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Lighthouse

JOURNAL OF THE CANADIAN HYDROGRAPHIC ASSOCIATION

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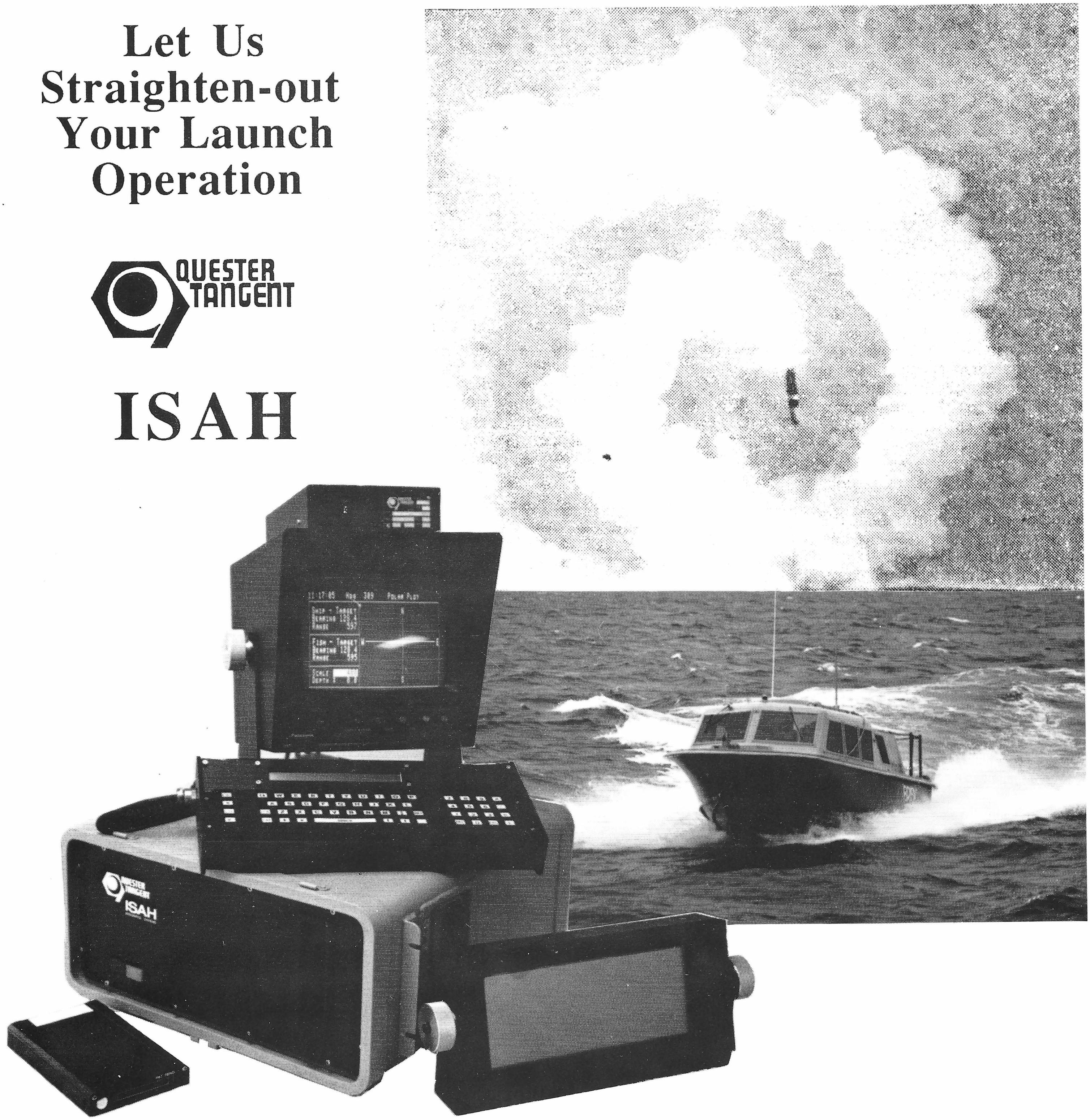

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Edition 41 **LIGHTHOUSE** Spring 1990

JOURNAL OF THE CANADIAN HYDROGRAPHIC ASSOCIATION

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Back Issues of Lighthouse

Back issues of Lighthouse, Editions 24 through 40, are available at a price of $10 per copy. Please write to the Editor.

Contents

Closing dates for articles are:
Spring issue March 1
Fall issue October 1

Editor's Notes

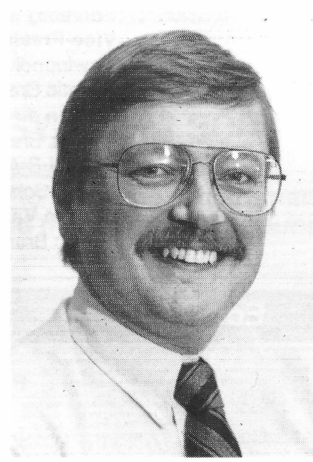
Barry Lusk has recently completed his three year term as National President and passed the responsibility to Dave Pugh. First I would like to thank Barry for all of his work in the CHA, a period which saw changes to our Association in both name and structure. This voluntary position requires a great deal of time and dedication and Barry is to be commended on a job well done. Secondly I would like to congratulate Dave Pugh and wish him the best of luck on his new appointment.

The editorship of Lighthouse has also changed hands. George Macdonald has now completed his latest appointment as editor (1988-1989). Through his very dedicated work the journal has grown tremendously in professional stature. George's many achievements during his most recent assignment as Editor included the creation of the present Macintosh layout, the reduction to four colour printing and the switch to a lighter paper weight, which all served to cut the high costs of printing a journal such as Lighthouse, yet maintain a high standard of quality. His continuing help as an Assistant Editor and advisor is greatly appreciated.

As the new editor of Lighthouse I should introduce myself. My name is Bruce Richards, and I have been active in the CHA for over ten years as Central Branch Secretary/Treasurer, Vice President and Executive member. I have been assisting with the production of Lighthouse for the last four issues.

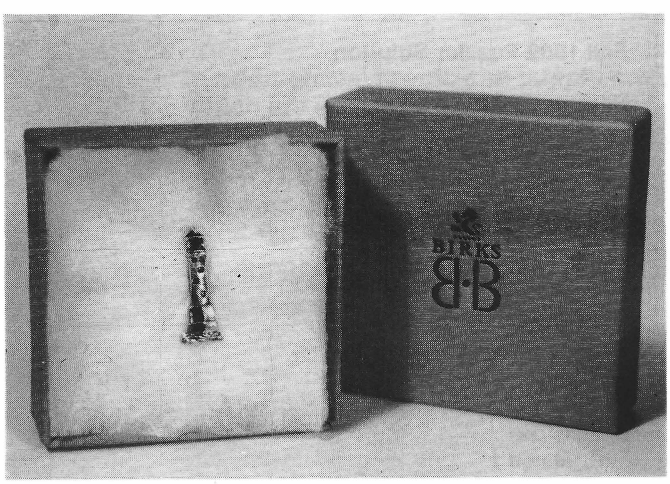
Graduating from the University of Waterloo in 1977 with a Honours Bachelor of Environmental Studies degree, in Geography, I also hold a Canada Lands Surveyor Commission and an Ontario Land Surveyor Certificate of Registration in Hydrography.

I am currently employed with the Canadian Hydrographic Service as acting Manager of Chart Production for Central and Arctic Region. I started out with Central and Arctic Region of the CHS in 1978 as a Marine Cartographer. In July 1981 I became a Field Hydrographer with our present Field Surveys Division. During this period I was involved in hydrographic surveys throughout the Great Lakes, Hudson Bay and the high Arctic, and also participated in the CHS/NOS (National Ocean Service of NOAA) exchange program, throughout the continental United States. In 1987 I once again joined the Chart Production Division as a Cartographic Supervisor.



I hope to maintain the fine editorial standards set by George, and the previous editors. However, the production of Lighthouse also depends on the efforts of the entire editorial team and the membership. We rely on continued support of Lighthouse by all CHA members as well as others in the International, and Canadian, hydrographic community. We welcome your input through the submission of reports, advertising, letters, and comments. All contributions will be very much appreciated.

Finally, I would like to thank my wife JoAnne for putting up with me through all of the long nights and weekends spent working on this 'first' edition.



Lighthouse Pin

Commencing with edition 27 (April 1983), a sterling silver pin has been awarded to all first-time writers of articles published in LIGHTHOUSE. This quality piece of jewelry, inlaid with an emerald-like gem, is being worn proudly by 104 different authors.

YOU can join this elite group by having your paper published in LIGHTHOUSE.

Remember that a maximum of two pins are awarded per article. Please let the editor know the identity of the primary authors so that the "Pin Man", Ray Chapeskie, can quickly forward these coveted keepsakes to LIGHTHOUSE's most valued contributors.

Message from the National President

I would like to take this opportunity to provide the general membership with a brief 'curriculum vitae' of myself. My name is David G. Pugh and my past involvement with the CHA has included terms as Central Branch Vice-President and Branch Secretary-Treasurer. In addition I have been Social News Editor of Lighthouse.

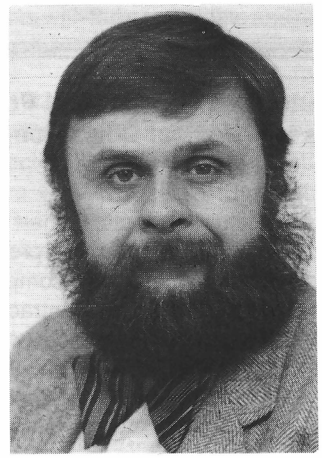
The Canadian Hydrographic Service, Central and Arctic Region, has kindly consented to be my employer for the past sixteen years where currently I am Hydrographer-in-Charge of Arctic Surveys. I have worked throughout the Great Lakes, Hudson Bay and Arctic Archipelago areas as mandated by Central and Arctic Region.

Academically I have an Honours Bachelor of Science degree (Earth Sciences) from the University of Waterloo and hold a Canada Lands Surveyor Commission.

Domestically, I am happily married with two children.

My term of office as CHA National President not only marks a change in personnel of the board of directors but also a change in editorship of Lighthouse. The past Board of Directors and Editor of Lighthouse have completed and initiated many beneficial projects. To maintain this momentum requires continued support from our 500 members.

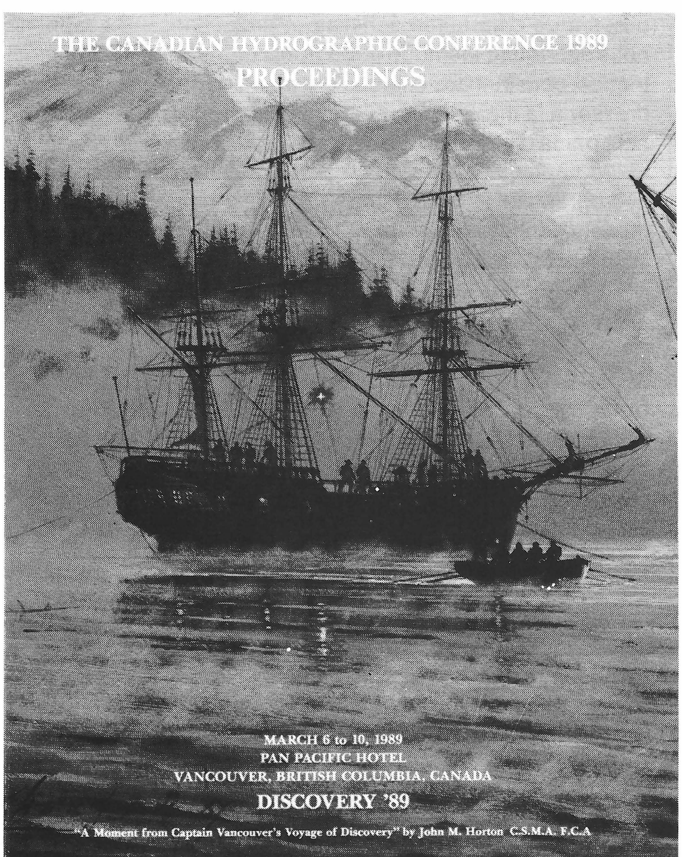
Communication is a key aspect of our organization. This can be accomplished either by passing technical information via seminars,



workshops or association-supported Technical reports, or by socializing at Branch, National and International functions. Each provides an excellent forum for the exchange of ideas and information. Please feel free to communicate your ideas, concerns or interests to the CHA Executive.

In this regard, perhaps a theme for the coming year could be "nautical chatting in the nineties".

Regards,
Dave



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Lighthouse Abstracts / Résumés pour Lighthouse

The Automatic Selection of Prime Soundings for Nautical Chart Compilation

by

S. Zoraster

The selection of soundings for nautical chart compilation is still a major concern in the automation process of chart production. This paper describes a new computer sounding selection algorithm, produced under contract for the U.S. Department of Commerce, which can be used to support nautical chart compilation, and discusses subsequent test results from two existing National Ocean Service charts.

La sélection automatique de sondes de première ordre pour la compilation de cartes marines

par

S. Zoraster

La sélection des sondes pour la compilation de cartes marines est encore d'une préoccupation importante tant qu'au processus de production automatisée des cartes. Ce rapport nous décrit un nouveau algorithme de sélection de sondes par ordinateur, réaliser sous contrat pour le "U.S. Department of Commerce", qui peut être utiliser pour supporter la compilation de cartes marines et discute les résultats d'épreuves subséquents de deux cartes courantes du "National Ocean Service".

Digital Depth Model and Automated Contours

by

J.S. Warren, L.G. Boone and P. Guibord

Contouring maps by hand is time-consuming and the results are often inconsistent without professional expertise. Maintaining and updating hand-drawn bathymetric contours is expensive. Automated contours can be more easily updated, and are more easily incorporated into other map projects that use different scales and projections. This paper describes a method that allows digital bathymetric data to be contoured by machine, in much the same way as the data would be contoured by hand. "CONTOUR", a computer program designed and written by the Ocean Mapping Division of the Canadian Hydrographic Service works with hydrographic field data, creates digital contours and produces a Digital Depth Model from the data set.

Un modèle de profondeurs numériques et les courbes automatisées

par

J.S. Warren, L.G. Boone and P. Guibord

Le dressage des courbes de niveau à la main, prends beaucoup de temps et le résultant est souvent incohérent, sans de bonnes connaissances techniques. Le maintien et mettre à jour des courbes bathymétriques fait à la main est coûteux. Les courbes automatisées sont mise à jour plus facilement et sont plus aisément incorporées à des cartes utilisant de différantes échelles et projections. Ce rapport nous décris une méthode qui, d'après des données bathymétriques, construit des courbes par machine semblable à ceux dresser à la main. 'CONTOUR' est un programme conçu et écrit par la division de 'Cartographie des océans' du Service hydrographique du Canada qui agis sur une base de levés hydrographiques, crée des courbes numérisées et produit un modèle de profondeurs provenant de la base de données.

A Cartographic Tale a Half-Century Old

by

W. Covey

In this nostalgic article, Bill Covey relates his experiences as a student draftsman hired by the Geological Survey of Canada in 1939 and describes the working conditions, and pay, in the Civil Service during this era.

Un récit cartographique vieux d'un demi-siècle

par

W. Covey

Dans cet article nostalgique, Bill Covey nous transmêt ses expériences d'étudiant, engager par la Commission géologique du Canada en 1939 et décrit les conditions de travail, et salaires d'un fonctionnaire, durant cette époque.

Validation

by

J.R. MacDougall

The concept of 'validation' of data, as applied to hydrographic data, is explored from different viewpoints, including; why explicit validation is becoming important; different levels of validation; and identifying possible steps that hydrographic organizations can take to validate data for the information age.

Validation

par

J.R. MacDougall

La notion de 'validation' des données, tel qu'appliquée aux données hydrographiques et investiguée de différentes perspectives, tel que; pourquoi la validation explicite devient importante; les différents niveaux de validation, et l'identification des étapes que les organismes hydrographiques prendrerons pour valider les données dans l'age de l'informatique.

Lighthouse Abstracts / Résumés pour Lighthouse

GPS and the Electronic Chart will go a Long Way towards Preventing Tanker Groundings

by

R.M. Eaton

Many of the recent tanker groundings (Amoco Cadiz, Exxon Valdez, etc.) could have been avoided with the use of Differential GPS positioning and the Electronic Chart. This paper looks at the causes of ship groundings and how these two navigation tools could be used for prevention. The present status of GPS, Electronic Chart development, and navigational regulations are also examined.

La Carte électronique et le système de positionnement global (GPS) seront de bonne augure pour éviter l'échouage des pétroliers

par

R.M. Eaton

Plusieurs des échouages récents (Amoco Cadiz, Exxon Valdez, etc.) auraient put être éviter avec l'aide du GPS différentiel et la carte électronique. Ce rapport nous décris les raisons d'échouages et comment ces deux outils de navigation pourront être utilisés pour la prévention. L'état présent du GPS, le développment de la carte électronique, et les règlements de navigation sont aussi examinés.

Marine DGPS Using Code and Carrier in a Multipath Environment

by

G. Lachapelle, W. Falkenberg, D. Neufeldt and P. Kielland

The operational constraints of Differential GPS in the marine environment are reviewed. In particular, the problem of recovering the initial baseline, i.e., the initial coordinate differences between the shore-based monitor station and the vessel is discussed. The recovery of this initial baseline requires the use of code measurements. However, the relative positional changes of the vessel are best determined using the relatively more accurate carrier phase measurements. A procedure to combine both code and carrier phase measurements to achieve the above goal in an operationally acceptable manner is discussed. An external accuracy of 5 metres (at the 95% confidence level) can generally be obtained with this method. However, code measurements can be affected significantly by multipath, which can decrease the reliability of the above method to an unacceptably low level. Two multi-path counter-measures are discussed and tested, namely the use of a RF absorbent ground plane made of carbon impregnated foam at the monitor station and the use of paralell filters at both the monitor and mobile stations. These methods reduce the effect of code multipath to a level sufficiently low to maintain the accuracy quoted above in a high multi-path environment.

Le Système de positionnement global (GPS), différentiel marin, son code et onde porteuse, dans un environnement de transmission sous plusiers angle

par

G. Lachapelle, W. Falkenberg, D. Neufeldt and P. Kielland

Les contraintes d'opérations du GPS différentiel dans un environnement marin sont examinées. En particulier, le problème de récupération de la ligne de base, exemple: les différences initiales entre les coordonnées de la station réceptrice et le navire sont discutées. La récupération de la ligne de base requiert les mesures de codes. Toute fois, les changements relatif des positions du navire sont mieux déterminer en utilisant plus précisément la mesure de phase de l'onde porteuse. Une procédure pour combiner les deux méthodes de mesures de code et de phase de l'onde porteuse, pour obtenir le but mentionner dans une mode d'opération acceptable, est discutée. Un degré de précision externe de cinq mètres (à un niveau de confiance de 95%) peut être atteint avec cette méthode. Cependant, les mesures de codes peuvent être influencées considérablement par la transmission sous plusieurs angles; ce qui peut réduire la fiabilité de cette méthode au point où elle devient innacceptable. Deux contre-mesures pour la transmission sous plusieurs angles sont discutées et mis à l'épreuve; c'est à dire, l'emploi d'un absorbant de fréquences radio, plan à terre, fait de caoutchouc mousse, saturé de carbon, situé à la station d'écoute et l'emploi de filtres parallels à chacune des stations d'écoute et de relais. Ces méthodes réduisent l'effet d'échos du code, à un niveau suffisament bas pour maintenir la précision mentioné auparavant dans un environnement de hautes échos.

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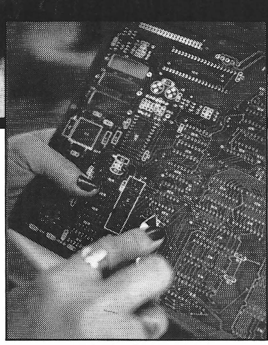

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The Automatic Selection of Prime Soundings For Nautical Chart Compilation

by
S. Zoraster

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Introduction
All nautical charts include soundings posted to provide detailed information about the shape of the ocean bottom and about the density of the sounding data from which the depth curves on the chart were derived. Today the selection of soundings for chart display is performed by tedious and costly manual methods. This paper describes research on a new computer algorithm which selects "prime soundings" for display on a nautical chart from a set of soundings provided to support chart compilation. Prime soundings are those soundings selected for chart display to provide detailed information about the shape of the ocean bottom between depth curves. To a chart user trying to navigate outside designated channels, prime soundings are the most important soundings on the chart.

The two most important goals of the prime sounding selection research were; to implement a prototype sounding selection algorithm; and to test that algorithm using real hydrographic data. This research was performed for the National Ocean Service (NOS) which is part of the National Oceanic and Atmospheric Administration (NOAA). A detailed description of the algorithm and the research completed is contained in [11].

The Sounding Selection Problem
Sounding selection can have different meanings depending on which part of the hydrographic data collection, data analysis, and nautical chart compilation process is being considered. Most sounding selection algorithms which have been presented in the hydrographic literature are "thinning" algorithms designed to choose from a complete survey a dense set of important soundings to be displayed without overplotting on a smooth sheet (field sheet in Canadian usage) [2,3,4]. "Cartographic" sounding selection, which includes prime sounding selection, involves selecting for chart display a subset of the soundings on a smooth sheet to convey to the chart user specific information about the shape of the ocean bottom between depth curves or about the survey data from which the chart was compiled.

There are three types of cartographic soundings on a nautical chart. Those soundings that detail the significant fine structure between depth curves are called "prime soundings." Soundings that show the shallowest depths encountered when following the deepest part of a natural channel or river are called "controlling depths" or "limiting depths". Because these two types of soundings are so important to safe navigation, they are sometimes characterized together as "critical soundings". Soundings displayed on a chart that are not critical soundings are called "background soundings". Background soundings provide the chart user with information about the location and density of the survey data from which a chart is compiled.

Cartographic sounding selection has long been recognized as a potentially critical bottleneck in the automation of chart compilation. Research performed for NOAA between 1978 and 1981 produced reports analyzing the sounding selection process, and also produced research software designed to automatically select prime and background soundings for chart display [5,6,7]. The algorithm developed for prime sounding selection picked prime soundings according to the amount of deviation between the true depth of each sounding and a computed "expected" depth for the sounding. Least squares interpolation based on depth curves and previously selected soundings was used to calculate the expected depth at each sounding location. The algorithm developed for background sounding selection picked new background soundings to fill a triangular pattern of soundings starting from a set of "seed" soundings provided by the prime sounding selection algorithm. These two algorithms have not been used in chart production. More recently, there have been attempts to extend the use of data thinning algorithms to handle cartographic sounding selection [4], but again these algorithms have not been accepted for use in regular chart production.

The Prime Sounding Selection Algorithm
The choice of prime soundings for chart display is highly dependent on the ocean bottom features marked by chart depth curves. Prime soundings show significant deviations in the ocean bottom from what would be expected by linear interpolation between nearby depth curves and between depth curves and the other prime soundings shown on the chart. In fact, because depth curves are so important in delineating ocean bottom features, soundings selected on one side of a depth curve have little influence on the selection of soundings on the other side. The importance of depth curves to the sounding selection process, and the assumption of linear interpolation between depth curves and other soundings, are critical to understanding the prototype prime sounding selection algorithm.

The automated sounding selection algorithm tested for this project is simple in concept. First build a model of the ocean bottom honoring only the depth curves and shorelines shown on the chart; next detect soundings which show significant deviation from that model; then update the model to reflect the selection of those soundings; and finally repeat the sounding selection and model updating process until no more soundings are candidates for selection.

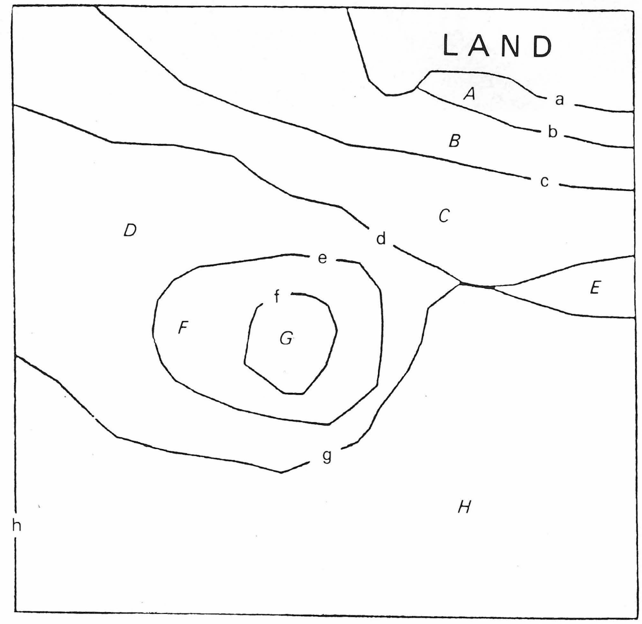
A grid-based ocean bottom modelling scheme relying on linear curve-to-grid interpolation and constrained iterative smoothing of the grid are used in the sounding selection algorithm. The curve-to-grid algorithm provides the starting point from which the first sounding deviations are measured. Constrained smoothing of the gridded ocean bottom model provides support for the iterative phase of prime sounding selection by adjusting the model to honor selected soundings as well as the original input depth curves. Grid smoothing is performed using a biharmonic convolution operator or a combined biharmonic-Laplacian convolution operator. Both smoothing operators are implemented using a successive-over-relaxation algorithm [10]. The biharmonic operator creates an ocean bottom model which approximates a two dimensional spline function [1] near selected soundings, while the biharmonic-Laplacian operator creates a more linear model [9].

The curve-to-grid interpolation program performs linear interpolation between data curves in a manner similar to the interpolation performed by a chart user navigating between depth curves [8]. After the ocean bottom model is built, the next step in the sounding selection algorithm is to segment the soundings into independent partitions corresponding to ocean bottom areas surrounded by depth curves, shorelines and chart boundaries. Figure 1 shows a possible partition scheme for a particular set of depth curves. The method used to segment the ocean bottom model uses a second auxiliary grid the same size as the ocean bottom model grid. Each sounding is assigned to an ocean bottom segment by finding its position relative to this grid.

Once the initial ocean bottom model is initialized and all the soundings are assigned to ocean bottom segments the actual sounding selection process can start. Based on the ocean bottom model, residuals are calculated at each sounding which has not previously been selected for display or otherwise eliminated from further consideration. Residuals measure the normalized difference between the true sounding depth and the depth implied by the ocean bottom model. The residuals for each segmentation of the ocean bottom are compared with one of two tolerances, one tolerance for soundings that are shallower than the current ocean bottom model and one tolerance for soundings that are deeper. The tolerance for the shallower soundings is usually smaller than the tolerance for the deeper soundings. Both tolerances are expressed as fractions of a depth curve interval. Residuals are also expressed as a fraction of the interval between two depth curves and are calculated by the formula:

$$\frac{\text{(sounding depth - model depth)}}{\text{(deeper curve depth - shallower curve depth)}}$$

Soundings shallower than the model will have negative residuals and soundings deeper than the model will have positive residuals.



Area	Boundary Curve
A	a,b,h
B	b,c,d,h
C	c,d,h
D	d,e,g,h
E	d,g,h
F	e,f
G	f
H	g,h

Figure 1: Sounding Segmentation: Area Bounded by Curves

When all soundings have been assigned a residual, the algorithm locates the maximum absolute residual for each segmentation area, and if the residual exceeds the tolerance with the same sign then that sounding is selected for display as a prime sounding. (On the first pass through the loop, the sounding with the largest negative residual is always selected whether it exceeds the threshold or not. This ensures that at least one sounding showing the least depth will be selected in each bounded area.) After a sounding is selected, all soundings in a neighborhood around that sounding are discarded. This prevents their selection in the future and any overplot conflicts in sounding symbolization that might result from their selection.

Once a selection has been made within each area, the ocean bottom model is adjusted to reflect this new information. This is the point in the prime sounding selection algorithm where constrained grid smoothing comes into play. Grid smoothing adjusts the ocean bottom model near each selected sounding to smoothly integrate the selected sounding data into the model. The grid node closest to each selected sounding is changed so that its depth is the same as that of the selected sounding and then is marked so as to remain unchanged through all subsequent processing. All grid nodes in a rectangular window around that node are then marked for smoothing. The ocean bottom model grid is now subjected to multiple passes by the smoothing operator. Only free grid nodes are allowed to change value. Those nodes in the ocean bottom model that are fixed do not themselves change value, but their values are used in the flexing of neighboring nodes. The smoothed ocean bottom model should again approximate the depths that would be obtained by interpolation between the chart depth curves and all previously selected soundings, including those selected on the current iteration of the sounding selection algorithm.

After grid smoothing, sounding residuals are again calculated and again the soundings with the largest residuals that pass the threshold tests are selected, one for each segmented area of the ocean bottom model. Again, soundings near the selected sounding are discarded, the ocean bottom model is adjusted by smoothing, and the whole process repeated until all prime soundings have been selected. The sounding selection process stops when the maximum residual for all not yet selected soundings falls below the two threshold levels.

Algorithm Testing

The prototype prime sounding selection algorithm was tested against two hydrographic data sets supplied by NOS. Both data sets included charts, smooth sheets, and digitized soundings. The soundings on the smooth sheets covered only small portions of each chart. One data set covered part of NOS Chart 12284 "Patuxent River, Solomons Island and Vicinity", in Chesapeake Bay, and the other data set covered part of Chart 11324 "Galveston Bay Entrance", in the Gulf of Mexico. Both charts are at a scale of 1:10,000. Depth curves were digitized from the charts; an initial ocean bottom model was developed using the curve-to-grid interpolation program; and then the selection algorithm was run repeatedly using several different sets of algorithm parameters.

Chart 12284 shows part of the Patuxent River passing near the Solomons Island into Chesapeake Bay. The chart had depth curves at 6, 12, 18, 30, 36 and 60 feet. The deepest sounding shown on the chart inside the area covered by the available sounding data was at 123 feet. The ocean bottom model built by the curve-to-grid interpolation program had a grid spacing of 30 metres, with 187 rows and 231 columns, and covered an area with approximately the following dimensions:

Min. Longitude:	76°, 29', 30" (W)
Max. Longitude:	76°, 25', 00" (W)
Min. Latitude:	38°, 17', 10" (N)
Max. Longitude:	38°, 20', 00" (N)

The total number of soundings available for selection in the grid area was 7,122. Of these available soundings, a total of 242 were selected by the soundings selection algorithm using the combined biharmonic-Laplacian grid smoothing operator, and 219 were selected using the bi-harmonic operator.

As part of the algorithm evaluation for Chart 12284, algorithm selected soundings were counted and assigned into four categories. Those categories were:

1) Soundings which matched prime soundings on the chart.
2) Soundings which were good choices for prime soundings even though they did not closely match soundings shown on the chart.
3) Soundings of uncertain status, for example, soundings in areas in which it was difficult to distinguish between background soundings and prime soundings.
4) Soundings which obviously should not have been selected.

The selected soundings were assigned to selection categories as shown below in Table I.

	Combined Filter	Bi-harmonic Filter
Matched soundings on the chart:	105 (43%)	91 (42%)
Reasonable alternatives to soundings on the chart:	79 (79%)	81 (37%)
Uncertain status:	45 (45%)	31 (14%)
Obviously wrong soundings:	13 (13%)	16 (7%)
Total selected:	242 (100%)	219 (100%)

Table I: Allocation of automatically selected soundings to categories for Chart 12284.

Figures 2, 3, 4 and 5 show a small part of Chart 12284, the soundings available for selection in that area, and the soundings selected by the prototype algorithm using bi-harmonic and combined bi-harmonic-Laplacian grid smoothing.

Chart 11324 shows the entrance to Galveston Bay. On the right is the Gulf of Mexico and on the left, Galveston Bay. The sounding data set provided by NOS covers a large area in the center of the chart at the Bay entrance between Bolivar Peninsula and Pelican Island. This area is crossed by the marked Bolivar Roads ship channel, the Inner Bar ship channel, and small parts of other ship channels. It has one large outlined anchorage area, and one large and several small spoil areas. Numerous warnings about submerged piles and other features important to navigation appear on the chart. The chart has depth curves at 3, 6, 12, 18, and 30 feet. The deepest sounding shown on the chart in the area covered by the test data was 49 feet, right on the edge of the Inner Bar ship channel. The ocean bottom model used during the tests had a grid spacing of 40 metres, with 204 rows and 309 columns.

The total number of soundings available for selection in the grid area was 12,913. The sounding data was from a survey more recent than the survey used to compile Chart 11324 and there were some significant differences between the ocean bottom model represented by the chart and the model implied by the soundings. Of the available soundings, a total of 255 were selected by the prototype prime sounding selection algorithm using the combined biharmonic-Laplacian grid smoothing operator. Because of the discrepancies between the sounding data and the chart and the complexity of the ocean bottom on the chart, the algorithm selected soundings were not assigned to the same four categories used for Chart 12284. However, of the selected soundings, approximately 50% either matched prime soundings shown on the chart or were reasonable alternatives to soundings shown on the chart. Less than 15% of the automatically selected soundings should not have been selected, and the majority of these were in steep areas where the algorithm tended to over-select soundings.

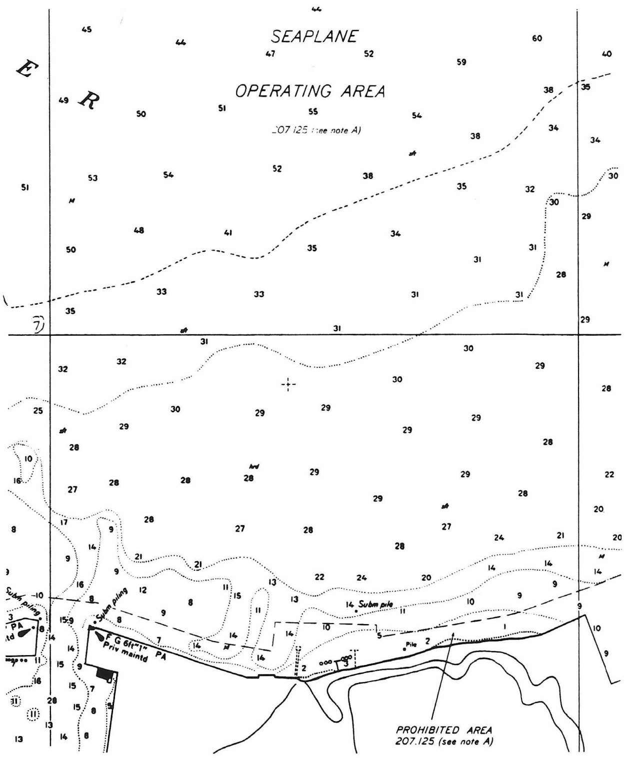


Figure 2: Detail from Chart 12284.
Vertical grid lines are at 76°, 26' (W) and 76°, 27 ' (W).
Horizontal grid line is at 38°, 18' (N)

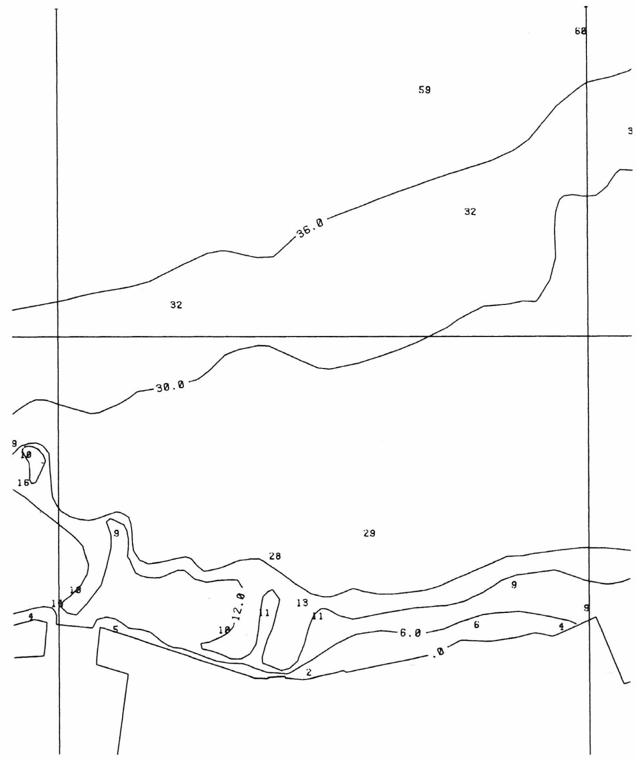


Figure 4: Automatically selected prime soundings using biharmonic grid smoothing

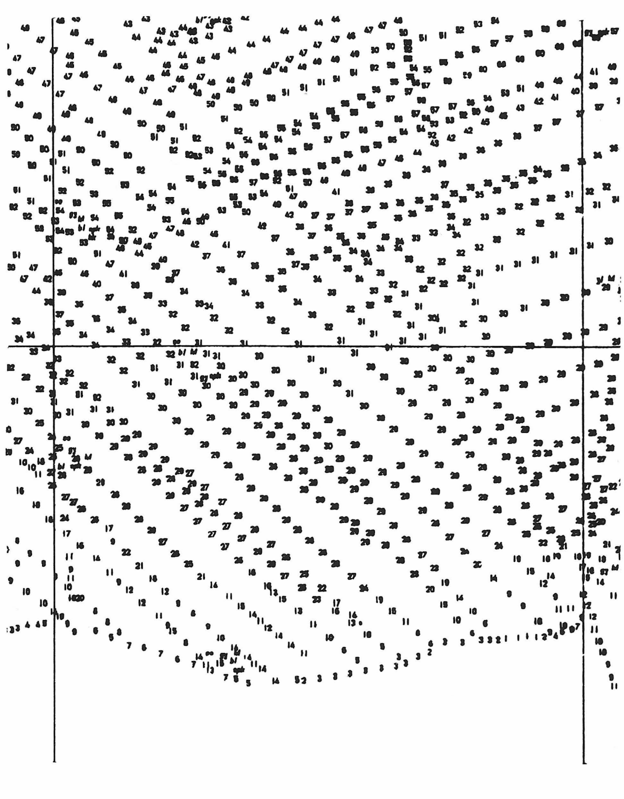


Figure 3: Soundings available for selection.
(Over the same section of chart 12284)

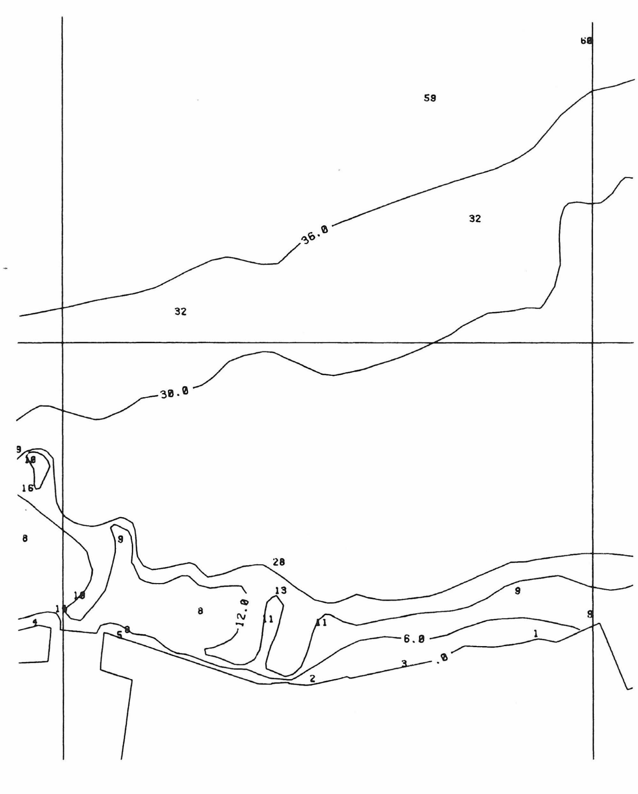


Figure 5: Automatically selected prime soundings using combined biharmonic-Laplacian grid smoothing

Discussion of Test Results

The prototype prime sounding selection algorithm selected many of the same prime soundings shown on the two test charts, and many of the algorithm-selected soundings not on the charts were reasonable alternatives to the charted soundings. Only a few of the soundings on the two charts, which were obviously prime soundings and which were available in the test data, were not chosen by the prototype algorithm.

Based on the comparison of the algorithm-selected soundings for chart 12284 and the soundings displayed on the chart, over 40% of the automatically selected soundings were the same as, or very close to, manually selected soundings. Over 30% of the algorithm-selected soundings were obvious alternatives to prime soundings shown on the chart. The remainder of the algorithm selected soundings, about 20%, would mostly have been candidates for selection as background soundings or prime soundings. A small percentage, between 5% and 7%, should not have been selected at all. Many of these erroneous choices could have been eliminated by the addition of more complex software logic in a production oriented sounding selection algorithm. Only a very few of the obvious prime soundings on Chart 12284 were not selected by the algorithm. No formal attempt was made to quantify the algorithm results for Chart 11324, primarily because of discrepancies between the test data, and the soundings and depth curves shown on the chart. However, the results obtained for that chart were also encouraging.

The prototype algorithm proved to be sensitive to the ocean bottom model grid spacing. For example, a sounding on one side of the depth curve may appear to be on the other side when the only data available is the depths recorded at nearby grid nodes. However, the number of algorithm errors caused by the use of a grid-based ocean bottom model is relatively small. A triangulated irregular network (TIN) to model the ocean bottom was considered as an alternative and rejected since TINs are difficult to build from contour data, mathematical algorithms to smooth TINs are not well developed, and because a TIN defined on a large set of soundings is likely to take up a very large amount of computer memory. Some additional selection errors can be eliminated by requesting additional input data to characterize shape of the ocean bottom, and by processing improvements to various algorithm sub-routines.

Typical CPU times required by the prototype sounding selection algorithm were between 1 1/2 and 2 1/2 hours on VAX 750 and VAX 3500 computers. The overwhelming majority of the CPU time for the algorithm was spent executing the grid smoothing module. This step accounted for well over 80% of the time on all runs. No other part of the algorithm required over 10% of the time.

Conclusions

Based on the results obtained during this research effort, a computer algorithm using a gridded model of the ocean bottom and iterative grid smoothing appeared to be a practical aid for primesounding selection. The prototype algorithm selected many of the same soundings chosen manually by cartographers for chart display. Furthermore, the algorithm had a relatively small error rate as measured by the small number of algorithm-selected soundings that were obviously not prime soundings, and the small number of obvious prime soundings that were not selected by the algorithm.

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A Digital Depth Model and Automated Contours

by
J.S. Warren, L.G. Boone, and P. Guibord

Introduction

Manual contouring in map compilation is a labourious task. In areas of rough terrain or in sparsely surveyed areas, several iterations may be required before the area is satisfactorily contoured by hand. When more than one person contours adjacent map areas, the contours are subject to individual methods of interpretation and unique style. Maps contoured by hand therefore, are not always consistent and may vary in their uniformity.

A useful automated contouring package must be of assistance to the hydrographer or cartographer. The results must be consistent, and the package must be flexible to suit the user's specialized needs. A decrease in production time and an increase in production output are important features, but the most important feature of an automated contouring package is for the contours to be representative of the field data.

Some early-generation, as well as some contemporary, automated contouring packages, intended for random data sets, created contours that did not always honour all of the hydrographic data. Most of these packages fitted a grid to the data, and then determined a depth value for every cell, replacing the field data with interpolated values. Often there were inadequacies in the methods by which the cell values were interpolated. These packages used the assumption that the data were random, rather than time-series, and replaced the field data with values that had been interpolated from data on other tracks.

A computer program named "CONTOUR" was designed and written by Lewis G. Boone and John S. Warren of the Ocean Mapping Division of the Canadian Hydrographic Service (CHS) in 1989. This program places a grid over the map area, retains the field data, interpolates secondary depth values, produces a Digital Depth Model for bathymetric data, and creates contours. The resultant contours are interpolated, but not extrapolated beyond the limit of the data. This program does not generate contours unsupported by the field data, nor does it replace the field data with interpolated values. Field data are retained and used in the interpolation of all other data required to provide a Digital Depth Model. Contour maps are created with user-selected combinations of contours and/or the values in the Digital Depth Model.

Digital Depth Model

Bathymetric Data

Most bathymetric data (water depth and position) are collected from a track profile of depth versus distance. A bathymetric (hydrographic) survey usually consists of a series of parallel tracks of data, intersected by various other tracks (checklines). Bathymetric depths that are gathered along track are a continuous, rather than random stream of data. The sequence that was used to capture the data, when plotted, depicts the survey track. It is important that the bathymetric data retain this characteristic in order to allow, among other things, a linear interpolation between successive depths. Without this time-series characteristic, the data appear to be random; apparently successive data points may in fact belong to different tracks, and a linear interpolation between those data points would not be appropriate.

In the areas between intersecting tracks, where there are no field depth data, polygons are formed, with the polygons bounded by track segments. An interpolation of the values within these polygons should be based only on the bathymetric data that lie on the polygon boundaries.

"CONTOUR" first subdivides the map area into grid cells. To produce a Digital Depth Model (DDM) field data are interpolated to provide depth values for every grid cell. The field data and their exact locations are retained, but in the case where two or more depths occupy one grid cell, the grid cell will be assigned the value of the shoalest depth.

There is a link between successive field data points (the track). Between two successive field data points, the track may pass through other empty grid cells. The depth value assigned to these grid cells is determined by a linear interpolation between the two field data points that bracket the empty grid cell. Next, a sixteen-ray regression interpolation is employed in the assignment of depth values to the remaining empty grid cells. The interpolation along track and between tracks is explained in detail in the next section.

Interpolation Along Track

When an empty grid cell lies between two successive field depths from the same track segment, the program calculates a depth value by a linear interpolation between each of the two adjacent field depths. The linear interpolation is based on the magnitude of and distance to the field depths on either side of the grid cell in question.

If there are grid cells that are intersected by more than one track, only one depth value is assigned. In the case where a grid cell is occupied by a field data point, the field value supercedes all interpolated values from other tracks, even if the interpolated values are shallower. Should there be more than one field depth value in the grid cell, then the shallowest is assigned. Should there be more than one linearly interpolated depth value in the grid cell, then again the shallowest is assigned. At this stage of development, the selection of the shallowest depth for every grid cell provides a process similar to overplot removal tailored to the scale of the project.

Interpolation Between Tracks

After all grid cells intersected by tracks have been assigned a depth, either from the field data or by linear interpolation, the remaining empty grid cells that do not lie on any track are addressed. The depth values for these grid cells are interpolated by regression. A sixteen-ray regression technique is employed, where field data and linearly interpolated data that lie along the polygon boundaries surrounding the grid cell are used to obtain the depth value. As shown in Figure 1, sixteen rays radiate from the centre of each empty grid cell at 22.5 degree intervals. The rays continue until they encounter a grid cell occupied by either a linearly interpolated depth or by a field depth. This value and the length of the ray are used to calculate a likely value for the empty grid cell. More emphasis is given to the depth values at track intercepts that are closer to the empty grid cell. There are occurrances where some of the rays will not encounter tracks, ie. map borders or data limits. At least two rays must encounter track intercepts, and they must be no more than 22.5 degrees apart in order for a depth value to be calculated for an empty grid cell. When all possible grid cells have been assigned a depth value, a Digital Depth Model has been created.

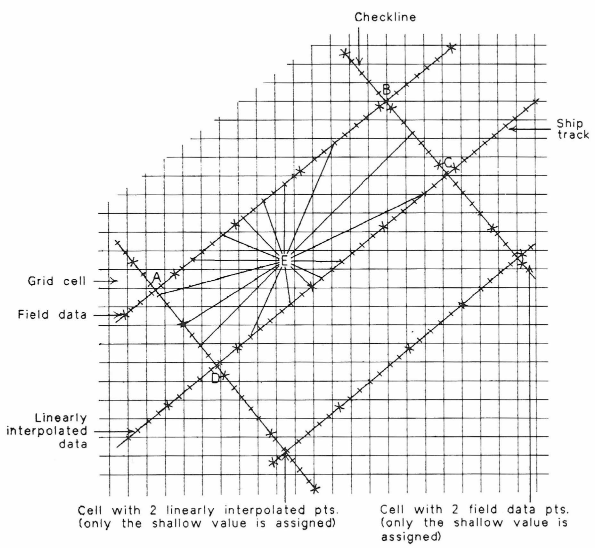

Figure 1: Hydrographic field data with grid overlay
ABCD is a polygon formed by intersecting track segments. Depth values for grid cells lying along tracks have been linearly interpolated. Depth values for grid cells such as 'E', between tracks, are interpolated using a16 ray regression interpolation technique, based on the data from the polygon bounded by ABCD

The calculations for the regression interpolation are based on the equation:

$$\frac{E}{i} = \frac{\sum D * \frac{1}{d^{n}}}{\sum \frac{1}{d^{n}}}$$

Where:
- D = the depth value at each track intercept
- d = the distance from the centre of the empty grid cell to the track intercept
- n = the weighting factor
- E = the value for the empty grid cell
- i = the sum of the series from 1 to 16 (the contribution of each of the sixteen rays)

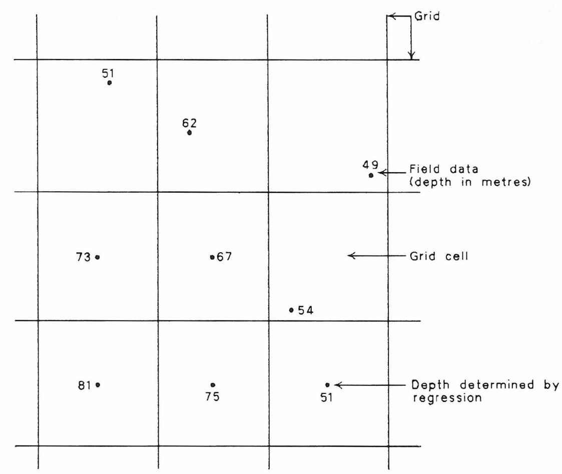

Figure 2: Enlarged grid cell area indicating field depth values (random locations) and depth values determined by the 16 ray regression technique

There is a default grid cell size computed by the program, based on the average distance between data along survey track segments, tempered by the number of depths that a certain size of grid cell will cause to be dropped. The intention is to minimize the number of field data dropped, and maximize the occurrence of one field depth per grid cell. The program user can override this default grid cell size.

A small grid cell size results in a highly detailed contour plot, with a satisfactory representation of most of the field depths when only one depth is contained in any one grid cell.

A large grid cell size may give a more generalized, less accurate view of the seafloor since deeper data will not be considered if there are shallower data in the same cell. The DDM also provides information useful in creating three-dimensional views or other modelling applications.

When each grid cell has been provided with a depth value, the data can be contoured. In the process of determining the grid cell values, we have created three types of bathymetric data:

1. The original or field depth data, as captured from a hydrographic survey;
2. Depth values that were linearly interpolated between the field data along track; and
3. Depth values within track polygons that were interpolated by regression.

These data are categorized in order of importance when more than one type of data is assigned to any one grid cell (ie. '1' takes precedence over '2' and '3', and '2' takes precedence over '3'). The grid cells and their depth values form the Digital Depth Model.

Contour Generation

Contour Cells

After all the grid cells have been assigned depth values, the

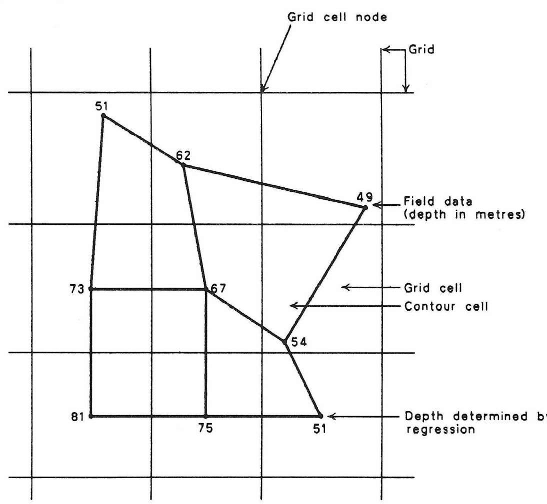

Figure 3: Field and Interpolated data linked to form contour cells.

Depth values will be determined at the grid cell nodes, to avoid the dilemna when two different values are interpreted at contour cell diagonal intersections.

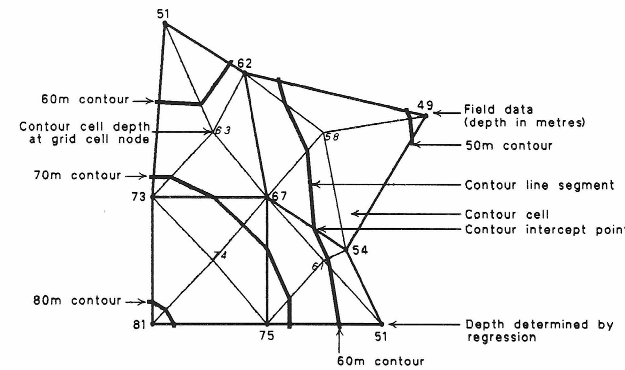

Figure 4: Contour Line Generation.

Contour cell depth values are inserted at grid cell nodes, then all data are linked to adjacent depth values. Contour intercepts are then determined by linear interpolation and are joined forming contour line segments. The contour lines are then smoothed

locations of these depth values are used as the nodes of a contour cell system (Figure 3). This cell system is not symmetrical, because the field depth data are retained along with their exact locations, which are not necessarily in the centre of the grid cells. Adjacent depth values from within the grid cells form the corners of this new contour cell system.

The contour cells are then subdivided to form four triangles. Each node of the original grid cell system, located within a contour cell, is then joined to each of the four surrounding contour cell depth values. The depth value of the grid cell node is then determined by a weighted average (1/d**2) of the four contour cell node values.

Contour Output

Contour intercepts are linearly interpolated between each connecting pair of depth values, and contour lines are drawn by connecting all of the adjacent contour intercepts.

The contours can be generated at any interval. They honour the grid cell values and are more representative of the original data when the grid cell sizes are kept small. The contour cell geometry controls the shape and direction of the contours between the depth values. The contour values are specified by the user. This, for example, allows the user to bias the contours on the shallow side of the data, or to bias on the deepside. For example, specifying a contour value of 10.05 metres will result in the contour encircling all depths less than 10.049 metres. Similarly, specifying a contour value of 9.950, will exclude depths greater than 9.951 metres.

Conclusion

This new computer program "CONTOUR" has the potential to be a very powerful tool. It has been tested on dense and sparse data sets, and compares favourably to both hand-drawn contours and the output of other contour packages. One of its strengths is the fact that it recognizes that hydrographic survey data are not random and that there are different relationships between soundings along tracks and between tracks.

It is necessary to give any new contour package a rigorous test employing typical data. All seafloor terrain types as well as both sparse data and dense data sets, must be tested. In this way we can appreciate the strengths and weaknesses of new packages. Only when we find or create a contouring program that gives satisfactory results in all circumstances can we feel confident about the resultant contours.

To achieve this result, "CONTOUR" will be made available to other CHS user groups. Default parameters are presently being designed so that the program will calculate certain input, and other default parameters will be determined through the testing on the various data sets. This computer program works with hydrographic field data in the interchange (NTX) format. The digital contours, as well as the Digital Depth Model, produced from a digital data set, using this program, can be used with the Geographic Information System, CARIS (Computer-Assisted Resource Information System), currently used by the CHS.

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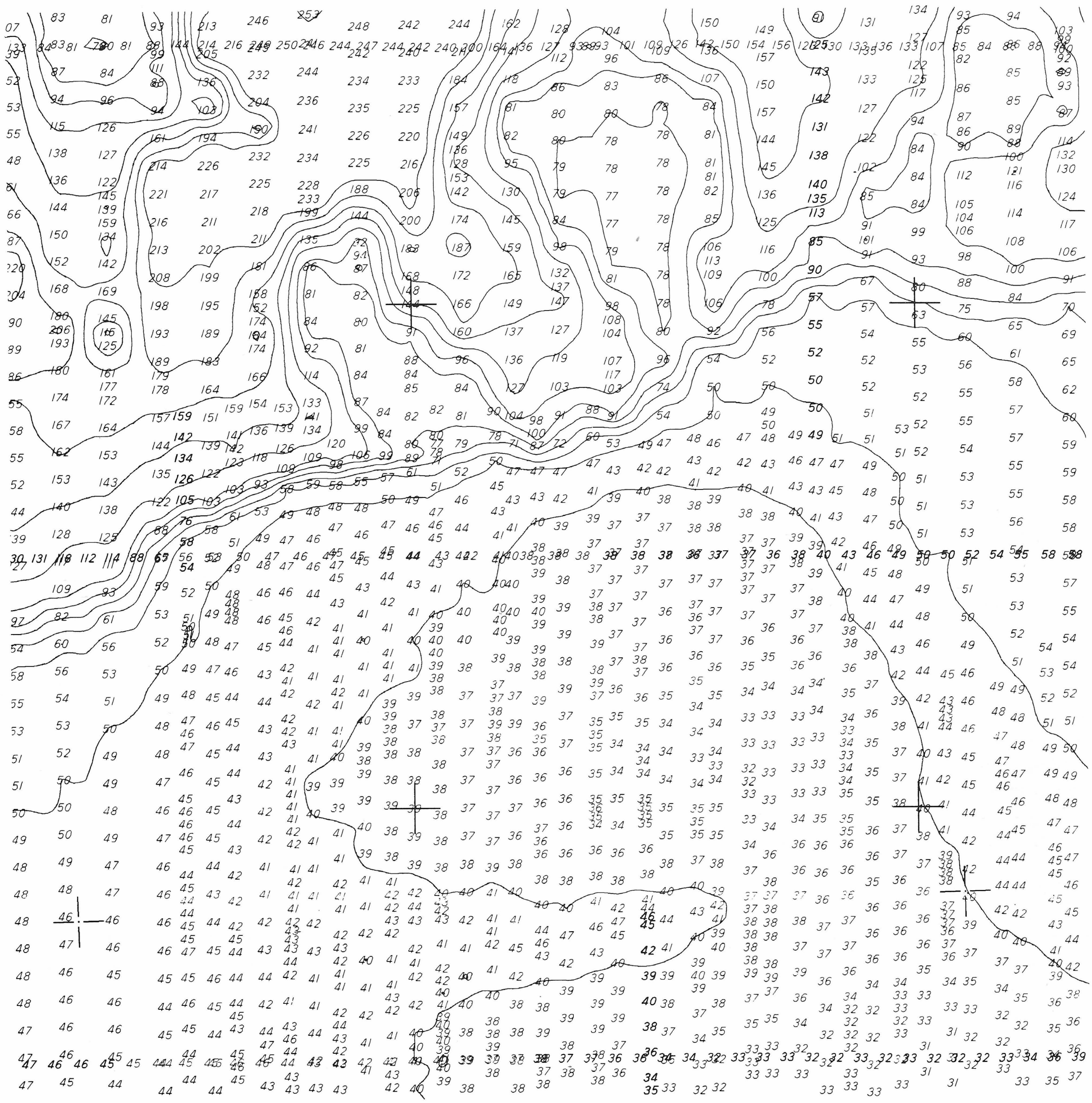

Figure 5: Example of field sheet contours generated by the "CONTOUR" package.
From a portion of CHS Field Sheet 9070 (Scotia-Fundy Region). Soundings are from a digital NTX file. The 40, 50, 60, 70, 80, 90, 100, 120, 140, 160, 180, 200, and 250 metre contours have been generated in this example.

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A Cartographic Tale a Half-Century Old

by
W. Covey

Early in 1939, when I was nineteen, I was one of four students in the Grade 12 Architectural Drafting class at Central Technical School in Toronto. One March morning Archy Stringer, our Form Master, gathered us in his office, gave us application forms for a competition for the position of a Student Map Draftsman in the Geological Survey in Ottawa and ordered us to complete them and have them back on his desk in an hour.

We all objected strenuously. We didn't want to move to Ottawa to be map draftsmen! We were looking forward to going to work for an architect in Toronto, since the economy was beginning to pick up after the Depression of the Thirties. However, Archy said the matter was not open for discussion. We did as we were told, completed the applications and promptly forgot about the matter.

However, the wheels started to grind somewhere in the Nation's Capital. The four of us, along with some twenty other applicants, gathered in the Engineering Department of the University of Toronto one Saturday morning, about a month later, to write a series of academic tests. In the afternoon we suffered through a pen-and-ink map drafting test. We were also asked to submit samples of freehand sketches or drawings. Being an architectural student, I was able to provide a good selection. I later discovered that some 270 applicants across Canada wrote the examination for this job that day. But, once the deed was done, I promptly forgot about the whole thing again.

A month before graduation I was offered a job as an apprentice draftsman and blueprint boy with a major steel construction firm in Toronto at the glorious salary of $6 a week. The school forgave me from writing my final examinations, except for Chemistry which I loathed, and away I went to work. Work was scarce in May, 1939 and an offer of a job was something to jump at. Steel construction drafting was challenging and interesting even though the firm's blueprint machine had been a fixture on Noah's Ark. Six dollars a week was not much, even in 1939, but it was a start. The firm was busy and we all worked long hours with a daily quota of work that had to be completed and submitted to the steel fabrication shop for the night shift. There was no overtime pay but we could draw 75 cents for supper. The journeymen draftsmen were paid $25 a week, a good wage for 1939.

On August 1, I received a letter from the Civil Service Commission in Ottawa informing me that I was the successful candidate in the competition for Student Map Draftsman with the Geological Survey of Canada and was being offered the job for a period of six weeks, at a salary of $960 per annum. My eyes just about bugged out of my head! $80 a month! $20 a week! The salary was fantastic, but what was this six week bit? I promptly replied asking them to explain why they expected me to give up a job in Toronto to come to work for them for only six weeks.

This was to be my first of many encounters with "bureaucratese", because the Civil Service Commission replied just as promptly to tell me that, as an employee on probation I would be hired for six-month periods and that the present period expired in six weeks at which time my employment would undoubtedly be extended for a full six months. That was good enough for me! I told them I would report for work August 15. The steel construction firm offered me a raise to $12 a week but I had grabbed the brass ring and was off to seek my fortune in Ottawa.

On August 14, I sat up in the day coach on the overnight train to Ottawa, arriving at the Union Station at 7:30 a.m. I had made arrangements through friends to board with a couple in Ottawa and went there from the station. We agreed that I would pay $7 a week for my room, laundry and three meals a day. At 1:00 p.m. I reported to the Department of Mines and Resources Head Office on Sparks Street, where I was told to report to the Administration Office (the term "Personnel" hadn't been put into use yet) of the Geological Survey in the Victoria Memorial Museum on Metcalfe Street, a pleasant fifteen-minute walk on a sunny, warm summer afternoon.

The Victoria Memorial Museum, built about 1910 as a memorial to Queen Victoria, is a fine old sandstone castle-like building. Today, cleaned and refurbished outside as well as in, it is still one of Ottawa's beautiful landmarks. The only part of the original building that is missing is the tower over the main entrance. Shortly after being completed, the building began to settle on an unstable base common to that section of Ottawa. The weight of the tower was endangering the entire building and it was demolished. The architect was so distraught over the fate of his design that the unfortunate man committed suicide.

In 1939 the Museum building housed the National Museum, the National Gallery and the entire Geological and Topographical Survey and Administration staffs.

The Depression had hit the Civil Service hard. A freeze on hiring went into effect in the early thirties and many employees were laid off. Those that were still employed had to take a ten-percent wage cut and annual increases were cancelled. In 1938 financial restraints began to ease. The Bureau of Geology and Topography was given a million dollars to expand and modernize their cartographic capability. I was the first permanent, full-time appointment to be made to the cartographic staff in ten years. Two years earlier, three draftsmen had been hired in temporary positions but weren't slotted into permanent positions until well after the war ended.

I checked in at the Administration Office on the third floor where I was directed to the Drafting and Reproduction Division which occupied the entire west end on the fourth floor. The sheer size of this enormous open room with its twenty-foot ceiling accommodating some thirty draftsmen and engravers certainly intimidated a visitor and particularly me. I had been told to report to Mr. Dickison, the Chief Draftsman. His office, a glass-partitioned corner of the room, was as far removed from the entrance as possible and I made my way across the room past thirty pairs of eyes, knocked on his door and a deep, booming voice demanded, "Come in!" I entered to meet what Reader's Digest so aptly refers to as "The Most Unforgettable Character I Have Ever Met".

Sitting at a roll-top desk was an enormous man six and a half feet tall, weighing 280 pounds, as bald as an egg but with huge hairy arms and hands like hams covered with thick, black curly hair that also tufted over the edges of his white shirt collar. He was wearing a green celluloid eye shade of the type favoured by bank tellers and gambling dealers. The right side of his face was disfigured by an enormous livid scar that ran from the corner of his eye, across his cheek and under his chin.

I introduced myself to this formidable giant, he shook my hand with his great hairy paw without getting up, stared at me for what seemed an eternity and then growled in a deep Scottish voice, "So ye're Covey!"

"Yes sir."

"And what dae ye ken aboot the makin' o' maps, Covey?" he rumbled.

I gulped and truthfully answered, "Nothing, sir."

He took a minute to digest that and then said, "Nothin', eh? And we're aboot tae pay ye eighty dollars a month and ye ken nothin'?"

"Good Lord", I thought, "What am I into here?" The only reply I could think of was, "Yes sir".

He stared at me, nodding his huge head slowly and growled, "Eighty dollars a month and ye ken nothin!" By God, laddie, ye'd better be a good one!"

With that he pushed a button on his desk, a buzzer sounded somewhere in the drafting room and almost immediately a middle-aged white-haired gentleman came into the office.

Dickison said, "Mr. Covey, this is Mr. Joannes. Mr. Joannes, this is Mr. Covey our new Student Draftsman who kens nothin' aboot making maps!" Having informed Joannes of my complete ignorance and having reminded me of the fact for the third time, he turned to his desk and went on with whatever he had been doing before I came in.

I soon discovered that "Dick", as the staff called him, and well behind his back I might add, was just running true to form. He was the king of the Division and he ruled it with an iron hand. His word was law. Most of the staff lived in terror of him. Arthur Joannes (pronounced jo-anns), Dick's second-in-command, was a polite, courtly, soft-spoken English gentleman and a fine cartographer. He was nearly a nervous wreck from working so closely with Alexander Dickison. He chattered volubly to himself, scurried around the room in nervous agitation and even when working at his desk would often drum his feet on the floor like a tap dancer. In later years he confined to me that the only thing that kept him going was a complete colonic irrigation every Saturday night before he went to bed.

The next-in-line to the throne was a wee Scot, Stanley (Sandy) Alexander. Although not as openly nervous as Arthur Joannes, Sandy still lived in abject fear of Dick and toadied up to him in a most obsequious manner. Of course, Dick enjoyed all these power trips. Stories of how he twisted the tails of Joannes and Alexander and most of the staff were legend and could be told long into the night.

Yet I have seen Dick exhibit moments of genuine kindness. Arthur Hale, a draftsman ten years older than I, received word one morning at the office that his father had died suddenly in Victoria, B.C. It was impossible for Arthur to get to Victoria by train in time for the funeral. Dick took him to the nearby bank of the Rideau Canal, sat beside him on a bench and talked to him in a most kind and fatherly manner for the rest of the afternoon.

When I enlisted in the Air Force during the Second World War, Dick wrote warm, friendly, chatty letters to me in his magnificent Copperplate script instead of having his secretary type them. I still have them.

The first thing Arthur Joannes told me was that the Civil Service was on summer hours during July and August. We worked from 9:00 to 12:30, from 2:00 to 4:00 and on Saturday worked from 9:00 to 1:00. After the hours I had worked in Toronto for six dollars a week and 75 cents for supper, I thought I had reached "Nirvana". I couldn't believe my good fortune, particularly when I "knew nothin' aboot makin' maps".

Joannes then introduced me to my new four-by-six foot drafting table and had the equipment man outfit me with a complete matched set of Keuffel and Esser "Paragon" drafting instruments which really left me agape. To a draftsman, it was like being given the keys to a new Jaguar! The smallest ruling pen was worth more than all the drafting instruments I had owned up to then. All told, I was issued some $300 worth of equipment, including a Hard Arkansas oil stone for keeping ruling pens and knives in shape. After a half-century it sits on my workbench at home with hardly a wear mark on its smooth white surface. It should be able to serve many more generations.

By the time I had stowed my new gear, it was 4 p.m. and time to quit for the day. As I was leaving, Arthur Joannes told me that, although we began work at 9 a.m. tomorrow, he expected to see me at my desk by 8:45 sharp.

So began my first day at work with the Civil Service, the first of 12,918 in their employment. I went home to my boarding house riding on "Cloud Nine", eagerly anticipating "Day Two".

At 8:45 the next morning Arthur Joannes solemnly handed me a clean white dusting cloth and told me that my job each morning before work began at 9:00 was to thoroughly dust each window sill in the room. There were plenty of them! Three other draftsmen were already busily engaged in dusting everything that didn't move, as Dickison hated dust with a passion. They were glad to see another recruit in the dusting corps. The cleaning staff who came in after work were only allowed to sweep the floor and were not allowed to dust anywhere. Each afternoon when work ceased each drafting table was covered with a white cotton sheet mounted on a roller. I fell to my task with a will but soon found that I couldn't properly dust all those window sills in fifteen minutes. After that I arrived at work by 8:30 each morning. My dusting career never progressed beyond the window sill stage, as I had enlisted before an opening at a higher level became vacant.

Work began at 9:00. Dickison arrived on the dot of 9:05. When he lumbered the length of the room to his office in the corner, the same long walk I had taken the previous afternoon, every drafting stool was occupied and every head was down, just the way he wanted it to be! Once he closed his office door one could feel the room relax with an audible sigh of relief. Nobody raised a voice during the day.

Dickison had a drafting table in his office at which he would occasionally examine work. The senior member of "Dick's Dusters" was Frank James, a very nervous 25-year-old draftsman who meticulously dusted Dick's entire office each morning, finishing up by sharpening and arranging Dick's set of pencils at the lower right-hand corner of his drafting table. They had to be needle-sharp and aligned as straight as soldiers on parade from the 9H on the left to the 5B on the right, fourteen pencils in all. At least once a day a deep booming "Mr. James!" would ring forth from Dick's office and poor Frank would scurry in, emerging with a pencil whose point was no longer perfectly round and needle sharp because Dick had been using it. Frank would carefully rub it up on a sandpaper block and rush it back for Dick's approval. To my knowledge, Dick never condescended to sharpen a pencil during his career as Chief Draftsman.

At the opposite end of the Drafting Room, as far removed from Dick's presence as possible, were four copperplate engravers. They were the last of the cartographic engravers left in the employ of the Federal Government since cartography had converted to pen-and-ink drawing. Map engraving consisted of a great deal of sound and smell. An error in engraving could be corrected only by noisily hammering on the back of the copper plate with a brass-headed hammer until the error was higher than the surface. The lump was then burnished level with the surface and the work re-engraved. The copy was printed on the plate by sensitizing the surface with sulphur dioxide gas.

The engraving unit was supervised by an irascible, surly, elderly Scot who went out of his way to antagonize all and sundry. He and Dick mutually detested each other. When they would have a difference of opinion, we could count on a session of error correcting and plate coating that would make the place sound and smell like the steel fabrication shop in the firm I had just left in Toronto. Dick would end up in a foul mood and we all walked on eggshells. Fortunately, Dick had the engravers converted to draftsmen early in 1940 and the sound and smell ceased forthwith, thank God!

There were four long rows of plan-file cabinets in the centre of the drafting room where the working copies of the maps in progress were stored. These cabinets had black linoleum tops and Dick liked the tops to be scrupulously clean. Each Monday I spent the entire morning rubbing the tops to a glossy finish with O-Cedar Oil, making sure that there was no vestige of oil left on the linoleum that could ever get on a document. Periodically Dick, assisted by me, would glean through the contents of the drawers winnowing out material that was no longer needed. My job was to destroy the document by tearing it neatly into square pieces about the size of a postcard. If Dick didn't like the squareness of the finished product he would have me tear the ragged pieces more neatly growling, "We'll hae none o' yer slops, Mr. Covey, if ye please!" To this day I can't tear a piece of paper of any size into anything but a neat package. The voice still booms in my ear when I see a ragged edge.

Each drafting table was covered with two strips of heavy brown Kraft paper that had been carefully mitred at the corners and stapled in place. The senior draftsmen were allowed to ask any of "Dick's Dusters", usually me as the new boy, to replace their paper covers whenever they thought it was dirty enough. Every so often Dick would prowl through the room examining each draftsman's work through a large magnifying glass while Sandy and Arthur Joannes followed him, dancing with the nervous jitters. When Dick saw what he considered to be a dirty desk cover, he would say nothing but would take one corner of the cover in a huge paw and rip the cover off as he moved to the next desk. About twice a year on his return from lunch he would stop by a desk, rip the corner of the cover off, trumpet, "This place is filthy! Every desk needs covering!", stride into his office slamming the door behind him while the dusting crew went to work. Needless to say, the senior draftsmen enjoyed the break, lighting their pipes and cigarettes while we four went to it. In the time I worked at the Geological Survey, I don't ever remember having to work to a deadline, so these diversions of Dick's were nothing to get excited about. He was utterly unpredictable and certainly made life interesting.

Except for Frank James, the three dusters took weekly turns emptying everyone's waste basket before lunch and at the end of the day. Arthur Joannes fought a life-long battle with congested sinuses and he filled copious quantities of Kleenex each day which he deposited in his basket. I was a strong-stomached individual and it didn't bother me and besides, he was a kindly gentleman.

However, the head cartographic engraver in one of his nastier moods one day hawked a great gob of spit into his basket just as I was about to empty it. I looked at it, at him, told him I would never empty his basket again and he could complain to Dick if he felt so inclined. He didn't. He never spoke to me again nor I to him which I considered to be my very good fortune.

I accepted all these menial chores as part of my training and was extremely pleased with the job. Arthur Joannes took me under his wing and spent hours each week teaching me the theory and construction of map projections, the photolithographic process, fine-line ink drawing and how to "patch", the art of placing names on maps.

The poor man suffered twice at my hands for his labours. One day we were constructing a map projection when he nervously bobbed his head too close to the work. The dividers I was holding in my hand pierced his cheek. On another occasion I had a large plan file drawer open putting some documents away when he came steaming down the aisle with a huge map manuscript held out in front of his body with both hands. Before I could say anything he had sprawled arse over tea kettle into the drawer. He apologized to me for his carelessness for both of these incidents, saying they had been entirely his fault, but I still felt like an absolute heel. As I have said, he was a kindly gentleman in the best English tradition. He eventually retired to Victoria to join the rest of the retired Brits where he purchased a house by the sea and was able to hang his most prized possessions (an original Monet and a Degas) where the light displayed them to their best advantage.

When I showed a bit of aptitude for hand lettering, I was assigned to Arthur Sullivan for three hours a week for calligraphy training. Sullivan was the best Canadian calligrapher of the day and did magnificent presentation work for the Canadian Government. In fact, such were the demands for his services he did little else. About one percent of his skill rubbed off on me but it has given me hours of pleasure and satisfaction over the years. I still have the original pens that "Sir Arthur" gave me.

In spite of these extra-curricular activities handed to us as young trainees, we still received a good, disciplined cartographic training. Dickison may have been the antithesis of every principle of modern effective personnel management, a domineering bully and a dictator, but he was an excellent cartographer. His standards were high and uncompromising. He never communicated directly with a draftsman, but passed on the criticism, be it good or bad, by way of Sandy or Joannes, so we eventually discovered how we were progressing. If he examined the work on your desk in passing, the most you got out of him was either a loud sniff or a gruff "Humph!" as he left. He personally and minutely examined every item of finished drafting at a large drafting table just outside his office. He would don his eye shade, turn on a bright desk lamp, take his large magnifying glass and pore over the map inch by inch while the draftsman who had drawn it worked at something else and did his best to appear as though he knew nothing at all about what was happening.

Alexander Dickison was unique and I am glad that I came under his influence. Many of the staff went on to become key personnel in cartography throughout the Government and in the private sector. Dickison training was a distinct advantage when applying for a position in another cartographic office.

After enlisting in the Royal Canadian Air Force I never saw Dick again. When I returned to my job with Geological Survey in 1946 he had retired at 65 two years before and lived only a short time, dying of a stroke at home. Arthur Joannes had succeeded Dick as Chief Draftsman and the "Dusting Crew" no longer existed.

Author's Note
The people in this article are not fictional, but, with the exception of the author, died long ago. I'm sure their descendants, if they should ever chance to read this article, could not possible be offended.

About the Author
Bill Covey was born in Moose Jaw, Saskatchewan in 1919 and at an early age moved to Toronto with his parents. He was educated at Central Technical School and moved to Ottawa in 1939 where he worked as a Draftsman for the Geological Survey of Canada. During World War II he served as a Navigator with the RCAF. In 1948 he transferred to the Cartographic staff of the Canadian Hydrographic Service where he supervised in the Compilation and Drafting Sections until 1965 when he became CHS Technical Information Officer. He retired in 1974 and moved to Middleton, Nova Scotia in 1983 where he and his wife Bette enjoy their hobby of choral singing. Bill also dabbles in writing from time to time.

His article "A Cartographic Tale A Half-Century Old" was written during a fit of nostalgic reminiscence with an ulterior wish to acquaint CHS folk with working conditions in the Civil Service when the staff were excused from work for a half-day in August to visit the Ottawa Exhibition and also in December to attend to their Christmas shopping, with pay, of course.

Validation

by
J. R. MacDougall

Introduction
Validation is a term that has been used to describe many related yet different operations, and one that is used differently by almost every user. In a hydrographic context, the uses of the term have ranged from validation of the internal consistency of survey data, to comparing the "fit" of adjacent and overlapping data, to choosing the "best" data sets that will be accessible by all users of an information system. Validation encompasses all of these and more because validators must not only state that these data are "good", or this data set is the "best", but they must also determine if the data are defined correctly and are accurate. Validators also have a responsibility to state the accuracy in concrete, unambiguous terms that do not depend on a particular application or assume that the user has special knowledge about the data.

The purpose of this paper is not to set out validation procedures but to identify the more general philosophy surrounding this "validation", such as "why validation is so important now", "when, where and how data validation affects our operations", and "what can be done to meet the challenges of data validation for the information age".

Why is Validation Important Now?
One can ask: Why is validation so important now, haven't we been validating data all along? Yes, parts of the validation operation have been incorporated in routine checking and operational procedures and are done almost subconsciously. So what has changed to cause this term "validation" to be attributed to these traditional actions and their expansion? The arrival of the Information Age, changing user expectations and the potential consequences of the changing use of data and products all impact validation.

The Information Age is creeping up on us and this time it is not only the visionaries who are singing its praises but users who are beginning to demand more information from the many different sources to support their decision-making and their businesses. The real goal of the Information Age can be defined as "supporting decision-making at all levels" by delivering the right information, in a usable form, to the right place, at the right time, that will allow decision-makers to make informed decisions about whatever subject they choose.

That is a very tall order but it is an achievement to which information system builders can aspire. The merging of different data to answer an ad hoc type of question, in real time, is what users expect. It is also what visionaries have been promoting as one of the potential promises of the Information Age. The validation of data for use by different people in combination with other, perhaps unrelated, data sets to arrive at decision-supporting conclusions, presents a new challenge. To meet this challenge, the data, the processes used on the data, the errors and constraints associated with each, and the validation decisions must all be clearly defined independently from applications and stored as a part of the data set.

This increased expectation is partially a result of the advances that have occurred over the past decade with respect to computer power, communication and data bases. The present concept of distributed data bases and information systems controlled by their respective owners and networked together to provide information is also a much more palatable solution than the massive centralized systems envisioned only a few years ago. However, there are residual fears concerning uninformed users misunderstanding, misinterpreting or misusing data.

The concept of a Canadian Hydrographic Service Information Network was based on such a distributed architecture and the Inland, Coastal and Oceans Information Network (ICOIN) concept follows a similar philosophy. A key to the acceptance of these concepts is the fact that data will continue to reside in the data bases, or information system, of the collector/owner, surrounded by their resident expertise, who will be responsible for data validation. It is envisioned that there will be certain levels of data that will be defined and validated such that any user can access the data and use them without requiring special knowledge, while other levels will require interpretation by the experts who manage the data before the data are available to users.

How do these concepts impact validation procedures? In the past, and at present, most hydrographic organizations, including the Canadian Hydrographic Service (CHS), collect and process most of their own hydrographic data, and these data are used primarily for in-house products produced by the hydrographic office (or for the hydrographic office if under contract). In this scenario, the principle users of the hydrographic data are trained cartographers who have access to special information and knowledge about the data, such as how they were collected. They are also able to obtain the data collector's "opinions" or "feelings" about both the data and the cartographic interpretation of the data as shown on charts. Since nautical charts, the main products of hydrographic offices, normally portray the data at a reduced scale, there is an assumption by cartographers that any uncertainties in the data are reduced accordingly. However, this assumption is valid only for the presentation of the data since a 10 metre horizontal uncertainty in data doesn't really change whether shown at scale as 1mm. or 0.1mm. The users of charts are primarily the boating public who traditionally have not had the positioning capability to challenge the accuracy of charted data. However, this is changing with the increasing availability and accuracy of the Global Positioning System (GPS).

The future will see major changes in how the data are collected, validated and used. New data collection techniques have given the CHS and other agencies the ability to collect and process massive volumes of data. On certain high density surveys as little as 0.1% of the data collected can be plotted legibly at the survey scale. This selection is made by depth processing algorithms and there is a requirement to understand both the philosophy of the selection routines and the uncertainties involved. New validation techniques are required to validate the 99.9% of these data sets that cannot be done using the traditional visual checking methods.

The new era of accessible data bases will make data available to users who do not have special knowledge about the data or data collection techniques, and who may not even want to portray the data in graphical form. Therefore the data must be defined very specifically with respect to content, accuracy and constraints. These definitions are independent from applications and assumptions such as plotting data at certain scales because these users may make very different decisions and assumptions about the same data than a more knowledgeable user would. This possibility of users misinterpreting data is frightening and it is the responsibility of the CHS and other data owners to adequately define and validate the data that are accessible to all users.

Third party access to data, the use of data in different value added products, and the use of this data to support complex decision making, will create new and different uses. Combining different data types in new and previously untried ways to support decision-making may result in unexpected results. There will be a requirement to understand the processes involved in producing products, the uncertainties in each and the propagation of those uncertainties, so that validators can predict the results.

Because of the changes in the way that data will be used, hydrographic organizations must act to ensure that their processes and procedures will support these future demands. Without data that are adequately defined to support both the new uses of data and advances in technology, the information age cannot live up to its potential promise.

What is Validation?

The definition of validation really consists of many variations when the requirements of supporting future issues are considered. Four levels of validation were arbitrarily chosen here to illustrate the differences in objectives when data are validated for different purposes. However, these levels are far from being cast in stone.

a) The validation of the internal consistency of survey data and the challenges posed by no longer being able to use traditional processing and validation techniques.

b) The requirement to validate data for input to data bases such that the level of data accessible to all users is clearly defined.

c) The testing and validation of the data base output to ensure that the data is defined sufficiently to support different, untried combinations of data.

d) The validation of products and the production processes used.

These issues will be discussed in the context of hydrographic data and products but many of the points could also apply to other data types.

The first level of validation is the internal validation of the survey data during the course of a hydrographic survey. Typical field survey validation tasks include; the merging of positioning data with sounding data, the selection of soundings to accurately represent the bottom, and the agreement of survey data with check lines. However, validation also includes the understanding of processing procedures and propagation of errors throughout each process to arrive at an accuracy estimate for each data set (or data point if applicable).

The validation of different data sets for entry into data bases is the second level of data validation. The overall goal of validation for data base input should be the choosing of "official" data sets, for each type of data that are adequately defined, validated and documented, so that the data can be entered into the appropriate data base and made accessible to all users. This requires more than a visual comparison of multiple data sets and the choosing of the "best" data set. There is a requirement for validators to understand and analyze error propagation through each data set process, including data collection, processing, standardization and conversion to data base, and all validation processes used. Documenting the accuracy and validation decisions on the data processes, are as important as making the decisions.

Validation for data base input can be a combination of both field and office operations depending on the situation. On hydrographic surveys, new and old data must be compared to determine if the new supersedes the old and how the new survey agrees with adjacent surveys. This requires a knowledge of the propagation of errors through the new survey data, an estimation of uncertainty of the old data and an understanding that these data are being validated for many uses, not just for a particular application. It is also the responsibility of the field surveyor to prove or disprove the existence of dangers or anomalies on the older surveys and document both the decision and the reasons for that decision on the proper action taken for data base updating.

In the office, many different types of historical data and new data from other sources (Navigational Waters Protection Act plans, Public Works surveys, Coast Guard data, etc.) must be compared and validated. Who does what, when, and where, depends upon the organizational structure of the hydrographic office and the sections responsible for different data types. The comparison and validation of data requires that data sets be brought to some common denominator. This will involve relating the time, horizontal and vertical datums, units of measurement, data formats and data content descriptions of each data set to the standard data base criteria. Any discrepancies should be resolved before updating data bases with the validated "official" data sets. Office validator's will also refer data to other areas of expertise, including field hydrography, for further investigation when necessary.

The third level of validation will ensure that new uses of the data in data bases with untried combinations of data and processes do not yield unexpected results. These validation procedures should not duplicate the validation procedures performed prior to selecting input data. One important aspect of this level of validation will be to use the uncertainties of the data base data, as determined on input, and add the propagation of extraction process errors and arrive at error and probability estimates for the extraction.

Finally, the roles of product quality control before release to the users is a fourth level of validation. In addition to traditional checks on content and adherence to standards and specifications, the product validators must also understand the propagation of error in all processes through to the final product and estimate the accuracy of the product and the probability of achieving that stated accuracy. Future product validation operations may also apply to value-added products such as Electronic Navigation Charts and will undoubtedly require investigation into the validity of ad hoc combinations of the data required to support decision-making.

Users will also continually carry out a validation exercise as they use hydrographic data and products. Errors and omissions will be detected and additional information will be added. The Notice to Mariners process is designed to ensure that any additional information that is critical to navigation is incorporated on products. Other data bases will also be updated as reported changes are confirmed. In this sense, validation is not static but a dynamic operation.

What can be done to Prepare for the Future?

The global information system/data access goals of hydrographic organizations such as CHS must be clearly communicated to the different areas of expertise involved in data and product validation. Validators must understand the different ways the data will be or might be used and should strive to define and validate data such that the data are independent from applications. Clearly responsibilities do not end when the hydrographic surveyor submits the survey field sheet, nor when the data base input validator has loaded the data into the appropriate data base, nor when the product validator releases the product. Since each validator's decision impacts or is impacted by those of the others, there is a need to understand how these contributions complement each other and contribute to the organization's goals.

When one considers the difficulty hydrographers have in determining the accuracy of survey data due to uncertainties such as vessel movement, positioning systems, sounder resolution and adjustment, sea state, bottom type, water level and draft corrections, and a number of other dynamic factors, as well as the propagation of error through the different collection and processing operations, it becomes obvious that uninformed users would have a great deal more difficulty and could possibly misuse data. Therefore, one of the most important factors will be the need to define our data such that the data can stand alone without requiring the users to have special knowledge about such things as the data collection methods, processing methods and traditional uses of the data.

While the definition of data, such that the data can support many applications, conforms to the concepts of the Information Age, in some cases it may be necessary to choose an alternative approach. Spatial data may have to be treated as a special case because, while the real world can be subdivided into and data measured at an infinite number of points, it would not be feasible to store and use all of these data. The spatial data bases store a synthesized representation of the real world in a form that is digestible and meaningful to users, therefore it will be necessary to study the uniqueness of spatial data in the Information Systems of the Information Age and determine whether the storing of one representation of spatial data can meet the needs of all users.

This issue requires serious thought. The realization of the promise of the Information Age can be adversely affected, both by choosing an idealized approach that is not feasible for all data types and by applying excessively rigid constraints. An example of this is the validation of data for a single use or single application such as plotting spatial data at survey scale or smaller. In this case, it will be necessary to weigh the costs of completely validating all of the data once against the costs of repeated validation each time a new and different demand arises. The validation of all data only once will allow the benefit of being in a position to control the direction of future opportunities rather than continually playing "catch-up" while reacting to changing demands.

New and different uses of data will also create unanticipated demands on the data. These user requirements must be incorporated into the survey planning process to ensure that the data collection operations are optimized and that the selection of sampling criteria will collect data that are adequately defined and qualified to support these uses. This will require investigating new and different planning techniques.

There will be a requirement for hydrographic organizations to study the propagation of errors and uncertainties through each step of the survey planning, data collection, data processing, data management, data extraction and product preparation processes. Where a process involves a "black box" type procedure, the uncertainties introduced by the procedure and those caused by the underlying philosophy of the algorithm must be understood. Validators need to know which errors are systematic, which of these cancel others, and which are random, and must understand the consequences of each. They also need to be trained in determining, understanding and documenting the probability of the data sets in meeting the estimated uncertainties. The propagation of error analysis methods used to arrive at the conclusions, and the stating of the uncertainty and probability should be objective and should conform to standard practices that can be understood and incorporated in formulae which calculate these factors for the different combinations of data.

Present data definitions and accuracy specifications of hydrographic and other organizations may require a review to determine if they continue to adequately define the data and the uncertainty of the data in a way that is meaningful to users. Many hydrographic accuracy specifications were established in the days of the sextant and leadline and may not address probability and confidence in the accuracy estimations and almost certainly did not consider novice users, or user customized products such as Electronic Navigation Charts and ad hoc decision support.

Standardized validation procedures must be developed and formalized for every type of data. These are required so that all users can be assured of the validity of the data regardless of who collected and validated the data. Since different types of data collected in different eras may be validated to different levels of detail (e.g. modern surveys can have a horizontal and vertical accuracy for each depth while older ones may only have such a statement for the whole survey) these procedures need to be comprehensive. Because the data may be used by many users for many different reasons, the validation procedures must yield more than subjective decisions as to quality based on visual comparisons of data sets. This will require not only development of procedures but also training for validators in the tasks to be performed and in the documentation of validation decisions. Defining the data, and their status clearly and unambiguously should be the overall goal such that a user who is totally unfamiliar with the data will not have to make assumptions about validity and appropriate use of the data.

Standard criteria for time, horizontal datum and vertical datum must be established for data bases so that all input data can be converted to these standards before entry to the data bases. Performing this standardization on input will ensure that all data in a particular data base are referenced to the same standard criteria and should eliminate the need to resolve discrepancies each time data sets are extracted.

New validation procedures will undoubtedly continue to evolve as computer use in validation increases. New data collection methods that cannot be validated using traditional visual comparison techniques will be one area of change. As new application routines are developed and employed to extract data and convert it into various products, validation procedures must be developed to verify these processes and determine the impact of each new process on the accuracy of the final products. For example the CHS is aware of certain applications such as Electronic Navigation Charts, but there will also be other, as yet unidentified, applications and products such as user-customized, real-time solutions for decision support. Thus there will continue to be a requirement for on-going development of validation procedures and the training of validators.

Conclusions and Recommendations

Fulfilling the potential promise of the information age will require accessible, validated data bases that can be used by many different users to support decision making as well as product preparation. The degree of commitment of organizations to this goal and their willingness to invest now for future benefits will be a key to attaining the goals of a CHS Information Network and ICOIN.

To support the Information Age, data must be validated independently from applications and be defined in terms that are meaningful to all users. The lack of adequately defined and validated data will be a far greater hindrance than technology in achieving these goals.

The responsibility of adequately defining and validating the data and products of organizations such as the Canadian Hydrographic Service rests with the respective organizations because the expertise and specialized knowledge about the data and products reside in these organizations. The degree of special knowledge that users have of the data will decrease as more and more users have access to data and use them in different ways.

It is recommended that the propagation of errors through all processes employed by an organization be studied and defined. Validators should be trained in the determination of the uncertainties in each step of the processes and the propagation of these uncertainties through to the final product. Validators should also be trained in the documentation of the uncertainty and probability of error in unambiguous, standard terminology.

It is recommended that the definition of data and accuracy specifications of data and products be reviewed to determine if they are acceptable, based on the new processes and the propagation of error through all of the processes. The existing standards will at least require modifications to the wording so that they are defined in modern terms, such as "standard deviations" and "probabilities".

It is recommended that the feasibility of validating one spatial data set to support users portraying the data at an infinite number of scales, be investigated to determine if spatial data is unique and should be treated differently, such as validating data sets to applicable ranges of scales.

About the Author

Dick MacDougall works with the Canadian Hydrographic Service in Ottawa. This paper was written to identify the breadth of the processes covered by the term "validation", with an objective of building a case for focusing on the validation of data for many uses rather than for specific uses. The timing is appropriate for the CHS, since validation is becoming a much more conscious process than in the past.

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GPS and the Electronic Chart will go a Long Way towards Preventing Tanker Groundings

Roman Proverb: ***"Prevention is better than cure"***

by
R.M. Eaton

Introduction
Of the world's eight largest tanker spills, three resulted from grounding ("Amoco Cadiz", "Torrey Canyon", "Urquiola"). Now, the "Exxon Valdez" appears to have been a classic case of grounding in the confusion resulting from altering course to avoid collision with ice. I believe all of these, and many other groundings, would have easily been avoided using two new developments in navigation:

1. precise positioning wherever it is needed, by Navstar GPS;
2. continuous display of ship's position on chart background, by the Electronic Chart (EC).

This system is illustrated in Figure 1.

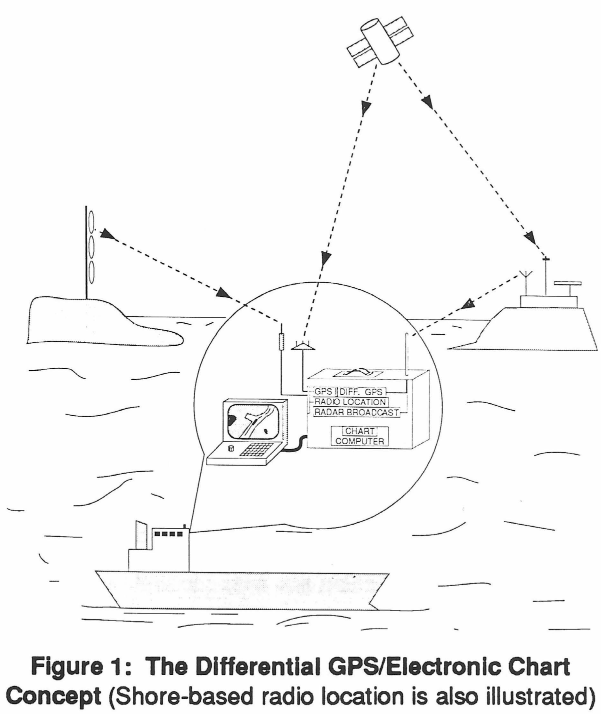

Figure 1: The Differential GPS/Electronic Chart Concept (Shore-based radio location is also illustrated)

For those who have no experience of bridge watch-keeping it may be difficult to conceive how such accidents happen, on a ship fitted with modern navigation equipment in a channel marked by buoys and lights. But most people who have served on the bridge have got lost on some occasion and can understand all too easily how confusion builds up, particularly in bad weather or with other distractions. Take, for example, the case of a frigate that grounded off her home port during helicopter landing operations, while the captain and navigator argued over which buoy they had just passed. I can easily see how that could happen.

The problem is that it is difficult to merge and then visualize instantly the two vital pieces of information: where the ship is located and where she is heading (from position receiver and compass); and where the dangers are (from the chart). Transferring the position to the chart by hand takes too long and is too error-prone.

The EC does this integration continuously, displaying the ship's position and projected track against a chart background. It also has the capability of adding radar as a positioning check (by coastline match) to complete the operational picture (See figure 2). This bird's-eye view of the ship and her surroundings enables everyone on the bridge to grasp the situation accurately, completely, and near-instantaneously, and therefore make well-informed decisions.

Causes of Groundings
<u>Confusion over Ship Position</u>
The "Amoco Cadiz" and "Torrey Canyon" grounded in areas where positioning by radar is weak. The "Exxon Valdez" was in an area that should be good for radar fixing, but the mate on watch apparently became confused under the pressure of avoiding ice, plotting a radar fix, etc., and lost his sense of where the ship was heading in relation to the surrounding shallow water. As a reconstruction of the event by Offshore Systems Ltd. (OSL) of Vancouver has demonstrated, an EC would have shown graphically and clearly just how far off the planned route the ship was and how she was standing into danger. If radar had been superimposed and had picked up the ice to the westward that caused the initial diversion from the shipping lane, the mate could also have seen clearly what his options were.

<u>Radar Blinding in Rain and Snow</u>
About ten years ago a ship was entering Tampa Bay, Florida, at the height of a storm. As she approached the Sunshine Skyway Bridge, heavy rain blanked out her radar completely and she lost track of her position. The ship then struck a bridge pier bringing down the roadway and a bus, carrying 30 people, and 5 cars drove over the edge.

In February 1988 the ferry "Sir Robert Bond" was entering Port aux Basques, Newfoundland when a heavy snow flurry blanked out the range lights and blinded the radar. She grounded. The Marine Casualties Investigations Report noted that other ships using Port aux Basques were fitted with visual electronic positioning equipment (the OSL electronic chart) "... which is well accepted and has greatly assisted berthing in severely reduced visibility".

Radar Interpretation
All mariners know that radar will only reflect from good targets and not necessarily from the charted high waterline. But it is not always easy to predict what will be a good reflector and misinterpretation of what the radar screen is showing can cause trouble.

The master of one of the CHS survey ships gives an example where radar interpretation would be useful. The causeway across Canso Strait, which separates Cape Breton Island from mainland Nova Scotia, has a shipping lock on the north shore. Approximately one mile west of the causeway a power line crosses the Strait, running parallel to the causeway. This power line returns a strong radar echo which a ship approaching from the west could easily mistake for the causeway. A navigator unfamiliar with the area and misled by this could close the north shore to enter the lock a mile too soon, at a point where dangerous shoals extend offshore. An EC would give immediate indication of this error and a radar overlay would explain it.

In a report in "Seaways" (Journal of the Nautical Institute) of March 1987 the master of a container ship describing his use of an EC to enter New York Harbour, commented on how he could distinguish pleasure boats from buoys by matching radar echoes with the chart. This is a good illustration of the ability of the EC to help interpret radar.

In winter, or in the Arctic, the edge of pack ice will show up on radar while ice floes inshore may mask out radar echoes from the true coastline. The superimposing of radar on the EC immediately shows which echoes are coming from pack ice and which from the coastline.

Bridge Collisions
In the late 1970's a ship struck the Second Narrows Bridge in Vancouver. Radar will pick up the roadway of a bridge, but unless the bridge piers stand out from the face of the bridge they will not show up. On an electronic chart all features of the bridge show clearly.

In the mid-1980's, an Indian freighter blocked the St. Lawrence Seaway at the Valleyfield bridge for several weeks. This might have been avoided by an electronic chart. By projecting the current course made good ahead of the ship the EC can give warning of an impending collision with a bridge if the present heading is maintained.

Navigation in Confined Waters

Definition
Navigation is the art of finding out where the ship is and getting her safely to her destination. I define confined waters as waters where a small error in navigation can cause grounding in a matter of minutes. This includes harbours and harbour approaches; shipping channels, such as the St. Lawrence River, above the Saguenay, and particularly difficult areas such as the Traverse at the eastern end of the Isle D'Orleans; straits such as the Gulf of Georgia approach to Vancouver; and rounding points that bring ships close to hazards such as Cape St. Mary's on the approach to Come-By-Chance, Newfoundland.

Risks in Confined Waters, and the Navigation Requirement - The U.S. Federal Radio-Navigation Plan (FRP)
The U.S. FRP is updated periodically based on technological developments; "Users Conferences" to determine navigation requirements; and U.S. government policy. The current (1986) issue of the FRP has a paragraph that applies equally to Canada:

> *"2.12.1 Safety*
> *A. Increased Risk from Collision, Grounding and Ramming*
>
> *Cargoes of particular hazard (petroleum, chemicals, etc.) are carried in great volumes in U.S. coastal and inland waterways. Additionally, the ever-increasing volume of other shipping and the increasing numbers of smaller vessels act to constantly increase the risk of collision, grounding and ramming. Economic constraints also cause vessels to be operated in a manner which, although not unsafe, places more stringent demands on all navigation systems."* (Author's underlining)

The FRP goes on to state the navigation requirement for harbour and harbour approaches. In section 2.17.1 they specify 8 to 27 metre accuracy, and a position fix interval of 6 to 10 seconds, and point out that "To utilize radio navigation information at 6-10 seconds interval on a moving vessel some form of automatic display is required".

Navigation Techniques
There are three general approaches to navigating in confined waters:
1. plot a fix and correct the course;
2. "eye-balling" plus "guidance lines;"
3. continuous automatic plotting of radio positioning.

1. Plot a Fix and Correct the Course
This is very familiar to any hydrographer from pre-computer days: Plot the position fix on the chart and correct the course to keep the ship on the planned route. The position fix may be plotted from:

a) Loran, either position line or Latitude, Longitude output,
b) visual compass bearings (seldom used now),
c) radar ranges and bearings.

Loran is an excellent offshore aid to navigation with a "geographic" accuracy (i.e. relative to the rocks) of 150-500 metres depending on land-path calibration and fix geometry. But this accuracy deteriorates close to shore due to unpredictable near-land effects. Loran is subject to occasional gross errors (cycle skips), and Latitude-Longitude conversion receivers may have large errors due to inaccurate land corrections. Therefore Loran is not suitable for coastal navigation.

Visual fixing depends on good landmarks and clear visibility and is seldom used except by the Navy (who have to be prepared to navigate under "radar silence" conditions).

Radar is the preferred fixing method close to shore, particularly because it is measured to the land near the ship, not on a distant radio transmitter. Correct identification of radar targets used is vital.

The prime weakness of this "plot and correct course" method is that it takes several minutes to take the measurement, plot the fix and correct the course, and several more for the correction to take effect. This doesn't matter if there is plenty of sea-room but it is too slow for use in confined waters where deviations from planned route must be corrected almost instantaneously.

2. "Eye-balling" plus "Guidance Lines"

Ship channels are often closely buoyed for visual navigation. Most are also marked by twinned range beacons and lights in line to guide the ship along the recommended track. Buoys or shore points may be used as wheel-over markers when coming up to a turn. Problems can arise in haze or when snow flurries suddenly cut visibility. At night, buoys and navigation lights may be difficult to distinguish from the bright lights on shore. In winter, ice may drag the buoys under the water surface, rendering them invisible.

The radar equivalent is to steer by "eye-balling" the radar picture of buoys and beacons and the land when in a well marked or relatively open channel. In a confined channel, particularly one with no radar marks along the edges, the pilot may use heading markers; wheel-over bearings and constant radius turns on a radar pivot target; index lines parallel to the ships course made good to mark a safe distance off a radar-visible point of land; etc.

3. Continuous Automatic Plotting of Radio Positioning

Versatile video plotters have been in service since the 1970's. The electronic chart is a special type, incorporating chart information and other capabilities.

For use in confined waters the radio positioning input must have 10-20 metre accuracy. Systems capable of this include UHF "Syledis" used in Canada and extensively in Europe for dredging, minesweeping, etc.; microwave systems such as "Microfix" used for example by Offshore Systems Limited (OSL) in Port aux Basques and OSL's polarizing radar transponders also used at Port aux Basques. Differential GPS (DGPS) will be a more general and cheaper alternative when it becomes available in the mid 1990's (see below).

This method in effect makes the "plot and correct course" technique effective in confined waters through instantaneous automatic plotting. Used on an electronic chart, with radar option so that the mariner can compare the radar coastline with the chart coastline, DGPS provides a check on correct positioning that has never before been available, and therefore a very high confidence level.

<u>Radar and the EC - Two Displays Compared</u>

The critical part of any voyage is the navigation through confined waters. These are often difficult passages best made under good weather conditions. But "time is money" and modern ships masters don't often wait for the fog to clear. They (or the pilot) bring the ship in on radar.

Radar has the advantage of giving a pictorial representation of the ships surroundings, but the picture is not always clear or is incomplete. It may have rain or snow clutter; objects close to the ship may not be detected; the targets it picks up may be difficult to relate to the chart; and of course at best it can only show the coastline and bridges, not the safe channels, shoals or bridge piers.

In practiced hands radar is a very impressive navigation tool with the advantage of "seeing the real thing". But it has limitations and depends entirely on good targets at the right places. For example, radar is ineffective on a low sandy or muddy coastline.

The electronic chart plots the ship position continuously on a chart background, using satellite navigation corrected by a local monitoring station (for differential GPS), or a local radio-location network, or radar transponders, etc. The chart scale can be altered to show the detail required. The chart display features, such as the ship's individual danger contour, can be selected to suit the master's needs. The planned route can be pre-plotted by the master (or pilot), and the past track displayed together with the ship's heading and projected course made good will assist in the detection any cross-track set.

Alarms can be preselected, such as; maximum allowable off-track digression; safe distance from the ship's individual danger contour; ship entering regulated area; etc. (However alarms must be used with discretion because of the possible operator stress that could build-up on a modern bridge with too many alarms).

Eventually it may be possible (though not necessarily desirable) to navigate the ship hands-off, using the EC to monitor progress and to warn immediately of dangerous navigation situations.

The EC is driven by fallible radio navigation. It provides the capability of superimposing radar in order to check the coastline fit. This is a new feature, enabling a mariner to detect navigation errors with near 100% certainty under good radar fixing conditions, as illustrated in figure 2.

Navstar GPS -The Final Solution for Positioning?

Satellite navigation has some very important advantages over land-based radio aids:

(a) Satellite signals arrive nearly vertically. This avoids the attenuation, shadowing, and wave distortion due to refraction and ground effects that first weaken and eventually kill all land-based radio signals.

(b) The direct propagation permits using short wave transmissions, allowing robust coding to improve performance for a very high resolution of ships position and velocity.

(c) The GPS fix geometry will always be good when the full constellation is in place. Land-based systems have good geometry in the centre of the coverage which deteriorates rapidly at the fringes.

(d) With the full constellation there will be more satellites "visible" than the minimum required for a fix, providing a valuable accuracy check. This is often

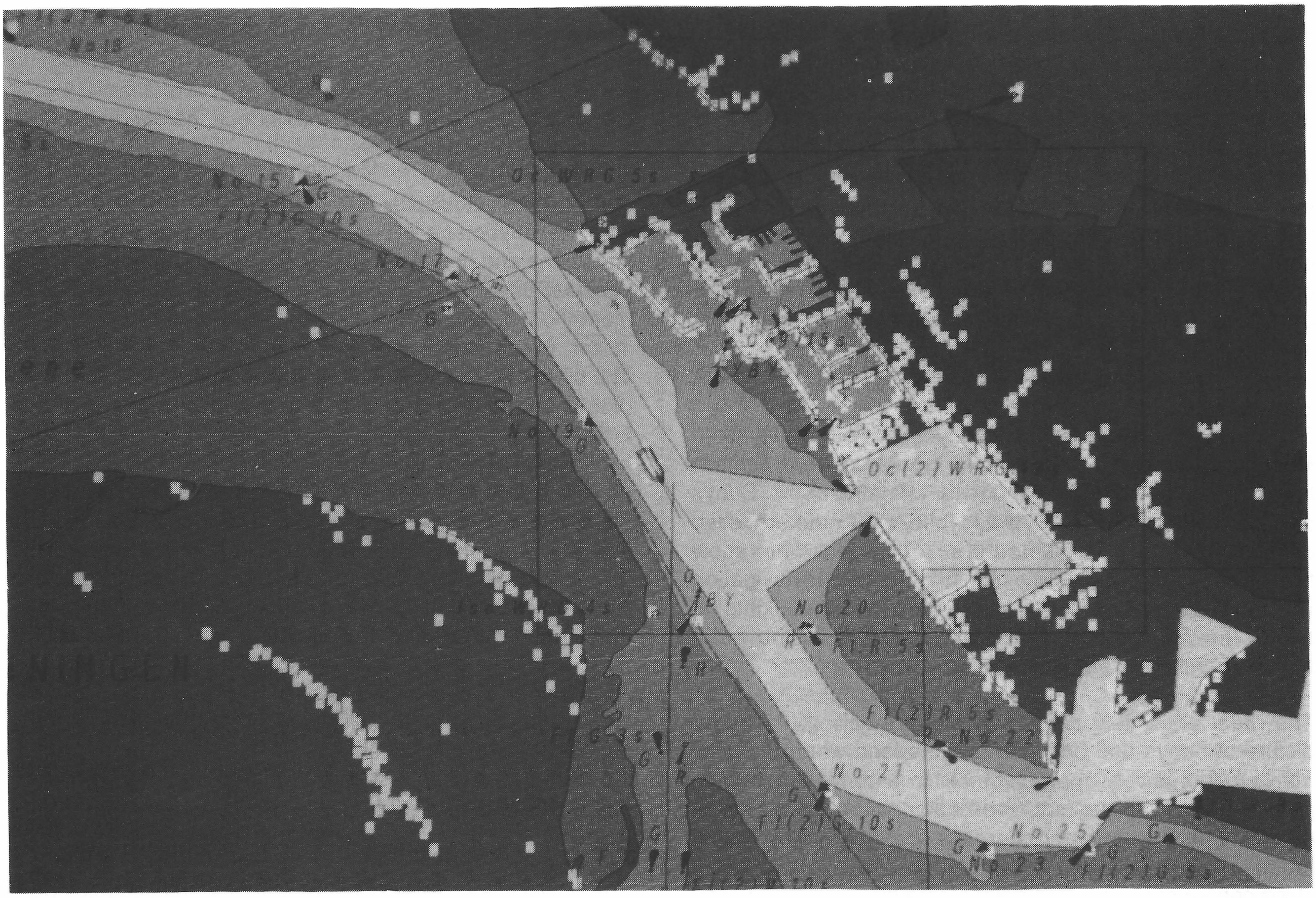

Figure 2: The CHS Electronic Chart Testbed display of the port of Esbjerg, Denmark.
The full colour display, reproduced here in black and white, gave a very clear picture of the situation around the Norwegian ship "Lance" as she approached the harbour entrance during the 1988 North Sea ECDIS demonstration. The exact fit of the radar to the wharves and breakwater, to the eastward, confirms to the mariner that the ship's positioning is correct. However the variable fit on the low sand hills, to the south-westward, illustrates the uncertainty of radar navigation, if it was to depend solely on the ill-defined targets of a sand or mud coastline. (photo by Steve Glavin)

not available with a land-based system due to lack of appropriate transmitter sites.

However, nothing is perfect, and GPS also suffers from (minor) propagation anomalies and from deliberate biases inserted by its military operator. Fortunately, the resulting position errors are constant over large areas (several hundred km. in radius). The errors can be corrected by placing a verification monitor receiver at a known geographic location in the service area and transmitting real time "differential corrections" to ships in the vicinity.

"Stand-alone" GPS accuracy will be +/- 100 metres 95% of the time; "Differential GPS" accuracy is +/- 10 metres, or better. A GPS test constellation has been in orbit for nearly a decade, and tests by the Canadian Hydrographic Service and many others have demonstrated a performance that is as revolutionary as radar was in the 1940's. There will inevitably be some detailed operational problems, but differential Navstar GPS really does appear to be capable of completely solving the positioning aspects of the navigation problem for the first time in history.

Unfortunately GPS is not yet operational and there have been repeated delays in its schedule. However, the present forecast is for marine coverage by mid 1991. Five new satellite launches in 1989 indicate that this forecast is reasonable.

Differential GPS is the most universal and the cheapest solution for navigation in confined waters but someone has to provide the differential broadcast. Who will provide and who will pay for this service? If it is accepted that we need reliable navigation to prevent tanker groundings it seems to be clear that the government should provide and we taxpayers should all pay a part of the price for a renewable planet!

Present Status of the Electronic Chart

<u>ECs at Sea</u>

Although a functional full colour EC with radar overlay was on the market in 1983, the electronic chart development is still in its early stages. Thousands of mini-versions have been sold to yachtsmen and thousands more video plotters are in use by fishermen but there are very few of the "electronic chart for safe navigation by a sizeable ship" variety presently at sea.

Those that are in use are generally where the need is obvious, for example: on ferries; on a freighter running into the narrow channel at Port aux Basques in very bad weather; on ice-breakers working in Lac St. Pierre on the St. Lawrence River with the difficult job of clearing an unmarked channel in mid-lake with broad shallows to either side; and on a feeder tanker running into a very narrow channel on the U.S. Gulf coast. (All of these examples are using the OSL "PINS" system.)

Why hasn't the EC taken off? This is possibly because shipping is a conservative and very cost-conscious industry. Ships have navigated safely without an EC in the past, so there is no need to buy one now. The shipping industry is waiting on further EC development. This attitude is reinforced by two problems discussed next.

Regulations and Chart Information for the E.C.

Regulations will require that the EC use official hydrographic office (HO) data, so these topics go together. Both are important for several reasons:

- to ensure that equipment meets minimum standards and that operating methods, conventional symbols, etc., do not differ widely enough to cause confusion;
- to legitimize Electronic Chart Display and Information Systems (ECDIS) in the minds of mariners and ship owners;
- to support a mariner should he be involved in an accident;
- to encourage the EC manufacturer by relieving him of two major sources of liability;
- to legitimize the EC for obligatory use,(see below).

International Regulations

Any EC regulations will have to be international. Proposals are currently submitted to the IMO (International Marine Organization, a United Nations body) for study them and eventual issue as Minimum Operational Performance Standards. These IMO Mininmum Standards however, are advisory, until individual countries issue their own national regulations based on, and often exceeding, the IMO Recommendations.

In the case of the EC, two problems compound this slow process:

1. In order to cover the EC within their terms of reference, IMO and its charting adviser, the International Hydrographic Office (IHO), require a version, called "ECDIS", that is "equivalent to the paper chart". This is a valuable guideline if the EC requirement is restricted to performing the same function and providing the same service as the paper chart. But if too much emphasis is placed on having the display closely resemble the paper chart, this requirement may unbalance the standards to the detriment of operational effectiveness.

2. The EC is in an early stage of development, and one of its most promising characteristics is flexibility, both immediately to give broad capabilities and in the future to take advantage of new technical developments. Equally important, there is so little sea experience with the EC that it is dangerous, at this stage, to decide once and for all exactly what it will be used for, or how it will be used. Greater sea experience is needed to determine the modes of operation. Therefore the writing of EC regulations should be a progressive "write-test-rewrite" process.

Normally development and rule-making takes about 20 years, such as with ARPA (Automatic Radar Plotting Aids). But in January 1989, IMO issued "Provisional Performance Standards for ECDIS" based largely on the IHO's 1988 "Draft Specifications for ECDIS" and set a target date of 1993 for final standards. It will not be easy to draft final standards that are specific enough to be enforceable yet general enough to allow continued evolution. Hopefully IMO will issue temporary standards subject to review after a set period, although this goes against precedent.

Chart Information

Mariners, manufacturers and regulators all insist on official HO chart data for the EC. Unfortunately it is a major change to go from producing a paper chart directly under HO control, to producing a flexible, well annotated digital information base for use in ECDIS. Particularly since the ECDIS data must be updated continuously, instead of every few years as for a new edition of the paper chart.

HO's are government organizations with a set mandate, a set budget, and normal institutional inertia. It is not possible for them to reorganize to provide a new service, in addition to the paper chart, without a new mandate and new funding. A new mandate is unlikely without a new demand, which is not yet there.

One approach a HO might use to get data base production started would be to authorize selected companies to produce and market electronic chart data provided that:

- they follow the HO specifications;
- they use only HO chart data issued to them under license;
- they return the EC data base to the HO for validation before marketing;
- they issue the data in the standard IHO format.

Chart updating would have to remain an HO responsibility. The resources to enable the HO to carry out this arrangement could either come from additional government funding, or in some cases from a proportion of the proceeds from the sale of chart data.

Future Considerations

How to Ensure there is an E.C. Onboard: The Carry-on Concept

Let us now think about the next bad tanker grounding. Perhaps it will come one July near a vacation beach under the noses of thousands of holiday makers, and this time something will have to be done about the problem.

I hope such an event doesn't happen for some years, and that by then the extraordinary accuracy and effectiveness of Navstar GPS will be well established and the use of electronic chart for ship handling well accepted. One part of the solution would then be to require that all ships with dangerous cargoes use Differential GPS with an ECDIS for certain critical passages. But how do we in Canada, with nearly all of our trade carried in foreign ships (often flag of convenience) ensure there is an effective ECDIS onboard?

One answer was suggested during the 1988 North Sea ECDIS demonstration, by pilots at Esbjerg, a very exposed port on the west coast of Denmark with a long approach channel through sandbanks, and subject to cross currents. Worried by plans to bring in ever larger ships, these pilots enquired about the possibility of a portable EC which could be easily hoisted aboard from the pilot boat and set up on the bridge quickly by the pilot, to help in handling the ship when weather and visibility were bad.

In fact it is already feasible to develop a carry-on EC with built-in GPS receiver, and when larger flat screens arrive it will be easier still. Perhaps the main problem will be in setting up the small GPS antenna on the weatherdeck and connecting a lead-in to the bridge. This will require reasonable weather and a little time. However, a ship that is a regular visitor to a particular harbour could carry a permanent antenna with a jack on the bridge. This "carry-on" concept is illustrated in figure 1.

Conclusion

People probably realized that "Prevention is better than Cure" long before the Romans put it that way. I believe that a well-designed electronic chart, in partnership with 10 metre accuracy GPS or other precise positioning such as OSL's passive radio transponders, will be a very effective contribution towards reducing the risk of grounding. Eventually the EC may be just the display part of a sophisticated "expert system" navigation package. But in any case, the whole development will be based on having the right kind of chart information, in the right form. This gives a challenging new twist to how we organize our final product which is likely to reflect right back to how we do the surveys.

About the Author
Mike Eaton started his working life as a mariner, in the British Royal Navy, and joined the Canadian Hydrographic Service in 1957. He started the CHS EC testbed project in 1984 and ran it for four years until shortly before it was demonstrated (and well received) during the Norwegian North Sea ECDIS tests in 1988. Mike retired from the CHS in 1988 but doesn't seem able to stop writing about the electronic chart. This paper is taken from a brief to the 1989 Public Review Panel on Tanker Safety.

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Marine DGPS Using Code and Carrier in a Multipath Environment

by

G. Lachapelle, W. Falkenberg, D. Neufeldt, and P. Kielland

Introduction

In 1986, shipborne Differential GPS (DGPS) tests were conducted by Nortech Surveys (Canada) Inc. for the Canadian Hydrographic Service to test a newly developed algorithm for the combination of code and carrier phase measurements in marine mode. The requirements of the algorithm were as follows:

1. It should be a robust algorithm for the hydrographic launch environment;
2. It should have an accuracy of 5 metres in real-time at the 95% confidence level;
3. It should make use of GPS measurements available with a non-classified C/A code receiver;
4. It should have a quality assurance (outlier detection and warning) of 10 metres with a confidence level of 99%.

The above accuracy requirement implied the use of both code and carrier measurements and of the differential operation technique. A further condition imposed was that the differential range corrections be suitable for real-time transmission using a data link with a maximum capability of 50 bps (bits per second) and a transmission format similar to that proposed by RTCM SC104 (Radio Technical Committee for Marine Services) Kalafus et al. [4].

The algorithm was tested using DGPS data collected by two different types of hydrographic survey vessel; a 10 metre launch and a 40 metre ship, in a wide range of sea conditions deemed suitable for hydrographic operations. Texas Instrument TI-4100 receivers were used for this test. Despite a sub-optimal GPS constellation, the above mentioned accuracy objective was achieved. Further details are given in Lachapelle et al., 1988 [8]. The realization of the quality assurance objective specified above remained, however, to be achieved. In the later development of an operational software package, several enhancements were implemented towards achieving this latter goal. This software package, HYDROSTAR, is described in Lachapelle et al., 1989 [9].

An important remaining concern was the effect of code multipath on both the monitor and the remote stations. A series of experiments was designed to analyze the effect of multipath under field conditions and test the use of appropriate counter-measures at both stations. These experiments were conducted in Calgary, Alberta during the summer of 1988 using TI-4100 and Norstar 1000 GPS receivers.

Combination of Code and Carrier Measurements

C/A code measurements contain random noise typically at the 2-3 metre level in the absence of multipath. However, multipath effects can reach several tens of metres. In DGPS mode, orbital and ionospheric effects are reduced substantially. Uncorrelated effects of the troposphere can account for a few metres of uncertainty, especially when satellites are observed at a low elevation, of a few degrees, above the horizon as may be done to improve the geometry. Despite these shortcomings, code measurements are essential, at least initially, to provide the position of the vessel with respect to that of the monitor station on shore, i.e., the initial baseline. Likewise, in single point kinematic mode, code measurements are required to establish the position of the mobile in the GPS coordinate system (i.e. White et al., 1989 [11]).

Carrier phase measurements have at least two orders of magnitude less noise and are less affected by multipath than code measurements. Once the initial position of the mobile is established in DGPS mode, phase measurements can, in principle, provide the position changes of the mobile with an accuracy of 10 cm. or better (see Figure 6). If one were to use differential code measurements only to establish the initial baseline, and then use solely differentially corrected carrier phase measurements to determine subsequent mobile position changes, the position of the mobile relative to its initial position would be within 10 cm. but the positional accuracy of the mobile relative to the monitor station would remain low, typically at the 5 - 10 metre level (e.g. Lachapelle et al., 1986 [7]). The problem is illustrated in Figure 1.

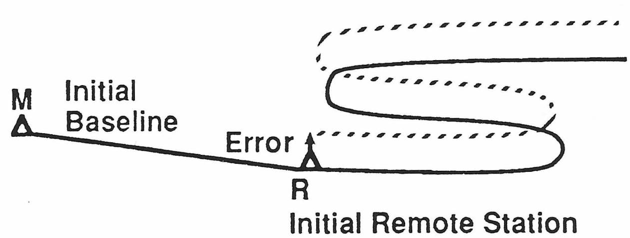

Figure 1: Effect of Error in Initial Baseline between Monitor and Mobile Stations on DGPS Operations

In airborne and land kinematic and semi-kinematic modes, several operational methods exist to recover the initial baseline, such as co-location of the stations at the beginning of each observation session or precise determination of the initial baseline while the remote station is still immobile (e.g. Keel et al., 1989 [5]; Cannon, 1989 [1]). In marine mode these procedures are clearly impractical or impossible.

The approach used herein is as follows. Code and carrier phase measurements were combined to take advantage of their individual characteristics. The contribution of the less accurate code measurements was allowed to decrease rapidly after the initial measurement epoch t_o, while the contribution of the more accurate carrier phase measurements increased proportionally after t_o. At t_o, the weight on code measurements was 1.00 while that on phase measurements was 0.00. At subsequent measuring epochs, the estimated code and carrier measurement variances were used to derive the proportion of weight on code and phase. This resulted in an exponential phase weight increase. After some 95 to 99 measurement epochs, the weights were frozen to values of 0.05 to 0.01 and 0.95 to 0.99 on code and carrier phase respectively. Thus, if measurements are made at a rate of 1 H_z, the final weight relationship between code and carrier is reached after some 90 to 100 seconds. Similar algorithms were used at both the monitor and the mobile stations. The effect of the ionosphere on single frequency C/A code and carrier phase measurements was corrected for using the broadcast ionospheric model. This correction is important even in DGPS mode because the group delay and the carrier phase advance have different signs (e.g. Klobuchar, 1983 [6], Loomis et al., 1989 [10]). Experience has shown that unless multipath is present the initial distance can be recovered with an accuracy of 2-3 metres with this method, as compared to the accuracy of 5-10 metres quoted above when only the initial code measurements are used [8].

Carrier phase cycle slips result in a break in the computation of the position changes of the mobile. Once a cycle slip is detected on a satellite, the corresponding filter on this satellite is reset to its initial values, i.e. a weight of 1.00 on code and 0.00 on phase with a subsequent exponential weight increase on phase measurements. Cycle slips are detected using a velocity trend method as described in Lachapelle et al., 1986 [7]. Changes in position at epoch t_i are predicted using phase measurements taken at previous epochs. If the actual changes as calculated with measurements taken at epoch t_i are different from the above predicted changes by a specified threshold value, a cycle slip is assumed to have occurred. This method is estimated to be accurate to about 5 cycles in the marine environment due to the large roll and pitch motion of the vessel. On the L1 carrier frequency, 5 cycles is equivalent to a range difference of approximately 1 m which is sufficient for the present purpose. The frequency of cycle slips is a function of many parameters, including sea state, vessel type, receiver characteristics and satellite elevation. An example is shown in Figure 2 for two satellites observed with the TI-4100. Note the exponential nature of the phase weight. In the case of the first satellite which was initially at a low elevation, cycle slips were detected every 5 to 10 minutes. In the second case, the interval between cycle slips varied between 5 and 40 minutes. These examples constitute a worst case, since the roll of the survey launch exceeded 25°.

Multipath in the Static and Kinematic Modes

The presence of surfaces with strong RF (Radio Frequency) reflective properties will result in multipath. C/A code multipath will result in pseudo-range errors which can theoretically reach 293 m. An experiment was set up to analyze the effect of code multipath both at the monitor and mobile stations. Multipath was induced using flat and convex metallic reflective surfaces having a dimension of approximately 1.5 x 1.5 m. Typical C/A code multipath obtained during the experiment at the monitor station is shown in Figure 3. The experiment is fully described in Falkenberg et al., 1988 [3]. The typical sinusoidal signature of multipath is evident. C/A code pseudo-ranges are compared with carrier phase derived range differences. Such a comparison is valid even in a high multipath environment because carrier phase multipath is approximately two orders of magnitude lower than code multipath (e.g. Evans, 1986 [2]). The effect of multipath on carrier phase measurements can also be seen in Figure 6. The code multipath shown in Figure 3 has a peak to peak amplitude of 20 metres with a period of 2 to 3 minutes. For comparison purposes, P code multipath at the same site is shown in Figure 4. In this case, the peak to peak amplitude is 6 metres with a period of 5 to 8 minutes. The different characteristics of C/A and P code multipath are due to different clock rates, namely 1.023 MH_z and 10.23 MH_z respectively.

The systematic effects seen in Figures 3 and 4 for the static case are not present in the kinematic case due to the very motion of the antenna. This is illustrated in Figure 5, which was obtained using an oscillating mast made of a Texas tower with a length of 5 metres and a period of several seconds in an attempt to reproduce the roll motion of a hydrographic ship. The oscillating mast was set up within a distance of less than 30 metres from the monitor station and was surrounded by several flat reflective metallic surfaces. The higher pseudo-range noise was due to the wider bandwidth of the receiver required to accommodate the dynamics of the antenna. No

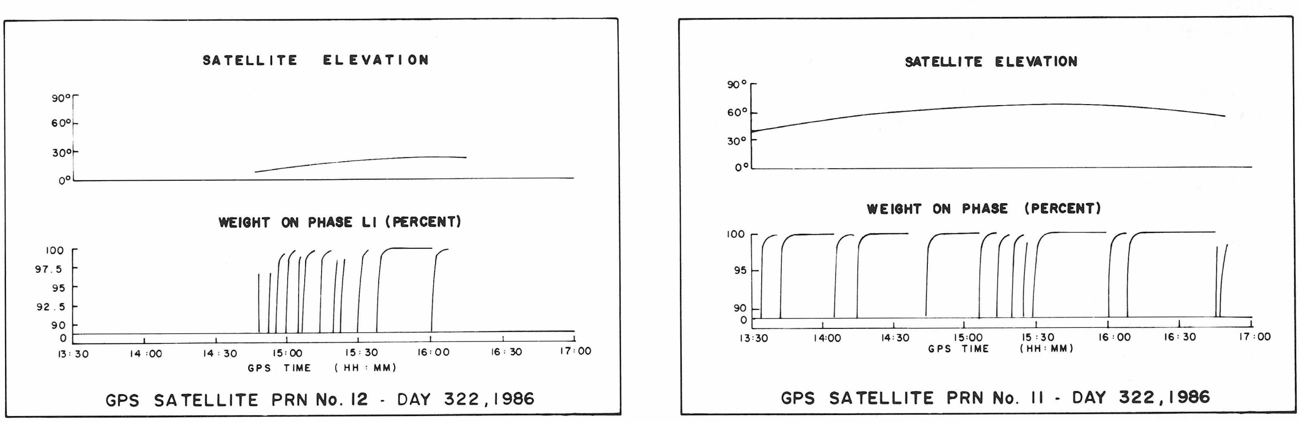

Figure 2: Effect of cycle slips on phase weight. The weight is reset to 0% when a cycle slip is detected. Maximum phase weight is 99% in this example.

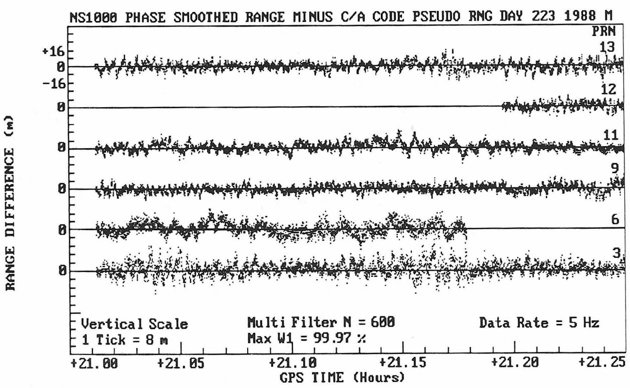

Figure 3: C/A code noise characteristics in a multipath environment - static case

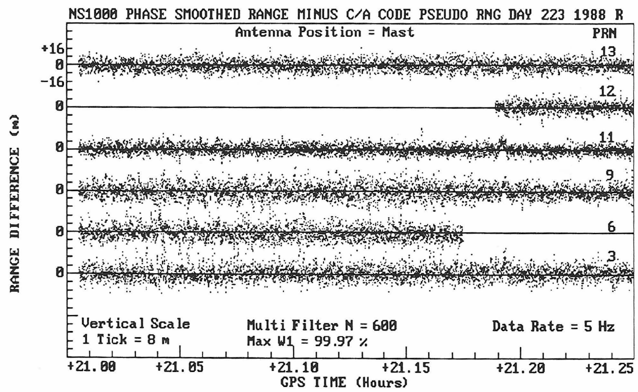

Figure 5: C/A Code noise characteristics in a multipath environment - kinematic case

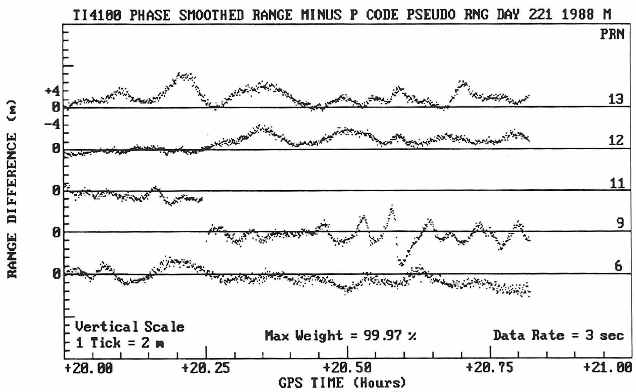

Figure 4: P Code noise characteristics in a multipath environment - static case

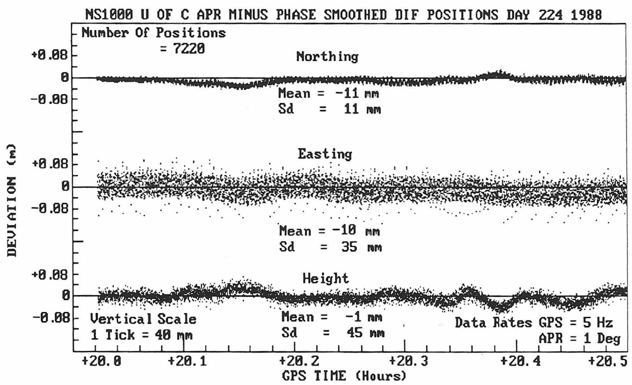

Figure 6: Performance of pure carrier phase positioning in DGPS kinematic mode

systematic effect due to multipath could be detected. As the motion dynamics decrease however, multipath would likely become significant. Thus on calm water surfaces, multipath effects are likely to be more significant than on agitated surfaces. Multipath at the mobile is therefore still of concern in shipborne applications.

In order to analyze the performance achievable with pure carrier phase measurements in DGPS kinematic mode, the GPS-derived positions of the oscillating mast were compared with positions determined independently by an Angular Position Reference (APR) as described in Falkenberg et al., 1988 [3]. A modified version of the algorithm described previously with 100% weight on phase measurements was used for the experiment. The initial coordinate differences at the beginning of the observation sequence were determined independently and used to resolve the initial phase ambiguities. The carrier phase measurements were made with two Norstar 1000 receivers which had a raw phase data output rate of 5 H_z. The mast length was set at 2.1 metres with a period of 13 seconds and a maximum roll angle of 20^0 from the vertical. The differences between GPS and APR derived positions are shown in Figure 6 for a period of 30 minutes during which no cycle slips were detected. The mast was oscillating in an east-west direction which resulted in a higher noise in the east component. The variations in height differences exhibited multipath characteristics with a peak to peak amplitude of 15 cm. The carrier phase multipath likely originated at the monitor station. The overall fit for each of the three components in terms of standard deviation was better than 5 cm. This is the level of performance which could theoretically be achieved in the absence of cycle slips and provided the initial baseline could be determined *a priori.*

The code multipath effects shown in Figures 3 and 4 are significant and will result in biased differential corrections derived at the monitor station. The use of code measurements according to the weighting scheme previously described will introduce a bias in the phase-smoothed pseudoranges. The use of appropriate counter-measures is therefore important to reduce these effects.

Multipath Counter-Measures

Two methods were analyzed to counter the effect of multipath, namely the use of a RF absorbent ground plane and the implementation of parallel filters in the algorithms.

The use of a RF absorbent ground plane is practical only in static mode when no roll or pitch motion affects the observation of the satellite relative to the horizontal plane of the antenna. This is the case for the monitor station where multipath effects are the most likely to bias the differential corrections. A RF absorbent ground plane was used, made of carbon-impregnated foam provided by the Department of

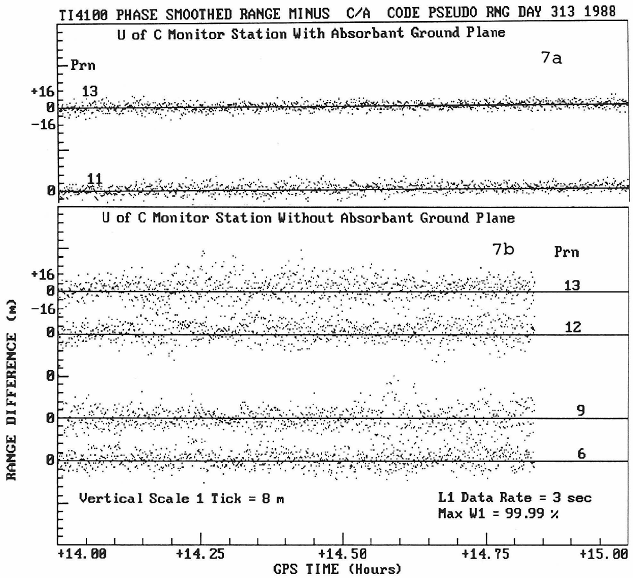

Figure 7: C/A Code multipath signature - (a) with and (b) without the RF absorbent ground plane

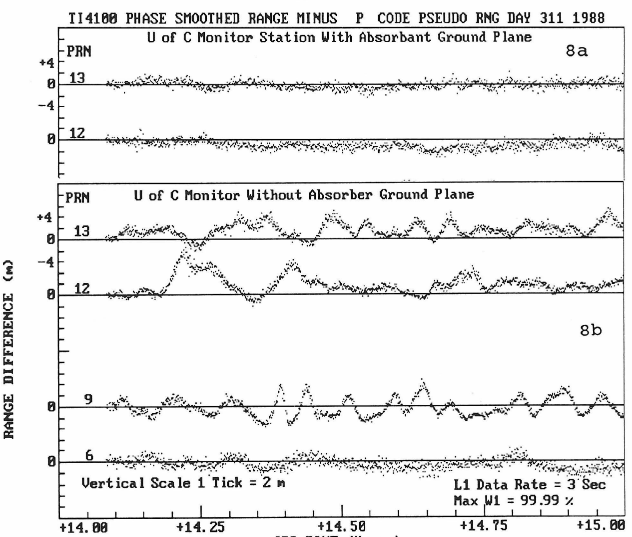

Figure 8: P Code multipath signature - (a) with and (b) without the RF absorbent ground plane

Electrical Engineering of the University of New Brunswick. The ground plane, with a dimension of approximately 1.5 x 1.5 metres, was in the shape of an inverted cone to shield signals coming from an elevation angle of 15^0. The resulting code noise characteristics are shown in Figure 7 for C/A code and in Figure 8 for P code. In each case, the corresponding code characteristics when no RF absorbent ground plane was used are also shown for comparison purposes. The effect of the ground plane is significant as it reduces peak to peak multipath amplitude by a factor of five. The use of absorbent ground planes at monitor stations is therefore recommended to improve the quality of the differential corrections.

The next method analyzed for reducing multipath effects was the use of two parallel filters in addition to the main filter. These parallel filters can be used indiscriminately at either the monitor or the mobile stations and operate in a similar manner to the main filter described in the previous section. They are however re-initiated differently than the main filter and reset each time a maximum count or period specified by the operator occurs. The period between resets is typically of the order of a few minutes. The second parallel filter is re-initiated at half the period of the first. Prior to the resetting of a parallel filter, its phase smoothed pseudo-range is compared to that of the main filter. If the difference exceeds a maximum value set by the operator, e.g. 2 - 3 metres, the main filter is reset by averaging its value with that of the parallel filter. The behavior of a parallel filter for a C/A code static case is shown in Figure 9 over a period of 30 minutes. During that period, code multipath exhibited characteristics similar to those shown in Figure 3, with peak to peak amplitudes of 20 metres and periods of 2 - 3 minutes. The filter was reset every 120 seconds. Discontinuities at reset times reach several metres and are due to multipath affecting the heavily weighted pseudo-ranges immediately after reset while the filter is converging. The total effect of multipath on differentially corrected positions can generally be kept under a few metres using parallel filters, even under such extreme circumstances.

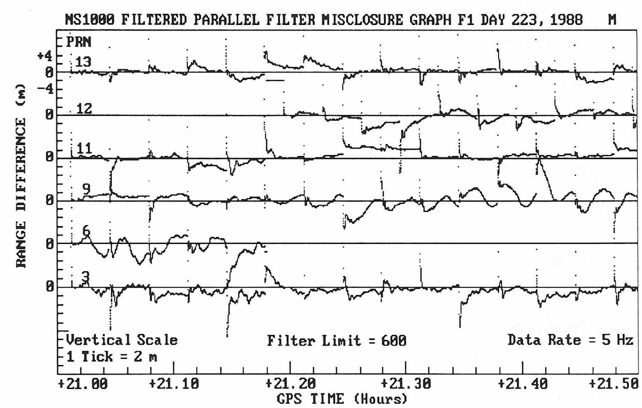

Figure 9: Parallel filter performance in a multipath environment

Conclusions

The code and carrier combination method discussed herein is well suited for the effective recovery of the initial distance between monitor and vessel for marine DGPS operations. Two effective multipath counter-measures have been successfully tested, namely the use of an RF absorbent ground plane at the monitor station and the use of parallel filters at both the monitor and mobile stations. Implementation of these techniques will ensure that the 5 metre (95% confidence level) external accuracy demonstrated earlier can be achieved under a wider range of conditions where multipath could otherwise limit the performance of DGPS.

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About the Authors:

Gerard Lachapelle currently is professor of hydrography and geodetic positioning at the University of Calgary. W. Falkenberg at the time of writing was with Nortech Surveys Canada Inc, and is now a senior applications engineer in the GPS Products Group of NovAtel Communications Ltd. of Calgary. D. Neufeldt is a software engineer and Project Manager of HYDROSTAR Development with Nortech Surveys Canada Ltd., in Calgary. Peter Kielland is a development officer with the Canadian Hydrographic Service in Ottawa.

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Fall 1989 Puzzler Solution - part 1

Hardnose Hank, the Hydrographer-in-Charge of the survey party in Georgian Bay this past year, was of the old school: we should all go back to using sextants and leadlines. In fact Nelson did just fine with his quadrant! In a word, Hank didn't care much for new-fangled technology, nor for the new graduates of technical colleges and universities.

His first day with the survey, Bill, the newest hydrographer (fresh from the best technical college in Ontario), was sent out by Hank to establish and monument a station on a bleak windswept islet about ten miles offshore. He was told to give it a certain name.

Hank gave Bill a simple code using hydrographic words. Bill must solve the code and stamp this new station with the given name. Can you help him with his little difficulty?

1.	YUJGV	_ _ _ _ _
2.	YUPJANJS	_ _ _ _ _ _ _ _
3.	RBGVK AGKPT	_ _ _ _ _ _ _ _ _ _ _
4.	YPVEWLUV	_ _ _ _ _ _ _ _
5.	MUYKUJ ZBGCWV	_ _ _ _ _ _ _ _ _ _ _ _ _
6.	AWOKB	_ _ _ _ _
7.	YBUGC	_ _ _ _ _
8.	HNWCA ZUVX	_ _ _ _ _ _ _ _ _ _
9.	YWQKGJK	_ _ _ _ _ _ _ _
10.	FWJNKB	_ _ _ _ _ _ _
11.	DPGAVGJK	_ _ _ _ _ _ _ _

The station's name is: IGFF _ _ _ _

The Solution

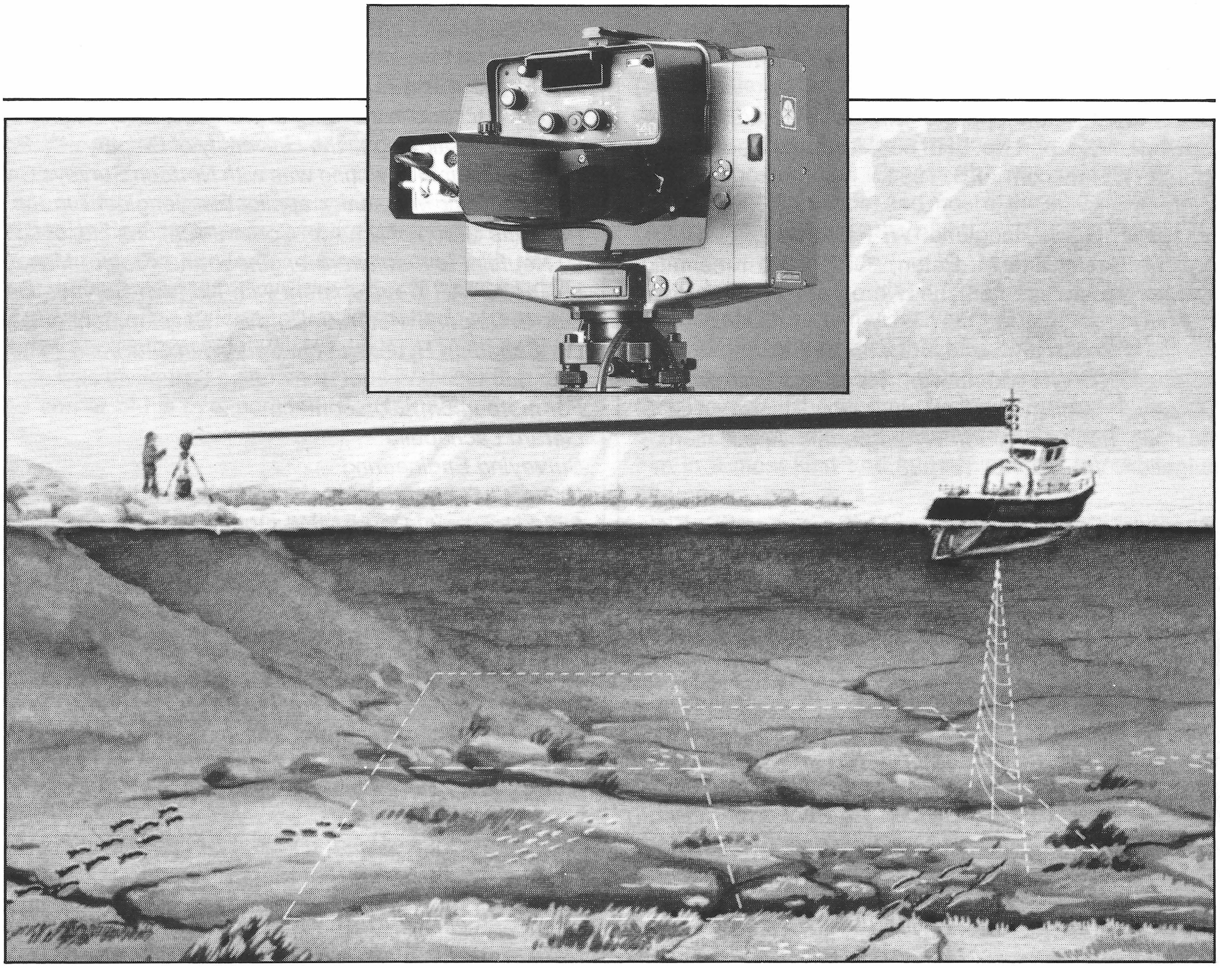
The starting point for this sort of puzzle is to list the letters of the alphabet, then as each letter is identified note it on the list.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_	_

We are told that Hank is of the old school... so start by listing some of the words he might be likely to use in his code, for instance: sextant, leadline, shoal, overtime [!], sounding line, sounding datum, chart datum, charts, ...

Now see which of the words might fit. Several of Hank's "hydrographic words" begin with the code letter Y. Our list of possible words has several beginning with S, so Y probably stands for S. Now try fitting the words and note each new letter on the code list as it is identified.

For the final completed solution, please turn to page 46



Letters to the Editor

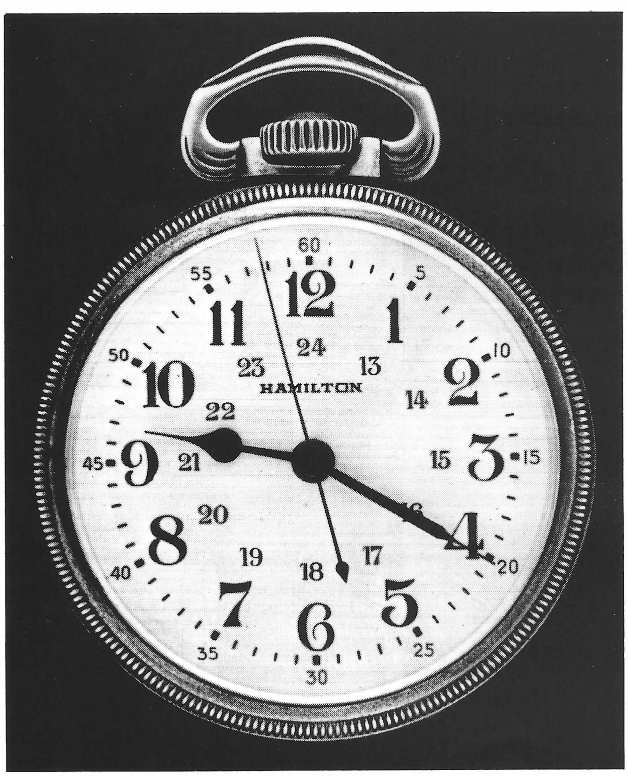
Information Wanted:

The following photographs and letter excerpt recently found their way to the Editor's desk.

"...This watch was purchased at Lunenburg, Nova Scotia on Thanksgiving Weekend in 1989 and you can imagine my delight to (finally) find a deck watch. Chronometers are far more common perhaps because of the number manufactured or because the deck watches make convenient pocket watches and many might have ended their days in vests, not in sponge-sprung walnut cases. At any rate when I had the watch evaluated for insurance purposes, the watch-maker suggested it was made in the 1930's.

That is really all I know for sure, excepting that deck watches were at one time common on small boats where the larger, gimballed chronometers did not fare well in the quick plunging and rolling. I assumed from the two serial numbers on the reverse that the watch was one of an order by the Royal Canadian Navy, perhaps acting as purchasing agent for the Canadian Hydrographic Service. Any confirmation or other information you can find would be most welcome...."

(Peter) Francis Emmorey

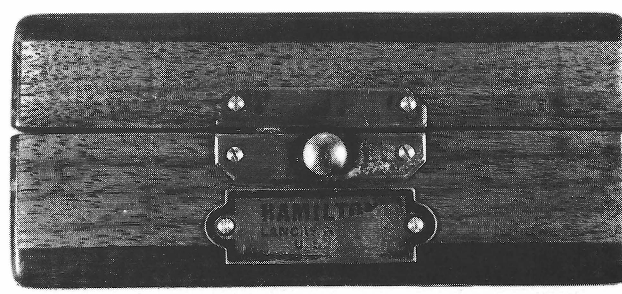


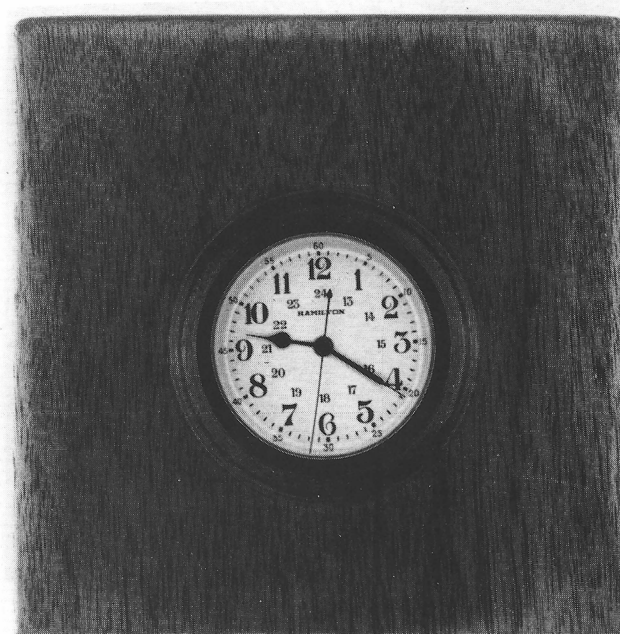
Mr. Emmorey has requested information on his recently purchased deck watch which, as shown in figure 1, has C.H.S. 3 stamped on its back casing. The following is the complete manufacturer's inscription found on the back of the watch casing:

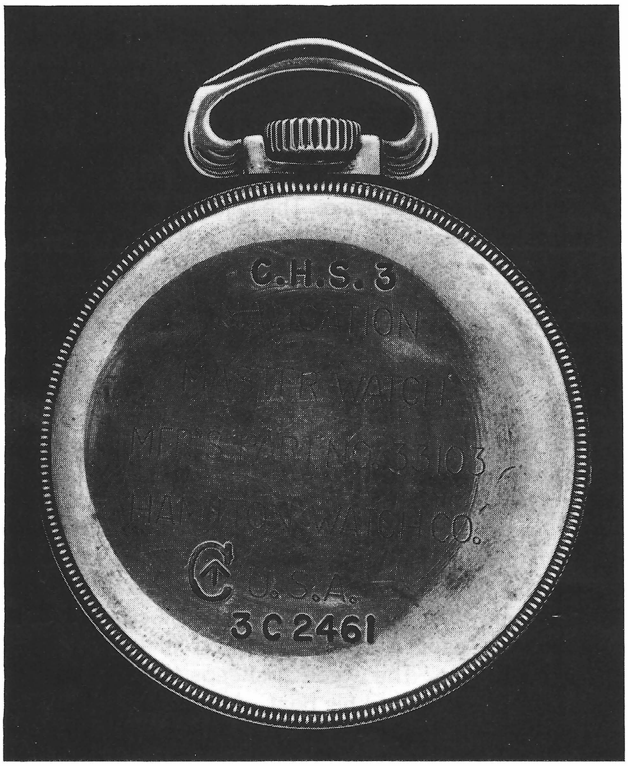
Navigation
Master Watch
Mfr's part No. 331013
Hamilton Watch Co.
U.S.A.

Inside the case are the additional numbers "K016779 (Keystone)" and "Silver 800 Fine".

In restoring the walnut display case Mr. Emmorey replaced the plastic window and would like to know if this was original. There are also faint lines on the front of the case which he believes were caused by clamps which held the watch in place aboard ship. The watch still keeps good time and he plans on using it aboard his boat. Anyone able to provide information about the history of this watch please contact the Editor.



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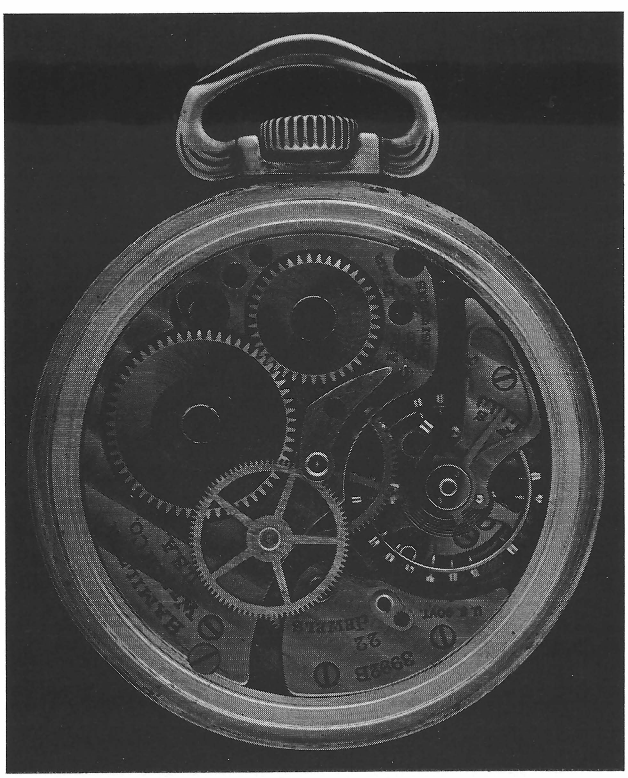


Sustaining Members

In 1987 the CHA defined a new form of membership to allow 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 audience of people involved with hydrographic work. The benefits of Sustaining Membership include:

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

The annual dues for Sustaining Membership in the CHA has been set at $150.00 (Canadian)

The names of each of the Sustaining Members are listed below:

Aanderaa Instruments Ltd.
560 Alpha Street,Victoria, British Columbia, V8Z 1B2
contact Gail Gabel

CARTOSAT Inc.
6020 Jean Talon Est Bureau 800
Montreal, Québec, H1S 3B1
contact G.-H. Huard

Garde côtière canadienne
104 rue Dalhousie, Suite 311, Québec, Québec, G1K 4B8
contact Claude Duval

GENEQ
7978 rue Jarry Est, Anjou, Québec, H1J 1H5
contact Maurice Parisé

Hydro-Québec
855 rue Ste-Catherine Est, Montréal, Québec, H2L 4P5
contact A. Turgeon

IDON Corporation
875 Carling Avenue, Ottawa, Ontario, K1S 2E9
contact Herbert Brown or James Feeley

Institut Maritime du Québec
53 St-Germain Ouest, Rimouski, Québec, G5L 4B4
contact Claude Jean

Krupp Atlas Elektronik
1075 Central Avenue, Clark, New Jersey, USA 07066
contact Karl Wm. Kieninger

Quester Tangent Corporation
9865 West Saanich Road, Sidney, British Columbia, V8L 3S3
contact John Watt

SURNAV Corporation
1000-38 Antares Dr.
Nepean, Ontario K2E 7V2
Telephone: (613) 723-1830, FAX: (613) 723-0786
Contact: Harold Tolton

Terra Surveys Ltd.
1962 Mills Road, Sidney, British Columbia, V8L 3S1
contact Rick Quinn

TOPOMARINE Inc.
2960 Boulevard Laurier, Suite 501
Ste-Foy, Québec, G1V 4S1
contact G. Biliveau

Each issue of Lighthouse contains information about some of our Sustaining Members. This time we can tell you about Surnav Corporation:

Surnav Corporation

Surnav Corporation is an Ottawa based company supplying technologically advanced navigation/survey systems, bathymetric systems and tidal and water quality sensors to the Canadian survey marketplace.

Surnav represents manufacturers including:

Del Norte	- Microwave and UHF Trisponder
Trimble Navigation	- GPS Receivers and Software
Krupp Atlas	- Bathymetric sounders and laser positioning
Comstar	- Navigation and bathymetric data processors
Ocean Data	- Bathymetric sounders, tidal and water quality sensors

Clients include federal and provincial government agencies, Canadian Armed Forces, survey and mapping industry, and oil and gas exploration, dredging, aerial application and aircraft manufacturing companies.

In addition to new equipment sales including lease to purchase agreements, Surnav provides an extensive inventory of GPS, microwave and UHF positioning and bathymetric equipment for term rental.

All equipment sold, leased or rented is technically supported throughout and after warranty by a fully equipped maintenance facility. Training, installation and field engineering support services are also provided.

Surnav maintains close lines of communications with its principals, ensuring that the changing needs of the Canadian surveyor are fulfilled in the evolutionary process of technology development.

News from Industry

Andrews Hydrographics Ltd.
Andrews Hydrographics of Reading, UK, have recently completed their 800th Seismic Operation. Ranging from shallow surface surveys to more specialized transition or surf zone work close to shore, the surveys often include points both on land and at sea.

Andrews provide a crew and software dedicated to each task and are also involved in most of the main borehole surveys. These range from vertical incident operations in which the source is positioned directly above the geophone to remote positioning covering static offset and the more complicated walk-away surveys. Specially produced software calculates the target position of the geophone in the well for any given depth, whether TVD or MD. Subsequent charts and data bases log the position of the seismic source in relation to the geophone within the borehole and the wellhead. This can be in either XY and/or UTM co-ordinates and UK00A format.

Ashtech Inc.
Ashtech of Sunnyvale California and the Institute of Space Device Engineering (ISDE) of the USSR have signed a Memorandum of Understanding to jointly develop a combined GPS/GLONASS receiver following the guidelines and pertinent laws of both countries.

Ashtech also announce that they have selected **Edo (Canada) Ltd.** (formerly JMR Instruments) of Calgary to be their Canadian representative for sales and leasing of their GPS and geodetic survey equipment. Ashtech and Edo also plan to conduct joint development activities in the area of integrated navigation systems and azimuth determination systems using GPS.

Edo has established a complete maintenance and training depot in its Calgary facility to accommodate the Ashtech line of GPS survey equipment. An extensive lease pool of Ashtech precision geodetic GPS receivers is maintained and available for immediate delivery.

The Ashtech XII Receiver has 12 independent hardware channels and automatically tracks all satellites in view and offers an optional additional 12 hardware channels to provide ionospheric corrections using the L2 squaring technique.

International Centre for Ocean Development
The International Centre for Ocean Development (ICOD) of Ottawa has developed a computer program library for the delimination of maritime boundaries. Known as DELMAR, this package is designed for IBM or IBM compatible XT or AT personal computer and a graphics display adapter to allow full use of the graphics capability of DELMAR.

Key features of the program library include an on-line tutorial and a collection of modules to compute marine areas, determine offshore limits, delimit equidistant boundaries etc. Also included is a suite of utility programs for the solution of relevant peripheral tasks, a full-screen text editor, and a suite of graphics programs for the display of geographic data.

Marimatech APS.
Marimatech APS of Aarhus, Denmark, have introduced new shore-based tide measurement equipment.

The Marimatech Hydrometric Station HMS 1820 is a complete station for measuring, recording and transmitting water level and temperature data. The controller and data logger unit are delivered with built-in modem complying with most standards and RS-232C interfaces. Software has also been developed for use with standard IBM PCs.

The Hydrometric Station HMS 1820 is designed to operate under severe conditions and has an internal battery pack to operate the station for up to two years. The station is self-calibrating and can store the collected data internally as well as transmitting it by telephone or radio. This makes the unit ideal as a stand-alone station in remote areas. And there are two models, one being designed to be completely submerged for security.

McElhanney Geosurveys Ltd.
McElhanney of Vancouver, B.C. have been appointed sole distributer in Canada for the John E. Chance Associates of Lafeyette, Louisiana, Starfix system receivers and say that continuous, accurate positioning coverage is now available throughout Canada with the Starfix system.

Starfix, the world's first and only commercially available satellite-based positioning system, was introduced by John E. Chance & Associates in 1986. It is able to provide continuous positioning coverage made possible by using commercial communication satellites which remain at a fixed position relative to the earth.

A network of reference stations relay data to a central master computing centre which then makes the data available to users via the satellites. Combining the information from the reference stations and its own measurements to the satellites, the Starfix receiver can compute its precise geographic position at all times with an accuracy of 5 to 10 metres over the network area.

The system is not affected by weather or atmospheric conditions and claims a reliability rate of 99.7%. No special licensing is required.

Pulstrac
The Canadian Coast Guard is gearing up to use the Pulstrac network being set up by the US Coast Guard's Ninth District and the US Army Corps of Engineers Sault Ste. Marie area office. Plans are to use the passive self-calibrating network for such tasks as buoy placement and monitoring, hydrographic surveying and routine Coast Guard functions. Two networks will be established to cover the St. Mary's River.

Krupp Atlas Elektronik

Krupp Atlas Elektronik of Clark New Jersey have announced *Atlas Polartrack*: a new all-purpose high precision three-dimensional laser tracking and dynamic position fixing system designed for hydrographic survey and other applications.

Suitable for automatic continuous horizontal and vertical tracking and the positioning of moving targets with optical prisms for returning the signal, the *Atlas Polartrack* system can operate as a total station, theodolite, or as an automatic or remote-controlled tracking unit. Operational range (1.5 times line of sight in adverse weather conditions) ranges from 109 m to 10 km or more in favourable conditions. Typical dynamic accuracy is in the order of 5 to 10 cm per km of measured distance, with a continuous positional update rate of 5 or 10 times per second.

System components include a tripod-mounted battery operated fixed station controlled by either a hand-held keyboard display terminal or a telemetry link with optional voice communications. A semi-duplex telemetry link to laptop computers or automated survey systems via standard RS 232C interface can also be provided.

Krupp Atlas also have an optional IBM PC-compatible software package called *Atlas Polarsoft* available for general hydrographic and navigation operations. Designed for remote control and data acquisition purposes, this typically provides a navigation display in addition to data output in the formats of Polarfix, Miniranger, Trisponder or other positioning systems and is suitable for simple connection to existing automated systems or peripheral devices.

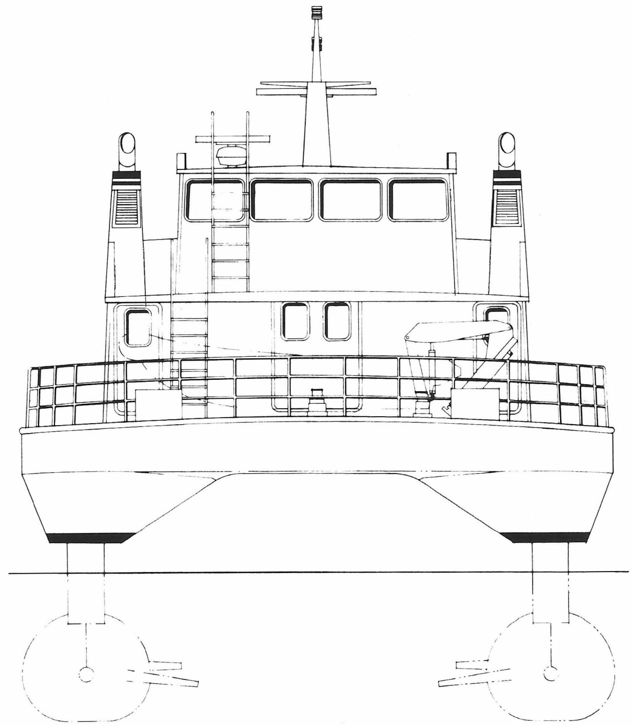
Aanderaa Instruments Ltd.

Aanderaa Instruments Ltd. report that Argos has designed a near real-time tide gauge station to interface with Aanderaa Tide Gauges WLR-5 and WLR-7. This compact terrestrial station is simple to operate and reliable, designed to monitor the tide gauge; collect measurement data (pressure, temperature, salinity) from the tide gauge; encode and compress the data and send it through *Argos*; and provide power to the tide gauge. A total of six sensors can be input into the system.

Once data is received by the *Argos* centre it is converted to physical units as measured by the tide gauge with some quality control before output. Data is then either disseminated by real-time *Argos* through public data transmission on networks or archived and output to print-out, tape or floppy disc.

Swath Ocean Systems Inc.

Swath Ocean Systems Inc. of San Diego tell us that their SWATH vessel *Frederick G. Creed* was chartered by the Canadian Department of Fisheries and Oceans for trials by the Canadian Hydrographic Service off the coast of Newfoundland, following trials by the US National Oceanic and Atmospheric Administration off the NE US coast. [See the reference to this exercise in Central Branch News.]



SWATH stands for Small Waterplane Area Twin Hull (not to be confused with "swath sounding" using an array of echo sounders) and such a vessel looks rather like a catamaran. The secret is below the water: the vessel sits on two parallel submarine-like pontoons several metres below the waterline, their level ride aided by stablilizing fins. The above-water part of the vessel is connected to the submerged hulls by thin vertical struts running nearly the whole length of the vessel. This configuration produces a remarkably steady ride and the ability to maintain high speeds (20 knots) and continue sounding even in heavy seas.

The 68 tonne vessel *Frederick G. Creed* is 20 m long with a beam of 10 m. She can carry a 10 person scientific staff and crew for a week at sea and on trials achieved speeds of 25 knots.

ChartNav

How's this for a modern navigation technique? Billy Reisner was making a trip late one evening using his ChartNav electronic chart and tried to enter Brunswick, Georgia. Unfortunately Hurricane Hugo had destroyed the entrance and the new opening was not yet on the charts. So. Guess what? Yep. He ran aground. But not to worry. He backed off and used his echo sounder to follow a fisherman into the new channel.

Next morning? Thick fog. Fortunately Mr. Reisner had stored his track route from the previous night on his ChartNav cartridge. He was able to leave habour simply by following this route in reverse. Six other vessels followed him out. "I never had the slightest fear," said Mr. Reisner. "Many people do not realize how powerful and versatile this system is."

(from ChartNav News)

Qubit North America

Qubit North America of Rockville, has introduced CHART V, an improved version of its data-processing and plotting system to complement the latest, more powerful version of its TRAC integrated navigation and data-logging system.

CHART V features an updated processor with integral hard disc using batch processing techniques to speed the throughput of data collected by the associated TRAC system. An improved user interface allows editing to produce smoothsheets either on-line or in post-processing mode.

Qubit says the features now include 3-D views, digital elevation models using weeded data, and non-overwrite of depths with colour banding. Multi-panel charts can also be produced with title blocks.

Qubit have also introduced a powerful GIS data-base management system that enhances the capabilities of the CHART V system. This Qubit GIS provides detailed pictorial representations in colour of any aspect of the bottom.

The Qubit GIS greatly extends the ability to manage survey information and provides a dynamic capability to process, merge and overlay the large quantities of data collected before and during hydrographic surveys. It also allows the operator to call up combination plots and to make rapid comparisons with historical data or to spot incompete areas.

Source data may include fixed features such as shoreline, channels, buoys, pipelines and rig positions as well as field survey data or variable data such as tidal heights. The whole Qubit GIS can also be integrated with other larger systems to suit operational, analytical, or reporting requirements.

The Digital Chart of the World Project

What happens when 20 gigabytes of digital geographic information system data (the world at 1:1,000,000) is released on 35 CD-ROMs early in 1992?

The United States of America's Defense Mapping Agency (DMA) in cooperation with Australia (DOD Army), Canada (DND D Geo OPs), and the United Kingdom (MOD) has initiated a research and development project to establish a new digital product: The Digital Chart of the World (DCW), accessible using PC-based systems.

Employing a topologically based vector structure, the product will provide a digital representation of land surface information on (about 35) CD-ROMs. Coverage will be worldwide at a scale of 1:1,000,000 with the information being derived from DMA's Operational Navigation chart (ONC) series.

A $10,000,000 contract has been awarded to a prominent GIS firm - Environmental Systems Research Institute (ESRI) of Redlands California - for the production of four DCW prototypes and the retrieval software, the digital data base, and the first sets of production CD-ROMs. Other USA agencies involved include the Army, Air Force, Navy, Geological Survey, Central Intelligence Agency, Defense Intelligence Agency, National Oceanic and Atmospheric Administration, and the Department of Energy. The two-year DCW Project began in October 1989 with the DCW expected to become a product for public sale in 1992.

The Department of National Defence has signed a Memorandum of Understanding with DMA. David G. McKellar (D Geo Ops 5) is the Canadian project manager.

Canada carries out is responsibilities by

* participating in the bi-monthly Technical Review meetings (usually 2 or 3 days long);
* evaluating the four DCW prototypes being provided in 1990;
* critiquing technical documentation;
* making recommendations to DMA and ESRI as appropriate;
* involving the Canadian Hydrographic Service of Fisheries and Oceans, and the Department of Energy, Mines and Resources in the DCW Project by integrating their evaluations, critiques and recommendations with DND's responses;
* holding informational meetings for those who might be interested in this product;
* preparing for the use of the final CD-ROMs with DND.

Through the Department of Supply and Services DND has contracted **IDON Corporation of Ottawa** to assist it in carrying out its responsibilities.

In March 1990 representatives from DMA were in Ottawa to discuss the project with another meeting in Ottawa planned for 1991 or 1992 to discuss progress and possible uses of the data.

Timothy V. Evangelatos is the CHS contact on this project.

Association of Canada Lands Surveyors: Update

by Geof Thompson and Sean Hinds

By 1994 the Association of Canada Lands Surveyors (ACLS) will have evolved from a voluntary to a self-regulating association similar to the provincial land surveying associations. Membership in the ACLS will then become a condition of being able to practice as a Canada Lands Surveyor.

The above paragraph could well be an abstract of the proposal that was approved by the general membership of the ACLS in the fall of 1989. In the last "ACLS Update" (Edition #40, Fall, 1989) we outlined the proposal in general and the process by which the ACLS elected to follow. In this Update we will outline the reorganization of the ACLS in the transition stage 1989 to 1993 and the final organization in 1994 (fully self-regulating and self-financing).

In the proposal for the transfer of responsibilities the following steps and actions were identified for a successful transfer:

1. The ACLS must reorganize into a strong and viable association with a strong executive, administrative structure, board of directors and committee structure so that it may

assume the responsibilities of the CLS Board of Examiners. Amendments to the present legislation must be prepared and enacted.

2. The CLS Examination Syllabus will require to be amended because the transfer of responsibilities imposes obligations of professional accreditation and development upon the ACLS. During the amending process several areas will require attention: firstly, new subjects would be added to the syllabus; secondly, the Board would amend examination regulations for subsequent approval and enactment by Provincial Order-in-Council; thirdly, a continuing education program would be formulated. Finally, the cooperation of the provincial land surveying associations must be sought to promote the writing of CLS exams by provincial land surveyors.

At the moment the ACLS is a voluntary association consisting of the Board of Directors (President, Vice President, Past President and two elected Directors) and the Council (President, Vice President, Past President, and the Secretary-Treasurer). The existing committee structure (outlined below) does not satisfy the requirements of a self-regulating association.

Auditor	Insurance
Continuing Education	Membership
Liaison	Public Relations
Nominating	Regional Groups (ad hoc)
By-Law Review	

To become an effective self-regulating body several steps will be required to re-organize the ACLS committee structure. It is proposed: that the present four Officers become the Executive and the present Board of Directors be expanded to include committee and regional representation; that the committee structure be revised to reflect the requirements both during and after the transitional period, and that administrative capabilities be strengthened.

In the transition stage the following six committees are considered vital to the transition program and would require to be added to the existing structure:

1) Administration
- to set up and cost a permanent administration structure for the ACLS;

2) Bylaw
- to undertake a complete review of the present bylaws of the ACLS;

3) Communication
- to keep the membership of the ACLS well informed about the evolution from voluntary to self-regulating status and to stimulate interest among provincial land surveyors in working towards CLS certification;

4) Continuing Education
- to form a continuing education program related to the revised syllabus, and to organize a series of seminars related to the program;

5) Legislation (standards)
- to work on the preparation of a draft lands surveyors act and to draft standards related to the work of Canada Lands Surveyors;

6) Liaison
- to Liaise with the Board Of Examiners and the Surveyor General of Canada on all matters related to the surveying of Canada Lands and the practice of the Canada Lands Surveyor.

Once self-regulating status is achieved three additional committees would be required. These committees would be the core which would made it possible for the ACLS to become a professional self-regulating association. Their names and tasks are:

1) Board of Examiners
- to be responsible for all matters relating to the examination, admission and qualification of candidates for Commission as CLS;

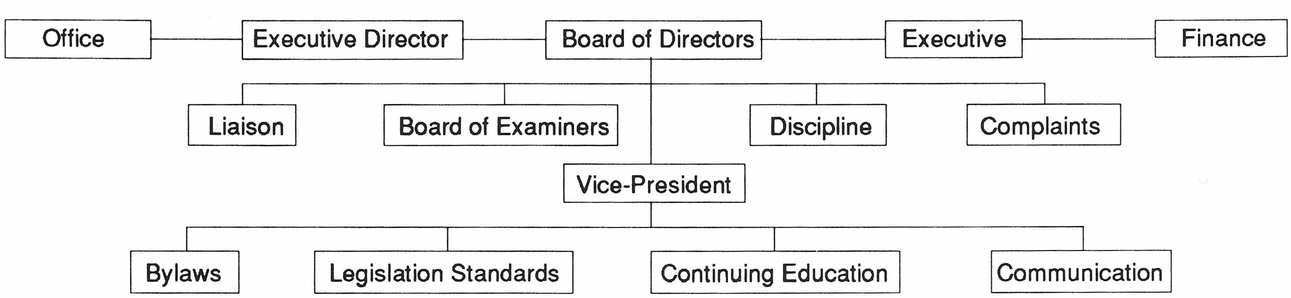
2) Complaints
- to receive and take action on complaints concerning members of the ACLS;

3) Discipline
- to deal with disciplinary matters concerning members of the ACLS.

The organizational Chart below shows the structure of the ACLS once it becomes a fully self-regulating association.

In future "Updates" Sean and Geof will outline how this is going to be paid for.

Association of Canada Lands Surveyors
New Organizational Chart



Coming Events

FIG XIX Congress is in Helsinki, Finland, June 10 - 19, 1990. The Congress theme is *"The Challenge of the Information Society for Surveyors"*. Each of the nine Commissions will have a program of presentations and Commission IV (Hydrography) will no doubt have an outstanding program as it did at Congress XVIII in Toronto.

International Symposium on Kinematic Systems (KIS'90) in Geodesy Surveying and Remote Sensing: will be held in Banff, Alberta, September 10-13, 1990. This symposium is organized by the Department of Surveying and Engineering at the University of Calgary and sponsored by various national and international agencies, including the International Association of Geodesy. The meeting will involve papers, poster sessions and demonstrations on kinematic methods used in geodesy, photogrammtery and surveying including INS, GPS and other emerging kinematic technologies.

Hydro 90, the 7th Biennial International Symposium of The Hydrographic Society, will be held at the University of Southampton, England, from December 18 to 20, 1990. This is co-sponsored by the International Hydrographic Bureau, The Nautical Institute, the Canadian Hydrographic Association, the British Marine Equipment Council, the International Federation of Surveyors and the World Organisation of Dredging Associations. Themes cover wide areas of charting and navigating concerns including the electronic chart, remote sensing, GPS and the environment.

Canadian Hydrographic Conference will be held in Rimouski, Quebec, Canada from April 16 to 18, 1991. This biennial conference is jointly sponsored by the Canadian Hydrographic Association and the Canadian Hydrographic Service, and is part of an agreement established by the Canada / U.S. International Hydrographic Commission.

The main theme for this conference is *"Hydrography INFOSTRUCTURE of the Future"* corresponding to the new technological era of management of digital geo-referenced data. Topics to be presented include the electronic chart, legal aspects of hydrography, environment, navigation, internetional development of hydrographic data acquisitionand management. There will be an ICOIN (Inland waters, Coastal and Ocean Information Network) workshop held before the conference on April 15, 1991. There will also be an Oceanic Industry Forum held after the conference, on April 19, 1991, which will be addressed to the users and suppliers of goods and services in the hydrographic industry.

15th International Cartographic Conference, will take place from September 23 to October 1, 1991, at the Bournemouth International Centre in Bournemouth, England. The theme of this conference *"Mapping the Nations"* has been chosen to reflect the many national mapping organizations now in existence. Sub-themes include Marine Cartography; the impact of ECDIS, GIS technology, Cartographic Expert Systems, National mapping organizations in the 1990's, The development of global digital cartographic databases, and Using maps and spatial data.

Fall 1989 Puzzler Solution - part 2

Completed Fall Puzzler solution from page 37

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
G	*M*	*R*	*A*	*W*	*H*	*S*	*B*	*N*	*I*	*X*	*C*	*T*	*J*	*U*	*O*	*D*	*V*	*Y*	*K*	*P*	*E*	*Z*	*Q*	*L*	*F*

1.	*YUJGV*	S O N A R
2.	*YUPJANJS*	S O U N D I N G
3.	*RBGVK AGKPT*	C H A R T D A T U M
4.	*YPVEWLUV*	S U R V E Y O R
5.	*MUYKUJ ZBGCWV*	B O S T O N W H A L E R
6.	*AWOKB*	D E P T H
7.	*YBUGC*	S H O A L
8.	*HNWCA ZUVX*	F I E L D W O R K
9.	*YWQKGJK*	S E X T A N T
10.	*FWJNKB*	Z E N I T H
11.	*DPGAVGJK*	Q U A D R A N T

The station's name is: *IGFF* J A Z Z

Social News

Obituaries

On a sad note, it is with regret we report the death of one of our International Members: **Luis Alfonso de la Rocha**. Luis was a dredge surveyor with Antigua Masonry Products in the West Indies and died with his father in a plane crash on October 21, 1989 in Honduras. Our deepest sympathies go out to Luis's brother Walter and their families at this tragic time.

It is with great sadness we heard of the death on March 17, 1990 of **Tony Smits** after a long struggle with cancer. Tony was a helicopter pilot with the Department of Transport in Ottawa and had worked closely with the Canadian Hydrographic Service in Central and Arctic Region and Scotia-Fundy Region over the years. He was a fine pilot and always helped make that part of our work much easier as well as becoming a good friend to many CHA members.

Newfoundland Branch

The Newfoundland Branch began its winter season with a seminar on G.P.S. The talk was given by Derek Peyton of Grantor Surveys and George Eaton of the Canadian Hydrographic Service and was held at the Northwest Atlantic Fisheries Centre. The talk was well attended and received media coverage.

The same night elections were held to choose the executive for the coming year. The results were as follows:

Vice-President	Gary Day (Campbell's Ships Supplies)
Secretary-Treasurer	Richard Palmer (C.H.S.)
Executive Member	Ken Spence (Cabot Institute)

Shortly after the elections an informal business/social gathering was held at the home of our Vice-President to break in our new executive and to plan our strategy for the year. It was decided that Gary Day would be sent to Ottawa to attend the 1990 Annual General Meeting of the CHA in May. It was also resolved that a sponsorship drive would be initiated to recruit Sustaining Members for our Branch of the CHA. Subsequently, a package was compiled and sent to prospective companies as part of our program to boost membership.

The majority of the membership of our Branch comes from the private sector, which we perceive as a healthy trend. To maintain this trend and to introduce Hydrography to the general public we are continuing our seminar series. Our next seminar on Tuesday 29 May 1990 will be given by Steve Grant of the C.H.S. Atlantic and will discuss the Electronic Chart.

We have been publishing a Branch newsletter to keep our members informed of meetings and other matters of interest. In addition to the usual type of items we have featured in each issue a survey program for lap-top computers. This has been received with enthusiasm and we hope to continue this regular column in our newsletter.

On a final note, we would like to extend our thanks and best wishes to Dale Nicholson, who is leaving us to assume duties as Validation Officer in the C.H.S. Atlantic Region. Dale was formerly our Secretary-Treasurer and has been with the Newfoundland Branch since its inception and for two years, with Frank Hall, ran the Cabot Institute field survey camp. Before his departure the Cabot Institute presented him with a plaque as a token of their appreciation.

Atlantic Branch

Atlantic Branch's membership has had a very busy winter/spring. We are glad to report that this has been noted in both the public and private sectors. Branch activities have therefore suffered somewhat, however we did hold Atlantic Branch's 5th Annual Bolorama on 30th March. This was well attended and enjoyed by all.
The members of the Atlantic Branch Executive for 1990 are:

Vice-President	Mike Lamplugh
Secretary-Treasurer	Glenn Roger
Executive Members	Alan Ruffman
	Dave Lombardi
	Geoff Wright
	Charlie O'Reilly
Past Vice-President	Galo Carrera

New arrivals:
On 26 Oct. 1989 a girl, Mariana, to Galo and Marta Carrera; and on 18 Feb 1990 a boy, Mathew Clive, to Peter and Jeanne Barr. The mothers, fathers and babies are all beaming with delight. Congratulations!

CHS/CHA Volleyball wrapped up in March with all participants ready to get back to their "unfit shapes" for the summer!! Looking forward to next fall to start up again.

Dale Nicholson has won the competition to head up the Validation Unit and assumes his new responsibilities in April. Congratulations, Dale (and good luck!).

T. Burt Smith has accepted a one-year SAPP assignment with Small Craft Harbours, starting last October.

We would like to welcome Signa Nickerson to the Hydrographic Data Centre in a full time capacity.

Chris Rozon has recently received her Watchkeeping Mate's Certificate. We believe she is the first female hydrographer in Canada to do so. Happy sailing, "Captain" Rozon.

John Cunningham has now passed all exams for his CLS commission, only his paper to go (which will be in by June, he tells us).

Mike Lamplugh, Dave Roop and Paul Parks successfully passed all the CLS exams they wrote.

Training has been a big factor this winter and combined with many assignments to different sections throughout our region, has kept the sectretaries hopping with all the changes in phone numbers, to say the least.

The following courses of varying length were held:
- CARIS in Fredericton;
- VMS/HIPP/CARIS at BIO;
- MED A2 at the Nautical Institute in Halifax;
- Hydro I and Carto I in Halifax and Ottawa;
- First Aid & CPR at BIO;
- GHOST in Ottawa and BIO;
- NOS/VE/ORACLE at BIO;
- Employee Assistance Program at BIO;

Two well attended Boat Shows (Halifax and St. John) were manned by CHS personnel. Both were considered successful and well worth the effort to raise the profile of hydrography.

Paul Bellemare (our Regional Director of Hydrography) enjoyed the last two weeks of April in Singapore by taking vacation after two weeks work as Scientific Authority with the Singapore Port Authority.

The best is saved till last. Frank Burgess proudly reported that he caught the largest trout in Country Harbour Lake's Annual Competition. It was 15 inches long but he would not divulge its weight. He did admit, though, that it was a bit skinny!

Section du Québec

Trois réunions du conseil d'administration de l'Association canadienne d'hydrographie ont eu lieu du mois d'août jusqu'à novembre 1989. Les principaux points soulevés lors de ces réunions furent la participation à divers projets d'emplois, le recrutement et la distribution de publications marines.

Vendredi le 10 novembre 1989, une trentaine de membres ont participé à la visite offerte par la Garde côtière canadienne à Québec d'un système de carte électronique. Ce fut un grand succès.

Le nouvel exécutif élu en assemblée générale tenue le 2 décembre 1989 se compose maintenant des personnes suivantes:

P. Pagé, Y. Boulanger, R. Sanfaçon, S. Guimont, J. Proteau, B. Labrecque

Vice-président	Richard Sanfaçon
Secrétaire-trésorier	Bernard Labrecque
Conseillers	Yvon Boulanger
	Sylvain Guimont
	Pierre Pagé
	Jean Proteau

Le rapport annuel 1989 présenté lors de cette réunion contenait le mot du président de la Section qui se résumait ainsi: "En 1989 nous nous sommes principalement efforcé à trouver des moyens qui nous permettraient de compter sur des ressources humaines permanentes dans le but de promouvoir l'Association et assumer son fonctionnement. Devenir distributeur de publications marines nous permettrait possiblement de nous qualifier pour certains programmes d'emploi. Nous disposons maintenant d'un plus grand local prêt pour y assumer ces nouvelles fonctions. Nous pouvons constater, de plus en plus, la stabilité et la maturité de notre organisme et je vous encourage à continuer de supporter notre Section."

Plusieurs réunions de notre exécutif ont eu lieu depuis l'élection du nouveau conseil d'administration pour l'année 1990. Le programme des activités a été élaboré et déjà deux conférences très intéressantes ont été présentées dont une le 26 février 1990 à l'Institut Maritime du Québec à Rimouski par le docteur Michel Leclerc, spécialisé en génie mécanique (hydrodynamique). Ce dernier nous a entretenu sur l'origine des marées et sur l'utilisation des modèles numériques dans la prédiction des courants. Également, une visite au bureau des glaces à la Garde côtière canadienne de Québec a eu lieu le 24 mars dernier.

Récemment, l'exécutif de la section du Québec a souscrit à deux causes qui meritaient notre appuie. Il s'agit du fond de l'Institut Maritime du Québec à Rimouski et de la campagne de parrainage d'un béluga.

La section en profite pour féliciter et souhaiter la meilleure des chances au nouveau président national, monsieur David Pugh.

Mentionnons aussi que notre section dispose maintenant d'un répondeur téléphonique et qu'il nous fera plaisir de vous retourner vos appels. Notre adresse postale demeure toujours la même, soit:

Association canadienne d'hydrographie
Section du Québec
C.P. 1447
Rimouski, (Québec)
G5L 8M3
Tel. (418) 723-1831

Ottawa Branch

At the Branch general meeting in December 1989 the 1990 Executive members were elected:

Vice-President	Sheila Acheson
Secretary-Treasurer	Marilyn Van Dusen
Executive Members	Warren Forrester
	Ralph Renaud
	Ilona Hilbert-Mullen
Past Vice-President	Dick MacDougall

At press time Ottawa Branch has 67 paid-up members, including several new members this year. A warm welcome to:

Bernice Allard	-	with the office of the Dominion Hydrographer;
Leah Donnelly	-	programmer/analyst in the CHS Cartographic Development unit;
Susan Greenslade	-	with the chart amendments unit of CHS.

We also have three new student members this year: Ingrid Vanderschot; Doug Jones; and Chris Daughney, who are working with the CHS for their work terms. They spend the rest of the year at Waterloo University.

Continuing a Branch custom, at the end of the membership drive there was a draw for a bottle of wine for Renewing Members and another draw for New Members. This year's winners were: Renewing Members - Pat Bell; New Members - Doug Jones. Congratulations!

Branch Activities:
We had 100 guests at the 1989 Ottawa Branch Christmas luncheon. Much of the success of this event was due to the generosity of the many sponsors who donated door prizes. Our warm thanks to:

J.M. Ellis	Dupont Canada
Duotroll Canada	Terra Surveys
Gentian Electronics	IDON Corporation
Runge Press	Continental Dining Lounge
Bill Gould	Surnav Corporation
Kromar Ltd.	Canadian Hydrographic Service
McElhanney Ltd.	Versatec Canada
Anna Singereff	Bytown Marine

The Branch organized a tour of the historical cartography exhibit at the Public Archives on March 15. Ralph Renaud arranged this event, including an interesting introductory talk by archivist Ed Dahl.

On March 22 we were fortunate to have Prof. Jeff Austin of McGill Weather Radar Observatory present a talk on "Positioning by Radar". Professor Austin discussed vessel positioning by correlating radar images with a navigational chart data base and/or reference data.

On April 10 the Branch sponsored a special day trip to Prescott and twenty members of Ottawa Branch took this opportunity to see an Electronic Chart demonstration on board the CSS Bayfield.

Activities by Members:
Tim Evangelatos organized and chaired a workshop on GIS Standards at GIS '90. Tim also attended a CEDD Working Group meeting held in January 1990 to review a new CEDD feature object catalogue and a proposed DX 90 interchange format. The meeting just happened to be held in Paris.

Ross Douglas and Neil Anderson attended the GLOBE 90 Conference in Vancouver.

Mike Casey co-authored a paper with L.R. Muir, S. Blasco and R. Stoddard: "Niches for Canadian Ocean Science: Industry and Government Partnerships" presented at Oceanology International 90, in March at Brighton, UK.

Neil Anderson presented "Geomatics" - Lessons from the Future" at GIS '90.

Herb Brown also presented a paper at GIS '90: "Standards: the Key to Geomatics System Integration".

Tim Evangelatos wrote the chapter "Geographic Interchange Standards" which is in the book *"The Microcomputer in Contemporary Cartography"*.

Ottawa Branch congratulates Sam Masry of Universal Systems Ltd. on being named "Innovator of the Year" by the Atlantic Provinces Economic Council and Atlantic Canada Plus.

Congratulations to CHA members Ilona Hilbert-Mullen, Dick MacDougall, Richard Horrigan, Garry Kosowan, Susan Greenslade, Anna Singereff, Denis Chartrand and their CHS assistants, who together won third prize in the government category of the Winterlude snow sculpture contest. Their entry was entitled *"No Such Thing"*.

We are also delighted to hear - just as we go to press - that Tim Evangelatos has won an award. His paper "The Technology of Interactive Compilation" published in the July issue of the *International Hydrographic Review* has been selected by the International Hydrographic Bureau as the winner of the 1989 COMMODORE COOPER Medal. His paper has also been nominated for the Prince Albert I Medal in 1992.

Central Branch

The Central Branch elections took place in December and our new Executive for 1990 is:

Vice-President	Sean Hinds
Secretary-Treasurer	Brent Beale
Executive Members	Jim Berry
	Terese Herron
	Ken McMillan
	Brian Power
	Boyd Thorson
	Keith Weaver
Past Vice-President	Sam Weller

Many thanks to our past executive for their efforts with special thanks to Sam Weller for his dedication and energy in keeping our association healthy and active these past three years. As our Branch's past Vice-President Sam was involved in the processes of "Incorporation" and did an excellent job of keeping the membership informed and presenting this Branch's views.

Sam is also responsible for the excellent newsletter we all receive and he has agreed to continue as its editor, so please drop him a line.

We have recently made a prominent corner of our newsletter available for a Business Card. This offers an opportunity for our members to bring their services to the attention of our readers and at the same time help defray the costs of the newsletter. The price is $50. per issue. Give us a call at (416) 336-4732 or 336-4842.

Incidentally, our Central Branch *NewsLetter* is not only a local Branch circular. It is sent out several times a year and is a valuable vehicle for keeping our International Members in touch between issues of Lighthouse. The *NewsLetter* also goes to the V-P of the other CHA Branches and on request to others for a modest annual fee of $5.00 to cover postage etc.

Central Branch would like to thank Barry Lusk for his efforts as our National President these last three years. Barry devoted a tremendous amount of volunteer time and energy to the CHA at a difficult period and managed to steer us through the interesting intricacies of Incorporation and the learning experiences of embarking on co-sponsored International Aid projects with the Canadian International Development Agency (CIDA). All this in addition to the day to day demands of keeping the CHA alive and healthy. Thanks again, Barry.

And we extend a special welcome to Dave Pugh as our new National President. Dave is a long-time member and past V-P of our Branch and can certainly rely on our total support and encouragement in his new position.

Speaking of support, we owe a huge vote of thanks to George Macdonald for his diligence as Editor of Lighthouse these past two years. Due to his efforts our journal has made it out on schedule every time. Quite an achievement, George. Thanks for everything. And it is with great pleasure that we now extend a warm welcome to our friend and colleague Bruce Richards as he takes on the Lighthouse hot seat. We're behind you all the way, Bruce. Pay's rotten (like zero), and the hours are terrible, but the prestige... [!!! Ed.]

Our membership committee reports that Central Branch ended 1989 with another record of 80 paid-up members: 38 In-House, 41 Out-House, and Krupp Atlas Elektronik of New Jersey is our first Sustaining Member.

Since our last report in Lighthouse we have signed on two new Branch Member and we take this opportunity to extend a warm welcome to Dave Caswell and Jordan Smith, both of McQuest Marine. Welcome aboard!

This year our Branch was fortunate to have two of its members from the private sector elected as Executive Members. <u>Jim Berry</u> was on the executive last year and has been writing a column in our newsletter featuring news from the Out-House members. <u>Ken McMillan</u>, president of McQuest Marine Sciences of Burlington, has already been active on our Membership Committee and in suggesting topics and speakers to our Seminar Committee.

<u>What's been happening:</u>
Recently the Association of Ontario Land Surveyors expanded their Constitution to include the discipline of Hydrographic Surveying. The following Central Branch members attended the necessary seminars and were accepted under the Grandfathering Regulation: Bruce Wright; Bruce Richards; Paul Davies; Arnold Welmers; Mike Crutchlow; John Medendorp; Raj Beri; and Rear-Admiral Kapoor (former Editor of Lighthouse).

After diligent studies and successful exams George Fenn recently received his Canada Land Surveyor Commission. Congratulations, George.

Denis Pigeon has recently returned from Dartmouth Nova Scotia, having successfully completed the Basic Hydrography course. Ray Treciokas and Roger Robitaillesuccessfully completed the Carto I course in Ottawa, in April.

Andrew Leyzack (former Central Branch member; recently graduated to International on accepting employment with Wimpol of Houston, Texas) is due to get married in June. Andrew met his bride-to-be Cindy Mai while working as a summer student with the CHS in the North Channel of Lake Huron. The marriage is to take place in Kentucky. Congratulations!

Brian Power participated in SWATH Evaluation Trials in Newfoundland. Brain says he enjoyed the Newfoundland hospitality and the opportunity of working with fellow hydrographers from across Canada. He says the SWATH vessel would make a grand hydrographic survey platform and has promised more details for next issue of Lighthouse.

Darren Keyes of McQuest Marine, Burlington, organized an Ice Fishing Trip to Lake Simcoe on March 3rd. Unfortunately only one smelt was caught all day. Those who chose to stay overnight faired better the next day, we hear, with record catches of perch, northern pike and pickerel. Ah. well. We'll try again next year. [The beer was good, though].

In Jim Berry's column we recently heard some news from Guenter Bellach who is spending two and a half months in Asia. He's just finished a 1,500 km bicycle trip through NE Thailand along the Mekong delta and... "I think I stumbled over a couple of bench marks from the famed Mekong Survey CIDA Project of umpteen years ago." After a bit of beach combing in south Thailand he's then off to the Philippines before heading back to Canada at the end of May. Tune in to future newsletters for more news on his trip!

Our mid-summer barbecue is once again being hosted by Bruce and Jo Anne Richards. The day is Saturday August 11, 1990 at 14:00. All members, prospective members, friends and family will be warmly welcomed. Pony rides for the kids (they have three horses and a pony), softball and horseshoes for the active among us, extra cold beer for the others...

Boyd Thorson put together another magnificent H2O Bonspiel in February this year. His report is given below. This year we had 66 people sign up for the 64 available spots... So

Boyd and Geof Thompson imitated a cheering section and just sat back and enjoyed the spectacle of the success of their labours. Thanks again, guys.

<u>Central Branch [the Original and Genuine] H2O Bonspiel</u>

The Bonspiel: 1990 19th Annual H2O Open Bonspiel.

The Venue: Grimsby Curling Club, Grimsby, Ontario (across the Lake from Toronto).

The Time: February 18, 1990 (0800 - 2100 hours).

The Hunt: Two trophies, 64 prizes, the year to gloat.

The Curlers: Sixty four of 'Ontario's Finest'.

The Struggle: Head to head, body to body, broom to broom, rock against rock, end to end, nine and half hours of scintillating action.

The Winners:
- All sixty-four!;
- the "Big Trophy and gloat" going to Dave Pyatt's stone slingers Lyn Roth, Jason Kennedy and Dan Dexel;
- and the "little big trophy and gloat" going to the Rob Peachy Francine Dexel, Susan Batchelor, Richard Burton fearsome four some.

The Generous Sponsors:

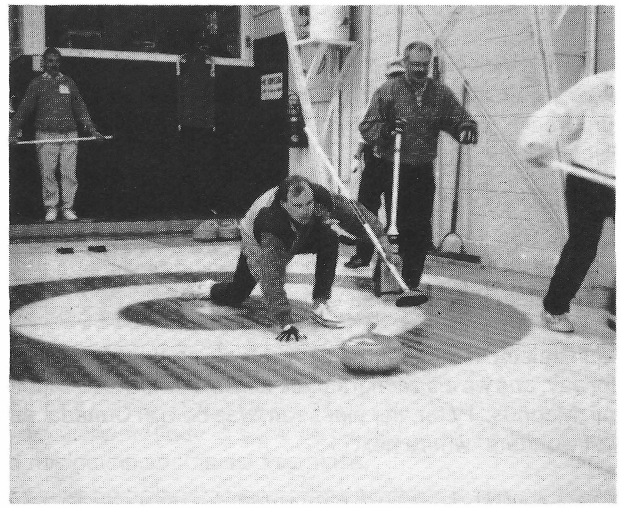
terra surveys ltd., Ottawa, Ontario
Quester Tangent Corporation, Sidney, B.C.
R.C. Marine, Dartmouth, Nova Scotia
Surnav Corporation, Nepean, Ontario
Marshall Macklin Monaghan Limited, Don Mills, Ontario
Wild Leitz Canada Ltd., Willowdale, Ontario
Geodimeter of Canada Ltd., Toronto, Ontario
J.M. Ellis Ltd., Metcalfe, Ontario
Klein Associates Inc., Salem, New Hampshire, U.S.A.
Universal Systems Ltd., Fredericton, New Brunswick
Canadian Hydrographic Association, Burlington, Ont.
Adam Promotions, Toronto, Ontario
Norman Wade Company Ltd., Hamilton, Ontario
terra surveys ltd., Sidney, British Columbia

The Thanks: To the organizers: Ron Solvason for arranging the venue, Brian Power for getting umpteen jobs done, Geof Thompson for the score-keeping, Boyd Thorson for generally running a loose ship, and to the curlers who filled the two draws, but most of all to the Sponsors who make the day for all the first-time Curlers, who in receiving that first little prize starts them down the road on their curling careers.

The Comments:

Great Time - Great Chow - Great Prizes - Great Day!

The Pics:



New Curler and CHA's Central Branch Vice-President Sean Hinds getting down the delivery.

The "B u l k - a - M a n i a c s" hamming it up:
Win Booth, Rick Sandilands, George Duncan, Dennis St. Jacques, (loaded rink!) - finished ? - ah who cares?

The End: See you all next year!

Capt. Vancouver Branch

The Annual General Meeting of Captain Vancouver Branch was held on December 5 at the Vancouver Maritime Museum, courtesy of the Director, Mr. Robin Inglis. The beverages and attractive buffet were organized by Alex Fakidis at no charge to the members attending. Say, Alex, when is the next meeting?

The election of office bearers for 1990 was confirmed by acclamation as:

Vice-President	George Pugach
Secretary-Treasurer	Warren Williams
Past Vice-President	Rob Lyall

George was with Swan Wooster and Sandwell/Swan Wooster for nearly ten years; he is now Manager of Bennett Surveys Ltd.

Warren is with Public Works Canada, in Marine Engineering.

Out-going Vice-President Rob Lyall of Offshore Systems was given a warm vote of thanks for his achievements in steering our Branch so well through the magnificently successful Discovery '89 Conference. A huge venture for a Branch only three years old! Thanks again, Rob, for everything.

Captain Vancouver Branch can ill afford the loss of two of its more active members and it is with mixed feelings that we congratulate them on their career moves:

Carl Christensson has transferred to Simrad in Kongsberg, Norway, and we also congratulate him on the birth of a second son, Magnus. Peter, the elder son, was born in Canada, and Carl wonders "where next?"

Mike Slater has been with Northwest Hydrographic Surveys for many years; now he and Crystal have settled permanently in San Diego, California. "Mike, where are you when we need you?"

Retirement: After more years with Public Works Canada than he would care for us to remember, Bob Richardson has handed over the "Bridge". (C'mon Bob, a young lad like you?)

Duty roster: Rick Bryant has been assigned to the Federal Review of Tanker Safety. Added to his responsibilities for Aids and Waterways with Canadian Coast Guard, Western Region, this duty made it impracticable for him to stay on as Secretary-Treasurer of the Captain Vancouver Branch; a position which he has filled admirably since the formation of the Branch in 1986.

At the September Branch meeting a unanimous vote of thanks to Rick was recorded.

Captain Vancouver Branch closed 1989 with 27 paid-up members and all have exciting ideas for activities in the new year.

Pacific Branch

The advent of spring has Pacific Branch members gearing up for the usual summer activities: field duties for some, holidays for others, but generally a busier schedule for the next few months. The Branch Executive have continued to meet over the winter with a smooth transition from the 1989 to the 1990 slate of officers in Pacific Branch. The 1990 Executive is as follows:

Vice-President	George Eaton
Secretary	Carol Nowak
Director (Social)	Mike Ward
Director (Financial)	Ray Chapeskie
Director (Membership, Lighthouse)	Mike Woodward
Director (Newsletter)	Mike Bolton
Past V-P (Seminars)	John Watt

CHS Activities

C.H.S. Pacific Region's field program for 1990 is getting underway. Dave Thornhill and Olen Vanderleeden have been in Vancouver doing revisory work in wonderful wet coast spring weather.

Mike Woods and his party of Pete Milner, Ken Halcro, Knut Lyngberg and Doug Popejoy eagerly await the arrival at Pat. Bay of the new coastal survey ship R.B. YOUNG. She will be working on surveys along the coast for the next five months.

Vern Crowley is in the process of finishing a plan of Pat. Bay wharf and then will be moving off to Campbell River, Gold River and Nootka Inlet. Frank Coldham, Carol Newak, Ron Woolley and Janet Lawson are the hydrographers with this party.

The barge PENDER and her crew will spend the summer in Hakai Pass surveying and keeping an eye on the springs and cohos for the Department. George Eaton will be H.I.C. with Alex Raymond, Rob Hare, George Schlagintweit and Dave Thornhill on board.

Mike Ward will start the season in PENDER and then spend the rest of the summer in Victoria working on revisory surveys or contracts with Kal Czotter, John Larkin and Barry Lusk.

With mixed emotions (great joy or painful regret) and/or a medium priced California wine (something better than your average Zinfandel) we mark the passage of Ernie Sargent into the bosom of Pacific Region's Tides and Currents Section. Congratulations or condolences Ernie.

The major reconstruction program and subsequent move of Production and Distribution has not only mystified several people, it has created a severe strain on the production workload. However, despite this major encumbrance, charts continue to be produced and distributed.

Nine staff members attended and successfully completed a CARIS course in November. Dave Prince and Harvey Pfluger completed Marine Cartography II, Ron Bell and Mike Jennings completed another phase of the UVIC computer course "Office Automation". L. Thompson, R. Bell and B. Kenny attended a pre-retirement seminar in Vancouver. Clearly they failed, as all are still working.

A study of surface currents in southern Hecate Strait and Queen Charlotte Sound will be the major field program of Tides and Currents. This will include a July cruise on PARIZEAU plus a 10 week charter aboard the M.V. BEATRICE of recent Oak Bay Salvage fame.

The recent retirement of Fred Hermiston and John Smedley has led to an infusion of new blood including Larry Derosh from Engineering Services and the afore-mentioned Ernie Sargent. Bodo de Lange Boom has also joined the Current Survey from the private sector, bringing a wealth of experience.

Willie Rapatz has moved into the Regional Director of Hydrography chair in an acting capacity while Tony O'Connor is in Ottawa.

Tony Mortimer won the recent competition for Sandy Sandilands' old job.

Personal

New arrivals: Congratulations to Linda and Ardene Philp for a baby boy. Ditto for Mary and Bodo de Lange Boom for a baby boy.

Movings: Knut Lyngberg to a new house, George Schlagintweit, ditto, Alex Raymond to flatter ground, Ken Holman – welcome back to gardening. Sev Crowther to Hawaii for six weeks.

Sweating it out: Kal Czotter, Knut Lyngberg, Ken Halcro, Carol Nowak, George Schlagintweit, Mike Ward, Ron Woolley awaiting results of C.L.S. examinations.

Congratulations: to Jim Galloway and Brian Watt who walked away with all the prizes at the November BBBBash (darts, shuffleboard and cribbage).

On Sunday March 25 a group of transplanted Easterners with a few misguided Webfoots tried to pretend it was winter as they took to the ice in the 3rd Annual H2O Bonspiel sponsored by Pacific Branch of CHA.

Winners of the prestigous trophy were John and Shirley Demeriez, Dave Paton and Chris Jang (Shirley of Chart Amendments, Dave from Ocean Chemistry).

This year's event was organized by John Larkin and Ernie Sargent. Thanks to our Sustaining Members and many local sponsors everyone who participated received a prize.

Seminars were presented by the following CHA members:

Knut Lyngberg	-	on his recent assignment to the Norwegian Hydrographic Service;
Willie Rapatz	-	on his recent trip to Russia;
Jim Galloway	-	on a correlation sounder which extends the maximum depth capability of an echo sounder through application of modern signal processing methods (developed by Ocean Probe Manufacturing).

Stan Huggett has received an editorial award from the Hydrographic Society for an article entitled "Juan de Fuca Strait and Strait of Georgia Current Atlas" published in the Hydrographic Journal No. 47. This award is based primarily upon the originality of content and upon its value to hydrography.

Our warm appreciation to the Sustaining Members of Pacific Branch of CHA:

Aanderra Instruments;
Terra Surveys;
Quester Tangent.

And the last word...

If we learn from our mistakes, then hydrographers must be the most learned people on earth.

International Members

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

As authorised under the CHA by-laws, the National President has arranged for Central Branch to continue administering the International section of the CHA membership. Under this arrangement we endeavour to ensure that all International Members receive the same level of service and do not accidentally lose touch in any local change of executive responsibilities.

The cost of International Membership per year is $30.00 (Canadian) or the equivalent in Sterling or US currency. This includes a personal Membership Certificate suitable for framing along with annual update seals, and as well as Lighthouse and other occasional mailings each International Member also receives the Central Branch *NewsLetter.* This helps our far-flung members keep in touch between issues of our journal and also offers a forum for members to share views and concerns.

Commander Larry Robbins of the Royal New Zealand Navy has agreed to be foreign correspondent for the *NewsLetter* and write for us with items of particular interest to International Members. Comander Robbins is presently on assignment in Hove, UK, as on-site representative for the RNZN working with Racal Marine Systems and has already contributed a good in-depth column with news of several International Members. Drop snippets of news to him at: 12b Bedford Towers, Kings Road, Brighton, BN1 2JG, United Kingdom, or FAX: 0273-773789, c/o Racal Marine Systems. All scraps very welcome! And if you have special news or views or a favourite hobby-horse, you are most welcome to write something longer for the newsletter. *[Or even Lighthouse itself. Ed.]*

Membership

Since our last Lighthouse report we have welcomed several new International Members to the CHA:

- Mr. Paul Day of Great Yarmouth, Norfolk, UK;
- Mr. A. Redwood of Hove, Sussex, UK;
- Mr. John Pointon of New Malden, Surrey, UK;
- Mr. Gary Chisholm of Christchurch, New Zealand;
- Lt. Cdr. A.R.M. Alshehri of Saudi Arabia,
- Mr. Wayne J. Sula of Westwood Mass. USA;
- Mr. Steven G. Withrow of Westwood Mass. USA;
- Mr. Jack Wallace of Rockville, Maryland, USA;
- Mr. William Monteith of Rockville, Maryland, USA;
- Mr. Hasanuddin Z. Abiden of Indonesia;
- Mr. Michael Owen Kirton of Wollongong, NSW, Australia.

The first three of these new members are all with Racal Marine Systems Ltd. in the UK. Recently John Pointon while visiting Canada came to Burlington and gave our Central Branch members a good overview of Racal and their recent developments. Thanks again, John.

Gary Chisholm, a hydrographer now with Datacom of Christchurch, New Zealand, was also in the Burlington area this year and presented an interesting evening talk on the new Datacom data acquisition and processing software package "Hydro" designed for laptop computers.

Lieut. Commander Abdul Rehman M. Alshehri is Chief of Hydrographic Wing in the Military Survey Dept. of the Kingdom of Saudi Arabia.

Wayne Sula, Marketing Manager, and Steven Withrow, Director of Marketing, are with the Undersea Systems Division of General Instrument Corporation in Westwood, Massachusetts, USA.

Jack Wallace and Bill Monteith, both with National Ocean Service of NOAA, have long been subscribers to Lighthouse and have now up-graded to be full Members of CHA.

Hasanuddin Z. Abidin is studying for his PhD at the Dept. of Survey Engineering of the University of New Brunswick.

Michael Owen Kirton is with the Land Technologies Divisions of BHP Engineering at Wollongong, Australia.

Welcome aboard. We take this opportunity to extend a warm welcome to each of you and remind you that you have a full voice and vote in our Association. You are also most welcome to attend meetings and other events of any Branch of the CHA if you happen to be within reach, so let us know in good time if you are planning a trip to Canada. Hope you can all make it to some of our meetings soon!

We are delighted to record official notification from *The Hydrographic Society* that Adam J. Kerr, a director of the International Hydrographic Bureau in Monaco, has been elected President of The Hydrographic Society in succession to Ir. Jan Riemersma.

Adam Kerr has been a member of the IHB Directing Committee since 1987 following his election as its first Canadian (and first civilian) Director. He had previously spent many years with the Canadian Hydrographic Service surveying the waters around Canada, leading to his becoming Director of Central and Arctic Region (1972 to 1977) and Atlantic Region (1981 to 1987) of the CHS.

His career and qualifications have the perfect ingredients for this new honour and responsibility, including a British Master (Foreign-Going) Certificate, a BSc in Computer Science from Ottawa University, and an MSc in Marine Law and Policy from the University of Wales. Not to mention his Commission as Canada Lands Surveyor.

Adam is a noted author and specialist on international maritime affairs and was also Chairman of the International Cartographic Association's Commission on Marine Cartography from 1972 to 1982. He has recently completed a 17-year term of office as a member of the FIG-IHO Advisory Board on Standards of Competence for hydrographic Surveyors.

We might also add that his crowning claim to fame is surely that he was one of the founding organizers of the *Canadian Hydrographers Association* in 1966 and has been a very active supporter in every way over the years, including several years as editor of this journal Lighthouse.

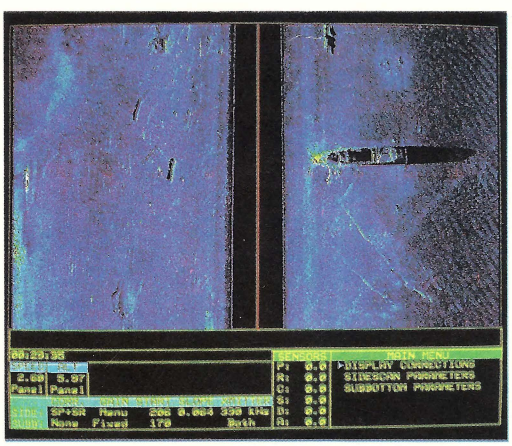
*** Notice ***

Due to administrative difficulties the CHA lost touch with many International Members enrolled prior to 1987. If you are one of these earlier members please contact us. We would like to re-establish contact with you and have you on the correct mailing list again.

Incidentally, if you are now a subscriber to Lighthouse and are interested in becoming a full member you would be most welcome. Just sent us a Membership Application form with some information on yourself along with a cheque for the extra $10.00 or $5.00 (depending on whether you are now a Canadian or a foreign subscriber) and we'll be happy to transfer you to our membership rolls. As a Member you would either be attached to a nearby Branch (we have eight across Canada) or registered as an International Member.

As well as their copy of Lighthouse, members receive other mailings from time to time. Most Branches have a newsletter to keep their members informed about their meetings and seminars as well as any other special events and other items of interest to their members, and most Branches have a program of local seminars and social events for members.

NO OTHER SIDE SCAN SONAR COMES CLOSE



Monitor displays sidescan data, sub-bottom data, time, sensor status and menu information.

Model 972 SIDE SCAN Sonar features:

- Display resolution 1280 x 1024 x 128
- Undistorted side scan displays with the water column removed and corrected for slant range and towfish speed
- Available simultaneous side scanning and sub-bottom profiling
- Available towfish sensors: speed, roll, pitch, compass, depth and altitude

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