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Lighthouse

JOURNAL OF THE CANADIAN HYDROGRAPHERS' ASSOCIATION

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INTERNATIONAL FEDERATION of SURVEYORS

XVIII CONGRESS

JUNE 1 - 11, 1986
TORONTO, CANADA

The Canadian Institute of Surveying will be hosting the XVIII Congress of the International Federation of Surveyors from June 1 - 11, 1986 in Toronto, Canada.

The Congress Organizing Committee is planning ten exciting days designed to fulfill the expectations of this international meeting. The theme of the technical program will be "Inner and Outer Space - Limitless Horizons for the Surveyor". Included, is a wide range of interesting and informative sessions from the nine technical commissions:

1) Professional Practice
2) Professional Education
3) Land Information Systems
4) Hydrographic Surveying
5) Instruments and Methods
6) Engineering Surveys
7) Cadastre and Rural Land Management
8) Urban Land Systems
9) Valuation and Management of Real Estate

Technical tours and excursions have also been organized for delegates and accompanying persons to see central and northern Canada.

This will be the last opportunity in 50 years to meet and exchange information with hundreds of international surveyors in Canada. You are therefore invited by your surveying friends to participate in this memorable occasion - the XVIII FIG Congress.

INFORMATION

FIG CONGRESS '86
P.O. BOX 186
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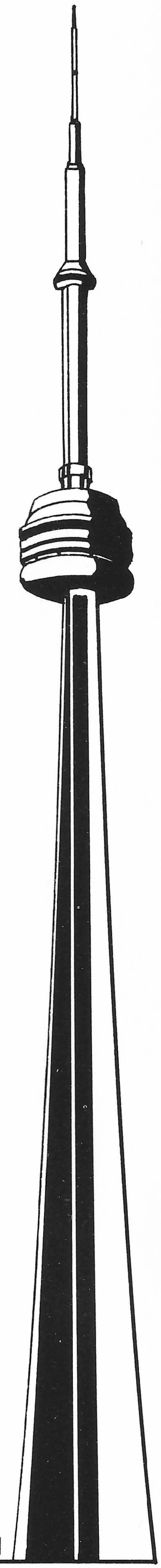
TORONTO, ONTARIO
CANADA, M4T 2M1



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EDITION NO. 33

LIGHTHOUSE

APRIL, 1986

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Typesetting and production
by
Instructional Media Services
University of Toronto.

Contents — Page

NAVITRONIC SOUNDIG-30 – the next generation of professional survey Echosounder

Representing the very latest in microprocessor technology, the SOUNDIG-30 combines a powerful CPU with advanced I/O control for communication with peripheral devices such as heave compensators, remote displays, and CRT's.

The modular design of the SOUNDIG-30 allows the system to be configured as a basic single channel, digital-only sounder or by simply adding modules as a three channel sounder with both digitization and analogue graphic recording.

The SOUNDIG-30 can operate simultaneously on any three independent frequencies in the range of 2 kHz to 700 kHz, thereby making the instrument ideally suited for shallow water, high resolution hydrography, or deep sea oceanography.

Better bottom coverage and higher survey speed are made possible by the extremely high sounding rate of the SOUNDIG-30. In shallow water, the unit can measure 210 soundings per second, whereas in deep water, a multipulse option increases the updating rate. Such sounding speeds are far above the acquisition rate of most hydrographic data collecting systems and for this reason the SOUNDIG-30 has its own built-in, user programmable depth processor.

The recorder offered with the SOUNDIG-30 system is a three channel line scan recorder which incorporates many unique features, including paper rewind and a digital paper counter. When used in conjunction with the formatter module, the recorder provides annotation and full graphics capability with 8000 point resolution and 16 shading levels over 25 cm of paper. As a stand alone unit, the recorder can be used for many applications, including side scan sonar and sub-bottom profiling.

NAVITRONIC SOUNDIG-30 – the in-depth solution to your sounding problem at a price you can afford.

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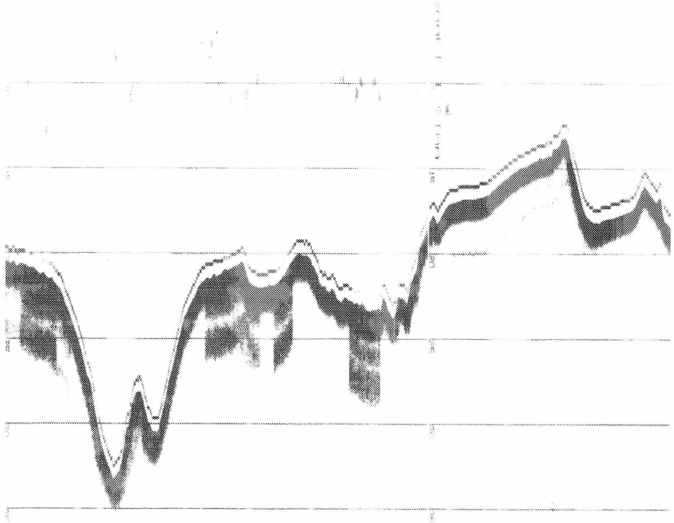
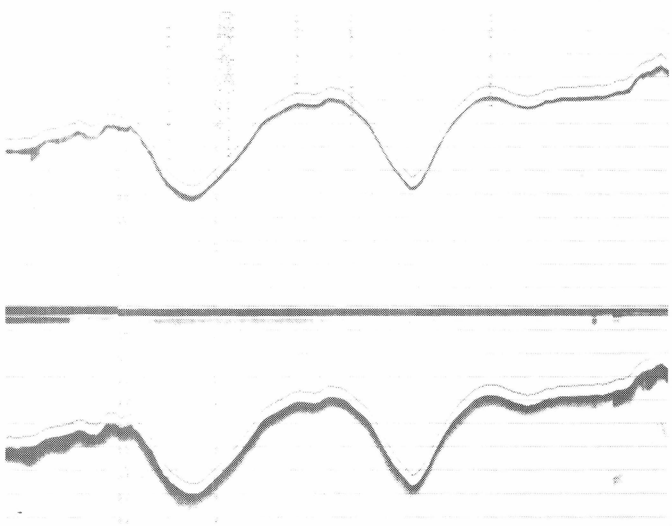
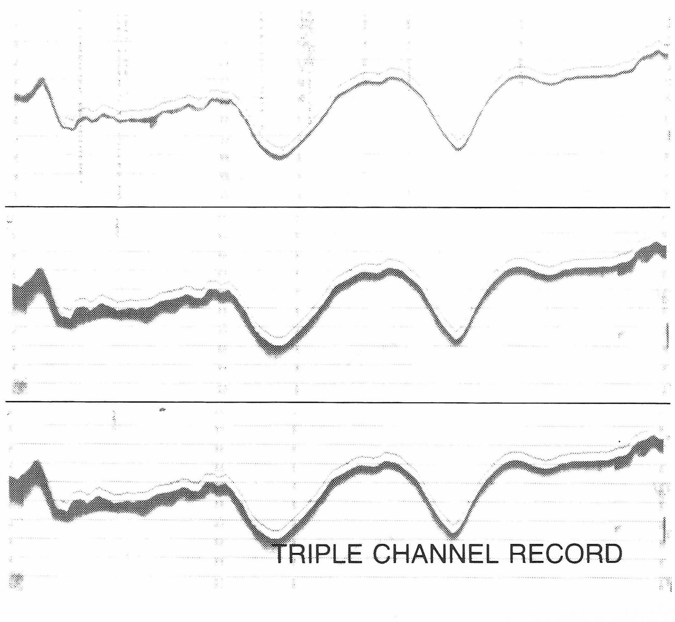


SINGLE CHANNEL RECORD



DUAL CHANNEL RECORD



TRIPLE CHANNEL RECORD

President's Message

J. Bruce
President, CHA

First, I wish to apologize for the lateness of the 1985 issues of "Lighthouse". Numerous printing and technical problems caused delays but I have been assured that the 1986 editions will be published on schedule. Central Branch has agreed to assist, in any way, the Editor in the preparation of our Journal. With this technical help from Burlington I feel confident that the 1985 problems will be eliminated.

Our name change to the Canadian Hydrographic Association and the new Constitution have been ratified by all the membership. The printing of membership certificates is underway and it is hoped to print copies of the new Constitution for issue to all members.

I have approached Mr. S.B. MacPhee, Director General, CHS, for a possible grant to our Association. He has looked favourably on this request and is preparing a Treasury Board Submission on this matter. We are also studying the feasibility of having our Association incorporated.

We have recently received membership listings from most of the Branches and an updated list appears in this issue of Lighthouse.

As this is the last year of my term of office, an Election Committee will be established later this year to elect a new President. This will enable the incoming President to be elected well in advance of April 1987 when my term expires.

Best wishes to all members,
J. Bruce, President, CHA

Back Issues of LIGHTHOUSE

Back issues of Lighthouse, Editions 24 through 32, are available at a price of $10.00 (Can.) per copy. Please write to the Editor.

Horizontal Accuracy of Soundings and the ARGO DM-54

M.V. Woods
Canadian Hydrographic Service
Pacific Region
Sidney, B.C.

INTRODUCTION

Canadian Hydrographic Service Standing Orders require that soundings be positioned to $\pm$ 1 mm at the scale of the survey. For example, at 1:20,000 the tolerance is $\pm$ 20 metres. To meet this criteria it is necessary to:

(i) Carry out preanalysis computations, prior to any field work, to determine the optimum location for positioning system transmitters as well as provide theoretical accuracy contours and confidence ellipses for selected points throughout the survey area.

(ii) Calibrate the positioning systems and determine the standard deviation of range measurements, in order to provide proper weighting of position lines being used in the least squares computation of each sounding position.

(iii) Conduct post-analysis computations to ensure that proper standards have been met or exceeded. This includes computing confidence ellipses, testing the variance factor, and testing residuals for outliers, using observed data gathered throughout the survey area.

All soundings gathered during the 1985 survey off Kugmallit Bay in the Beaufort Sea were positioned with the ARGO-DM54 Medium Frequency (1702 kHz) positioning system. The ARGO chain was calibrated on board the C.S.S. John P. Tully with the Super High Frequency (Microwave 9500 MHz) Del Norte Trisponder 542 positioning system. Two ARGO receivers on board, one operating in the Range-Range mode and one in the hyperbolic mode, were used to continuously monitor the ARGO chain throughout the duration of the survey. The launches operated in the hyperbolic mode, with all sounding positioned by three hyperbolae. The horizontal accuracy of these soundings depends on chain configuration (geometry) and proper calibration techniques.

PREANALYSIS

In order to compute the theoretical positional accuracy of the ARGO chain, an understanding of the accuracy of each measured line of position is required. The standard deviation (σ), or measure of dispersion, of a single range measurement is arrived at by means of an error budget. The error budget for a single measured range is an empirical estimate of the magnitude of random errors affecting each measurement. This can be expressed as:

$$\sigma^2_s = a^2 + b^2 s^2 \qquad (1)$$

where σ_s = standard deviation of a single range
a = random error independent of distance
b = random error proportional to distance
s = measured distance

For ARGO ranges formula 1 can be expanded to:

$$\sigma_s = (\sigma_1{}^2 + \sigma_2{}^2 + \sigma_3{}^2 + (\sigma_4.S)^2)^{1/2} \qquad (2)$$

where σ_1 = noise and instrumental errors $\cong$1.5m
σ_2 = survey control errors and varying conditions at transmitter sites $\cong$ 2m
σ_3 = uncertainty in calibration constant $\cong$ 3m
σ_4 = error in propagation velocity $\cong$ 5 km/sec

The magnitude of σ_s is approximately 4 metres for ranges between 20 and 70 km.

Since the launches were positioned in the hyperbolic mode, it is necessary to expand the variance of single range measurements into the distance difference model.

The distance difference observation equations for the Kugmallit Bay chain can be expressed as:

$$\Delta S_1 = S_k - S_h \qquad (3)$$
$$\Delta S_2 = S_p - S_h$$
$$\Delta S_3 = S_r - S_h$$

where S_k = Range from KILO (Slave 1)
S_p = Range from PULLEN (Slave 2)
S_r = Range from RELIEF (Slave 3)
S_h = Range from C82-20 (Master)

Applying the Covariance Law $\varepsilon\Delta_s = B\varepsilon_s B^t$ gives:

$$\varepsilon_s = \begin{bmatrix} \sigma_{sh}{}^2 & \sigma_{shsk} & \sigma_{shsp} & \sigma_{shsr} \\ & \sigma_{sk}{}^2 & \sigma_{sksp} & \sigma_{sksr} \\ & & \sigma_{sp}{}^2 & \sigma_{spsr} \\ \text{Symmetric} & & & \sigma_{sr}2 \end{bmatrix} \qquad (4)$$

Where εS is the variance — covariance matrix of ranges, and

$$B = \begin{bmatrix} \frac{\partial \Delta S_1}{\partial S_h} & \frac{\partial \Delta S_1}{\partial S_k} & \frac{\partial \Delta S_1}{\partial S_p} & \frac{\partial \Delta S_1}{\partial S_r} \\ \frac{\partial \Delta S_2}{\partial S_h} & \frac{\partial \Delta S_2}{\partial S_k} & \frac{\partial \Delta S_2}{\partial S_p} & \frac{\partial \Delta S_2}{\partial S_r} \\ \frac{\partial \Delta S_3}{\partial S_h} & \frac{\partial \Delta S_3}{\partial S_k} & \frac{\partial \Delta S_3}{\partial S_p} & \frac{\partial \Delta S_3}{\partial S_r} \end{bmatrix} \begin{bmatrix} -1 & 1 & 0 & 0 \\ -1 & 0 & 1 & 0 \\ -1 & 0 & 0 & 1 \end{bmatrix} \qquad (5)$$

Where B is derived by partial differentiation of (3)

Multiplying through:

$$\varepsilon\Delta_s = \begin{bmatrix} -1 & 1 & 0 & 0 \\ -1 & 0 & 1 & 0 \\ -1 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \sigma_{sh}{}^2 & \sigma_{shsk} & \sigma_{shsp} & \sigma_{shsr} \\ & \sigma_{sk}{}^2 & \sigma_{sksp} & \sigma_{sksr} \\ & & \sigma_{sp}{}^2 & \sigma_{sksr} \\ & & & \sigma_{sr}{}^2 \end{bmatrix} \begin{bmatrix} -1 & -1 & -1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \qquad (6)$$

Results in expression for the standard deviation of observed distance differences:

$$\sigma\Delta_s 1^2 = \sigma_{sh}^2 - 2\,\sigma_{shsk} + \sigma_{sk}^2 \qquad (7)$$
$$\sigma\Delta_s 2^2 = \sigma_{sh}^2 - 2\,\sigma_{shsp} + \sigma_{sp}^2$$
$$\sigma\Delta_s 3^2 = \sigma_{sh}^2 - 2\,\sigma_{shsr} + \sigma_{sr}^2$$

At this point, from equation (2), we realize that we can assign values to the variance terms; i.e. σS_h σS_k σS_p and σS_r are known. Also, if no correlation exists between observations, and one measurement does not affect another, we can assume that the covariance terms $\sigma S_h S_k$, $\sigma S_h S_p$, etc. are all zero. However, in the hyperbolic mode and distance difference model, surely there is correlation between observations, but in the practical sense this covariance is impossible to evaluate. By assuming zero covariance the expressions for standard deviation become:

$$\sigma\Delta_s 1 = (\sigma_{sh}^2 + \sigma_{sk}^2)^{1/2} \qquad (8)$$
$$\sigma\Delta_s 2 = (\sigma_{sh}^2 + \sigma_{sp}^2)^{1/2}$$
$$\sigma\Delta_s 3 = (\sigma_{sh}^2 + \sigma_{sr}^2)^{1/2}$$

and if $\sigma S_h = \sigma S_k = \sigma S_p = \sigma S_r = 4$, then $\sigma\Delta_s = 5.7$ m.

Assuming the error of each measurement is of the same magnitude, the standard deviation of distance difference measurements may be written as:

$$\sigma\Delta_s = [2(1\sigma_1^2 + \sigma_2^2 + \sigma_3^2 + (\sigma_4 - S)^{2)}]^{1/2} \qquad (9)$$

Using the values given for equation (2):

σ_1 = 1.5 m (noise)
σ_2 = 2 m (control and transmitter conditions)
σ_3 = 3 m (calibration)
σ_4 = 5 km/sec (velocity)
$\sigma\Delta_s$ = 5.6 metres for a range of 40 km.

The effect of neglecting the covariance terms in (7) is that $\sigma\Delta_s$ is slightly larger than it should be, which will result in actual error ellipses being slightly smaller than calculated. This can be seen from the weight matrix, P, where:

$$P = \begin{bmatrix} 1/\sigma\Delta_{sl}^2 & 0 & 0 \\ 0 & 1/\sigma\Delta_{s2}^2 & 0 \\ 0 & 0 & 1/\sigma\Delta_{s3}^2 \end{bmatrix} \qquad (10)$$

and the covariance matrix, $C_{\hat{x}}$, of the estimated position which is given by:

$$C_{\hat{x}} = (A^t P A)^{-1} = \begin{bmatrix} \sigma n^2 & \sigma ne \\ \sigma ne & \sigma e^2 \end{bmatrix} \qquad (11)$$

Since the weights are too pessimistic, the values in $C_{\hat{x}}$ will be larger than they should be, and this flows directly into the computation of confidence or error ellipses. The semi-major and semi-minor axes of the error ellipse are given by:

$$a^2 = \tfrac{1}{2}[\sigma_n^2 + \sigma_e^2 + \{(\sigma_e^2 - \sigma_n^2)^2 + 4\,\sigma_{ne}^2\}^{1/2}] \qquad (12)$$
$$b^2 = \tfrac{1}{2}[\sigma_n^2 + \sigma_e^2 - \{(\sigma_e^2 - \sigma_n^2) + 4\,\sigma_{ne}^2\}^{1/2}]$$

Common sense dictates that the smaller the variance of a measurement, the better the computed position. Therefore, when we compute preanalysis accuracy contours or confidence ellipses using a pessimistic standard deviation, the area within which our sounding tolerance is met, is drawn slightly smaller than it really is. If we then run our sounding lines to the limit of the area, we have a small margin of safety in maintaining the required accuracy. The only negative aspect of neglecting correlation between measurements is that we no longer optimize the coverage of a given chain configuration, but stretching coverage to the limit for the sake of a few square miles of sounding usually creates more problems than it is worth. For example, as accuracy breaks down at the limits of good geometry, contours no longer match with adjoining surveys.

(See Figure 1 for Preanalysis Accuracy Contours)

CALIBRATION

Calibration of the ARGO chain was very much simplified by using an HP-85 computer interfaced simultaneously to the ARGO Range-Range receiver and to the Trisponder 542 receiver. The ship steamed across the survey area stopping at 5 locations roughly 5 miles apart. A regular grid of calibration points was rendered impossible due to the heavy ice conditions. At each calibration point the HP-85 calibration program was used to compute the ship's position based on 3 received Trisponder ranges, while at the same time, recording observed ARGO lane counts. By inversing the known (Trisponder) position, the each ARGO station, the correct lane count is computed and a comparison of observed ARGO with calculated ARGO lane counts indicates the calibration correction to apply to the ARGO delta range settings. With the HP-85 program this procedure only takes a few seconds, therefore, at each calibration point at least 5 computations were taken, and the mean Δ Ranges were noted. By taking the mean value of the 5 points an average Δ Range for the whole area was set into the ARGO Control Display Unit (C.D.U.).

Once the Range-Range unit was calibrated, the hyperbolic lane counts for the ship's receiver were computed, taking into account the offset of the hyperbolic antenna from the Range-Range antenna. This again utilizes the versatility of the HP-85 and the C.H.S. ARGO MONITOR PROGRAM. This program has a "BUOY FIX" routine which computes ARGO lane counts for a position directly astern of the ship. This "BUOY FIX" routine was used to compute hyperbolic lane counts for the launches at a distance of 99 metres from the ship's antenna. By taking several readings of observed lane counts the launch receivers were calibrated. By getting the launches well away from the ship, any problems associated with the ship's hull reflecting or warping signals, are overcome. For details on the calibration and monitor programs see the ARGO, HP-85 documentation manual, Pacific Region.

Maintaining correct lane count once the ARGO chain has been calibrated has always been a bothersome problem. Bad weather, skywave, and mechanical breakdowns often cause lane jumps. In the past, it was common practise to drop a buoy somewhere in the survey area as a known point of reference. With the Trisponder set-up, a buoy is not needed, and although Trisponder will not usually cover the whole survey area, it is far better than a single buoy. This season we were fortunate to have a Syledis SR3 Receiver on board as Canadian Engineering Surveys Ltd. (C.E.S.) were contracted to gather Syledis and G.P.S. data throughout the survey area. The Syledis position, which varied from ARGO by about ±10m, enabled the lane count to be checked at any time throughout the entire survey area. In future, it looks as though G.P.S. will also be used for checking lane counts and will eventually replace medium frequency systems altogether.

Following the initial calibrations, the ARGO chain was monitored daily during sounding operations. As ice conditions and weather conditions changed, the variance of the ARGO fixes began to increase. Range residuals grew from one or two metres to as much as 10 metres. When this occurred, the Trisponder was used to refine the Δ Ranges set in the ARGO, much the same way monitor corrections used to be applied to Decca Systems. In this manner, we were able to ensure that horizontal accuracy of soundings was maintained at the highest possible degree.

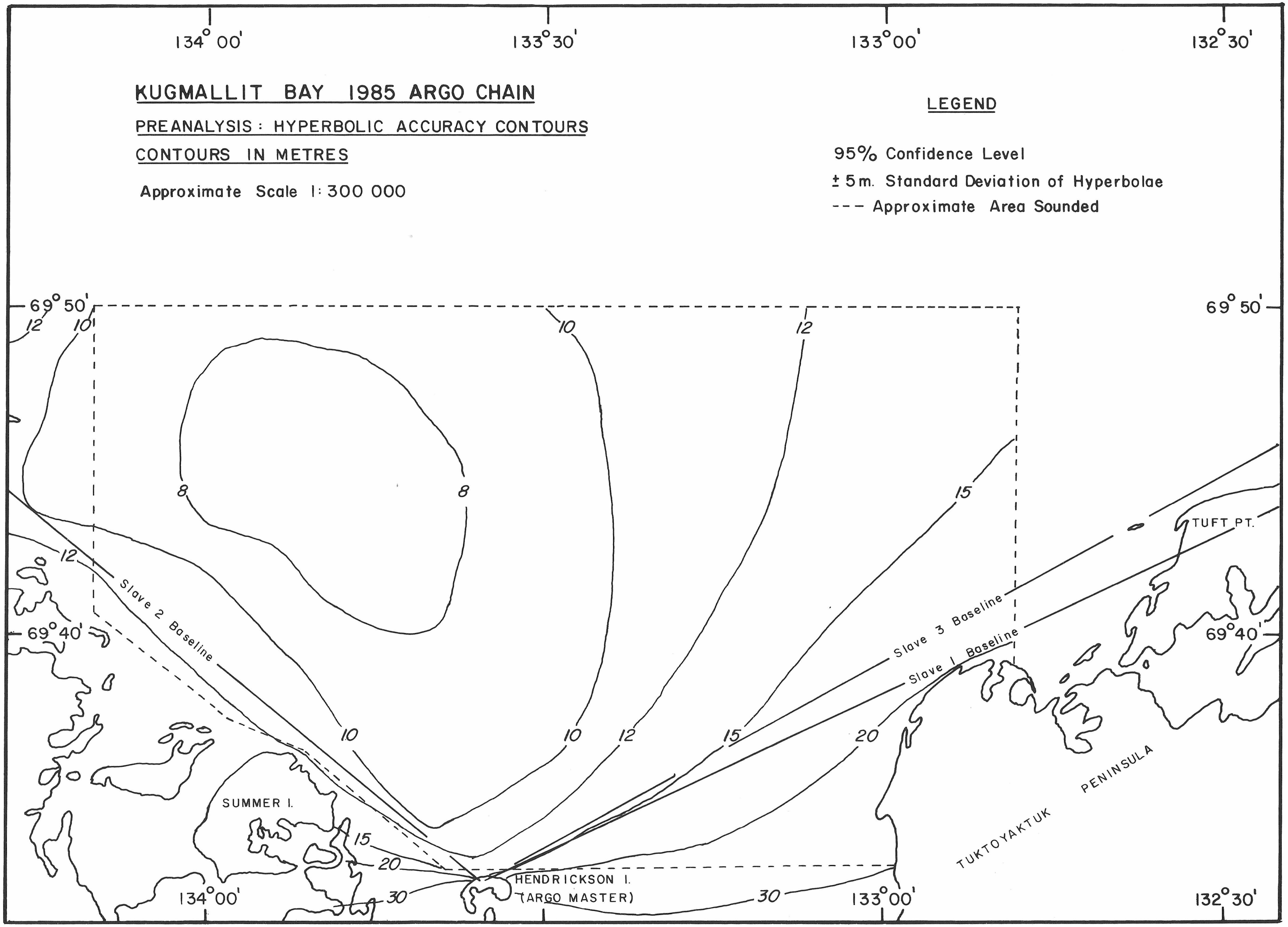

KUGMALLIT BAY 1985 ARGO CHAIN
PREANALYSIS : HYPERBOLIC ACCURACY CONTOURS
CONTOURS IN METRES
Approximate Scale 1: 300 000
LEGEND
95% Confidence Level
± 5m. Standard Deviation of Hyperbolae
--- Approximate Area Sounded
134° 00'
133° 30'
133° 00'
132° 30'
69° 50'
69° 40'
Slave 2 Baseline
Slave 3 Baseline
Slave 1 Baseline
TUFT PT.
SUMMER I.
HENDRICKSON I.
(ARGO MASTER)
TUKTOYAKTUK PENINSULA
8
10
12
15
20
30

Figure 1

POST ANALYSIS

Throughout the survey area a few samples of raw data were analysed as a post-analysis quality control. It would not be practical to analyse all the raw data, or all the selected soundings, simply because there is far too much data. For example, in one day's sounding 489,497 raw soundings were collected and 28,155 of these were selected to be plotted. Figure 2 shows the point confidence ellipses computed using the three observed hyperbolae, each with a standard deviation of ±5 metres. These observed accuracies compare very well with the predicted values. The magnitude of the semi-major axis computed from raw data, varied less than a metre from predicted in most cases, with the worst discrepancies showing up at the south east corner of the area where land path and proximity to the base line extensions decrease reliability.

One of the statistical tests commonly applied to a least squares solution is a test on the a posteriori variance factor $\hat{\sigma}_o^2$ where

$$\hat{\sigma}_o^2 = \frac{v^tPV}{n - u}$$

V = vector of residuals
P = weight matrix
n = number of observations
u = number of unknowns

and n-u represents degrees of freedom, or redundancy, in the adjustment.

With 3 observed hyperbolae and 2 unknowns (Northing and Easting) the redundancy is only 1 and the test on the variance factor is less reliable than normal adjustments with several degrees of freedom. However the computed variance factor $\hat{\sigma}_o^2$, when compared to the a priori variance factor of 1, will still indicate a poor adjustment. If the test fails we know that either the model is incorrect or the observations are improperly weighted. With ARGO, phase lag over land path and changing propagation velocity over ice, are sources of model error that have only been roughly accounted for in estimating the standard deviation of the hyperbolae. This factor also makes statistical testing of the variance factor or the residuals less reliable. In spite of the problems involved, the simple raw data tends to show that as long as residuals are less than 4 metres, the positioning is trustworthy.

EXAMPLES:

1. RESIDUALS of 4 metres, with $\sigma\Delta_s = \pm 5$ m.

$$\hat{\sigma}_o^2 = \frac{v^tPV}{n - u} = (4\ 4\ 4)\begin{bmatrix} 1/25 & & \\ & 1/25 & \\ & & 1/25 \end{bmatrix}\begin{bmatrix} 4 \\ 4 \\ 4 \end{bmatrix}$$

$\hat{\sigma}_o^2 = 1.92$

(a) Two tailed test on $\hat{\sigma}_o^2$, 95% confidence, $\alpha = .05$

$$\frac{\nu\hat{\sigma}_o^2}{X^2\nu,\alpha_2} < \hat{\sigma}_o^2 < \frac{\nu\hat{\sigma}_o^2}{X^2\nu, 1 - \alpha_2}$$

$$\frac{(1)(1.92)}{5.02} < \hat{\sigma}_o^2 < \frac{(1)(1.92)}{0.001}$$

$0.38 < 1 < 1920$: Test Passes

(b) One tailed test on $\hat{\sigma}_o^2$, 95% confidence, $\alpha = .05$

$$Xr^2 = \frac{r\hat{\sigma}_o^2}{\sigma_o^2}$$

$$X_1^2 = \frac{(1)(1.96)}{1} = 1.96$$

The null hypothesis; $H_o: \sigma^2 = \hat{\sigma}_o^2$ vs $H_1: \sigma^2 > \hat{\sigma}_o^2$ would be rejected if $X^2 > X^2a$, 1 and at the level of significance, $\alpha = 0.05$; $X^2 0.05, 1 = 3.84$: $1.96 < 3.84$, test passes.

(c) test on residuals, 2 σ level

$$-\xi n(0,1),\ 1\text{-}\alpha/_2\,\sigma < \hat{v} < \xi n(0,1),\ 1 - \alpha/_2\,\sigma$$

$$-(1.96)(5) < 4 < (1.96)(5)$$

$-9.8 < 4 < 9.8$; Test Passes

2. RESIDUALS of 5 metres.

(a) Two tailed test: $0.6 < 1 < 3000$; test passes.

(b) One tail test: $X1^2 = 3$
$X^2_{.05},1 = 3.84$
$3 < 3.84$, test passes.

(c) Residuals: $-9.8 < 5 < 9.8$

The above examples show that with only one degree of freedom the two tailed test on the variance factor is less reliable than the one tailed test. As long as the residuals are 5 metres or less the variance factor remains within limits. The sample size is too small for the rigorous test on residuals to be meaningful. In fact, all these tests break down with low degrees of freedom indicating the need for a better method of determining fix quality. Possibly reliability and sensitivity techniques may work and possibly Baarda's data snooping techniques may be able to point directly to poor ranges.

CONCLUSIONS

One of the major drawbacks of ARGO is the inability to calibrate at long distances from the transmitters. Baseline crossings and Trisponder positioning are usually limited to a very local area. If GPS proves to provide sufficient accuracy we may be able to check the ARGO system over long distances during the few hours a day that GPS is currently on the air. In years to come, and GPS provides continuous coverage, perhaps all our sounding vehicles will simply need a satellite receiver.

However, as long as ARGO is required to cover large expanses of open water, the optimum accuracy of soundings must be carefully monitored. The steps to ensure accuracy include a detailed pre-analysis, careful calibration, and a continuous monitoring of raw data. Right now it looks as though a careful look at residuals and the variance factor are the best means of determining fix quality. Implementation of reliability and sensitivity techniques needs to be looked at with the aim of flagging bad ranges.

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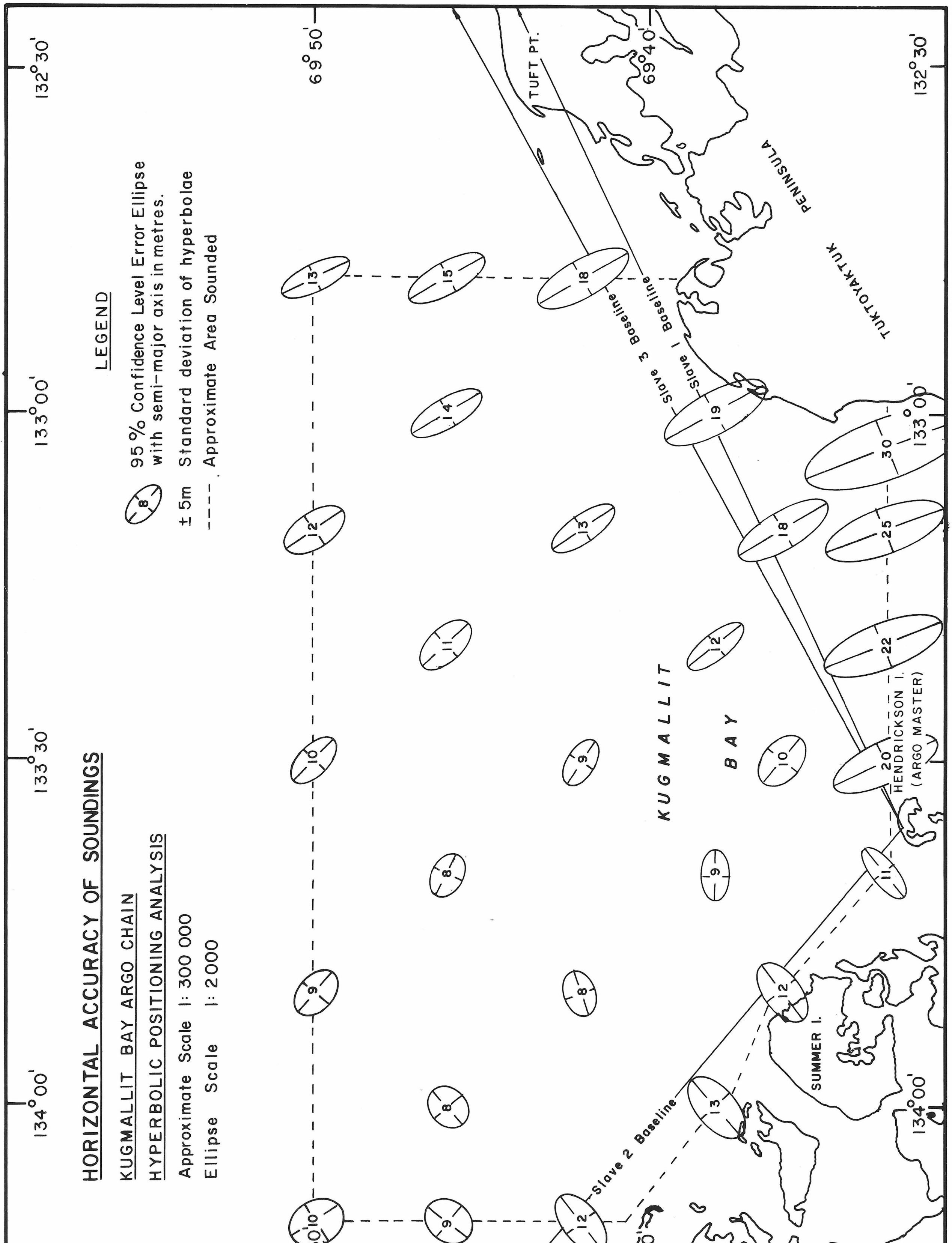
HORIZONTAL ACCURACY OF SOUNDINGS
KUGMALLIT BAY ARGO CHAIN
HYPERBOLIC POSITIONING ANALYSIS
Approximate Scale 1: 300 000
Ellipse Scale 1: 2000
LEGEND
95 % Confidence Level Error Ellipse with semi-major axis in metres.
± 5m Standard deviation of hyperbolae
- - - Approximate Area Sounded
134°00'
133°30'
133°00'
132°30'
69°50'
69°40'
TUFT PT.
TUKTOYAKTUK PENINSULA
KUGMALLIT BAY
SUMMER I.
HENDRICKSON I. (ARGO MASTER)
Slave 1 Baseline
Slave 2 Baseline
Slave 3 Baseline

Figure 2

Cartographic Design Considerations For the Electronic Chart

by
Stephen J. Glavin
Department of Geography
Carleton University
and
David Monahan
Canadian Hydrographic Service
Ottawa

1. INTRODUCTION

This paper considers the cartographic design of the electronic chart within the greater context of display dynamics. Most cartographic research to date relating to the use of "soft copy" displays has considered the simple reproduction of conventional maps and mapping techniques on C.R.T. devices. Although the resolution of the screen is the immediately noticeable difference between the paper and the video display mediums, it is not the most important factor influencing the quality of the display. The value of the electronic chart's development is not in simply imitating the present nautical chart, but in providing a dynamic display which successfully combines the real-time location of the ship with radar returns and chart information. To maintain the visual simplicity of this more complex display, the type of chart features shown, and the way they appear on the screen, must reflect the relative importance of the information to safe navigation. Unlike the static paper chart, the electronic chart can change the display and emphasis of symbols, based on actual real-time events and the viewing scale chosen. The computer-based algorithms of the electronic chart allow it to always include the least number of symbols which are most relevant to a given situation. This paper examines the purpose of a real-time display and its capability to be dynamic within the context of navigation charting.

2. DESIGN CONSIDERATIONS

2.1 The Nautical Chart

Over the years the conventional chart has developed into a complex document of nautical information. The content and design of the paper chart has been modified with respect to changing user requirements within the fixed limits of sheet size. By necessity, the chart has remained essentially a multi-user, multi-purpose product. Through the production of charts at various scales, several broad categories of user and purpose requirements are fulfilled.

At any particular scale there is a fixed amount of information that can be portrayed. Once the selection of the various types and amounts of data to be shown is complete, the concise arrangement of them on the chart must be decided. The depicted chart components, e.g. symbols, labels, linework, have fixed definitions of size, shape, and colour, and their application must be consistent with these standards. The final printed chart is a single cartographic solution which attempts to show a combination of different types of symbolized information in restricted space. A successful chart is one which balances content with scale and design with purpose. It should provide an appropriate amount of information and present it in an uncluttered manner.

Briefly, the conventional chart can be described as a combination of the following qualities:

— fixed scale sheet
— fixed north-up orientation (usually)
— fixed symbol definition
— fixed symbol arrangement and application with respect to north
— limited paper size
— limited types and amounts of information
— limited number of colours and combined use.

2.2 The Electronic Chart

The electronic chart, properly designed, can be a significant advance in information provision, not because it is essentially electronic, but because of its utility as a dynamic chart. The overlay of constantly updated radar returns with the moving chart information can be displayed on a C.R.T. device. Although the overall size of the display is dependent on the screen size, the chart and radar image can be displayed at variable scales. The necessity to use displays of differing scales varies with the purpose and user requirements. The types and amount of information shown must also be dynamic if the display is to be satisfactory at all possible scales. At a particular display scale, the information content and design will be determined by the restrictions of fixed screen size, resolution, and the potentially different function of that scale. If the type and amount of information shown changes with scale, then the definition and application of the symbolism will change accordingly. The full potential of the new combined chart and radar display lies in the dynamic selection and presentation of the information to be shown. The electronic chart can be described as having the basic characteristics listed below:

— fixed display size
— fixed resolution
— variable display scale
— variable types and amount of information
— variable orientation with respect to north
— variable symbol arrangement and application
— variable symbol definition
— variable number and use of colours

The design of the conventional chart was based on working within a set of limits. The design of the electronic chart will largely be the setting of the appropriate limits on the numerous variable components.

2.3 Real Time Chart Display

Having a real-time display is both the major difference between the electronic chart and the paper chart and the reason for interest in electronic chart development. The electronic chart is not needed to show more or different information, but simply to show the chart data in relation to real-time radar returns. This means that the display is constantly being updated and the ship's position is shown changing with time. The electronic chart provides a "window on the real world" type of display compared to the conventional chart which only details the static stage backdrop on which events can be plotted. This difference in the display of the electronic chart information will be the most influential factor in the design and presentation of its content.

Most computer cartographic research, to date, has been concerned with only the difference in the display medium. The problem has been perceived as simply how to use C.R.T. and computer-based technology to duplicate what can already be produced by conventional lithographic techniques. The more fundamental issues, above and beyond screen resolution, remain largely unaddressed in the research literature. Electronic chart development research must focus on the design aspects which are different than those of the paper chart and explore the new display potential. The electronic chart has the capability of improving the conventional chart, but this will only occur if it is designed to solve more problems than it creates.

The three major attributes of the electronic chart which previously never needed to be considered with conventional chart design are that the display is: 1) real-time based; 2) interactive; and 3) dynamic. These qualities are often treated as being synonymous but their effects on the design and use of an electronic chart, although interrelated, are quite different.

The fact that the display is occurring in real-time means that the screen image is being updated at some chosen time interval. The electronic chart is actually a series of slightly different map images displayed in a time sequence, rather than being static. The power of this type of display is that it is constantly referring to the present. The information being displayed on the screen is actually occurring in reality. The display is a combination of the more permanent chart data and the corresponding radar returns, shown in relation to the ship's present position. Thus, the image displayed is potentially a very good document of the changing reality by showing what should be out there (chart features) and what is actually out there (radar returns).

The display is interactive in the sense that it responds to user actions. If the ship is stationary, the display is stationary. When the ship moves, the chart documents the motion. Similarly, changes in the ship's speed and heading are reflected in the rate and direction of change in the image. This interactive link between operator action and the resultant screen display gives the electronic chart its potential to depict reality. The movement of a ship causes two types of interactive changes in the display image. Small absolute changes in the ship's position are shown as a series of new ship locations in relation to a fixed display area. However, when the ship's position, relative to the screen, is too near the edge, the whole image (ship, radar, chart) must shift back to being ship centered. The first type of change in the display is obviously related to operator action. This shift in the display is seen as uniformative and unrelated to reality other than being the implicit result of having "gone so far" since the last shift. Nevertheless, the interactive, real-time display of information necessitates that the screen image be dynamic and change with time.

A dynamic display is visually more complex than a static paper chart, but the ease of use and the accuracy must be maintained. There are several aspects of a dynamic display that will affect the manner in which the screen and its contents are read by the operator. The display will have chart features and radar images which will move both in relation to the ship and in relation to the screen. As discussed above, this is the fundamental advantage of the electronic chart, but it may also make visual concentration on any particular moving object difficult.

In association with this motion will be the effect of information entering and exiting the screen as the display is shifted to the ship center. When objects appear and disappear from the screen, the operator may be surprised by the new information and perhaps angered that some still relevant information has dropped out of view. If the screen image is moving slowly, the reverse is true, and the operator tends to anticipate the display and stare at the leading edge of the display, waiting for new information rather than monitoring the ship's current position.

In addition to actual motion, the precise information display on the electronic chart will change with time. The display will change in the long term with additions, deletions, and other corrections being made to the chart's data base. The display will also change when time and date-dependent events occur. There will also be short-term changes in the chart display based on real-time events, such as the flashing of hazard symbols. Unlike the static chart sheet, it will be virtually impossible for the operator to memorize the dynamic chart display as it constantly changes with real-time updated content.

The ability to change the scale of the display is an advantage when carrying out different chart tasks. However, the variable scale also changes the size of features and the distance between objects on the screen. The scale of the display influences the relative speed of change in the ship's position with respect to chart information and, the rate at which the display has to be recentered. The operator no longer has a fixed relationship between features at a single chart scale and those features in reality as was the case with the conventional chart. Also associated with the variable scale and fixed screen size is the aspect of the display showing only a partial view of a feature. A feature of reasonable size and importance may only appear at the edge of the screen, thus making it difficult for the operator to recognize and identify it. Although, this problem cannot be completely solved, it underscores the difference between the design of a static chart and the presentation of a dynamic display. The electronic chart must be designed to take advantage of its real-time interactive capability while also minimizing the potential confusion of having a display that is constantly changing.

3. CHART PURPOSE AND CONTENT

3.1 Examination of Purpose

The design of any cartographic display must start with an analysis of its intended purpose. The original content and design of the paper chart must now be re-examined with respect to the information an electronic chart can and should provide a user. The conventional chart has been designed, as a single document, to satisfy many different users and meet a complexity of other requirements. The characteristics of the electronic chart will significantly narrow the range of users, and the purposes it must satisfy, at any one time, or in any one configuration. Equipment costs alone predetermine that the electronic chart will likely be used, initially, only on large commercial vessels with specific requirements and experienced operators. The electronic chart's computer technology-based system clearly changes the need and the method of carrying out various chart tasks.

The electronic chart instantaneously displays the ship's position which alleviates the need for the operator to constantly fix and plot new positions, as was the case with the paper chart. This changes the need for certain types of position fixing information on screen displays for any reason other than error checking. The electronic chart also allows for route planning ahead of the actual mission. This makes it possible to show all the complex chart information only during the planning session when the display can be studied at length. Once a particular route has been decided, any information unrelated to the completion of the mission can be omitted from the screen when displayed in real-time. The purpose and associated content of the real-time display is specifically concerned with ensuring safe navigation. However, the electronic chart is not an "automatic pilot" in control of the ship's motion, it simply displays the results of the operator's actions. In the most extreme case, the electronic chart could document and display, in real-time, without any warning, the operator running a ship aground. This scenario can easily occur if the screen display contains, either inadequate or an excessive amount of information, thereby misleading the operator. The purpose of the electronic chart is to show the successful progression of the planned route and also to provide adequate real-time information about anything that may impede the continuation of the mission.

3.2 Selection of Information

The electronic chart is a much more specialized type of navigation display than the paper chart. Although the conventional chart could be reproduced on a C.R.T. device, the electronic chart display must be designed to achieve its primary purpose, not just imitate the previous techniqes. The number of features shown must be decreased, not due to screen resolution but because the dynamic chart display is more complex in the type of information it presents. The real-time electronic chart can now show less, but more relevant information, than the paper chart, which shows more information, which may or may not be relevant to a specific situation. The problem becomes, not how to show all the possible chart features on the display, but how to show just the right selection of information. There is no reason why an operator using an interactive real-time display should be forced to spend time and energy visually searching for only the necessary information within a cluttered image. The necessary simplification of the electronic chart facilitates its safe and easy use, provided that the selected information is, in fact, a responsible choice.

All the information available is not of equal value. The selection and emphasis of certain types of data must be based on the importance of the function that the information serves. A very simplified single function display would show the ship's position relative to two types of information; those areas which are navigable, and those areas which are not. The electronic chart can support many different levels of information but the objective remains the same, to create a graphic display which reflects the determined hierarchy of relative importance.

There is a minimum subset of information; features such as shoreline and dangers are always required for safe navigation. In addition to being constantly shown, they must be visibly recognizable within the dynamic image, no matter how much other information is displayed, or the scale of the display. At the opposite extreme are types of information which, although shown on conventional charts, will have little effect on the planning or safe execution of a ship's passage.

Because the electronic chart image is being constantly updated in real-time, there is little value in having the computer spend time repetitively processing and redrawing information which is of a non-essential nature. Features such as inland roads and topography will rarely ever influence a voyage. However, these types of information must also be available for viewing at the operator's discretion, but caution must be exercised in that, the addition of one of these sets of data, does not obscure the higher level, more important, navigation information. The addition, or deletion, of one or more of these data types may cause unexpected negative results. The necessary minimum information and, the other optional data sets, must be designed, not individually, but, as if they were made to be viewed together, otherwise, restrictions will have to be placed on data sets which cannot be viewed simultaneously.

A third type of data is a combination of the two extremes discussed previously. This information would always be shown in its location, but with variable levels of complexity. The fixed location of the feature would be accompanied by differing amounts of graphic detail and text, explaining the feature, depending on the scale of the display, or a request from the operator. At smaller display scales, some features such as lights and buoys must be represented in the simplest manner. As the scale of the display increases, the amount of specific information shown, concerning each feature, can also be increased.

In general, there are both miminum and maximum amounts of data which can, and should be, viewed at various chart scales. Because of the fixed screen size, the electronic chart will have to select information, not only by type, i.e. level of importance, but also in relation to the viewing scale. Attempting to display too much information at a small scale is as inappropriate as displaying too little information at a very large scale. The electronic chart has complete scaling capabilities and should have some function for deciding what informaton is appropriate at a given scale. The operator could override this automatic content limiter and include, or exclude, certain features as necessary. The information content of the display must always include the minimum number of features which are most relevant to the safety of real-time navigation.

4. SUMMARY

We have outlined here the context, within which electronic chart design as a cartographic exercise, must proceed. We will report on a specific part of the design, and the symbols, in a later paper.

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A Cartographer's Experience on a Field Survey

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Having been chained to a drafting table all my working life, I was delighted to be asked to join the 1984 Shuswap Lake Survey, with Barry Lusk as hydrographer-in-charge.

Our convoy left Pat Bay in mid-April and consisted of trailers carrying the Tern, Crane and Whaler 10. Two days later we arrived at base camp (The Paradise Motel) in Sycamous. We wasted no time in locating primary triangulation stations by helicopter on top of the local mountain and brought good control down to the lake. I was given Whaler 10 with 72 HP outboard to coxwain and sped around the lake setting up secondary stations at prominent locations which could be identified on the aerial photos. I actually hammered fourteen stations together in one day, dutifully flagging them red and white as Carol Nowak instructed. Naming stations brought out the poet in Ron Woolley as can be noted on Field Sheet 7725 L—MIA, DOG, HAS, FLE, ICH. One hydrographer with socialistic sympathies named his stations MAU, CHE, MAX + ENG. Kal Czotter almost adopted a wild dog as the survey mascot but saner heads prevailed.

As a breed, I find hydrographers arrogant. Captain Cook had such a right as Hydrographer-in-charge of three world cruises —out of contact with Mother England with only a clockwork chronometer for longitude, and having to fend off natives who wanted the longboats and the brass fittings — he had to contend with disease, rotting planks, treacherous reefs and carpenters who traded nails for indiscreet favours. Today's hydrographer, however, has helicopter support, satellite fixing, LORAN navigation, direct read-out theodolites with built-in distance measurement capability, aerial video-grammetry, etc., making the business child's play in comparison.

Once the primary traverse tied in nicely, Barry Lusk relaxed and we had a barbecue with Barry's special salad, washed down with the finest wine.

At first the locals were pretty hostile to us, saying "Who needs a chart — just look down"; "Why are we wasting taxpayers' money"; "You'll never find the bottom of this lake"; but when we started to beat them at pool at the Legion and got our pictures in the local paper, they accepted us.

Let me describe Shuswap Lake. It actually has five arms, of which one lies along the Trans-Canada Highway and main CP railway line. Salmon Arm has orchards and vineyards along its coast, whereas Anstey Arm is almost a complete wilderness. There are about twenty provincial campsites around the lake which are visited by houseboats rented predominantly by Albertans. Shuswap is only 3-1/2 hr. drive from Calgary. The lake is fed by the Adams, Salmon, Shuswap and Seymour Rivers. It is 171 metres at its deepest, 440 km in circumference, and flows into the Thompson River. The main towns are Salmon Arm and Sicamous.

The survey continued using a batch of new aerial photos, a state-of-the-art digital table and those amazing lightweight Microfix Tellurometers.

Local knowledge helps when one is constructing a chart, i.e., maybe the location diagram should show Calgary; an island may be noted on the fair sheet as being 37 m — this measurement is to the top of trees which are 36 m high; whether or not a ramp is abandoned or, conversely, re-constructed; whether a bridge is fixed or swing (a swing bridge will be shown open); whether a light on a tower can be seen from the water, and how much of the shoreline is natural or man-made; whether a stream is intermittent or not, etc.

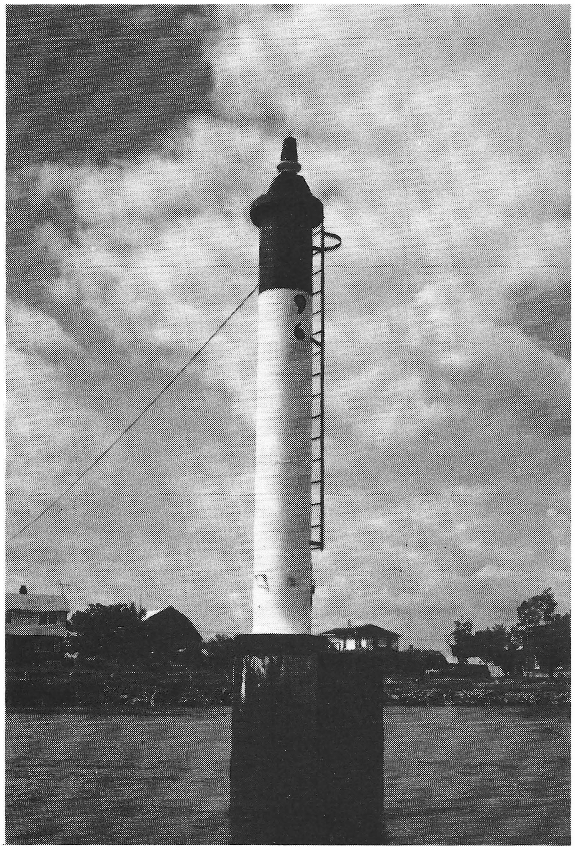
The weather was horrendous on occasion and once, during a blinding snowstorm and a three-foot chop, I panicked and headed the Whaler to the protection of Cinnemousum Narrows, thereby abandoning Knut Lynsberg on a station. Why didn't somebody inform me the Whaler was unsinkable? Mike Ward promised to dunk me but never did!

In anticipation that I would eventually construct the chart, I took numerous photos with my 6x7 cm Pentax, one of which will be used for the cover.

What can a cartographer learn in the field? Well, it's a tough life and knowing the amount of effort put into a field sheet, I certainly will handle them with much more care from now on.

LIGHTHOUSES OF THE FRESHWATER SEAS

compiled by G. Thompson



Light 96 (St. Lawrence Seaway)

44-52-36 N Established 1958

75-13-32 W

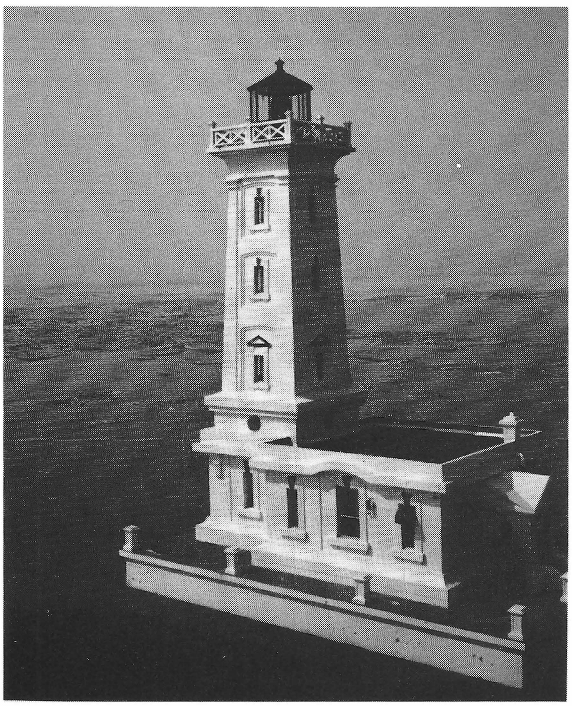
photo: J. Medendorp

Colbourg Pier Light (Lake Ontario

43-57-05 N Established 1883

78-09-57 W New Light 1983

photo: J. Medendorp



Point Albino Light (Lake Erie)

42-50-06 N Established 1918

79-05-48 W New Light 1976

Snug Harbour Back Range

(Georgian Bay)

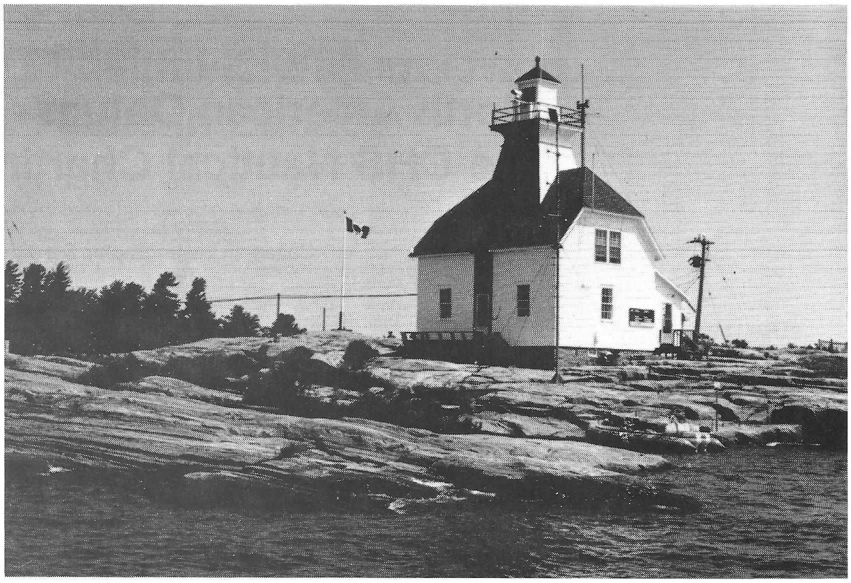
Established 1897

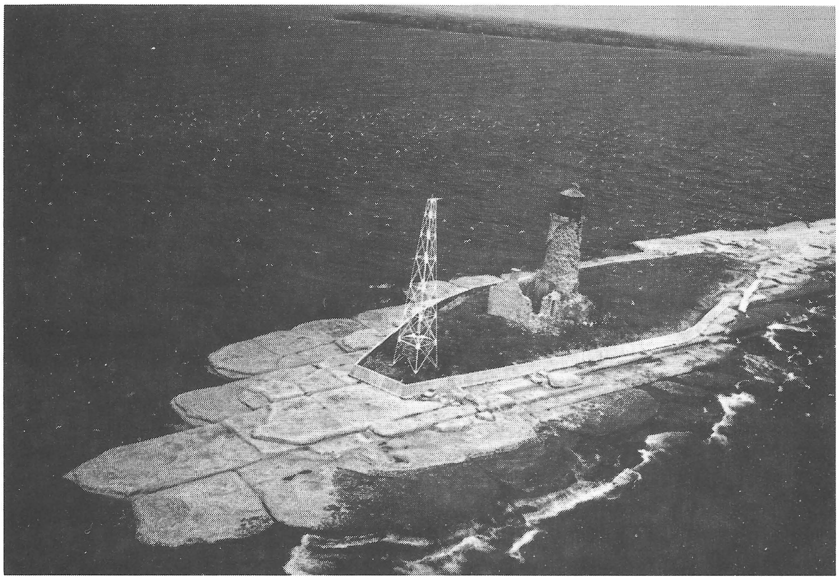
New Light 1980

45-22-15 N

80-19-20 W

photo: J. Weller





Scotch Bonnet Island

(Lake Ontario)

Established 1856

New Light 1983

43-53-57 N

77-32-33 W

photo: J. Medendorp

Salmon Island (Lake Ontario)

Out of service 1954

44-12-03 N

76-35-27 W

photo: J. Medendorp

Implementation of North American Datum of 1983 into The CHS Nautical Charting Program

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Ottawa.

SUMMARY

Today's mariner can position a vessel by SATNAV every few hours to an accuracy of 0.5 miles world-wide, or by Loran-C continuously to an accuracy of up to 100 metres in various parts of Canadian waters. Tomorrow's mariner will have GPS NAVSTAR with a positioning capability of 0.2 miles continuously, world-wide. Yet some of the charts that he must use are old and off datum by significant amounts in relation to these positioning accuracies.

Compatibility can be achieved by converting the charts to the North American Datum of 1983 (NAD83). Of the 1575 charts and chart insets that are in the inventory of the Canadian Hydrographic Service (CHS), 23% need reconstruction or a survey to relate them to datum. 68% need a new border with new latitude and longitude grid lines, whereas only 9% are acceptable without revision.

BACKGROUND

The first international formal discussions on the need to replace the North American Datum of 1927 (NAD27) were at a symposium at the University of New Brunswick in May 1974. (Int. Symposium, 1974). At the 1975 Canadian Hydrographic Conference in Halifax, C. David McLellan reviewed the need for a new datum, and outlined the effects and a probable schedule. (McLellan, 1975). The effect of an all-Canadian datum was addressed at the 1976 CHA conference. (Gray, 1976). A paper at the 1977 CHA conference, presented by Gray & Yeaton, outlined the strategy for a continental datum. The new datum (dated 1983) will be geocentric and will be based on a different ellipsoid from that used for NAD27. The primary stations (about 7800 in Canada) are scheduled to be computed by April 1, 1986, and those secondary points for which Geodetic Survey of Canada (GSC) is reponsible, computed within a year. The provincial survey agencies are responsible for the lower order surveys within their own boundaries, and are actively working towards making a transition to the new datum. The Nautical Geodesy Section of Canadian Hydrographic Service (CHS) is assembling computer files of the CHS surveys for adjustment on NAD83.

In preparation for the new datum, the United States/Canada Hydrographic Commission formed an Ad-hoc committee in 1979 to evaluate the effect of NAD83 on the charts of both nations, (Monteith & Gray, 1981). The National Ocean Survey (NOS) has done an exhaustive analysis of its charts to create an implementation plan, (Stembel & Monteith, 1985).

NORTH AMERICAN DATUM OF 1927 (NAD27)

The NAD27 is fundamentally an adjustment, completed in 1932, of the first order triangulation in the continental United States, Southern Ontario, St. Lawrence River Valley and New Brunswick. The surveys in the rest of the continent were added to this framework as time progressed. In Canada, the lower order surveys often preceded the higher order surveys so that there has been a continual need to update coordinates to reflect the latest values of NAD27. Complete updating has not always been carried out, but a significant amount of the primary survey control has been re-adjusted by GSC as a stop-gap action to alleviate some of the problems of distortion. Some re-adjustments are:

- Prince Edward Island: re-adjusted in 1968.
- Newfoundland: re-adjusted in 1971.
- Nova Scotia: re-adjusted in 1972.
- MacKenzie River & Delta: re-adjusted in 1972.
- Southern Ontario: re-adjusted in 1974.
- Northern Ontario: re-adjusted in 1974.
- Arctic Islands: re-adjusted in 1965, 1972 & 1975.
- Maritime Prov.: re-adjusted by Land Registration and Information Service (LRIS) on geocentric system (ATS77) in 1979.
- Quebec: re-adjusted by Service de la Géodésie de Québec (SGQ) in 1978.

Despite such re-adjustments, major discordances across network boundaries remain. These discordances usually occur across water. Unfortunately, they have had to be accommodated in CHS surveys.

NORTH AMERICAN DATUM OF 1983 (NAD83):

As stated earlier, NAD83 will be based on a geocentric ellipsoid that is of a different shape than the present one. This has significant impact on CHS charting and navigation. The navigator will be able to plot his position as determined by SATNAV. GPS/NAVSTAR, LORAN-C lat/long, or any other external positioning system directly onto a NAD83 chart. That is the good news. The bad news is that all computer programs using ellipsoid parameters, including those for map projections, will have to be altered. Secondly, the surveyor will have more computations to do. The new ellipsoid will not fit Mean Sea Level as well because the ellipsoid is derived to fit world-wide; therefore, measured distances will have to be reduced to the ellipsoid, not just to Mean Sea Level. At the standard of surveys done by CHS, this refinement may only be needed at the adjustment stage.

As SATNAV is being used to provide overall constraints, major discordances between localities will be eliminated. Despite thorough data evaluation, a few problems may be encountered due to undetected blunders in the original surveys. GSC proposes to transform very old surveys to NAD83 rather than re-adjust them. Some distortions may be carried along in these transformations.

CONVERSION NECESSARY?

At present, CHS is melding new surveys into old charts by analyzing the shifts between surveyed coordinates and chart positions. Hydrographers are expending considerable extra effort to ensure that new surveys are internally consistent because, in many cases, they cannot rely on published coordinates for existing control stations.

Present day mariners have SATNAV and LORAN-C coordinate converters that provide accurate (100-800 metre) positions. Tomorrow's mariner will have GPS/NAVSTAR that will provide more accurate positioning for a larger user group. Increased use of the Video Chart Display (Electronic Chart) will result in the need for more digital data consistent with positioning systems in use. Consistency will be ensured through the use of NAD83.

The fact that CHS has promised the International Hydrographic Organization (IHO), to provide datum shift values between chart datum and World Geodetic System (WGS) is another consideration. For converted charts, the datum shift values will be zero.

COORDINATE DIFFERENCES

Preliminary estimates of the NAD83 coordinates of the 7800 station Canadian primary network were obtained from Geodetic Survey of Canada. Initially, each chart was examined to determine if it was based on NAD27, or systematically shifted from it, and the shift to NAD83 calculated using the shift at nearby primary stations. Because a detailed analysis would have been very time consuming, a very superficial examination (about 5 minutes per chart) was done. Results are based on the author's knowledge of surveys, both CHS and GSC, and the information given on the chart as to date of survey, publication, etc.

The coordinate differences between NAD27, as given in National Geodetic Data Bank (NGDB), and preliminary NAD83 are portrayed in Figure 1. The omission of coordinate differences in the Arctic is intentional. The NGDB coordinates in the Arctic are from a Doppler based 1975 readjustment, and few CHS charts are based on these data. In the Arctic, preliminary NAD83 coordinates are available only for the Doppler stations.

EXISTING CHARTS:

As charting is a dynamic process, chart status as of Friday, Oct. 4, 1985 forms the basis for reporting. At that time, there were 988 navigation charts listed in Notice to Mariners No. 969/85. Some of these charts have various compartments and insets. Following an examination of all 988 charts, an inventory of 1575 borders of charts, chart sections (excluding Continuations) and insets was produced. Insets having no geographic reference were omitted from the inventory.

The criterion that a chart needs a new border and grid lines was set at 0.2 mm displacement in position at chart scale, similar to the NOS criterion. The length of the vector from the presently charted position to the NAD83 position for any feature, e.g. grid intersections and particularly survey points, must be less than 0.2 mm on the chart in order that the chart meet the criterion. That criterion might be criticized but it is important because, in chart construction, the positions of survey stations are the highest priority. The positioning of other details can be less stringent, but not the Survey Control!

The break-down of existing chart datums is given in Table 1.

TABLE 1. Datum of Existing CHS charts.

	Number	Percentage
North American 1927	1202	76 %
Astronomic	27	2
Shoran	8	0.5
Air Photo plot	53	3.5
US Standard Datum (pre-NAD27)	29	2
Orphan (or unknown)	188	12
No grid lines	68	4
Total	1575	100 %

The data given in Table 1 clearly shows that only 76% of CHS charts were constructed on NAD27. It should be noted that individual charts may not now be on NAD27 due to updating of survey control.

It is interesting to note that very few charts contained wording indicating that the datum was 'North American Datum 1927', or equivalent. The few cases noted were reprints from U.S. sources of charts on the Labrador coast, an area where CHS has subsequently re-adjusted their surveys.

The effect of the shift of the individual charts to the new datum is broken down in Table 2.

TABLE 2. Charting action for conversion to NAD83

	Number	Percentage
No visible effect	80	5 %
Reference station in Title	70	4.4
New border and Grid lines	1071	68
Chart reconstruction	199	12.6
Survey required prior to transformation	155	10
Total	1575	100 %

It is not so much that only 10% of the charts pass the criterion for no visible effect or Title block change, but that 22.6% require reconstruction or survey to define the coordinate shifts. It is interesting to note that NOS also had only 10% of its charts pass the criterion but had only 2 charts that required a survey and none that required reconstruction.

There are 98 published charts with Loran-C lattices and another 21 existing charts for which lattices are being prepared for the first time. Any Line of Position ought to remain in the same physical position regardless of datum. Therefore, it is only necessary to redraw a lattice to move the internal registration marks to agree with the new grid lines. Thus, if the border doesn't change, the lattices don't need changing. Of the 119 charts, 72 charts will require new lattices. The remaining 47 charts belong to that elite group of charts requiring little or no charting for conversion to the new datum.

NEW CHARTS:

The 1983 graphic of the Five Year Plan (New Charts) for charts intended for production up to FY 87/88 and CHAINS were consulted for new charts already in production. From these sources, 195 charts were identified that will likely be in production before 1988. As the survey control should be converted to NAD83 by 1988, charts compiled after that date will be compiled on the new datum. If it is assumed that the 195 charts will be compiled on the NAD27 datum (the worst case scenario), the effect of the dátum shift on these charts is tabulated in Table 3.

TABLE 3. Charting action for conversion to NAD83 for charts in production to 1988.

	Number	Percentage
No visible effect	4	2 %
Reference station in Title	10	5
New grid lines and border	181	93
Chart reconstruction	0	0
Survey required for transformation	0	0
Toral	195	100 %

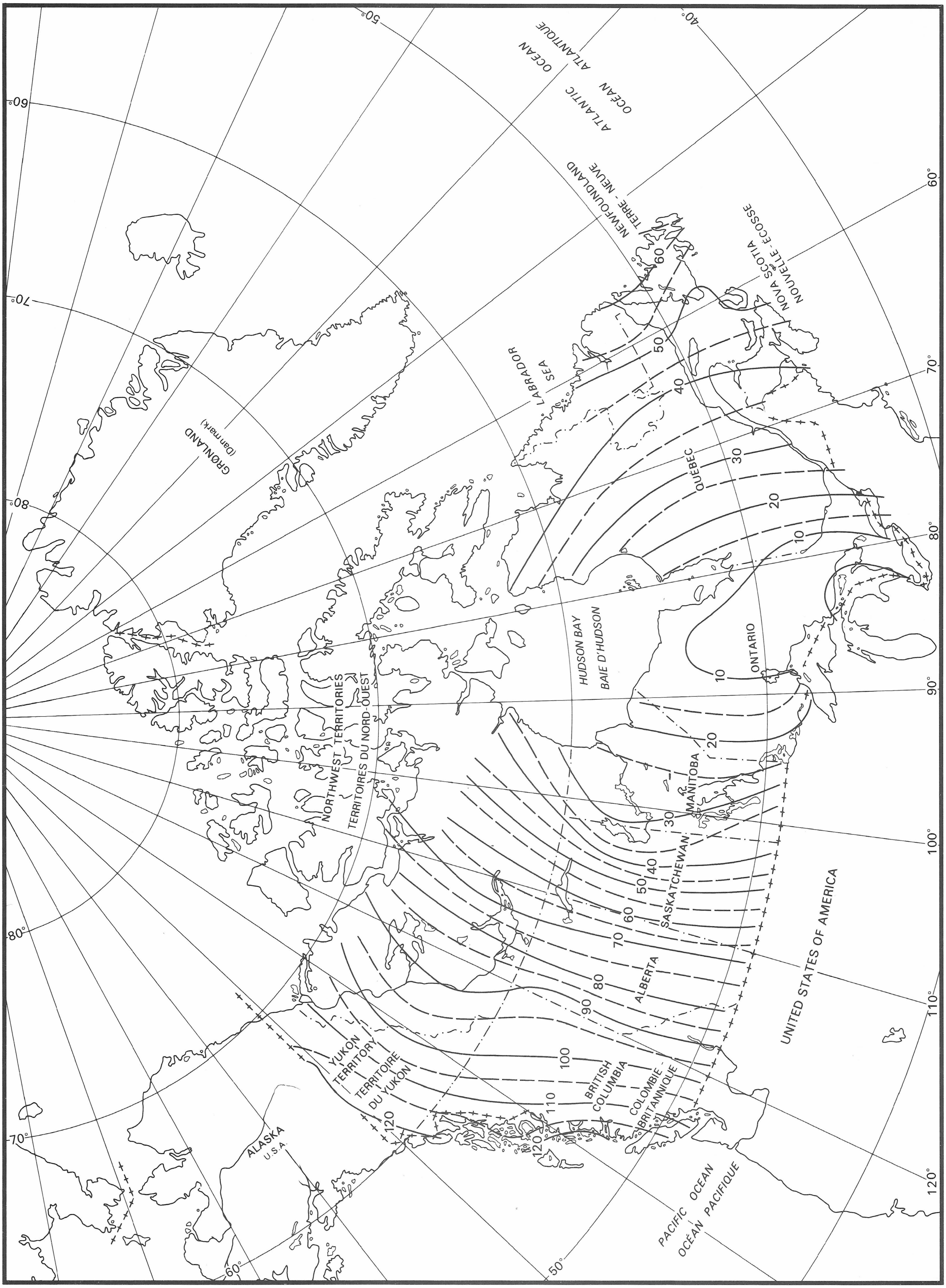

Figure 1 : Co - ordinate Shift (in metres) between NAD 27 and NAD 83

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Since 1981, ISAH technology has handled the massive task of acquiring and processing the data required to chart the entire Beaufort Sea Shipping Corridor. One ship and four launches worked 16 hours a day to provide the data. Our technology provided the chief hydrographer with a daily field plot over the 60,000 line Kms of the survey.

THE FIELD-READY ISAH

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Beaufort Sea Documents Chart 7651, Field Sheet WA10144, courtesy of the Canadian Hydrographic Service.

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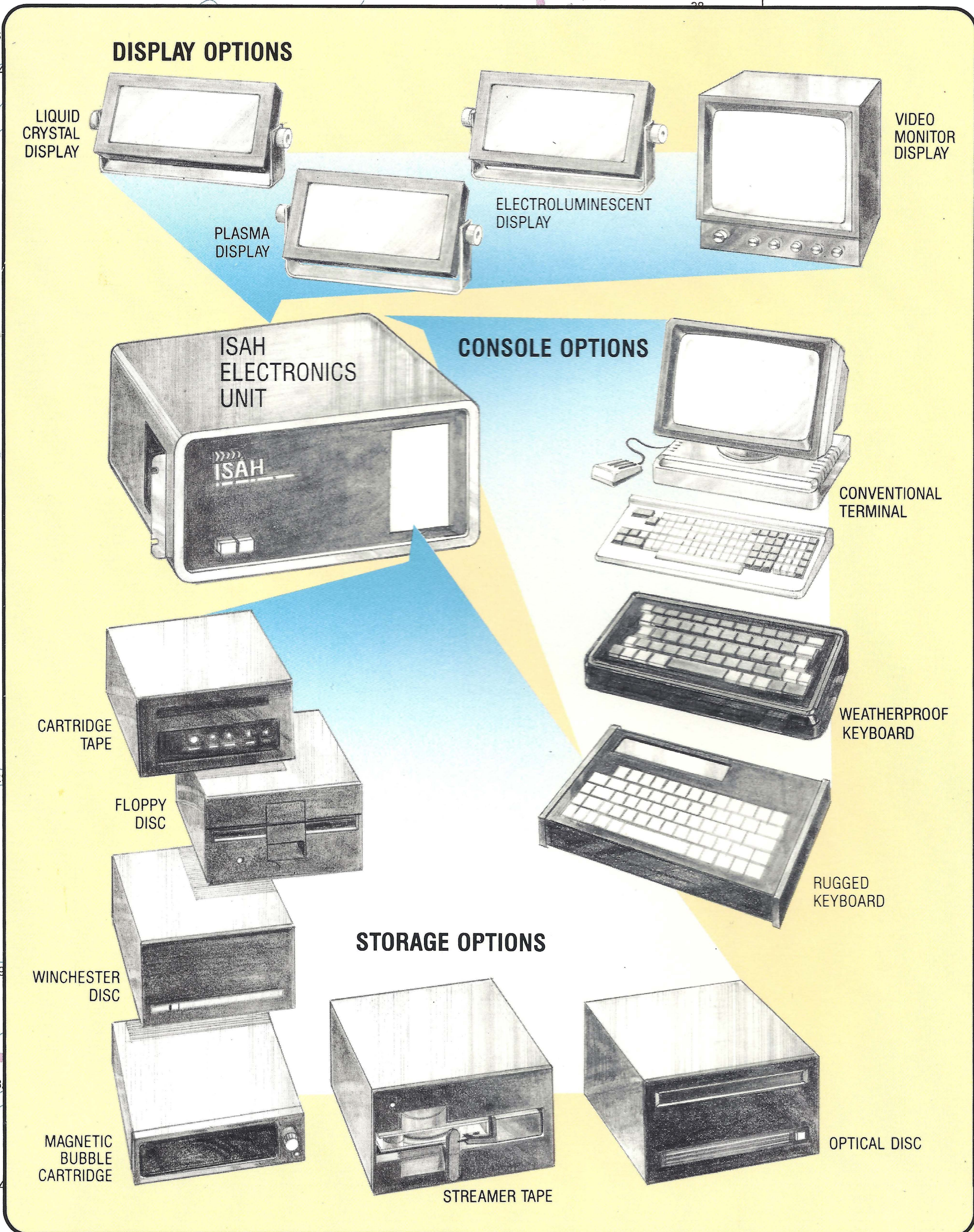

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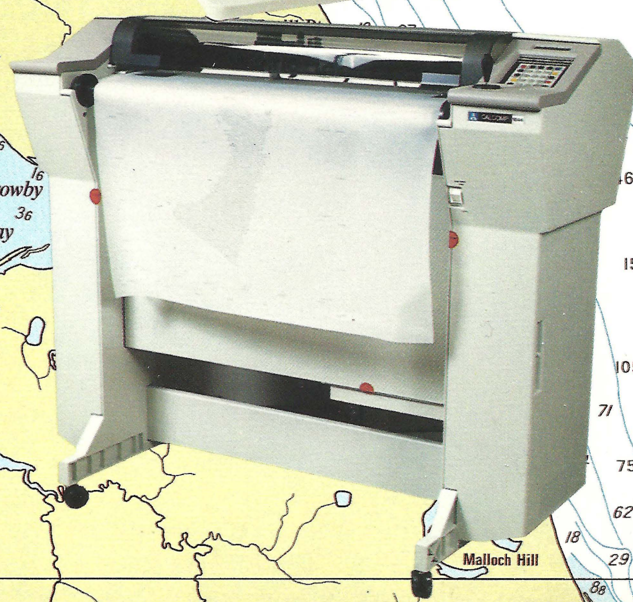

THE PRODUCTION SYSTEM

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- Remote vehicles
- Sweep systems

- Off-shore
- Coastal
- Harbours
- Canals
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- Rivers
- Lakes
- Reservoirs

- Hydrography
- Dredging
- Water management
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- Salvaging
- Geophysical
- Oceanography
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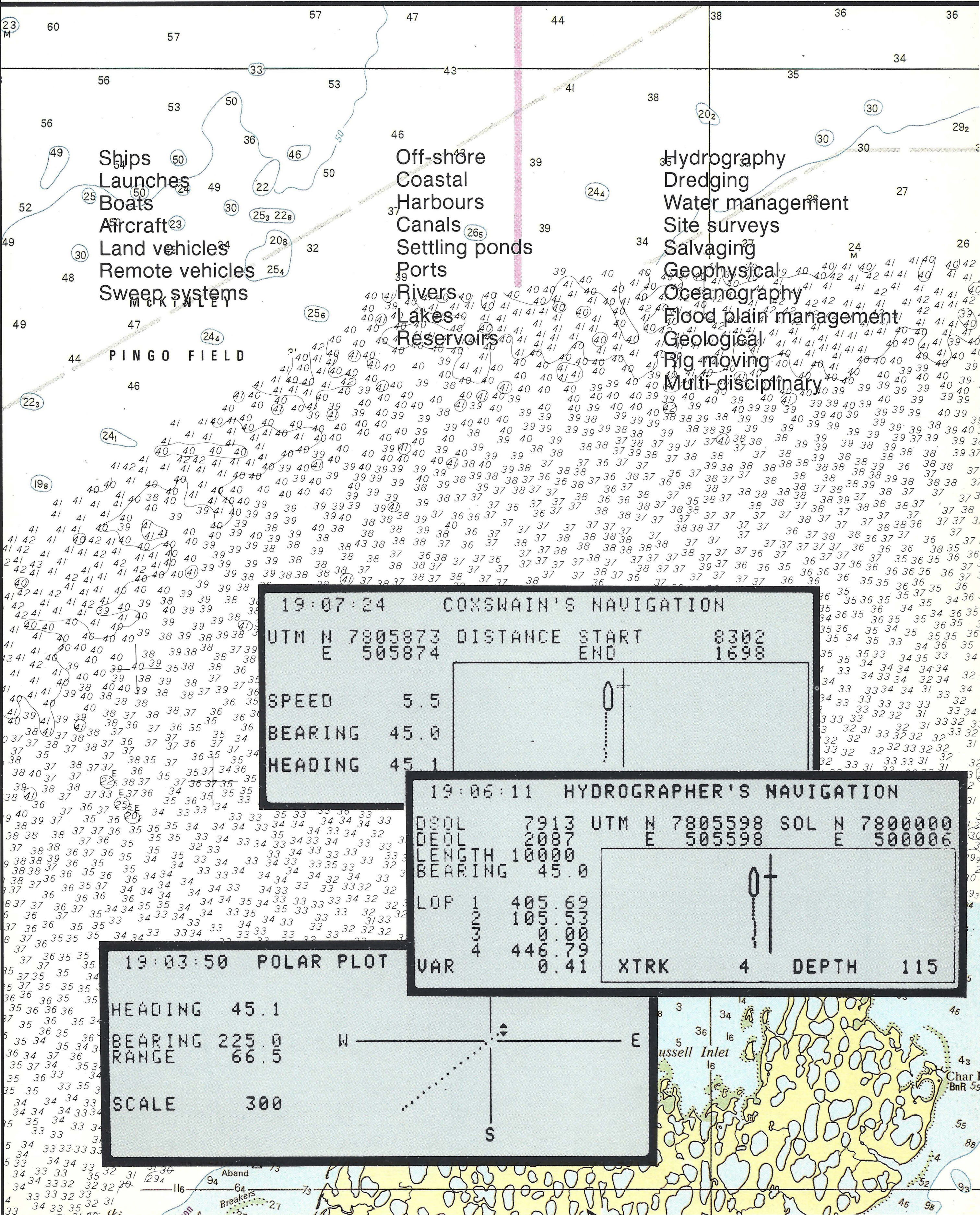
- Rig moving
- Multi-disciplinary



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The split between the new charts needing conversion and those that do not (92% / 7%) is more or less equal to the American value or the CHS existing charts, i.e. Table 2. How many of these new charts are going to replace existing charts that require reconstruction is not known.

There will be 43 of 48 of these new charts that will require Loran-C lattices because of the change form NAD27 to NAD83.

If the charts are constructed on NAD83 (best case scenario), even preliminary values, there will be no need to convert the chart at a later date.

CONVERSION MECHANISM:

The task of converting to NAD83 includes the following steps:

1. Re-adjusting CHS control on the NAD83.
2. Revising Computer Programs.
3. Establishing new hydrographic surveys.
4. Preparing notes to charts specifying the conversion.
5. Changing of borders and grid lines on charts.
6. Re-constructing charts.
7. Surveying positions to convert certain charts.
8. Revising coordinates in Publications.
9. Developing a Digital Data Base.

1. Re-adjustments

Once the primary survey network has been adjusted to NAD83 (April, 1986), Nautical Geodesy can start to adjust the CHS control that is now in adjustment decks. Data for about 20,000 control points are in the adjustment files and a guess is that it will take about a year to do the adjustments. Adjustment of some of the survey control networks is dependent on Geodetic secondary adjustments for at least some of the fixed stations, e.g. lighthouses, churches, etc. or on provincial control as in the Maritimes, Quebec and B.C. Scheduling of the secondary adjustments by other agencies will dictate the starting date of some of the CHS adjustments. Surveys that need to be converted to the new datum but are not yet automated will take such extra effort that extra resources will be required. These surveys include recent back-log as well as older networks.

2. Computer Programs

All computer programs will have an NAD83 version so that, in the transition years, work can progress on either datum. WIll Murphy's Law apply? A timely conversion will diminish the chances of an error from this source.

3. New Hydrographic Surveys

Once the CHS control in a particular area has been converted to the new datum, hydrographers can use that control for hydrography or for the establishment of additional control on the NAD83 datum. Care will have to be taken to use computer programs with the NAD83 ellipsoid constants. Again, a timely conversion will minimize the need to use distorted NAD27 coordinates.

4. Conversion Notes on Charts

Once NAD83 coordinates of survey control are known, CHS can start issuing Notices to Mariners advising users on using coordinates given in NAD83 or WGS systems.

CASE 1 For charts requiring no datum transformation:

HORIZONTAL DATUM
The horizontal reference datum of this chart is North American Datum of 1983 (NAD83) which for charting purposes is equivalent to World Geodetic System 1984 (WGS 84).

CASE 2 For charts requiring a change in position of the Reference station:

(The same note as CASE 1) plus,
New position for Reference Station, dated.

CASE 3 For charts that will require new border and grid lines:

HORIZONTAL DATUM
The horizontal reference datum of this chart is ________ (NAD 27, astronomic, other). To plot positions based on North American Datum 1983 or World Geodetic System 1984 (WGS 84), latitudes must be (increased/decreased) by ___._____ seconds and longitudes must by (increased/decreased) by ___.______ seconds.

CASE 4 For charts that will require reconstruction or survey:

There should not be any note giving the name of the datum or the relationship to NAD 83 or WGS 84. This is the continuation of CHS's present practice.

5. New Borders and Grid Lines

Once the NAD83 coordinates for an area are computed, charts requiring a new border and grid lines can be addressed. Charts should be thoroughly examined to verify that the shift between charted positions and NAD83 positions is consistent. Once consistency is established, the new limits of the border can be calculated. The chart will continue to show the same 'window of the world'. When the new border and grid lines are drawn, the positions of at least four registration marks that would fit the old grid intersections are needed. At the same time, the positions of survey control points and other computed points (lights, churches, towers, etc.) should also be plotted. The CASE 1 note (see above) can be added to the chart.

The next consideration is timing. The most probable way to change the border and grid on a chart would be to issue a New Edition, not just a Reprint or Notice to Mariners. A tabulation of the Edition Date for both the New Edition and last Reprint from N to M 969/85 was done to get some appreciation of the publication frequency of charts. The results are tabulated in Table 4.

TABLE 4 Printing dates of existing charts (New Edition and last Reprint)

Year of Printing	Tabulation by Edition Date	Running Total	Percent of Total	Tabulation by date Last Printed	Running Total	Percent of Total
1985	93	93	9 %	118	118	12 %
1984	115	208	21	149	267	27
1983	128	336	34	157	424	43
1982	40	376	38	82	506	51
1981	45	421	43	117	623	63
1980	27	448	45	95	718	73
1979	23	471	48	40	758	77
1978	14	485	49	49	807	82
1977	33	518	52	40	847	86
1976	26	544	55	38	885	90
1975	19	563	57	43	928	94
1970-74	100	663	67	41	969	98
1965-69	96	759	77	5	974	98.6
1960-64	115	874	88	6	980	99
before 1960	114	988	100	8	988	100

From inspection of Table 4, if the conversion is to be carried out in a reasonable time-frame, it has to be done at the next printing — be it a New Edition or Reprint. Of course, if it were only going to be a Reprint for all other reasons, it will have to be up-graded to a New Edition to reflect the datum conversion.

6. Reconstruction

The most labour intensive aspect of the implementation of NAD83 is chart reconstruction. Any effort to expedite the new chart scheme is obviously money and time well spent.

Reconstruction is much the same story as in the previous section, although far more cartographic time is involved in reconstructing a chart than in putting on a new grid and border. The same scheduling should also apply.

7. Survey of Positions

CHS Regional personnel should assess the charts within their Regions to determine those requiring extra positioning, and schedule the field work within the next few years. Some charts may require a complete survey because no datum correlation is currently possible. Provision of survey control to position the grid on the 155 charts is likely to be the major non-salary cost item in the implementation of NAD83.

8. Coordinates in Publications

These changes are a common occurrence in such publications as Radio Aids to Marine Navigation, List of Lights, Buoys and Fog Signals and Sailing Directions and will become more common as charts get their new grids. Nevertheless, the job will have to be done, but only Sailing Directions are a CHS responsibility.

9. Digital Data Bases

The conversion of data that is currently within a digital data base must be done. As digital data bases are going to increase in size rapidly, the sooner it is done the better. Further study is required to develop procedures for converting these data.

CONCLUSIONS

Assuming that the criterion that the displacement in position of survey points from charted to NAD83 position be less than 0.2 mm is accepted, approximately 22% of the published charts need either reconstruction or survey to define the geographic grid. Another 68% would require that the grid lines be shifted by some specified amount and the chart limits redefined. About 10% of the charts need datum correction — a figure roughly corresponding to that determined by National Ocean Survey.

The cost of converting the charts to the new datum is extensive in both manpower and funding because so much extra work is required to reconstruct or resurvey. This cost will be much more than NOS's estimate of $1.1 million (US) because 22.6% of CHS charts require reconstruction or a survey to define the lat/long grid on the chart.

The time frame to convert the charts to the NAD83 will be largely dictated by the CHS printing cycle. The only reasonable method is to tackle the job whenever a chart comes up for Reprint or New Edition. Even then, it will take 10 years to handle 95% of the CHS inventory.

PRIORITIES:

Because all other survey agencies will be converting their surveys to the NAD83, the NAD27 system will no longer be maintained. Also, as the CHS has been experiencing difficulties working in the NAD27 system, a conversion to the new datum will be of considerable benefit to the field hydrographer. Therefore, the first priority to benefit the field staff, is to enable new surveys to be computed in the field on the NAD83 datum as quickly as possible.

A possible set of criteria for setting priorities for converting charts to NAD 83 might be:

— the frequency of printing.
— the anticipated use of positioning systems when in that area.
— the amount and consistency of datum shift at chart scale.

All charts are of equal value in the eyes of the author when setting priorities for datum conversion, for he will not be satisfied that the project is complete until the last chart is done. But the real world just isn't that way.

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Vice Admiral William FitzWilliam Owen and his Life in Canada

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Canadian Hydrographic Service (Atlantic Region)
Dartmouth, Nova Scotia

ABSTRACT

William FitzWilliam Owen was the youngest of two sons of Captain William Owen of the Royal Navy. W.F.W. Owen followed in his father's footsteps and joined the Royal Navy to become one of the first generation of hydrographers.

Following the Napoleonic wars, after a troublesome period as a junior officer fighting the French, W.F.W. Owen became interested in hydrography and hence made a career of it. His first major activity as a naval surveyor took him to the Great Lakes of Canada where he met other surveyors who later left their mark on hydrography in Canada. He then went on to achieve major accomplishments along the African coast, as a surveyor: laying the foundations of hydrography in British East Africa and the Gold Coast.

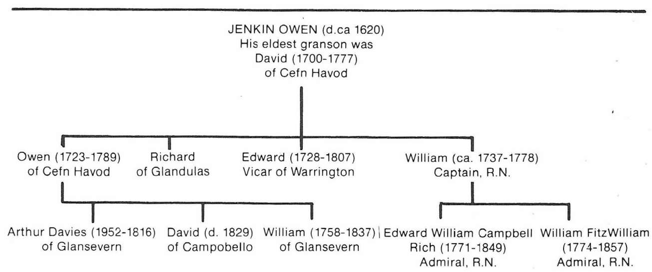
Upon retirement from the Navy, in 1835, he returned to the land his father had acquired in 1767, Passmaquoddy Outer Island, now known as Campobello Island. Between 1842 and 1847 he surveyed the waters of Passmaquoddy Bay and the surrounding areas of the Bay of Fundy. The remainder of his life was spent ruling the island of Campobello. He died at Saint John on November 3, 1857.

W.F.W. Owen came from a family with a long record of leadership and community service. His grandfather, David Owen of Cefn Havod, had four sons, Owen, Richard, Edward and William. William, the youngest son joined the Royal Navy. Although he fathered two sons, Edward William Campbell and William FitzWilliam, he never married.

Although he died leaving both his sons and their mother destitute, both rose to the rank of admiral, William FitzWilliam becoming one of the most distinguished hydrographic surveyors of the Royal Navy.

William Owen was born in 1737 and entered the navy as a youth. He spent half his adult life abroad, in India and North America. When not fighting in India or North America, he lived in Shrewsbury. In 1754, when he was eighteen, he was sent to the East where for the next seven years he saw considerable action as a fighting sailor in Indian waters. While helping Clive evict the French from India, a cannonball struck him and severed his right arm. At the end of the Seven Years War in 1763, he was broken in both body and spirit. When Lord William Campbell succeeded Wilmot as Colonial governor of Nova Scotia in 1766, he invited William Owen to accompany him as his secretary. Owen spent eleven months in North America in this capacity and laid the foundations of a feudal estate on Campobello Island that remained in his family's hands for three generations and lasted 114 years.

During the summer of 1767 Owen and a close friend, Sir Thomas Rich, set out from Halifax to explore Nova Scotia toward the Bay of Fundy and the Minas Basin. Soon after his return to Halifax, in September, Owen petitioned the Government for a grant of 4,000 acres of land "at Passmaquoddy", including the island then known as Passmaquoddy Outer Island. Governor Campbell had already reserved the adjoining island of Grand Manan for himself. Although the grant was issued, a few minor details were overlooked. The Crown Commissioners ignored the size of the grant, which instead of being 4,000 acres, actually exceeded 10,000 acres. Furthermore, William Owen's three nephews, who were also included in the grant, did not have any connection with the Army or Navy and should, therefore, have been excluded from the grant under the system of Royal Grants.

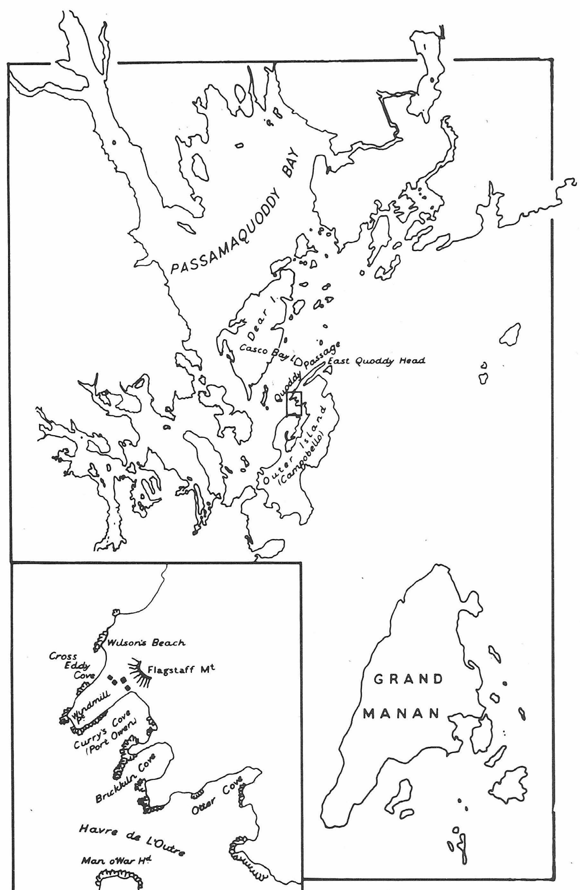


The Glansevern Owens of Montgomeryshire, Captain Owen's ancestors.

In any event, William Owen returned to England in the fall of 1767, a landowner in North America. While living in Shrewsbury in 1768, he lost the sight of his right eye in an election fight.

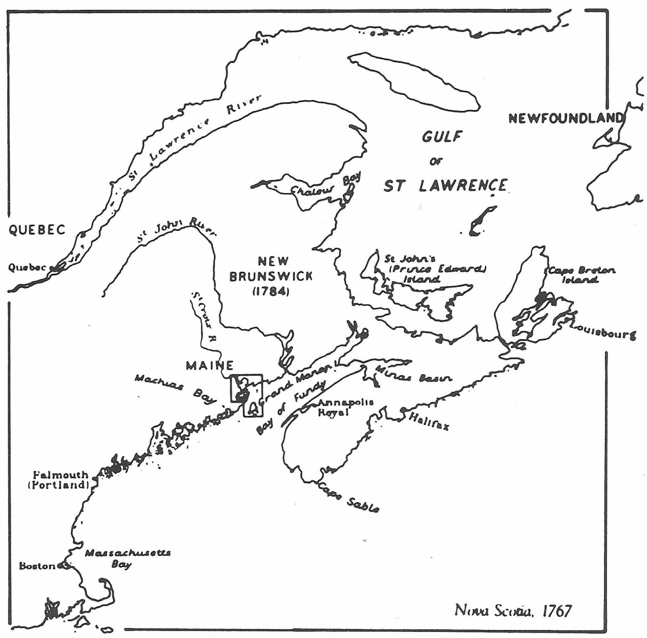
His thoughts returned to his property in Passmaquoddy Bay and after numerous meetings regarding the settling, cultivating and improving of Passmaquoddy Outer Island, it was agreed that a vessel be bought and Owen take possession of the island. In April, 1772, the OWEN, a 180 - ton vessel sailed for North America with William Owen, Master Pato Denny, Clerk William Isherwood and approximately twelve families to settle upon the Lands of Passmaquoddy. Upon arriving in Halifax, Owen and his two assistants were made Justices of the Peace and licensed to trade with the Indians. The Secretary also produced a billet that permitted Owen to grant passes to persons and vessels leaving the colony.

After leaving Halifax, Captain Owen crossed the Bay of Fundy, skirted the south side of Grand Manan Island and dropped anchor in Machias Bay, eager to meet the native New Englanders. On June 3 he inched his way north along the east side of the Outer Island and rounded East Quoddy Head, edged his way down Quoddy Passage and slipped into Havre de l'Outre. Here in Curry's Cove (Port Owen) they dropped anchor. The first Owen had come to Campobello.



Passamaquoddy, 1771

The first known explorer of Passmaquoddy Bay was Samuel de Champlain in 1604, he spent a winter at the mouth of the St. Croix and the Saint John River. Passmaquoddy Bay is rich in North American history. First, it was a hunting ground for a tribe of Indians. Thereafter successively the French and British and finally the Americans used it for hunting. It was only the fact that Owen and his people, owned and occupied Campobello Island before the end of the American War of Independence, that he and the islanders did not become American citizens.



Nova Scotia, 1767

From the moment that Owen and his people landed on Outer Island, the village of New Warrington (the name chosen by Owen but never widely used) flourished. This can probably be attributed to Owen's foresight and preparation in choosing the right people for the venture. There were people of almost every trade from the old country, including boat-builders, brickmakers and masons, millers, gardeners, carpenters, coopers, shoemakers and blacksmiths. At a place in the village, called the Market Gate, Owen erected a pair of stocks and a whipping post to punish and deter the unruly, and dishonest. He preached, baptised and informed them of news items they "needed to know". One surprising fact from Owen's diary is the amount of coastal trading and shipping which occurred; today Havre de l'Outre scarcely sees anything but a small fishing vessel. There were regular visitors from Halifax, Boston, Annapolis Royal and other New England ports and occasionally Newfoundland fishing vessels anchored in the cove.

On a return trip from England, the "OWEN" brought a letter from the Vicar of Warrington to his brother, which gave William Owen encouragement of active reinstatement in the Royal Navy. He, therefore, decided to return to England. By this time Captain Owen had acquired a family. Edward Campbell Rich Owen had been born on Campobello Island in February 1771, but it's not known which of the women living in the Owen household was the mother. However, it is certain that she and her son left with Owen and returned to England in June 1771. They lived near Warrington, and it was here that William FitzWilliam was born on September 17, 1774. In 1777, Lieutenant William Owen was promoted a Commander in the Royal Navy, and in 1778, he and his family moved to India. He was never to return to Passamaquoddy Bay for, late in the year 1778, he died at Madras leaving William FitzWilliam and his mother destitute. His eldest son Edward, now five, had his name on the books of the ship of his father's friend, Sir Thomas Rich. Apparently, William and his mother drifted into an ordinary military barrack and it was here that Rich found him playing with the soldier's children.

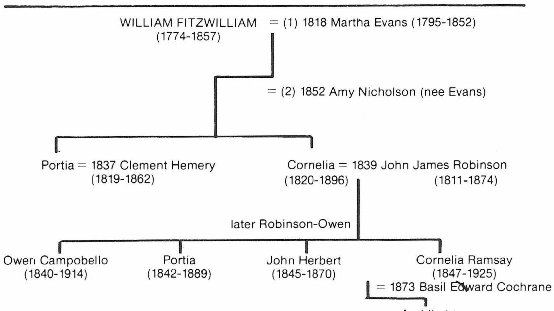
Sir Thomas Rich took charge of William, in addition to Edward, and carried him on the books of his ships. Before leaving the ship ENTERPRISE, at the age of six, William took part in his first naval battle. This battle, referred to as the Moonlight Battle, occurred in 1780 off Cape St. Vincent against the Spaniards.

During the next eight years young William moved between various boarding schools in North Wales. He also learned about his other brother, his Welsh cousins and his family circumstances. At school he was referred to as "the boy that never had any father or mother". It was discovered he had above average intelligence so Rich had him placed in a mathematical academy until he returned to sea.

At the age of fourteen, in 1788 he joined the CULLODEN as a midshipman under Sir Thomas Rich, the vessel's captain. He now went to sea permanently and nearly sixteen years of service followed as a naval officer in times of war. After the CULLODEN he transferred to the ZEBRA. Then in rapid succession he saw service in the ASSISTANCE, VENGENANCE, CARNATIC and HANNIBAL. In 1793 he returned to CULLODEN, he was now reunited with his brother Edward and together they sailed in the West Indies under Sir Thomas Rich (now Rear Admiral). The highlight of William Owen's career as a midshipman came when he took part in "the Battle of the Glorious First of June" under Captain Isaac Schomberg who took six French ships with CULLODEN. William Owen now twenty, received a commendation from his captain for his conduct during the battle. Later in the year he was temporarily promoted to a lieutenant. For a brief period, during 1794-95, he served as a lieutenant on board the RUBY along the shores of Africa.

After reverting to midshipman he served on board the LONDON under Captain Griffith (known as Colpoys). It was during this period that the English Navy mutinied and Owen was in the thick of it. The sailors complained of abusive behaviour from junior officers, press-ganging, floggings, and inadequate pay. Eventually, the mutiny was quashed, thanks to the action of old Admiral "Black Dick" Howe. But, not before Owen was singled out for punishment by the seamen because of the way he exercised his authority.

In June, 1797, Owen was appointed lieutenant in command of the FLAMER and he began a hectic decade of service in home waters, starting with the Battle of Copenhagen and ending at Camperdown. In 1798, the FLAMER protected the ports of South Wales and the coastal trade of Falmouth. Until the Peace of Amines, Owen served as a lieutenant in various ships under Sir Keith Elphinstone, Earl St. Vincent and finally Lord Nelson. In 1803 he became commander of the SEAFLOWER, a vessel in which he served for the next five years, much of it in India.



Captain Owen's family

His service on board the SEAFLOWER, started a relationship that was to last a lifetime. It was here he first met Richard Emeric Vidal, the eldest brother of Emeric Essex Vidal, who later served under Edward Owen in Canada and achieved distinction as an artist. The careers of these four men overlapped, and all but Edward spent their retirement in Canada.

Between 1806 and 1811, the Cape of Good Hope, the Indian Ocean islands and Java all fell to British attack and it was on a voyage to India, in 1806, that marked the change from Owen the career officer, to Owen the hydrographer. While the SEAFLOWER was on passage from the Seychelles to Madras through the Maldive Islands, Owen found two channels, through which he led a convoy.

In 1808, in the Bay of Bengal, returning from the British outpost at Bencoolen (Bengkulu) in western Sumatra, a French frigate overtook and captured the SEAFLOWER. Owen and his crew were taken to Mauritus and made prisoners of war until 1810. However, Owen was promoted to Commander and later appointed to the BARRACOUTA in the Java Sea.

In May, 1811, at the age of 37 Owen was promoted to Post Captain. In Java he was senior officer of the Batavia squadron in command of CORNELIA. With no specific military assignments, he sailed to Borneo and surveyed its coast. This expedition introduced him to two illicit sea activities that he would despise and fight against for the rest of his professional life — piracy and slavery. Owen deployed the ships of the Batavia squadron to intercept as many slave traders as possible.

In 1813, Captain Owen in the CORNELIA escorted a convoy of fourteen large East Indiamen bound from China to Saint Helena. Captain Owen returned to England, at the age of 39, after nine years absence. He returned well known in the world of science as a man possessing a talent in scientific navigation.

The years of peace that followed brought great changes to the Navy. Many ships were laid up and thousands of sailors discharged from the service.

Since William Owen Senior left Passmaquoddy Bay in 1771, the British had lost one American empire and started another. The British turned their attention to the development of the so-called British North America, out of which grew the Dominion of Canada. In December, 1814, Captain Sir Edward Owen returned to the continent of his birth as Commodore and Commander-in-chief of the Royal Navy in the Great Lakes of Canada from Lake Huron to Montreal. In the early summer of 1815, the Lords Commissioners chose an experienced naval surveyor, Captain William FitzWilliam Owen to make a military survey of the Great Lakes.

At Quebec, he assembled his team which included Henry Wolsey Bayfield, Alexander Thomas Emeric Vidal, Alexander Bridport Becher and John Harris. Others assisted, but none so directly as this team. Captain Owen established his headquarters at Kingston, while his brother, Commodore Owen, was preoccupied with frontier security. The first surveying task was to verify the boundary line accepted as the international frontier with the United States. Most of Owen's surveys in the lakes were made in bateaux or schooner gunboats, which he severely criticized.

The summer of 1815 was occupied examining the Canadian shore of Lake Erie and the eastern side of Lake Huron. Captain Owen, with assistants Vidal and Harris, set out in the schooner CONFIDENCE in late July. Some areas were surveyed in detail, while "running surveys" (sailing parallel to the shore and recording the outline) were conducted between the "particular surveys".

In the Detroit River, they met the Americans, where disagreements were common and Vidal was arrested and held in Detroit before being tried. They made surveys of the Detroit, St. Clair and the Thomas Rivers and entered Lake Huron. A "running survey" was made on the eastern shore of the Lake and a "particular survey" of the main channel into Georgian Bay. The survey ended with a detailed examination of Penetanguishene and its surroundings.

This part of Canada abounds with place names bestowed by the surveyors of this era. Some areas were named after old friends and fellow seamen, — Cape Hurd, Colpoys Bay, Griffith Island, Cape Rich and Owen Sound, to mention a few.

Commodore Edward Owen was recalled to London in November, 1815 after only six months of duty in Canada. However, Captain William Owen remained "Senior Officer and Acting Commissioner of His Majesty's Navy".

The Canadian surveys continued with the St. Lawrence River above the Galop Rapids, then Lake Ontario, Niagara, Lake Huron, the Manitoulines and finally the Richelieu River. Owen continued work through the winter, sounding through the ice until it became impossible, then, while the surveyors drew the charts and waited for the ice to break up, Captain Owen prepared his boats for the following survey season. When the survey of the Thousand Islands was completed in August 1816, work began on the triangulation of Lake Ontario which continued through the winter of 1816-17. Owen then turned his attention to the other Great Lakes, expanded on earlier surveys, and dispatched parties to the Niagara Peninsula. Captain Owen, himself, set out on an expedition up the Trent River.

On June 14, 1817 orders reached him to break off the survey and return to Kingston. Captain Owen was to report to the Lords Commissioners in London as soon as possible. His plans for a summer survey of Lakes Huron and Superior were abandoned. Only Bayfield and two draftsmen were to stay behind to finish the charts. Owen returned to London in December 1817. He put the finishing touches to the charts he brought with him and, on January 21, 1818 he went on half pay. Henry Bayfield remained in Canada until 1825, completing the surveys of Lakes Huron and Superior.

Captain Owen, now on half pay, left London and settled on the coast of Kent early in 1818. Later that year, he married Martha Evans, approximately twenty years his junior, who bore him two daughters in rapid succession. The two Owen girls were named Portia and Cornelia. At the end of 1919 the Owens moved near London.

The decade that followed marked the peak of William FitzWilliam Owen's career. It was during this period that he conducted the Great African Survey where he surveyed 20,000 miles of coastline (300 charts) and examined thoroughly the bays, harbours, inlets and river entrances along the coast. All the while tropical diseases plagued his crew. His hatred of the slave trade diverted his attentions from surveying and caused him much grief. Later he became Superintendent of Fernando Po and cruised around South America in the EDEN before returning to England in 1831. His return to England marked the end of his "active career" in the Royal Navy. Again on half-pay, Captain and Mrs. Owen made their home in the Channel Islands; of the thirteen years they had been married she had seen him for scarcely four. The girls also had to get to know him all over again.

In 1834 he applied to the Foreign Office for an appointment as "Consul General for Eastern Africa and for Southern Arabia in the Indian Ocean", he was however rejected for the position.

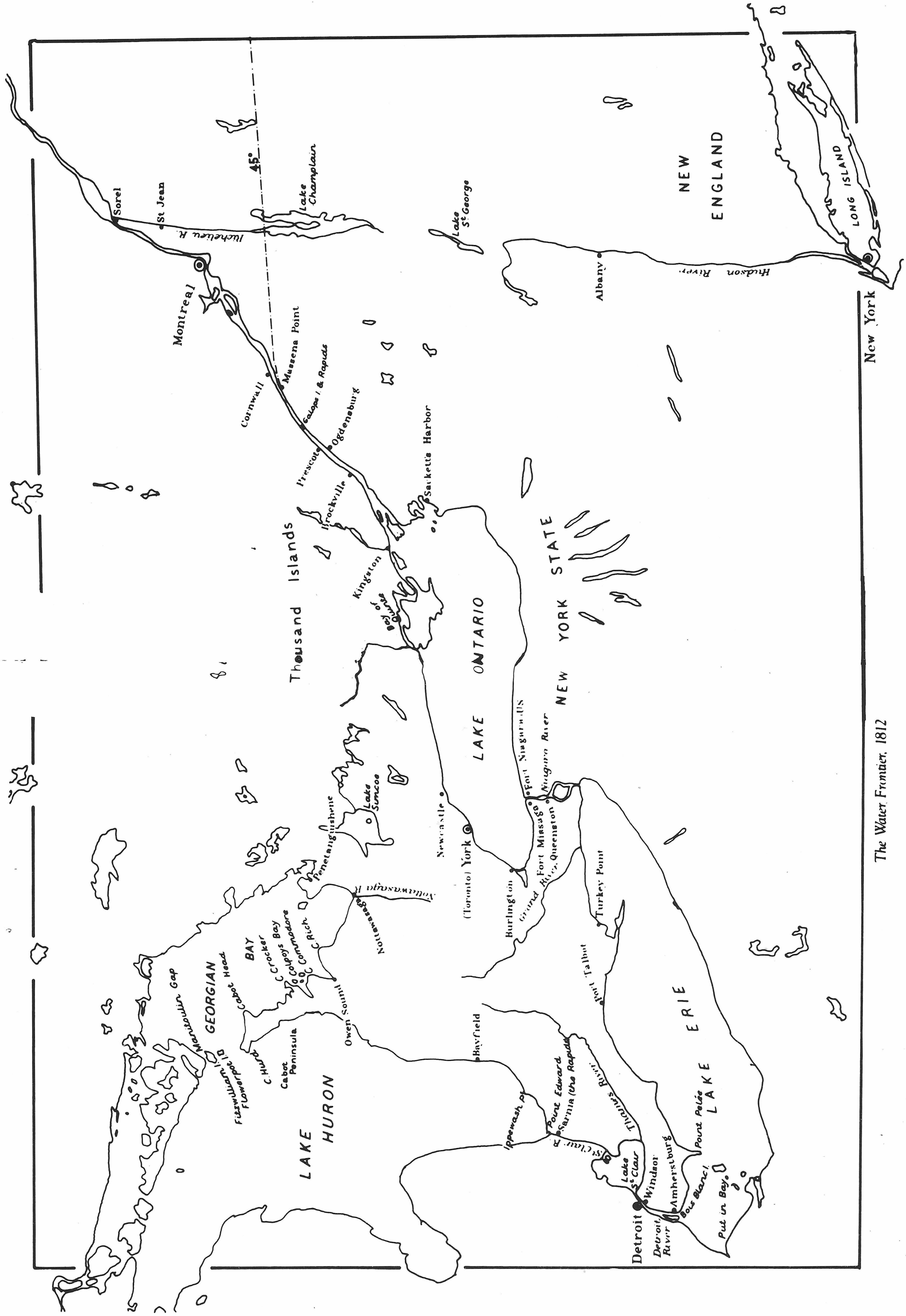
Had it not been for Campobello Island, Captain Owen may have faded into retirement. The settlement his father founded in 1770 was administered by a family member, David Owen, a Master of Arts of the University of Cambridge, who spent forty years under conditions described as mental isolation and loneliness. He was described as a surly and difficult man, physically large and loud-mouthed. Before he died in 1829, David Owen signed over the whole estate to Captain William's two sons, Edward and William FitzWilliam Owen. Edward sold his share to his brother and Campobello passed absolutely into the hands of William FitzWilliam in April, 1835.

He made plans to move there immediately, but a few days before his departure from England he was thrown from his horse and spent most of the crossing confined to a bunk.

Upon arrival he took stock of his estate and made plans to develop the island. He devoted his attention to making it the hub of Passmaquoddy.

The island flourished, mainly because of the forest. Captain Owen lived in a large wooden house at Welshpool known as The White House. Family life in the White House has, however, not been well documented. Portia was the first daughter to leave, she married a wine merchant from St. Helier and returned to the Channel Islands. In 1839 Cornelia married Lieutenant John James Robinson, a young naval officer on the North American Station, and after his retirement he returned to Campobello where he gradually assumed charge of the estate.

By 1845 Captain Owen had been on the island ten years as feudal landlord, clergyman, businessman and surveyor. He became involved in the public affairs of the Province in 1838 when he took his seat in the Provincial Lower House at Fredericton. Later he served on the Executive Council of New Brunswick.



The Water Frontier, 1812

In August 1842, survey instructions were issued to Captain Owen to conduct surveys in the Bay of Fundy with its islands, rivers and roadsteads. A paddle steamer, COLUMBIA, was outfitted as a survey ship and sent across the Atlantic in the charge of Lieutenant Alfred Kortright. Captain Owen took charge of the survey and made his headquarters in Welshpool. This survey occupied Captain Owen and a new generation of hydrographers until 1847 when COLUMBIA was ordered to return home. The survey efforts were concentrated in Passmaquoddy Bay, however, other surveys were made in the Minas Basin, Saint John River and, on one occasion, tidal observations were made in the Gulf of St. Lawrence. Near the end of 1847, Captain Owen was promoted to Rear Admiral.

Local tales of the Admiral's last active years on Campobello Island are in abundance. During his final years he mellowed somewhat and is remembered for his generosity, kindness, devotion to duty and his concern for the well-being of his tenants.

In 1852, his wife Martha died at the age of fifty-seven, but before the end of the year he married her close friend, Amy Nicholson of Saint John.

In October, 1854 at the age of eighty, he was promoted to Vice Admiral. However, W.F.W. Owen enjoyed his pension for only three years, for on November 3, 1857, he died at Saint John and was buried at Campobello.

Campobello passed on to his daughters and grandchildren. Captain Robinson became seigneur and ruled this island until his death in 1874. In June, 1881 the island was sold to the newly founded Campbello Company. This marked the end of an era, the island had been in the family's name for 114 years and continuously occupied by an Owen for nearly a century.

REFERENCE:

Burrows, E.H., Captain Owen of the African Survey. A.A. Balkema, Netherlands.

All photographs and sketches are taken from above text.

CHA/CHS News

CENTRAL BRANCH

The new Central Branch CHA executive is as follows:

Vice-President	— Geof Thompson
Secretary-Treasurer	— Mike Powell
Executive	— Dave Pugh
	— Brian Power
	— Brent Beale
	— Bruce Richards
	— John Dixon

Personal News
Our best wishes to Ray Treciokas on his marriage.

The stork flew by with a little package for each of the following families:

- Robitailles — a girl
- Solvasons — a girl
- Moates — a boy

The region would like to extend a warm welcome to Terese Herron, our newest member.

Our condolences go out to the families of DeGrasse, Wade, Davies, Eidsforth and Little on the loss of a family member during the past year.

15th Annual H_2O Bonspiel
On February 9, forty-eight curlers turned out for the 15th Annual Bonspiel at the Grimsby Curling Club. Adding their names to the two prestigious trophies are:

1st Event: Del Coleman, Joanne Tinney, Mike Smith and Bill Dorion.
2nd Event: Derek Vachon, Bernie Eidsforth, Michelle Clarke and Paul Warren.

The following eleven companies generously supported our awards table, and we wish to thank them for their support:

Wild Leitz Canada Ltd.	Willowdale, Ontario
Klein Associates, Inc.	Salem, New Hampshire
Rapid Blue Print Ltd.	Burlington, Ontario
Telefix Canada	Thornhill, Ontario
Norman Wade Company Ltd.	Hamilton, Ontario
J.M. Ellis	Metcalfe, Ontario
Terra Surveys	Sidney, British Columbia
Digital Equipment of Canada Ltd.	Burlington, Ontario
Geotech Ltd.	Markham, Ontario
CHA Film Club	Burlington, Ontario
CHA, Central Region	Burlington, Ontario

From the curlers and organizers of the '86 H_2O Spiel — thanks, donors, for your generosity.

OTTAWA BRANCH

ROLLY HAMILTON has announced his retirement for the end of March '86. Rolly has been in the CHS for 39 years and is considered one of its finer employees. He will be missed by his many friends. We wish Rolly and Pat a long and happy retirement.

LYNN ST. GERMAIN has found new employment in the Department of Agriculture.

JIM MACKENZIE has also annouced his retirement. Jim has been a long-standing member of Sailing Directions. We wish him well in his new-found leisure.

PACIFIC BRANCH

The new CHA executive for 1986 is:

Vice-President	— B.M. Lusk
Secretary	— R. Chapeskie
Treasurer	— F. Stephenson
Executive	— M. Bolton
	— M. Woods
	— P. Lacroix

The CHA Pacific Branch, under the leadership of Vice-President Barry Lusk, is alive and well. Over the past six months the branch has held two luncheon seminars; co-hosted the annual CIS/CHA Beer, Bun and Bellowing Bash; assisted CIS in holding a two-day workshop on terrain mapping; is working towards Colloquium IV in Banff; and did some of the legwork for Mike Bolton's retirement. In addition, CHA Pacific assisted the mainland members in establishing the new Captain Vancouver Branch.

Personal News

- Tony O'Connor replaced Mike Bolton as Regional Director. The CHA welcomes Tony back to the fold and wishes Mike a long and happy retirement. The branch will also benefit greatly from Mike's experience as he is staying on as a member of the executive.
- George Schlagintweit and Barbara Kerr joined the Hydrographic Service in the spring of 1985. George is a graduate of BCIT and has completed Step I this winter. Barb, who took Step I on her own last year, comes to us from Swann Wooster Engineering. Her credentials include a B.A. in Geography from York University and a diploma of Resource Engineering Technology from Seneca College.
- John Watt returned to the coast and is working with the development firm of Quester Tangent.
- Carol Nowak, Knute Lyngberg, Ron Woolley and Rob Hare all completed Step II last fall. Rob Hare came first.
- Sherman Oraas has returned from New Brunswick just in time to take charge of setting up our new MicroVax computer system.
- George Eaton obtained his C.L.S. Commission.
- Tracy Collins and Dave Jackson tied the knot in December.
- Make Ward has got engaged!

New Additions

Bill and Sue Hinds:	a girl, Marci
Jim and Sheila Parks:	a boy, Colin
Bruce and Sandy Johnson:	a girl, Erin
Fred and Andrea Stephenson:	a boy, Andrew

Sporting Goods

- The IOS Mariners softball team capped off a very successful season by winning the Fisheries and Oceans Tournament in Nanaimo.

- Stan Huggett, Willie Rapatz and Alex Raymond all skip rinks in the Glen Meadows men's curling league.

- The 15th Annual Tournament was held at Prospect Lake in August. Again, Mike Foreman won it all with a 38 on the par 36 nine-hole course. The lake scored 16 golf balls.

New Business

- Pacific Branch has three new ISAH (automated data acquisition systems) units which will be used on coastal surveys this summer. Vern Crowley will be running a three-launch party from the Pender and surveying in the vicinity of Tofino.

- The New MicroVax is destined for field use in 1987. Meanwhile, Sherman Oraas, John Larkin and Kal Czotter are busy getting the system going. The MicroVax will eventually replace the PDP-11 and its greater speed and capacity should make data processing a whole lot easier.

- Mike Woods will be taking the John P. Tully back to the Beaufort Sea this summer.

- George Eaton will be doing coastal surveys with the Richardson in Kyuquot and the Queen Charlottes.

- Charting activities continue at a hectic pace. The new special edition, Chart 1986, of False Creek and Vancouver Harbour, has just been released in time for Expo '86. Also, chart production is putting the finishing touches to a Cruising Atlas of Jervis Inlet to Desolation Sound. Both the Expo chart and the Cruising Atlas are expected to be best sellers.

- The Pacific Branch of CHS is going out to contract on three areas within the region. Larsen Lidar will be used on a production survey in the western Arctic during the month of August. The Mackenzie River request for proposal is now out and a bidder's meeting was held on Wednesday, February 19. A great deal of interest is being shown in what could be a very interesting and long survey of this river. The final contract for a small survey on the north coast of Vancouver Island is also in the works. Bull Harbour at 1:10,000 and Nahwitti Bar at 1:30,000 will be surveyed this summer.

RÉGION DU QUÉBEC

Les nouveaux membres de l'exécutif sont:

Vice-Président	— Richard Sanfaçon
Secrétaire-trésorier	— Denis Hains
Conseiller	— Normand Doucet
	— Michelle Grenier
	— Paul Bellemare

Félicitations à M. John Charreyron pour ses 35 ans de service au sein du gouvernement fédéral. M. Paul Bellemare a profité de la réunion annuelle de la région du Québec du S.H.C. pour présenter à Monsieur Charreyron une médaille soulignant ses 35 années de loyaux services.

La réunion annuelle du S.H.C. a aussi été l'occasion pour remettre à Anne Frenette et à Michelle Grenier leur diplôme attestant qu'elles ont réussi le cours de Cartographie I du S.H.C. à Ottawa.

Suite au projet de relocalisation des bureaux du S.H.C. (Région du Québec) à l'Institut Maurice Lamontagne, Messieurs René Lepage et Peter Mushinsky nous ont quitté pour retourner dans la Capitale nationale. René Lepage travaille maintenant à la Section de Cartographie automatisée. Bonne chance à tous deux.

Quatre nouvelles cartographes ont été engagées par le S.H.C. (Québec) pour une période déterminée. Bienvenue à Geneviève Robichaud, Hélène Pelletier, Odette Trottier, et Marie-Josée Parent.

Bienvenue à Tony Mortimer qui s'est joint à la région du Québec à titre de chef de la planification et coordination des levés du S.H.C.

Trois nouveaux hydrographes ont été engagés. Bienvenue à Jacynthe Cormier, Bernard Labrecque et Pierre Pagé au sein de la région du Québec du S.H.C.

Le nouvel exécutif régional a entrepris l'année 1986 en force en présentant à chaque semaine des films traitant des domaines reliés à l'hydrographie (initiative de Normand Doucet).

Félicitations à Paul-Émile Bergeron, Normand Doucet, Pierre Pagé et Richard Sanfaçon qui ont réussi le cours d'Hydrographie II, édition 1985 du S.H.C. à Ottawa.

Félicitations également à Monique et Denis Hains pour la naissance de leur garçon, Eric.

Bonne chance à Marc-André Baillargeon qui a accepté un poste au Ministère des travaux publics.

Souhaitons aussi la bienvenue aux nouveaux employés déterminés, soient: Claude Côté, Jean-Charles Cambron, René Sarra-Bournet, Robert Jodoin et Luc Ménard.

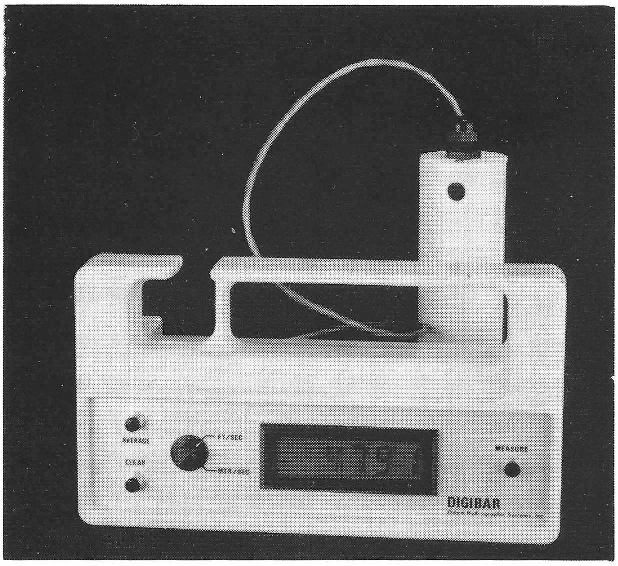
News From Industry

Telefix Canada

Telefix Canada is marketing two interesting products, the DIGITRACE and the DIGIBAR.

The DIGITRACE is a compact, low cost digitizer, suitable for installation in the DE 719 and the DESO 10 and possibly other analogue echo-sounders. The unit, which is supplied in kit form, displays depth and provides sound velocity and vessel draft inputs.

The DIGIBAR — as the name implies — is a digital alternative to the conventional "bar-check". The probe measures the sound velocity and converts the reading into feet or metres. The correction can then be applied to the speed of the echo-sounder. The equipment is portable, operates on "C" battery cells, and retains up to 30 different samples with computed averages.



Del Norte

Del Norte Technology Inc. announces a new member to the TRISPONDER family of systems. The new positioning system has the designation PULSTRAC — Pulse sequential Transmission Radiolocation with Automatic Calibration. This is a multi-user, over-the-horizon system, which operates on a single frequency. The shore-based network consists of four stations with interchangeable transponders.

CSI France

CSI France, being the export company for NEREIDES products, has announced details of oceanographic data acquisition systems in addition to the WADIBUOY which was launched in 1979.

The SPEAR F is a new product which computes, in real time, wave energy data and transmits, via Argos, the 30 bands of energy spectrum distribution from a standard WAVERIDER buoy. The system is available either as a complete buoy or a plug-in module.

The XM 25 buoys provide a sturdy platform for oceanographic and meteorological instrumentation at sea. The BABYBUOY is constructed in modular form for easy deployment.

Two versions of instrumentation are available for the transmission of real-time data:

- a VHF radio link for near shore application (range within 40 km) and network monitoring;
- the ARGOS satellite link for ocean deployment.

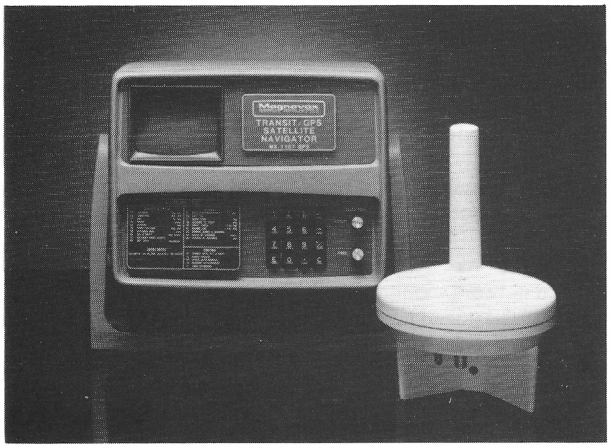
Qubit Ltd.

Qubit's TRAC IVB integrated navigation system has been installed on four rock-dumping vessels. The system assists the vessel to precisely navigate along its route, for instance a pipeline, by using special displays to manoeuvre its bays above the pipeline and by integrating data from a dual-headed sonar.

Magnavox

Magnavox has announced four satellite navigation receivers which offer both GPS and Transit capabilites. Designated the MX1100-GPS series, these receivers combine GPS and Transit data to generate position information. Speed and heading sensors are used for dead reckoning between position fixes.

The Magnavox integrated system approach permits the immediate utilization of GPS towards obtaining enhanced accuracy.



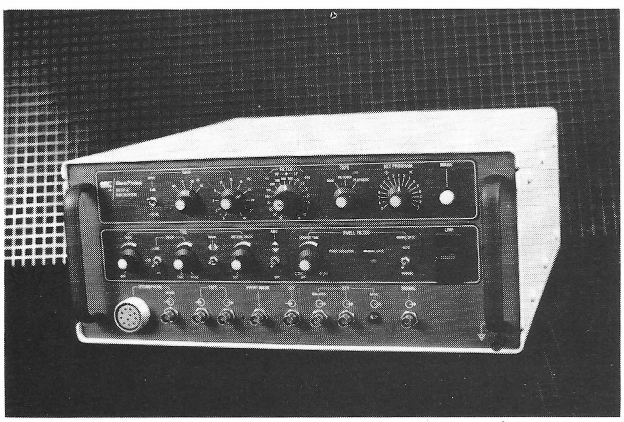
Sonatech Inc.

Sonatech's Long Baseline Acoustic Navigation System, SONATRACK II, now incorporates the DEC KDJ-11/AA (LSI 11/73) processor unit which provides a higher system speed; allows more concurrent programming; and permits operation in noisier environments.

The LSI 11/73 also facilitates the expansion of the SONATRACK to a fully integrated navigation system (acoustic/geodetic) by permitting high-speed data logging from a variety of geodetic sensors.

Ferranti

Ferranti Ocean Research Equipment report the availability of a versatile seismic receiver designated the "GeoPulse Receiver" which, amongst other features, has a built-in swell filter for removing the effect of ship heave and roll from sub-bottom profile records. The receiver has been designed for use with virtually any high resolution boomer or sparker system.



New Constitution of the Canadian Hydrographic Association

Article 1: Name

This organization shall be known as the "Canadian Hydrographic Association".

Article 2: Aims

Section 1 To advance the technical and professional ability of association members by:

(a) Encouraging members to acquire a comprehensive knowledge of hydrography, by a continuing program of study and development.
(b) Maintaining professional standards of work.
(c) Fostering a critical interest in hydrography.
(d) Encouraging interest in the work of related organizations and disciplines.

Section 2 To encourage a spirit of cooperation, tolerance, understanding and equality amongst all members in order that unity of purpose, throughout the association, can be established and maintained.

Section 3 To promote the free exchange of information and ideas.

Section 4 The Association shall not engage in trade union activities.

Article 3: Membership

Definition — Hydrography
Hydrography is the study, description and mapping of oceans, lakes and rivers.

Membership
Membership is open to all those interested in hydrography and closely associated disciplines.

A member shall be an individual eligible for membership.

A sustaining member shall be an organization or company eligible for membership. A sustaining member shall not be a member of the association within the meaning of the constitution.

Honorary membership may be conferred upon any person who, in the opinion of the National Executive, has made a significant contribution to hydrography. An Honorary member shall not be a member of the association within the meaning of the constitution.

Life membership may be conferred upon any member who has, in the opinion of the Branch Executive, made a significant contribution to this Association. Life members shall enjoy all rights of the other members. The Branch conferring the Life Membership shall be responsible for that member's dues.

International members are members residing outside of Canada. They shall be members of the Branch of their choice and shall enjoy all rights of other members.

All memberships are subject to the approval of the National President and Vice-President of the Branch in which the member shall be registered.

Article 4: Fees

The national membership fees shall be decided by the National Executive and ratified by a simple majority of the members present at the annual national meeting. The branch fees shall be decided by the Branch Executive and ratified by a simple majority of the members present at the annual Branch Meeting. All fees shall be collected by the Branches in accordance with their By-Laws.

Fees shall be payable in the month of January of each year and will be in arrears on February 1st of the same year. Members in arrears are subject to expulsion.

Article 5: Fiscal Year

The fiscal year of the Association shall be from January 1 to December 31.

Article 6: Executive

Section 1 There shall be a National Executive consisting of the immediate Past President and all Branch Executive Members, headed by a President. Each National Executive Member shall have one vote. The President shall be elected for a term of three years by a mailed ballot among the general membership. The election will be held prior to the appropriate Annual National Meeting.

Prior to the Presidential election the National Executive shall appoint an elections committee to accept nominations, inform the membership and conduct the election.

The President will be eligible for re-election to one additional term of office.

The President shall appoint a member as National Secretary-Treasurer, and shall appoint other members to his staff as necessary; these members shall not have an executive vote by virtue of their being on the Presidents' staff.

Section 2 There shall be a Branch Executive composed of a Vice-President, Secretary-Treasurer and one additional Executive member for each fifteen full members or majority fraction thereof, one of whom shall be the immediate past Vice-President. If the immediate past Vice-President is elected National President, he shall not become an executive member of the Branch and the resulting vacancy shall be filled from the Branch membership. The Branch Executive shall be elected by ballot among full members of the Branch in good standing.

A nominating committee will be appointed by the Branch Executive to nominate a slate of officers, subject to the approval of the nominees. Further nominations will be accepted from the floor at the time of the Branch meeting. The election shall take place at the annual Branch meeting, and the new Branch executive shall take over at the start of the fiscal year. Their term of office shall be for one year and the Vice-President or Secretary-Treasurer may not serve for more than three years in succession.

Section 3 The National Executive shall meet at the call of the President, and the Branch Executive at the call of their Vice-President.

Section 4 No business may be transacted at any National or Branch Executive meeting unless a quorum of sixty percent of the respective executive members be present.

Article 7: Duties of Officers

Section 1 The President shall preside over all National Executive meetings and any national general meetings. The immediate Past President shall act for the President where required or requested.

Section 2 The Vice-Presidents shall preside over all Branch Executive or Branch General meetings and shall keep the President informed of all activities by forwarding a copy of the minutes of all meetings.

Section 3 The National Secretary-Treasurer shall keep minutes of the proceedings of all National executive and general meetings. The Branch Secretary-Treasurers shall perform the same respective duties for their branches and, shall perform the duties of the Vice-President in case of the absence of that officer. They shall collect all monies payable to the Association, issue receipts for the same, and deposit all funds in a chartered bank or trust company to the credit of the Association and in joint account to the Vice-President and Secretary-Treasurer. The Branch Secretary-Treasurers shall produce their account books and a financial statement two weeks before the Annual Branch meeting, and the National Secretary-Treasurer, two weeks before the annual national meeting. The Vice-President and the President respectively shall then appoint two members who are not on the executive or staff to audit the accounts.

Article 8: Meetings

Section 1 General Meetings shall be held by each Branch, at the call of the Branch Vice-President

Section 2 An annual Branch Meeting shall be held by each Branch every year during the month of December, at which the election of officers shall take place.

Section 3 The National Executive shall meet annually, or more frequently, at the call of the President. Vice-Presidents may appoint alternative delegates with voting powers, if they are unable to attend. Any member of the Association may attend as an observer.

There shall be an annual meeting of the general membership. The National Executive shall circulate the agenda to all Branches at least six weeks prior to the meeting.

Section 4 A special Meeting of the general membership may be called by the National Executive at any time deemed necessary.

Section 5 In addition to these business meetings, which shall generally be restricted to full members, the Executive shall take every opportunity to organize meetings on matters of professional interest, which shall be open to all members and invited guests.

Article 9:

Section 1 This constitution may be amended by the National Executive by a two-thirds majority vote. Notice of any proposed constitutional change shall be circulated to all branches six months in advance.

Section 2 The National and Branch Executives may adopt such by-laws as are consistent with this constitution.

Canadian Hydrographic Association
List of Members

ATLANTIC BRANCH

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Chris Rozon
Mike Ruxton
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Claude Côté
Roger Côté
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Michel Morin
Antony Mortimer
Peirre Pagé
Jean-Yves Poudrier
Jean Paul Racette
Geneviève Robichaud
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T. Jolicoeur
D. Jake Kean
Gary Kosowan
Leo Labrie
Ron Lamirande
Gil Lance
Roger Landriault
Ron Lemieux
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J. MacKenzie
Paul MacMillan
Stephen MacPhee
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H.D. Tolton
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C. Jim Elliott
Phil Elliott
George Fenn
J.B. Fitzpatrick
Richard Hancock
Sean Hinds
Richard J. Kennedy
Albert Koudys
George MacDonald
Dan Mahaffy
R. Marshall
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Janet Moate
J.W.L. Monaghan
Stephen Nelson
Richard C. Padmore
Michael Powell
Brian Power
Dave Pugh
Dave Pyatt
Norman A. Randa
S. Rawlinson
Clyde S. Raynard
Roger Robitaille
Bruce Richards
A.R. Rogers
Rick Sandilands
S.J. Statham
D.A. St. Jacques
T.T. Tapley
Geoff Thompson
A. Boyd Thorson
Ray Treciokas
G.E. Wade
David G. Watson
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Bruce Buffet
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Bruce C. Calderbank
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Kenneth R. Clifford
Francis A. Colton
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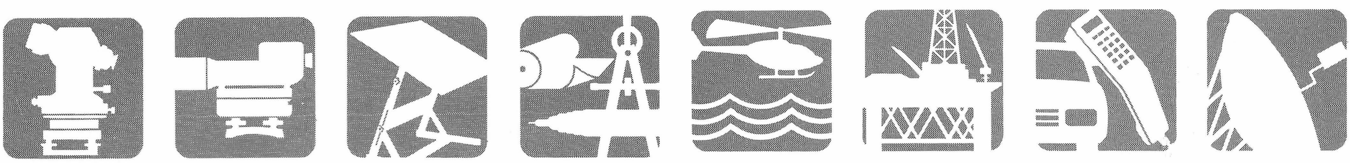

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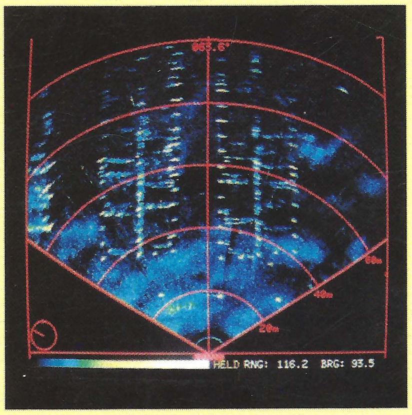
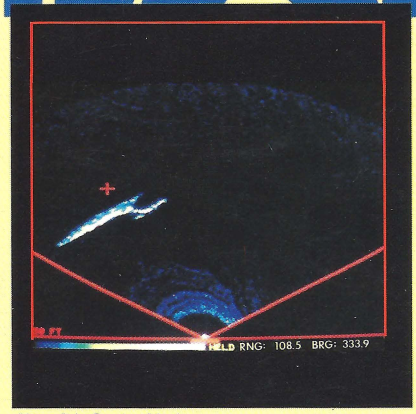


Marina with pilings in Sector Mode.

As shown here, the colours represent about one tenth of the actual brilliance of the monitor screen. The sonar also displays a dynamic sequence of images, enhancing your interpretation.

With the 971, you can 'see' as far as 500 metres. Compare that to a few metres with your eye or TV. Add the feature of five operating modes/display formats and you have an unrivalled versatility. For instance, the narrow sonar beam of the Sector Scan will detect even the smallest hazards and the display will reveal them. Perfectly. Switch to the unique Perspective Mode for Pilotage and a sound image of the outside world is presented with stunning realism. You 'fly' into the scene guided by the perspective grid.



Aircraft in Sector Mode.

Switch to the Polar Scan Mode for General Surveillance. If a job calls for monitoring and controlling traffic at an oil rig, this mode will guide divers and vehicles directly to a rendezvous or work station. Constant monitoring can be achieved with an NTSC or PAL converter and a standard video recorder. And playback utility is enhanced by the on-screen data, which lets you record date, time, depth . . .

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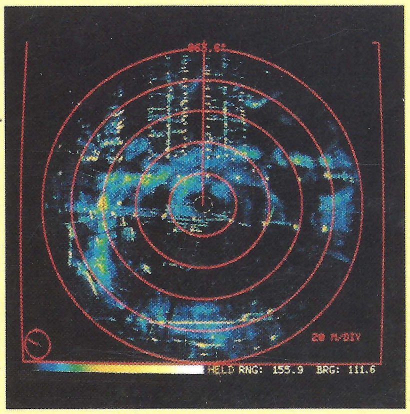

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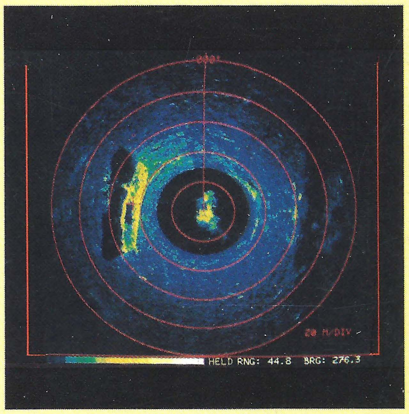
This much performance would normally require a rack full of equipment. Not so with the 971. The on-board processor is compact, the Sonar Head is small and yet light enough to fit any ROV. Or to pass through drill strings, casings and sea chests.



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