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LIGHTHOUSE

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JOURNAL OF THE CANADIAN HYDROGRAPHIC ASSOCIATION
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Views expressed in articles appearing in this publication are those of the authors and not necessarily those of the Canadian Hydrographic Association.

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

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Fall Issue	September 1/1er septembre	Édition de l'automne

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1996 CHA Academic Award

The fourth winner of the CHA award is Jean François Olivier from the University of Laval. Jean François is in his second year of a Baccalaureate en Geomatique program. On July 15 he was informed of winning this award and received a cheque for $2000. He was also given a framed certificate. He is the first student from the province of Quebec to win this award.

The initial fund money of $29,000 was invested in a five year GIC in 1992 and generates about $2400 a year. It matures in 1997 and other investments will be looked at in order to maintain the award at $2000.

The awards committee encourages applications and at the present sends information to twenty-one educational institutions across the country.

Mesdames,
Messieurs,
Je voudrais remercier l'Association Canadienne d'Hydrographie pour avoir choisie ma candidature à l'obtention de cette bourse de 2000 dollars. Elle me permettra de me concentrer sur mes études et non pas sur mes états financiers. À m'a première année d'étude dans ce domaine, je trouve la géomatique tres intéressante et je suds anxieux d'en connaître d'avantage sur le métier d'arpenteurgéomètre et sur toute les technologies qui si rattachent.

Je vous remercie de nouveau de l' aide financière que vous apportez aux étudiants et je vous présente, Mesdames, Messieurs mes salutations distinguées.

Jean-François Olivier
780, place Belmont app. 407
Sainte-Foy (Québec)
G1V 2W9

Index of Advertisers / Index des annonceurs

Message from the National President
Mot du Président national

Ken McMillan

Since this issue is going to press early in 1997, I wish to extend Season's Greetings to all CHA members as well as Lighthouse subscribers.

Having returned recently from Malaysia, I was letting my fingers do the walking through the Yellow Pages of the Toronto phone book. I expected to find listings under Surveyors - Hydrographic or possibly Hydrographic Surveyors, to my surprise, there were no listings! Here in Canada, in the largest city in the country, there are no listings for Hydrographers. Compare this to the Yellow Pages for Surveyors - Hydrographic in the Kuala Lumpur phone book where there are listings for over 20 companies. The influence of the Federal Government on hydrography in Canada is one possible explanation. Another is that Toronto is situated on Lake Ontario, one of the Great Lakes, and not close to the salt water environment. I would be interested to continue this informal survey in cities on the east and west coasts, as well as along the St. Lawrence River. Canada has the longest coastline for any country in the world, particularly after the breakup of the Soviet Union, and commercial hydrographers are a rare species. Maybe , in Canada, we take hydrography for granted.

To the volunteers who have assembled this issue, congratulations. The editor and associate editor have worked hard to get the release date of the upcoming issues back onto schedule and the light at the end of the tunnel is not an express train.

Editor's Note / Note du redacteur

Terese Herron

Edition 54 has come together quickly as a result of most items being submitted on time; it really does make a difference! I hope everyone is happy with the changes that have been occurring over the past four editions. If you have any comments please write to the editor—they could be the start of a 'letters to the editor' column. As you will notice the FIG column is now a regular feature and the ACLS column will be a feature in every Spring issue.

Included in this edition is a short article by Barry Lusk about the CHA Malaysia Project. We have heard, over the past few years, about this project and it is great to read about what has been accomplished through this CIDA sponsored project.

As always I am searching for papers to publish; if you have a paper you would like published, please send a copy to the editor for review. Of interest are papers on Electronic Navigation Charts, Electronic Chart and Display Information Systems, Multi-Beam Systems, Hydrographic Processing Software, GPS, Bottom Classification Systems as well as papers of general interest.

Ian Miller, a former CHS employee, brought to my attention that Pentland Press is releasing a book "Voyages into Eternity" in January 1997. This book is a collection of memoirs spanning the years 1812 to the present. Of particular interest are the years the author worked with the CHS (1953 to 1966) and Project Caesar (1958 to 1968). This book will be of interest to people in the Marine Sciences Business. We will let you know when we receive the press release.

Please remember that the email address for Lighthouse is lighthouse@bur.dfo.ca; we would like to hear from you.

Abstracts / Résumés

Use of Low-Cost GPS Receiver Technology for Sonobuoy Positioning

by

H. Sun, M.E. Cannon, G. Lachapelle, D. Connell and P. Shouldice

The use of precisely positioned sonobuoys for military and civilian applications such as anti-submarine warfare (ASW) and search and rescue missions are summarized. The use of low cost GPS receiver technology to resolve the positioning problem is assessed through a series of marine trials conducted by DND/DREA between January and October 1995. During these trials, sonobuoys were deployed from a ship and positioned relative to the ship using DGPS. The DGPS data collected during the January 1995 trial off the coast of Bermuda was analyzed in post-mission mode. During the October 1995 trial, conducted off the coast of Nova Scotia, DGPS was used in real-time. Low cost Rockwell MicroTracker receivers were used on the sonobuoys while NovAtel Model 951 units were used on the ship. The data analyses presented herein show that a relative DRMS accuracy of about 3 m, which is sufficient for most applications, was obtained during both the trials.

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Utilisation d'une technologie GPS peu coûteuse pour le positionnement d'une bouée-balise

par

H. Sun, M.E. Cannon, G. Lachapelle, D. Connell et P. Shouldice

L'usage de bouées-balises positionnées précisément pour des applications militaires et civiles comme des opérations anti-sous-marines et des missions de recherche et sauvetage est résumé. L'utilisation d'une technologie GPS peu coûteuse pour résoudre le problème du positionnement a été estimé par une série de tests marins menés par le MDN/CRDA entre janvier et octobre 1995. Durant ces tests, les bouées-balises étaient déployées d'un navire et positionnées relativement au navire en utilisant le DGPS. Les données DGPS obtenues au large des Bermudes durant les tests de janvier 1995 ont été analysées en post-mission. Durant les tests d'octobre 1995, effectuées au large de la Nouvelle-Écosse, le DGPS a été utilisé en temps réel. Des récepteurs peu coûteux MicroTracker de Rockwell étaient utilisés sur les bouées-balises tandis que des unités NovAtel/modèle 951 étaient utilisées à bord du navire. L'analyse des données présentées ici montre qu'une précision relative "DRMS" d'environ 3 m, laquelle est suffisante pour la majorité des applications, a été obtenue durant les deux séries de tests.

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Using DGPS To Measure The Heave Motion Of Hydrographic Survey Vessels

by

P. Kielland and J. Hagglund

One quite significant error source encountered by hydrographers is wave induced vertical motion of their survey vessel (heave). In heavy swells, uncorrected heave noise will degrade the accuracy of the surveyed soundings upon which mariners rely for safe navigation. Heave motion can be measured using inertial technology thus enabling the raw surveyed soundings to be corrected to calm water conditions. Unfortunately, the high cost of inertial heave compensators has prohibited their widespread use. This paper documents a test carried out by the Canadian Hydrographic Service in which very accurate relative positions derived from GPS phase observations were used to determine heave corrections for a hydrographic survey vessel. The algorithm is simply a high pass filter acting on the unused DGPS vertical position record already being observed on the vessel. An inexpensive pitch and roll inclinometer is used to correct for the lever arm effect between the GPS antenna and the sounder's transducer. The experiment indicated that decimetre heave compensation accuracy was obtained.

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Le DGPS pour mesurer le mouvement de soulèvement des bateaux hydrographiques

par

P. Kielland et J. Hagglund

Une source significative d'erreurs rencontrée par les hydrographes est le mouvement vertical (effet de soulèvement) qui est produit par les vagues sur les bateaux hydrographiques. Durant les grosses mers, le bruit non corrigé du soulèvement dégrade la précision des sondes sur lesquelles les navigateurs se fient pour naviguer sécuritairement. L'effet de soulèvement peut être mesuré par la technologie inertielle laquelle ramène les sondes à la condition de l'eau calme. Malheureusement, les coûts onéreux des compensateurs à soulèvement inertiel ont empêché son usage populaire. Cet article présente une étude faite par le Service hydrographique du Canada selon laquelle des positions relatives et précises obtenues par des observations de phases du GPS ont servi à déterminer les corrections de soulèvement d'un bateau hydrographique. L'algorithme est simplement un filtre à haute fréquence agissant sur la donnée inutilisée de la position verticale DGPS qui a déjà été observée à bord du bateau. Un inclinomètre de tangage et de roulis peu dispendieux est utilisé pour corriger l'effet de bras de levier entre l'antenne du GPS et le transducteur du sondeur. L'expérience a démontré qu'une précision de la compensation du soulèvement au décimètre près a été obtenue.

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Twenty-five Years of Co-operation
by
L. Reading

The Canadian Power and Sail Squadron (CPS) has enjoyed a long relationship with the Canadian Hydrographic Service. One of the chief benefits of this relationship is the MAREP or Marine Reporting Programme now celebrating its 25th anniversary. The MAREP programme was initiated by N.G.Gray, a former Dominion Hydrographer and CPS member; it allows mariners to send in reports on matters of importance to navigation. The MAREP reports contribute to accuracy and timeliness of CHS nautical publications.

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Upgrading of Arctic Charts and Conversion to NAD83
by
W. Mazoka and R. Bennetto

The conversion of CHS charts to North American Datum 1983 (NAD83) presents several problems. Poor control on existing products has resulted in shoreline several kilometres out of position. The use of recent aerial photography as compared to satellite imagery to update the coastline of several arctic charts was evaluated. While new methods have greatly improved the accuracy of CHS charts, further studies concerning absolute accuracies are warranted.

Page 25

Vingtcinq ans de coopération
par
L. Reading

Les Escadrilles canadiennes de plaisance (ECP) apprécient leur relation durable avec le Service hydrographique du Canada. Un des principaux avantages de cette relation est le programme RAMAR ou Rapport Maritime qui célèbre ses 25 années d'existence. Ce programme a été initié par N. G. Gray, un ancien hydrographe fédéral et membre des ECP; il permet aux plaisanciers d'envoyer des rapports sur des sujets pertinents à la navigation. Les RAMAR contribuent à la justesse et à la mise à jour des publications nautiques du SHC.

Page 23

Mise à jour des cartes de l'Arctique et conversion au NAD83
par
W. Mazoka et R. Bennetto

La conversion des cartes du SHC au NAD83 (North American Datum 1983) présente plusieurs problèmes. La manque de points de contrôle sur les produits existants fait que plusieurs kilomètres de rivage sont hors position. On a évalué la comparaison de l'utilisation de photographies aériennes récentes aux images satellites pour mettre à jour la ligne de rivage. Bien que ces nouvelles méthodes ont grandement amélioré la précision des cartes du SHC, d'autres études sur la précision absolue sont requises.

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Malaysia Project CHA/CIDA

A Culmination of many years of work
Hydrographic Training at the University of Technology, Malaysia
Barry M. Lusk

The Canadian Hydrographic Association has reached one of its major goals with the recent graduation ceremonies of the first IHO/FIG accredited Hydrographic 1, Category B course in Malaysia.


Visitors and Graduates

Nearly eight years ago the Canadian Hydrographic Association agreed to become the Canadian sponsor of this CIDA supported project that would bring an accredited hydrographic training program to Malaysia. Tom McCulloch, past Director General of the Bayfleld Laboratory for Marine Science in Burlington, began this project in 1985. He offered the CHA the opportunity to sponsor the project after CIG, previously CISM, gave up their sponsorship in 1988. I remember the date clearly because it took place at the biennial Hydrographic Society meeting in Amsterdam and I was the National President of the association at that time.

The University was granted accreditation for a Category B course by the IHO/FIG board in June of 1995. This board has been empowered to review applications for accreditation by these two international bodies, IHO and FIG. Canada has an important representative on the board, namely Dr. Dave Wells of the University of New Brunswick in Fredericton. Not only is Dave a member of the accreditation board, but he also was engaged by the CHA to teach the Hydrographic session of the course. He, along with his daughter and son, arrived in Johor Bahru in January and spent five weeks with the students. Campus accommodations for him and his family were supplied by the University and they quickly adapted to the Malaysian ways.

A second Canadian was also engaged to teach Ports and Coastal Engineering, Ken McMillan of McQuest Marine in Burlington, Ontario and our new National President of the CHA, taught for 2 weeks. The faculty of the University was most complimentary of these two men's work.

Six students graduated from this six month course that was held at the University of Technology in Johor Bahru, Malaysia on May 17, 1996. A large crowd of interested spectators gathered and Canada was well represented. John Bell, the High Commissioner for Canada in Malaysia and Victoria Sutherland, who is director of the Canadian Cooperation Support office, were in attendance. Mr. Bell gave a very good speech during which he emphasized the importance of cooperative efforts between Canada, a world leader in the hydrographic sciences, and other developing nations, like Malaysia. He gave CHA high praise for their voluntary efforts in bringing this about. I was in attendance and accepted his accolades on CHA's behalf.

The second and larger class for the next Category B course will be assembling for the course that will start on September 2, 1996. Seven students are required to attend in order that the course be self sustaining and two of these are from Brunei. Brunei is a small country on the Island of Borneo (Kalimantan) and ruled by the Sultan of Brunei, reputed to be the richest man on earth. Students from other South East Asia countries are encouraged to take this training in Malaysia and the project managers are happy to see this interest.

The Managers of this CHA project will continue supporting this activity right through accreditation at the Category A level and look forward to serving the interests of the Canadian Hydrographic Association in these International activities.

Use of Low-Cost GPS Receiver Technology for Sonobuoy Positioning

H. Sun, M.E. Cannon, G. Lachapelle
D. Connell and P. Shouldice

Introduction

The pace of advancement of GPS technologies and micro-electronics has led to the development of a broad range of GPS applications that only a few years ago were not feasible. One such application is the use of GPS in sonobuoys for relative position determination [1]. It is understood that sonobuoy reference systems (SRS) utilizing interferometer techniques are available, however the accuracy, cost of implementation, and associated applications of GPS technology make it an attractive alternative. An SRS system does not rely upon high absolute accuracy and hence is an excellent application for relative GPS techniques.

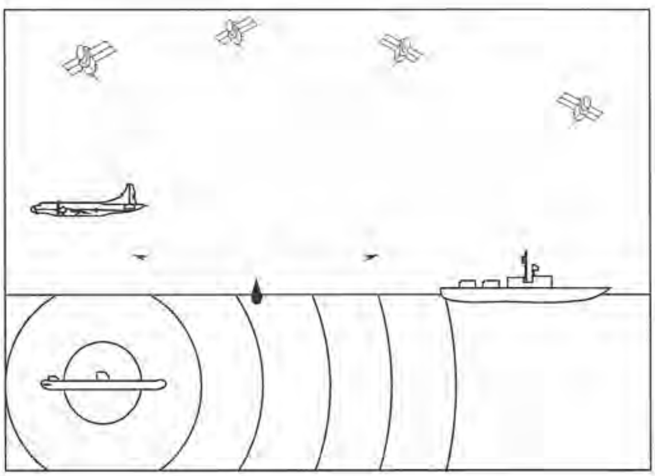

Figure 1: System Components

A sonobuoy is essentially an underwater microphone. It is an expendable electro-mechanical device which converts underwater sound energy into electronic signals which are then relayed via a radio frequency (RF) link to a ship or aircraft which processes the acoustic information to detect, classify and localize surface and underwater targets, as illustrated in Figure 1. The localization of these targets is accomplished by exploiting the Doppler, range and bearing information contained within the acoustic signals. Since the sonobuoys provide these acoustic signals they are critical to localizing the targets. The relative positions between the sonobuoys and the prosecuting platform must be accurately known in order to permit the ship or aircraft to determine its location relative to the target. Absolute positions are therefore not as critical to the prosecution so much as the relative positions between the targets, the sonobuoys and the prosecuting platform. A relative accuracy of at least 10 m is required for such a sonobuoy reference system (SRS). The objective of this research is therefore to evaluate the performance of DGPS applied to sonobuoy tracking. Several tests were conducted in the marine environment in order to investigate system performance and characteristics in an operational mode.

Applications

GPS-equipped sonobuoys have numerous military and civilian applications. Operationally, maritime patrol aircraft would benefit from the higher accuracy through more effective use of current sensors and tactics, and possibly take advantage of new detection techniques. Search and rescue (SAR) personnel would have a new method enabling them to conduct highly accurate homings in poor visibility conditions and shorten search times.

The accuracy of current generation SRS systems is unacceptable given the target and weapon capabilities that exist throughout the world with respect to new generation nuclear and diesel-electric submarines. A relative GPS-based SRS is capable of sub-meter accuracy in principle, but nominally would lie in the 1 to 10m range. The following, although not discussed in detail, represent the operational applications of a GPS-based SRS:

(1) low cost with accuracy of 10 m or less;

(2) more accurate sonobuoy bearings and weapon placement;

(3) ability to discriminate same RF channel interference;

(4) enables broadband time of arrival (CODAR) processing on any two buoys in a pattern;

(5) potential weight savings for aircraft applications; and

(6) potential for accurate between platform position determination.

The scientific community at DREA also has a requirement for an extremely accurate SRS. Scientific trial data collected relies heavily upon reconstruction and post-trial analysis. This analysis drives the requirement for positional accuracy as high as possible. The greater the accuracy achieved, the more valid are the observations, analysis and recommendations made. A GPS-equipped sonobuoy could be used for the following applications:

(1) automated acoustic processing and analysis for localization;

(2) algorithm development and assessment;

(3) sonobuoy beamforming, parallel and array processing; and

(4) environmental measurement and analysis including remote sensing.

Finally, search and rescue could be aided with the use of a GPS equipped sonobuoy. The Aurora aircraft currently carries an emergency sonobuoy beacon which could be replaced with a GPS capable sonobuoy increasing its effectiveness and accuracy. Similarly, a relative GPS sonobuoy could be placed on commercial fishing vessels, or pleasure craft for deployment in times of distress. The relative accuracy is sufficient for a GPS-equipped aircraft to home-in in all weather, day or night conditions. Lastly, Aurora survival kit drop procedures could be aided in low visibility conditions based upon the positioning accuracy and the ability to measure drift with a GPS-equipped sonobuoy.

System Design

Efforts to design a prototype GPS-equipped sonobuoy have focused upon the criteria of small size, low power and cost. The AN/SSQ53D(2) DIFAR (Directional Frequency and Ranging) sonobuoy has been used as our test bed since it is the only passive sonobuoy being maintained in Canadian Forces inventory.

As illustrated in Figure 1, the system uses either an aircraft or a ship to deploy the sonobuoys and collect the acoustic information transmitted from the buoy using a VHF telemetry link. Either the aircraft or ship is equipped with a GPS receiver and each buoy is also installed with a GPS receiver engine. The GPS receiver on the aircraft or ship is used as a reference receiver while the receivers in the buoys are used as remote receivers. The concept is therefore to position the sonobuoys relative to the vessel. Positions of the reference receiver on the vessel are either from single point positioning or DGPS using broadcast corrections from a shore-based reference station. GPS measurements, together with acoustic information, are transmitted to the ship from the sonobuoy through a carrier signal. A real-time positioning system is then used to compute the relative location of each buoy. A diagram of the system is shown in Figure 2.

The GPS antenna on the sonobuoy is mounted typically 10 cm above the water line, as during the trials described herein. Since surrounding waves are usually of the order of several decimetres to a few metres, they will cause intermittent GPS signal shading. Receiver signal reacquisition time and a multi-satellite tracking strategy designed to deal with this problem will therefore be important characteristics which will affect the overall performance of GPS. This problem is somewhat similar to that of GPS signal tracking under foliage (e.g., Lachapelle & Henriksen 1995).

For ASW applications, there may be an array of sonobuoys deployed. Therefore, the system should be able to accommodate a larger number of buoys simultaneously. In the present system, each buoy is assigned to a different frequency channel when transmitting information to the vessel. After demodulation, the GPS data from each channel is funnelled to a separate serial port for retrieval.

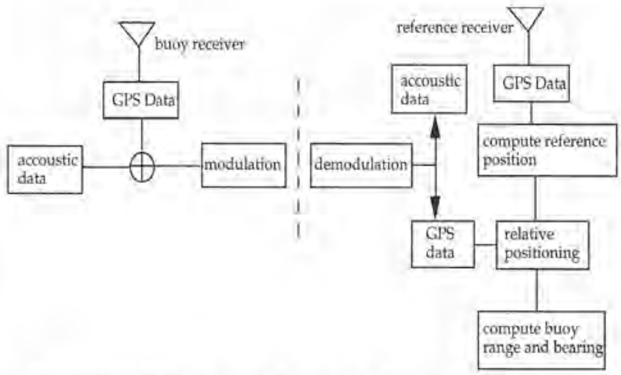

Figure 2: Sonobuoy Relative Positioning System

GPS Receiver Selection

Two receiver types were selected for the trials reported below, namely a low cost unit to be used on the sonobuoys and a reference unit to be used on ship to generate differential corrections.

The low cost GPS receiver selected is the Rockwell MicroTracker which is a 5-channel single frequency C/A code receiver unit [4]. The first four channels are dedicated while the last one is a monitoring channel sequencing between the remaining satellites to provide the best GDOP. The current version does not provide carrier phase measurements. The dimensions of the receiver are 51 mm x 72 mm x 14 mm and the weight is 50 grams. These small dimensions allow the unit to fit inside DREA's miniature DIFAR sonobuoy.

Two limitations occur with the MicroTracker receiver which affect the accuracy of the DGPS positions. The first is that the time tag of the code measurements is not an integer second. The second is that the accuracy of the instantaneous Doppler measurements is relatively low. When the relative position of a sonobuoy is computed with respect to the ship, a prediction of the measurements or the position is required. This prediction will degrade the position accuracy as a function of the ship and buoy dynamics. In the trials reported below, the data was collected at rates such that the prediction interval was always less than 1 second.

The reference unit selected for the ship was the NovAtel 951R which is a 10-channel C/A code receiver employing Narrow Correlator™ spacing to improve the code noise to the 10 cm level [5].

Trial Description And Results

Several trials were conducted throughout 1995 to evaluate the performance of the system shown in Figure 2. The tests include (1) static land tests, (2) post-processed sea trial tests and (3) real-time sea trials.

Static Land Trial

The objective of this trial was to assess the accuracy achievable using the two receiver types selected above under favourable conditions. Two survey markers separated with known positions separated by 100 m were used. The 951R was on the roof of the DREA building, Halifax, while the MicroTracker was on the ground. The known coordinates of these survey points were used as truth to check the DGPS accuracy performance.

The data was reduced using the University of Calgary's C³NAV™ software which performs code or carrier smoothed code DGPS positioning using either a fixed or a moving reference station (e.g., Cannon & Lachapelle 1992). Since the MicroTracker receiver does not output raw carrier phase data, carrier phase smoothing was performed only on the 951R data which was used to generate the ship reference station corrections.

Figure 3 shows the epoch by epoch differences between the DGPS estimated distance and the known distance between the two antennas as a function of time. The effect of multipath can be seen very clearly from the pattern of the differences. The average and RMS differences are -0.15 m and 3.7 m, respectively. This level of agreement is satisfactory given that MicroTracker raw code measurements were used.

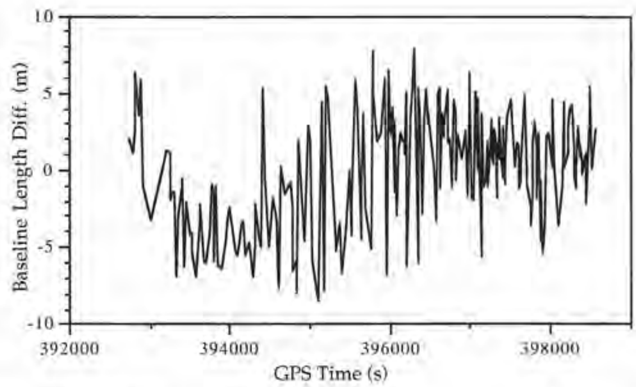

Figure 3: Differences Between Estimated and Known Inter-Antenna Distance - Static Test

January '95 Sea Trials (Post-Processed)

A first series of sea trials was conducted off the coast of Bermuda in January '95. A 2200 ton vessel, namely the CFAV Quest, was used for this trial during which selected sonobuoy GPS positioning tests were performed under different sea conditions. Two NovAtel 951R GPS receivers were installed on the ship while Rockwell MicroTracker receivers were used on the sonobuoys. Active Sensor Systems GPS antennas were used on the sonobuoys while the NovAtel Model 501 antennas equipped with chokering groundplanes were used on the ship. The GPS data from this test was collected and analyzed in post-processing mode. Five series of tests were performed on five separate days with a two to five hour period on each day. During these tests, four sonobuoys were deployed simultaneously. The sea conditions prevailing during the trials are summarized in Table 1.

Date (1995)	No. of Sonobuoys	Wind (knots)	Wave (m)
Jan. 9	4	10	1.5
Jan. 11	2	15	2.5
Jan. 13	4	25	3
Jan. 16	3	35	4.5
Jan. 18	2	40	4

Table 1: Number of Sonobuoys and Sea Conditions During January 1995 Trials

A problem encountered during the trials was the integrity of data transmission from the sonobuoys to the ship using a VHF link. When the sonobuoys were very close to the ship, the engine noise affected the integrity; conversely, if the sonobuoys were too far from the ship, the signal power affected the integrity. The typical distance between sonobuoys and ship ranged between 0.1 to 10 km.

The post-mission analysis focused on satellite geometry, measurement residuals, as well as sonobuoy trajectory patterns. The two reference receivers on the ship were used to verify the consistency of the results.

Results from the January 9 trial are summarized in Figures 4 to 6 and Table 2. The observed PDOP for channel (sonobuoy) # 3 is shown in Figure 4 while the trajectory of the sonobuoy relative to the ship is shown in Figure 5. From these two figures, it can be seen that the PDOP exceeds 5 during some periods. This is due to signal masking by surrounding waves since the sonobuoy GPS antenna is only 10 cm above the nominal water line. The trajectory shown in Figure 5 contains the positions for which the PDOP was < 10.

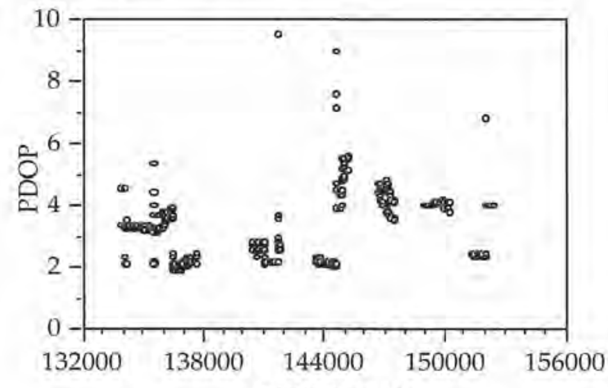

Figure 4 : PDOP for Sonobuoy Channel 3 - January 9

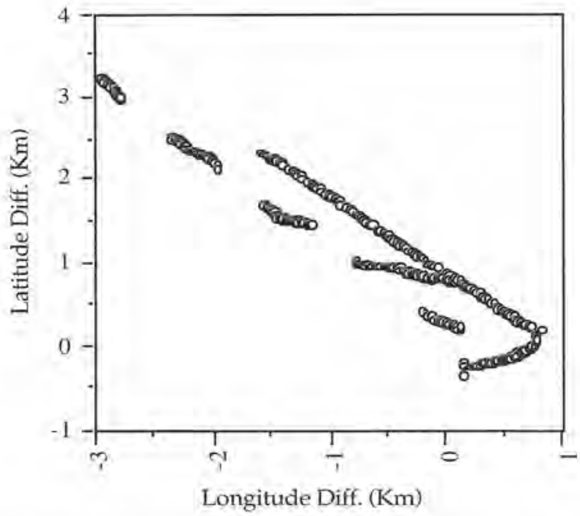

Figure 5: Sonobuoy Trajectory with Respect to the Ship, Channel 3 - January 9

Figure 6 shows an enlarged section of the trajectory. Each cell represents an area of 20 m x 10 m. The sea was calm on that day and the self-consistency of the trajectory is a measure of the quality of the relative GPS solution.

The quality of the GPS measurements can be analyzed by inspecting the differential pseudorange residuals when at least one redundant satellite is available. Table 2 gives the single difference residuals obtained with C3NAV™ for the satellites tracked during the session. The residual RMS is ≤ 0.8 m, with an average of 0.6 m. This is a valid measure of the relatively high quality of the MicroTracker pseudoranges. If one uses the above 0.6 m as a measure of the differential UERE (User Equivalent Range Error) and that an HDOP of 5 is available, the DRMS accuracy is 3 m.

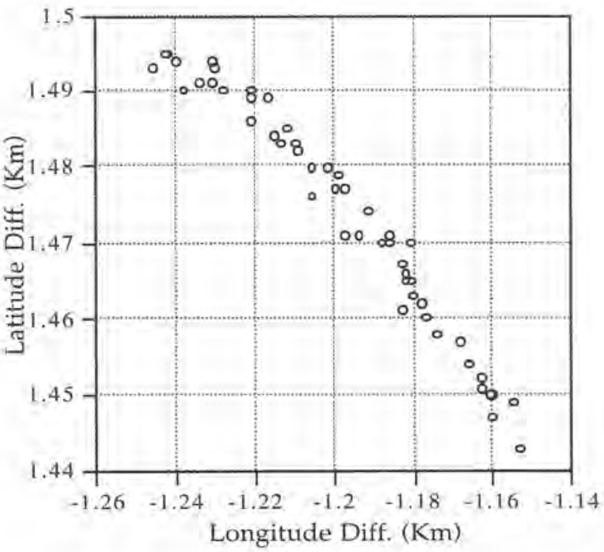

Figure 6: Enlarged Section of Sonobuoy Trajectory

Satellites on Channel 3 - January 9

PRN	No. of Epochs	Average (m)	RMS (m)
1	594	0.04	0.55
5	628	0.03	0.66
6	126	0.15	0.73
9	469	0.02	0.77
12	620	0.01	0.80
16	223	-0.01	0.27
17	708	-0.03	0.62
21	748	-0.01	0.64
23	1027	-0.09	0.63
26	629	-0.06	0.56

Table 2: Differential Pseudorange Residuals for Satellites on Channel 3 - January 9

Since two NovAtel receivers were installed on the ship, they could be used independently to perform relative positioning to each sonobuoy. The relative 3D position vector between the two NovAtel reference receivers was determined through carrier phase processing with an accuracy of a few cm. The consistency of the two sonobuoy trajectories was assessed to insure that the two reference receivers were performing within anticipated specifications. The RMS difference between the two trajectories was < 1 m when the PDOP was < 5.

Table 1 shows that the waves were highest, at 4.5 m, on January 16. An analysis of satellite availability did not show a significant drop, however, as compared to that of January 9. The average residual RMS was however slightly higher at 0.86 m than on January 9. Under the same HDOP assumption of 5, the DRMS accuracy would drop to 4.3 m.

October '95 Sea Trials (Real-Time)

This series of trials was performed off the coast of Nova Scotia. The same hardware as in the January '95 trials were used, except that GPS Micropulse passive antennas were used in this case. A real-time version of C3NAV™, namely C3NAVRT™, was used during this trial, as shown in Figure 7. This system can graphically display the relative trajectory between the ship and the sonobuoys. It can also display the relative coordinates, range, bearing, geometry information and other information which is required for the acoustic analysis. Data from each channel corresponds to one sonobuoy which is output to an individual serial port. The system first performs point positioning for the reference receiver (or alternatively differential positioning if corrections are available from a shore-based reference station). Differential corrections are computed for the ship reference receiver based on this solution. The different sonobuoy channels are polled to determine whether data has been received. If there is data from one of the channels, differential corrections are predicted to the timestamp of the channel data and relative positions are computed.

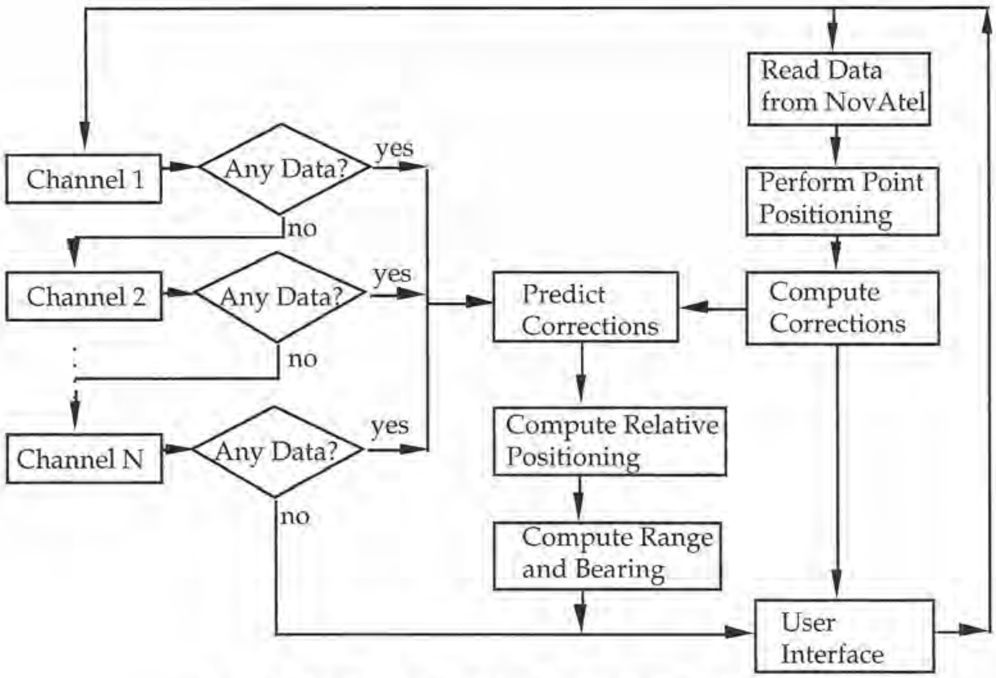

Figure 7: Real-Time Relative Positioning System Design

Based on the reference position and the sonobuoy position, the relative range and bearing are computed. These parameters are graphically displayed to the user.

Statistics of the differences between the real-time and post-processed positions are listed in Table 3. The RMS values range from 0.6 to 0.8 m. These differences are mainly due to the differences in processing strategy between the two modes. Since the time tags of the MicroTracker receivers are not at integer seconds, either a prediction of the measurements or a prediction of the computed position is required to synchronize the MicroTracker and the NovAtel information in order to compute the relative position between the ship and the sonobuoys. During post-processing, the 951R pseudorange measurements were predicted using the instantaneous Doppler measurements since this prediction is very precise. It requires, however, a computation of the ship's position based on the predicted pseudorange measurements for each sonobuoy. This significantly increases the computational burden in real-time and is almost impractical. Therefore in real-time mode, the ship's position is predicted in order to compute the relative position between the ship and the sonobuoys. Figure 8 shows the differences between real-time and post-processed latitude and longitude differences for October 27.

	Lat.Diff.		Long.Diff.	
Date	Average (m)	RMS (m)	Average (m)	RMS (m)
Oct. 27	-0.56	0.80	0.55	0.73
Oct. 29	0.33	0.65	0.73	0.76

Table 3: Statistics of the Differences Between Real-Time and Post-Processed Positions

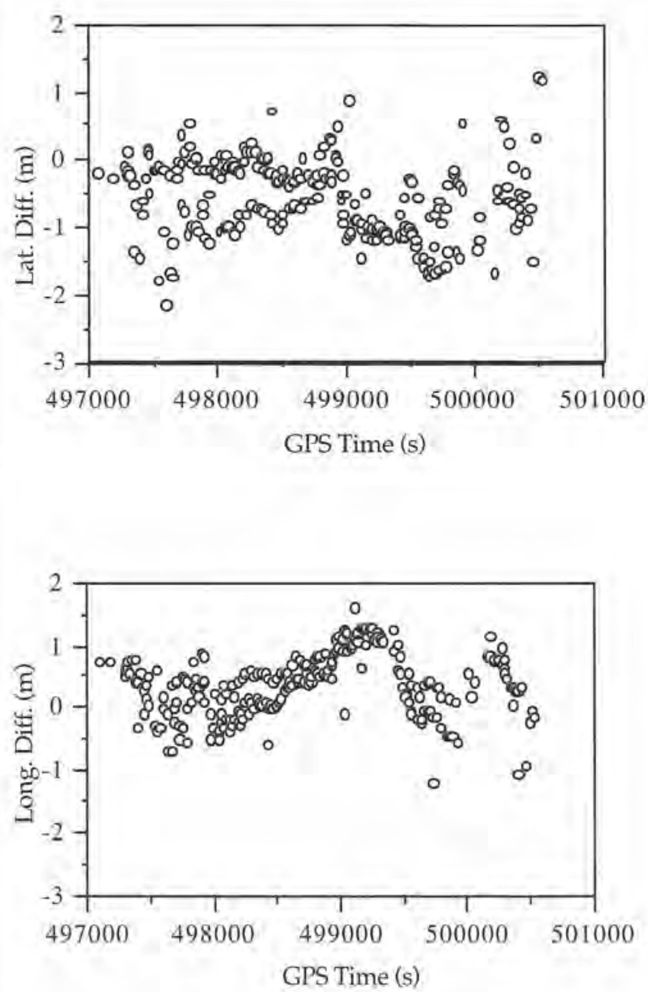

Figure 8: Differences Between Real-Time and Post-Mission Positions

Conclusions

The integration of GPS in sonobuoys was shown to be feasible. The initial design goals have been achieved and limitations of the current system have been identified. Further evaluation trials are planned in order to fully characterize the potential accuracy as well as the operational impact of GPS on sonobuoys. Future developments will include the evaluation of new hardware candidates and processing techniques which may impact on the design architecture. Ultimately the final design shall be based upon the constraints of cost, accuracy, platform integration and interoperability.

Acknowledgement

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Using DGPS To Measure The Heave Motion Of Hydrographic Survey Vessels

P. Kielland and J. Hagglund

Introduction

Hydrographic data plays a major role in assuring safe navigation. From a navigator's perspective, the safety intrinsic to any surveyed seafloor model is its fidelity with respect to the real seafloor. If a seafloor model defined by hydrographic data perfectly models the true seafloor then that data is perfectly safe. All bathymetric seafloor models are less than perfect and some are very imperfect. This continuum of degrading spatial fidelity is critical knowledge to mariners. When deciding how close they can safely approach shoal features portrayed by a seafloor model, mariners need to know just how reliable that picture is. This requirement for safe navigation defines the two prime directives for hydrographers:

1)- Minimize the spatial imperfections in the surveyed seafloor model.
2)- Estimate whatever level of spatial infidelity remains after all data collection and modelling is complete.

This paper deals with only a small part of the first of these two tasks. If we wish to minimize the spatial imperfections in a seafloor model, there are two types of error sources that must be controlled. The first is the interpolation errors caused by merely sampling discrete point soundings over the continuous seafloor surface. Reducing interpolation errors can only be accomplished by observing depth soundings at closer intervals over the seafloor being surveyed. As a rule: the rougher the seafloor being modelled, the denser the depth samples must be. The desire to totally eliminate interpolation errors has given rise to multibeam echo sounders which increase the efficiency of collecting extremely dense soundings. For sparser data sets: after data collection is complete, gridding techniques based on geostatistics can be used to estimate the probable magnitude of interpolation errors at every location on the interpolated seafloor surface model [1].

The second error source that can be minimized is instrumental errors which contaminate either the position or depth coordinates of the sampled data points. There are a host of factors which contribute to instrumental errors. Increasingly sophisticated signal generation, signal timing and signal propagation modelling have been developed to minimize them. A good example of this trend towards sophisticated instrumentation is GPS. There are many other examples of electromagnetic and acoustic survey systems in which instrumental error sources have been efficiently minimized. One instrumental error source specific to hydrography is the wave induced vertical heave motion affecting bathymetric data. A low cost means of reducing these heave errors is the subject of this paper.

Heave Errors

In order to compensate for the effect of changing water level (due to tidal effects or other environmental factors), all measured depth soundings must be reduced to a vertical sounding datum. This reduction to datum enables navigators to later make use of the surveyed soundings by adding their current local water level elevation onto the charted depths. The water level elevations can be obtained from published tide prediction tables. The sounding datum elevation is established by first analyzing a history of water level elevations. A statistical value is then determined for "Lower Low Water Large Tides": an elevation which the water level very rarely falls below. During a hydrographic survey, a tide gauge keeps track of the water level elevation above this datum and the water level elevations are subtracted from all acoustically measured depths.

This whole data reduction process is essentially a water level transfer. It requires a noise free (calm) water surface for projecting the tidal elevations observed at the gauge site out to the location of each surveyed sounding. Any uncorrelated noise (such as wave action) that exists between the tide gauge location and the depth sounder location adds directly to the overall uncertainty of the charted soundings. If for example the survey vessel is sounding in 1 metre swells, then all of its measured depths will have a +/- 1 metre uncertainty. For many critical survey situations these instrumental errors must be reduced.

Conventional Heave Compensation

There are two traditional methodologies for reducing heave noise in the data.

1) *Analog heave reduction:* On surveys which still employ analog data capture and processing techniques, the graphical sounder trace must be visually interpreted to select and digitize depths. This presents an opportunity for the hydrographer to identify any oscillations in the seafloor trace that have been induced by heave motion. A regular saw-tooth pattern often indicates the presence of heave induced noise. The reliable identification of heave artifacts during data processing is facilitated if

during data collection the hydrographer has annotated the analog trace with sea-state commentaries. If the data digitizer is quite certain that a saw-tooth artifact has been induced by heave noise, then the analog trace can be visually smoothed to simulate calm water conditions. This manual heave compensation technique has obvious shortcomings, particularly if the seafloor is rough. For example, when examining an irregular shoal structure it becomes impossible to reliably differentiate between a spike on the graph that was caused by the survey launch falling into the tough of a wave and an identical spike caused by a dangerous rock on the seafloor.

2) *Digital heave compensation:* On more modern surveys that log and process data digitally, it becomes feasible to continually measure heave motion and correct all measured soundings. Typically this is done using inertial technology to measure vertical acceleration at the location of the sounding transducer on the vessel. By integrating acceleration twice, the heave motion can be computed in real-time and used to correct the soundings as they are logged from the echo sounder.

The one major drawback of inertial based heave sensing is its high cost. Heave sensors based on a simple triad of accelerometer and rate of turn sensors (such as the TSS 335B) start at about $30K (US). Damped pendulum based sensors (such as the HIPPY) are also in this price range. More sophisticated gyro based systems (such as the POS/MV) can cost over $100K. This high capital cost has limited the use of heave compensation to critical surveys carried out by well funded agencies. Multibeam echo sounders require pitch roll and yaw information (also available from a heave sensor) in order to form and steer the multiple acoustic beams. Heave compensation is therefore considered compulsory only for multibeam sounding operations. While technology has advanced towards somewhat lower cost sensors, inertial heave compensators continue to be relatively high cost survey system components.

A GPS Based Heave Compensation Algorithm

Differential GPS presents a third possible method of heave compensation; one which eliminates the need for expensive inertial sensors. By exploiting phase tracking information from GPS receivers we can very accurately measure a change in elevation. Uninterrupted carrier phase tracking can in theory detect changes in elevation of less than a centimetre from one epoch to the next. This characteristic is exploited by the heave compensation algorithm described below.

Heave is considered here to be the height of the vessel's sounding transducer relative to its location "during calm water". Since over time vertical wave movement appears as a random noise, the elevation of calm water should be equal to its average elevation over a period of a minute or two. In this heave algorithm, a moving weighted mean is used to define this "calm water" reference elevation. The weight used for each elevation observation used in the weighted mean is its standard deviation (estimated by the 3D GPS position adjustment). The epoch of each heave value is contained within the sample used to compute the weighted mean reference surface. At each of these epochs, the computed heave value is simply equal to the difference between the instantaneous GPS elevation and its moving mean reference elevation.

The number of measurement epochs in the moving window used to compute the weighted mean is user defined. In this experiment, a variety of window durations between 50 and 250 epochs were tried. One hundred (one second) epochs appeared to adequately model calm water yet still permit the smoothed reference surface to follow trends which might otherwise bias the heave values. Such trends can be caused either by real tidal movement, changes in the trim and draft of the vessel, or any of the many GPS instrumental error sources affecting the absolute elevations. The location of the single heave epoch within the moving data window can also be specified by the user (leading edge, centred or trailing edge). In this experiment we used centred windowing since it provided better heave results. Its only drawback is that, in order to consider both the past and future on either side of the single epoch, centred windowing constrains the algorithm to post processing of logged data. Heave differencing at the windows edge is more susceptible to biasing the heave results but has the advantage of being easily implemented in real-time. Near real-time, centred windowing (heave output delayed by half the window duration) could also be implemented by maintaining appropriate data buffers.

The weighted mean algorithm is implemented as follows:

$$\overline{X} = \frac{\sum_{i=1}^{n} Wt_i X_i}{\sum_{i=1}^{n} Wt_i} \quad \text{where} \quad Wt_i = \frac{1.0}{StdDev\, X_i \times StdDev\, X_i} \qquad (1)$$

The traditional formulation of the Standard Error of the Arithmetic Mean for observations with unequal weighting is given by:

$$S_{\bar{x}} = \sqrt{\frac{\sum_{i=1}^{n} Wt_i \left(X_i - \overline{X}\right)^2}{(n-1)\sum_{i=1}^{n} Wt_i}} \qquad (2)$$

to ease the computational burden of maintaining data buffers, this was reformulated as follows:

$$S_{\bar{x}}^2 = \frac{\sum_{i=1}^{n} Wt_i X_i^2 - 2\overline{X} + \overline{X}^2 \sum_{i=1}^{n} Wt_i}{(n-1)\sum_{i=1}^{n} Wt_i} \qquad (3)$$

It should be noted that this Standard Error of the Weighted Arithmetic Mean is actually reflecting the tightness (precision) of the data used to calculate it. It may in fact be very precise, but not necessarily very accurate (due to biasing). As long as any bias is varying slowly relative to the time interval of the window selected, accurate heave estimates can be determined. By definition, whatever bias might exist in the population used to compute the moving weighted mean is also present in the single epoch height value. The elevation bias therefore drops out in the subtraction used to calculate the instantaneous heave value.

If the standard deviations assigned to the X_i observations truly reflect the uncertainty of the observation, an estimate of the accuracy of the Weighted Mean elevation can be calculated using the weights only:

$$S_x = \sqrt{\frac{1.0}{\sum_{i=1}^{n} w_i}} \quad (4)$$

A previous experiment based on the Hydrostar Post Mission (HPM) processing software used in this experiment demonstrated that the estimated standard deviations of the X_i are in fact statistically non-biased [1]. Equation 4 is therefore a good indicator not only of the precision of the elevation of weighted mean reference surface but of its absolute accuracy.

Pitch and Roll Reductions

The raw "heave" from the algorithm described above is merely the high frequency vertical movement of the GPS antenna ... not the heave at the vessel's sounding transducer. Since the GPS antenna must be mounted away from the centre of gravity of the vessel, angular pitch and roll movement of the vessel induce a vertical movement of the GPS antenna. This vertical pitch and roll movement contaminates the heave computed for the offset location of the sounding transducer and therefore must be removed. Before using any GPS elevations either for computing the weighted mean height or for differencing the instantaneous heave values, the elevations must first be corrected for vessel pitch and roll effects.

As a rule, the GPS antenna will be located at some considerable distance from the sounding transducer. This forms a lever arm around which the pitch and roll of the vessel add noise to the heave sensed at the GPS antenna. The effect of the antenna's lever arm offsets (defined in the vessel's structure coordinates by *Dx, Dy.* and *Dz.*) can be removed from the heave signal if the angular pitch and roll of the vessel are measured. The lever arm correction to each height is given by (5):

$$Corr_{height} = -Cos(roll)Sin(-pitch)\,Dx_{ant} + Sin(roll)\,Dy_{ant} + Cos(roll)Cos(-pitch)\,Dz_{ant}$$

From equation 5 it is apparent that the horizontal components of the antenna lever arm (D_x and D_y) should be as close to zero as possible. For a vertical lever arm (only D_z), the effect of angular errors on the heave correction is a pure cosine function and therefore has very little effect on the heave values. For example: through a vertical 10 metre lever arm, a 1° pitch and roll error produces only a 0.2 mm heave error. As the inclination of the lever arm increases, the effect of angular error increases as a sine function. Thus, at a rather extreme pitch or roll angle of 20°, the same 1° measurement error over 10 metres would induce an error of 6 centimetres in the instantaneous heave. In order to minimize pitch and roll induced errors, it is thus very important to mount the GPS antenna as close to the sounding transducer as possible (D_x and $D_y = 0$). The pitch and roll sensor itself should be located close to the centre of gravity of the vessel to minimize lateral forces which could increase its susceptibility to overshoot errors. On typical survey launches, the antenna lever arm is less than 10 metres and it is often quite feasible to mount the GPS antenna directly above the transducer.

Since GPS data is already observed for horizontal positioning of the sounding data, any GPS derived heave compensation is essentially free. However, to realize this potential cost-effectiveness, the pitch and roll data required for lever arm corrections must come from an inexpensive sensor. Digital inclinometers with a claimed angular accuracy of +/- 0.2° can now be purchased for under $0.5K. Since these sensors are currently based on a viscous electrolytic fluid, it is obvious that +/- 0.2° could not be maintained in a high dynamic environment. For this application however it is not really necessary to use a +/-0.2° sensor. Occasional 1 or 2 degree pitch and roll errors would still support useful and cost effective heave compensation. Further field testing is required to see how inexpensive inclinometers perform in different dynamic environments. In any event, inexpensive magnetic fluxgate technology is under development which should provide pitch and roll sensing that is impervious to lateral acceleration. Provided the horizontal components of the antenna's lever arm are kept small, it appears at least feasible to use a low cost pitch and roll sensor to provide sufficiently accurate lever arm corrections.

Data Collection and Test Methodology

Significant instrumental errors were introduced onto the two data sets used in this experiment. Unfortunately, logistical constraints prevented re-observing a "better" data set in time for preparation of this paper. Despite some uncertainties inherent to this test data, the GPS heave estimates derived from it are presented and discussed below. These results provide useful insight into the potential for GPS heave compensation and have helped to identify how to conduct a more conclusive field test in the future. The sub-optimal data sets were actually quite helpful in devising a more robust Quality Control (QC) procedure that will be implemented in the production heave algorithm.

The primary objective of this experiment was to ground truth GPS derived heave estimates to see if they are "sufficiently accurate" for use on production surveys. Raw acoustic depths are generally measured with a resolution of 1 decimetre however, the heave noise in this signal can easily be 10 times that. An optimal level of heave compensation accuracy would therefore be 1 decimetre, however 2 to 3 decimetre heave compensation accuracy would often provide a useful improvement over uncorrected soundings. In fact, the accuracy requirement for heave compensation should be dependent on sea state. For example, in 2 metre swells even heave corrections accurate to +/- 0.5 metre would still significantly improve the quality of the bathymetry. In calmer seas, applying the same +/- 0.5 heave compensation might actually degrade the raw soundings. This sea state dependent accuracy requirement is used in the Quality Control procedure described later in this paper.

When planning the data collection mission for this experiment, it was expedient to make use of a TSS model 335B heave compensator to provide the reference heave values. A TSS 335B had already been purchased by CHS as part of a SIMRAD EM1000 multibeam sounding system installed aboard the *CSS F. G. Creed*. The TSS 335B is based on a relatively inexpensive strap-down triad of accelerometers and angular rate sensors. Recent CHS testing has shown this configuration can produce attitude errors during hard turn manoeuvres [2]. It has since been replaced with a more costly gyro based inertial platform for providing attitude information to the multibeam sounder. At the time of data collection for this experiment, the TSS was however deemed sufficiently accurate to act as a ground truth heave sensor.

The DGPS sensor originally selected for this experiment was the NovAtel 951 narrow correlator C/A code receiver. The reason for preferring the NovAtel is that all its raw pseudorange and phase measurements are spatially qualified with estimates of standard deviation. The NovAtel is the only receiver we are aware of that outputs error estimates for every code and phase observation. A previous CHS experiment documented significant improvements in both positioning performance and position error estimation capability when the NovAtel raw data error estimates were fully exploited [1]. The improved performance resulted from using the NovAtel raw data error estimates to form a dynamic weighting matrix within the position solution, in lieu of the normal practice of using constant a priori weights for each code and carrier measurement.

It was originally planned to use Nortech Survey's HPM PC software to process the L1 only NovAtel data. HPM, and its real-time version called HPC are used by CHS for GPS processing and Quality Control. As explained above, the HPC/HPM software had previously been optimized for use with Novatel raw data however raw data from other receivers can be decoded (Trimble, Ashtech and Magnavox). HPC also provides a helmsman's navigation display for following survey lines and can both log and time stamp input from any digital data sensor. The heave estimation algorithm described here was to be developed and tested using the HPM post mission software prior to a possible port to the HPC real-time software. As it turned out, the algorithm proved to be more efficient as a post-mission application.

The first attempt to collect data took place on board a 10 metre survey launch near Victoria, BC. HPC was used to log and time stamp all data. The TSS heave data was logged at 20 Hz, all NovAtel raw GPS data at 2 Hz and the pitch and roll data from a Trimcube digital inclinometer was logged at 10 Hz. The NovAtel raw data at the reference site on shore was logged at 1 Hz. Unfortunately sea state conditions during the time allotted for the heave experiment were flat calm. In order to simulate heave conditions, it became necessary for the survey launch to perform violent corkscrew manoeuvres in the wake of the Vancouver to Victoria ferry. All experimental data was logged in one afternoon and the borrowed equipment immediately returned to its owners.

The NovAtel GPS data was then processed through both HPM and the experimental heave filter. When the GPS derived heave values were compared to the TSS reference values, there was a strong visual correlation between the two heave wave forms however very significant wandering biases existed between the two. When the TSS heave record was examined by itself, it became apparent that it had been severely degraded by the violent manoeuvres performed during data collection. For minutes on end, the TSS heave values would remain almost completely positive. Obviously real (unbiased) heave values must go both positive and negative as the vessel transits from wave crest to wave trough. It was therefore concluded that the TSS was not outputting usable reference data. It appeared that the violent turn manoeuvres of the survey launch were upsetting the turn rate sensors and thus biasing the heave output. This hypothesis was later confirmed by more experienced users of the TSS. It works well when running reasonably straight survey lines but can degrade significantly during hard turns. The west coast data set therefore had to be discarded and new data observed under more realistic conditions of sea state and vessel turn rate. Unfortunately, no time or vessel resources were available to collect new data in time for preparation of this paper.

Fortunately, the University of New Brunswick volunteered to supply a previously observed data set which appeared more suitable for this experiment. This new data set had been collected on day 149, 1994 on board the *CSS F. G. Creed*. The mission took place in the Bay of Fundy approximately 90 km east of St. John NB. The *CSS F. G. Creed* had been following long straight survey lines so the TSS reference data (logged at 2 Hz.) was almost certainly more accurate than what had been collected on the west coast. The *CSS F. G. Creed* is a SWATH vessel (Small Water-plane Area Twin Hull) riding on submerged floatation pods. The effect of the SWATH hull configuration is to greatly stabilize the sounding platform thus enabling high speed data collection in rough weather. Heave conditions aboard the *CSS F. G. Creed* were therefore only moderate (about +/- 0.5 m.). Another attribute of the *CSS F. G. Creed*'s hull design is that the spectral content of the residual heave is very distinctive with peculiar horizontal acceleration components in rough weather. The heave data from the *CSS F. G. Creed* is therefore not very representative of typical survey vessels.

On board the *CSS F. G. Creed* and also at the reference site at Harbourville, NS., Ashtech Z-XII dual frequency GPS data was logged at 1 Hz. Using the Ashtech Z-XIIs for this experiment had the advantage of providing more processing options than with the single frequency NovAtels. Ashtech's PNAV software could now also be used to compute double difference float solutions. PNAV processed L1/L2 data should provide more accurate positions to the heave estimation algorithm than L1 only data processed using HPM's phase smoothing algorithm. This L1/L2 data set, permitted both GPS processing approaches to be tested in conjunction with the heave filter algorithm.

The Ashtech GPS data set from UNB did however have three disadvantages:

1) The slower (1 Hz) data rate made aliasing of the heave signal more of a problem.
2) Unlike the NovAtel receiver, the Ashtech Z-XII's data output doesn't provide error estimates for the code and carrier phase data. We therefore could not exploit HPM/HPC's ability to dynamically weight each observation in the position solution.
3) During processing it was discovered that the reference station data set was corrupt. Later tests showed that the data corruption had been caused by the laptop computer used to log data at the Harbourville reference site. The serial port on that computer was not fast enough to keep up with the data flow without occasional buffer overflows corrupting the logged Z-XII records. In the data set illustrated below, 84 records were found to be corrupt. While this flaw in the data was not fatal, it complicated interpretation of the results.

No inexpensive digital inclinometer was logged on board the *CSS F. G. Creed* during this mission. The pitch and roll values needed for lever arm corrections to the GPS data therefore had to be taken from the TSS data record. The lever arm configuration on the *CSS F. G. Creed* was very sensitive to any errors in the pitch and roll sensor. Instead of being mounted directly above the sounding transducer, the GPS antenna was mounted 7.7 metres aft and 4.6 metres to port of it. The vertical lever arm component was 16.34 metres. Given this poor lever arm geometry, it was therefore advantageous to use the pitch and roll angles from the TSS heave compensator rather than the less accurate attitude data that would have come from an inexpensive digital inclinometer.

Despite the above shortcomings, the *CSS . G. Creed* data set offered by UNB was gratefully accepted and processed to extract the heave results illustrated below.

Results

The first round of data processing made use of Ashtech's PNAV software to produce a GPS elevation trajectory. The moving weighted mean algorithm was then applied to this trajectory to extract the GPS heave estimates. PNAV made use of the Z-XII's L2 observable in a double difference float solution. PNAV was also used to process the GPS data both as a forward and reverse time series. In addition, PNAV's automatic data filtering option was invoked to help smooth over the corrupt records that had contaminated the reference station's raw data set. This comprehensive PNAV processing insured the cleanest possible elevation file for input to the heave extraction algorithm. After obtaining PNAV results, all data was then reprocessed using Nortech's HPM software. The HPM L1 only, phase smoothed positions were then input to the same heave filter and time series plots of both series of heave results were produced.

Figure 1 depicts 100 seconds of typical heave results. The one caveat here on "typical" is that this 100 epoch data window covers a period during which there were no obvious data dropouts caused by the faulty logging hardware at the GPS reference site. The short time scale of all the Figure 1 graphs is also necessary to permit adequate resolution of the predominant 5 to 10 second wave period that the *CSS F. G. Creed* experienced throughout the mission. Heave amplitudes ranged between 3 and 6 decimetres. In Figure 1a, the aliasing effect caused by the low (1 Hz) GPS sampling rate can be seen in the jerky trace near wave peaks. Clipping of the wave peaks is a problem that only a high sampling rate can address. In previous testing, the HPC real-time software has been used with a NovAtel GPS data stream of 10 Hz. That rate of sampling and logging should provide adequate anti-aliasing for a production system.

Figure 1a shows the TSS heave as well as the GPS heave derived from both the PNAV positions and the HPM positions. It is difficult to see all three traces on the graph because the PNAV and HPM results are almost coincident. The TSS heave results are more easily distinguished as a separate trace but are still tightly correlated with the two sets of GPS derived heave. There does not appear to be any correlation between the wave amplitude and the discrepancy between the TSS and GPS derived heave. This would indicate that the same level of heave errors present in this sample of 0.5 metre waves would also be present in heavier swells. That hypothesis cannot however be tested until more data sets are collected in a variety of sea state conditions.

Figures 1b and 1c show a clearer picture of the difference between TSS and GPS heave results. Figure 1b shows the difference between the TSS and the PNAV derived heave

FIGURE 1: 100 SECONDS OF HEAVE RESULTS

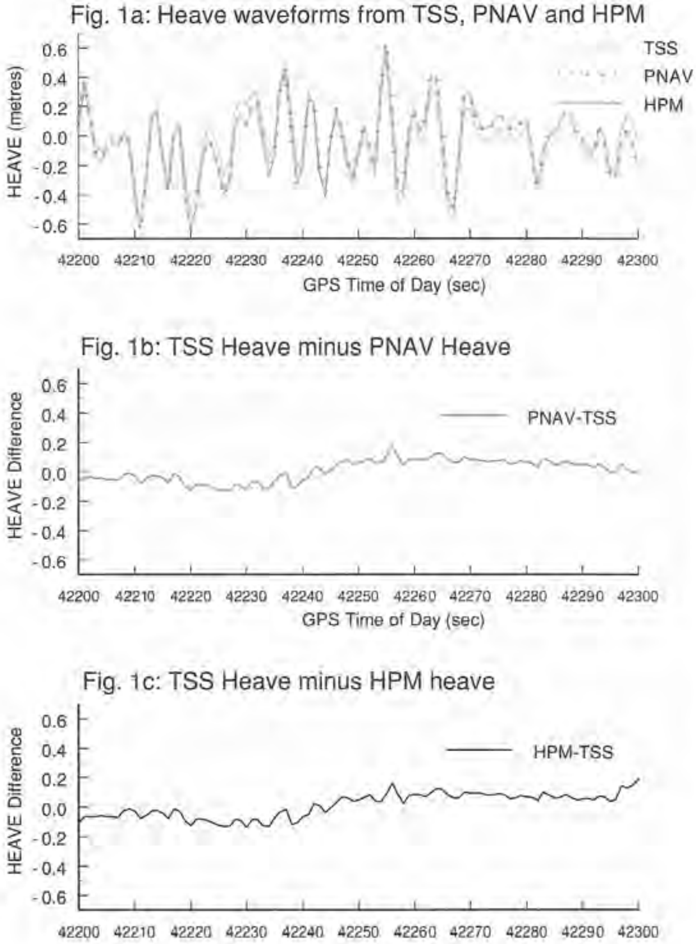

Fig. 1a: Heave waveforms from TSS, PNAV and HPM

Fig. 1b: TSS Heave minus PNAV Heave

Fig. 1c: TSS Heave minus HPM heave

records and Figure 1c shows the shows the difference between the TSS and the HPM derived heave records. The two error signals are almost identical except for the rise of almost 2 decimetres in the HPM heave error during the last 5 seconds of the data set. This rise in heave error is due to an impending bad reference site record that was later logged at 42340. Its inclusion in the moving data window is starting to degrade the weighted mean reference elevation used to difference those heave values. The 6 worst data logging errors in the reference site GPS data set produced long term biasing affects on the moving weighted mean reference elevations. Those problems will be discussed with reference to Figure 2. In Figures 1b and 1c (except for the last 5 seconds of 1c) both the PNAV and HPM derived heave records are almost identical. Both are within about 1 decimetre of the TSS ground truth heave record. There is a high frequency (single epoch) noise level of about 5 cm superimposed on a longer term drift that goes from -1 dm to +1 dm during the 100 second sample.

To provide an illustration of the GPS heave performance over a longer period, Figure 2 illustrates over 20 minutes of results (1400 epochs). Figure 2a shows only the TSS reference values. At this time scale the heave wave form overplots itself and thus provides a noisy looking record of maximum wave heights for the 20 minute period. Figures 2b and 2c show heave discrepancy with respect to the TSS for both the PNAV and HPM position record. In Figure 2b, the heave derived from the PNAV processed L1/L2 data maintains a 1 to 2 decimetre agreement with the TSS heave. In Figure 2b, if we consider the TSS heave values to be error free then the mean error of the GPS derived heave is -0.01 metres and the standard deviation is 0.08 metres.

In contrast to the 100 second sample shown in Figure 1, the long term heave results from PNAV processed positions appear very significantly better than those derived from the HPM positions. In Figure 2c the trace of the HPM derived heave accuracy makes 6 sudden jumps to unusable levels of 1 metre or greater. When the GPS data record was examined, it became apparent that all of these jumps correspond exactly to the epochs when severe logging errors occurred at the GPS reference site. On 4 of these 6 occasions the number of SV's logged from the Z-XII receiver dropped instantly from 7 to 3. On the other 2 occasions the logged record showed zero satellites tracked for 3 or more consecutive epochs. The PNAV, forward/reverse processing combined with its data spike detection filter, removed the effect of the 6 corrupt reference site records.

FIGURE 2: 1400 SECONDS OF HEAVE RESULTS

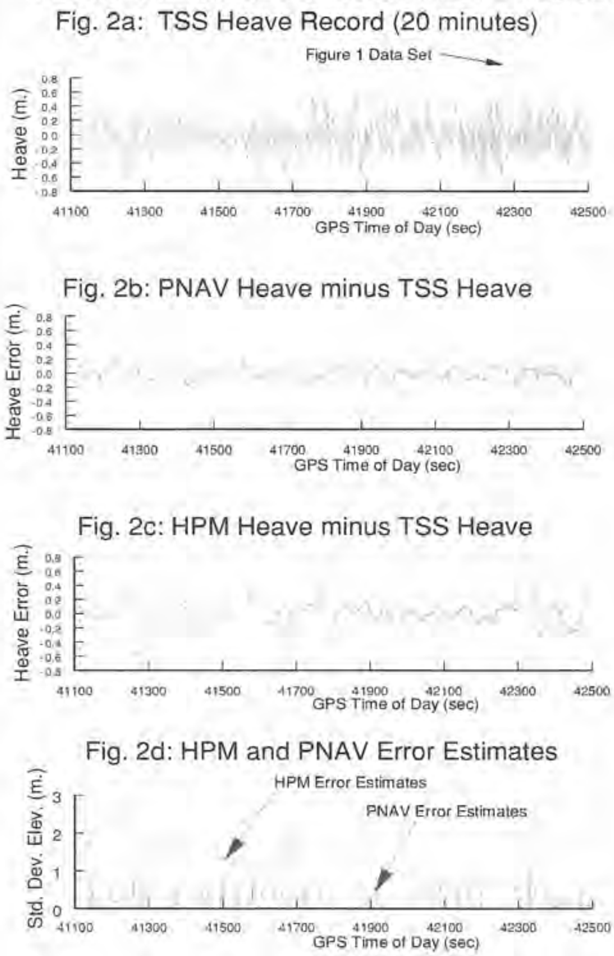

Fig. 2a: TSS Heave Record (20 minutes)

Fig. 2b: PNAV Heave minus TSS Heave

Fig. 2c: HPM Heave minus TSS Heave

Fig. 2d: HPM and PNAV Error Estimates

The 6 severest data dropouts in the reference site's logged data file were responsible for the much poorer long term HPM results. Due to the faulty serial port on the logger, the reference site data was very "dirty". There were 84 logging errors where either no data or only partial data records were written. Seventy eight of these errors were minor dropouts that were successfully bridged over by both PNAV and HPM. However there were 6 severe dropouts containing only partial records which caused some or all of HPM's phase smoothing filters to be reset (i.e. the algorithm decided the satellite was truly lost and would not try to interpolate through the outage).

After losing a satellite, an HPM phase smoother is reset to full weight on the noisy pseudorange observations. Phase tracking then regains influence in the solution as a $^1/_N$ function, where N is the number of epochs. It therefore takes a while for the phase smoothed solution to re-build a high weight on phase observations. During this interim following a satellite reset, the noisy positions will degrade both the single epochs and the weighted mean reference elevations used to compute heave. Once the phase smoothing has converged back to a high weight on phase, the HPM heave results become identical to the PNAV processed data (as illustrated in figure 2 between 41850 and 42300). Clearly HPM would have benefited from the 6 worst records being smoothed out of the corrupt data set in the same manner as the PNAV (forward/reverse) processing.

Figure 2d's upper trace shows a plot of HPM's estimated standard deviation for the elevation trajectory. It illustrates that the 6 bad GPS elevations which caused the degraded heave performance were quite well predicted by the statistics. The two spikes that go off scale were series of "zero SV's tracked" records for which the GPS positions were not differentially corrected at all. For those two periods of single point elevations, the estimated standard deviations went off-scale to 55 metres and 40 metres respectively. The other 4 records that caused less catastrophic SV smoother resets contained corrections for only part of the constellation. In those cases HPM, applied partial differential corrections and left the other SVs uncorrected (a non-RTCM approach based on the logic that partial correction is better than no correction at all). The default HPC/HPC DGPS rule follows the standard "all or nothing" RTCM guideline.

From a Quality Control perspective, Figure 2d would be useful for identifying and flagging the 6 sudden gross errors. HPM's trace of estimated standard deviation is not however as realistic as it could be. Truly non-biased statistics would almost certainly have predicted generally lower error estimates. Recent experience with NovAtel receivers indicates that considerable improvements can be gained through "tuning" the weighting matrix to fit the characteristics of the receiver [1]. Prior to this experiment, HPM had not been used with the new Ashtech Z-XII receivers. Its weighting scheme was therefore based on a default a priori weighting model conceived for a "generic receiver" assumed to possess noisier technology than the Z-XII. The position standard deviations therefore tend to be quite strongly biased towards large error estimates. The lower trace on Figure 2d shows the error estimates made by Ashtech's PNAV software. These are generally more realistic (smaller) error estimates based on a more realistic a priori model of the receiver's real noise characteristics. The many small spikes in the PNAV error estimates correspond to the 84 minor dropouts in the corrupted reference site data.

When analyzing the original data set collected on the west coast, it was evident that the TSS "reference" heave estimates were not necessarily always error free. Since the *CSS F. G. Creed* data had been observed along a fairly straight survey line, the TSS reference heave values appeared to be free of any gross artifacts that can be produced by violent turn manoeuvres. However, this TSS reference data still warrants a close look to determine if it is providing the sub-decimetre accuracy required to ground truth this experiment.

What is remarkable about Figures 2b and 2c is the 60 second ripple pattern which dominates the error signal. This regular one cycle per minute artifact has a 1 to 2 decimetre amplitude and has no apparent correlation to the dominant 5 to 10 second wave periods. What could be causing this error signal? It might conceivably result from a GPS related phenomenon such as multipath. Since the GPS positions were mainly derived from GPS phase observations (which are highly immune to multipath effects), this is not very likely. The often identical heave results obtained from the PNAV and HPM positions also suggests that GPS is not responsible for the 60 second ripple effect. Another possible explanation might be a bug in the implementation of the test algorithm such as a sign inversion in a lever arm component. Again, this does not appear likely since such a bug would also produce artifacts at the predominant wave period of 5-10 seconds. The most plausible explanation for the observed beat frequency between the TSS and GPS heave signals appears to be that there was some inadequacy in the high pass filtering assumptions used to extract the heave motion from the two sensors. Either the GPS position sensor or the TSS acceleration sensor could be subject to this problem.

Both the TSS firmware and the GPS heave algorithm being tested require a user defined time constant for the high pass filter's bandwidth. Wave periods longer than the chosen bandwidth cannot be sensed. The low end frequency cutoff is required not only to block out the tidal signal but also any other biasing influence such as changes to the draft or trim of the vessel. To produce both figures 1 and 2 the GPS heave algorithm used a 100 second moving time window for computing the weighted mean reference elevations. During the CSS *F. G. Creed* data collection, the TSS real-time firmware had been initialized with a relatively short 16 second filter constant. It is obvious that its much longer high-pass filter time constant should enable the GPS heave filtering to detect much longer period waves (if any were present in the vessels real motion).

In Figure 1a we see that the predominant wave period is between 5 and 10 seconds. The question is; were longer period wave phenomenon also affecting the vessel? The *CSS F. G. Creed*'s twin submerged hull configuration might conceivably generate harmonics of the predominant 5 to 10 second waves. The test site in the Bay of Fundy is also subject to very large tides and the test data was collected during quite rough weather. In following seas, any vessel under way has a tendency to surf up and down the waves at a lower frequency than the waves themselves. It is therefore possible that the 60 second ripple artifact apparent in Figure 2 might actually be a real 1 to 2 decimetre heave phenomenon that had been blocked by the TSS's 16 second high pass filter but detected by the 100 second filtering done on the GPS elevations.

If this hypothesis is true, then the real GPS derived heave errors would be significantly more accurate than the +/- 1-2 decimetres observed in Figure 1 and 2. In Figure 1 we see that the high frequency (1 to 5 second) noise level of the discrepancy signal is generally less than 5 cm. This higher level of heave sensing accuracy is consistent with the performance repeatedly demonstrated in GPS experiments based on semi-kinematic DGPS [3]. Unfortunately the *CSS F. G. Creed* data set does not permit us to test this tempting hypothesis. The TSS filtering was done in real-time so its accelerometer data could not be post-processed using a longer filtering parameter than the chosen 16 second real-time value. When planning data collection for a future, more conclusive experiment, this problem will be addressed.

Quality Control of GPS Derived Heave

The heave filtering algorithm described above is being added to the HPC/HPM software suite used by CHS. The heave algorithm will be incorporated into the HPOST utility used to format an output file containing the depth measurements logged by HPC. Each depth record in this file has its position interpolated from the neighbouring GPS position epochs in the asynchronous logged data stream. The time stamp accuracy of all logged records in the file (depth, position, pitch and roll) is continually calibrated by HPC using the 1 pps time sync pulse from the GPS receiver. The HPOST output file therefore provides an appropriate environment for computing heave corrections and applying them to the logged soundings. A statistical QC algorithm is required to insure that the heave is only applied if it will improve the accuracy of the soundings and that all the final soundings are tagged with realistic error estimates. The QC approach being implemented is as follows:

QC Step 1- Estimate heave corrections as per equation 1. Then estimate the error of each heave correction based on the expected error for the weighted mean reference surface (from equation 4) together with the expected error of the single epoch used to difference the heave value (HPC's estimated standard deviation logged in real-time).

Both the computed heave and its estimated standard deviation are thus computed for each GPS epoch, interpolated for the epoch of each logged depth measurement and then written into the HPOST file. When and if a sounding is corrected for heave (QC step 3 below) the reduced sounding will take on the uncertainty of its heave correction. That uncertainty will also include an estimate of error due to uncertainty in the lever arm correction (lever arm offsets and an estimate of pitch and roll measurement accuracy will be required in the HPOST file's header). Other positioning and acoustic factors affecting a depth's accuracy will not be analyzed by this utility.

A user defined tolerance on the single epoch standard deviation will also reject "bad" elevations. This will cure the poor results derived from this data set due to the logging errors at the reference site.

QC Step 2- As the moving data window computes the "calm water" reference elevations, it will also compute and buffer an "average maximum wave height" within the span of each window. This value to be used for decision making in step 3 below.

QC Step 3- The QC algorithm will then decide whether or not to apply each computed heave correction to its corresponding raw sounding. The decision will be based on the average maximum wave heights observed around the time of the sounding. If the expected error of the heave correction exceeds a user defined proportion of the average maximum wave height, then the sounding will not be corrected (the logic here is that the water is too calm to apply the too uncertain heave "correction"). The uncorrected depth together with its estimated error (the average maximum wave height) is then written to the HPOST file as a separate entry and also flagged as being uncorrected.

If on the other hand the expected error of the heave correction does not exceed the user defined proportion of the average maximum wave height then the sounding will be corrected for heave (the logic being that the uncertainty of the heave correction is low enough to still provide a net gain over not correcting heave at all). The heave compensated depth together with its estimated error (computed in step 1) is then written to the HPOST file as a separate entry and flagged as being corrected.

The statistical details of this general QC algorithm will be worked out during implementation and testing. This HPOST heave utility should be ready for deployment on CHS production surveys during 1995.

Conclusions

This experiment has demonstrated that high pass filtering of GPS elevations can be used to estimate highly cost effective heave corrections for acoustic depth soundings. Preliminary ground truth testing indicates that these heave corrections are accurate to +/- 1 decimetre. Using L1 only phase smoothed GPS positions to compute the heave corrections can produce virtually the same results as to those computed from dual frequency GPS data and processing. Provided that the GPS antenna is situated directly above the sounding transducer, lever arm corrections for the GPS positions can be made using an inexpensive digital inclinometer. Error estimates for the GPS elevations used in the heave computation permit a robust quality control of the final corrected depth soundings. Further field testing is required to provide a more definitive assessment of the accuracy and robustness of this technique.

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John Hagglund *holds a B.Sc. in Survey Engineering from the University of New Brunswick and a Masters Degree in Survey Engineering from the University of Calgary. He has worked on software development projects at Nortech Surveys (Canada) Ltd. since 1974. His development experience includes: a NNSS Transit system, a Ferranti Inertial Land Surveying system (FILS), numerous GPS projects and most recently, a Digital Video Geographic system (DVG).*

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Twenty-five Years of Co-operation

L. M. Reading

The Canadian Hydrographic Service (CHS) deals with many organizations on a daily basis in order to provide mariners in Canadian waters the most accurate and up to date information possible via CHS Charts, Sailing Directions, Small Craft Guides and the Tide and Current Tables.

One organization with which the CHS has had a long standing association is the Canadian Power and Sail Squadrons (CPS), formerly known as Canadian Power Squadrons.

Canadian Power and Sail Squadrons is a nationwide, non-profit organization of approximately 25,000 members who have taken and successfully completed at least one course on safe vessel operations, known as the Boating Course. Advanced and Elective Courses are also available to members dealing with subjects involving tides, currents, weather, seamanship, electronics, celestial navigation, etc. Units of Canadian Power and Sail Squadrons are located in every Canadian province as well as in the Yukon Territory.

The CHS and CPS association dates back to 1970 when, with the boom in small craft operations, the need for accurate, up-to-date small craft charts became urgent. As a result CPS was approached by the CHS to undertake a formalized program in which information pertinent to CHS charts and publications would be reported in a uniform manner by CPS members through a program to be known as MAREP or MARine REPorting.

As a result the MAREP Program, now known as the MAREP Hydrographic Program, was initiated in 1971. B.G. Gray, a former Dominion Hydrographer of the CHS and member of CPS was the chairman of the program for CPS at that time.

As the CPS MAREP Hydrographic Program celebrates its 25th Anniversary it is important to realize the co-operation that has existed between the CHS and CPS over this time period. Throughout the years CPS members have reported on changes to navigational channels, marine facilities including marinas, new landmarks such as stacks and radio towers, destruction of landmarks, launch ramp locations, bridge construction and clearances and cable locations both submerged and overhead. The list of reportable items goes on and on; in short, if an item can be charted or described in a CHS publication it can, and likely has, been reported to the CHS via the MAREP Hydrographic Program.

Unfortunately the total number of reports filed by CPS members since the inception of the program in 1971 is not available. However, it is known that over 13,000 pieces of information have been received by the CHS from CPS members since 1977.

While CPS members do not produce large scale hydrographic surveys their assistance by providing the CHS with information concerning known changes allows the CHS to better provide accurate navigational aids including Charts, Sailing Directions, Small Craft Guides and Tide and Current Tables while at the same time CPS members benefit from having a practical reason to use the skills they have learned in their CPS courses pertaining to navigation and plotting positions including chart-work.

Each year the CHS provides a number of awards at the CPS National Conference. These awards recognize individuals, Squadrons and Districts of CPS for the effort which they have put into the MAREP Hydrographic Program over the course of the prior year.

The CHS and CPS also produce a manual to be used by those participating in the program. This manual details what to report, how to report, how to achieve required accuracy as well as equipment that may be used and which is found on the vessels of individual CPS members, such as depth sounders, radar, GPS, DGPS, sextants, compasses, rangefinders and even leadlines.

What are the benefits to each organization from the MAREP Hydrographic Program?

The CHS receives reports from knowledgable CPS members concerning recommended changes to CHS publications in order to maintain the accuracy of their publications. These reports are actioned either by Notices to Mariners for items of significant importance, forwarded to revisory surveys for verification and positioning data, promulgated as amendments to Sailing Directions and related publications, or placed in chart files for future action concerning new editions.

CPS receives a great deal of support from the CHS. The CHS provides reporting forms for the use of CPS members. The CHS produces a MAREP Hydrographic Manual in co-operation with the national MAREP Hydrographic Committee of CPS. Representatives of the CHS attend MAREP Hydrographic information sessions at all levels of CPS, as well as attending the CPS National Conference where an awards presentation is made as part of the CPS Annual General Meeting. CHS representatives also have the opportunity to have a dialogue with an important client group for the CHS, the recreational boat operator.

There can be no doubt that as the CHS and CPS move into the next quarter century there will be many dramatic changes in the methods used to gather data for the CHS publications as well as in the methods used to publish this information. Who would have believed just a decade ago that GPS and DGPS would be available to the recreational vessel operator; or that ENCs and ECDIS systems would play such a paramount role in vessel operations. Whatever may take place we can only guess. However, it is my belief that the CHS and CPS will continue to be partners, hand in hand, providing accurate data for mariners throughout Canada to ensure safe navigation.

About the Author / À propos de l'auteur

***Leslie Reading** is currently the national chairman of the CPS MAREP Hydrographic Program. He has been active in submitting MAREP Hydrographic reports since 1978; and has twice won the CHS Individual Award for efficiency in the MAREP Hydrographic Program. He received an Honourable Mention for participation in the MAREP Hydrographic Program for the 1995 reporting year. His vessel,* Coast Navigator, *is moored on Lake St. Clair.*

About Canadian Power and Sail Squadrons

The Canadian Power Squadrons began in Windsor, Ontario in 1938.

CPS is :

- A national organization extending from coast to coast;
- An organization of 28,000 boating enthusiasts;
- A charitable organization;
- A recreational boating organization, where the administrative work and teaching are done by its members without remuneration.
- Interested in teaching many phases of seamanship, boat handling and navigation.

More than 500,000 concerned boaters - men, women and juniors - have successfully completed the CPS Boating Course.

Source: CPS Operations Manual

Upgrading of Arctic Charts and Conversion to NAD83: Final Report

W. Mazoka and R. Bennetto

Background

A number of the nautical charts located in Canada's northern most regions were originally mapped from a variety of poorly controlled sources such as existing topographic maps created from 1950's vintage photogrammetric methods or datum surveys based on astronomical observations. This has resulted in nautical charts with positional errors ranging from a couple hundred metres to several kilometres in magnitude.

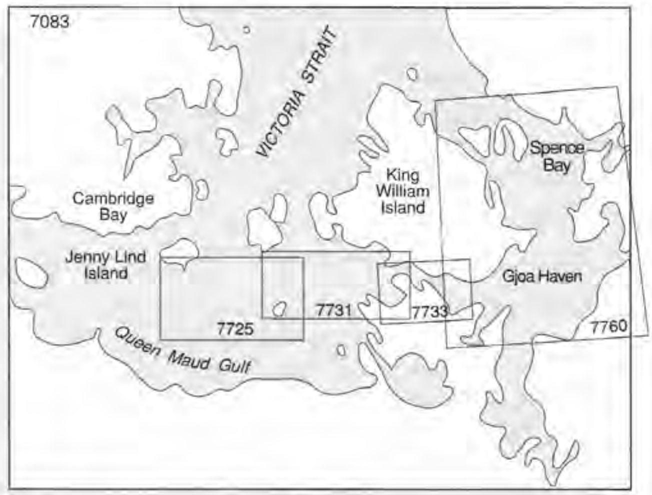
With errors of these magnitudes, it is apparent that navigators utilizing these maps to safely chart the course of their ships through these waters are faced with a great degree of uncertainty as to the location of their ship with respect to the coastline of land masses, shoreline of islands, and most importantly, the rocks, reefs, and other perils which represent a danger to the crews as well as the cargo on these ships. When mariners are also faced with poor weather conditions, such as snow or fog which can greatly reduce visibility, it is apparent how crucial it is to have nautical charts which can be confidently relied upon in potentially dangerous waters. These nautical charts must not only be positionally accurate with respect to a particular coordinate system and datum, but also must be accurately defined in terms of the shape of both coastlines and island shorelines.

Potential solutions to the problems with the existing nautical charts include the use of conventional photogrammetric methods using recently flown aerial photos to update the nautical charts, or the use of satellite imagery with some recent photogrammetric mapping and conventional survey data.

The former approach would be very expensive, while the latter could be a much more attractive approach to update the charts, in terms of cost with relatively accurate results. The Canadian Hydrographic Service (CHS) undertook a research project in 1994 to evaluate the use of satellite imagery for chart updating purposes. Phase one, completed by LGL Limited of Sidney B.C., involved the generation of new coastline features for Chart 7083, using Landsat ™ imagery which was registered to the UTM projection using the NAD83 datum. Phase two of the project is the basis for this report and involves the integration of modern survey data and bathymetric data from the existing nautical charts, with the redrawn coast line.

Objective

The objective of this project was to upgrade existing nautical charts 7725, 7731, 7733 and 7760 (Figure 1). These charts would be upgraded utilizing various sources of information in order to improve the positional and representational accuracy of coastline features and to integrate additional chart features, obtained from recent surveys, with existing chart features.



The updated coastline features for the new charts were primarily generated from LandSat ™ imagery, although some modern survey data (LIDAR) was also utilized for this purpose. Other chart features, such as low water lines and soundings, were captured from the existing charts and positionally adjusted to the new coastline.

Input Materials

As previously noted, the updating procedure relied on a variety of sources of information. The following materials provided by CHS, were utilized for the project.

(1) Chart 7083 LandSat™ image mosaic (bands 1,2,4 and 7) geo-coded to UTM Zone 14 on the NAD83 datum. The imagery had a resolution of 50m by 50m and was provided in "ERDAS.LAN" format on CD-ROM.

(2) CARIS "NTX" format vector files containing LandSat™ imagery derived coastline, portions of LIDAR survey derived coastlines and control points.

(3) Existing nautical charts in both paper and mylar format.

Methodology

The updating procedure followed for this project involved a number of distinct tasks as summarized below. Detailed descriptions of this work are provided later under the heading Discussion.

Task 1:
Digital conversion of existing charts and datum conversion.

Existing nautical charts were converted from hardcopy to digital format using optical scanning and raster to vector conversion techniques (both batch and interactive processing). Attribute and symbology information were then added to the digital data. The final step of this task was to transform the geographic reference of the data from the NAD27 datum to the NAD83 datum.

Task 2:
Validate and edit new coastline data.

This task involved super-imposing vector representations of the coastline onto the satellite imagery for updating and validation. The vector data included a coastline which was derived from the Landsat ™ imagery using image classification techniques, as well as portions of coastline obtained from recent LIDAR field surveys.

The vector data was superimposed upon the Landsat ™ imagery using image analysis software.

The vector data was visually inspected and edited to correct any errors resulting from the automated derivation of the coastline and to capture any additional shoreline features including inland lakes and rivers. Where coastline was also available from field survey data this was integrated with the image derived coastline since it provided more detail. Finally the data was exported from the image analysis system for incorporation with the digitized nautical charts.

Task 3:
Rubber-sheet nautical chart data to updated coastline and shoreline features.

The bathymetric and low water features to be maintained from the original charts, needed to be re-positioned relative to the new coastline. This was accomplished by capturing control points between common features along both the image derived coastline and the original coastline generated from the nautical charts. These control points were then utilized to "rubber-sheet" (geometrically reposition) the chart data to better coincide with the updated coastline.

Task 4:
Integrate and structure digital data.

The final task was to integrate the bathymetric and low water features, to be maintained from the original chart, with the updated coastline. This involves the resolution of any representational or positional conflicts and the full structuring of the digital data to create a topologically sound data set.

Equipment

The following hardware and software were utilized for this project. Specific applications are detailed under the heading Discussion.

Scanning and automated raster to vector conversion were performed on a 66 MHz COMPAQ personal computer (DOS) with 16 MB RAM and 527 MB disk storage. The documents were scanned using an IDEAL/CONTEX 600 dots-per-inch full scale scanner. The scanning and automated raster to vector processing were accomplished with the CADImage and Draftsman softwares, respectively.

All other processing was performed on a SUN SPARCstation 10, UNIX workstation (40MHz), configured with 160 MB RAM, 535 MB internal and 2.1 GB external data storage, CD ROM optical drive, 8mm Exabyte tape drive and an HP pen plotter.

The EASI/PACE image analysis software from PCI Inc. was used for image display and analysis and for vector editing of the image derived coastline. The Semi-Automated Mapping Input (SAMI) software from Universal Systems Ltd. was utilized for interactive vectorizing of scanned chart data (including soundings). All other processing of the vector data was accomplished with the CARIS GIS system from Universal Systems Ltd. This included rubber sheeting, attribution and topological structuring.

Discussion

Digital Conversion of Existing Charts:

As noted earlier, the objective was to integrate satellite derived coastline data with existing bathymetric data available from the paper charts. One of the first tasks was to convert the existing nautical charts from paper to digital format.

In the final updated digital charts, only a subset of the existing chart features would be maintained. Specifically, this included bathymetric data such as the soundings and low water features. Bathymetric contours were not to be captured as they would be replaced by a new metric version under a separate undertaking. Although in the end only a subset would be maintained, it was necessary to capture most other chart features including coastlines, shorelines and watercourses. These features were necessary for the collection of control points between the existing chart features and the satellite image derived features. From these control points, the existing chart data could be re-positioned relative to the more accurate satellite image mosaic.

Mylar plots of the existing charts were provided by CHS. The mylars were scanned using an Ideal/Contex optical scanner at a resolution of 600 dots per inch. Diagnostic scans were performed on selected windows from the source material in order to establish appropriate scanning thresholds. This is necessary to ensure that all features of varying line weight and size are captured with sufficient detail and clarity. If the threshold is too high, then features with a light line weight may not be processed to the output file. While if the threshold is too low then the definition of features becomes blurred. The output of the scanning process is a raster format file.

To efficiently capture the variety of features represented on a nautical chart it is typically most effective to use a combination of batch and interactive raster to vector conversion methods.

Linear features without symbolization; such as coastlines, shorelines and watercourses, can be effectively digitized using batch vectorizing. The software automatically creates a vector line from the raster image representation of the feature. This procedure involved scanning the source mylar to generate an RLC raster format file, which was further processed with the Draftsman DM version 7.2 software to create a DXF format vector file, which could be imported into the CARIS GIS software for registration and further processing. Cartographically symbolized features such as low water lines, point symbols and soundings must be interactively captured. The procedure to capture these features involved scanning the mylars to generate a TIFF format raster file. The TIFF file was then imported into the SAMI software system as a "raster object". Within SAMI the operator can perform heads-up digitizing (over the image backdrop) of point features and soundings, and can selectively vectorize symbolized linear entities such as dashed linework. Once captured the data could be registered and integrated with the batch vectorized features, using the CARIS GIS.

The registration of the scanned chart data was complicated by the fact that the charts were constructed on an unknown datum. Therefore some assumptions were necessary. However, since this data would be re-positioned relative to the NAD83 coastline and it was known that significant discrepancies exist in the position of these features, it was concluded that the selection of a preliminary datum would not be critical to the final output and would only be necessary to allow the interactive capture of coincident control points between this data and the satellite derived coastline referenced to the NAD83 datum. For these purposes the existing chart data was initially registered to a CHMR (chart based) coordinate system using the NAD27 datum. It was then converted to the NEMR (Northings and Eastings) coordinate system with the UTM projection and the NAD83 datum.

Once registered, some preliminary topological structuring was performed on the data to correct for a number of errors resulting from the data capture procedures. A comprehensive structuring was not performed until all of the final chart data was compiled from the various sources.

Validation and editing of satellite derived coastline:
The CHS let a contract out to LGL Limited of Sidney, British Columbia to utilize satellite imagery to redraw the coastlines and island shorelines for Chart 7083 which is at a scale of 1:50 000 LGL Limited selected Landsat ™ imagery with its pixel resolution of 50m by 50m for this purpose. Through the assistance of Pacific Geomatics Limited of White Rock, British Columbia, LGL created a mosaic of six Landsat ™ images which provided coverage for the entire chart. Using existing ground control point descriptions, topographic maps and recent aerial photos, they geocoded this Landsat ™ image mosaic to the NAD83 datum and the Universal Transverse Mercator projection in Zone 14. This geocoded image mosaic was then utilized in the PCI ImageWorks software to create "training sites" for land and water features, which were subsequently used in the PCI EASI/PACE image analysis software, to create spectral signatures of these "training sites". These spectral signatures were employed in a supervised classification and thresholding process to arrive at a bitmap which could then be processed with a raster-to-vector conversion algorithm to create the coastlines and island shorelines features. This vector data then underwent line editing to remove gross errors associated with the auto-generation of these features.

Both the LandSat™ image mosaic and the derived coastline file were provided by CHS as input to the current project, along with some additional data. CHS provided ASCII files for each of the nautical charts in question as well as two files containing the LandSat ™ image mosaic derived coastline for Chart 7083. The ASCII files for each of the nautical charts consisted of various features from a number of sources. The coastlines and shoreline features included the satellite image derived data as well as varying amounts of coastline obtained from Terra Survey's aerial photogrammetric project for CHS, collected as base plots for Lidar surveys.

The remaining features in the ASCII files included horizontal control stations, triangulation stations, radar reflectors, and spot elevations. These were obtained from descriptions of survey monuments, navigation aids and air photo control points courtesy of the Geodetic Survey of Canada and the CHS.

Before proceeding to integrate the image derived coastline with the digitized chart data it was necessary to validate the satellite image derived coastline and to integrate the field sheet features. Due to the nature of the two sources of coastline data, the survey data was used whenever available because it is more accurate and contains more detail and definition than the image derived features. Where coastline features were represented in both sources of data (survey and imagery derived) the portion was deleted from the image derived vector file and the survey features were integrated with the remaining image derived coastline.

Due to the process in which the LandSat™ derived coastline features were originally generated, it was necessary to validate this data. The validating of the coastline and island shoreline features was performed by importing both the LandSat image mosaic and the corresponding vector data, into the PCI image analysis software. Using the PCI ImageWorks software (Vector Editing utilities), the vector data could be superimposed over the image data. It could then be visually inspected and edited as necessary to resolve any problems where the auto-generation method used to create the vector data was not able to adequately interpret the coastline.

Additional features such as watercourses and inland water bodies were also added when not previously shown on the charts or when the chart representation did not accurately represent the feature.

Rubber-sheeting of nautical chart data to updated coastline:
Having validated the new coastline features, the next step was to integrate the bathymetric information digitized from the existing charts. Based upon the information available to the CHS regarding the creation of these original nautical charts "it is assumed that all of the bathymetry was positioned relative to the old coastline and has to be put on the NAD83 coastline with the same relationship".

The image derived (NAD83) coastline data was combined with the digitized nautical chart data which included the original coastline features. Having superimposed the two data sets, an initial assessment was made of discrepancies between the image derived and chart derived coastline features. It was found that both the direction and the magnitude of these discrepancies was inconsistent, both within and between the nautical charts. In some data sets the average difference between the location of corresponding points along the two sources of coastline was in the range of several hundred meters, while on other charts this difference could be as large as 1600 metres.

The direction of the discrepancy also varied within the chart. However, the discrepancies were generally consistent around the various land masses. Accordingly the re-positioning of the bathymetric data would require more than a simple shifting of the data. A rubber sheeting technique would accommodate the inconsistencies. It was determined that a triangulation algorithm would provide the most suitable approach to adjusting the bathymetry relative to the adjacent land masses which would themselves be undergoing differential shifting. The triangulation algorithm essentially breaks the entire data set into a series of triangular facets, each of which is defined by three control points. The data within any given triangular facet shifts relative to the three control points but the shifting is weighted based upon the proximity to the control points. For example, with three control points representing various land masses, then the shifting of the bathymetric data nearest a given land mass would be more heavily weighted by the shifting of the control point representing the corresponding land mass. All rubber-sheeting for this project was performed with the CARIS GIS system.

The fitting of the bathymetric data to the new coastline was further complicated by the fact that the original charts were not only positionally but representationally inaccurate. The graphical representation of the coastline did not always accurately reflect the shape or definition of the image derived coastline. The implication was that significant localized "warping" of some low water features was necessary to ensure that they remain consistent with the corresponding coastline. The soundings however should maintain a more generalized relationship to the land mass. It was therefore determined that these two groups of features should be rubber-sheeted separately.

A considerable number of control points were collected along each individual land mass (typically several hundred per data set). This full set of control points were then utilized to rubber sheet the low water features. This set of control points was then broken down into sectors, where each sector represented either a specific region of a significant land mass or a cluster of islands. The control points within each sector were then averaged to derive a more general set of rubber sheeting control points, which were used to adjust the soundings to the new coastline.

After the rubber sheeting was performed on both the low water features and the soundings, they were both combined back together and incorporated with the updated coastline features (and miscellaneous point data). During the steps in the creation of these updated nautical charts, all source identifications and user/theme numbers were maintained.

Integration and structuring of updated nautical charts:
Because the data for these upgraded charts came from several sources, a significant amount of editing was required in order to integrate all of it. In this process, some of the existing nautical chart features, other than the coastline, were replaced or updated. For example, some features found on the original charts; such as triangulation stations, radar reflectors and spot elevations were replaced with features from more recent surveys. In the case of rock features, represented as point entities, it was found that the locations of rocks on the original chart were different than the ones from recent surveys, and so both the original and new data for these features were maintained in the updated nautical chart since they could not be confirmed with the satellite imagery which had a resolution of 50m.

Generally, the low water lines captured from the existing charts could be integrated with the updated coastline.

However, the definition of the coastline for some land masses has changed so drastically that the low water lines were extremely difficult to integrate. In a few instances entire portions of low water lines were now positioned on a land feature. In these cases, the low water line was deleted from the data set.

Having integrated all of the data into the new nautical chart, the final step was to perform a comprehensive topological structuring to ensure a clean data model, free of undershoots, overshoots, pseudo nodes and polygon misclosures. The final nautical charts were reformatted to a CARIS ASCII format for submission to CHS.

Conclusion

Due to the known discrepancies with the original nautical charts, there is no doubt that the upgraded nautical charts resulting from this project represent a significant improvement in terms of both the positional and representational accuracy. This is particularly true of the coastline and shoreline features which were derived from the satellite imagery. The repositioning of the bathymetric data from the original charts also represents a significant improvement. However, with limited knowledge as to the accuracy with which these elements were originally referenced relative to the landmasses, the absolute accuracy with which they are now positioned and represented is still unknown.

Although this approach may not represent a permanent solution to the accuracy of these type of charts, it does represent a relatively cost effective means of making substantial improvements in these products within a relatively short time line.

About the Authors / À propos des auteurs

Mr. Bennetto *is a Civil Engineer with experience in survey engineering and computer science. He has worked extensively in the GIS field since 1987 and is completely familiar with CHS's standards for production of digital chart files. He is also experienced in the field of remote sensing and image analysis. He has an in-depth working knowledge of the CARIS GIS software and the EASI/PACE image analysis system. He has been the project leader for a number of related projects conducted for the CHS, including the digital conversion of Nautical Charts and Field Sheets. He has led Devel-Techs's remote sensing division which has successfully qualified for all phases of the Canada Centre for Geomatics (CCG) program for map updating utilizing satellite imagery.*

Mr. Mazoka *is a graduate of the University of Saskatchewan with a Bachelor of Science degree. He is also a graduate of the two year CAD/CAM Engineering Technology program. Wayne worked with Devel-Tech as a GIS technician. His experience included digital mapping of topographic maps and nautical charts utilizing the CARIS GIS system, as well as image analysis of optical and radar satellite imagery utilizing the EASI/PACE Image Analysis system from PCI.*

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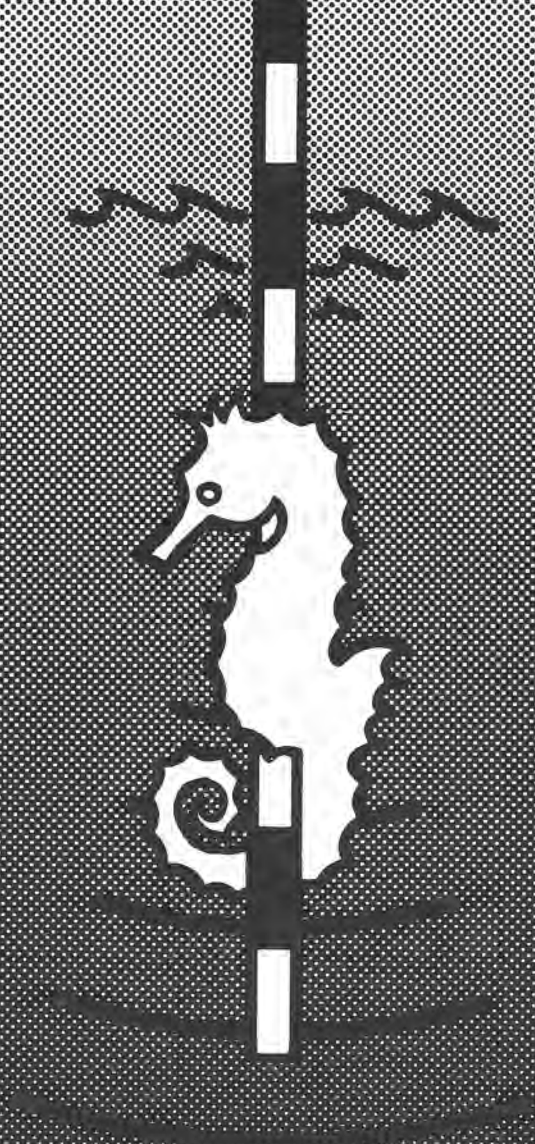

In the last issue, I left you with an Internet address for Commission 4 and a promise to let you know more about the activities of Commission 4, Hydrography. If you visited our home page, then you know that the executive for Commission 4 for the period from 1994-98 are Wilfried Schleider (Germany), Chairman; myself Vice-Chairman and Adam Greenland (United Kingdom), Secretary.

The main work of the Commission for this period was determined at the last Congress in Melbourne, Australia. At that Congress, four working groups were established to look at a wide variety of topics. Working Group 420a, under the Chairmanship of Stephan DeLoach, USA, was asked to conduct a review of the methods for chart datum determination given the recent advances in GPS Technology. Working Group 420b, headed by Professor Delf Egge, Germany, was tasked with investigating methods of combining hydrographic and land information in a GIS for coastal areas and waterways in collaboration with Commission 3. Working Group 420c, chaired by Mike Crutchlow, Canada, will investigate the criteria for determining the quantity of data to be retained and managed in multibeam sounding systems. Lastly, Working Group 419a, directed by Professor David Wells, Canada, will study systematic errors in multibeam sounding systems and the methods for compensating for these errors.

In addition, the Commission has two standing working groups: the FIG/IHO Advisory Board on Standards of Competence for Hydrographic Surveyors and the FIG/IHO Technical Assistance Co-ordination Committee (TACC). I will present more information on the activities of these working groups in a later issue.

The business of the Commission is carried out by correspondence and by ad hoc meetings. Since Melbourne, Commission meetings have been held at Hydrographic conferences in Europe, at the Canadian Geomatics Conference 1995 and at the Permanent Committee Meeting of FIG. Minutes of these meeting are available from the Secretary of the Commission, Mr. Adam Greenland, Hydrographic Surveyor, Port of London Authority, London River House, Royal Pier Rd., Gravesend Kent DA12 2BG, England or email: 10031.2737@compuserve.com.

FIG

Go FIGure

by/par Dennis St. Jacques

Dans la dernière édition, je vous ai laissé avec une adresse Internet pour la Commission 4 (Hydrographie) et une promesse de vous en faire connaître plus sur ses activités. Si vous visitez notre page, vous apprendrez que le conseil exécutif de la Commission 4 pour la période 1994/98 est composé de Wilfried Schleider (Allemagne), Président, moi-même, Vice-président, et Adam Greenland (Royaume-Uni), Secrétaire.

Le plan de travail de la Commission pour cette période a été déterminé au dernier congrès qui s'est tenu à Melbourne (Australie). À ce congrès, quatre groupes de travail ont été constitués pour étudier une grande variété de sujets. Le groupe de travail 420a, sous la gouverne de Stephan Deloach (EU), a eu pour mandat de revoir les méthodes de détermination du Zéro des Cartes suite aux récents progrès technologiques du GPS. Le groupe de travail 420b, dirigé par le professeur Delf Egge (Allemagne), a eu pour mandat d'examiner les méthodes pour combiner, dans un SIG, l'information hydrographique et terrestre pour les régions côtières et les chenaux maritimes en collaboration avec la Commission 3. Le groupe de travail 420c, présidé par Mike Crutchlow (Canada), examinera les critères déterminant la quantité de données à retenir et à gérer des systèmes de sondage multifaisceaux. Finalement, le groupe de travail 419a, dirigé par le professeur David Wells (Canada), étudiera les erreurs systématiques des systèmes de sondage multifaisceaux et les méthodes de compensation de ces erreurs.

De plus, la Commission a deux groupes de travail permanents: le bureau conseil de la FIG/OHI sur les normes de compétences pour hydrographes et le comité de coordination d'assistance techniques (CCAT) de la FIG/OHI. Je donnerai de l'information additionnelle sur les activités de ces groupes de travail dans une prochaine édition.

Le travail de la Commission se fait par échange de correspondance et par des réunions ad hoc. Depuis Melbourne, les réunions de la Commission ont été tenues aux conférences hydrographiques en Europe, au Colloque géomatique canadien de 1995 et au Comité permanent des réunions de la FIG. Les procès-verbaux de ces réunions sont disponibles auprès du secrétaire de la Commission, Mr. Adam Greenland, Hydrographic Surveyor, Port of London Authority, London River House, Royal Pier Rd., Gravesend Kent DA12 2BG, England ou par courrier électronique: 10031.2737@compuserve.com.

Ends of the Earth
Au bout du monde

by/par Bob Hinchley

*The **Ends of the Earth** feature describes the activities of hydrographers and those practising related disciplines. We encourage readers everywhere to send accounts of their own work.*

MADAGASCAR MEMORIES

One of the perks of being a hydrographer-for-hire is visiting parts of the world that the average person does not. I've worked on projects in sixteen countries covering six continents and visited many more. Some jobs I've finished with a sigh of relief and a resolution not to return to the country in question, but in many cases I've thought that if the opportunity arose to return then I'd jump at it.

Madagascar is one such place. The fourth largest island in the world, Madagascar was cut off from the African continent at an early stage in the history of the earth and has developed its own plants and animals, many of which are not found anywhere else on earth. Even the people are unusual. There are people who, to a Caucasian eye, look typically African. However the dominant culture and about 40% of the total population is that of an Asian people of Malay-Indonesian origin who invaded and settled the island probably some two thousand years ago.

In 1988, I went to the southeast corner of Madagascar as project leader of a group of Canadians. The requirement was to carry out a hydrographic/geophysical survey that would assist in the feasibility study for constructing a port to be used in the exportation of titanium ore. The survey area, near the town of Taolanaro (or Fort Dauphin in French colonial times), was divided into two: a lagoon area that was sometimes fresh water and sometimes salt water depending on the season and whether or not the ocean had penetrated through to the lagoon across a narrow part of a spit that varied from a low sandy area some hundred metres or so wide to high dunes about a kilometre wide. The second area extended several miles seaward on the offshore side of the dividing spit. This second area was known as the Baie des Dauphins or Bay of Dolphins and each day when we were working here the resident dolphins came over for a curious look at us and a brief gambol round the bow of the boat.

Meeting the lemurs

Apart from carrying out a bathymetric and geophysical survey, current metering over a lunar cycle, tidal flow observations and bottom samples were needed. A high-tech sensor was to be established on the sea bed to conduct a long term survey of wave and tidal action. Land seismic methods were also required to check the level of bedrock underneath the line of high sand dunes separating lagoon from ocean.

This was in pre-GPS days so control for the Motorola MiniRanger system, to be used for vessel positioning, had to be established using traditional land survey instruments. Echo-sounders with digitizers, sparkers and boomers were the main survey tools once the water-borne part of the project began. All equipment had to be brought from Canada except for the survey vessels which were found on site. A covered trimaran normally used for transporting tourists on sightseeing tours of the lagoon was used for the lagoon survey and a small harbour tug for the offshore area.

Sensitive survey equipment that has to be transported over great distances generally has a few problems upon arrival and the equipment used on this project was no exception. The short seismic streamer had been emptied of fluid during transit and a mad search went underway for replacement. Finally, the local hospital was raided and their entire stock of paraffin and glycerine was "borrowed" to fill the streamer. Computers, interface cables and other sundry items refused to operate satisfactorily despite extensive testing before departure. Field hydrographers will no doubt be familiar with the phrase 'Well, it worked on the bench in the shop.' Unfortunately 'the bench' had been left behind in Canada. However, a plentiful supply of spares ensured that there were no undue equipment delays.

Survey Trimaran in lagoon (with boomer)

The energy source for the land seismic equipment was a metal plate struck with a sledge hammer providing a sound wave that could penetrate the ground and be reflected back and refracted by underground strata. This proved to be spectacularly ineffective as all data were wiped out by the sound of surf crashing on the beaches near the survey area. Finally some ageing Russian-made dynamite was discovered and used successfully, not without some trepidation and careful examination for nitroglycerine weepage.

Working in both water areas was not without difficulties. The trimaran used in the lagoon was extremely difficult to steer down the prescribed survey lines. The harbour tug used in the offshore area was a single-screwed vessel that seemed to take ages to turn round at ends of survey lines. On one occasion a freak wave hit as we were turning at the inshore end of a line near a rocky coast (Mr. Murphy strikes again) and almost capsized the tug. Fortunately the only casualties were the AC generator that was tied down on the wheel house roof and was completely drenched in salt water and never ran again, and the tug crew's communal rice lunch bowl that was washed overboard never to be recovered.

Vivid memories still linger of the traumatic view of the 'killer' wave curling up over the wheelhouse, and of the French client rep frantically turning the wheel to try to get the bow into the sea and uttering some interesting words, in English strangely enough. Afterwards, on shore over some cooling Three Horses beer (excellent) we realized how much difference a few seconds makes between a problem that can be solved and complete disaster.

In spite of all the problems, it was a fascinating experience working there. Although Madagascar is one of the more economically disadvantaged parts of the world the people were friendly and welcoming. The legacy left by the French in this corner of the island ensured a supply of restaurants that served delicious seafood along with local wines and beer. We also managed to take a day off and visit a large sisal plantation that contained a game reserve filled with some of the original inhabitants - the peculiar lemurs - which was a unique experience.

My advice to any hydrographer who gets the chance to work in Madagascar is "seize the opportunity." It will be an experience that you'll never forget.

Editor's note: Bob Hinchley (pictured on opposite page) is a Canada Lands Surveyor and an Ontario Lands Surveyor (C of R Hydrography). In recent years he has been engaged as a surveyor and consultant on hydrographic surveys in the oil and gas sector; for fibre optic telephone cables; and for projects such as described in this article. He is also involved in ISO 9000 quality assurance consulting work. Bob lives in the country near Ottawa, Ontario and can be contacted through The Ovis Group, P.O. Box 435 Arnprior, ON K7S 3L9. Fax or Phone (613) 623-7017

Baie Des Dauphins

The Canadian Hydrographic Association
L'Association canadienne d'hydrographie
Academic Award / Bourse d'étude

(established / constituée en 1992)

Rules for eligibility:

1. The applicant must be a full-time student registered in an accredited program related to Hydrography (these programs include Geomatics, Geography, Cartography, or Survey Sciences) in a university or technological college in Canada. The CHA Academic Award administrators reserve the right to determine applicability of the program.

2. The award will be available only to students who have completed at least one year of instruction in the program.

3. The applicant will be required to write a 500 word paper on the relationship of their academic work to hydrography.

4. The applicant will be required to write a short paragraph explaining how this financial award will assist them in their academic career.

5. The awards applications must be submitted to the CHA Academic Awards Manager by the end of June of the applicable year. The award will be given by September 15th of the same year. All officials from the academic institutes of students submitting applications will be notified by mail of the results.

6. The value of the award will be $ 2,000.00.

7. The successful candidate will receive a special Canadian Hydrographic Association certificate.

8. The successful candidate will be requested to write a letter of appreciation to the CHA for publication in "Lighthouse".

9. The award will be presented to an individual only once.

10. At the time of application, the applicant will be required to submit an official transcript from their academic institute indicating their previous years' grades.

11. The applicant must submit one letter of reference from an official of the university or college at which the applicant spent the previous year. The letter of reference must include the address and phone number of the official.

12. Applications must be made on forms supplied by, and submitted to:

    Barry Lusk,
    Academic Awards Manager,
    CHA Academic Awards Program,
    4719 Amblewood Dr.,
    Victoria, B.C.
    V8Y 2S2

Critères d'admissibilité:

1. Le postulant doit être un étudiant à plein temps, inscrit à un programme reconnu dans le domaine de l'hydrographie (comme géomatiques, géographie, cartographie ou sciences des levés) à responsables de la bourse d'étude seréservent le droit de décider si le programme est conforme.

2. La bourse ne sera disponible qu'aux étudiants ayant complété au moins une année de formation dans un programme avec diplôme ou licence relié à l'hydrographie.

3. Le candidat devra présenter un travail de 500 mots portant sur la relation entre sa formation scolaire et l'hydrographie.

4. Le candidat devra présenter un court paragraphe expliquant comment cette bourse aidera à son état d'étudiant.

5. Les formulaires d'inscription pour une bourse doivent être soumis au directeur aux bourses d'études de l'ACH d'ici la fin juin de l'année concernée. La bourse sera versée avant le 15 septembre de la même année. Les responsables du corps enseignant d'un établissement dont des membres ont postulés recevront les résultats par la poste.

6. Le montant de la bourse est de 2,000 dollars.

7. Le candidat sélectionné recevra un certificat spécial de l'ACH.

8. L'étudiant qui reçoit la bourse devra remercier l'ACH par lettre, lettre qui sera publiée dans «Lighthouse», revue de l'ACH.

9. La bourse n'est remise qu'une seule fois à une personne.

10. Le postulant devra fournir au moment de la demande, une copie officielle provenant de l'établissement d'enseignement des notes obtenues lors des années précédentes.

11. Le postulant doit présenter une lettre de référence d'un représentant de l'université ou du collège où il a passé la dernière année. Cette lettre doit porter l'adresse et le numéro de téléphone du représentant.

12. On doit utiliser les formulaires fournis et les faire parvenir à:

    Barry Lusk,
    Directeur aux bourses d'études,
    Programme de bourses d'étude de l'ACH,
    4719 Amblewood Dr.,
    Victoria (C.-B.)
    V8Y 2S2

Lighthouse Puzzler
Casse-tête du Lighthouse

by/par Beth Weller

Lighthouse Puzzler # 15

Four hydrographers, one a student, were preparing to go on the winter Arctic survey. Along with the usual gear, each packed something special to read (one took a binder of articles submitted for the next Edition of Lighthouse) and also the makings for a favourite bed-time drink (one was rum toddy).

From these hints, can you figure out who took what?

The clues:

1. The student, who took a textbook, does not drink rum or coffee.
2. Paola, the Japanese tea drinker, the one who took Arabian Nights, and Halsall, were all looking forward to this adventure.
3. Jennifer took the makings for Irish coffee.
4. Koudys and Brian have been hydrographers for more than twenty years.
5. Warrender, who brought the Lighthouse binder, drinks hot chocolate.
6. Biggar does not like logic puzzles.

	Halsall	Warrender	Koudys	Biggar	Lighthouse binder	Textbook	Arabian Nights	Logic puzzel book	Japanese tea	Rum toddy	Hot chocolate	Irish coffee
Paola												
Brian												
Keith												
Jennifer												
Japanese tea												
Rum toddy												
Hot chocolate												
Irish coffee												
Lighthouse binder												
Textbook												
Arabian Nights												
Logic puzzel book												

Solution to Spring Puzzler (#14)

Goldsteen is not George or Karl or Frank (Clues 1, 3 & 4) so must be Ron, and the others must be Karl Furness and George Kieninger.

Karl was not at Glen Abbey (Clue 2) nor in Bermuda or St. Andrews (Clue 6) so must have been at Augusta. Frank Randall was not at Glen Abbey (Clue 2) or St. Andrews (Clue 4) so must have been in Bermuda.

Ron did not have the 1 iron or 7 wood or spoon (Clues 5 and 3) so must have had the driver, and Karl the spoon (Clues 3 & 7), and Frank, in Bermuda, used the 7 wood. Which means the one at Glen Abbey (Clue 2) must have been Ron, with George at Augusta.

Sustaining Members
Membres de soutien

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

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

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

Aanderaa Instruments Ltd.
100 - 4243 Glanford Avenue
Victoria, British Columbia
Canada V8Z 4B9 Fax: (250) 479-6588
contact: Gail Gabel
(affiliation - CHA Pacific Branch)

Cansel Survey Equipment
3751 Napier Street
Burnaby, British Columbia
Canada V5C 3E4 Fax: (604) 299-1998
contact: Bo Skapski
(affiliation - CHA Captain Vancouver Branch)

Garde côtière canadienne
104 rue Dalhousie, Suite 311
Québec, Québec
Canada G1K 4B8 Téléc: (418) 648-4236
contact: Claude Duval
(affiliation - ACH Section du Québec)

l'Institut maritime du Québec
53 St-Germain Ouest
Rimouski, Québec
Canada G5L 4B4 Téléc: (418) 724-0606
contact: Claude Jean
(affiliation - ACH Section du Québec)

NovAtel Communications Ltd.
6732 8th Street N. E.
Calgary, Alberta
Canada T2E 8M4 Fax: (403) 295-0230
contact: Art Silver
(affiliation - CHA Central Branch)

Quester Tangent Corporation
9865 West Saanich Road
Sidney, British Columbia
Canada V8L 3S3 Fax: (250) 655-4696
contact: John Watt
(affiliation - CHA Pacific Branch)

Simrad Mesotech Systems Ltd.
202 Brownlow Avenue
Dartmouth, Nova Scotia
Canada B3B 1T5 Fax: (902) 468-2217
contact: John Gillis
(affiliation - CHA Central Branch)

terra surveys ltd.
1962 Mills Road,
Sidney, British Columbia
Canada V8L 3S1 Fax: (250) 656-4604
contact: Rick Quinn
(affiliation - CHA Pacific Branch)

• Simrad •

Norway

SIMRAD, a world leader in multibeam sonar technology, publishes an informative newsletter in which many details of its activities and products are described. The Newsletter is published by Naval & Ocean Science Division, P.O.Box 111, 3191 Horten, Norway; Fax: 47 33 04 44 24; email: nos@simrad.no

Articles in the September 96 issue of the *Simrad Newsletter* include: *New software releases (Merlin, Neptune and Triton multibeam software); Improved dual-channel hydrographic echosounder; CHS opts for flexible survey launches; Italian cablelayer to carry out own surveys; Fully integrated Simrad system for new SOFAD research vessel; and Geoteam - Wimpole orders next generation Simrad multibeam.*

• NovAtel •

Calgary, Alberta, Canada

Headquarted in Calgary Alberta, NovAtel is a world-class leader in the development and manufacture of GPS products including GPSCards, GPSAntennas and accessories. The latest from NovAtel is the MiLLenium' GPS receiver.

Capable of real-time 2 cm accuracy the new system is designed to support the most demanding surveying, differential reference station, and navigation applications.

• Institute maritime du Québec •

Rimouski, PQ, Canada

La Fondation de l'institut maritime du Québec lancera le 28 octobre prochain sa campagne annuelle de souscription avec l'objectif d'amasser 40 000 $ en dons.

C'est le président du Conseil d'administration de la Fondation, M. Robert Dorais, qui présidera cette campagne. M. Dorais est un diplômé en navigation de l'institut maritime du Québec qui, après avoir oeuvré quelques années à bord des navires, occupe maintenant un poste au sein du Service hydrographique du Canada, de Pêches et Océans Canada.

Partenaire de l'industrie maritime depuis plus de cinquante ans, l'Institut maritime du Québec ne cesse d'ajouter à sa réputation d'excellence. De plus, il fait preuve d'un dynamisme remarquable, ayant réussi au cours des dernières années à étendre sa mission de formation, unique au Québec, à la plongée professionelle, la logistique du transport, l'hydrographie et au nautisme. Le support de sa fondation est important pour faciliter son développement.

Les personnes intéressées à contribuer à la campagne peuvent faire parvenir leur don à la Fondation de l'institute maritime du Québec, 53 rue Saint-Germain Ouest, Rimouski, Québec, G5L 4B4. Un reçu pour l'impôt sera émis sur demande.

THE GERALD E. WADE ESSAY AWARD COMPETITION

GERALD E. WADE (1922 - 1986)

Gerald E. Wade, a valued member of the Canadian Hydrographic Association, was born in Fredericton, New Brunswick where he received his early education. He volunteered for Service duty at 17 and served with the Canadian Forces for 5 years in the Mediterranean and Western European theatres of war. When his tour of duty had ended, Gerry attended Mount Allison University and earned his Engineering Certificate in 1949. He then went on to obtain a B.Sc. from Carleton University, a Dominion Land Surveyors license and two Provincial Survey Licenses in Nova Scotia and Prince Edward Island.

Gerry's life work was in the field of surveying, initially with the Topographic Survey Branch of the Department of Mines and Resources and then with the Canadian Hydrographic Service from 1951 to 1977. Gerry was an effective, hard-working Hydrographer-In-Charge of many survey operations coast to coast in Canada.

Subsequent to Gerry's retirement from the Canadian Hydrographic Service in 1977, he was instrumental in establishing the Hydrographic Surveying programs at Humber College of Applied Arts and Technology, Rexdale, Ontario and the University of Toronto, Erindale Campus, Mississauga, Ontario. He was one of the founding members, who first conceived the idea of the Canadian Hydrographic Association, and he worked hard nurturing it, both as its National President in 1977 and as a strong supporter of its basic aims. Gerry was also very supportive of young people and their activities. It is for these reasons, in conjunction with the high esteem that the members of the Canadian Hydrographic Association held of him, that we wish to perpetuate the memory of this fine man through the establishment of this essay competition.

OBJECTIVE:

to encourage students to expand their research, further their interests and improve their writing skills.

OPEN TO:

students enrolled in Survey, Geography, Marine Navigation programs at any Canadian colleges or universities.

ESSAY THEME:

should relate the disciplines of marine navigation, geography, hydrography or land survey sciences and can be either technical or non-technical, or human interest oriented.

ESSAY FORMAT:

should be 1500 to 2500 words in length and must be submitted typed, preferably double spaced. Essays may also be submitted on disc if created in WordPerfect or Microsoft Word.

JUDGING:

a committee of judges will be formed by the Central Branch Executive of the Canadian Hydrographic Association for evaluating the essays and granting the awards. The two best essays will share the $400.00 award as two prizes of $200.00 each. All prizes will be awarded at the discretion of the judges and their decisions are final and binding on all the entrants.

PUBLICATION:

Lighthouse, the journal of the Canadian Hydrographic Association is published twice yearly with an international circulation of 700 copies. On author's approval, essays submitted to this competition will be directed to the Editor of the CHA journal Lighthouse for possible publication.

CORRESPONDENCE:

all correspondence with respect to this essay competition should be directed to the:

Canadian Hydrographic Association
Wade Essay Award
867 Lakeshore Road, PO. Box 5050
Burlington, Ontario L7R 4A6

CLOSING DATE: May 29 of each year.

Coming Events
Événements à venir

Satellite Navigation Technology 1997 and Beyond
April 8 to 10, 1997
Sydney, Australia

The Space Centre for Satellite Navigation, Queensland University of Technology (QUT) is proud to join with the School of Geomatic Engineering, University of New South Wales (UNSW) to present "The Satellite Navigation Technology Conference". This is the third Australian Symposium highlighting the latest in satellite navigation technologies and applications.

For information:
Organizers Australia
PO Box 1237
Milton, Qld 4064
Australia
email: oa@bnec.design.net.au
telephone: (07) 3369 7866
telefax: (07) 3367 1471.

International Hydrographic Organization
XVth International Hydrographic Conference
April 14 to 25, 1997
Monaco

The XVth International Hydrographic Conference will take place in Monaco, between Monday, 14 April and Friday, 25th April 1997. The Opening Ceremony will be held on Monday, 14th April and it is expected that HSH Prince Ranier will participate. Secretary General William O'Neil of the International Maritime Organization will present the opening address.

The Conference will be held in the Centre de Congrès-Auditorium of Monaco. Apart from the business meetings of the Organization, there will be an Exhibition of Charts, a Commercial Exhibition of Hydrographic and Cartographic Equipment and a Technical Symposium. The latter two events will take place during the second week, from 21 to 24th April. Several research and survey vessels of the IHO Member States will be on display during the Conference.

For information:
The International Hydrographic Bureau
4 Quai Antoine 1er
B.P. 445. MC 98011 Monaco Cedex
email: ihb@unice.fr
telephone: (377) 93 10 81 00
telefax: (377) 93 25 20 03

SOCIETY 25
Saturday 10 May 1997
SS Great Britain, Bristol, UK

The inaugural meeting of the Hydrographic Society was held on 24th March 1972. To mark the 25th Anniversary of the Society's foundation, the South West Region of the UK Branch will be hosting SOCIETY 25 on board the SS Great Britain at Bristol on Saturday 10th May 1997. The event will take the form of a one-day seminar followed by an evening banquet in the recently restored First Class Dining Salon.

The theme for the seminar will be International Practice with consideration being given to the professional issues which concern the hydrographic surveyor (e.g. consultancy, professional indemnity, copyright, liability and negligence). SOCIETY 25 aims to reflect the international nature of the Hydrographic Society.

For information:
SOCIETY 25
Institute of Marine Studies
University of Plymouth
Drake Circus, Plymouth, PL4 8AA, UK
email: society25@hydrography.ims.plym.ac.uk
telephone +44 (0)1752 232409 or
telefax: +44 (0)1752 232406

The 64th FIG PC Meeting and
International Symposium
New Thrusts for Surveyors
May 11 to 16, 1997
The Westin Stamford and Westin Plaza, Singapore

The symposia will cater to the full range of surveying interests - from professional practice through education, information management, land and hydrographic measurement, land management, the valuation of properties "as-built" and the provision of effective cost management in building and civil engineering projects.

The 64th Permanent Committee will consider several issues that are crucial to the future of the Federation including the basis on which subscriptions are raised, the possible creation of a permanent office and a total review of FIG's statutes and internal rules.

For information:
Symposium Secretariat
c/o Singapore Institute of Surveyors and Valuers
20 Maxwell Road #10-09B
Maxwell House, Singapore 069113
telephone: (65) 222 3030 or
telefax: (65) 225 2453

International Symposium
Geomatics in the Era of Radarsat
May 24 to 30, 1997
Ottawa Congress Centre
Ottawa, Canada

Geomatics in the Era of Radarsat (GER'97) will be the conference of the year for geomatics and particularly for radar remote sensing applications. Researchers from all over the world will present the results of their work and representatives from the geomatics industry will dispaly their wares. This joint conference of, The 9th International Geomatics Conference, The 19th Canadian Remote Sensing Symposium, The Mid-term RADARSAT ADRO Meeting and The Fourth GlobeSAR Symposium, will encompass all aspects of geomatics including GIS, GPS and remote sensing, from fundamental research to commercial applications. It will also cover policy, education and training issues.

For information:
email: ger97@ccrs.nrcan.gc.ca
telephone: (613)996-2817 or
telefax: (613)947-1382

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KIS97
International Symposium on Kinematic Systems in Geodesy, Geomatics and Navigation
June 3 to 6, 1997
Banff, Alberta

The symposium is being organized by the Department of Geomatics Engineering of The University of Calgary. The Convenors are Dr. M. Elizabeth Cannon (email: cannon@ensu.ucalgary.ca) and Dr. Gerard Lachapelle (lachapel@ensu.ucalgary.ca). The Call for Papers is available on WW http://www.ensu.ucalgary.ca (Click KIS97). The Technical Program will be posted in April 1997.

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9th International Congress of the International Association of Institutes of Navigation
November 18 to 21, 1997
Amsterdam, The Netherlands

As the new millennium approaches, large changes are taking place in the institutional and technology aspects of the navigation infrastructure.

The tri-annual congress of the IAIN is the major international congress where the navigation community meets and where the latest developments in the science and practice of navigation will be presented and discussed.

For information:
c/o Eurocongres Conference Management
J. van Goyenkade 11
1075 HP Amsterdam, The Netherlands
email: eurocongres@pi.net
telephone: +31 20 679 34 11 or
telefax: +31 20 673 73 06

Canadian Hydrographic Association
Association canadienne d'hydrographie

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

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

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

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

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

What the CHA Can Do For You

- advance your knowledge of hydrography, cartography and associated disciplines, and keep you abreast of the latest development in these disciplines;

- enable you to develop and maintain contacts with others involved with hydrography, nationally and internationally.

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

Lighthouse
The journal of the Canadian Hydrographic Association, LIGHTHOUSE, is published twice yearly and distributed free to its members. Timely scientific, technical and non-technical papers and articles appear in the journal, with authors from national and international academia, industry and government. Present circulation of LIGHTHOUSE is approximately 700.

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

Branch & Regional Activities
The Canadian Hydrographic Association has seven (7) branches located across Canada. National headquarters is located in Ottawa.

For further information write to:

National President
Canadian Hydrographic Association
P.O. Box 5378, Station F
Ottawa, Ontario
Canada
K2C 3J1

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

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

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

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

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

Ce qu'elle peut faire pour vous
L'ACH vous offre des avantages tels que:

- parfaire vos connaissances de l'hydrographie, de la cartographies et des disciplines connexes, tout en vous tenant au courant des nouvelles techniques et des derniers développements réalisés dans ces domaines;

- établir et maintenir des contacts avec ceux qui oeuvrent en hydrographie, au niveau national et international.

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

Lighthouse
La revue de l'Association canadienne d'hydrographie, LIGHTHOUSE, est publiée deux fois l'an et distribuée gratuitement aux membres. Des articles scientifiques, techniques et non techniques, provenant du milieu de l'industrie ou du gouvernement autant national qu'international, apparaissent dans cette revue. Le tirage actuel de la revue est d'environ 700 copies.

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

Sections et activités régionales
L'Association canadienne d'hydrographie possède sept (7) sections à travers le Canada. L'administration central se trouve à Ottawa.

Pour plus d'informations, s'adresser au:

Président national
Association canadienne d'hydrographie
C.P. 5378, station F
Ottawa, Ontario
Canada
K2C 3J1

News From Industry
Nouvelles d l'industrie

• Bytown Marine •
Ottawa, ON, Canada

Bytown Marine Ltd. of Ottawa (Nepean), has signed an agreement with NEC Canada Inc. of Mississauga, ON for the Canadian distribution of NEC's Inmarsat Mini M terminal **MLink-2001.** Bytown Marine plans to offer the system to commercial organizations and government agencies who require portable satellite communications services for domestic and international applications.

NEC's Inmarsat Mini M terminal MLink-2001

• Racal Survey Ltd. •
New Malden, Surrey, UK

Racal Survey is to launch a seafloor mapping system which will introduce a new standard of data quality for cable route surveys and other sub-sea tasks.

The Racal SeaMARC system will become available in the first quarter of 1997 and is being commissioned to take advantage of the latest sonar techniques and advances in software. Unlike existing survey tools, it will provide a system which specifically addresses the needs of the cable survey.

The Racal SeaMARC system is a precision seafloor mapping system which will provide true-range, very high resolution backscatter imagery, perfectly registered with precision swath bathymetry. The SeaMARC system is being produced by Alliant Tech Systems Inc. of Mukilteo, Washington USA. The system is intended to overcome the problems currently experienced during cable surveys which fail to accurately map difficult seabed conditions.

Visit Racal on the World Wide Web at:
http://www.racal.com

• Ocean Data Equipment Corporation •
E. Walpole, MA, USA

Ocean Data Equipment Corporation has established several key email addresses on the Internet to facilitate customer service and support, in addition to a web page site designed to provide general information relating to the company and its products.

Technical support: odec@seabeam.com
Product price and delivery:
odecmkt@seabeam.com
Web site homepage: http://www.marinet.com/odec

Ocean Data Equipment Corporation has designed, developed and produced oceanographic instrumentation and related products since being established in 1969. It offers customers a comprehensive line of bathymetric systems consisting of shallow, medium and deep water echosounders; CHIRP sub-bottom profilers; tow fish; parametric narrow beam sonars; bottom and sub-bottom classification software processors; Doppler speed log systems; and related peripherals.

• Valeport Ltd. •
Dartmouth, Devon, UK

Valeport Ltd. UK has developed the Model 730 Wave and Tide Recorder. The model 730 will be used in hydrographic surveys for coastal engineering and offshore construction projects as well as in scientific studies such as wave analysis. High accuracy and resolution (0.01% and 0.001% respectively) are obtained by the use of a precision resonant silicon pressure transducer which is temperature compensated.

Valeport Ltd. email: sales@valeport.co.uk
Valeport Web site: http://www.valeport.co.uk

• STN ATLAS ELEKTRONIK •
Bremen, Germany

STN ATLAS Elektronik. introduces the *DESO 15DS*, a new compact modular single or dual channel survey echo sounder for operation over depths down to 1500 or 1800 m with a resolution of 1 cm depending on chosen frequency and transducer.

Suitable for rack-mounted installation on small vessels or as part of fully integrated systems aboard larger craft, the new system is designed for surveying of inland waters, rivers, harbours and coastal areas. Computer-controllable for remote operation, DESO 15DS includes a comprehensive range of interfaces and can therefore be connected to virtually any type of processing equipment as well as digital heave compensation units.

• The Hydrographic Society •

Polytechnic of East London, Dagenham, Essex, UK

The Hydrographic Society's UK Branch is to convene a one-day seminar on International Practice, which will be held aboard SS Great Britain, Bristol on 10 May, 1997. The event, which marks the Society's 25th anniversary, will be followed by a celebratory evening banquet.

Seminar proceedings will deal with key international policy issues affecting hydrographic surveying including consultancy, professional indemnity, copyright, liability, and negligence.

Three hundred word abstracts of papers are invited for submission by no later than 31 January 1997 and should be forwarded to Society 25, Institute of Marine Studies, University of Plymouth, Drake Curcus, Plymouth PL4 8AA, UK (Tel: 01752 232409; Fax: 01752 232406; email: society25@hydrography.ims.plym.ac.uk

Proceedings of *Hydro 96*, The Hydrographic Society's tenth biennial international symposium held in Rotterdam in September 1996 and attended by over 400 delegates from 27 countries, have been published for general availability.

Dealing with Port & Coastal Hydrography, they comprise 34 papers presented by leading specialists from Australia, Canada, Denmark, Germany, Hong Kong, Monaco, The Netherlands, Norway, Turkey, UK and USA. Main topics covered are Port Hydrography, New Technology, Dredging and Silt, 3D Positioning, Multibeam Sonars, Technical Standards and Cooperation.

Bound copies of the 294-page publication are available at £60 for society members and £70 for non-members from the Hydrographic Society, University of East London, Longbridge Road, Dagenham, Essex, UK. RM8 2AS, (Tel: 0181-597 1946; Fax: 0181-590 9730).

For further information please contact David Goodfellow, 23 Derby Avenue, London N12 8DD. Tel: 0181-445-3453; Fax: 0181-446 8986

• Communications and Measurement Technologies •

Newport Pagnell, Buckinghamshire, UK

Communications and Measurement Technologies Ltd. has supplied the underwater survey and surface navigation system to Northern Ireland's Coastal Studies Research Group.

One of the most advanced suites of offshore survey equipment to be bought by a UK academic body is now being used to map the nearshore marine environments of Northern Ireland and Lough Neagh the largest freshwater lake in the British Isles.

• SeaBeam Instruments Inc. •

East Walpole, MA, USA

The Japan Maritime Safety Agency (JMSA) of Tokyo, Japan, has purchased a multibeam bathymetric survey system from SeaBeam Instruments Inc., for installation aboard the *R/V Shoyo*. The survey sonar is a *SEA BEAM 2100 Series* system, model *SEA BEAM 2112 (12 kHz)*, and is scheduled to be delivered in 1997. Since 1982, SeaBeam has contracted with Japanese customers for a total of ten multibeam survey systems.

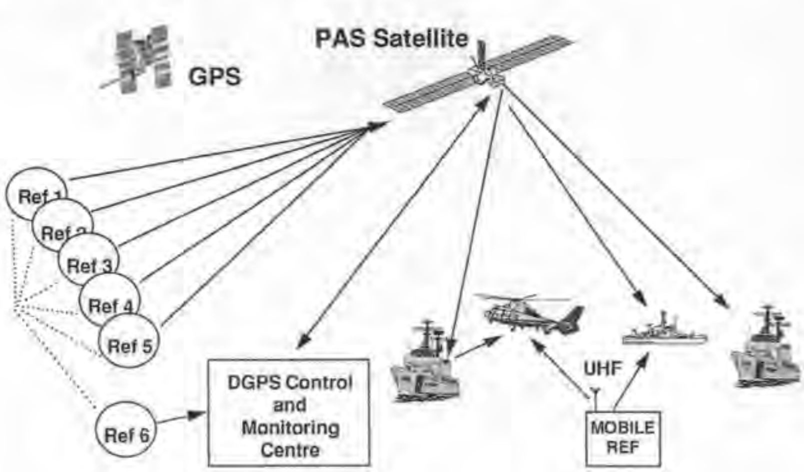
• Svitzer Ltd. •

Great Yarmouth, Norfolk, UK

Vacancies currently exist for experienced offshore surveyors and engineers.

A full CV should be sent to: *The Personnel Officer, Svitzer Limited, Morton Peto Road, Great Yarmouth, Norfolk, NR31 0LT, or faxed to 01493 440319*

Seatex DGPS Reference Infrastructure Indonesian Network



• Seatex •

Trondheim, Norway

Seatex AS, Norway, as a subcontractor to Blom Survey AS (working under a contract with Indonesian hydrographic authorities), is currently establishing a complete and comprehensive SATREF Differential GPS Network System covering the Indonesian ocean territory.

Seatex Internet email:
firmapost@seatex.msmail.telemax.no

Retirement

On December 2, 1996, George Macdonald, our good friend and long time colleague, retired from the Canadian Hydrographic Service (CHS) after many years of exemplary service.

George joined the CHS on May 23, 1966 immediately after graduating from the Southern Alberta Institute of Technology with a diploma in Land Surveying Technology.

He started his career as a junior field hydrographer and like many of his peers he was employed primarily as a Sextant operator. His knowledge, abilities and excellent work ethic were recognized at an early stage of his career and in 1970 he was Senior Assistant on a Central Region survey. By 1972 he was Hydrographer-in-Charge and he remained in an HIC position until 1979 when he assumed the duties of Central Region Hydrographic Development Officer.

Early in his career, George developed a keen interest in new technology and his duties as Development Officer were a natural fit. He contributed in a large way to the "automation" and implementation of new technology to the CHS. He was recognized, not only in the CHS, but within the International Hydrographic community as a leader in developing automated survey and data processing techniques. He presented many papers at Hydrographic and Survey related conferences in many parts of the world.

During his 30 plus years with the CHS he contributed in a wide variety of activities and to the collection of hydrography at many areas of Central Canada and the Arctic.

In addition to his many contributions in the fields of technology, he also contributed to the national and international hydrographic community in other ways. He taught hydrographers in India, he conducted surveys in Senegal, Africa. He was President of the Canadian Hydrographic Association in 1973 and 1978 to 1980, and was Editor of *Lighthouse* for editions 37 through 40.

George assumed the duties of Assistant Regional Director of Central Region in 1989 and remained in that position until 1995 when he accepted a special assignment for the last year of his career with the CHS.

In order to celebrate the many achievements during George's career with the CHS, a party was held on the day of his retirement. Attending with George, were his wife Eva and his two children Corina and David.

We all join in wishing George and Eva a long and happy retirement in their newly renovated home near Sprucedale, in Ontario cottage country.

Headquarters

Electronic Charting
Electronic Charting has primarily been involved working with CHS regions and NDI in the collaborative production of NTX ENCs. The headquarters role involves data certification, file processing, the release process, and delivery to, and coordination with, NDI. Related to this function is national digital standards coordination, answering queries from NDI and clients, and liasing with ECDIS manufacturers and other data users.

S-57 implementation, coordination and support services have become the primary focus of the division in recent months. The division shared in the preparation of the CHS S-57 Version 2 test dataset (CH9995) and in the preparation of the CHS S-57 version 2 test datasets from Montreal to Quebec and provided subsequent support for these files during the maiden voyage of the *USCG Juniper*.

The group worked on the creation of the CHS S-57 ENC Product Specification and Coding Guide (PSCG) for S-57 Edition 3 and has initiated a project to develop data certification tools and procedures as they relate to CHS S-57 ENC Edition 3 production. Members of the group have also been involved in the production and certification of a sample S-57 edition 3 data set and will be liasing with CHS partners in their S-57 development. A national CHS S-57 course is scheduled to take place in Ottawa in December 1996.

CHS was asked by DND to work as a partner in the Digital Nautical Chart production programme and this work is under way. The group is the point of contact between CHS and DND for the conversion, supply, and certification of digital chart data.

The CHS Chart Catalogue is now starting to appear on the CHS world wide web page at www.chshq.dfo.ca. This new interactive catalogue goes far beyond the graphics catalogue of the past in that, using the CARIS Internet Server, chart limits are used as links into a number of the CHS databases so that clients get 'live' information about the chart(s) they are interested in. It is anticipated that eventually all products on the web-based catalogue will allow clients to browse not only by the traditional paper chart numbers, but also by ENC numbers, raster chart numbers, place names, shipping routes and geographic windows.

The group is responsible for national CARIS licensing, chart production manuals, bug reporting, cartographic research, a number of standards documents, and the chair of the CARIS Working Group. A number of staff are kept very busy updating a variety of system components in order to meet revised CHS standards and departmental specifications. Related activities also involve exploring new technology, such as raster plotting, Postscript plotting, wet strength and UV-resistant papers and inks, and optimizing Print On Demand and direct-to-press capability.

The group is often called upon to provide special digital products for other divisions or for senior management. Recently the group provided a number of special products.

The group participates in over 12 working groups, committees and special projects.

For more information on these and other activities of the Electronic Charting division, please contact Paul Holroyd by e-mail at paul_holroyd@chshq.dfo.ca or by phone at (613) 995-4520. Also, please visit the CHS home page at http://www.chshq.dfo.ca

The last six months of 1996 was notable for the number of retirements from CHS Headquarters. During this period seven employees took advantage of the early retirement/departure offers: Tim Evangelatos (Database Research and Standards), Marie Park (Chart Distribution), Pat Bell (Notices to Mariners), Roger Landriault (Reprographics), Terry Tremblay (Nautical Publications - Translations) and Ron Lemieux (Reprints/Notices to Mariners). Their many contributions to the Canadian Hydrographic Service are deeply appreciated and their expertise will be missed. Congratulations and best wishes to them all!

Mary Beth Bérubé has left her postion as the CHS Client Liaison Officer; she is now the BC and Yukon Regional Director of Communications for Environment Canada. Although with CHS for only a few years, Mary Beth made a significant contribution, particularly in promoting electronic chart technology and in promoting Canadian leadership in this field.

Hydrographic Planning and Research
Dave Pugh has just returned from a six-month secondment to the Policy Program Coordination Branch at DFO headquarters.

Lee Alexander will remain in Canada as a visiting scientist with the Canadian Hydrographic Service through to the spring of 1997. He continues his duties in Ottawa to facilitate the implementation of electronic chart-related technologies in Canada and North America.

Although Tim Evangelatos retired in August 1996, he is still very active at CHS headquarters as a scientist emeritus. In this capacity Tim continues to be active, both nationally and internationally, in the areas of hydrographic information systems, data standards and related activities.

Marine Cartography
In addition to his Nautical Geodesy responsibilties, Rick Mehlman is now Acting Supervisor of Reprints and Notices to Mariners.

Other News

CHS Headquarters entered two teams in this fall's United Way Trike Rally, which was under the command of Chief Referee, Dave Monahan. Our two teams, the CHS Lats and Longs (Steve MacPhee, Nancy Akerley, Lise Lague and Mike Casey) and the Russell Road Wrecking Crew (Denis Chartrand, Bruce Pettinger, Mike Horrigan and Trevor Hutchinson) struggled valiantly to defend the honour of the CHS, allowing themselves to be beaten only by the team lead by the Deputy Minister. Ray Chapeskie, the CHS Fiddler in Residence, provided the musical inspiration for our two teams, who also had the support of the most enthusiastic cheering section in the department.

The CHS Russell Road warriors : (L to R) Bruce Pettinger, Denis Chartrand, Mike Horrigan and Trevor Hutchinson

Mike Casey and Steve MacPhee warming up for the big race

Pacific Region

Nautical Publications Division

New Chart Program

Four new charts will be released in the Spring of 1997 including Chart 3675 which was largely compiled on board the Pender during the 1996 survey season. The ENC version is to be released in March 1997 for DND, however, the printed version will not be released until adjoining Chart 3676 is completed in the spring of 1998.

Sailing Directions

The current project is to combine and reformat all of the Pacific Region Sailing Directions and Small Craft Guides into approximately 9 to 11, spiral bound booklets.

DND / DNC Project

The Department of National Defence has engaged a contractor to digitize and process five Pacific Region charts. In return for Quality Control checking of these files, DND will supply these files to the Region. In addition to the above DND has requested 40 other charts that require some action to bring them to complete ENC status. A major portion of the work load is to be handled by four co-op students. This project is to be completed by Mar 31/97.

Geomatics Engineering Division

Source Data Management

Vancouver Harbour field sheets were upgraded and converted to NAD83 in preparation for 1997 field work.

Charting priorities have identified seven high priority charts, five on the central coast and two on the north coast.

Up to 39 field sheets are to be digitized (pending an assessment of their suitability). Priority will be assigned on greatest utility (coverage, accuracy, and vintage) to the production of the five central coast charts, then the two northern charts. Some control will need readjusting to bring the field sheets to NAD83.

Hydrographic Surveys Division

Higgins Passage and Esperanza Inlet

Priorities were to survey the entrance to Esperanza Inlet, Port Eliza, Espinosa Inlet, Nuchatlitz Inlet and time permitting, Bajo Reef. These surveys comprised a segment of a larger project to complete chart 3675 and 3676 by March 1997.

Arctic Surveys

The objectives of the Summer Arctic Survey onboard the *CCGS Nahidik* were to ground truth TIBS data and examine shoal areas identified by TIBS in the Dolphin and Union Strait and Victoria Strait during previous winter surveys. This survey also completed some sounding in Simpson Strait around the grounded cruise ship

M/V Hanseatic and produced a large scale field sheet (1:10,000).

Fraser River, and Revisory Surveys In The Gulf Islands, Vancouver Harbour
This survey addressed 340 documents and discovered four uncharted navigational aids in Vancouver Harbour,

Stewart Harbour Survey
The hydrographic survey of the Port of Stewart, B.C. was a response to a reported grounding of a commercial vessel, the 340 gross tons and 38 meters long *TYEE Princess*.

EM3000 Multibeam System
The Multibeam on board the *CSL Puffin* completed the survey of Roberts Bank in October of 1996. The completed field sheets will be now used in the construction of a new chart.

Tidal Survey Activities
More than 24 field trips have been made since April for equipment maintenance and ensuring instrument time and height calibration. Three gauges: Tofino, Campbell River and Point Atkinson were rebuilt this season and a new gauge was deployed in Nanaimo Harbour at the request of the Harbour Master. New phone lines were installed at a number of sites.

Five submersible pressure gauges were removed in the arctic and only conventional equipment remains at Tuktoyaktuk and Cambridge Bay.

Client Liaison And Support Division
The three main projects were migration to Windows 95 and Exchange, Ocean Feature Classification work and Salmon Riverine monitoring.

Hydraulic Research
A multiple-year tidal analysis of all Canadian Tidal Reference Stations was undertaken to determine if there was any drift in tidal constituents over the duration of the records. An Excel spreadsheet program was developed to evaluate such a drift and to plot the results. This analysis also identifies years with unusual features or poor quality data.

Institute Electronics
Knudsen 320M
Five sounders were purchased and used on two major surveys and three revisory surveys during the survey season. Excellent performance was achieved in field.

EM3000
The system was acquired and launched in the Spring of 1996. Three technicians from this region were trained on the operator/maintenance of this hardware. The *Puffin* with EM3000 was used on the Robert's Bank survey with success. Some software bugs were encountered. The POS/MV system was upgraded to add a heading capability to the package.

Imagenex Side Scan
An Imagenex Side Scan was acquired and tested. The system was configured and used to survey the profile of the Fraser River Flow Meter site and HMCS MacKenzie.

Deep Water Sounder
A Simrad EA500 precision deep water sounder for scientific use was acquired with refit money and installed on the *CSS Vector*.

GeoSurv Training
A one week course was held for CHS staff at IOS, excellent information was presented on the use of Semikin and Flykin for survey control. This has given this region the ability to use common GPS hardware in a number of applications, forgoing the need to purchase expensive geodetic receivers and software.

IOS DGPS Datalink
The UHF store and forward repeater worked flawlessly in a rugged area for the Pender survey. Two repeaters and reference station transmitters provided seamless coverage over a large area. Hydrographers, without adjusting anything in the launch, could survey around islands down inlets with DGPS correction throughout the survey area.

GPS Receivers
Eight new NovAtel receivers were acquired including three with Multipath Elimination Technology, all were used during the field season. Geodetic receiver packages were made using Novelette 3151R, Poison Walkabout and internal battery mounted in a convenient to use portable waterproof container giving CHS Pacific a low cost package with multiple uses for the receivers. An installation of a reference station with a simple batch file to log pseudo-range corrections daily was developed. If a Hydrographer needed DGPS corrections to post process static data he would visit the easily accessible reference site and download the daily corrections onto a Zip drive disk. Because of the robustness of the DGPS datalink and repeaters, the reference site location was selected for the easiest access from the Pender and repeaters were used to provide the actual corrections to the survey area.

Offshore Systems Ltd. (OSL) Ecpins
Training for two technicians on maintenance and installation of OSL Ecpins systems. A CHS/OSL ECPINS was installed by IOS technicians on the *W.E. Ricker* in Nanaimo for fisheries Biology activities.

Communications
An MSAT transceiver was installed on the barge *Pender* under the GTIS trial program (no cost to CHS), and was used extensively over the course of the survey. The

system demonstrated good communications for both voice and data. Radio inspection and maintenance of VHF and HF communications equipment for the Science fleet occurred over the year.

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Central and Arctic Region

Multibeam a success in Rankin Inlet!

The Government of the Northwest Territories and the Canadian Hydrographic Service have entered into an agreement to survey a deep draft tanker route into Rankin Inlet on the western shore of Hudson Bay. During the first year of the survey, a potential route was delineated using conventional acoustic survey techniques. In the second year, the newly-acquired Simrad EM3000 system was used to give complete bottom coverage along the centre of the proposed route. The system operated trouble free and was able to detect depths shoaler than the single survey of the same area. Additional hydrography was also obtained using conventional launches operating from the *CSS Hudson* and completes the data collection for three new charts of the area.

Griffon used again in Georgian Bay.

The *CCGS Griffon* was used during May and June as the base of operations for a survey in southeastern Georgian Bay. Four launches equipped with the new Knudsen 320M echosounders were used to collect the sounding data. This completes the data acquisition phase of the new chart of Nottawasaga Bay.

Larsen finds uncharted shoal.

As part of its program to upgrade arctic charts, Central and Arctic Region used the icebreaker *CCGS Larsen* on an opportunity basis to collect hydrographic data in Barrow Strait and McDougall Sound. However, poor ice conditions forced the survey to proceed to Peel Sound where they discovered an uncharted shoal with a minimum depth of less than 1m just north of Bellot Strait. Later in the year, the *CCGS Larsen* was also on stand-by during the grounding of the *Hanseatic* in Simpson Strait.

S-57 Production on the roll.

The ENC Division has begun S-57 production to meet the needs of ECDIS users on the Seaway. The S-57 production, combined with the planned Updating Service being pioneered by CHS/NDI, should enable our friends in the shipping industry to sail the Inland Waterways with an IMO-compliant ECDIS during the 1997 navigation season. Four of the ENC staff participated in Objects training in mid-December to further speed the transition to the S-57 Object-based format.

Product Maintenance
Division forms five Sections.

The Product Maintenance Division (for new CHS Central and Arctic Region reorganization see Edition #53 of Lighthouse) is responsible for updating all CHS Central and Arctic Region products (ENCs, paper charts and Sailing Directions) for all outstanding and incoming source data. The Division is currently composed of five units:

<u>Navigation Information</u> (Supervisor - George Fenn) This unit is primarily responsible for reviewing all incoming source data and generating Notices to Mariners (written and graphic) as required, for all CHS Central and Arctic Region (C&AR) products. This office is also the CHS liaison to Canadian Coast Guard and other navigational aids responsibility centres involved with waterways in Ontario, Manitoba and the Arctic.

<u>Chart Maintenance</u> (Supervisor - Mike Bennett) This unit is currently concentrating on digitally updating all regional charts (paper and ENC) for outstanding and incoming source data. In addition, a New Chart for McGregor Bay in Georgian Bay is nearing completion and will be available for the 1997 navigation season.

<u>New Editions</u> (Supervisor - Al Koudys) This unit is responsible for producing New Editions as required (stock requirements, numerous corrections, unknown datum conversions). New Editions currently in progress include:

1437 (St. Lawrence River);
2110 (Lake Erie - Long Point Bay);
2181 (Harbours in Lake Erie);
2225 (Approaches to Parry Sound);
2300 (Lake Superior);
6214 (Lake of the Woods);
7502 (Arctic - Gulf of Boothia)
- *Print-On-Demand product*; and
7740 (Arctic - McClintock Channel)
- *Print-On-Demand product*.

Recent New Editions completed include: 1513 (Rideau Canal - Smith Falls to Kingston); and 2282 (Georgian Bay - Cabot Head to Owen Sound). In addition, a New Chart for Port Dalhousie is nearing completion and will be available for the 1997 navigation season.

<u>Sailing Directions</u> (Supervisor - Sam Weller) This unit is responsible for maintaining all existing C&AR Sailing Directions publications, and the publication of new Sailing Directions as required. Current projects include the new booklet-style Sailing Directions for the Great Lakes. Five new booklets were produced in 1996: CEN 300 - General Information; CEN 301 - St. Lawrence River (Montreal to Kingston); CEN 302 - Lake Ontario; CEN 303 - Welland Canal and Lake Erie; and CEN 303 - St. Clair Waterway. These booklets replaced Sailing Directions - Great Lakes Volume 1 and the Lake Ontario Small Craft Guide. CEN 306 - Georgian Bay is currently in production, and will replace the Georgian Bay portion of Great Lakes Volume 2 and the Georgian Bay Small Craft Guide.

Quality Control - Reprographics (Helen Fuchs-Trapp) This unit is responsible for quality assurance of all PMD products. Helen is also the Supervisor of the Reprographics Lab which looks after all C&AR photomechanical needs.

Database Activities Accelerate.
The number and volume of Oracle database applications has increased a great deal over the year. All database development is now on the UNIX platform. In addition to general database administration, the Technical Services Division provided ongoing support to users and developers of specific database applications such as the NavAids database, Object Manager, the new CHS Directory and Chartnet/CIDAS. This Region is taking the lead in implementing the newest version of CIDAS.

As part of the national development of the Hydrographic Information System, the Division continued the development of the NavAids database. Work focused on linking the NavAids system to the Canadian Coast Guard's aids information database (SIPA). The hardware link to SIPA is in place, although there is still work to be done to get the link operational in terms of software and network configuration. In addition, users were given access to the modules of the NavAids System that were operational. To date, staff in the Navigational Information Section, the Hydrographic Data Centre and the Product Maintenance Division are active users of the system.

Progress on the CHS Directory database (CHSDIR) was significant. The Products meta-data portion was operational early in the year. SDS records were transferred to the CHSDIR in September and work on the next stage, the incorporation of CHAINS data into the CHSDIR, has begun. Central & Arctic Region Data Management were the primary team tasked with national development of the meta-database. The region maintained all CHS chart records in the CHSDIR during the year.

GPS Improvements.
The Technical Services Division introduced the new Novatel RT20 GPS receivers and upgraded the data links to 9600 baud. There have been a number of improvements that have been introduced such as reference station remote control, shipboard repeater, RT20 aircraft units, new pilot displays, and a remote data link for the water level gauges.

Survey Electronics develop display.
The Survey Electronic Section developed a remote liquid crystal display for the Knudsen sounders to give immediate readings during shoal examination or when working in shallow water when the inherent delay of the paper chart causes a problem. The Section also undertook the design and installation of a GPS roof antenna system that brings satellite signals into several lab's to be used as test signals for various GPS receivers and other GPS related computer programs. Lastly, the Section commissioned and installed a number of MSAT satellite telephone systems for Hydrography and other sections of Fisheries, particularly in the Arctic.

Personal Notes.
Brent Beale is off to the 'Rock' for a one year assignment at Nautical Data International located in St. John's, Newfoundland. Jacqueline Miles has done a great job as the Special Events Coordinator for CCIW in this year's United Way campaign - thanks Jacqueline. Al Shepherd participated in the hydrographic exchange program with the Pacific Region. Greg Levonian is on a 6 month secondment from CHS in Ottawa.

Obituary

Central Branch regrets to announce the untimely death by cancer of former Central Region hydrographer, Joe McCarthy. Joe died at age 57, at McMaster Hospital, Hamilton, Ontario, September 11, 1996. Many hydrographers, especially of the boom time 1960 to 1970 era, will remember Joe for his aggressive personality, dynamic drive and colourful social agenda both off and on the playing surface of many surveys. Joe served on surveys on the Lower St. Lawrence River with Adam Kerr or Bruce Wright (Tadoussac, Riviere–du–Loup, St. Jean Port Joli), on the Georgian Bay survey of 1966 with Earl Brown, on the Lake-of-the-Woods survey, 1967, and on several Arctic surveys including James Bay, Hudson Bay, and Chesterfield Inlet. He was also on a noteworthy *CSS Hudson* Greenland oceanographic program, and on the *CSS Baffin* Caribbean training cruise of 1967. Joe remained with the CHS hydrographic until the latter part of the seventies, when he married and broke ranks to become a very successful operator/owner of three Dairy Queen stores.

The hydrographer with the booming voice and compelling presence is no longer with us, but hydrographers and contemporaries will always reflect back vividly on someone who cast a profound impression as an individual and as a hydrographer.

CHA News
Nouvelles de l'ACH

Section du Québec

En juillet 1996, plusieurs plaisanciers se sont rencontrés à Rimouski pour participer au Championnat de courses au large du Québec. Bernard Labrecque a participé au bazar nautique organisé à cette occasion pour mieux faire connaître notre Section et pour y vendre des cartes marines.

La Section du Québec a aussi tenu un kiosque d'information en août à Sainte-Luce-de-Rimouski lors de la Grande traversée du fleuve Saint-Laurent en kayak entre Forestville et Sainte-Luce, ce qui représente environ 60 km à pagayer contre vents et marées. Il y avait des concurrents qui venaient d'aussi loin que de l'Australie. Cette journée a été des plus intéressantes.

Nous avons conclu une entente, à l'automne, avec l'Institut maritime du Québec à Rimouski. Notre magasin de cartes se trouve maintenant à l'intérieur de la bibliothèque, donnant ainsi à la Section du Québec une meilleure visibilité auprès des étudiants et du public en général.

La région Laurentienne du Service hydrographique du Canada a acccepté, pour une quatrième année, notre proposition de créer et de gérer la réalisation d'une publicité en commun afin de mieux faire connaître son réseau de dépositaires autorisés au public. Ce projet sert aussi à appuyer les efforts de marketing de la Section du Québec pour son magasin et son Carnet de bord.

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Central Branch

Meetings

The year's first Branch meeting, held at the home of Bill and Helen Warrender, in Burlington, featured an entertaining and educational slide show by Hamilton based wooden boat builder Gill Bibby (builder of the CHA/CB Heritage Launch). Gill spoke on some of the rather ambitious building proposals that are on the 1812 Ship's Company agenda.

Sam and Beth Weller graciously stepped in and hosted the second meeting with a show by Dr. Chip Weseloh of the Canadian Wildlife Service who spoke about his studies of the Double-Crested Cormorant and its use as an environmental indicator. He also informed us about the on-going habitat restoration project in Hamilton Harbour.

The third meeting, hosted again by Bill and Helen Warrender, featured a presentation by author and sailor Al Saunders (*Small Craft Piloting and Coastal Navigation*) with a slide show of his South Pacific cruise aboard a topsail schooner.

The fourth meeting of 1996 was held at Terese Herron's home in Waterdown and featured a presentation on the Simrad EM3000 swath system by in-house member Mike Crutchlow.

This year's fifth meeting was held at Bill and Helen Warrender's. Doug Cuthbert, a Civil Engineer with Environment Canada and member of the International Joint Commission, spoke on Great Lakes water levels, the "diversion" of Canadian water and "turning off the tap" at Niagara Falls!

H_20 Bonspiel

The 25th Annual H_20 Bonspiel was held February 25th at the Dundas Granite Curling Club. This year's champions were Todd Breedon, Mike Mawhinney, Ralph Currier and Al Shepherd. The second place team included Bob Covey, Bob McMurray, Dave Large and Danielle Milani. Many thanks to the sponsors of the event: Canadian Hydrographic Association-Central Branch; Canadian Hydrographic Service, Central and Arctic Region; Emma's Back Porch, Burlington; Kev-Tech Associates, Bolton; Knudsen Engineering, Perth; Leica Canada Inc., Willowdale; Offshore Systems Ltd., Vancouver; Quester Tangent Corporation, Sidney, B.C.; RC Marine Electronics Ltd., Dartmouth; Simrad Mesotech Ltd., Dartmouth; Telecom Computer Products, Burlington; Terra Surveys Ltd., Ottawa; Xerox Engineering Systems Canada, Markham. Everyone had a great time and are eagerly awaiting 1997's event.

Summer BBQ

Thanks to Jacqueline Miles and Andrew Leyzack (and Mother Nature for bestowing upon us such lovely late September weather!) the annual summer barbeque was a resounding success! Thirty-five adults and children enjoyed the food and drink in the heart of southern Ontario's "winebasket".

Central Branch Annual General Meeting

As in years past, 1996's AGM was held at the Mimico Cruising Club in Etobicoke, December 5th. The festively-decorated dining room lent warmth and colour to the evening's entertainment, which was provided by Dr. Steve Blasco, P.Eng., of the Geological Survey of Canada, who spoke on Neotectonics in the Great Lakes Basin. Steve's talk was introduced by Past CHA National President, Dave Pugh, with a tale about Steve's experience in a Russian submersible diving on the wreck of the *Titanic*. Earl Brown, Director, CHS, Central & Arctic Region, thanked Dr. Blasco with an anecdote about a conference attended by Steve and some of his CHS associates. This humour was greatly added to by the real story, as told by someone who was there, which was enjoyed by all 34 CHA members and guests in attendance. Thanks to Dave Pugh, our Master of Ceremonies, who helped the evening program flow smoothly. We would also like to thank the sponsors of this event: Aerodat Inc, Mississauga; McQuest Marine, Burlington; Canadian Hydrographic Service, Central and Arctic Region; Canadian Hydrographic Association - Central Branch; MDA Engineering Ltd., Brantford.

Many thanks go to the CHA members who volunteered their time to make the evening more enjoyable and to the staff of the Mimico Cruising Club for their efforts to get the fire going, which greatly added to the ambiance!

Elections

Autumn is election time for Central Branch and this year was no exception. The 1997 Central Branch Executive was introduced during the Annual General Meeting: Vice President - Terese Herron, Secretary/Treasurer - Andrew Leyzack, Executive Members: Jon Biggar, Chris Gorski, Mike Johnston, Al Koudys, Jacqueline Miles, Paola Travaglini and Sam Weller. Congratulations!

General

Helen and Brian Fuchs-Trapp have a new baby in 1996. Lukas Frederick, weighing in at 9lbs 6 ozs, was born on January 26. He joins Heidi age 9 and Markus age 5. Brian is having a busy summer with Environment Canada; his field work this year has involved ROXANNE bottom classification surveys at Darlington and Toronto on Lake Ontario, and Cornwall on the St. Lawrence River. Helen has returned to her position in the Product Maintenance division of the Hydrographic Service.

Long-time honorary member George Macdonald retired on December 2 to the resounding choruses of Raspberry Jam. Here's hoping you've got more time to enjoy your canoe, George! Bon voyage!

The snow is flying here in Burlington, and winter is fast approaching. We can now take pause to reflect on yet another successful field season. The year began with the Winter Arctic Survey based at Bernard Harbour, NWT. The staff included CHA members Jon Biggar, Terese Herron, Tim Janzen and Pacific Branch Member George Schlagintweit.

The Nottawasaga Bay survey aboard *CCGS Griffon* was blessed with calm but rainy weather for most of the six weeks. CHA members aboard included Al Koudys, Terese Herron, Jon Biggar, Andrew Leyzack, Mike Johnston, Peter Knight and Fred Oliff.

The Rankin Inlet Survey used multibeam technology for the first time and those members aboard the *CSS Hudson* included Paul Davies, Raj Beri, Andrew Leyzack, Paola Travaglini and Tim Janzen.

The summer Revisory survey was led by John Medendorp. This survey did some work aboard the CCGS *Henry Larsen* in Canada's High Arctic with John and fellow CHA members Jon Biggar and Ken Dexel.

Pacific Region

A noon seminar was held on October 24 in the auditorium of IOS. Gord Snow of Knudsen Engineering Ltd. of Perth, Ontario gave a short talk on the KEL product line and in particular the 320-M echo sounder used presently by the CHS. He demonstrated a portable, waterproof system that is easily carried into the field. The 320M-P contains simple hardware and customer defined software.

Jim Galloway gave a talk entitled "Stock Assessment Using Hydrographic Tools" on December 4th. It was held at the Glen Meadows Golf and Country Club at noon, 65 members in attendance.

Careful timing and planning (to avoid complete Government collapse) has allowed John Gould to officially retire from the public service on November 1. John started in September of 1963 with the Department of Mines and Technical Surveys in Ottawa as a trainee Cartographic compiler. Warm weather and attractive waterfront property values on the Island finally convinced John to migrate west. In 1978 he transferred from CHS charts HQ to the west coast office. John served as the Navigational Aids Officer for Pacific Region CHS. Best of luck to you John, we hope to see you at future CHA activities.

Noticeably absent this summer were visits by CHS retirees; it must have been the great weather we had. Anybody seen Mike, Ken, Willie, Barry, Sandy, Vern or Grahame?

Retired CHS/CHA member Murray Farmer has now taken up residence in Napier, New Zealand. His wife Kaye has taken an exchange faculty position with the Eastern Institute of Technology for one year. Houses, cars and even the pet dog were exchanged with their counterparts from New Zealand.

Our own CHS Brewmaster, Dave Garltley has become famous. Quick thinking and fast decision making, some of the same qualities Dave uses in his work at CHS, led him to discover a unique hybrid beer recipe. Dave entered this beer in the Provincial contest hosted by the BC Amateur Beer and Winemaking Association. He ended up winning First Place and Best of Class in the Dark Beer and Ale catagory as well as qualifiying for the Canadian Nationals. In the Nationals he won First Place. Congratulations Dave, perhaps we might sample this brew at the up-coming Photo Contest.

Ernie Sargent has a new addition to his family. This one barks and has four legs.

After a long stretch on the Pender this summer, Brian Wingerter and his wife travelled to England and France in October.

James Wilcox and Linda were married this summer in Brentwood Bay. A reception was held in their honor at the Stonehouse Pub in Sidney.

Tony Mortimer (did this guy retire?) is in Japan visiting his daughter.

Canadian Institute of Geomatics Beer, Bun and Bellowing Bash -by George Schlagintweit
(editor's note — I had nothing do with the contents of the following)

The eve of Wednesday, October 23rd was a humbling one for seasoned veterans of the 12th Annual BBBB. The cribbage, shuffleboard and darts tournaments saw numerous upsets, making for a long evening. Some team members simply had to leave early, presumably due to the unprecedented level of competitive intensity. Of particular note was the emergence of new cribbage ringer Dilsher Virk who, while filling in for the early departed Alex Raymond, made it possible for George Schlagintweit to claim the prestigious cribbage championship. Shuffleboard went to Willie Rapatz and Sandy Sandilands, while darts were claimed by Gordon Wilkinson and Fern Shultz. When the dust settled, the highly acclaimed "Sitting Bull" trophy was grasped by long-time contender George Schlagintweit with the most wins. His will be the sole name on the trophy as all his partners cracked under pressure on the road to victory.

In early July, Doug Popejoy and Neil Sutherland took the long drive from IOS to Inuvik, NWT to set up for the arrival of Knut Lyngberg (HIC), Ken Halcro, and Ron Wooley on July 22. The survey party joined the *CCGS Nahidik* in Inuvik. Work was performed in Dolphin and Union Strait and Bernard Harbour. Also joining the party was Gordon Worthing for electronics support. At the end of July Ron Wooley transferred to the *CCGS Sir Wilfrid Laurier* to do coastline checks by helicopter throughout the Coronation Gulf and Queen Maud Gulf areas. Track soundings in areas with few or no soundings along the ship's way were also performed. Meanwhile, back on the *CCGS Nahidik*, a search and rescue mission was in progress at the end of August. The *M/V Hanseatic*,a 408 foot passenger cruise ship ran hard aground on a **charted** shoal. Nine days later the ship was pulled free by the Nahidik and the tug Edgar Kotokak. The survey crew left the ship in Cambridge Bay for their departure home.

Alex Raymond (HIC) , Dave Thornhill, Brian Wingerter, Doug Cartwright , and Al Shepherd (Central and Arctic Region) all spent a delightful summer surveying Esperanza and Nuchatlitz Inlets.

Preparations for the Pacific Branch H2O curling bonspeil are already spinning in the heads of the CHA executive. Bodo has the ice booked for February 16. As usual the winner of this event will be declared national champions.

The World's Largest Sextant is broken! Alex assures us that arrangements are in progress to have it back in working order.

Plans to celebrate the 30th Anniversary of the Canadian Hydrographic Association early in the new year..., are on the back burner.

1997 Executive

- Rob Hare - Vice President
- Mike Woods - Secretary
- Bodo de Lange Boom - Treasurer
- Willie Rapatz
- Brian Watt
- Dave Gartley
- Al Schofield
- Doug Cartwright
- Alex Raymond - Past VP

Ottawa

Ottawa Branch has had an active year with 54 members to date. In addition to activities reported in the Spring Edition 53 our year included:

A course on HTML given by Richard Horrigan from the Russell Rd. Chart Distribution office, teaching members how to set up a personal Web page. Service was purchased from a local service provider and was available to the Ottawa branch members free of charge (service included with association dues) for 1996. Dave Monahan gave an interesting seminar on the 'Law of the Sea'. We also watched a video 'Icebreaker to the North Pole' which originally aired on Global.

The Ottawa Branch yearly golf tournament was held at Nation Golf course in early September

An Xmas pot-luck lunch rumored to be subsidized by the Ottawa branch was held by Headquarters CHS staff.

Personal notes:
Richard Horrigan has recuperated from a stroke he suffered last summer.

The latest addition to the Brunt family, Nicholas born Nov. 20,1996.

Canadian Hydrographic Association A G M

Tuesday
April 15,1997
08:00 PST

See your local VP for details

Application for Membership
Formule d'adhésion

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

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

☐ Member / membre
$30.00
(for most branches/pour la plupart des sections)

☐ Sustaining Member / membre de soutien
$150.00

☐ International Member / membre international
$30.00

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Fall 1996

Lighthouse

Journal of the Canadian Hydrographic Association
Revue de l'Association canadienne d'hydrographie

LIGHTHOUSE originally began as an internal newsletter of the Canadian Hydrographers' Association (CHA) in the winter of 1969. It was conceived as a means of stimulating discussion between the branches of CHA. Over the years, **LIGHTHOUSE** has become Canada's national hydrographic journal. It still remains faithful to the original goal of providing a mix of technical, historical and social information of interest to those associated with hydrography in Canada. But its circulation has expanded to include over 700 individuals, companies and hydrographic organizations in Canada and around the world.

Automne 1996

Lighthouse

Revue de l'Association canadienne d'hydrographie
Journal of the Canadian Hydrographic Association

Originalement à l'hiver 1969, **LIGHTHOUSE** était le journal de l'Association canadienne des hydrographes (ACH). Il représentait un moyen pour stimuler les discussions entre les Sections de l'ACH. De par les années, **LIGHTHOUSE** est devenue la revue hydrographique nationale du Canada. Elle reste fidèle à son but original de fournir une source d'information technique, historique et sociale à ceux qui s'intéressent à l'hydrographie au Canada. Son tirage a augmenté pour inclure au-delà de 700 membres, compagnies et organisations hydrographiques au Canada et dans le monde entier.

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

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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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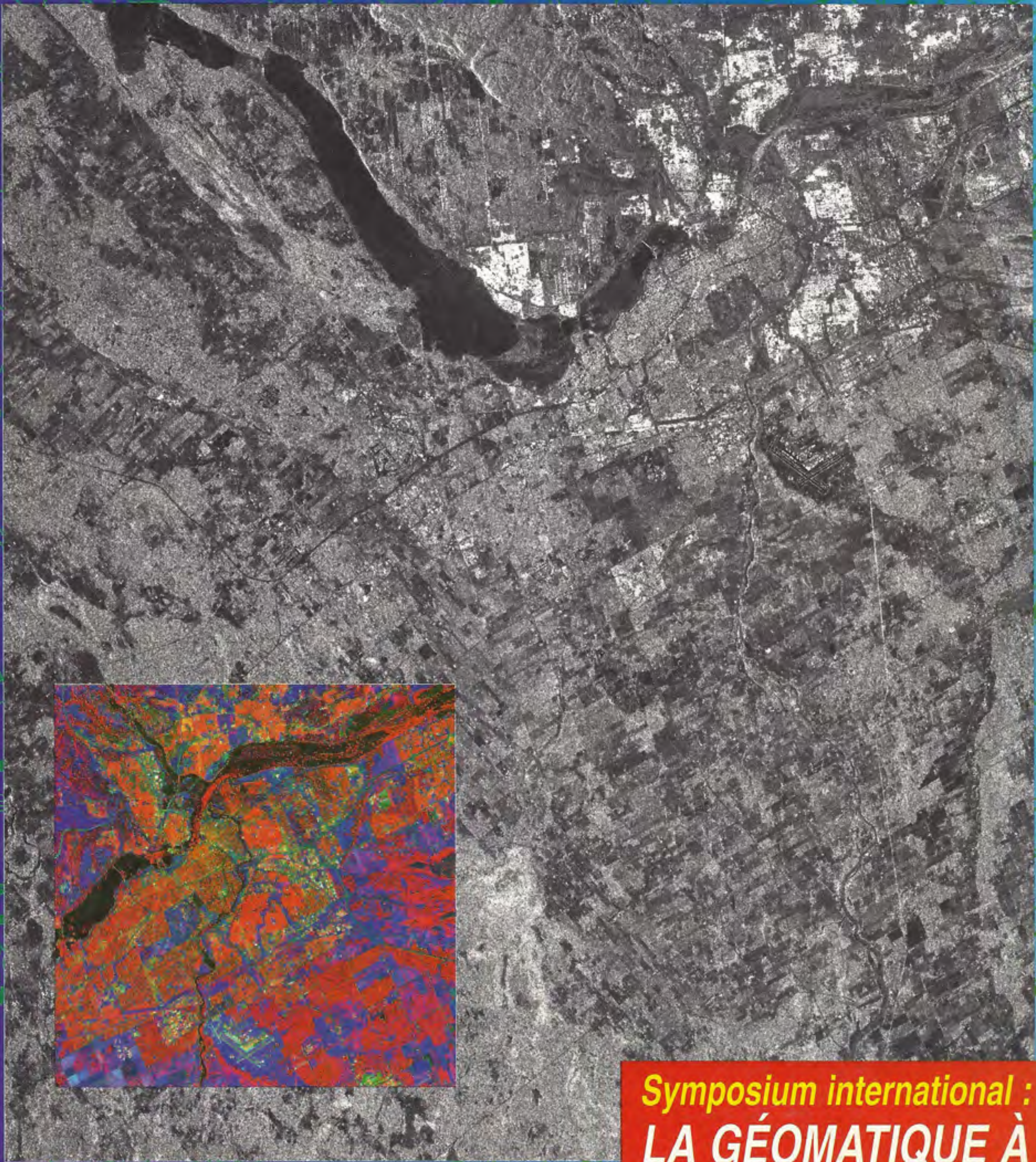

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