule as (Haykin, 1999):

$$\Delta w_{ji}(n) = -\eta \frac{\partial \mathrm{E}(n)}{\partial w_{ji}(n)} = \eta \delta_j(n) y_i(n) \qquad (8)$$

where η is the learning rate parameter; and $\delta_j(n)$ is the local gradient defined by:

$$\delta_j(n) = -\frac{\partial \mathrm{E}(n)}{\partial v_j(n)} = e_j(n) \varphi_j'(v_j(n)) \qquad (9)$$

where $\varphi_j'(v_j(n))$ is the derivative of the associated activation function. This means that for $\delta_j(n)$ to exist, the activation function must be continuous, which is satisfied by both the sigmoid and hyperbolic tangent functions presented above.

The selection of the learning rate parameter η affects the rate of learning of the neural network. The smaller the value of η is, the smaller the changes in the weights and the network rate of learning. Smaller η values result in smaller changes to the weights in the network, and consequently slower the rate of learning. If, on the other hand, the η values are too large, the network may become unstable (i.e., oscillatory) and the algorithm diverges. To overcome this problem, the generalized delta rule is used, which introduces an additional term to (8) known as the momentum constant (see Haykin, 1999 for details).

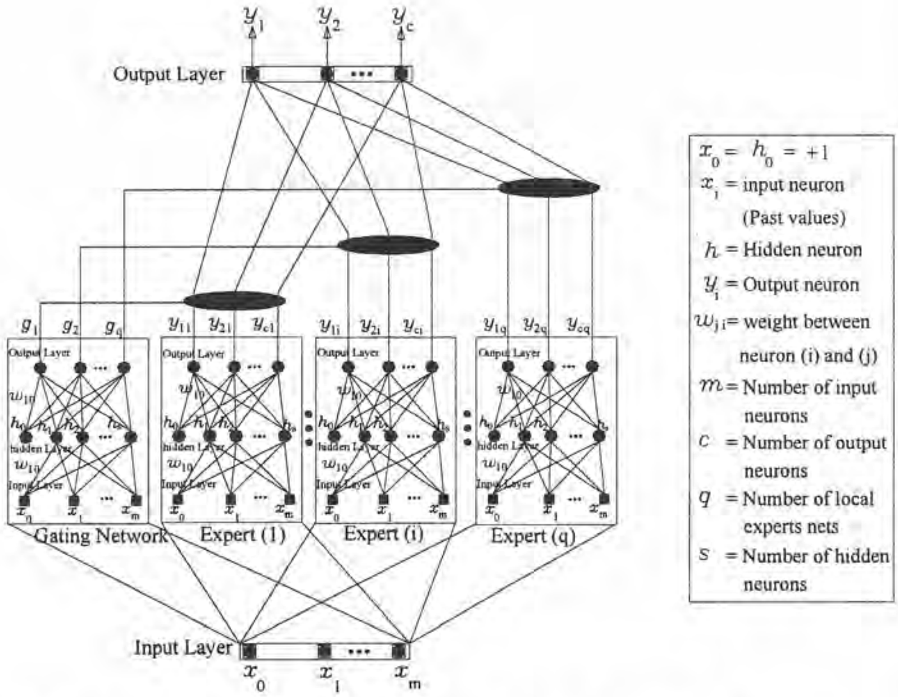

Figure 4: A modular neural network with the Structure [m-s-q-c]

The weights will be adjusted iteratively by presenting new epochs of training examples to the neural network. Unfortunately, there is no clear-cut criterion to decide when to stop the training, i.e., to consider that the back-propagation algorithm has converged (Haykin, 1999). If the training is not stopped at the right point, an over-fitting of the training data (i.e., model does not interpolate well between the points) might occur. One way of overcoming this problem is to create a test dataset, which tests the neural network for its generalization performance (NeuralWare, 2001).

Under certain circumstances, for example when encountering a prediction problem, it might be better to use the modular neural networks (NeuralWare, 2001). A modular neural network has the capability of dividing a problem into sub-problems and resolving each sub-problem rather well. It consists of a group of back-propagation networks, sometimes referred to as "local experts", each with the same architecture. This group of networks competes to learn the various aspects of the problem, which is then controlled by a "gating network". The number of local experts is determined by the number of output neurons of the gating network. Figure 4 shows an example of a modular neural network, which is referred to as m-s-q-c (m source neurons, s hidden neurons for both the local experts and the gating network, q "gating" output neurons, and c output neurons).

4. Results for Sea Ice Concentration Prediction

As mentioned earlier, weekly ice charts of the Gulf of St. Lawrence over 11 years (1987-1998), in digital format, were used to train the neural networks. A test area of 200 points was considered for this purpose (Figure 5). The total size of the available dataset at each point was 603 values, representing over 11 years of weekly ice concentration records. The dataset was divided into three subsets: training, testing and validation subsets (Figure 6). The first 50 patterns were assigned to the testing subset, while the last 50 patterns were assigned to the validation subset. The training subset was selected to represent the middle portion of the dataset. The training was stopped based on testing the generalization performance of the neural network using the testing subset. After training and testing the network, we generalized the model to predict ahead the last 50 patterns of the dataset and compared the results with the actual values of the ice concentration.

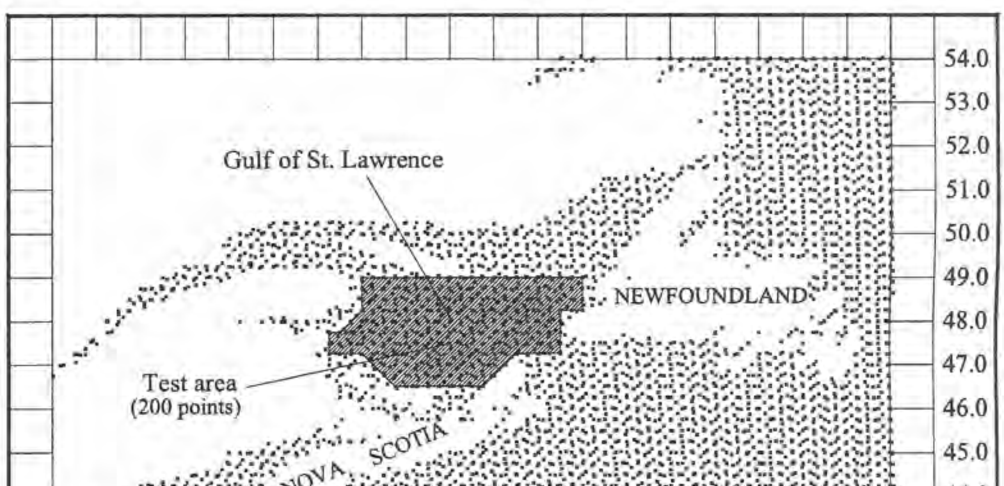

Figure 5: Study area (200 points)

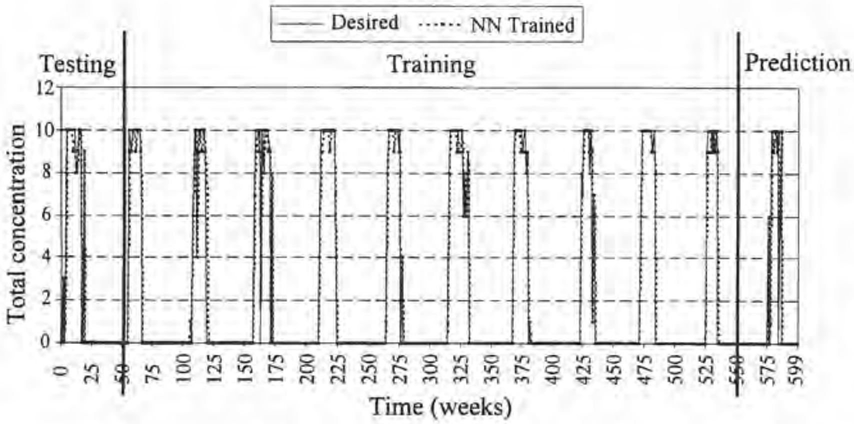

Figure 6: Selection of testing, training and validation data subsets

4.1 Results and Discussion of Batch Model

The batch model was proposed by El-Rabbany et al. (2002). In this approach, the time variables are used as the only input to the network, and the ice concentration is assigned as the desired output. In other words, the input layer consists of two neurons – the year and week number – and the output layer consists of only one neuron. Two artificial neural network structures, feedforward neural network (FFNN) and modular neural network (MNN), were constructed. In the processing stage of both FFNN and MNN, we used the back-propagation learning algorithm, a hyperbolic tangent activation function, a learning rate of 0.30, and a momentum coefficient of 0.40.

Data series at a randomly selected point within the test area was used to validate the batch neural network model. The structure of the neural network was built using the NeuralWorks software (NeuralWare, 2001). Several tests were conducted to optimize the structure of the neural network. As specified in Table 1, it was concluded that FFNN and MNN with structures [2-10-1] and [2-8-5-1], respectively, give the best results; meaning they have the lowest root-mean-square (RMS) error. Both structures gave good results in the absence of abrupt changes in the values of ice concentrations. However, as shown in Table 1 and Figure 7, this was not the case when abrupt changes in the values of ice concentrations were encountered. Although the trained network represented the training dataset reasonably well, the network prediction was rather poor. The performance of the MNN was slightly better than that of FFNN. For MNN, the average normalized RMS and correlation (CORR) of the validation (i.e., prediction) set were 0.2640 and 0.9058, respectively. Similar results were obtained when datasets at a group of points were used simultaneously to train the neural networks. We therefore followed another approach – the sequential approach (Schuh et al., 2002; El-Diasty et al., 2002; El-Rabbany and El-Diasty, 2003).

Symbols	With abrupt changes	
	FFNN	MNN
N (Total set)	603	603
N_S (Testing set)	50	50
N_T (Training set)	503	503
N_V (Validation set)	50	50
Structure	[2-10-1]	[2-8-5-1]
RMS (Testing)	0.2735	0.2750
RMS (Training)	0.2762	0.2550
RMS (Validation)	0.2827	0.2640
CORR (Testing)	0.9088	0.9079
CORR (Training)	0.9007	0.9158
CORR (Validation)	0.8880	0.9058

Table 1: Results of batch model for a single point (with abrupt changes)

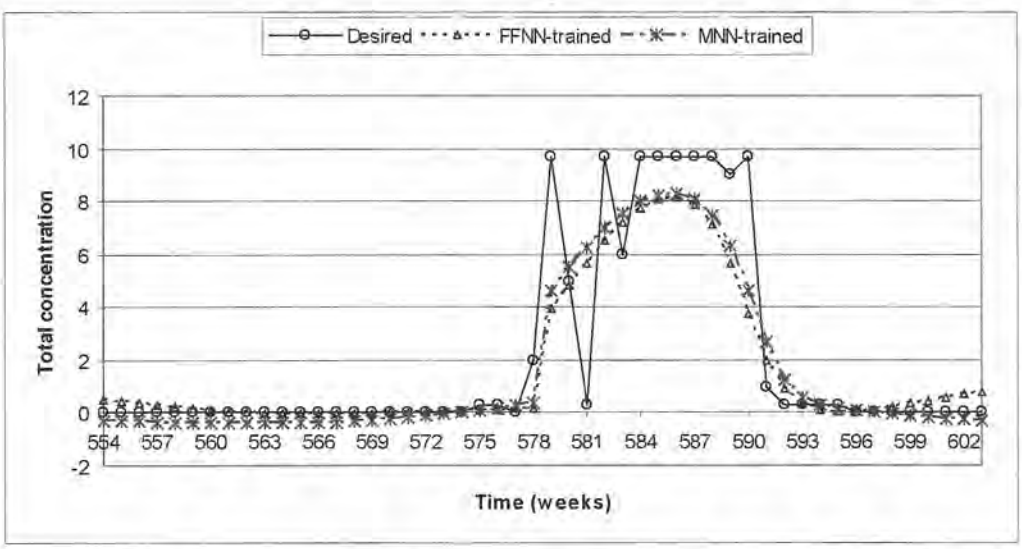

Figure 7: Actual versus predicted ice concentration values of batch model for the year 1998 - a single point with abrupt changes

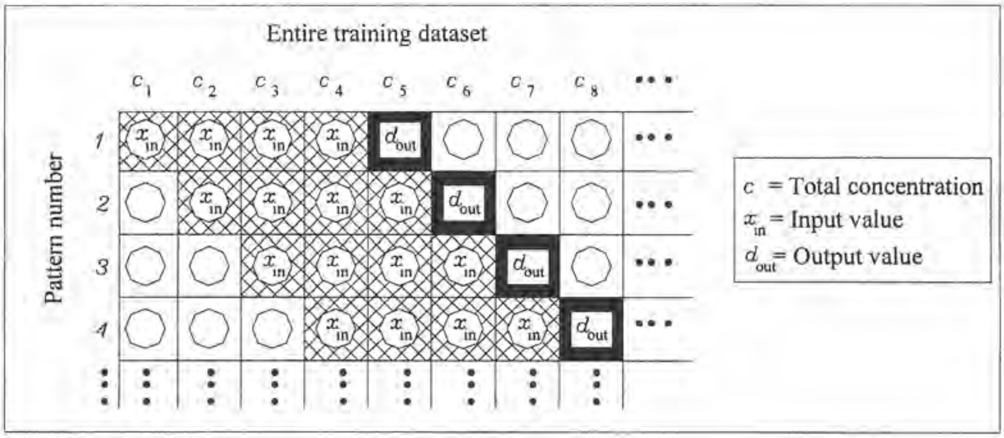

Figure 8: Training patterns used in the neural network input

4.2 Results and Discussion of Sequential Model

In this approach, the immediate past values of the ice condition records are used as input to the network, while future records are used as the desired output. In the subsequent epochs, the training patterns are time-shifted as shown in Figure 8. Three different scenarios were considered. The first one used the ice concentration records as input to the network, the second used the stages of development records, and the third scenario used both the ice concentration and the stages of development records. In all cases, the network was trained to predict future ice concentration.

Several tests were conducted to optimize the number of test points, which would be used in training the neural network. It was found that a weak solution is obtained when the number of test points is either too few or too high. The best results were obtained when the 200-point study area was divided into 7 regions, each containing a number of points that varied between 25 and 35 (Figure 9). Table 2 shows the optimal number of points and network structure for each region.

Similar to the batch approach, two artificial neural network structures, namely FFNN and MNN, were constructed using NeuralWorks. In the processing stage of both FFNN and MNN, we used the back-propagation learning algorithm, a hyperbolic tangent activation function, a learning rate of 0.30, and a momentum coefficient of 0.40. For the sake of space, only the results of the first region, Region-C.1, are given below.

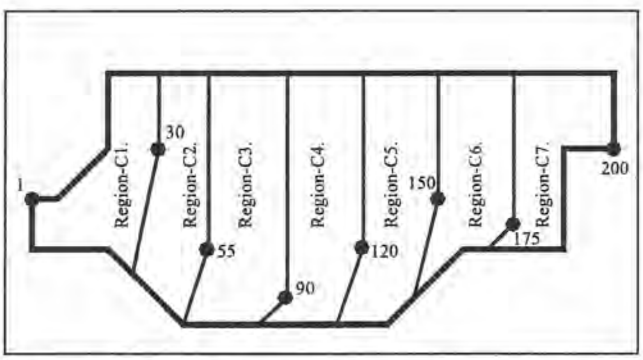

Figure 9: Relative location of various regions (Refer to Figure 5.)

Table 3 summarizes the results of both FFNN and MNN. It is shown that, regardless of which scenario is considered, the sequential model is capable of modeling and predicting the ice concentration with high accuracy and reliability levels. For a particular scenario, the performance of MNN is always better than that of FFNN. The best overall results are obtained when the third scenario is considered. In the case of MNN, the average normalized RMS and correlation (CORR) of the validation (i.e., prediction) dataset are 0.101 and 0.984, respectively. Figures 10 through 12 show the actual versus predicted ice concentrations for the year 1998, at a randomly selected point within the test area. Clearly, the best results are obtained with MNN when the ice concentration and the stages of development are both used as input to the neural network.

Sub-regions	Optimal number	FFNN structure	MNN structure
Region-C.1	30	[120-180-30]	[120-60-5-30]
Region-C.2	25	[100-150-25]	[100-150-5-25]
Region-C.3	35	[140-210-35]	[140-280-5-35]
Region-C.4	30	[120-120-30]	[120-120-5-30]
Region-C.5	30	[120-270-30]	[120-270-5-30]
Region-C.6	25	[100-150-25]	[100-100-5-25]
Region-C.7	25	[100-150-25]	[100-100-5-25]

Table 2: Optimal structure of sequential model for all regions

Symbols	First Scenario (30 points)		Second Scenario (30 points)		Third Scenario (30 points)	
	FFNN	MNN	FFNN	MNN	FFNN	MNN
N (Total set)	599	599	602	602	598	598
N_S (Testing set)	50	50	50	50	50	50
N_T (Training set)	499	499	502	502	498	498
N_V (Validation set)	50	50	50	50	50	50
Structure	[120-180-30]	[120-60-5-30]	[90-180-30]	[90-180-5-30]	[210-300-30]	[210-300-5-30]
RMS (Testing)	0.124	0.089	0.2056	0.163	0.090	0.085
RMS (Training)	0.143	0.095	0.205	0.124	0.111	0.086
RMS (Validation)	0.163	0.144	0.1744	0.150	0.121	0.101
CORR (Testing)	0.978	0.989	0.940	0.959	0.988	0.989
CORR (Training)	0.965	0.982	0.932	0.973	0.979	0.987
CORR (Validation)	0.958	0.967	0.939	0.967	0.975	0.984

Table 3: Summary results of the three scenarios (Region-C.1)

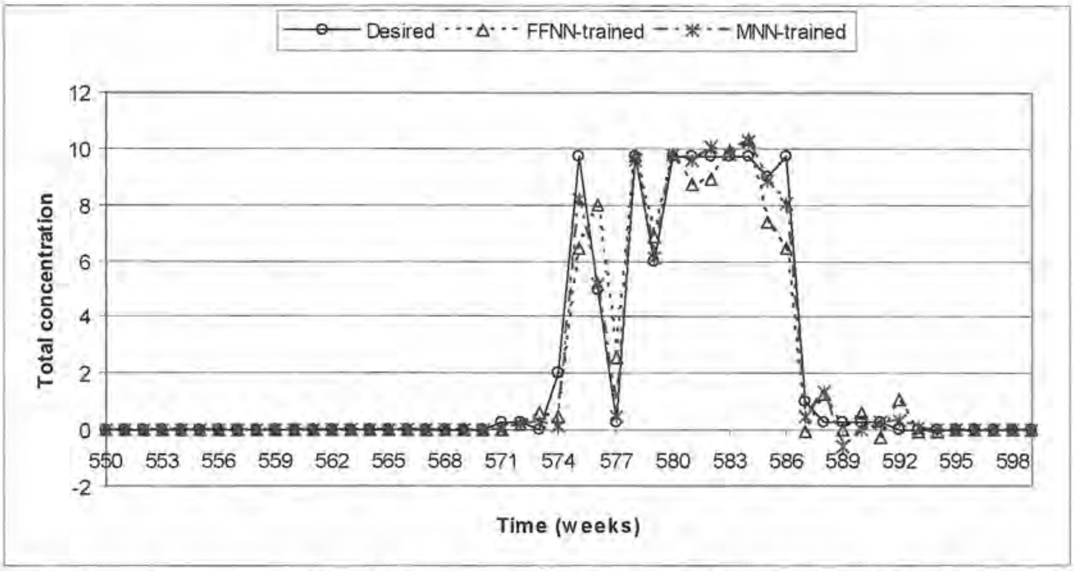

Figure 10: Actual versus predicted ice concentration values for the year 1998 - first scenario

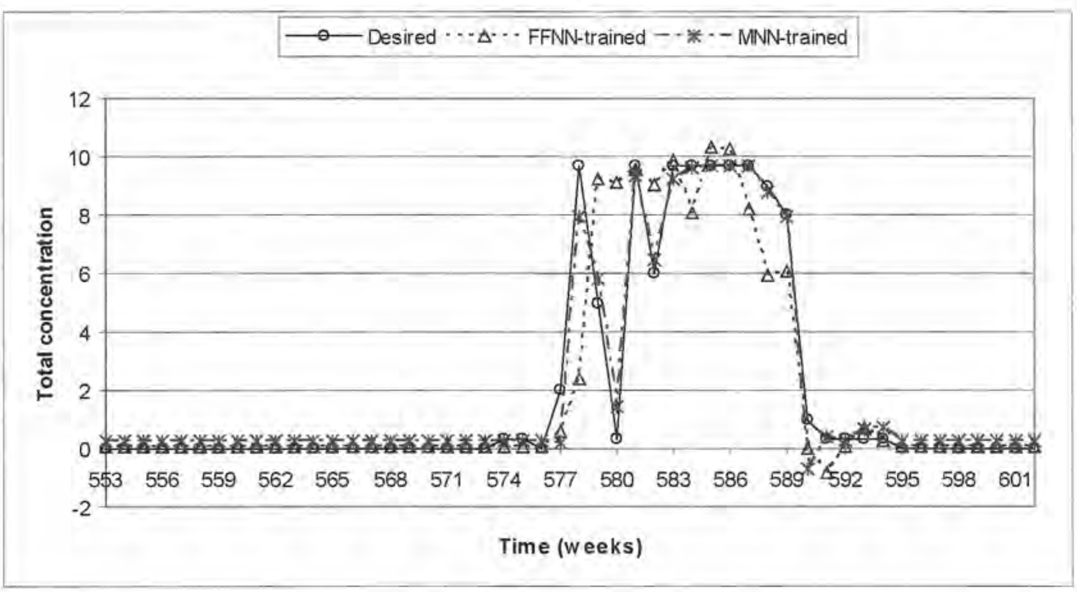

Figure 11: Actual versus predicted ice concentration values for the year 1998 - second scenario

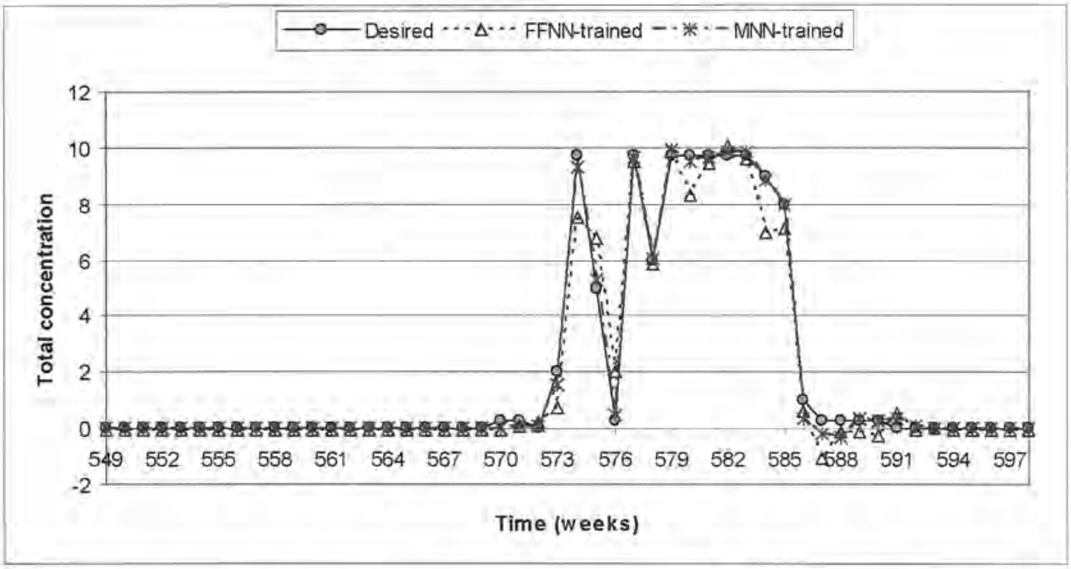

Figure 12: Actual versus predicted ice concentration values for the year 1998 - third scenario

5. Conclusions

It has been shown in this paper that artificial neural networks can be used effectively in predicting the total ice concentration for a given region when trained using multiple-year ice concentration readings. A batch and sequential neural network-based models with two different structures were developed in this paper. It has been shown that the performance of modular neural networks is always better than that of non-modular neural networks. The performance of the batch model was rather poor when abrupt changes in the values of ice concentrations were encountered. Although the trained network represented the training dataset reasonably well, the network prediction was rather poor.

On the contrary, the proposed sequential model, which uses modular neural networks, was capable of modeling and predicting the ice concentration with high accuracy and reliability levels. The performance of the sequential model was further improved when both the ice concentration and the stages of development were used as input to the neural network. In such a case, the average normalized RMS and correlation of the validation (i.e., prediction) dataset were 0.101 and 0.984, respectively.

Acknowledgments

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DID YOU KNOW...

LOG BOOK

As early ship's records were inscribed on shingles (cut from logs) and hinged so that they opened like a book, the name "log book" was logical and lasted to this day.

S57-Based Paper Chart Production

By: Alexey Pirozhnikov, Hydroservice AS

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A modern HO is forced to consider ways of efficiently producing and updating both electronic and paper charts. One way of achieving this is to unify the respective production lines. This paper briefly outlines different approaches that can be used to combine production and maintenance of traditional paper charts and electronic charts. It also offers a deeper insight into dKart Publisher technology aimed at S57-based paper charts production and maintenance.

Un hydrographe moderne est obligé de considérer des méthodes efficaces pour produire et mettre à jour les cartes marines électroniques et papier. Une bonne façon de le faire est de fusionner les différentes lignes de production. Cet article décrit brièvement différents procédés qui peuvent servir à combiner la production et la maintenance des cartes marines traditionnellement en papier et des cartes marines électroniques. Il présente aussi une vision plus approfondi de la technologie du dKart Publisher pour la production et la mise à jour des cartes marines papier sous format S57.

A Problem

In recent years, a number of relatively new "digital" chart products such as electronic charts (e.g. ENCs, Inland ENCs), thematic charts (e.g. climatic charts, ice charts), military charts (e.g. Additional Military Layers (AML)) were introduced to a hydrographic office's production routine. This change is supplemented with the requirements for higher quality and greater reliability of produced charts. There is also a constant demand for improvement in updating of cartographic products.

Is it possible to find a practical solution that may help the data producer cope with these problems?

Possible Solutions

It is commonly found that production and maintenance of traditional paper charts (navigational, thematic, military, etc.) and electronic charts (ENCs, AML, etc.) are run in parallel. The main disadvantage of such an approach is that it inevitably implies a doubling of resources, as most operations are duplicated and therefore the risk of data error and inconsistency is increased.

A possible way to improve the situation, saving on costs and gaining in quality, is to introduce a single unified production line. Within this approach a data producer may proceed in various ways, including:

1. Produce and maintain electronic charts (ENCs, AML, Inland ENCs, etc.) based on paper charts;
2. Produce and maintain paper charts based on electronic charts;
3. Produce and maintain both products based on a unified database of source hydrographic information.

Note that the first and second options (electronic charts from Paper Chart and vice versa) may appear quite similar but only at first glance; these differences are quite significant and will be explained further in the article.

Digitizing

Let us begin with the first option that implies digitizing/ attribution of paper charts and updating of the resulting electronic charts on the basis of traditional Notices to Mariners.

An obvious advantage of this approach is that it has a minimum impact on the traditional production line. It also helps to create the electronic chart portfolio quickly and inexpensively, so naturally this method has been used for the initial population of the electronic chart portfolio at most HOs. There are, however, significant drawbacks to this method:

1. Typically, an electronic chart (e.g. ENC) is more informative than a paper chart, providing additional details taken from nautical publications, for instance, information from List of Lights. Therefore, in order to produce an electronic chart, one is forced to use additional sources of information, which in turn makes consistent updating very complicated;
2. Positional accuracy of data derived from paper charts may be not suitable for modern cartographic applications due to various reasons (e.g. data generalization, imprecise positioning);
3. Coverage of paper charts and electronic charts differs in general (e.g. in data limits and scales);

4. Use of traditional paper-oriented updating routines (e.g. selecting and applying Notices to Mariners issued for paper charts) is not a simple and straightforward task (e.g. due to difference in data limits and content, a change to a paper chart may be not applicable to the relevant electronic chart or vice versa).

Unified Hydrographic Database

Considering the alternatives to digitizing, let's begin with the third option, which implies the use of a so-called "unified hydrographic database". This seems to be the most logical way of achieving consistency between paper and electronic charts. In the "unified" database approach, a data producer creates and maintains one database containing all source cartographic features. Products such as electronic charts and paper charts become extracts from this database, matching applicable product specifications. This idea is ingenious in theory, but in practice does have shortcomings.

The initial problem is creating a "unified" database that will embrace all possible aspects of the cartographic data use, including scale-dependence and generalization of data. Additional problems in the structure of the database and work management arise when the data producer maintains multiple formats and chart series (e.g. national and international charts).

In addition, if electronic and paper chart production lines already exist in an HO, combining them by introducing a "unified database" will most likely lead to a fundamental restructuring of the HO organization and infrastructure. A more preferable solution would be to add a new component into one of the existing lines that will allow such a combination without shifting of the existing technology.

It may be concluded that the task of creating a "unified" database is extremely complicated even in theory; practical solutions do not really exist and its implementation would require extensive resources, money and time.

Making Paper Charts out of ENCs

Let us now approach the task from another perspective. In essence, electronic charts and paper charts are two different ways of expressing the same hydrographic reality. The main distinction is the difference in presentation of the cartographic data. To use these facts requires an understanding of the IHO S-57 standard for digital hydrographic data exchange. One of the basic principles and advantages of S-57 is the separation of cartographic data (i.e. information) from its presentation (e.g. for ENCs, S-57 Data Model is used to describe the information content of a chart, while S-52 guides the information display).

The production of paper charts from electronic charts can be described as a "simple" output of electronic chart objects according to "paper chart" presentation rules (e.g. INT1/INT2/M4 or national derivatives). This results in an S57-based approach to paper chart production and maintenance, where the starting point is an existing product, namely the S57 electronic chart (e.g. ENC, AML, Inland ENC).

A typical technological chain looks like this:

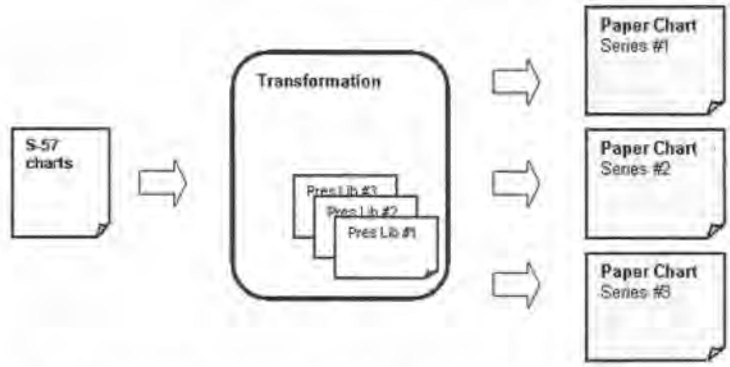

Figure 1: ENC-based paper chart production scheme

In this method, when a paper chart is produced and maintained on the basis of electronic charts, it makes the production and maintenance of traditional and electronic charts consistent, overcoming the difficulties of the "unified database" approach:

- Tools can be easily integrated into the existing production infrastructure as "add-on" components;
- The solution is easily expandable (the same electronic chart can be used to produce and maintain multiple paper chart products built according to different presentation rules);
- The solution is practical and necessary tools are already available on the market.

A Scope of Tasks

Let us review the typical tasks that arise in S57-based paper charts production and maintenance. They are:

- The presentation of the same cartographic information (objects) differs between traditional and electronic charts. Therefore one needs an intelligent converter equipped with specially designed libraries of cartographic symbols and line / area patterns.
- Paper and electronic charts may differ in scales, data limits and projections. There is also a growing demand for "Print-on-Demand" (POD) and "Chart-on-Demand" solutions where the end-user defines specifications (limits, scale, etc.) for paper charts.
- There is, therefore, a need for automated data transformation/compilation tools.
- A data producer may simultaneously support several chart series that differ in presentation.

The presentation may change with time. It's also a common understanding and rule that national specifications define national products, with reference to all the national variants of the INT1 standard. Therefore, both the presentation of paper chart and the transformation routines must be configurable.

- It is not possible to achieve complete automation of ENC to paper chart transformation. Factors such as text placement, smoothing and masking of lines cannot be formalized and therefore are subject to reviewing and manual editing. There is, therefore, a requirement for a manual cartographic editing tool.
- A paper chart usually makes use of additional information (e.g. tide tables, notes) provided either as files or as a separate database. Therefore, there is a need to import information and to process data stored in an external database.

In order to be able to maintain a paper chart using digital updates created for the source ENC(s), the software should be capable of recognizing cartographic elements of a paper chart affected by the digital update ("ER-file"). The most logical solution would be to create a link between paper chart entities and the "parent" ENC object(s) during the transformation and to maintain this link automatically throughout the paper chart lifecycle.

The Result: Digital Paper Chart

Let us now take a look at the result of the operator's work that is a digital paper chart. A digital paper chart is an electronic chart with defined borders, scale, projection and datum. The content of a paper chart is built in accordance with S-57 Data Model, having the following implications:

- The information is divided into entities called "objects" ("an identifiable set of information"). An object has attributes that describe its presentational characteristics.
- As in S-57, objects are divided into two groups: paper chart objects (presenting cartographic data just like feature objects in ENC) and spatial objects (providing positional information). A paper chart object (or simply "object") cannot exist on its own, as it is always linked to a spatial object. Design elements, such as chart title, also have underlying geometry defining its placement on a resulting sheet, even though these spatial objects have no "cartographic" meaning. Several objects can be linked to the same spatial object. For example, a light buoy may be encoded as four objects (buoy symbol, topmark symbol, light symbol, light description string) sharing the same node but having different positional attributes (shifts, orientation, etc.).

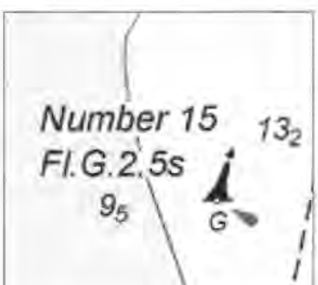

Figure 2: Sample of several objects(buoy, light flare, text strings) sharing one node

- Each paper chart object belongs to a certain object class in accordance with a "paper chart dictionary". The dictionary includes all typical cartographic elements such as symbols, lines, sectors, images (raster pictures), etc. Additional object classes are introduced in order to link information on a paper chart with source ENC(s) and stipulate combining of different charts/insets on one paper sheet.
- Spatial objects are nodes, edges, lines and areas. It should be noted that spatial objects define a "flat picture". In order to place objects relative to each other along the Z-axis (e.g. place a text on top of a region), a "priority" attribute may be used; in this way priorities create a layered picture.

It is easy to see that the selected way of storing/handling paper chart contents makes this solution compatible with S-57.

Creating Paper Charts Out Of ENCs

An automatic conversion from an S-57 data model to a digital paper chart will exploit the idea of the S-52 Presentation Library. The Presentation Library is a formal description of rules for cartographic information presentation, designed for and approved by the data producer. It includes symbols, fonts, color tables, patterns, etc. The program reads this library and builds the output according to cartographic rules for paper charts.

In brief, the process of paper chart production from an electronic chart requires the following steps:

- Source ENC(s) are loaded into the program;
- An empty paper chart of required datum, projection, scale and borders is created;
- Guided by the Presentation Library, the automatic conversion starts. During the conversion, the software creates a virtual ENC with borders as of resulting paper chart and contents taken from sources; objects within this virtual ENC are converted to paper chart objects;
- At this point the automatic conversion creates a draft paper chart that is subjected to validation. The operator also performs a final "make-up" of the paper chart that includes fine positioning of text and symbols (where results of automatic conversion are found to be unsuitable), manual or semi-automated masking of lines, adding text, pictures and tables from external sources, positioning insets, frames and other design elements;

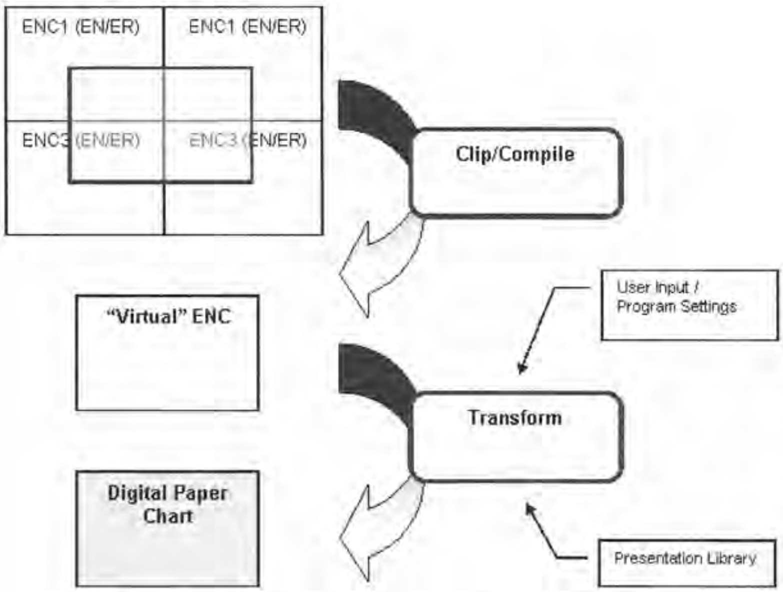

Figure 3: ENC to paper chart transformation layout

from the default object position (i.e. as described in the Presentation Library) and checks if this position is already occupied by another object. If it is, the software searches for another placement rule;

- Automatic testing of the resulting chart is performed and detected problems are rectified.

The transformation routine may be implemented as a Look-Up Table (direct analogue to S-52 presentation in the ENC) additionally enriched with procedural rules handling the complexity of the paper chart presentation (that is, compared to ENC, subjected to far more numerous regulations imposed by international and national standards). Procedural rules may be implemented as separate scripts written in a programming language (e.g. Java).

- The resulting digital paper chart is saved in a printable file format (e.g. PostScript[i], PDF[ii], DGN[iii]) or exported to a graphic file (e.g. TIFF/GeoTIFF).

Let us now consider some of the technical aspects in more detail.

Source Zones

As mentioned before, a paper chart can be made from several ENCs, each having its own geodetic parameters and geographic extent, which may even overlap. Before conversion to the resultant chart, a cartographer has to define which part of the paper chart is to be taken from which ENC. To do this, the operator defines special areas ("source zone" regions) and associates them with source materials. This division is maintained and used during the whole life span of the paper chart (e.g., digital updates will be selected depending on source zone configuration etc.).

Transformation Routine

Generally speaking, the transformation routine can be described as follows:

- Source electronic chart(s) are loaded into the program;
- An object of the electronic chart (set of logically related objects) is read;
- Presentation Library is loaded and applicable rules are selected;
- Paper chart object(s) are constructed;
- Created objects are placed according to the applicable rules. At this stage, the program starts

The important point here is that both the Presentation Libraries and the transformation scripts are "external" to the software and can be easily substituted/modified without re-designing or even re-installing the program thus facilitating the support of different final products (e.g. charts of national and international series, plans, inlets). The same scripting engine can be used to process the data stored in external files or in a database. A trained user might complete all the required customization in-house.

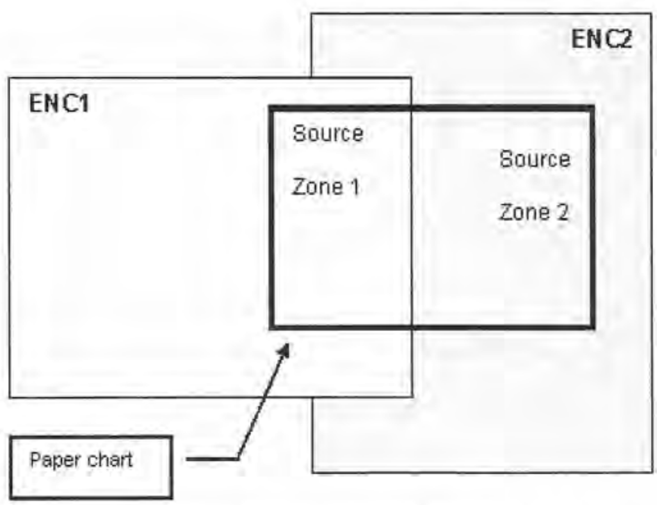

Figure 4: "Source Zone" concept. Note that a source zone is an intersection of the target paper chart and visible part of the source ENC

[i] PostScript is a registered trademark of Adobe Systems, Inc.
[ii] Acrobat PDF is a registered trademark of Adobe Systems, Inc.
[iii] MicroStation DGN is a registered trademark of Bentley Systems, Inc.

Let us consider an illustrative example.

The program takes a "lighthouse" that is encoded as the following ENC objects grouped into the "master-slave" hierarchy:

-LNDMRK
-3 x LIGHTS

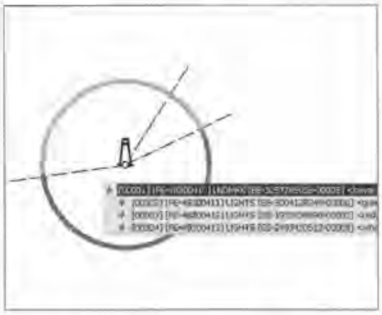

Figure 5.1: "Lighthouse" on ENC

Having analyzed object classes and attributes the program creates the following paper chart objects:

-lights99 symbol for LNDMRK
-lightdef symbol for the light flare
-3 different sectors with delimiting bearing lines and text strings indicating respective light colors for LIGHTS
-A light characteristic text string is created (note that the string reflects that more than 1 visibility range exists)

All objects are placed accordingly.

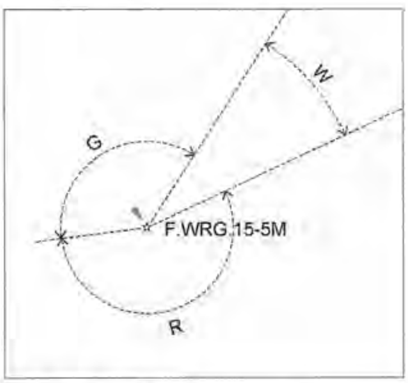

Figure 5.2: Result of automatic conversion

Cartographic Editing

Being a powerful and sophisticated tool, the automatic transformation may perform up to 90% of work necessary for ENC conversion ("typical" operations). Nevertheless, not all operations can be entirely automated and will still require manual editing. For this purpose a cartographic editor should be implemented as an integral part of the program. When using the editor, the operator can edit objects either directly on-screen or with the help of precise coordinate input (table).

A typical editing session includes:

- Placement of complex text;
- Editing lines and symbols to avoid clutter in complex cases;
- Chart title, tables and picture placement;
- Combination of insets on one paper sheet;
- Frames, text outside the chart border, printing marks;
- Pre-print quality control.

Editing operations may be enriched with script-based tools that automate line masking, creation of flaps/ continuations, frames and various design elements (e.g. compass roses, tide tables, etc.). It is also quite important that when "parent" links are used the operator can always get the necessary information on the ENC object related to the paper chart.

ER-Based Paper Chart Updating

An ENC is updated via digital updates (ER-files). The paper chart should also be updated accordingly. Direct use of digital updates for paper chart updating is the most promising solution ensuring maximum information consistency.

The algorithm for ER-based paper chart updating might be implemented as follows:

- The operator loads an update file(s);
- The software displays a listing of update instructions to the operator (supplemented with the textual Notice message if possible);
- Highlighting an update instruction in the listing automatically highlights affected object/position on the paper chart (this becomes possible since "parent" objects maintained in the paper chart allow linking of paper chart information with source ENC). This automation along with the textual Notice message aid the operator in identifying the affected object(s)/position(s);
- The operator then applies the ER-file instructions. The program automatically (or semi-automatically) updates the paper chart by re-applying the transformation routine only to objects affected by the update; all manual changes previously made by the operator to the "original version" are kept in the modified object.

As practice shows, this scenario seems to be quite effective and reliable.

Commercially Available Answer

The approach described in this paper lies beneath the whole idea of the dKart Publisher software developed by HydroService AS. dKart Publisher provides all the proposed functionality for S57-based paper chart production and updating.

The software consist of:

- Intelligent and easily configured converter of S-57 data;
- Clip/compile tools allowing the combination of data from several sources (electronic charts) into the single final product;

- External, easily configurable presentation libraries;
- Support of multiple converters and libraries defined by the end user's product specification;
- Powerful editing tools supplemented with QC routines;
- Import/export facilities.

The program can be integrated into any existing infrastructure or deployed as a part of dKart Office solution for a Digital Hydrographic Office. Several Hydrographic Offices have already practically implemented dKart Publisher with positive results.

Conclusions

Presently, a data producer faces a problem of simultaneous production and maintenance of both traditional paper charts and electronic charts (ENCs, Inland ENCs, AML), and therefore has to think about ways of restructuring the production process in order to minimize costs and sustain maximum quality. This can be achieved by the integration of processes into a single technological chain. The S57-based production and updating of paper charts seems to be a promising way of integration, since it achieves the highest quality of data with minimum impact on the existing production infrastructure. LH

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About the author...

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DID YOU KNOW...

HE KNOWS HIS 5 L's

A tribute from one seaman to another shipmate's knowledge: meaning, "He knows all about latitude, longitude, lights, log and lead."

Implications of the Navigation Surface Approach for Archiving and Charting Shallow Survey Data

By: Andrew Armstrong and Richard Brennan, NOAA/University of New Hampshire Joint Hydrographic Center
Shepard Smith, NOAA Ship *Thomas Jefferson*

This paper was developed from a presentation by the authors at Shallow Survey 2003, the 3rd International Conference on High Resolution Surveys in Shallow Water, Sydney Australia, 17-20 November 2003.
It was subsequently presented at FIG Working Week 2004, Athens, Greece, May 2004.

The Navigation Surface is a digital terrain model approach to managing, archiving, and creating multiple products from hydrographic survey data. Lieutenant Shep Smith, National Oceanic and Atmospheric Administration (NOAA), proposed the Navigation Surface concept at the Shallow Survey 2001 Conference (Smith, 2001). Lt. Smith further developed the concept in his Masters of Science Degree thesis in 2003 (Smith, 2003). NOAA is adopting the Navigation Surface concept into its hydrographic survey and nautical charting process. In the Navigation Surface approach, survey data are archived as a certified digital terrain model rather than as a set of verified or certified soundings. The archived elevation model is saved at the highest resolution supported by the sounding data. The adoption of a digital terrain model as the officially archived hydrographic survey product has significant implications for both hydrographic survey practice and for the nautical charting process. Some of our oldest and most cherished hydrographic and nautical charting "rules" will no longer apply. In this paper we examine five of those rules. The increasing redundancy of depth measurement and the greatly improved confidence provided by swath sounding techniques provide us the opportunity to improve our products and reduce the manual effort required to create them. We should end our practice of shoe-horning high resolution surveys into lead line molds and adopt new approaches to our charting process.

La navigation de surface est un procédé de modèle numérique de terrain pour la gestion, l'archivage et la création de plusieurs produits à partir de données hydrographiques. Le lieutenant Shepard Smith de la NOAA, a proposé le concept de la navigation de surface à la conférence Shallow Survey 2001 (Smith 2001) qu'il a par la suite étayé dans sa thèse de maîtrise en sciences en 2003 (Smith 2003). La National Oceanic and Atmospheric Administration (NOAA) est en cours d'adoption du concept de la navigation de surface pour faire ses levés hydrographiques et ses cartes marines. Dans le procédé de la navigation de surface, les données sont archivées comme un modèle terrain numérique certifié plutôt qu'un ensemble de sondages vérifiés ou certifiés. Le modèle d'altitude archivé est sauvegardé à la plus haute résolution permise par les données de sondage. L'adoption d'un modèle terrain numérique comme produit de levé hydrographique officiellement archivé a des implications importantes dans la réalisation des levés hydrographiques et dans la production des cartes marines. Quelques-unes de nos plus vieilles règles sacrées en hydrographie et en cartographie ne seront plus appliquées. Cet article examine cinq de ces règles. La croissance de la redondance des données de profondeur et l'amélioration grandissante dans la confiance des techniques de sondage multifaisceaux nous donnent l'opportunité d'améliorer nos produits et de réduire l'effort humain à les créer. Nous devrions cesser de jumeler une couverture à haute résolution à de simples plombs de sonde et adopter de nouvelles façons de faire dans le procédé cartographique.

Introduction

The Navigation Surface is a digital terrain or elevation model approach to managing, archiving, and creating multiple products from hydrographic survey data. Lt. Shep Smith, NOAA, proposed the Navigation Surface concept at the Shallow Survey 2001 Conference (Smith, 2001). Lt. Smith further developed the concept in his Masters of Science Degree thesis in 2003 (Smith, 2003). NOAA is adopting the Navigation Surface concept into its hydrographic survey and nautical charting process. The underlying technology has been made freely available for technology transfer, and CARIS ™ has commercialized the concept by incorporating it into their hydrographic and charting software.

In the Navigation Surface approach, survey data are archived as a certified digital terrain model rather than as a set of verified or certified soundings. The archived elevation model is saved at the highest resolution supported by the sounding data. That is to say, that if the beam footprint on the seafloor of a full-coverage multibeam sonar survey is 0.5 meter, for example, the elevation model would be saved at a grid spacing of 0.5 meter. This practice has the advantage of preserving this high-resolution data for a variety of known and unknown future purposes, even if such resolution will never appear on a navigational or charting product. Charting products such as paper charts and electronic charts are created from scale-appropriate generalizations of the elevation model.

Implications

The adoption of a digital terrain model as the officially archived hydrographic survey product has significant implications for both hydrographic survey practice and for the nautical charting process. Some of our oldest and most cherished hydrographic and nautical charting "rules" will no longer apply. In this paper we examine five of those rules:

1. Surveys are conducted and recorded with a shoal bias;
2. A survey database is a representative collection of corrected soundings;
3. Charted soundings can be directly traced to a unique measured depth;
4. All survey depths are portrayed on a chart as equally valid;
5. Charts are compiled successively through the scales, from largest to smallest.

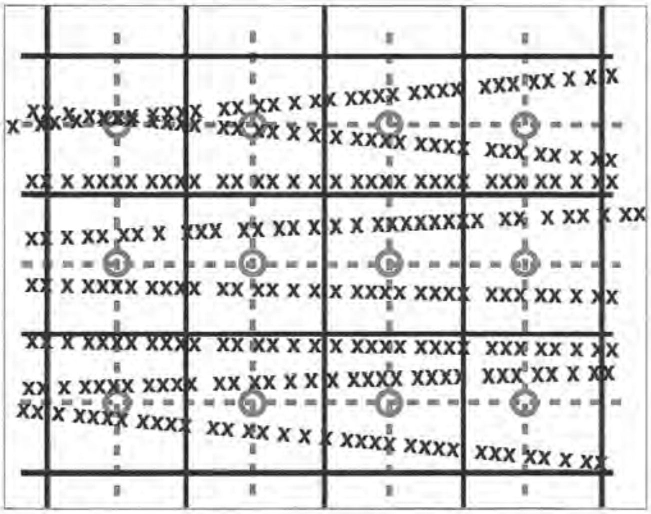

Figure 1: Multiple soundings in bins ***(courtesy deMoustier, C.)***

1. Surveys are conducted and recorded with a shoal bias

With multibeam and swath sonars, we will typically acquire multiple soundings in essentially the same location. At chart scales for example, soundings within 5 meters of one another are often considered as a group or bin (Figure 1). In deep water, the size of a bin may increase to tens of meters. In many hydrographic surveying organizations, a single depth is selected, after some cleaning process to remove outliers, from a bin as the representative depth. The selected depth could be the depth closest to the mean, it could be the median or the mode, but for safety of navigation purposes, it is usually the shoalest accepted depth from the cleaned data. This process creates a dataset of manageable size, but we thin the data once again to create our smooth or fair survey sheet. At survey scale, we can plot soundings at a spacing not much tighter than 5 mm., so for the same reason, we once again choose the shoalest sounding in the area.

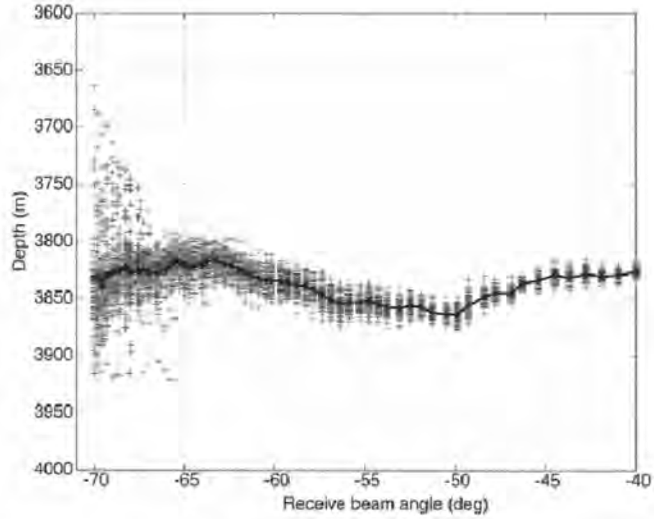

Figure 2a: Multibeam sounding distribution and variation with beam angle ***(from deMoustier, C. in Oceans 2001 ITS/IEEE Conference Proceedings)***

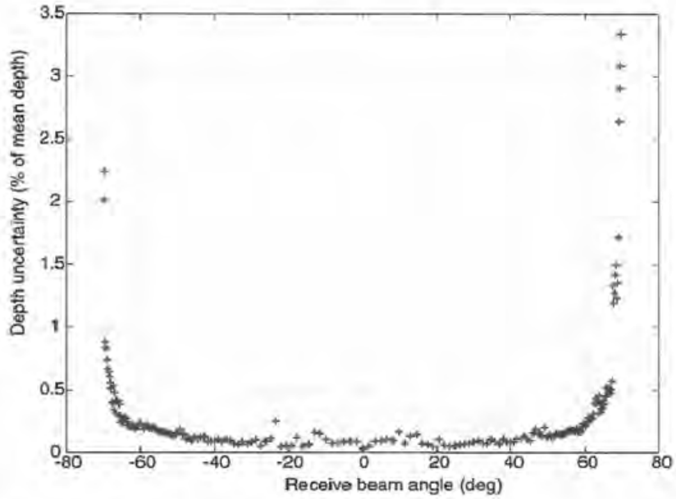

Figure 2b: Uncertainty of sounding accuracy by beam angle ***(from deMoustier, C. in Oceans 2001 ITS/IEEE Conference Proceedings)***

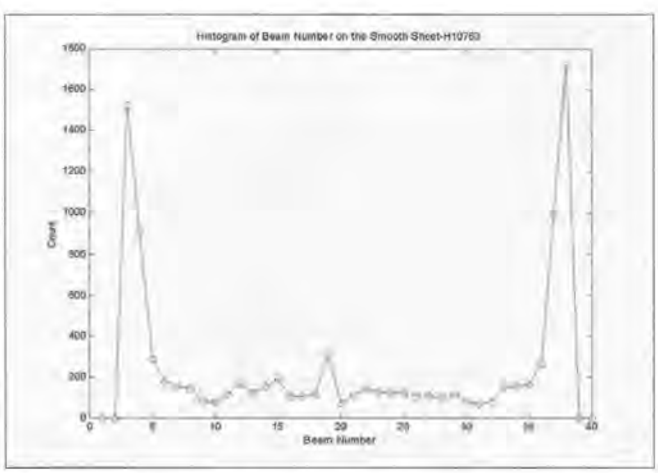

Figure 3: Smooth sheet selected soundings by beam number

Figure 2a portrays a set of multibeam soundings taken over a period of time from a stationary vessel. The data clearly show depths varying somewhat at the same position, with the range of variation increasing with increasing receive angle. This is precisely as we would expect. The dark line shows the mean, which we would take to be the most likely depth. Figure 2b shows the computed uncertainty of depth vs. receive angle, with the uncertainty increasing as beam angle increases, and steeply at the outer beams. Now consider Figure 3, which shows a histogram by beam number of the selected depths that were portrayed on a recent NOAA hydrographic survey. The overwhelmingly greatest contribution of depths to the final archived survey was from the outermost (and most uncertain) beams. Note that the very outermost beams were not accepted, and that all soundings had passed through a careful cleaning process. Looking again at Figure 2a, one can easily imagine the smooth sheet soundings as being from at or near the top of the swarm of soundings at the least accurate portion of the sonar swath. One can argue that the cleaning process should assure that no outliers are charted, but the inescapable conclusion is that our present practice leads to charting the noise, not the seafloor. With the Navigation Surface approach, we will create a survey product that most faithfully depicts the seafloor. This is the right thing to do. If a margin of safety is required for charting, that should be accomplished at the product level, not by imposing a bias in the database.

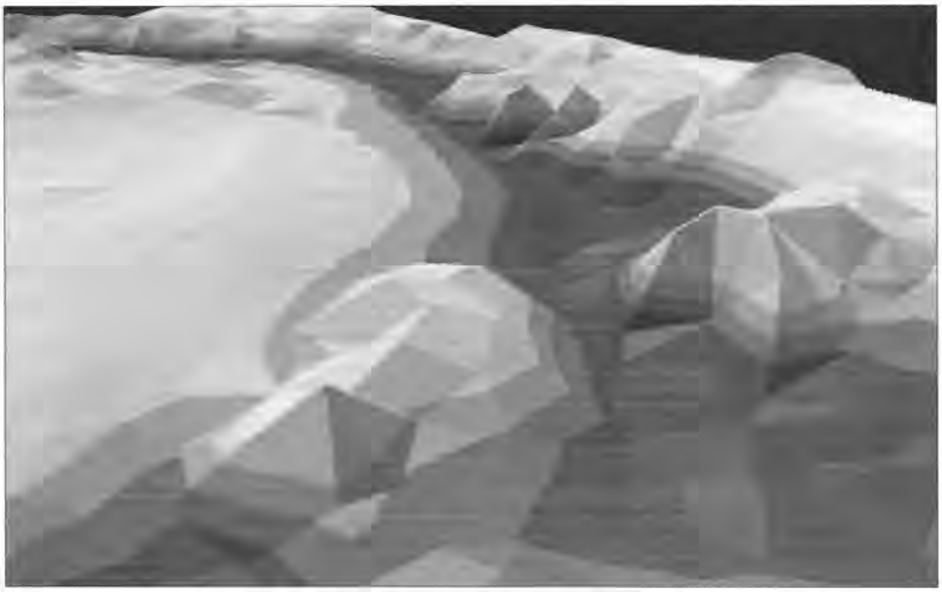

Figure 5: TIN-model at smooth sheet density

2. A survey database is a representative collection of corrected soundings

A typical survey smooth sheet is shown in Figure 4. In most hydrographic offices, the smooth sheet is the archived survey product, and the smooth sheet soundings constitute the archived sounding database. Figure 5 is a TIN-model depiction of soundings from a smooth sheet. For paper charting purposes, this is probably an adequate representation of the seafloor. Figure 6 shows the same seafloor at the full resolution of the multibeam sonar survey. Clearly this depiction tells us much more about the seafloor, and this data would be far more useful for a variety of scientific and engineering uses beyond nautical charting.

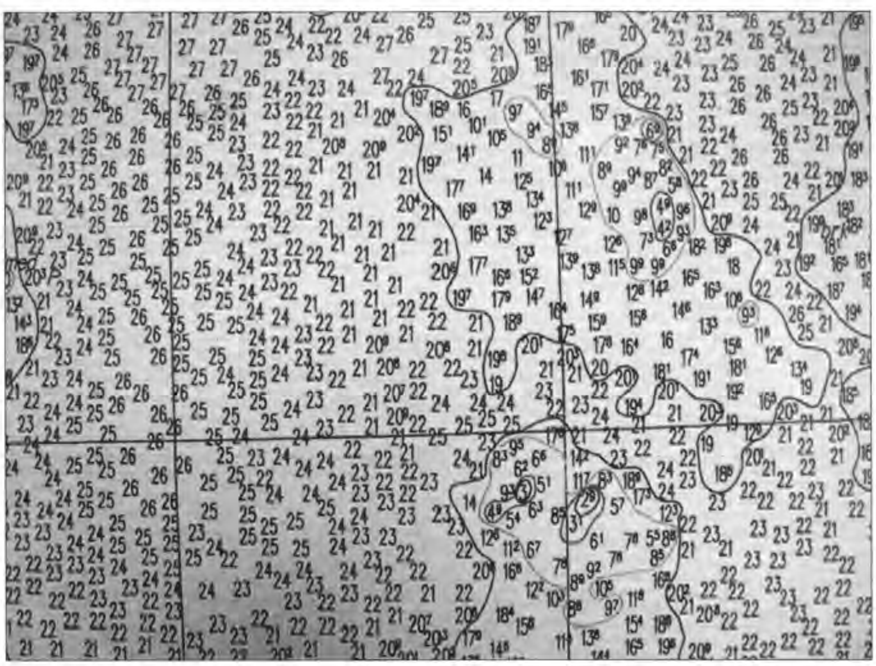

Figure 4: Portion of a NOAA Smooth Sheet

Particularly for high-resolution data, there are significant advantages to archiving a high-resolution grid model instead of soundings. Up until now, this idea has been something of an anathema to hydrographers. We have a strongly imbued sense that a discreet depth measurement is superior to an estimate—which is precisely what a grid implies. That prejudice comes from the fact that up until recently, our depth measurements were quite sparse. We long ago recognized in our geodetic surveying that the best results were obtained by meaning multiple observations, and in our positioning at sea, we happily record the output of multiple observations passing through Kalman filters for our GPS-derived positions. With today's multibeam and swath sonars, we now obtain many depth measurements at or near the same location. Each of these discreet measurements will differ from the others. There can be only one depth at a single position, so unless we wish to save a contradictory set of multiple depths for the same position, we must save

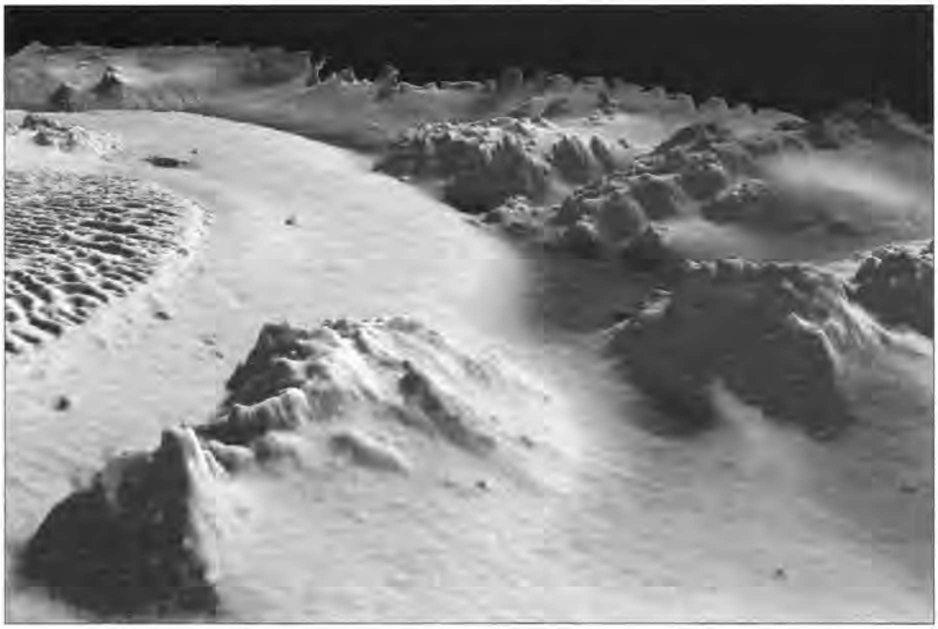

Figure 6: Grid model at original survey density

some representative value. Just as in geodetic surveying and GPS positioning, we believe that a mean value is most likely to be closest to the truth, and that the most efficient and highest fidelity approach—for high-resolution data—is a regular grid. The Navigation Surface approach does, however, recognize that there are instances, for purposes of navigational safety, that a discreet measurement should be honored. An example would be an actual measurement of the shoalest point of a danger to navigation such as a rock or wreck.

Figure 7a: Chart Section

Figure 7b: Smooth sheet section

3. Charted soundings can be directly traced to a unique measured depth

When we measured depth with a lead line, or even with a single-beam echo sounder, our set of measured depths was relatively sparse. Our smooth sheet reduces these surveys to even sparser levels. With multibeam sonars and traditional data cleaning and binning techniques, we are still working with measured depths, and our smooth sheet reduces these surveys to the same density as our single-beam surveys. Charts are created by automated, manual, or some combination of automated and manual selection of soundings from the survey. Figures 7a and 7b show a current edition of a NOAA nautical chart, and the 1954 vintage survey from which the charted soundings were selected. When we begin to archive our survey as a grid, we will not be (as noted above), archiving soundings, but estimated depths at regularly spaced grid nodes. For each chart scale, we will create a suitably generalized product surface. If we choose to chart soundings, they will be depths plucked from the product surface. At any location we choose, we can select a depth. The depth will not be a measured survey sounding, however. It will be the DTM value of the product surface at that location. If we choose to chart contours, they will likewise be contours cut from the product surface. From a cartographic point of view, this will have the significant advantage that no sounding can inadvertently be selected from the wrong side of a generalized depth contour. Figure 8 shows a product surface (as a mesh) draped over the high-resolution survey surface from which it was derived. Figure 9 is a section of a trial chart created from a product surface. Although the extra features of color and sun-illuminated terrain model show beneath the depths and contours, the product is clearly equivalent in utility to a traditionally compiled chart.

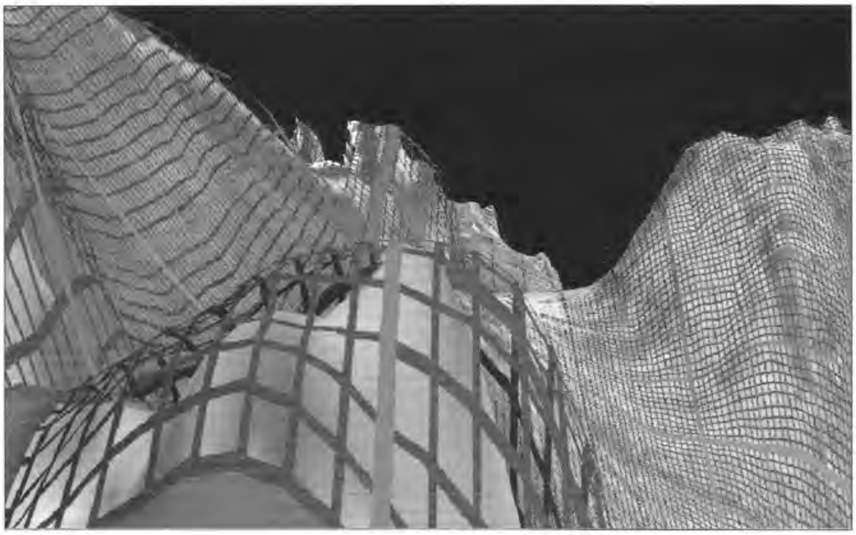

Figure 8: Product surface draped over high resolution survey surface

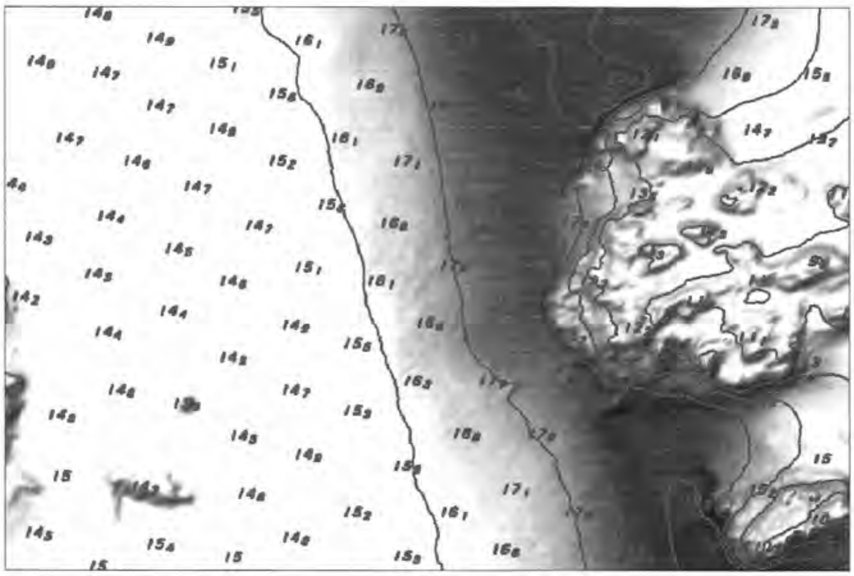

Figure 9: Trial chart section from product surface

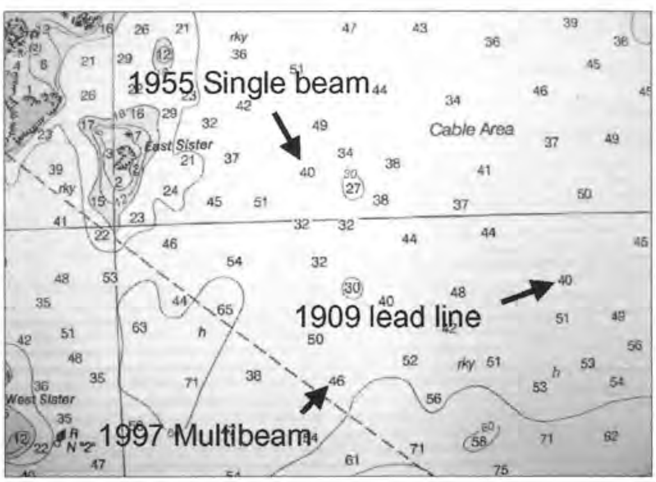

Figure 10: NOAA Chart with soundings from different sources marked

4. All survey depths are portrayed on a chart as equally valid

Figure 10 is a section of the current edition of a NOAA chart covering the approaches to Portsmouth, New Hampshire. Three soundings are annotated in the figure with their survey source. One is from a lead line survey of 1909, one from a single-beam echo sounder survey of 1954, and one from a multibeam sonar survey of 1997. They are from very different sources, have very different positional accuracy (and subsequently different depth accuracy) and most importantly, represent a depth from surveys of very different sounding density. Yet they all look the same, and more importantly, the white space around them looks the same. To the mariner, they are the same, and the faithfulness with which they portray depth in the vicinity, is the same. To those of us who know the source, however, the lead line depth tells us nothing about the seabed nearby. In this area of rocky seafloor outcrops, an undetected rocky shoal could easily lie within meters of the lead line depth. In fact, the 1997 multibeam survey located several significantly shallower rocky depths between historical lead line depths. (For hydrographers who remain opposed to charting digital terrain model depth estimates rather than measured soundings, what is the white space surrounding a lead line sounding and the depth curve enclosing lead line soundings if not a model?) The Navigation Surface will include, in addition to a depth model, an uncertainty model. Figure 11 shows the uncertainty model as color overlaying the sun-illuminated digital terrain model for the area from which the chart in Figure 10 is drawn. The green color is low uncertainty from the multibeam survey, orange is moderate uncertainty from the single-beam survey, and violet is high uncertainty from the lead line survey. How we should portray this uncertainty for the mariner or other user is unclear. That we should portray it somehow, seems clear.

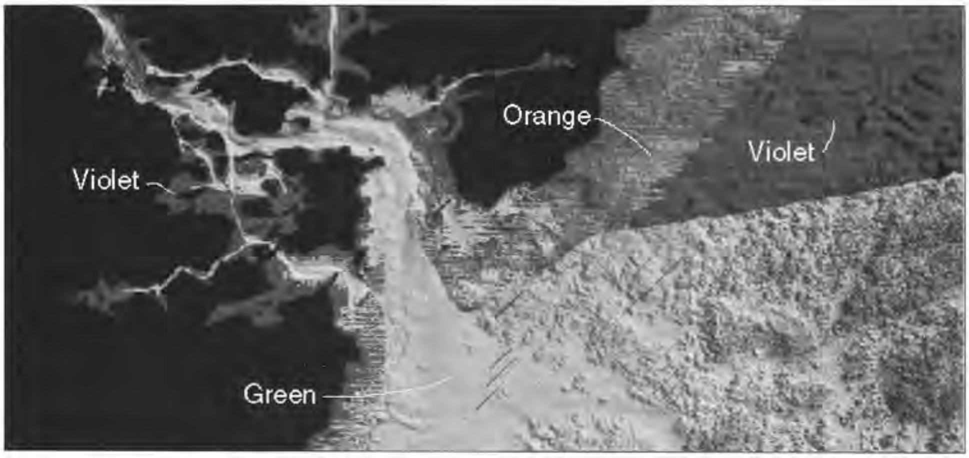

Figure 11: Uncertainty by color over digital terrain model (in area shown in Figure 10) ***(Ed. Note: Colour indicators added due to grayscale printing.)***

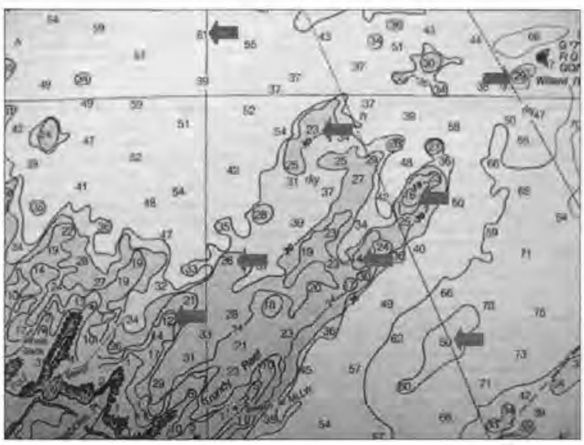

Figure 12a: Chart section from 1:20,000 scale chart

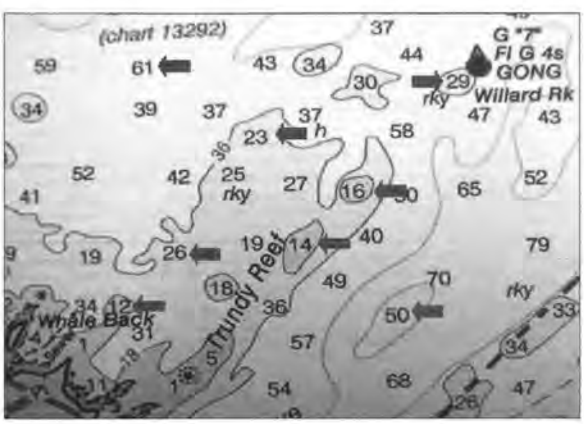

Figure 12b: Chart section from 1:40,000 scale chart

5. Charts are compiled successively through the scales, in order from largest to smallest

This practice allow the nautical cartographer to successively generalize the survey data, selecting fewer and fewer soundings and smoothing the contours while masking finer and deeper detail on the chart. Figures 12a-c show the same piece of seafloor as it appears on successively larger scale charts. Several soundings are highlighted to demonstrate their appearance at each of the scales. This is an entirely rational and reasonable process, but one that will not be the same with the Navigation surface. The process will be much simpler and require much less manual cartographic effort. The generalization rules of the Navigation Surface will automatically result in more generalized product surfaces as the product scale decreases. However, there will be no need to do this in sequence, as the automated approach will always create the same generalization regardless of the order in which done. The product generalization will be applied to the original surface each time, not the next lower level generalization. Furthermore, except at the shoalest points on the surface, any depth picked from the product surface will differ from a depth picked from the same latitude and longitude on a product surface at a different scale or

Figure 12c: Chart section from 1:80,000 scale chart

Figure 13a: Survey surface and product surface at 1:5000 scale generalization

Figure 13b: Survey surface and product surface at 1:10,000 generalization

level of generalization. Figures 13a and 13b show that a depth drawn from a point midway between the two higher elevations will be different at the two scales. Since the important shoal depths will remain constant, and since as always, the appropriate scale representation should be selected for the intended navigational use, this should be of no practical concern to the mariner.

Conclusions

The increasing redundancy of depth measurement and the greatly improved confidence provided by swath sounding techniques provides us the opportunity to improve our products and reduce the manual effort required to create them. We should end our practice of shoe-horning high resolution surveys into lead line molds and adopt new approaches to our charting process. It is inevitable that when we do this, things will be different.

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About the authors ...

Captain Armstrong is the NOAA Co-Director of the Joint Hydrographic Center at the University of New Hampshire. Along with the UNH Co-Director, he manages the research and educational programs of the Center. He is chairman of the FIG/IHO/ICA International Advisory Board on Standards of Competence for Hydrographic Surveyors and Nautical Cartographers. Captain Armstrong has nearly 30 years of hydrographic experience with NOAA, including positions as Officer in Charge of hydrographic field parties, Commanding Officer of NOAA Ship *WHITING*, and Chief, Hydrographic Surveys Division.

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LT Smith is a NOAA Corps officer currently serving as the Executive Officer of the NOAA Ship *THOMAS JEFFERSON*. He was the first Masters graduate of the University of New Hampshire Ocean Mapping Masters Program in 2003. He has previously served aboard the NOAA Ship *RAINIER* and *S/V BAY HYDROGRAPHER* conducting hydrographic surveys for charting in Alaska and the US east coast. He is a 1993 graduate of Cornell University in mechanical engineering and an alumnus of Deep Springs College.

FIG

Go F.I.G.ure

by Andrew Leyzack

International Federation of Surveyors (FIG) Annual General Assembly and Working Week 2004

Held at the Hotel Intercontinental, Athens, Greece, 21-27 May, 2004

Working Week 2004 was a forum for the Commissions to hold working group meetings, workshops and to communicate their joint activities through technical sessions. The event was jointly hosted by the International Federation of Surveyors, the Technical Chamber of Greece and the Hellenic Association of Rural and Surveying Engineers.

In participating at this event, I served a number of roles:

- Canadian Institute of Geomatics delegate to the General Assembly
- Vice Chair to Commission 4 (Serving as secretary, the minutes were taken from two Commission 4 meetings)
- Chair for Hydrography Workshop#1- Hydrography and Charting
- Rapporteur for Hydrography Workshop#3- Vertical Reference Surface

I also had the opportunity to present a paper to Commission 4 on a Proposed Certification for Hydrographic Surveyors in Canada. The presentation and discussion which followed provided for valuable feedback for the joint CHA-Association of Canada Lands Surveyors (ACLS) Task Force which has been tasked with performing a study on the subject (See report on CHA-ACLS Task Force in the *Announcements* section of this current edition of *Lighthouse*).

Updated Version of the Definition of Surveyors

My previous report to *Lighthouse* described the proposed updated version of the FIG Definition of Surveyors (See *Lighthouse* Ed. 65 p. 39). This year's General Assembly approved the adoption of the updated definition. Perhaps a slightly different philosophy from that of the "Expanded Profession", the updated definition recognises the evolution of the surveying profession which encompasses the spheres of GIS and Data Management as new tools of the trade. Essentially the new definition affirms the fact that surveyors have always performed these tasks and that only the tools have changed.

New Vice President from Canada

It is a pleasure to inform you that Ken Allred of Alberta was elected as one of four new VP's at this year's General Assembly. Many senior Hydrographers (especially those educated in the West) will know that Ken has served as head of the Canadian delegation and has been an effective voice for Canada for several years. Ken will serve a four-year term on FIG council. Recently, Ken has toured a number of locations in Western Canada with FIG executive director Markku Villika to seek out a suitable host city for the 2010 FIG Congress.

Good Practice in Hydrographic Applications

The main product of FIG is the development of good practice resulting from the collective research and development of participating nations. For example, the issue of vertical reference (datums) in data management applications is a going concern. FIG working group 4.2 is developing a white paper on the merits of adopting a seamless vertical reference surface. The Workshop session generated such a great deal of interest that discussion ran on 20 minutes past schedule. It was an excellent example of how delegates from multiple disciplines (hydrography and geodesy) could network to discuss practical problems common to both. It is the hope of Working Group 4.2 that the recommendations developed from their work may aid hydrographic offices and others in relating data from various vertical reference frames to a common surface.

Also, Working Group 4.3 on Ocean Governance and Coast al Zone Management are dealing with issues relevant to Canada's approach to managing Marine Protected Areas (MPA's) and the development of an (Offshore) marine cadastre. The most immediate source on Good Practice is the FIG Surveyors Reference Library. It is FIG's newest portal to recommended papers on all subjects pertaining to surveying practice.

Global Experience

From participation in FIG the Canadian hydrographic surveyor, geodesist, cartographer and GIS professional stand to benefit immensely from the experiences of their colleagues abroad. New technology and new techniques are introduced and exploited. At this year's Working Week, I chaired a hydrographic workshop which included an informative paper on the Implications of the Navigation Surface Approach to Archiving and Charting Shallow Survey Data. This paper demonstrated the American approach to using a digital terrain model for managing, archiving and creating multiple products from hydrographic survey data. As an organisation just starting to utilize a source data base to store multibeam data, this paper provides some useful food for thought for the Canadian Hydrographic Service. Subsequently, I have acquired permission to republish this paper in this current edition of *Lighthouse*.

Groupe Francophone de la FIG (GFF)

There exists a Francophone arm of FIG to which French speaking Canada may better network with geomatics organizations in other French-speaking countries. The Groupe Francophone de la FIG (GFF) facilitates exchange between French-speaking nations under FIG. Under sole fundamental motivations on profession exchanges, education, training, communication, documentation and representation of the profession at decision levels, the GFF has formalised a union of French speaking surveyors called the Federation des Geometres Francophones. Given the formation of the GFF under FIG, given that France already has 3 accredited hydrographic training programs and given that FIG and the IHO have recently signed a renewed agreement for future cooperation, there may be accredited French language training opportunities for Canadians through this network.

Links for Canadian Hydrographic Expertise and Standards of Competence

The link for hydrography is obvious because hydrography is international in scope. Our standards for data acquisition and nautical cartography must be international as are the standard for professional competence and expertise. The FIG has a strong link with the International Hydrographic Organisation (IHO) and have co-published documents prescribing standards and best practice significant for the surveying community. For example, FIG/IHO/ICA accreditation of training programs has set expected standards of competence which can be found in FIG/IHO Special Publication M5, for graduates in hydrographic surveying and nautical cartography. I would like to take this opportunity to announce that Andy Armstrong, president of The Hydrographic Society of America has been elected Chairman of the FIG/IHO/ICA Advisory Board on Standards of Competence for Hydrographic Surveyors and Nautical Cartographers. Mr. Armstrong replaces Mr. Svante Astermo (former Hydrographer of Sweden) who has served in this role for 10 years.

Commission 4 Technical Tour

During Working Week 2004, Commission 4 delegates spent a day in the Saronic Gulf aboard the Hellenic Navy Hydrographic Ship *HS-OS* (Hydrographic Ship-Oceanographic Ship) *NAFTILOS*. What surprised us was the fact that the Hellenic Navy still carry radio positioning systems as a survey navigation backup. Recently I gave a presentation on the tour at a CHA Central Branch general meeting.

CIG Ways and Means Committee

In closing, I would like to acknowledge the assistance of my employer, Fisheries and Oceans Canada, FIG Commission 4, the CHA and the Canadian Institute of Geomatics (CIG) in providing the funds to travel to this year's Working Week and General Assembly. I am presently participating in a Ways and Means committee within the CIG which has brought together organisations like the Canada Council of Land Surveyors (CCLS), ACLS and Geomatics Industry Association of Canada (GIAC) to seek out ways to increase support from the Canadian geomatics community to better fund our participation with organisations like FIG, the ICA and ISPRS.

For more information on FIG, I encourage you to visit www.FIG.net.

DID YOU KNOW...

LAYING ON OARS

This salute to a passing superior officer's launch or boat is paralleled by other forms of salutation, such as stopping a launch's engine, or letting fly the sheets of a sail. They are all official methods of acknowledging the presence of a ranking officer.

Establishing a Seamless Vertical Reference along the Tidal Segment of the Saint John River

By: Jianhu Zhao, UNB Ocean Mapping Group and School of Geomatics and Geodesy, Wuhan University
John E. Hughes Clarke and Steven Brucker, UNB Ocean Mapping Group

A method is developed to use GPS ellipsoid height observations as a means of applying a seamless vertical reference to hydrographic surveys along a 110 km tidal segment of the Saint John River. In order to be able to use the GPS ellipsoid heights, the national geoid model HTv2.0 is first modified using a GPS/levelling geometric method to achieve a locally more accurate transformation from NAD83 ellipsoid height to CGVD28 orthometric height. The second step is to develop a cross-section linear interpolation method to define an equivalent, continuously varying chart datum reference from which the transformation from CGVD28 height to CD2000 height can be derived. Using this approach to a seamless vertical reference, the method is tested using two GPS tidal measurement experiments.

Le Groupe Ocean Mapping (OMG) entreprend présentement une étude de faisabilité sur la section à marée de la rivière Saint-Jean de Fredericton à Saint John, une partie intégrante qui requiert une cartographie précise de la bathymétrie. Dans cette étude, un effort a été fait pour utiliser les observations des altitudes de l'ellipsoïde du GPS comme substitution à la mesure conventionnelle de la marée. Par conséquent, les résultats des mesures des élévations par GPS doivent être reliés quantitativement aux niveaux de la marée qui sont enregistrés par des marégraphes conventionnels. Pour le levé topographique du lit de la rivière, le résultat final doit se refléter sous forme d'altitude de carte, laquelle a été antérieurement établie section par section le long des segments identifiés de la rivière. Ainsi, faisant partie intégrante de cette étude, nous faisons face à la problématique à savoir comment transférer l'altitude de l'ellipsoïde dérivée du GPS aux niveaux de référence déjà établis des cartes et établir un niveau de référence vertical continu pour la rivière. Une transformation en deux étapes, laquelle implique le modèle précis du géoïde local acquis en modifiant deux géoïdes nationaux canadiens et le modèle du niveau de référence continu par une technique d'interpolation linéaire d'une coupe transversale spéciale, est développée dans cet article. Les modèles ont été vérifiés en se servant de points connus de nivellement GPS le long de la rivière.

Introduction

The Ocean Mapping Group (OMG) is currently implementing a habitat mapping campaign along the tidal section of the Saint John River from Fredericton to Saint John, an integral part of which involves precise bathymetric mapping. As part of this campaign, an effort has been made to substitute GPS ellipsoid height observations as a proxy for conventional tide measurement. Implicitly then, the GPS elevation measurements need to be quantitatively related to the tidal levels that are observed with conventional tidal gauges. For the riverbed topographic survey, the final result needs also to be reflected in the form of chart datum height, which has been previously established piecewise along discrete segments of the river. Two kinds of GPS carrier phase techniques, Real Time Kinematic (RTK) and Post Processing Kinematic (PPK), are used for precise horizontal and vertical positioning. Thus, we face the issue of how to transfer ellipsoid height derived from GPS to the previously established chart datums. A similar approach has previously been attempted for sections of the St. Lawrence Seaway (Biron and Dupuis, 2001).

Two official height transformation models, which are used for the transformation from North American Datum 1983 (NAD83) or Canadian Spatial Reference System 1998 (CSRS98) ellipsoidal height to Canadian Geodetic Vertical Datum 1928 (CGVD28) orthometric height, have been developed successfully. They are Height Transformation version 1.0 (HTv1.0) and version 2.0 (HTv2.0) (Natural Resources Canada, Geodetic Survey Division, online application). Although the accuracies of the two models are estimated to be ± 5 cm (with 95% confidence) throughout Canada, the two models unavoidably contain local biases (Loo, 2002). Sometimes the bias is more obvious and will influence the accuracy of local height transformation in the actual applications. Thus, it is necessary to modify them and ensure the calculated result acquired by them has a high consistency with the result derived from the local GPS/levelling data along the particular river segment.

The GPS/levelling geometric method can fulfill the modification (Erol, 2003). Although there are 5 high-precision (First Order) GPS control points along the particular river segment, these points are located far from the river and are not sufficient for constructing the geometric modification model. An ideal distribution and number of benchmarks can be found along the river, but their horizontal accuracies were very low (about 30 seconds in latitude/longitude). In addition, the NAD83

(CSRS98) ellipsoidal height was not known at each benchmark. Thus, a GPS control network needed to be designed and implemented.

The definition of Chart Datum 2000 (CD2000) was based on the lower, low water level in each river segment. When the chart datum was defined, it was also associated with CGVD28 orthometric height by spirit levelling (Saint John River chart description, 1996). This means, once HTv2.0 or HTv1.0 is improved, the relationship between NAD83 (CSRS98) ellipsoidal height and CD2000 height is better defined in the particular river segment. CGVD28 orthometric height acts as a bridge relating the two vertical datums.

Although the Saint John River drains into the Bay of Fundy with ~ 7m tides, the restriction of the Reversing Falls limits the tides in the Saint John River to a range of 30 to 70cm. The decay in amplitude and lag in phase that occurs progressively up the river is heavily influenced by the local riverbed topography and cross section. Hence, the existing discrete definitions of chart datum are quite different at successive segments. A ladder-type change of chart datum definitions along the river segment of interest shows that the vertical reference datum is intermittent and discontinuous. If a constant definition of chart datum is adopted directly in the hydrographic survey, the problem of mismatching riverbed topography will appear in the riverbed terrain model as one moves between datum application areas. Whilst this would not have been previously noted in sparse single beam operations, the steps would be all too apparent with the continuous bathymetric surface created with swath sonar systems (e.g. Riley et al., 2003). Such datum jumps are meaningless in the context of the GPS elevations and thus a means of generating an equivalent continuously varying chart datum reference is required.

This paper describes in detail the concepts of ellipsoid, geoid and chart datum; the procedure of implementing a GPS control network, the modification of HTv2.0 model and the development of a continuous chart datum model. Finally, the precise transformation from NAD83 (CSRS98) ellipsoidal height to CD2000 height is fulfilled. These models are also tested by some known GPS/levelling data and GPS tidal measurements. Some conclusions and discussions are presented at the end of this paper.

Introductions of Vertical Reference Surfaces

In this research, three vertical reference surfaces are used. They are the ellipsoid, geoid and chart datum respectively. The corresponding height systems are ellipsoidal height, orthometric height and chart datum height. These reference surfaces and corresponding height systems are depicted in Figure 1.

The ellipsoid surface is a mathematic surface and can be expressed with a regular geometric function and thus it is a regular surface. The WGS84 ellipsoid is fundamental for GPS positioning and is a global, earth centred ellipsoid. The WGS84 ellipsoid height h, which is measured from the actual topographic surface to the ellipsoid surface along the ellipsoidal normal, can be calculated using GPS. Generally, different countries or regions like to build corresponding ellipsoids to best fit the earth's shape locally. For Canada, the local ellipsoid NAD83 (CSRS98) is often adopted in actual applications.

With respect to a regular ellipsoid, the geoid is defined as an equipotential surface of the earth's gravity field which best fits, in a least squares sense, global mean sea level. It is the reference for physical height systems such as orthometric height. Due to density variations inside the earth, the geoid is an undulating surface, not smooth and regular. Orthometric height H^o is the distance between the geoid and the earth's surface along the plumb line. Previously, there was no way to accurately measure the geoid, so it was roughly approximated by Mean Sea Level (MSL). Although, for practical purposes, at the coastline the geoid and MSL surfaces are assumed to be essentially the same; at some spots the geoid can actually differ from MSL by several metres (Fraczek, 2003). In Canada, CGVD28 orthometric height is defined above MSL (Geodetic Survey Division, HTv2.0 online application).

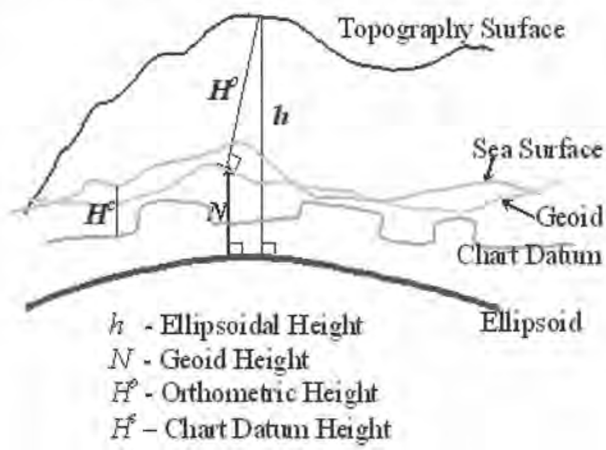

Figure 1: Height systems and their relationship

Generally at any point, because of the small size of the height error due to the angle between vertical direction and normal direction (less than 8×10^{-2}mm), the effect of the directional inconsistency can be ignored for many surveying applications. Thus, the relationship between ellipsoid height and orthometric height can be expressed as the following:

$$h = H^o + N \tag{1}$$

For the requirement of maritime navigation safety, where depth observations are integrated with the change of local water levels, hydrographic charts often adopt a variation of low tide instead of MSL for a reference datum such as CD2000 in Canada. Chart datum, to which all soundings are referenced, is not a coherent surface (Adams, 2003). Chart datum height H^c is the vertical distance above chart datum. Chart datum depth is the vertical distance between chart datum and seabed/riverbed.

In actual engineering applications, orthometric height and chart datum height/depth have more practical value. However, with the increasing application of GPS in all kinds of fields, useful and sufficiently accurate ellipsoid heights can be derived easily with GPS. Thus, the transformation from ellipsoid height to orthometric height or to chart height becomes essential.

GPS Control Network

In order to meet with the requirement of GPS carrier phase differential surveying for base stations and the requirement of establishing a seamless vertical reference for GPS/levelling points, the OMG designed and implemented a GPS network that covered the particular river segment of the Saint John River (Figure 2) in March of 2004.

In order to provide horizontal and vertical control to the GPS network, 5 First Order GPS control points were occupied. Considering that GPS/levelling data would be very important for the establishment of height transformation models, 15 benchmarks, distributed uniformly along the particular river segment, were included in the GPS control network.

The GPS control network was measured with 3 Trimble 5700 GPS receivers. For each basic triangular unit in the network, if the maximum baseline length was less than 10 kilometres, the synchronization observation segment was designed as 1.5 hours. Otherwise, 2 hours of sample time was set for concurrent observation. Within the entire GPS control survey network, 20 concurrent observation segments were completed.

Trimble Geomatics Office (TGO) software was chosen for the data processing of the GPS control network. NAD83 was adopted as reference datum in the GPS network adjustment for the coordinate transformation from WGS84 to NAD83. After baseline processing, loop closure check and network adjustment, a satisfying result was achieved. In the latitude direction, the maximum bias was 0.7 cm, minimum bias was 0.3 cm, and standard bias was 0.4 cm. In the longitude direction, the maximum bias was 0.5 cm, minimum bias was 0.2 cm, and standard bias was 0.3 cm. In the height direction, the maximum bias was 1.5 cm, minimum bias was 0.7 cm, and standard bias was 1.1 cm.

In order to ensure the accuracy of levelling data, some older benchmarks, used as vertical control points in the GPS network that were located on decaying concrete wharves, were checked and modified with stable benchmarks.

Using the GPS control network surveying, levelling surveying and data processing, we now have, at each of the GPS control points, an accurate horizontal solution, an ellipsoidal height and a levelling height.

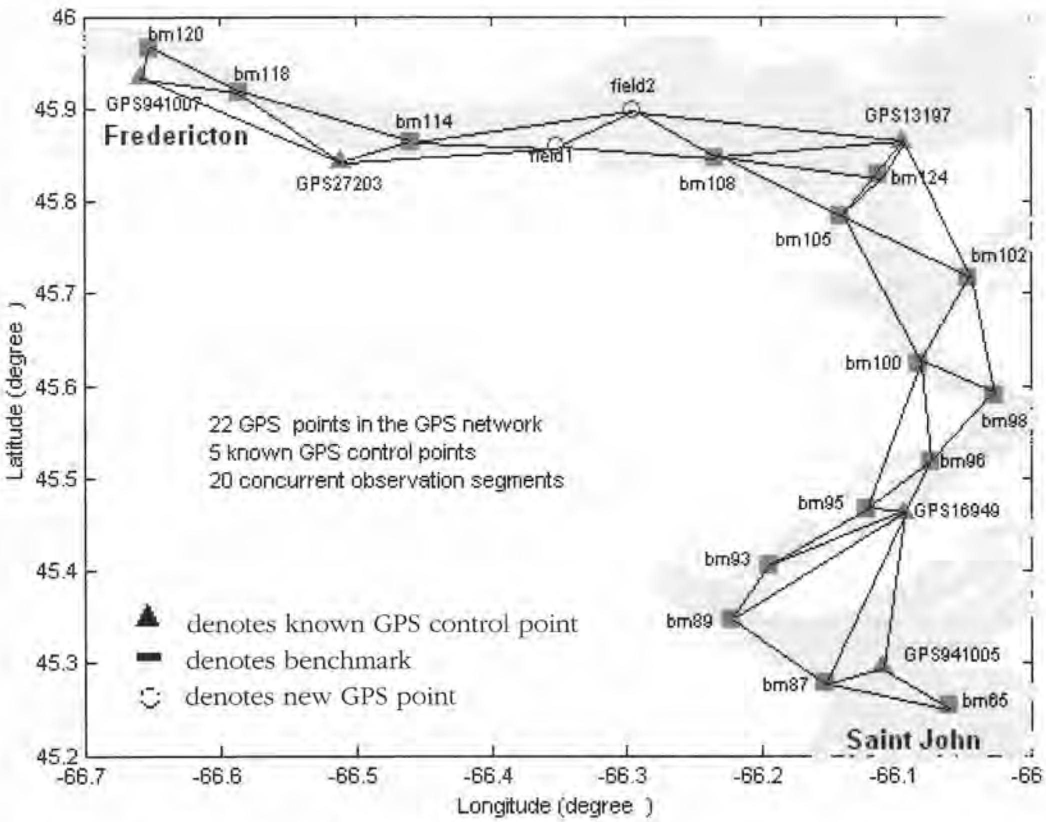

Figure 2: GPS control network

Modification of Canadian National Geoid Model HTv2.0

In Canada, two scientific geoid models have been successively developed for actual applications. One is Geodetic Survey Division 1995 (GSD95) and the other is Canadian Gravimetric Geoid 2000 (CGG2000) (Véronneau, 1997, 2001).

GSD95 was determined with gravity data collected up to 1995. The calculation method was spherical 2D-FFT (Fast Fourier Transform) (Véronneau, 1997). CGG2000 was constructed with gravity data collected up to 2000. The approach was a Helmert-Stokes spherical approximation. The calculation method was spherical 1D-FFT. The solution was optimum for the whole of Canada. Because more information sources and improved calculation methods were used in determining the CGG2000 national geoid model, CGG2000 was more accurate than GSD95 in Canada. Now, CGG2000 replaces GSD95 and is applied to the height transformation (Véronneau, 2001).

Based on CGG2000, the height transformation model HTv2.0 was finished by adding a Corrector Surface HRG01 model to CGG2000. The CGG2000 geoid model was adjusted to the Canadian primary vertical control datum CGVD28 by means of 1285 NAD83 (CSRS98) ellipsoidal heights throughout Canada. HT2.0 makes possible direct transformation of NAD83 (CSRS98) ellipsoidal height to CGVD28 orthometric height (Véronneau, 2001).

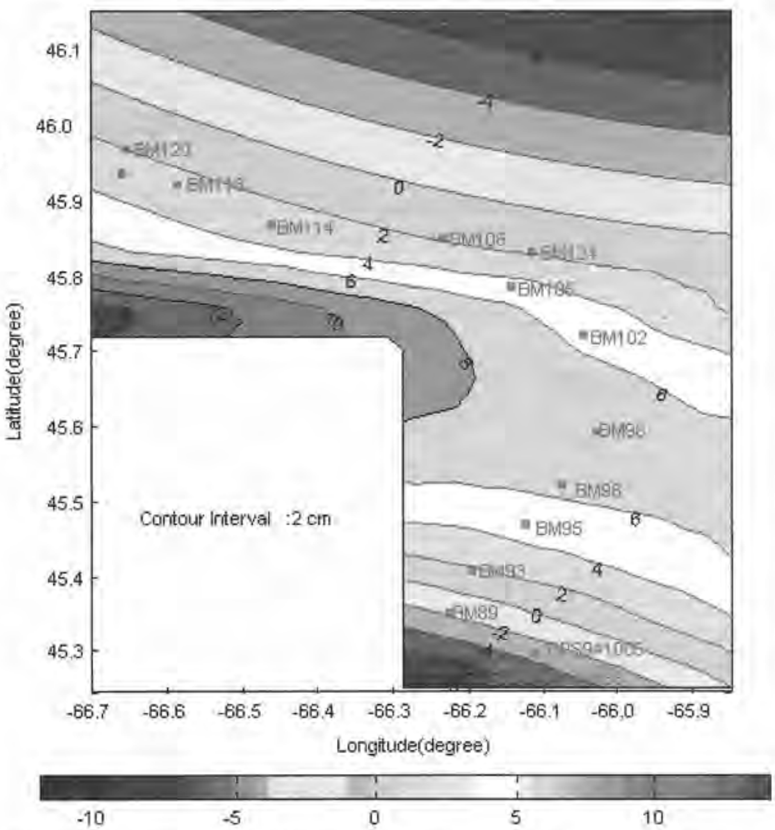

Figure 3: The distribution of the differences between the geoid height derived from HTv2.0 and the geoid height derived from known GPS/levelling data

Model	Model Test	Maximum bias (cm)	Minimal bias (cm)	Standard Bias (cm)
EW	Interior test	4.62	-1.32	±3.20
	Exterior test	1.35	-0.05	±0.93
NS	Interior test	3.24	-0.95	±2.32
	Exterior test	-1.43	-0.58	±0.97

Table 1: The statistics test parameters of EW and NS geometric models

HTv2.0 has an accuracy of ± 5 cm (with 95% confidence) in the southern region, with decimetre accuracy in the northern region (Loo, 2002). This is a statistic result throughout Canada. The local statistic accuracy of HTv2.0 can be lower than the national statistic result due to more significant local biases. This fact is also shown in this paper by comparing the geoid height N derived from HTv2.0 and the geoid height derived from GPS/levelling data along the particular river segment, where the difference ΔN ranges from -13cm to 14 cm (Figure 3). The inconsistency shows that the results from HTv2.0 needs to be modified so that it can be used for precise height transformation in the particular river segment.

Based on the assumption that the distribution of geoid height N is correlated with the distribution of earth's interior geologic structure, the difference ΔN between national geoid HTv2.0 and the local vertical datum reflected by GPS/levelling data, should be a function of location (Erol et al., 2003, Kadir 2003). Thus, polynomial models can be constructed with horizontal coordinates of these GPS/levelling points for simulating the difference ΔN.

Considering the shape of the particular river segment (Figure 5), two geometric models are constructed in EW and NS river segments. In the construction of two models, 29 GPS/levelling points, which are composed with 20 points in the GPS control network and 9 known First Order GPS control points, are adopted. Twelve of these points are used for constructing and testing internally the EW model, Five of them are used for externally testing the EW model. Eight of these points are used for constructing and testing internally the NS model, and 4 of them are used for externally testing the model. The statistic test parameters of the two models shown in Table 1 prove that the local biases of HTv2.0 results in the particular river segment can be simulated accurately by geometric models.

After the two geometric modification models are determined, the correction ΔN can be calculated by the two models at any location. The distribution of the correction ΔN around the particular river segment can be achieved and shown in Figure 3. Using the correction, ΔN and the geoid height, N_0 derived from HTv2.0, the accurate geoid height, N can be determined. The variety of geoid height N around the particular river segment can also be drawn with the 5′× 5′ -grid data of geoid height (Figure 4).

$$N = N_0 + \Delta N \qquad (2)$$

Then, NAD83 (CSRS98) ellipsoid heights can be transformed accurately to CGVD28 orthometric heights with formula (1) in the particular river segment.

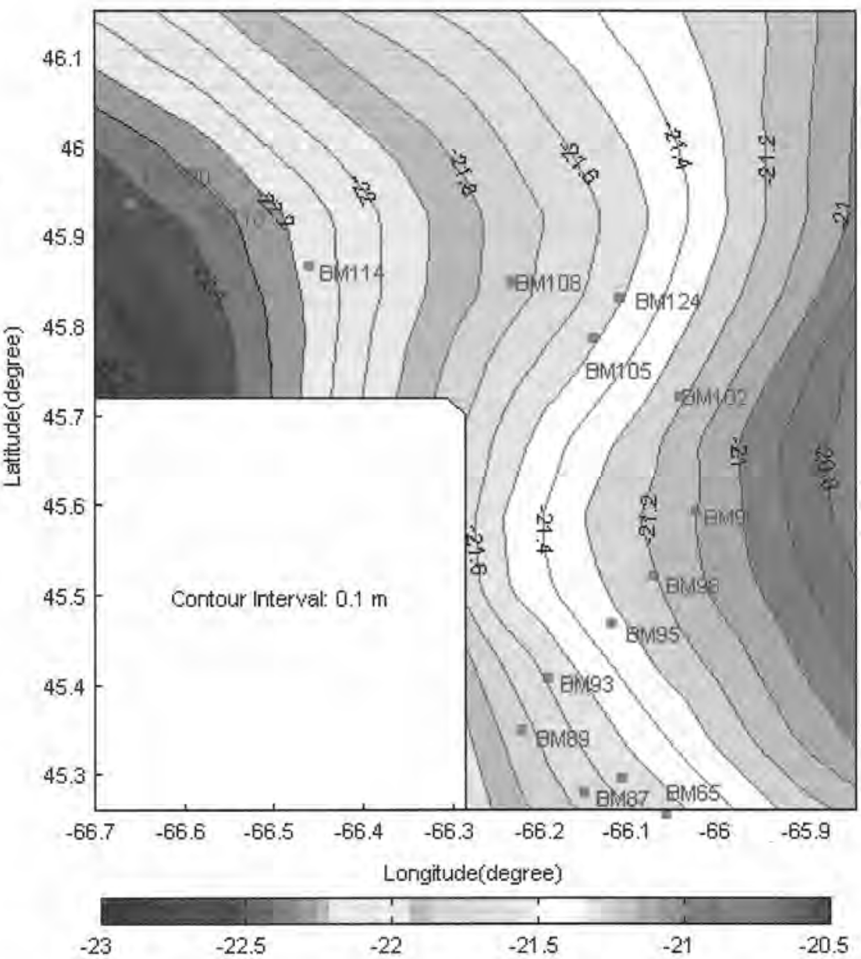

Figure 4: The distribution of the geoid height N around the particular river segment

Transformation from Orthometric Height to Chart Datum Height

Because the final results of tidal level measurement and riverbed topography surveying need to be provided in the form of chart datum height, it is necessary to transform orthometric height to chart datum height.

The characteristics of the tidal change and riverbed topography of the Saint John River have influenced the definition of the chart datum (CD2000) which to date has been described by a series of discrete steps. If these definitions of chart datum at different river segments are expressed in the form of CGVD28 orthometric height, a "ladder" character will be presented in Table 2.

In the section between Fredericton and Indian Town, the variations of chart datum definitions are less than 1 m at different tide gauges. However, between Indian Town and Saint John, the change reaches 4.5 m. If chart datum is considered to be constant in a corresponding river segment, the inconsistency will result in a mismatch in height direction at the interface between two adjacent river segments. Thus, in order to ensure the consistency of riverbed topography and the continuity of GPS tidal level measurement at different river segments, it is necessary to develop a continuous varying chart datum along the particular river segment. Therefore, the interpolation processing should be done between/amongst tide gauges. Considering the trend of the riverbed and the change of these definitions of chart datum (sometimes the change is slow and sometimes it is acute), neither cubic spline interpolation nor polynomial interpolation is thought to be appropriate. Both of them will lead to uncontrollable interpolation results in some river segments where the changes of chart datum definitions are more acute. Although the linear interpolation can't guarantee the continuity of 1st-order and 2nd-order differentials at the interface of two adjacent tide gauges, it can reflect more faithfully the actual change of these chart datum definitions. Thus, linear interpolation is adopted in this paper. Considering the curved nature of the river from Fredericton to Saint John, a form of cross-section linear interpolation method is presented in this paper for fulfilling the interpolation and transformation from CGVD28 orthometric height to CD2000 height.

The linear cross-section interpolation is implemented by projecting scatter points on the line formed between two adjacent benchmarks, then calculating the definition of chart datum at each of these projected points by linear interpolation. Connecting two adjacent benchmarks T_1 and T_2 and forming a line, the equation of the line can be determined with the coordinates (x_{T1}, y_{T1}) and (x_{T2}, y_{T2}) of the two benchmarks. For any point $P(x, y)$ that is between the two benchmarks, the corresponding projected point $P'(x_p, y_p)$ on the line can be calculated (Figure 6).

$$x_p = \frac{x + k_0 y - k_0 b_0}{k_o^2 + 1} \qquad y_p = k_0 x_p + b_0 \qquad (3)$$

$$k_0 = \frac{y_{T2} - y_{T1}}{x_{T2} - x_{T1}} \qquad b_0 = y_{T1} - k_0 x_{T1}$$

Benchmark	Chart datum definition (m)*	Benchmark	Chart datum definition (m)*
Saint John (BM65)	4.19	Gagetown (BM105)	-0.70
Indian Town (BM75)	-0.21	Upper Gagetown (BM108)	-0.73
Ketepec (BM87)	-0.34	Maugerville (BM114)	-0.80
Westfield Beach (BM89)	-0.50	Oromocto (BM115)	-0.79
Public Landing (BM93)	-0.60	Lower St Marys (BM118)	-0.85
Oak Point (BM96)	-0.70	Fredericton (BM120)	-0.92
Evandale (BM98)	-0.70		

*: CGVD28 orthometric height. If a chart datum is above CGVD28 datum, the separation is defined as a negative value. Otherwise it is positive value.

Table 2: The definition of the chart datum at each tidal gauge along the particular segment of the Saint John River

After getting the horizontal coordinate of the projected point P', the definition of chart datum $\Delta h_{p\text{-}cg}$ at the projected point P' can be acquired easily by linear interpolation.

$$\Delta h_{p-cg} = \Delta h_{T1} + S_{T1-p} \frac{(\Delta h_{T2} - \Delta h_{T1})}{S_{T1T2}} \tag{4}$$

Where, Δh_{T1} and Δh_{T2} are the chart datum definitions at benchmark T_1 and T_2; S_{T1T2} is the distance between benchmark T_1 and T_2; $S_{T1\text{-}p}$ is the distance between benchmark T_1 and projected point P'.

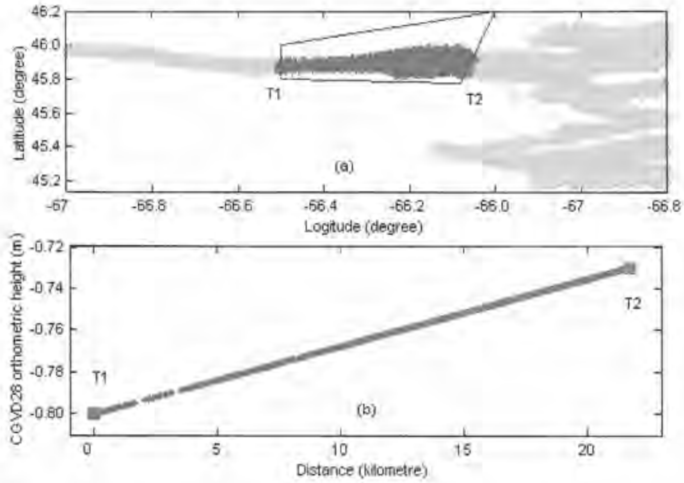

Figure 6: Cross-section linear interpolation method. ***In the upper figure, a polygon should be designed first for determining the valid GPS points within the area of the adjacent two benchmarks. In the lower figure, the definition of chart datum at any location within the polygon box, which is expressed in the form of CGVD28 orthometric height, can be determined by the interpolation method.***

Because P' and P are on same cross section line, the definition of chart datum at the projected point P' is also that at P. Thus, the method is named: cross-section linear interpolation.

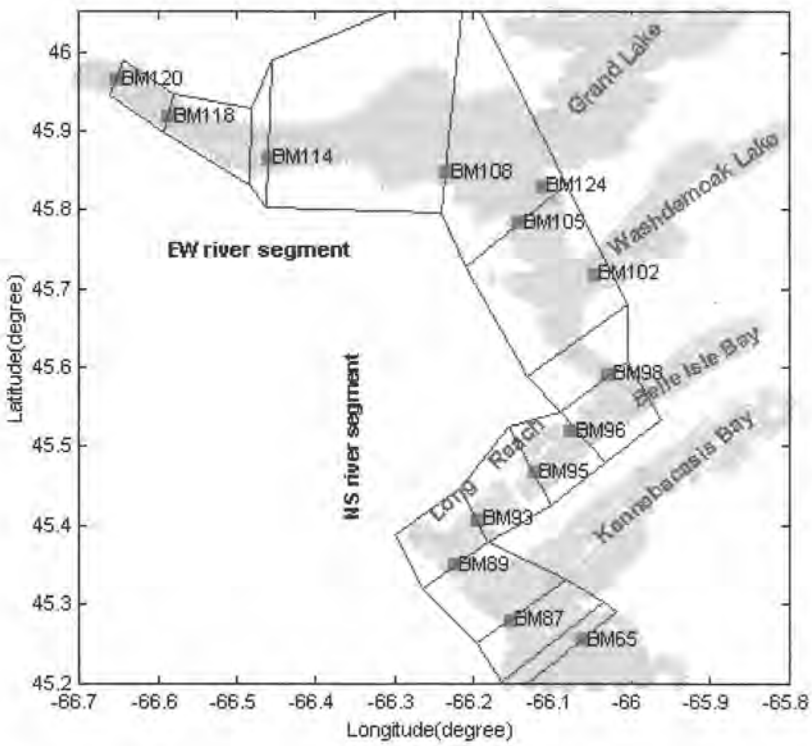

Figure 5: The particular river segment is divided into many small segments according to the distribution of benchmarks at which chart datums were defined. The scatter points that belong to the corresponding river segment will be found within these polygonal boxes.

In order to ensure the acquisition of the accurate chart datum at any point, considering the river's shape and the validity of the definition of chart datum, we need to design a polygonal box to find these scatter points which belong within the valid scope of the two chart datum definitions of the adjacent benchmarks. In designing the polygonal box, two cross sections, which are through the adjacent two benchmarks respectively, should be considered as the component sides of the polygon (Figure 5, 6(a)). Because the two polygon boxes of adjacent river segments have a common side (cross section) (Figure 5), the chart datum definitions determined by cross-section linear interpolation method are also continuous along the particular river segment.

Note that, at this time, we are ignoring the propagation of the tide into Grand Lake, Washdemoak Lake, Belle Isle Bay and the Kennebecasis Bay, as no data collection has currently been undertaken there (Figure 5). Should the interpolation model be extended into there, a fork-like interpolation model would have to be implemented.

Then, the direct transformation from CGVD28 orthometric height to CD2000 height can be expressed as the following:

$$H^c = H^o + \Delta h_{p\text{-}cg} \quad (5)$$

Now, transformation from NAD83 (CSRS98) ellipsoidal height to CD2000 height is fulfilled by the improved HTv2.0 model and cross-section linear interpolation model.

Test of the Height Transformation Models

In the construction of the HTv2.0 modification model, the statistic test parameters shown in Table 1 have proven the credibility of the two geometric models at some known points. In order to further test the validity of all height transformation models, two experiments of on-the-fly GPS tidal level measurement were implemented by OMG on May 17 and 18, 2004 along the Long Reach river segment (Figure 5), which is near the mouth of the Saint John River where more obvious tidal changes occur. Before this, 3 tidal gauges were installed beside benchmarks BM93, BM96 and BM98 (Figure 5) respectively for logging tidal readings concurrently with on-the-fly GPS tidal measurement.

In the data processing of GPS tidal level, the time series of filtered instantaneous water surface, which is expressed in the form of NAD83 ellipsoidal height, is first transformed to CGVD28 orthometric height by the improved HTv2.0, then to CD2000 height by formula (5). Finally, on-the-fly GPS tidal level is achieved in the form of CD2000 height.

In order to compare GPS tidal level and the tidal level derived from tidal readings, the tidal readings at the three tidal gauges are used for linearly interpolating the tidal levels of on-the-fly locations. On-the-fly GPS tidal level and tidal reading interpolation are shown in Figure 7 and 8.

Because GPS tidal level and tidal reading interpolation have same height datum CD2000, we can compare the two tidal level solutions at the same time/position. The statistic results of the difference between them are shown in Table 3.

Date	Minimal Bias (cm)	Maximal Bias (cm)	Standard Bias (cm)
May 17	0.2	3.8	±2.0
May 18	-0.1	5.0	±1.9

Table 3: The statistic parameters calculated by comparing GPS tide level and the interpolated tide reading.

The two-day statistic results show that these height transformation models, which are used for establishing the seamless vertical reference in this paper, are feasible and credible in the particular river segment of the Saint John River.

Conclusions and Discussion

CGVD28 orthometric height is a bridge in the establishment of a seamless vertical reference surface. Geometric models can efficiently improve the HTv2.0 geoid model and ensure the acquisition of accurate CGVD28 orthometric height from NAD83 (CSRS98) ellipsoidal height in a local area.

The cross-section linear interpolation is believed to be an ideal method in the transformation from CGVD28 orthometric height to CD2000 height. It not only makes chart datum and chart datum height continuous, but also ensures the continuity of the seamless vertical reference surface along the particular river segment of Saint John River.

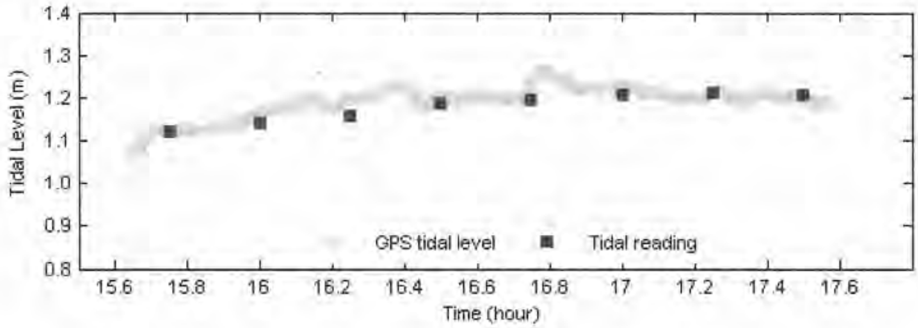

Figure 7: The comparison of GPS tidal level and interpolated tidal readings on May 17, 2004. ***In order to make the figure clear, only the interpolated todal readings with 15-minute interval are shown.***

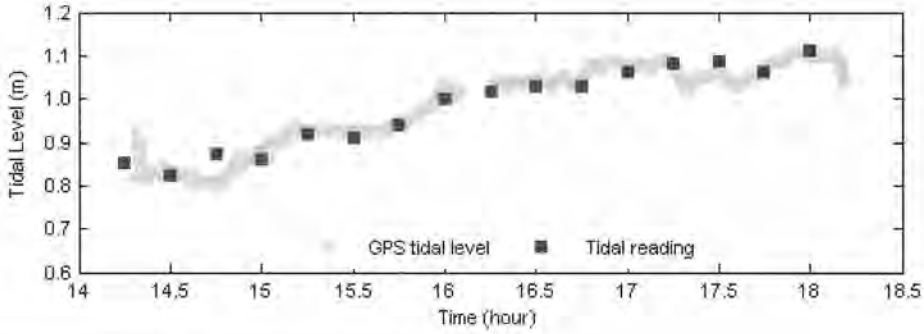

Figure 8: The comparison of GPS tidal level and interpolated tidal readings on May 18, 2004. ***In order to make the figure clear, only the interpolated todal readings with 15-minute interval are shown.***

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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.

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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 :

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Canada's Offshore: Jurisdiction, Rights and Management, 3rd edition

Written by Bruce Calderbank, Ted McDorman, Alec MacLeod and David Gray

Review contributed to *Lighthouse* by Bruce Calderbank

The text for the 1st Edition, called "Offshore Management", was assembled by Captain P.K. Mukherjee for the Canadian Hydrographic Service on behalf of the Association of Canada Lands Surveyors (ACLS) in 1989. Late that year, Mukherjee toured Canada to give a number of one-day ACLS seminars to present the information as a basis of a study guide for the then ACLS Schedule III - Item 5 examination, Offshore Management. Eight years later, the text and companion video tapes had become outdated and in 1997, new CLS candidates A. Leyzack and T. Janzen provided a brief critique with a recommendation to CHS to produce a new updated edition of "Offshore Management". Five years later, in 2003 a joint ACLS-CHA Ad Hoc Offshore Seminar Committee was struck, under whose auspices the text was to be revised and updated. The Committee consisted of the following individuals:

- Jean-Claude Tétreault, Executive Director, ACLS and Committee Chairman,
- Bruce Calderbank, Consultant, Hydrographic Survey Consultants Intl. Ltd.,
- David Gray, Geodesy, Radio Positioning and Maritime Boundary Specialist, Canadian Hydrographic Service, Ottawa,
- Andrew Leyzack and Tim Janzen, Hydrographers, Canadian Hydrographic Service, Central and Arctic Region, and
- Julian Goodyear, member of the ACLS Board of Examiners, and Regional Director General, Canadian Coast Guard, Central and Arctic Region.

Copyright for 1st Edition, "Offshore Management" was transferred from Fisheries and Oceans Canada (DFO) to the ACLS and using this text as a basis, the following authors began work on the 2nd Edition, revising the text as required:

- Bruce Calderbank - Parts I and IV (new) also serving as editor-in-chief,
- David Gray - Part II and
- Ted L. McDorman, Professor, Faculty of Law, University of Victoria - Part III.

The 2nd Edition, renamed "Canadian Offshore Property Rights", was first presented by Ted McDorman on 15 October, 2003 at an ACLS/CHA Offshore Seminar, in Calgary. To provide further enhancements and examples it was decided to proceed to a 3rd Edition, while funding/ support for the French translation of the text was pursued. Additionally, 23 days after the 2nd Edition was released, on 6 November 2003, Canada ratified the 1982 United Nations Convention on the Law of the Sea (UNCLOS), necessitating further updates to the text.

Additionally, each co-author added input to other Parts as required. Alec M. MacLeod, from the Legal Surveys Division of Natural Resources Canada (NRCan) and Legislative Advisor to the Surveyor General of Canada Lands, provided additional input to Part III and the Appendices. At this stage, it was determined that as a study guide, the current edition could be used for the ACLS Schedule III - Item 2: examination pertaining to Canadian Offshore Boundary Rights.

In 2004, MacLeod was again brought onboard as a co-author for the final iteration and the title was revised to "Canada's Offshore: Jurisdiction, Rights and Management", to better reflect the book's content. Other improvements included changes to the section numbering, improved quantity and quality of illustrations, and more Canadian content and examples.

We hope to have the English version of the 3rd Edition completed in early 2005. By the time you read this article, current revisions will have been sent out to the other co-authors and the CHS for their review. Comments and updates are expected by the end of this year. To date, many people and various organizations such as DFO-Science, CHS, NRCan, ACLS, and the CHA have contributed funding, time and effort into the making of this document.

In July 2004, the acting Dominion Hydrographer and Director General of the Canadian Hydrographic Service, Denis Hains offered to provide French translation services for the 3rd Edition. This will allow the ACLS to introduce the 3rd Edition in both official languages as the official reference for the Canadian Offshore Property Rights examination. As a source of information on the development of maritime boundary law, UNCLOS, the resolution of offshore boundary disputes and unilateral claims to the continental shelf regime, we are certain that hydrographers, students, and other stakeholders in Canada's Offshore will benefit from the information this text has to offer.

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(affiliation - CHA Ottawa Branch)

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3075 14th Avenue, Suite 224
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Contact: Anthony P. Sani
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Kongsberg Maritime
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Terra Remote Sensing Inc.
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Contact: Rick Quinn
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Website: www.terraremote.com
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L3-Klein Associates Inc.
11 Klein Drive, Salem, NH, 03079, USA
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University of New Brunswick,
Dept of Geodesy and Geomatics Engineering
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E-mail: email@mcquestmarine.com
Website: www.mcquestmarine.com
(affiliation - CHA Central Branch)

Usher Canada Limited
18136 - 102 Avenue, Edmonton, AB, T5S 1S7, Canada
Contact: Hal Janes, Edmonton Branch Manager
Tel: (780) 484-4644 FAX: (780) 486-1134
E-mails: hjanes@ushercan.com, rleeman@ushercan.com
Website: www.ushercan.com
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Your Company Here
Consider becoming a *Lighthouse* Corporate Member.
Your organizations contact information would be poseted here for all to see as a *Lighthouse* Corporate Member.
See the Corporate Members section for additional benefits.
Contact *Lighthouse* at the address listed in this journal or at www.hydrography.ca

Corporate Members

Membres corporatifs

We invite your organization to become a corporate member in our association. Consider the following benefits:

- ***Receive three copies of each issue of Lighthouse (published twice annually).***
- ***An invitation to participate in CHA seminars.***
- ***Listing and recognition in every edition of Lighthouse.***
- ***An annual 250 word description of your organization in Lighthouse.***
- ***10% off advertising rates in Lighthouse.***
- ***10% off exhibitor fees at CHA sponsored events.***
- ***Listing and link to your home page on each CHA Branch Web site.***
- ***News from corporate members in every edition of Lighthouse.***

The CHA, through *Lighthouse*, is active in promoting the strength and diversity of organizations and companies that support the hydrographic and related communities. Get onboard with us as a corporate member and we will help you reach potential customers throughout our worldwide distribution.

To join, please contact one of the Directors as listed on page 2. International applicants please remit to Central Branch. To obtain an application visit us at *www.hydrography.ca*

Annual dues for CHA Corporate Membership are $150.00 (CDN).

NetSurvey Limited

NetSurvey is one of the leading multibeam service solution providers worldwide. We provide a specialist service to survey companies, ports and harbor authorities and research and government organizations. We are at the forefront of multibeam technology, combining the latest equipment and software to give unrivalled results in new and complex areas, such as ROV based surveys, fisheries habitat mapping, detailed wreck investigation and many others.

We can supply any portable multibeam system suitable for vessel, ROV or AUV deployment and all ancillary sensors installed, operated and processed by a team of highly trained multibeam surveyors and engineers. Our specialist personnel are also available to supplement your offshore teams or to act as client representatives.

We offer an in-house data processing service that can range from simple swath bathymetry cleaning to full 3D Visualization and fly-through using Fledermaus software. NetSurvey also offers bespoke training courses with a practical emphasis.

All of our surveyors/engineers are trained up on Reson, ELAC, Simrad and GeoAcoustics multibeams; Applanix, TSS, Kongsberg-Seatex and CODAOctopus motion sensors; QPS, Eiva, CARIS HIPS/SIPS and Fledermaus software.

With our large equipment pool available for hire and some of the most experienced multibeam specialist personnel, NetSurvey can provide you with peace of mind and the complete multibeam solution at a very competitive rate.

If you would like to receive further information about NetSurvey and its services contact Duncan Mallace or visit *www.multibeam.net*

If you would like to receive further information about NetSurvey and its services please contact:

Mr. Duncan Mallace
Tel: +44 1295 690 007 FAX: +44 1295 690 881 E-mail: duncan@netsurvey.co.uk
Website: *www.multibeam.net*

Interactive Visualization Systems (IVS)

Interactive Visualization Systems (IVS) with their world class, scientific 3D visualization and analysis software, Fledermaus, provide innovative, interactive and client-driven solutions and knowledge for surveying, mapping and research. Fledermaus presents intuitive insight into massive geographic data sets of numerous data types promoting professional interaction and collaboration.

Fledermaus has been developed to allow our clients to explore, analyze, manipulate and gain knowledge from their data by representing very large complex information in the best possible way - in an intuitive fashion - in the way that we perceive the real world everyday. This virtual reality allows new insight to be rapidly gained and more information to be extracted from the underlying data. This results in Fledermaus providing our clients with added value in efficiency, accuracy, completeness, integration, and communication.

IVS has a dynamic and creative team of professionals that are committed to advancing visualization technology; and dedicated to unveiling opportunities to develop and improve visualization and interpretation software in ways that will provide our clients with first-rate software tools to ensure success of their business or research endeavours.

IVS is headquartered in Fredericton, New Brunswick, Canada with an office in Portsmouth, New Hampshire. Both offices provide full support, worldwide in association with a number of alliance partners.

If you would like to receive further information about IVS and its services please contact:

Ms. Sherry Rose
Tel: (506) 454-4487 FAX: (506) 453-4510 E-mail: info@ivs.unb.ca
Website: *www.ivs.unb.ca*

HydroService AS

HydroService AS is a Norwegian company with a strong technological base and a thorough understanding of requirements needed to establish and operate an effective Hydrographic Office.

Being the originators of the acclaimed dKart Inspector S-57/ENC QC/Validation software the company have additionally developed and have in service a complete range of modular COTS tools offering all the system functionality required by a Hydrographic Office.

With the introduction of S-57 International Standard of Cartographic Data Exchange, the nautical cartographic world (HOs) faced the problem of digital data production, as it required double work - to produce traditional paper charts and to establish and support ENC production.

In response to this challenge, HydroService AS developed dKart Office, a family of dedicated COTS software tools. The modular system comprises a fully integrated production environment aimed at:

- Electronic charts production and updating (S-57/ENC, AML, Inland ENC, etc.)
- Paper charts production and maintenance (INT1, INT2, M4, etc.)
- Notices to Mariners and other nautical publications compilation and design
- On-line Data Services (charts, publications, catalogues on the Internet, automated NtM delivery, etc.)

dKart Office can be smoothly integrated into any existing production environment either via independent modules or as a complete Digital Hydrographic Office solution. It will assist in building and improving production performance by reducing costs, expanding the product range and raising your office overall effectiveness.

HydroService AS also conducts basic and advanced training of system operators and managers in S-57, QC and ENC/Paper Chart production.

For further information please contact:

Egil O. Aarstad
Tel: +47 51 464960 FAX: +47 51 464701 E-mail: info@hydroservice.no
Website: *www.hydroservice.no*

Gemini Positioning Systems Ltd.

Gemini Positioning Systems Ltd. is a Calgary based GPS company with over 20 years experience in satellite positioning technology. In addition to providing integrated GPS based solutions, Gemini is the exclusive Canadian Ashteche distributor for Thales Navigation. Gemini also distributes the CSI Wireless brand of DGPS receivers and software.

The knowledge and experience of the management and staff have gained Gemini the distinction of being one of the premier Canadian companies geared exclusively towards the promotion, integration and support of GPS based solutions. On staff engineers, programmers and technicians allow Gemini to successfully find solutions to our clients needs.

Various industries that Gemini provides product and technical support for include surveyors, forestry, marine, seismic, mining, municipal and aerial applications. Gemini supports a national network of dealers and sub-dealers that provide coverage to all regions in Canada. Gemini's relationship with our sub-dealers includes provisions for joint sales and marketing efforts as well as educational seminars, product training and presentations of new technologies.

Due to the acquisition of Ashteche by Thales Navigation the DSNP product names such as 6501 SK/MK, 6502 SK/MK, Aquarius and Sagitta and the full Ashtech product line will be re-branded under the Thales Navigation brand name. Thales concluded that to enhance marketing efficiency these two product lines would best be represented under one professional brand name.

Gemini maintains an extensive lease pool of precision GPS products that are available for daily, weekly and monthly rentals. This lease pool is maintained at both our Ottawa and Calgary facilities and available for immediate delivery.

No matter what your GPS demands entail Gemini has the means to provide top line GPS equipment and unique

For further information please contact:

Mr. Frank Wiskar
Tel: (403) 252-5007 E-mail:fwiskar@gps1.com Website: *www.gps1.com*

C & C Technologies

C & C Technologies (C & C), an international hydrographic surveying company, headquartered in Lafayette, Louisiana, has approximately 170 employees and four offices worldwide.

As of January 2003, eighty percent of C & C's revenues were derived from survey work for the oil and gas industry and the other twenty percent are derived from US government contracts. The oil industry work includes high-resolution marine geophysics for hazard studies and pipeline route surveys, rig and barge positioning, acoustic positioning for ROV's, as well as satellite navigation services. The company has separate offshore oil industry survey departments for geophysical work, marine construction, and navigation.

C & C Technologies has performed hydrographic survey work for various Government groups including NOAA, the US Geological Survey, and the Corps of Engineers. In 1994, C & C was contracted by the U.S. Naval Research Labs to perform research and development work on semi-submersible autonomous underwater vehicles (AUV's) for hydrographic surveying purposes. In January 2000, C & C and Kongsberg Simrad began working on C & C's new commercial AUV rated for water depths up to 3000 meters. The AUV's sensor payload included multibeam swath high resolution bathymetry and imagery, chirp side-scan sonar and sub-bottom profiler, differential GPS integrated with acoustic / inertial navigation and acoustic communications. Since delivery in January 2001, C & C's AUV has completed over 11,000 nautical miles of survey lines for a variety of worldwide clients.

Additional services offered by C & C include: C-Navä, the highest accuracy worldwide Gc-GPS differential correction service available, deep water jumbo coring (up to 30m) collected in water depths to 3000m, in-house state-of-the-art soil analysis lab, and 3 D hazard assessment reporting for MMS deep water site clearances.

For more information regarding C & C Technologies services please contact:

Mr. Mike Dupuis, Mr. Jeff Fortenberry, Mr. Art Kleiner, or Mr. Frank Lipari
at (337) 261-0660 email to info@cctechnol.com or
visit C & C's Website at *www.cctechnol.com*

Kongsberg Maritime

Kongsberg Maritime, a company in the Kongsberg Group, is a leading supplier of advanced multibeam and single beam echosounders and instrumentation systems.

With its strong application knowledge and trend-setting quality products, Kongsberg Maritim is able to offer unique and complete solutions for ROVs, AUVs, positioning systems and sea bed surveying and mapping.

Kongsberg Maritime has about 980 employees with subsidiaries world wide. Canadian operations include a sales office in Halifax and a factory in Port Coquitlam, British Colombia.The Headquarters are located in Kongsberg, Norway. Kongsberg Maritime exports its products to all of the world's major markets.

For more information regarding Kongsberg Maritime please contact:

Mr. Nick Burchill
Survey & Underwater Vehicle Instrumentation
Tel: (902) 468-2268 FAX: (902) 468-2217 E-mail: nick.burchill@kongsberg.com
or visit Offshore: *www.km.kongsberg.com* and Marine: *www.simrad.no*

Association of Canada Lands Surveyors
Association des Arpenteurs des Terres du Canada

The Association of Canada Lands Surveyors (ACLS) is a federally enacted self-regulating professional association with 540 members located across Canada who have expertise in all disciplines related to geomatics. It's a true professional home for hydrographers.

L'Association des Arpenteurs des Terres du Canada (AATC) est une corporation professionnelle de juridiction fédérale. Elle comprend 540 membres répartis sur tout le territoire canadien qui oeuvrent dans toutes les disciplines de la géomatique. C'est un véritable domicile professionnel pour les hydrographes.

For further information please contact:

Association of Canada Lands Surveyors
Tel: (613) 723-9200 FAX: (613) 224-9577 E-mail: admin@acls-aatc.ca
Website: www.acls-aatc.ca

DID YOU KNOW...

STARBOARD SIDE

Because the Vikings shipped their star (steering) oar on the right hand side of their vessels, and called the side of a ship its "board", the right hand side of vessels has ever since been designated as the "star-board" side.

C & C Technologies Builds C-Surveyor II™ AUV

C & C Technologies, Inc. (Lafayette, Louisiana, USA), recently ordered critical components from Kongsberg Maritime to construct its second Surveyor Class autonomous underwater vehicle (AUV). The *C-SURVEYOR II*™ is expected to be available for hydrographic surveys starting in April 2005.

The design of the *C-SURVEYOR II*™ AUV will be modeled after C & C's existing state-of-the-art AUV, *C-SURVEYOR I*™. Sensors will include a multibeam echosounder, chirp side scan sonar, chirp sub-bottom profiler and a CTD system. The AUV will be positioned using ultra short baseline acoustics integrated with an inertial measuring unit and a Doppler velocity log. A fuel cell will provide 45 kWh of energy resulting in an endurance of 50 hours at 3.8 knots with all sensors operating. An acoustic data link will allow sub-sampled sonar data to be viewed in real time. The *C-SURVEYOR II*™ AUV will be initially rated for 3000 meters, but will be upgraded to 4500 meters in the fall of 2005.

"Our clients have requested our AUV expertise in several regions of the world," said Thomas Chance, President of C & C Technologies, Inc. "The *C-SURVEYOR II*™ AUV will enable C & C to more effectively service the needs of our clients, while decreasing mobilization costs on international projects". C & C's uptime during AUV surveys has gone from 16 percent in 2000 to over 95 percent today. "This success is mainly due to C & C's proprietary hardware and software improvements, C & C's highly detailed procedures, and C & C's experienced AUV personnel," said Chance.

C & C Technologies Performs COE Survey at Key West, Florida

C & C Technologies, Inc., is currently performing pre-dredge and post-dredge, quality assurance (QA) hydrographic surveys for the Jacksonville District of the Corps of Engineers, as a sub-consultant to Johnson–McAdams Survey & Mapping, LLC. The objective of the survey is to provide geo-referenced multibeam data, which is used to determine the progress of Bean-Stuyvesant's 12.8-cubic yard BH Dredge, *MARICAVOR*, working on the Key West Harbor, Florida, dredging project.

The survey is being performed using C & C's R/V Inland Surveyor equipped with an EM 3002 multibeam echosounder, navigation computers, C-Nav® RTK GPS and Hypack® volume computation software. "To date, the project has been extremely successful," said Frank Lipari, C & C 's Government Contracts Manager. "We expect to continue to support the project's quality assurance needs over the next year, until completion of the dredging operations."

C & C Technologies provides a variety of survey services including Globally-corrected GPS services, marine construction surveys, high-resolution geophysical surveys, geotechnical laboratory testing and land surveys.

R/V INLAND SURVEYOR

For more information, please contact:
Jay Northcutt at (337) 261-0660
Email: info@cctechnol.com
www.cctechnol.com/

Kongsberg Maritime Deliveries

EM1002 to Canadian Hydrographic Service Laurentien Region

An EM1002 multibeam echo sounder was sold to the Canadian Hydrographic Service, Fisheries and Oceans Canada, Laurentien region in September for installation aboard *CCGS F. G. CREED*.

EM 3002 Survey and Dredge verification

Saint John, New Brunswick, Canada is home of the Reversing Falls and some of the world's Highest Tides. Weather conditions, the strong tidal stream and the subsea conditions created in the estuary between Saint John and Kennebacasis Rivers have meant that silting and erosion are always concerns.

The turn-key EM3002 installed in Saint John by Kongsberg Maritime's nearby Halifax office will allow the Saint John Port Authority to survey, conduct dredge verifications and inspect subsea structures frequently. The port's customers and tenants can be assured of up-to-date information and a safe, navigable harbour year-round. The port will also be able to optimize the use of dredge time and offer multibeam services to the ports in the surrounding area.

Source: Kongsberg Subsea Newsletter

For more information please contact:
John Gillis at (902) 468-2268
www.km.kongsberg.com

Interactive Visualization Systems (IVS3D) and NetSurvey

IVS3D Inc. (Portsmouth, NH, US) in partnership with NetSurvey Ltd. (Claydon,UK) have delivered multi-user licenses of Fledermaus software to the United Kingdom Hydrographic Office (UKHO) and Service Hydrographique et Oceanographique de la Marine Establissement Principal (EPSHOM). The hydrographic offices will be using the advanced 3D area-based editing functionality to validate the Gigabytes of multibeam and lidar data that they receive daily. Fledermaus combines state-of-the-art 3D visualisation with spatial index access to data to enable the smallest spikes in data to be rapidly discerned and eliminated.

"Fledermaus is now clearly the market leader in multibeam data validation and editing, allowing the user to intuitively view the quality of data as never before" said Duncan Mallace, Managing Director of NetSurvey. "Outliers in the data jump out at you in 3D and with the ability to colour the surface based on a number of quality control and user customised values, the speed and accuracy of validation is at an unprecedentedly high level. We are very pleased that SHOM and UKHO will benefit immediately from the robust functionality of Fledermaus. All hydrographic offices have had to come to terms with the volume of data that they are now having to deal with and Fledermaus is now being seen as the software of choice for validating and editing multibeam and lidar data." said IVS 3D's General Manager, Lindsay Gee.

About NetSurvey

NetSurvey are a complete multibeam solution provider. With multi-talented multibeam surveyors and engineers they install, calibrate, acquire and post process multibeam data for all portable systems on the market today. To date they have completed over 50 projects and have supplied finished products from DTMs to full 3D fly-throughs with complete survey reports.

About IVS 3D

IVS 3D provides innovative and flexible tools for scientific 3D visualization and analysis for surveying, mapping and research and the software products and services are available worldwide. IVS 3D has offices in Fredericton, New Brunswick, Canada and in Portsmouth, New Hampshire, USA.

For more information please contact:
Sherry Rose at (506) 454-4487
www.ivs.unb.ca

Lighthouse puzzler

By
Beth Weller

Lighthouse Puzzler

The Lighthouse Puzzler is taking a break this Edition. The solution to Puzzler #25 is offered below.

Solution to Puzzler #25

Earl is on skis [clue 3] so Paola, not using the snowmobile or helicopter [clue 1], is the one using the dogsled, and Carol, not being in the helicopter [clue 4], is on the snowmobile, so, by elimination, Jim must be in the helicopter.

Earl is not from Ottawa or Vancouver [clue 3] or Dartmouth [clue 4] so must be from Rimouski. Carol is from Dartmouth so the one from Ottawa, not on the dogsled [clue 2], must be Jim, which means Paola is from Vancouver.

Jim, from Ottawa, was not looking for the deepwater port [clue 2] or the Inuit village [clue 3] or the landing strip [clue 4] so must be the one tagging polar bears. Way to go, Jim!

ANNOUNCEMENTS / ANNONCES

The purpose of this column is not to provide an all-encompassing calendar of hydrographic-related events but to provide you with information on events sponsored by organizations or individuals to whom CHA is connected. Input comes from organizations such as the CHS, ACLS, FIG, CIG, THSoA and the International Federation of Hydrographic Societies.

New CHA Atlantic Branch

Renewed interest at the Bedford Institute of Oceanography, Dartmouth, NS, has led to the resurrection of CHA's Atlantic Branch. For more information, see the Canadian Hydrographic Association News in this edition.

CHS Level of Service

An initiative to help better serve CHS clients through the development of new level of service standards was begun in September, 2004. A questionnaire was produced for the collection of feedback on CHS products and services. The survey, which ended in November, will be used to better prioritize services.

For more information visit:
www.charts.gc.ca/pub/en/los/

25th Anniversary Celebrations - Department of Geomatics Engineering, University of Calgary

The Department of Geomatics Engineering (formerly Surveying) was started in 1979, which makes 2004 the 25th Anniversary of the Department. This milestone was celebrated on October 28 and 29, 2004 by bringing together alumni as well as industry and government stakeholders.

A legacy of this special event was the establishment of three 25th Anniversary Scholarships for each of our second, third and fourth year programs. Over $100,000 has already been raised.

Since inception in 1979 as the Division of Surveying Engineering, the Department has grown into a dynamic world leader in education, research and impact on the community. Enrolment is now over 175 undergraduate students in the program, over 80 graduate students as well as 19 faculty members. Geomatics Engineering students and faculty have been recognized through major awards and continue to lead the way in sustaining excellence to the benefit of the geomatics community. Much of this is due to the ongoing support that the Department has received from alumni and from friends in industry and government.

For more information visit:
www.geomatics.ucalgary.ca/25th_Anniversary/

New Chairman of the FIG/IHO/ICA IAB

Capt. Andy Armstrong, president of the Hydrographic Society of America, has been elected Chairman of the FIG/IHO/ICA International Advisory Board on Standards of Competence for Hydrographic Surveyors and Nautical Cartographers. Mr. Armstrong takes over from Mr. Svante Astermo, former Hydrographer of Sweden, who has served as chairman of the IAB for the past 10 years. The IAB is currently preparing the 10th edition of the Standards of Competence.

US Hydro 2005

The U.S. Hydro 2005 Conference, sponsored by The Hydrographic Society of America (THSoA) is a continuation of the series of hydrographic conferences that alternate between the United States and Canada and follows the highly successful US Hydro 2003 held in Biloxi, Mississippi. The three-day event is scheduled for March 29-31, 2005 at the Manchester Grand Hyatt Hotel in San Diego, California.

In addition to the technical papers, the conference will feature an extensive series of workshops, social program, and an exhibition hall and waterfront with representatives from over 40 of the major companies and organizations associated with hydrographic surveying in the U.S. and worldwide. The conference will include technical sessions on the latest developments and applications in hydrographic surveying, multibeam and side scan sonar, data management, electronic charting, and related topics.

For more information, visit THSoA's website at:
www.thsoa.org.

FIG Working Week 2005

FIG Working Week 2005 and the 8th International Conference of Spatial Data Infrastructure (GSDI-8) will be held in Cairo Egypt, April 16-21, 2005.

"From Pharaohs to Geoinformatics" has been selected as the overall theme of the joint FIG/GSDI (Global Spatial Data Infrastructure) conference. The technical program of the conference includes plenary sessions addressing topics of interest both for spatial data infrastructure (SDI) experts and surveyors. The technical conference includes almost 40 technical sessions. Commission 4 (Hydrography) will be arranging sessions for presentation and discussion of its working group activities. Two sub-themes have been selected in addition to the general theme. FIG has called for presentations on surveying from pharaohs to the 21^{st} century and GSDI-8 for presentations that reflect the general conference theme of the role of spatial data and spatial data infrastructures in an information society.

For more information, visit the conference website at: *www.fig.net/cairo*

XXII International Cartographic Conference - Mapping Approaches to a Changing World.

On behalf of Janet Mersey, CIG's technical councillor for Cartography, we are extending an invitation to our members to visit A Coruña, Spain, 9-16 July, 2005 for the **22^{nd} International Cartographic Conference**. Hosted by the Spanish Society for cartography, Photogrammetry and Remote Sensing, Marine Cartography, Navigation and Ocean Mapping is but one of many proposed themes. A glance at the Canadian Cartographic Association website shows an upcoming **Canadian Cartographic Conference** will be held this June, 2005 in St. John's. However no link to this event has been established yet.

For more information visit: *www.icc2005.org*

International Cartographic Association/ L'Association Cartographique Internationale ICA-2005 1st call for map/ACI 2005 1re appel pour cartes

The Canadian Cartographic Exhibit Committee would like to assemble a new edition of the **Canadian Cartographic Exhibit** for the forthcoming 22nd International Cartographic Conference of the International Cartographic Association (ICA) to be held in A Coruña, Spain, 9-16 July 2005. The committee would also like to take this opportunity to prepare an exhibit of Canadian maps to be showcased at the 2005 joint conference of the Canadian Cartographic Association and the Association of Canadian Map Libraries and Archives to be held in St. John's, Newfoundland, 26-29 July, 2005. Your assistance is requested to identify and provide copies of significant maps and atlases produced in Canada since 2003. **The themes for these exhibits include** topography, **bathymetry**, geology, urban, recreation and orienteering, satellite images, globes, atlases and other cartographic products appropriate to the Canadian display.

Cartographic materials to be exhibited must have been published after January 1st, 2003 and submissions must be received no later than January 28th, 2005.

For more information, please contact Claire Gosson. Tel: (613) 992-4134 or by E-mail at claire.gosson@ccrs.nrcan.gc.ca

Le temps est venu de penser à la nouvelle édition de l'exposition internationale cartographique et de la participation canadienne à cette prestigieuse exposition, qui se tiendra dans le cadre de la 22ième conférence de l'Association Cartographique Internationale (ACI), à A Coruña, en Espagne, du 9 au 16 juillet 2005. Cette année encore, nous sollicitons votre participation à soumettre vos réalisations cartographiques. De plus, nous aimerions profiter de cette occasion pour préparer une exposition de cartes canadiennes qui sera présentée lors de la prochaine conférence conjointe de l'Association canadienne de cartographie et de l'Association canadienne des cartothèques et archives cartographiques, qui aura lieu à St.John's, Terre-Neuve, du 26 au 29 juillet 2005. Afin de mettre sur pied ces expositions, les membres du Comité canadien vous demandent d'identifier et de fournir des cartes et des atlas produits au Canada depuis l'année 2003. **Les thèmes sont variés et incluent les cartes** topographiques, **bathymétriques**, géologiques, urbaines, de loisirs et de courses d'orientation, les images satellitaires, les globes, les atlas ou tout autre produit cartographique.

Le matériel soumis doit avoir été publié après le 1er janvier 2003 et ne doit pas avoir été présenté lors de l'Exposition internationale de Durban en 2003. Les documents doivent être livrés au plus tard le 28 janvier 2005.

Si vous avez des questions, veuillez contacter Claire Gosson par courriel à l'adresse claire.gosson@ccrs.nrcan.gc.ca; ou par téléphone au (613) 992-4134.

The Canadian Remote Sensing Society - First Canadian LiDAR Applied Research and Training workshop (CLART).

LiDAR has been used in hydrographic applications since the mid-eighties. Since then the technology has improved and its application as an inshore mapping tool has become more widespread. The CLART workshop will provide an opportunity for the Canadian airborne LiDAR community to meet and discuss emerging key topics in research, training and service provision. The workshop is hosted by the Applied Geomatics Research Group, Nova Scotia Community College and will be held from 27 February to 1 March, 2005.

For more information take a look at: *www.casi.ca/docs/CRSSdocs/Clart_flyer.pdf*

GILLIS, John Raymond

October 14, 2004

GILLIS, John Raymond - 87, Pictou, passed away suddenly October 14, 2004, at home. Born in Point Prim, P.E.I., he was a son of the late Clarence and Bessie (MacLeod) Gillis. Ray served with the Royal Canadian Navy from 1939-1945. Following his service with the Navy, he joined the Canadian Hydrographic Service, retiring in 1979. Ray looked upon his career on the *C.S.S. ACADIA* (Chief Officer) with particular pride. After retirement from the hydrographic service, he was employed by Northumberland Ferries Ltd.

An avid and creative woodworker, as well as an expert knot/rope enthusiast, he also had a keen sense of humour. Ray is survived by his wife of 57 years, Marjorie (Ferguson) Gillis; sons, Clarence (Linda), Dartmouth; Glenn (Anne), Pictou; daughter, Zelda (Murray) McLaren, Pictou; grandchildren, Sarah, Matthew, David and Krista Gillis, Ian and Maggie McLaren; great-grandsons, Jack and Sam; brothers, Laughlin (Alberta), Point Prim, P.E.I.; Channing (Mary), Bedford; sister, Mary (Edwin) Chamberlain, Lower Sackville; numerous nieces and nephews. He was predeceased by brother, Eric Gillis, and grandson, Kevin Gillis (1999).

Central and Arctic Region

Data Acquisition Division

Hydrographic Surveys

Central and Arctic Region CHS has proceeded with their Survey plans as was described in the last issue of Lighthouse.

The **Western Arctic Survey** aboard the *CCGS NAHIDIK* successfully carried out the first two phases of their planned scientific projects and as of September 2004 was working on the final phase, a joint CHS/Geological Survey of Canada (GSC) program to map the seabed morphology in the Mackenzie River delta from Tuktoyaktuk to Herschel Island. The first two phases dealt more with scientific and biological studies in the delta. This third phase involved the mapping/surveying of the topography of the seabed looking at ice scours, mud volcanoes, gas vents and investigating the acoustic stratigraphy of sediments up to 10m below sea bottom. The survey is conducted in support of the Science sector in the Department of Fisheries and Oceans and is designed to assess the environmental impact of offshore hydrocarbon exploration and transportation on the renewable resources of the Beaufort Sea. The weather was extraordinarily calm and ice free for most of the program.

The **Eastern Arctic Survey** aboard the *CCGS HENRY LARSEN*, carried out surveys at Iqaluit, Pangnirtung, Pond Inlet, Clyde River, Grise Fiord and Broughton Harbour. These surveys are supported by the Nunavut Government and the Canadian Coast Guard who have requested harbour surveys in these areas. They are surveys carried out on an opportunity basis between Coast Guard's regular vessel escort and ice breaking duties. This year a joint military exercise took place between The *CCGS HENRY LARSEN* and the *HMCS MONTREAL*. The scenario was a search for a downed foreign satellite where the *LARSEN* played the role of a scientific vessel from the country whose satellite crashed. These moch-up scenes will better prepare our service personnel in the event this type of accident occurs in the future.

Our **Revisory Survey** crew investigated several charting queries on the Ottawa River, Lake Nipissing, the St. Lawrence River at Gananoque, Western Lake Ontario and Georgian Bay (centered around Britt) in support of pending charting and publication needs.

Two small **Multibeam Surveys** took place – one in the St. Mary's River for Canada Steamship Lines who are implementing the use of 3D high resolution S-57 ENC's. The other survey was a continuation of the *Fathom Five National Marine Park* survey off Tobermory, performed at the request of Parks Canada and in support of GSC's science program. (Noteworthy is the fact that soundings collected on the St. Mary's river survey were reduced using values obtained from RTK GPS heights).

Tides, Currents and Water Levels

Our Tides, Currents and Water Levels section was very active this summer. During the past four years the Canadian Hydrographic Service, Central and Arctic Region have managed a program funded by Environment Canada's Canadian Climate Action Fund to establish a network of tidal gauging stations through the Canadian Arctic. This program has been a collaborative effort between the CHS and Natural Resources Canada - Geodetic Survey Division (NRCan-GSD). The purpose of this program is to establish a network of gauging stations to monitor the height of sea level. The gauging stations are co-located with continuously recording Global Positioning System receivers to monitor the height of the earth's crust and remove the changes in height of the land from the apparent changes in sea level height. Stations have now been established at Nain on the Labrador coast, Qikiqtarjuaq on the eastern coast of Baffin Island, Alert at the northern tip of Ellesmere Island, Holman at the western end of Victoria Island, and at Tuktoyaktuk in the Mackenzie Delta.

The tide gauging stations are being operated by the CHS and the data collected is forwarded to the Marine Environmental Data Service (MEDS) for archival and distribution. The GPS receivers are operated and the data collected is archived and distributed by NRCan-GSD. Throughout the program, assistance was provided by the CHS Atlantic and Pacific Regional Offices.

Nautical Publications Division

New Charts

Work on the New Chart (1556) of Lake Timiskaming was completed and the chart has been published. This recreational chart completes the coverage for the Ottawa River and is printed on both sides of waterproof material and folded for handy storage. The New Chart (2242) near Parry Sound in Georgian Bay is at a final colour proof check stage and it is anticipated to be released before the end of the year. It is a coastal chart with modern surveys that complements the larger scale inshore strip charts and will replace an existing chart that is based on Admiralty surveys. A New Chart in the Arctic, Simpson Strait (7736), has been completed and sent to Ottawa for printing and release for publication. This chart is also based on modern surveys conducted after the grounding of the passenger ship *HANSEATIC*. Another New Arctic Chart (7792) in Bathurst Inlet was completed and released in the spring as part of the four chart suite in the area to support the navigation of ore carriers to and from a local mine. The final two charts (7790, 7792) are progressing well and when they are released this year it will complete the new chart coverage for the Bathurst Inlet region.

New Editions

Most of the focus this year has been on updating several important areas for recreational boaters. The completion and publication of two New Edition charts in the Trent-Severn waterway (2022 and 2023) complete the new edition work for the entire system. The new work is based on extensive Revisory Survey work and the correction of horizontal datum issues. Similarly, charts in the Rideau River (1512 and 1513) are incorporating new information gathered from our Revisory Survey project. A New Edition of a strip chart in Georgian Bay (2203) is in progress and it is planned to be completed for next year's boating season, coinciding with the publication of New Chart 2242 (see above). Two charts in Lake Muskoka (6021 and 6022) are currently being updated from Revisory Surveys and it is hoped they will be completed before the ice is off the lake in 2005. Commercial shipping in the Great Lakes will also benefit from the work being performed to update several important charts in Lake Erie (2120-2123, 2181). These charts will benefit from Revisory Survey work and will be published as New Editions in 2005.

Electronic Navigational Charts

A tremendous amount of progress has been made since the last report in April 2004; fourteen new edition ENCs and eleven S57 updates were released to Nautical Data International (NDI). A focused QC effort is underway to accelerate the remaining backlogged ENC files which resulted from contracting out production. A new ENC for Churchill Harbour is underway that incorporates several surveys conducted by the Department of Public Works to assess the water depth on approaches to the harbour and wharves of this important northern harbour in Hudson Bay. A paper chart New Edition will also be produced concurrently. We presently provide ENC coverage for the equivalent of 84 paper charts that are primarily in the Great Lakes and the St. Lawrence River.

Technical Services Division

The Multibeam launch *CSL MERLIN* has returned from the Manufacturer MetalCraft after a structural review and a somewhat successful attempt to reduce the acoustic noise level in the vessel. She has been outfitted with a Kongsberg Simrad EM3002 system. Once the installation is completed, testing of the new system will be done locally in Hamilton harbour, and the newly collected data will be reviewd against data collected in previous years with the EM3000 system and ground truthing of the harbour.

Data management is continuing to build capacity in its ability to handle very large data sets by building an infrasture in the areas of source data base. Under the funding umbrella of the CHS Hydrographic Information Network, several major pieces of network equipment will be acquired and put online over the next several months.

Technical Service's technicians are outfitting three new launches. The first of the three is finished and currently assigned to Revisory Survey. The launch christened the *WILSON J* was named after Jack Wilson, a well liked and respected retired CHS Hydrographer who died quite unexpectedly earlier this year. It is an 18 foot open Hourston launch, configured with conventional single beam transducer. The other two new launches are not named yet, and are currently being outfitted. One is an 18 foot open Hourston launch with factory installed, side-scan and single beam transducers. The second is 23 foot closed Hourston with factory installed side-scan and single beam transducers. This 23 foot launch will be joined by a similarly equipped sister ship in February 2005.

NATIONAL

Minutes, Canadian Hydrographic Association 2004 National Annual General Meeting Held by Video Conference November 9th, 2004 at 12:00 EST

National President Andrew Leyzack welcomed and thanked everyone for joining in on the videoconference. Atlantic Branch is in the process of reforming their branch and they were welcomed into the meeting. Andrew mentioned that after 10 years as VP Prairie Schooner Branch Bruce Calderbank has stepped down and Paul Sawyer will take on the duties of VP for that branch. Andrew thanked Bruce for his past and ongoing contributions to the CHA, noting Bruce's current efforts as Editor-in-chief *Canada's Offshore: Jurisdiction, Rights and Management* (see item 1 below).

There were technical difficulties in Ottawa which prevented them from participating and in Calgary where video was frozen at times where PSB could only communicate by audio.

Attendees: National President – Andrew Leyzack, Secretary – Terese Herron and Treasurer – Scott Youngblut
Atlantic Branch: Craig Zeller, Andrew Smith, Tammy Doyle, Stephen Parsons, Cathy Schipilow, Wendy Woodford, and Bruce Anderson.
Central Branch: Fred Oliff, Roger Cameron, Heather MacArthur, Jeff Walker and Sam Weller. Regrets: Tim Janzen and Brian Power
Prairie Schooner Branch: Paul Sawyer, John Brigden, Bruce Calderbank, Ian Thompson and Susan Scone
Pacific Branch: Dave Gartley, George Schlagintweit, Pete Milner, Rob Hare and Fred Stephenson
Regrets from Quebec Branch

The meeting was called to order at 12:10 pm.

To receive the reports of the Directors for the year 2003 and Quebec 2002.
A motion was made to accept the reports of the branches for the year 2003 and for Quebec Branch for 2002. Time was provided for everyone to look them over; they were available on the website prior to the meeting. These reports provide the branches with an opportunity to document their activities over the previous year.
Discussion: Prairie Schooner Branch reported three Corporate Members, one lunch and approximately $1,500 in the bank. Bruce Calderbank was a main contributor to the rewrite of P.K. Mukerjee's Offshore Management as a new text entitled *Canada's Offshore: Jurisdiction, Rights and Management* for the Association of Canada Lands Surveyors' Board of Examiners.
Pacific: Dave reported that their branch had a fantastic year.
Central Branch: There was a concern raised over the financial status of Quebec Branch, this will be addressed under item 2 on the Agenda

Moved: D. Gartley **Second: F. Stephenson**
CARRIED

Discussion: The question of a quorum was asked. According to the by laws, members present constitute a quorum

To accept the financial statement of the Corporation and the auditor's financial report for the year ending 31 December 2003.
Andrew mentioned that last year we began rolling up all branch statements and assets into one report to better reflect the financial affairs of the whole CHA. He would like to see this continue. There are three branches in arrears: Quebec, Ottawa and Pacific. A motion was put forward to accept the financial report for the year ending 31 December 2003.

Discussion: The seed money from CHC2004, is it coming back to National to pass along? Central Branch should be getting $5,000 back and the conference should ideally pass along the $10,000 received from CHC2002. The original plan was to open a joint purpose account that would be used to hold the conference money. Calderbank asked if any money had been received back from the ACLS Offshore Consultation Workshop held in Calgary? None has been received to date.
The assets of the branches should be rolled up into one statement to gain an overall picture of the organization. Andrew will meet with Scott to prepare a roll-up (for information only) financial report as well as review Section du Québec's 2003 year-end.

Moved: R. Hare **Second: J. Walker**
CARRIED

ACTIONS: National Office to follow-up with Quebec, Ottawa and Pacific Branches with respect to arrears and Quebec also with their current financial status. Contact CHC2004 regarding seed money returns to Central Branch and the CHC2006.

To accept the minutes of the 2003 Annual General Meeting held in Calgary, Alberta.
The Minutes of the National AGM 2003 held in Calgary were published in *Lighthouse* and available on the website.
A motion was made to accept the minutes.

Moved: D. Gartley **Second: G. Schlagintweit**
CARRIED

A request was made to move Item 11 up on the Agenda to accommodate some individuals who would not be able to stay for the duration of the meeting.

11. To vote on the following:

WHEREAS: The Hydrographic Society (THS) has recently restructured in response to the need for a more effective relationship with its branches.

WHEREAS: THS has recognized the need cooperate with all national hydrographic societies.

WHEREAS: The CHA has long been affiliated with THS.

WHEREAS: THS will be formalizing the International Federation of Hydrographic Societies (IFHS) at their 14th Biennial Conference, 2-4 November, 2004.

WHEREAS: The CHA directors have discussed the benefits of joining the IFHS.

WHEREAS: Membership in the IFHS presents a significant savings over the fee for individual membership in THS.

MOTION: That CHA join the International Federation of Hydrographic Societies effective 2005, where the increase in CHA dues (approximately $25.00 CDN per member) will be absorbed by the CHA National Office for that year.

Andrew commented that at HYDRO 2002, 2 years ago, the International Hydrographic Society was entering a restructuring process to create the International Federation of Hydrographic Societies. Their organizational structure at the time was not working for them; it was perceived to be biased to the UK and their branch voices not heard on equal ground. The Federation would allow for National Branches, each with an equal voice. THSOA, the Germans and the Russians are apparently moving to federate. This Federation will create new access to International experience and development. Included in membership would be the quarterly subscription to The Hydrographic Journal and the Annual Diary. Individual Membership is £65 ($140-$160 CDN); through federation it will be only $25 CDN per CHA member.

This item has been brought to the Directors and discussed at length. The Directors were to take this proposal to their membership over the past year and get some feedback and approval at the branch level. PSB is on board as all of their members are from private industry and realize the benefit (most are already hydrographic society members). There is concern all around that any increase in fees will result in a decline in membership.

Andrew read the motion from the Agenda and noted that individual members will not see any related increase in dues until 2006.

Discussion: Anderson - Would this result in the dues for 2006 being $65.00/member?

Leyzack replied the National budget would be looked at and restructured such that individual members may not see a $25 increase in dues. A portion of the dues now goes to *Lighthouse*; the future of *Lighthouse* is in question as we presently have no Editor. Andrew is trying to do double duty as National President and Editor, and this is not sustainable. We may have to look at *The Hydrographic Society Journal* as an alternative to *Lighthouse*; it carries similar information and is published four times per year. Canadian authors submit their papers elsewhere, why is this, do they not view *Lighthouse* as a viable journal for publication?

Hare – Have we consulted our corporate members? They see the benefits of advertising in *Lighthouse* and we may lose corporate members if we federate.

Leyzack – we would not be able to include membership to corporate members. Corporate members were not consulted.

Sawyer – We have a volunteer in PSB for the Editor of *Lighthouse*. The individual is Susan Skone.

Leyzack – thanked Susan for stepping forward for a two year commitment.

Schlagintweit – what percentage of dues go to *Lighthouse*?

Leyzack - $10 per member and $100 per Corporate Member, total is around $3,800 to *Lighthouse* per year.

Calderbank – CHA is the National hydrographic society in Canada and *Lighthouse* is of great value. We should join THS regardless to receive the benefits of the International Federation. In simpler terms we should join because we are the National hydrographic society in Canada.

Leyzack – we get our standards and competencies from the International scene anyway. Commission 4 chair, Adam Greenland, recently wrote an article for Hydro International entitled "Joined up Hydrography" which summed up the benefit of alliances in Hydrographic societies instead of competing for members (This is part of Adam Kerr's work in Commission 4). Hydrography is a small community and if groups are competing for members it becomes self defeating, there is benefit in working together.

Brigden – it pays to belong to both and is all in favour to reduce overall cost of memberships.

Moved: R. Hare **Second: F. Stephenson**
CARRIED

ACTION: Andrew to contact Susan Skone to discuss *Lighthouse* and duties. *Lighthouse* is the journal of the Association and without input/support from members, corporate members in the way of articles, news etc. the content would be lacking. Active members are good to have!

To accept the proposed National Budget for the year 2004

Andrew reported that the budget is being presented late in the year, it was passed by the Directors earlier in the year and still needs to be voted on even though the year is almost over. The expectation is to see the $10,000 seed money from CHC2004 returned to a special purpose account. Motion was made to accept the budget as presented.

Discussion:
Gartley – why is a special purpose account the preferred routing for the seed money?
Leyzack – it is considered a more transparent method for CHS to transfer the money from conference to conference. This has been discussed at Directors meetings, there has been an indication that the conference made some profit and the money would be carried forward. If there was no special purpose account then CHA would hold the money on behalf of CHC for future conferences. Normally, the budget is approved in early spring and voted on by the membership, sometime during the first six months. We need to have the AGM earlier in the year.
Walker – where are the bank service charges and miscellaneous items?
Youngblut – the balance negates service charges and there are no miscellaneous items.

Moved: J. Walker **Second: R. Cameron**
CARRIED

To appoint auditors (Al Koudys and Brian Power) for the year ending 31 December 2004.

A motion was made to accept Al Koudys and Brian Power as auditors for the National books for the year ending 31 December 2004.

Moved: J. Weller **Second: J. Walker**
CARRIED

MacDougall – are we looking for a decision on b&w or colour?
Leyzack – no, sometimes colour is needed and the decision would be made by the editors based on that. *Lighthouse* is not competing with Hydro International, is not as scholarly as Geomatica or The Hydrographic Journal, we get some papers from our own members. The journal is doing well, we receive complimentary feedback. Many complements at Hydro 2002 in Kiel.

***Lighthouse* Report including financial statement**

Andrew reported that Rick Sandilands stepped down as treasurer for *Lighthouse* upon his retiring this year. Jeff Walker has taken on the duties of treasurer and integrated the *Lighthouse* account into the Central Branch account under the "Lighthouse Convenience Account" which already existed. Earl has reiterated that *Lighthouse* needs branch support.

Moved: S. Youngblut **Second: R. Cameron**
CARRIED

Student Awards Program Report.

Andrew reported that the 2004 Award went to a UNB student Ivan Detchev. The 2003 report was submitted by Barry Lusk the Award Manager and was published in the Central Branch Newsletter. The certificate was shown during the videoconference. There is a plaque that resides with the Manager and Andrew indicated he would like to have a discussion regarding the location. Perhaps it should reside with the institution/award winner for the year. Barry was thanked for his efforts in looking after the award.

Calendar Initiative – Pacific Branch

Dave Gartley reported that this was an initiative brought forward by Doug Cartwright who is presently on one year leave. The idea was to have calendars with branch and national dates indicated on them for CHA events throughout the year.
Andrew indicated he liked the initiative; it would be a useful planner as to when to hand in news for *Lighthouse* etc. The THS Diary contains details of upcoming events to a certain extent.
Herron - the calendar could be posted on the website – a virtual calendar, this would negate any printing costs.
Schlagintweit – this is a unique way to have a low cost value added item. Have a photo contest and take the top five pictures and create a display on the website with the calendar to entice people to visit the website. The webmaster could receive photos from the branches and put them up in a calendar.
Leyzack – an assistant for the webmaster is needed as the current webmaster is busy with the layout for *Lighthouse*.

ACTION: Gartley to find someone to champion the calendar initiative. Agenda item for next Directors' meeting.

National Members Database – status update

Dave reported that the database will be distributed to the Branches next week for feedback. It is ready to go. Each Branch would be responsible for their database updates. Once the database is implemented it will be web driven. Each Branch will have access to their members over the web, National office will be able to view all. There are some security and privacy issues to iron out.
Discussion: Only have CHA members able to sign in. Who should have access and to what. CIG has a members-only sign in.

Gartley – It can be set up, all the above is possible, does not have to be implemented for all members. To get it up and going with functionality is minor at this point.
ACTION: Dave Gartley to forward each Branch's database to them.

Update on National Executive Activities
Andrew gave a brief report on national activities, which included the ACLS-CHA Task Force on the Certification of Hydrographers (see report below) and the recent CIG Council Fall Meeting where interest was expressed by the Maritime branches of the CIG to hold a joint CIG Geomatics Atlantic/Canadian Hydrographic Conference in 2006.

To transact any other business which may properly come before the meeting.
Everyone would like to encourage our colleagues in the Atlantic Branch to reestablish themselves. It will be great to have representation across the country from coast to coast.

Motion to adjourn, 13:45.
Moved: J. Weller Second: J. Walker
CARRIED

CIG Hydrography Committee Membership

The CIG Hydrography Committee is a cross-section of individuals employed in the Canadian Hydrographic Service (Fisheries and Oceans Canada), private practice and academia. It is comprised of the Directors of the CHA plus executive members appointed with academia and marine industry backgrounds. From west to east they are:
Dave Gartley (Director Pacific Branch, Sidney), Paul Sawyer (Director Prairie Schooner Branch, Calgary), Bruce Calderbank (outgoing director of Prairie Schooner Branch), Susan Skone (University of Calgary), John Brigden (Offshore Consultant), Tim Janzen (Director Central Branch), Stacey Kirkpatrick (Director Ottawa Branch), Bernard Labrecque (Director Quebec Branch) and Brian Pyke (Centre for Geographic Sciences- NSCC).

Canada's Offshore

On November 6, 2003, Canada ratified the 1982 United Nations Convention on the Law of Sea (UNCLOS). Perhaps the most significant international treaty to be signed and ratified in recent years, Canada has benefited from and contributed much to its development over the years. While the surveys required to support Canada's Article 76 (continental shelf) claim will be administered by the federal government, a significant portion of the field work will be contracted to private industry. Anticipating a renewed interest in the Canadian offshore, the CHA and the Association of Canada Lands Surveyors (ACLS) have collaborated to revise and republish a text originally entitled Offshore Management by P.K. Mukherjee of the Canadian Hydrographic Service. A limited release of Edition 2 was distributed at a seminar held during the CIG Geomatics 2003 conference. We hope to have the English version of 3rd Edition completed in early 2005. Comments and updates to the current revisions are expected by the end of this year. To date, many people and various organizations like DFO-Science, CHS, NRCan, ACLS, and the CHA have contributed funding, time and effort into the making of this document. (see the Book Review section of this edition of *Lighthouse*)

Association of Canada Lands Surveyors (ACLS)-CHA Task Force on Certification of Hydrographers

Recognizing an opportunity to fulfill a need for a national certification program for hydrographers and with an aim to protect the public from unqualified service providers, the ACLS Council tasked the ACLS Offshore Issues Committee (OIC) to look into this issue and make recommendations. As a result, the ACLS, OIC and the CHA have cooperated to form a joint task force to prepare recommendations to implement a certification program and to develop a policy on the ACLS Affidavit of Experience & Practical Training requirements. The task force which is composed of members of the CHA and/or ACLS, come from private industry, government and academia. They have been meeting regularly since February 2004 to carry out the following activities:

- Develop a terminology (definitions)
- Research other provincial (AOLS), national (US and Australia) and international (FIG/IHO and ISO/TR 19122:2004) certification models.
- Develop a model for the certification of hydrographers by the ACLS, which may involve changes to the CLS syllabus and address issues such as experience (log book), continuing professional development, and dues.
- Develop a policy on the ACLS Affidavit of Experience & Practical Training (log book) specifically for hydrographers.
- Look into the possibility of mutual recognition with respect to existing certification models.
- Present a report to the ACLS Offshore Issues Committee.

In October, 2004, the Task Force fulfilled its obligations and presented its findings and recommendations in a 10-page report to the ACLS Offshore Issues Committee. At the time of this report, the recommendations were under review by the ACLS Council.

PRAIRIE SCHOONER BRANCH

Member News

The Prairie Schooner Branch continues under the new direction of Paul Sawyer as Vice President. Paul Sawyer of Real Time Project Services Ltd., Calgary, AB is no stranger to our board of directors, having once led our former Capt. Vancouver Branch during its heyday in the 1980's. After a busy start to the year working in Russia and Korea, he has been staying in Calgary to work on various office based projects. He was called away urgently in mid September to go to Jamaica to view and evaluate damage left by Hurricane Ivan.

Bruce Calderbank, who has been a freelance offshore surveyor for over 25 years, has been active in navigation quality control services in Turkmenistan from May until July working on an Ocean Bottom Cable 3D seismic survey. In February and March he advised a major Canadian oil and gas company on updating their marine 3D seismic survey specifications. So far in 2004, as an offshore surveyor, he has been responsible for online survey and data acquisition for various offshore construction projects including a pipeline repair project in the Republic of the Congo (January), an 8-leg jacket installation in 38 metres of water off north east Trinidad (April), and hydrographic river surveys for a potential barge routing in the Mackenzie Delta in Canada (July to September).

Editor's Note:
On behalf of the Association, the National Office extends a warm thank you to Bruce, who has stepped down after 10 years of service as VP.

OTTAWA BRANCH

CHC2004

The Ottawa CHA executive was very busy this past spring preparing for the 2004 Canadian Hydrographic Conference (CHC2004). A CHA information booth was set up at the conference and we were given the opportunity to talk with many delegates and meet many of our members from across the country. Conference proceedings were made available on CD at the booth and can still be obtained by contacting Stacey Kirkpatrick via email at kirkpatricks@dfo-mpo.gc.ca. The CHS, CHA and the Canadian Nautical Research Society co-hosted the conference at the Westin Conference Centre, located alongside the Rideau Canal in downtown Ottawa. The theme of this year's event was: *A Canadian Celebration of Hydrography: Foundation for the Future.* Additionally, the conference was a chance to celebrate the 100th anniversary of the formation of the Hydrographic Survey of Canada. Delegates attended presentations ranging from historical subjects to future designs and new developments in the domain of hydrography. It was truly a wide ranging program that satisfied all preferences. Popular social events included: a boat cruise on the Ottawa River, an Ice Breaker Reception, tours of the National archives, a Centenary luncheon celebration, and a book signing for *Charting Northern Waters*. Ten of the book's authors gave presentations on their respective chapters in the book. A number of the authors were also available for a group book signing.

One of the historical highlights during the conference was a cruise around Dows Lake and the Rideau Canal aboard the Admiralty Launch *SURVEYOR*, a 27-foot spritsail launch, owned and operated by CHA's Central Branch. The vessel was captained by Admiral Steve Ritchie and crewed by numerous rowers and special guests, all in period uniform. The vessel helped to commemorate the historical role of hydrography in the development of Canada's waterways.

On a final note, exhibitors have expressed their gratification with the facility and organization of the catering and events. Exhibitors even reported success in sales during the event.

General Meetings

Our summer included meetings in June and July. Dave Gray was kind enough to give a presentation of his paper "Sir Wilfred Grenfell and the Charts of the Labrador Coast" for conference staff and CHA members that were not able to attend the Canadian Nautical Research Society portion of the conference. We were also pleased to have John Ells present "What is GPS Precise Point Positioning (PPP)?" This presentation explained that PPP is a positioning method created by the Geodetic Survey Division of Natural Resources Canada. PPP uses a single GPS receiver to obtain an absolute position from 1 to 10cm. It utilizes a single GPS receiver's code observation, carrier observations, satellite orbit corrections and clock corrections and allows users to survey in static and kinematic modes globally without the need for a second GPS receiver or control point.

Friends of Hydrography

This summer has also been focused on rekindling our affiliated organization, the Friends of Hydrography (FOH). We'd like to thank Ross Douglas for his time and dedication to the FOH. He is stepping down from developing and maintaining the FOH website and our VP, Stacey Kirkpatrick, has taken over. We are happy to have the continued support from Sid Van Dyke, one of our retired CHS employees who visits 615 Booth St. every Tuesday to work on collecting and compiling hydrographic history. We are also happy to add Susan Greenslade to the FOH roster of volunteers. Anyone who is interested in what the Friends of Hydrography are up to should contact Stacey Kirkpatrick at kirkpatricks@dfo-mpo.gc.ca. Please visit the FOH website at *www.canfoh.org*. We are always looking for new information to add so please look around the site and feel free to send us any information you may have. In particular, we are looking for histories of the various areas within CHS, such as Tidal offices, Sailing Directions, Notice to Mariners, Chart Distribution, Chart Production, Surveying, and Chart Corrections. Let us know how the area you work in has evolved over the years. Also don't forget to add yourself to our list of "People". See "Joe Example" for a suggested format.

Member News

Many of our Ottawa branch members are familiar with Dave Monahan and the many meetings for which he has given presentations. We want to thank Dave for his contributions and wish him luck in his new position teaching at the University of New Hampshire. Our Vice President Stacey Kirkpatrick will be leaving CHS on maternity leave, as she is expecting a baby girl November 15th. She will be back sometime in October 2005. Stacey will be stepping down from Vice President of the Ottawa branch, but will continue helping the executive and will be maintaining and adding to the Friends of Hydrography website.

Editor's Note:

On behalf of the Association, the National Office extends a warm thank you to Stacey who has stepped down after 2 years of service as VP and to Ross for his efforts in building the Friends of Hydrography.

Renewed ATLANTIC BRANCH

After several years of dormancy, renewed interest in the Maritimes, has led to the formation of a renewed CHA Atlantic Branch. The Branch held its first meeting on November 29 to establish a new executive. The Branch Vice President is Andrew Smith and the Secretary/ Treasurer is Wendy Woodford. Bruce Anderson and Tammy Doyle are behind the membership committee and additional board members are Mike Lamplugh and Craig Zeller. All are hydrographic staff at the Bedford Institute of Oceanography, Dartmouth, Nova Scotia. CHA Atlantic members affiliated with the "western" branches are encouraged to renew their 2005 membership through the new Atlantic Branch. Please contact Bruce Anderson at andersonb@mar.dfo-mpo.gc.ca for membership inquiries.

DID YOU KNOW...

KEEL-HAUL

Keel-hauling was a brutal punishment inflicted on seamen guilty of mutiny or some other high crime, in the "good old days" of sail. It practically amounted to a death sentence, for the chances of recovery after the ordeal were slight.

The culprit was fastened to a line which had been passed beneath the vessel's keel. He was then dragged under the water on the starboard side of the ship, hauled along the barnacle-encrusted bottom and hoisted up and onto the deck on the port side.

If the barnacles didn't cut him to pieces, and if he hadn't been drowned in the process of operation, he was considered to have paid for his crime and was free.

But as we said before, his chances of recovery were mighty slim.

Rates Tarifs

POSITIONING / EMPLACEMENTS

The acceptance and positioning of advertising material is under the sole jurisdiction of the publisher.

L'approbation et l'emplacement de l'annonce sont à la discrétion de l'éditeur.

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EXIGENCES NUMÉRIQUES

Advertising material must be supplied by the closing dates as digital Tiff 600dpi files. 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 fournie aux dates de tombée. 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.

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

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HINTS TO AUTHORS

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

1. Submit a hardcopy complete with graphics including tables, figures, graphs and photos.
2. Submit 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 (600 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.
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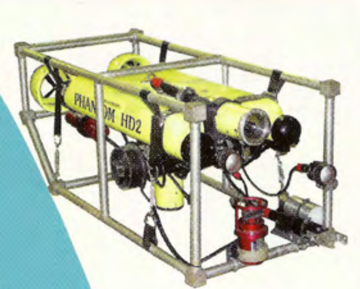

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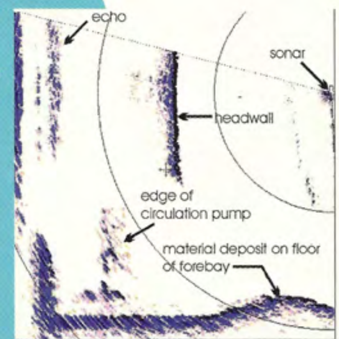

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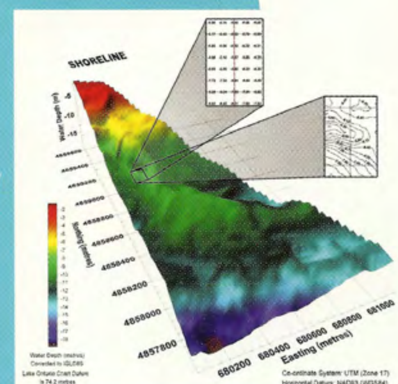

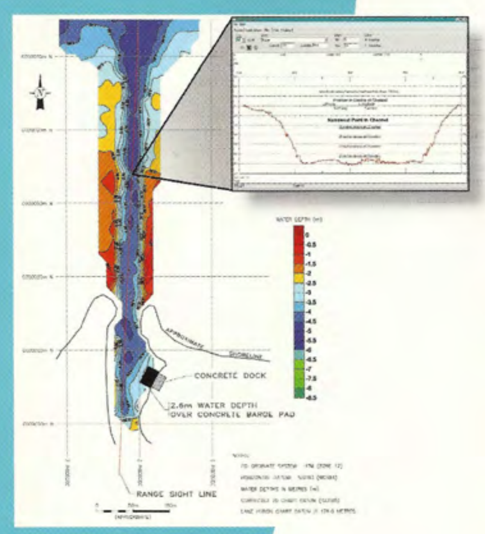

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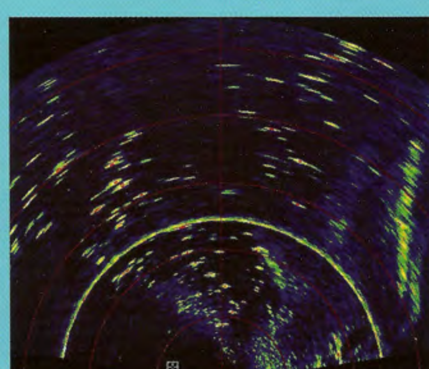

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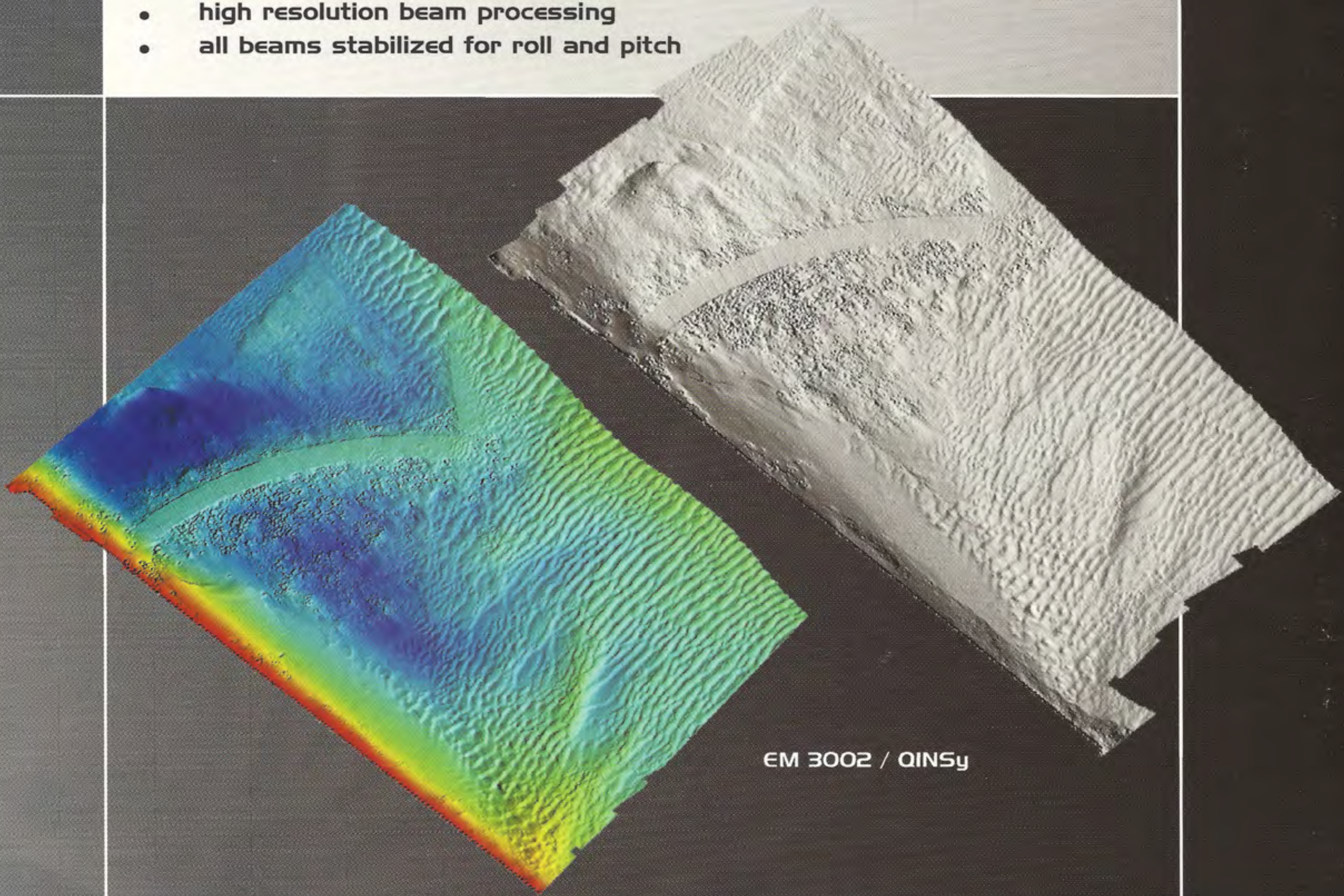

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