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Editor, LIGHTHOUSE
Canadian Hydrographic Association
c/o Bayfield Institute
867 Lakeshore Road
PO Box 5050
Burlington, Ontario
CANADA L7R 4A6
Telephone: 416-336-4856
Telex: 0618296

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Closing dates for articles are:

Spring issue	March 1
Fall issue	October 1

CALL FOR NOMINATIONS
NATIONAL PRESIDENT
CANADIAN HYDROGRAPHIC ASSOCIATION
1990 – 1993

PREPARATIONS FOR ELECTION

The National President's term of office will expire on December 31, 1989. In preparation for a smooth transition from our present national executive to our new executive, nominations are being solicited.

EXPERIENCE REQUIRED

It is strongly suggested that all nominees for President of CHA have previous executive experience within the Canadian Hydrographic Association or similiar organization.

NOMINATIONS ACCEPTED

Nominations for National President 1990 – 1993 will be accepted by the National Elections Committee until October 15, 1989. Any individual may submit his/her nomination on his/her own behalf, or nominations may be submitted on behalf of an individual by a CHA Branch.

WILLINGNESS TO STAND

The individual nominated or volunteered must submit a letter indicating his/her willingness to stand for this office to the National Elections Committee before this nomination will be accepted.

NOMINATIONS LIST

On October 16, 1989 a list of nominees will be circulated to all Branches and published in the Fall Edition of LIGHTHOUSE. As well, each nominee will be encouraged to state his/her election position in that edition of LIGHTHOUSE.

COUNTING OF BALLOTS – THE VOTE

Ballots will be distributed at this time to all Branches for voting within that Branch. Each Branch will collect the secret ballots and forward the ballots to the National Elections Committee for counting. The election will take place during the period of November 1 – November 30, 1989. The successful candidate will be declared on December 1, 1989.

NATIONAL ELECTIONS COMMITTEE
Chairman: E. Sargent

HYDROSTAR: A Computer Program For Accurate GPS Real-Time Kinematic Differential Positioning

by

G. Lachapelle, W. Falkenberg, M. Casey and P. Kielland

Abstract

The shipborne and airborne positioning requirements of the Canadian Hydrographic Service (CHS) which led to the development of HYDROSTAR are summarized. The algorithm, which is based on a combination of GPS code and carrier phase measurements and designed for real-time applications, is described. HYDROSTAR's operating environment, operator interfaces and major features are given. The program currently supports two receiver types, namely the TI4100 and the Norstar 1000 (also manufactured as the Del Norte 1005). The differential positioning mode is supported through phase-smoothed differential range corrections which can be transmitted in the RTCM SC 104 format at user selectable rates. The results of extensive land, shipborne and airborne trials designed to assess the performance of HYDROSTAR under normal operating conditions are summarized. The shipborne experiments, conducted with a 10 m hydrographic survey launch under a variety of sea states, resulted in external accuracies (rms) of 2 m or better in each of the two horizontal components. This corresponds to a 2D accuracy of 4.5 m at the 95% confidence level, which is within the 5 m accuracy requirement initially set by CHS for shipborne operations. The airborne photogrammetric trial resulted in external 3D accuracies of 40 to 80 cm, which is sufficient for a wide variety of precise airborne applications. Plans for enhancing the current HYDROSTAR performance are discussed. These include the use of parallel filters to counteract multipath, the modeling of pitch, roll and heave using a high carrier phase data rate, and the development of an efficient AT compatible version using the "C" language.

Introduction

In the early 1980's, Nortech Surveys (Canada) Inc. *{at that time Sheltech Canada, a division of Shell Canada Resources Ltd.}* began a series of extensive GPS evaluation tests. Shipborne trials conducted jointly with the Canadian Hydrographic Service (CHS) using a single channel STI 5010 receiver resulted in encouraging results and the company subsequently acquired several TI4100 receivers for development and operational purposes. Differential shipborne and airborne positioning tests with code (pseudo-range) measurements conducted in 1983 lead to external accuracies of the order of 5 to 10 m. This positively confirmed the potential of GPS for CHS shipborne and airborne hydrographic applications. GPS was subsequently used operationally by CHS for a variety of tasks such as Loran-C calibration. Nortech used GPS operationally to support its marine navigation services to the petroleum industry from 1983 onwards.

The objectives which led to the development of HYDROSTAR were established following the 1983 shipborne and airborne tests. The minimum accuracy requirement was set at 5 m with a confidence level of 95%. The quality assurance, which is defined as outlier detection with a near 100% certainty, was set at 10 m; this error bound should not be exceeded without some degree of warning. This concept is similar to that of integrity used in other navigation applications. The above requirements led to the adoption of the differential positioning mode. Another requirement was that the method be suited for real-time applications. This meant that the differential corrections generated at the Monitor station should be available in real-time for transmission using a cost effective data link. With proper raw data storage, the method should also be evidently usable in post-mission mode. The final methodology should be based on the use of C/A code and carrier phase measurements to guarantee unlimited availability with unclassifed equipment. The use of the P code was however permitted during the development phase for assessment purposes. The acceptable distance from the Monitor station to the vehicle was not specified since *Selective Availability* will adversely affect the performance of differential GPS if implemented. However, the accuracy of the methodology as a function of the distance between Monitor and vehicle was, in the absence of Selective Availability, to be analysed.

The above objectives led to specifications related to the type of field computer, the number of satellites observable simultaneously, the differential range correction transmission standards, the user interfaces and the type of input and output. Throughout the development phase, the methodologies proposed were assessed thoroughly using independent methods in order to obtain realistic performance results. This led to the design of sophisticated land and marine experiments where the positioning of the vehicle was always controlled by independent methods. An opportunity to assess the performance of HYDROSTAR methodology in airborne mode presented itself in late 1987. The trial resulted in excellent accuracies and confirmed the sub-metre capability of the program in differential airborne mode.

Description of HYDROSTAR

Algorithm

Code and carrier observations are combined to optimize both accuracy and operational effectiveness [Lachapelle et al. 1986]. Pseudo-ranges on individual satellites are smoothed using phase measurements. The smoothed pseudo-range at a given epoch is a linear combination of the measured pseudo-range at that epoch and of the smooth pseudo-range at the previous epoch. The measured phase difference between the two epochs is used to increase the relative accuracy of the pseudo-range. Its relative weight is a function of the time elapsed since the initial phase measurement in an unbroken sequence. Typically, a maximum relative weight close to unity is obtained after a few minutes provided that no cycle slip has been detected on the satellite observed during that period. If this situation arises, no attempt is made to recover the cycle slip and the filter is reset at its initial values. The weighting of a single range is entered in the least-squares solution of the position and the effect of a cycle slip on a single channel on the position is therefore minimized. The advantages of this method are manifold. Firstly, each satellite measurement is filtered independently from measurements on other satellites and a cycle slip on one channel does not adversly affect other measurements. Secondly, in the event of loss of phase lock on all satellites simuteneously due to a power outage or other phenomena, the position can be recovered with a minimum loss of accuracy.

Cycle slips on single frequency measurements are detected using a phase velocity linearity trend method. The reliable detection threshold is a function of many parameters, including receiver tracking bandwidth. The more accurate dual frequency cycle slip detection method is used when dual frequency measurements are available; see Lachapelle et al. [1986] for detail. Single frequency measurements can be optionally corrected for the effect of the ionosphere using the broadcast ionospheric model. The dual frequency method can additionally be used when L1/L2 measurements are available. Tropospheric corrections are applied using the modified Hopfield model. Broadcast ephemerides are used.

The phase-smoothed pseudo-ranges derived at the monitor station are used to calculate differential range corrections averaged over an operator selectable interval. A fading memory filter is used to provide range corrections in real-time for transmission to the vehicle. The cutoff elevation angle is user selectable. The actual choice is a function of satellite geometry, accuracy requirement and operating environment. In the marine mode, satellites down to an elevation angle of 5° are commonly observed. In this case, an antenna with an acceptable gain at an elevation below its horizon is required to compensate for the attitude motion of the ship. This however increases the possiblity of multipath effects significantly.

<u>Operating Environment</u>

The operating environment of HYDROSTAR is summarized in Table 1 below. The AT-compatible version being developed is resulting in a processing speed increase factor of 10 and will be required for real-time applications when the enhanced features being developed are implemented.

<u>Operator Interfaces</u>

The major operator interfaces are summarized in Table 2. Most options have preset values applicable to a wide range of cases. Program initialization is accomplished by entering an approximate position, the receiver type and the source of GPS measurements. Most algorithm related functions are automated and require minimal operator intervention. Operation of the program requires a relatively low level of training.

Table 1: HYDROSTAR Operating Environment

Current Environment

Parameter	**Requirement**
Language	PASCAL
Computer	HP 200 Series
Microprocessors	Motorola 68000 Floating Point Co-processor
Monitor	High Resolution for graphics
RAM	1.5 Megabytes
Interface cards	RS232, IEEE 488
Receiver Compatibility	TI4100 P or C/A code, L1, L2, or L1/L2 Norstar 1000/ Del Norte 1005, 5 or 7 channel versions
Mode/Input	Differential Real-time with Serial Interface to Receiver Differential post-mission with DC300XL tapes or disk files as input
Output	ASCII Configurable data logger

Under Development

Parameter	**Requirement**
Computer	AT Compatible, DOS Operating System
Language	Microsoft "C" version 5.0

Table 2: Operator Interfaces

Item	**Characteristic**
19 screen menus three categories:	Display Screen Entry Screen Entry/Display Screen
Movement Between Screens:	Increment Decrement Show (return to Screen 1) Jump (+ valid screen number)
Data Entry and Processing:	Modify Accept Process
Detailed Menu Selection:	Toggling between preset options
Initialization Utility:	Initial processing parameters and output of parameters to disk file for survey planning purposes

A List of HYDROSTAR major features is given in Table 3. These features allow the program to be usable anywhere in the world. An especially interesting feature is the availability of primary, secondary and tertiary constraints. A primary constraint defined as such by the operator is always invoked. Secondary and tertiary constraints are invoked only if the satellite geometry and/or the solution statistics do not meet a pre-established threshold. This feature further simplifies the use of HYDROSTAR under degraded satellite geometry and reduces further the risk of degraded positions being calculated without the knowledge of the operator.

Table 3: HYDROSTAR Major Features

- Position computation control parameters
- Solution quality diagnostics
- Graphics and navigation support (plane and curvilinear coordinates)
- Phase-smoothed pseudo-range on up to 7 satellites simultaneously
- Least-squares solution of redundant observations
- Dual and single frequency cycle slip detection
- 9-parameter datum and coordinate conversion: Built-in options and user-definable parameters
- GEM10B worldwide geoid on a 1° x1° Grid with four-point interpolation
- 3D antenna offsets
- Stationary monitor mode with constrained positions for computation of differential range corrections in RTCM SC 104 format
- Kinematic or static remote single point or differential mode
- GPS ephemeris health and status display
- Display GDOP, HTDOP, and HDOP
- Position error diagnostics and warnings on all screens when specified estimated error bounds are exceeded
- Choice of primary, secondary and tertiary constraints in case of degraded geometry.
- Constraint selection includes either 3D position, height only, or local clock
- Linear or quadratic model for local clock constraint
- Output devices supported: printer, two parallel ports, up to four disk drives, and two serial interfaces.
- Two independent output devices can be specified and up to 18 data items can be selected for output.

Test Results

Land Trials

A first series of land differential tests was conducted in 1985 to ascertain the accuracy of the HYDROSTAR algorithm in a controlled environment. The procedure utilized is described in detail by Lachapelle et al [1987a]. Road trials were conducted at speeds of 20, 50 and 100 km h^{-1} with TI4100 receivers outputting code and carrier phase measurements at intervals of 1.2 s. An infrared laser detector was used to locate the vehicle with respect to surveyed poles with an accuracy of approximately 1 m. Sample results obtained with C/A code and phase-smoothed C/A code measurements over a distance of 1,000 km are given in Table 4; these results are extracted from Lachapelle et al. [1987a]]. Such a long distance was used to assess related accuracy degration in the absence of Selective Availability. The GDOP and PDOP during the test, which took place on August 26, 1985, were better than 5. The Monitor station was located in Brandon, Manitoba, and the vehicle (Remote) in the Calgary area, Alberta. Three of the nine trials, namely No. 4, 5 and 6, were reduced using raw C/A pseudo-ranges. The latitude and longitude standard deviations for these three trials are of the order of 10 to 13 m which is expected in view of C/A code noise. The improvement obtained when using carrier phase measurements is remarkable and leads to standard deviations of 0.5 to 1.3 m which is satisfactory considering the accuracy of the pole detection method and of the algorithm employed. The mean differences reach 5.1 m, i.e. 5 ppm of the distance between Monitor and Remote; this is within anticipated differential orbit and ionosphere error bounds. The use of local clock constraints during trials 7, 8 and 9 did not result in significant improvement as compared to trials 1, 2 and 3 because the GDOP during the first three trials was relatively good (< 5). Other land trials conducted with phase-smoothed P code pseudo-ranges resulted in similar accuracies.

Shipborne Trials

Survey launch trials took place in the Halifax area during November 1986 to test HYDROSTAR in the marine environment [Lachapelle et al. 1988]. TI4100 receivers were

Table 4: Land GPS Differential Kinematic Positioning Results over a Distance of 1,000 Kilometres

SOL NBR	DIM	CODE AND FREQ	PHASE USED	CLOCK FIXED M	CLOCK FIXED R	VEHICLE SPEED (km/h)	DIFF LAT	DIFF LON	MEAN RMS LAT	MEAN RMS LON	STANDARD DEVIATIONS LAT	STANDARD DEVIATIONS LON
1	4D	C/A L1	Yes	No	No	100	0.1m	-3.6m	1.1m	3.8m	1.1m	1.3m
2						50	-0.1	-3.3	1.1	3.6	1.1	1.2
3						20	-0.4	-3.3	0.7	3.4	0.5	0.9
4	4D	C/A L1	No	No	No	100	0.5	-2.9	9.3	13.2	9.4	13.0
5						50	-1.7	-1.1	9.1	13.5	9.0	13.5
6						20	-0.9	0.8	5.9	11.6	5.9	11.8
7	3D	C/A L1	Yes	Yes	Yes	100	0.9	-5.1	1.3	5.2	0.9	1.1
8						50	0.7	-5.1	1.2	5.2	1.0	1.3
9						20	-0.1	-3.5	0.5	3.6	0.5	0.9

used. The C/A code was used throughout the trials except for a two hour period on Day 322 when the P code was used. The 10 m launch speed was 15 knots (7.7 m s^{-1}) and the wind reached 20 knots during some of the trials. The maximum roll and pitch motions detected were 30° and 15° respectively. The antenna was mounted some 3.9 m above water and a 30° roll motion corresponded to a 2 m linear antenna displacement. The trials on Days 319 and 320 (See Table 5) were conducted in Bedford Basin, a sheltered area providing relatively calm conditions. On Days 321 and 322, the trial site was located in the open sea outside Halifax Harbour and provided rougher sea states to assess thoroughly the performance of GPS. Cycle slips were detected every 5 to 30 minutes during the open sea trials. The cycle slip frequency generally increased as the satellite elevation decreased; satellites were observed down to an elevation of 5°. The Monitor station was located in Dartmouth and the distance to the launch reached some 28 km during the open sea trials.

External horizontal launch positions were provided by three independent shore-based systems, namely two Krupp Atlas Elektronik Polarfix systems and one Motorola Mini-Ranger Falcon 484 system. An intercomparison of these three systems resulted in an estimated accuracy of 1.5 m in northing and 1.3 m in easting at the one sigma level for either system.

Table 5: Shipborne GPS Differential Kinematic Positioning Versus Shore-Based Systems*

		PF1 - GPS			PF2 - GPS			MR - GPS		
Day[1]	N[1]E[2]	n.s.[3]	mean	rms[4]	n.s.	mean	rms	n.s.	mean	rms
319	DN	593	0.9	1.5	1068	0.1	0.7	2093	-1.1	1.6m
	DE		0.0	3.8		0.9	1.6		0.1	0.8
320	DN	440	0.4	3.2	1807	-1.3	3.0	5105	-2.0	3.2
	DE		-0.7	2.8		0.1	1.2		-1.2	2.3
321	DN	3090	-1.1	3.8	1736	-0.1	2.6	4932	-1.3	2.1
	DE		0.4	3.3		0.3	2.0		1.0	1.7
322	DN	3401	-0.2	3.2	2817	-0.6	1.7	6446	-0.9	1.3
	DE		0.4	3.0		0.3	1.5		0.7	1.1
All	DN	7524	0.6	3.4	7428	-0.1	2.2	18576	-1.1	2.2
	DE		0.0	3.2		0.4	1.6		0.4	1.6

* PF1 & 2: Polarix 1 & 2; MR: Motorola Mini-Ranger
1 1986 2 N - Northing, E - Easting
3 n.s. - number of samples 4 root mean squared

The GPS results, in terms of agreement with the shore-based systems, are summarized in Table 5 which is extracted from Lachapelle et al. [1988]. All GPS coordinates were derived using phase-smoothed pseudo-ranges. The results are consistent between the various trial days. The mean differences reach 2 m but are generally below 1 m. The rms differences vary between 0.7 m and 3.8 m. When the error contribution of the shore-based systems is taken into account, external accuracies of 2.0 m and 1.6 m in northing and easting, respectively, are obtained for differential GPS. The corresponding two-dimensional accuracy at the 95 percent confidence level is 4.5 m. This is within the accuracy objectives established initially by the CHS.

Airborne Trials

HYDROSTAR's algorithm was recently used to assess the performance of GPS for precise airborne positioning. The photogrammetric test was conducted by the Québec *Ministère de l'Énergie et des Ressources* over the Québec City area in November 1987 [Moreau & Perron 1988]. Nortech Surveys and Hauts-Monts Inc., a photogrammetric company based in Québec City, were contracted for the GPS positioning and aerial photography, respectively. Two TI4100 receivers operating in P code, differential mode were used. A point observed by the aircraft on the tarmac for a few minutes immediately prior to take-off and after landing provided Nortech with flight misclosures which are a valid indicator of the internal consistency of the system. The satellite constellation was poor during the trial and satellites down to an elevation of 5° were observed. Cycle slips were detected on several occasions during two (No. 3 and 4 - Table 6) of the three test flights when the satellites were at an elevation below 10°.

Table 6, which is extracted from Keel et al. [1988], shows the misclosures of the three photogrammetric test flights performed during the trial. The Start and End misclosures are these between GPS-derived and surveyed coordinate differences between the tarmac point and the Monitor station located some 100 m away. The Start misclosures are caused mostly by the code noise effect on filter convergence. The End misclosures are caused by the above effect and the error accumulation during the 60 minute flights. The differences between Start and End misclosures are good indicators of the accuracy maintained during the flights. These reach 62 cm in the case of the height component on Flight 4.

This was a blind test for Nortech Surveys. The photogrammetric reduction was completed subsequently by the *Ministère de l'Énergie et des Ressources* using independent ground geodetic control points. The external accuracies ranged from 40 to 80 cm, thus confirming the internal values quoted above. This is considered excellent in view of the cycle slips encountered, the low elevation of the satellites observed, and the real-time suitability of the algorithm.

Future Enhancements

HYDROSTAR is an evolving program which is being improved constantly. Two areas are being investigated at this time, namely the development of counter-measures to multipath effects, and the use of high carrier phase data rates for improved pitch, roll and heave determination.

The effect of multipath on C/A code pseudo-ranges can reach some 293 m which is the C/A code chip size [Lachapelle et al. 1987b]. The corresponding effect on P code measurements is 10% of that of the C/A code measurements, namely 29 m. If multipath is present immediately after a filter is reset when the weight on pseudo-ranges is realtively high, the resulting phase-smoothed pseudo-range obtained after a minute or two of observations could be biased and remain biased until the filter is reset. This phenomenon can obviously take place at both the Monitor and Remote stations. It is therefore important to detect the presence of multipath in the first place and design an appropriate counter-measure. One approach currently being investigated is the use of parallel filters computed simultaneously and reset on a regular basis. An intercomparison of the various solutions is made in real-time and an automated selection process is used to adopt a unique solution considered optimal. A field experiment using an oscillating mast to simulate roll or pitch motion was recently conducted to test the above methodology [Falkenberg et al. 1988]. Multipath was induced by using several reflective aluminium sheets. The measurements are currently being analysed.

Table 6: Airborne GPS Differential Kinematic Positioning: Flight Misclosures

Flight No.		Misclosures (m) Northing	Easting	Height
2	Start	0.01	-0.01	-0.46
	End	Not computed (PRN 12 ELEV < 5°)		
3	Start	0.25	-4.71*	-1.07
	End	0.48	0.33	-1.20
	D	***0.23***	***5.04***	***-0.13***
4	Start	0.50	-0.21	0.13
	End	0.45	0.16	-0.49
	D	***0.05***	***0.37***	***-0.62***

External Photogrammetric Agreement: **0.40 to 0.80 m**
*Poor Satellite Geometry - GDOP was 14.6

The estimation of roll and heave motion was initially attempted during the November 1986 shipborne trials [Lachapelle et al. 1988]. A low cost TRIM attitude sensor unit was used to measure independently roll and pitch motion. Tests were conducted both on the 10 m launch and on the Maxwell, a 38-m hydrographic vessel. In the case of the Maxwell where the roll motion period was approximately 7 s, GPS-derived roll motion could be correlated fairly well with corresponding attitude sensor derived measurements, although smoothing effects were obvious in view of the 1.2 s interval between TI4100 GPS measurements. This effect was much larger in the case of the launch where the roll period was estimated at approximately 2 to 3 s. In the latter case, the attitude sensor measurements became too noisy to provide a reliable independent control due to overshooting effects. An initial attempt to model the Maxwell heave motion with carrier phase measurements produced encouraging results. However, these results could not be verified against independent measurements, there being no heave compensator available on the ship. It is clear that the successful recovery of attitude and heave motion by GPS, especially on a survey launch, will depend upon the availability of carrier phase measurements at a high data rate. The oscillating mast experiment reported earlier was also designed to gather the data necessary to test the recovery of pitch, roll and heave motion. Specially modified Norstar 1000 receivers outputting phase measurements at 5 Hz were used at various known angular velocities [Falkenberg et al. 1988]. The analysis of these measurements is expected to result in a more accurate modeling of the attitude and heave motion components.

The above activities will increase the real-time processing capacity of HYDROSTAR. A "C" language version compatible with AT computers is currently being developed. Initial tests indicate a processing speed about 10 times superior to that of the HP Series 200 PASCAL version.

Conclusions

HYDROSTAR is an operationally oriented and user flexible program suitable for a wide variety of land, shipborne and airborne real-time or post-mission GPS differential positioning applications. The program is cycle slip tolerant and automated; its proper use requires only a low level of training. Its high level of accuracy and reliability is sufficient to meet many marine, land and airborne needs. Enhancements currently being developed will increase further its range of hydrographic applications.

The program currently supports data input from the TI4100 and the Norstar 1000/Del Norte 1005 receivers. The development of modules to accommodate data from other receivers is being initiated. The internal software of the Norstar 1000/Del Norte 1005 receiver uses fundamentally the same algorithm as HYDROSTAR and can deliver the accuracies reported in this paper.

References

FALKENBERG, W., P. KIELLAND, and G. LACHAPELLE, 1988. "GPS Differential Positioning Technologies for Hydrographic Surveying", Proceedings of PLANS88, I.E.E.E. [Orlando, Florida], pp. 310-317.

KEEL, G., H. JONES, and G. LACHAPELLE, 1988. "A Test of Airborne Kinematic GPS Positioning for Aerial Photography: Methodology", GPS 88 Conference, Institute of Navigation, Colorado Springs, September 19-23.

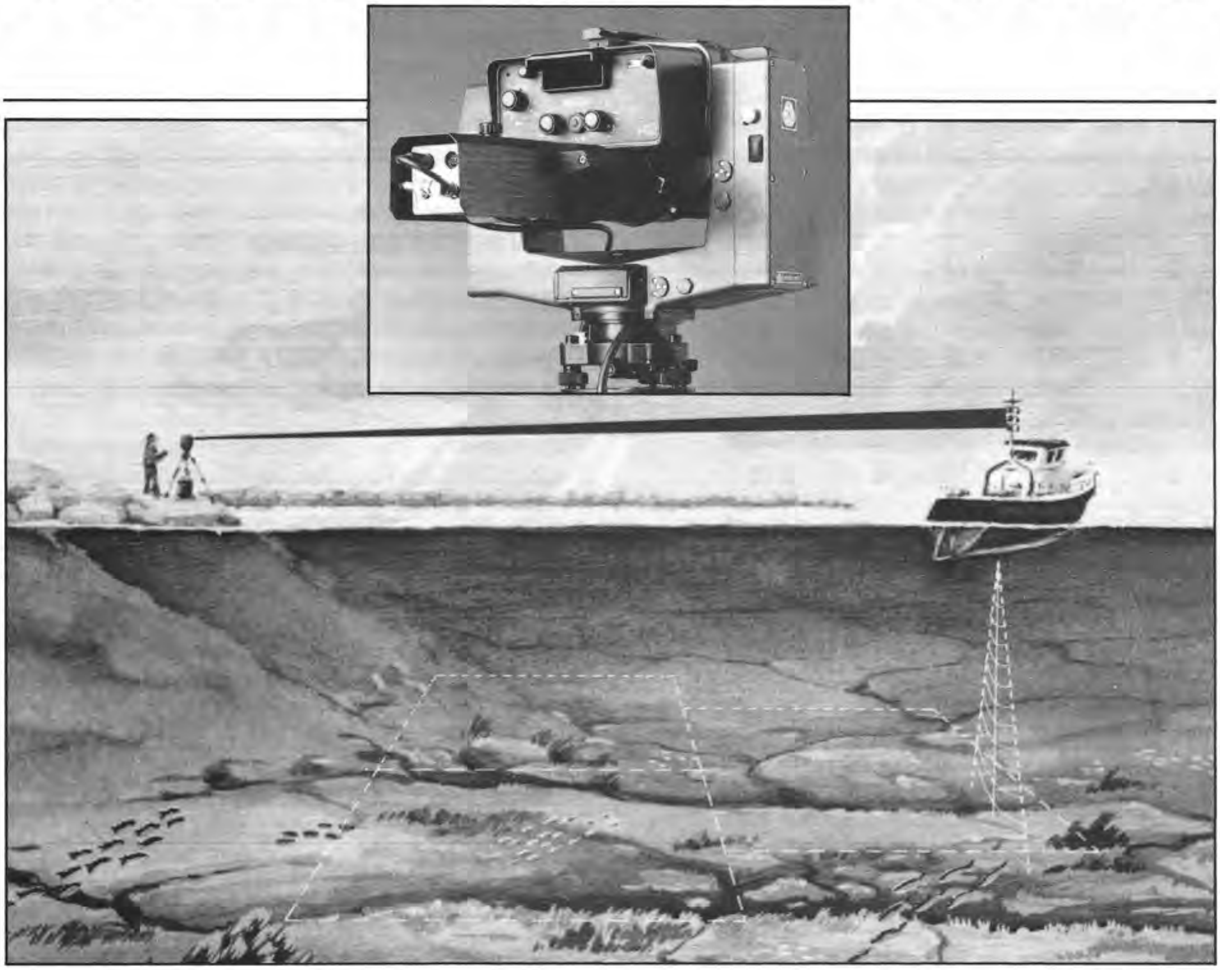
LACHAPELLE, G., J. HAGGLUND, W. FALKENBERG, P. BELLEMARE, M. EATON, and M. CASEY, 1986. "GPS Land Kinematic Positioning Experiments", The Hydrographic Journal, No. 42, pp. 45-55.

LACHAPELLE, G., W. FALKENBERG, and M. CASEY, 1987a. "Use of Phase Data for Accurate Differential GPS Kinematic Positioning", Bulletin Géodésique, Vol. 61, No. 4, pp. 367-377.

LACHAPELLE, G., M. CASEY, R.M. EATON, A. KLEUSBERG, J. TRANQUILLA, and D.E. WELLS, 1987b. "GPS Marine Kinematic Positioning Accuracy and Reliability", The Canadian Surveyor, Vol. 41, No. 2, pp. 143-172.

LACHAPELLE, G., W. FALKENBERG, J. HAGGLUND, D. KINLYSIDE, M. CASEY, P. KIELLAND, and H. BOUDREAU, 1988. "Shipborne GPS Kinematic Positioning for Hydrographic Applications", Navigation, Vol. 35, No. 1, pp. 73-88, Washington, D.C.

MOREAU, R., and M. PERRON, 1988. "A Test of Kinematic GPS Combined with Aerial Photography: Organization, Logistics and Results", GPS 88 Conference, Institute of Navigation, Colorado Springs, September 19-23.



ECDIS Development in Canada

by

G. Macdonald, S. Grant, M. Eaton,
J. MacDougall, B. Beale and P. Leenhouts

Abstract

The Electronic Chart Display and Information System will have a profound impact on marine navigation and marine safety throughout the world. The Canadian Hydrographic Service has initiated a number of development projects in order to respond to current and projected demands. An Electronic Navigation Chart testbed was built to gain direct, practical experience with the Electronic Navigation Chart. Display and design studies were initiated to investigate perception problems using the dynamic display. An automated generalization project was started this year to test generalization algorithms for digital charts and survey data sets. A pilot Electronic Navigation Chart is being developed by converting six digital charts on the St. Lawrence River to an Electronic Navigation Chart format. It will be tested on commercially available hardware. A comprehensive Information System is being developed with a number of component data bases and information bases. In addition to these Canadian Hydrographic Service projects, the Canadian Coast Guard is testing Electronic Chart Display and Information System capabilities in a number of operational areas including icebreaking and buoy positioning.

Introduction

The Electronic Chart Display and Information System (ECDIS) has emerged in the 1980's as one of the most promising navigation tools available to the mariner. It has great potential, not only as an aid to commercial and naval shipping, but also as a desirable product for the bridge of pleasure craft. Devices such as speed logs, gyro compasses, radars, echo sounders and electronic positioning systems are all part of a modern bridge. While these provide useful information, the chart is the one medium where all the observed data can be plotted and combined for navigation. There are errors and delays associated with obtaining data from each of these devices and transferring them to the chart. The ECDIS brings together all the information the mariner needs to navigate safely, and clearly displays it in real-time.

The ECDIS can have a profound impact on marine navigation throughout the world. It can be particularly important in congested harbours, in low visibility such as fog and snow, or when ice has removed or obscured the buoys and markers. It can help large tankers to berth safely, can enable ferries to remain on schedule and can greatly simplify navigation for a growing number of pleasure boaters.

The ECDIS will have a special role in the Arctic. By superimposing the ship's radar image of the ice edge on a chart background, it will enable the mariner to determine where the ice is blocking a navigation channel and to distinguish ice-edge echoes from coastline echoes. In addition, the ECDIS will provide a cost-effective means of supplying chart information to a limited number of Arctic navigators without having to actually print the paper chart.

In Canada, a number of ECDIS projects are presently underway. These include the Electronic Navigation Chart (ENC) testbed, chart design and display studies, chart generalization studies, the St. Lawrence River Pilot Electronic Navigation Chart, the Canadian Hydrographic Service (CHS) Information System and Canadian Coast Guard (CCG) operational trials.

The Electronic Navigation Chart Testbed

A testbed is a try-out installation. In 1984 the Canadian Hydrographic Service decided to build an Electronic Navigation Chart testbed in order to gain direct, practical experience with the ENC.

One fundamental requirement of a testbed is that it must be capable of accepting major modifications to try out new ideas. So the CHS contracted Universal Systems Ltd. of St. John, New Brunswick, to modify their versatile Computer-Aided Resource Information System (CARIS) into a flexible prototype ECDIS. CARIS has a ready-made chart display as part of its editing function and CARIS is compatible with the CHS digital chart files. The CHS developed the details, guided by a committee of mariners, Canadian Coast Guard navigation experts and hydrographers.

The ENC testbed has been tested and demonstrated in Halifax Harbour each year since the start of the project and has yielded a lot of useful information. It has provided feedback to the CHS Information System planning group on how an Electronic Chart Information Base (ECIB) is likely to differ from a paper chart information base. It has provided some insight into the extensive digitizing protocols required for data, even in the same format, to be transferred from one system to another with certainty of getting a correct chart display. It has also been used on display and design projects to study what can be done to produce a clear and readable picture on a screen that combines an extensive chart display with the planned route, ship's tracks, radar, and other vital information.

The ENC testbed now operates on a DEC MicroVAX II computer with 5 megabytes of operational memory plus two 70 megabyte hard discs. It is interfaced to radar via a digitizer that was developed by the McGill University Radar Observatory. It displays on a Tektronix 4225 with 2 megabytes of local memory.

The testbed can satisfy many of the International Hydrographic Organization (IHO) 2nd Draft Specifications for the ECDIS. Some of the testbed's features are:

1. colour-filled presentation of chart information;
2. optional radar overlay, plus radar recording;

3. automatic plotting of ship's position, plus track recording;
4. manual plotting of fixes, measuring bearing and distance;
5. automatic notice when approaching an area where a larger or smaller scale chart exists;
6. default presentation of minimum chart display;
7. grouped optional information such as light and buoy characteristics and anchoring information;
8. cursor call-up of individual feature attributes;
9. the ability to add "navigation notes";
10. the ability to apply hand-entered chart corrections; and
11. the ability to apply automatic chart corrections.

Although a testbed, almost by definition, is not user-friendly and can be expected to crash now and again, it was used during the North Sea Project on the Norwegian Survey Vessel LANCE, to demonstrate the potential of electronic navigation charts.

Beyond the immediate interests of the CHS, it is felt that during this growing stage of the ECDIS, while the concept is evolving, it will be very beneficial to run testbeds in nautical schools. This will introduce mariners to a completely new type of unified navigation display and will provide the CHS with feedback on how the ECDIS will be used and what types of information should be displayed.

Chart Display and Design

The function of cartographic design is to communicate chart information effectively to the user and therefore must take into account the user requirements, the anticipated level of user understanding, how the information will be used, the complexity of the information, the available display options and the cost. As a cartographic product the ENC must undergo the same detailed examination and development of design constituents as the paper chart.

In terms of designing an ECDIS, the major decisions about the graphic appearance of the ENC in relation to its content and use should come about in response to discussions between Hydrographic Offices, the chart user, regulatory bodies and the commercial ECDIS manufacturers. The preliminary development for ECDIS should involve a consideration for both the content and manner of representation.

In 1987, a small but interesting project was carried out under contract to study the effects of colour and display clutter on the user's ability to extract important information. The project concluded that the ENC might need different colours than the paper chart. It also concluded that an exact reproduction of the paper chart was far too cluttered for a video display. Text had to be about twice as large as on the paper chart and it was more suitable to have the text suppressed and selectively displayed on demand. Some symbols presently used on the paper chart were found to be unsuitable for the ENC. Also, a number of proposals were found to be completely unacceptable. For example, when buoys on the display flashed the same colour and rate as the real buoy, they were found to be too distracting.

The CHS continued to work on display and design in 1988. Under contract to the CHS, Universal Systems Ltd. investigated perception problems that an ECDIS user faces while operating the dynamic display.

The need for recognizable symbols, which an ECDIS user can quickly identify, restricted the freedom of symbol design which a cartographer normally enjoys when creating a new product. The International Chart for Symbols and Abbreviations was used to provide the basic chart symbols to be used on the ENC. An electronic version, containing all of the relevant chart symbols, was digitized to display on the ENC testbed. A balance must be struck between the minimum size at which the symbol is perceptible and the size required to demonstrate its level of importance within the ENC. The impact of changing scales while operating the ECDIS is being studied within the context of symbol sizes.

When devising new point, line or area symbols, the properties of size, form and colour have to be considered. In addition to the information they contain individually, they also present information collectively. For instance, a collection of marsh point symbols implies a 'marshy' area. Consequently, the design of symbols has to take into account their possible separation, because this will influence their appearance under varying circumstances. New symbols were carefully developed and specified in order to meet the special requirements of the ECDIS. These included radar-conspicuous objects, ship's position and cautionary-area symbols.

The different methods of displaying area features were investigated by employing various shade and tint overlays. Among the display techniques tested were varying additive tints, translucent mixing of colours, varying transparency values of colours, cross-hatch line-shading in both monochrome and colour displays, and developing a feature hierarchy for opaque layering of areas.

As part of the project a design analysis will be conducted, concentrating on the physical limitations of how human beings perceive visual information such as symbols, text, sizes, and colours used on the ECDIS. Final recommendations will be made by the Defense and Civil Institute of Engineering Medicine in Toronto, Ontario which is performing this phase of the project.

The CHS has the capability of testing ENC symbol design and the ECDIS display in a dynamic environment by modifying the ENC testbed to perform ECDIS simulations which include a radar overlay and ship's track. Simulations will be used to evaluate how a navigator interacts with the ECDIS display, how effective the information base queries are, how easily chart work is performed, and how the navigator may enter and use navigator's notes. The simulator will also be used to test an automatic "area detection" capability. This could be used for warning areas or cautionary areas and compilation scale-change boundaries. As the simulated vessel crosses an invisible boundary delimiting a warning area, the ECDIS would inform the navigator that the vessel had entered an area which requires the attention of the vessel's bridge crew.

Chart Generalization

Chart information and source data are routinely generalized when cartographers create products at scales smaller than the source documents. This necessarily involves a significant amount of time devoted to re-editing digital files to portray the information at smaller scales. The IHO 2nd Draft Specifications for the ECDIS states that six different scale ranges are desirable for ENC coverage. Without some form of computer generalization, the charted areas will have to be manually re-compiled and generalized six different times. In order to minimize the impact of producing two similar but distinct publications (the paper chart and the ECIB) the CHS must develop software that will enable the computer to aid in the generalization process.

The study is being completed, under contract, by Universal Systems Ltd. Generalization algorithms are being tested utilizing CHS digital chart and survey data sets. Results from various scale reductions will be plotted and examined. The plots and digital files will be assessed by a cartographic expert to determine whether generalization rules are properly observed and whether the generalized information set maintains safe navigation characteristics.

Specific types of symbols and generalization applications, such as line simplification, point symbol selection, hierarchical displacement/deletion of lines, and the exaggeration/deletion of closed line loops, lend themselves more appropriately to automated techniques. CARIS program modules are being used to test the following generalization conventions on CHS digital data:

1. filtering points along an incremental line to simplify its form without sacrificing its character;
2. masking incremental and point-to-point lines according to their relative proximity to each other;
3. removing short incremental lines which, after scale reduction, become meaningless;
4. removing small closed lines after a minimum area is reached within the closed feature; and
5. selecting soundings from survey data or from larger-scale chart data using sounding overplot removal techniques.

Future investigations will include feature displacement, combining chart features, symbol conversion and the development of selection and elimination rules.

Pilot Electronic Navigation Chart

The CHS must be capable of supplying official digital chart information to ECDIS vendors. The process of producing an ECIB should utilize existing digital chart information. In order to achieve this, a Pilot Electronic Navigation Chart research project has just started. Under contract to the CHS, Offshore Systems Ltd. of Vancouver, British Columbia will convert information from six digital CHS charts on the St. Lawrence River, to an ECIB format that will honour IHO 2nd Draft Specifications for the ECDIS. A preliminary ENC information set will operate on the ENC testbed. The final version will run on a commercially available ECDIS.

International standards for the content and display of an ENC are a prerequisite to a successful future for the ECDIS. This project will thoroughly test the practicality of incorporating each of the elements and concepts of the IHO 2nd Draft Specifications for the ECDIS when creating an ENC.

The CHS digital information will be converted to conform with the design of the Pilot ENC and will include the following steps:

1. organizing information into defined cells (7.5' X 7.5' lat/long cells);
2. filtering points to reduce the size of each information file;
3. building network topology and editing for closed line network;
4. adding nomenclature and chart notes in English and French (user selected by keystroke);
5. entering specific attributes for ENC information such as minimum feature display tags, navigational aids characteristics, compilation scales, prohibited and restricted area boundaries;
6. concatenating and digitally mosaicking the six chart files into one ECIB;
7. building polygon topology and adding polygon keys such as land, foreshore area and colour areas for depth ranges;
8. utilizing the ECIB to develop a testbed ENC; and
9. utilizing the ECIB to develop a manufacturer's ENC.

Updates to the ENC will be examined as part of this project and methods will be developed to efficiently communicate new information to the user while the vessel is at sea. Present data communication technologies permit the transmission of digital information to remote users. It is already possible to distribute the changes in an ECIB, but the situation is complicated by the fact that each ENC will be customized to optimize the features of the particular vendor's system. A satisfactory method of updating the ENC and effectively distributing that update to the customer is essential to the success of the ECDIS. The following types of updates will be examined:

1. correcting "point" features;
2. patch corrections less than 1 cell size;
3. patch correction for an entire cell; and
4. new edition of the entire ENC area.

The pilot ENC will be field tested on the St. Lawrence River in 1989, using the CHS ENC testbed and the Offshore Systems Ltd. ECDIS hardware. A variety of commercial and government maritime organizations will be invited to observe the trials.

CHS Information System

The need for a CHS hydrographic digital data base and data base management system has been recognized for some time. The CHS is currently developing a comprehensive Information System with a number of component data bases and information bases. Data bases are "stores of source data collected to describe or define certain subjects", while information bases are "stores of data prepared for some product." Collected bathymetry resides in a Bathymetric Data Base and collected tidal measurements reside in a Tidal Data Base. Chart files or published tide table files reside in Information Bases.

Information bases, not data bases, will be directly affected by ECDIS development. A data base will contain data that are uniquely defined by attributes describing the data and will not contain information related to the presentation of these data for specific applications or products. If such presentation criteria were mixed with the data definitions, then the flexibility of these source data bases to meet future applications would be severely compromised. It is essential that these source data bases not be customized to support any one application or display system.

The creation, maintenance and dissemination of a digital ECIB, along with continued support for paper chart products, is going to cause an increase in workload that will be difficult to support with existing resources. The completeness, accuracy and currency of the ECIBs is certainly the responsibility of the Hydrographic Offices. The expertise needed to decide what is important and what is not, resides within the Hydrographic Offices and must be used either to compile and update the ECIBs or to monitor how the tasks are performed by contractors.

It is not feasible for the Hydrographic Offices to customize ENCs for each vendor's system. As these systems develop, probably at a faster pace than international specifications for the ECDIS, the updating of these products directly by the Hydrographic Offices will become next to impossible. Third party manufacturers of ECDIS systems will acquire the ECIB information from the Hydrographic Offices and add value to the information to produce their own ENC.

ECDIS Developments in the Canadian Coast Guard

The Canadian Coast Guard uses ECDIS systems for icebreaking operations and is investigating the use of ECDIS systems for buoy positioning and Search and Rescue operations. As the Canadian representative on the International Maritime Organization Maritime Safety Committee, CCG will recommend international ECDIS standards.

An ECDIS, integrated with a precise navigation system, is undergoing trials on the St. Lawrence River. Preliminary results are very encouraging. They demonstrate that ECDIS systems significantly improve icebreaking activities. Often, icebreakers are required to work after buoys have been removed for the winter, during limited visibility conditions (such as at night or in the fog) and during tight manoeuvres. An ECDIS quickly and accurately portrays the vessel in relation to shore and navigation channels, and provides the navigator with the ability to quickly perceive the relative-position information. For Search and Rescue operations, tide, current and wind information would need to be integrated into an ECDIS display, along with the ability to establish and monitor search patterns. For buoy positioning, an accurate real-time position and a station-keeping capability are required. The ECDIS will be an effective navigation tool during these types of operations only if positions are accurate. Lower-accuracy navigation systems such as LORAN-C would not be suitable.

As a user of ECDIS equipment, the CCG is concerned about the development of standards. The First Draft Performance Standards for ECDIS, prepared by the IMO/IHO Harmonization Group on ECDIS in April 1988, were reviewed by the CCG after carrying out field trials of a prototype ECDIS. The trials showed that the ECDIS must be simple to operate and easy to update. Users preferred to use large-scale displays in harbours and for near-shore navigation. Smaller-scale displays were useful for look-ahead, route planning and long-range tactical purposes.

The First Draft Performance Standards for ECDIS describes 13 compulsory ENC display features. The CCG trials concluded that there was too much information on the display, which led to confusion during critical situations. Recommendations included re-classifying the ENC display features as 1. Required, 2. Default, 3. On-demand or 4. Not-required. Required features included coastline, isolated dangers, fixed and floating aids, boundaries of fairways and channels, and chart scale. Default features included the drying line, depth contours, cautionary notes, the routing system and restricted or prohibited areas. These features could be removed from the display and would then be available on-demand. On-demand features included latitude and longitude grid lines, radar-conspicuous objects, and units of depth and height in addition to other features listed as on-demand in the First Draft Performance Standards for ECDIS. Not-required features included ship's safety depth-contour, chart scale boundaries and a bar scale.

The results and conclusions of these trials were compiled and forwarded to the Canadian member of the IMO/IHO Harmonization Group on ECDIS.

Conclusion

The Electronic Chart Display and Information System is still in its infancy but it is growing up fast. Mariners who have used existing systems recognize the improvements the ECDIS can bring to both the safety and economic aspects of ship operations. Technological advances and the demand for the ECDIS by commercial and recreational users have already increased the demand for the Electronic Navigation Chart.

Hydrographic Offices around the world have a very small percentage of their chart information in digital form and a tremendous effort is required, not just to digitize the charts, but also to design the information bases, develop the administrative and technical infrastructure (both nationally and internationally) to transfer the information to the Electronic Navigation Chart user and, perhaps even more important, to keep it up-to-date. The Canadian Hydrographic Service and the Canadian Coast Guard have started to look at these problems but there is still a long way to go before the maritime community can set rigid specifications.

Bibliography

EATON, R.M., S.E. MASRY and B. SHAW, 1986. "An Electronic Chart Testbed", Proceedings, Hydro 86, Southampton, UK, December.

EATON, R.M., S.E. MASRY and B. SHAW, 1987. "Progress With an Electronic Chart Testbed", Proceedings, CHA/CHS Conference, Burlington, Ontario, Canada, February.

GILL, CAPT. E.W.S., 1987. "Using an Integrated Navigation System", Seaways, March.

GLAVIN, S.J., 1987. "Cartographic Design Considerations for the Electronic Chart", Lighthouse Edition 33, pp. 10-12.

GLAVIN, S.J., 1987. "The Electronic Chart: Display Design Criteria", Universal Systems Ltd. Report.

GLAVIN, S.J. and B. SHAW, 1987. "Preferred Digitizing Procedures for the Production of Charts for the Canadian Hydro-

Hydrographic Service's Electronic Chart Testbed", Universal Systems Ltd. Report.

IMO/IHO Harmonization Group on ECDIS, 1988. "First Draft Performance Standards for ECDIS", Hamburg.

International Hydrographic Organization, 1987. "2nd Draft Specifications for Electronic Chart Display and Information Systems (ECDIS)", The Hague.

KAUFMANN, R., 1987. "Colour Considerations for Electronic Charts", Technical Memorandum (HF 87/01), Defense and Civil Institute of Environmental Medicine, Dept. of National Defense, Canada.

MACDOUGALL, J.R., 1987. "A Hydrographic Information System", Lighthouse Edition 37, pp. 51-61.

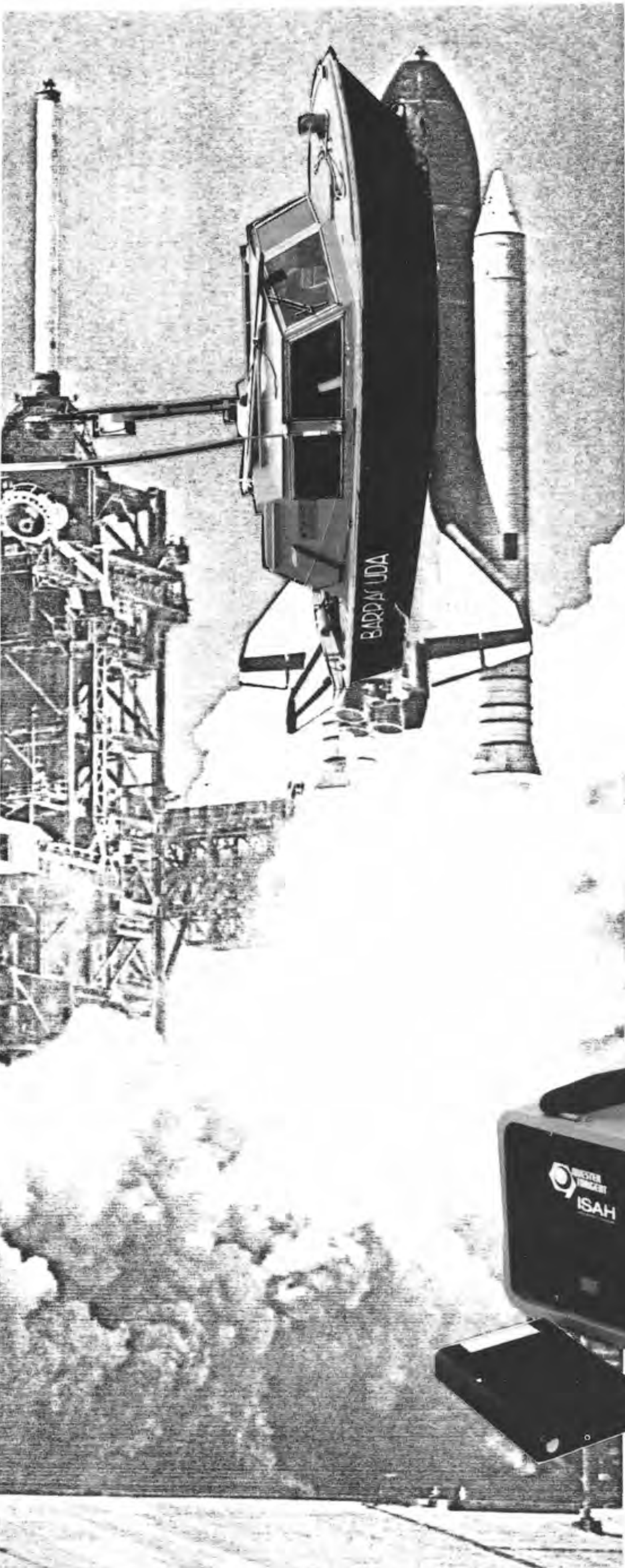
NICKERSON, B.G., 1987. "Development of a Rule-Based System for Automatic Map Generalization", Auto Carto VIII, Proceedings of the 8th International Symposium on Computer-Assisted Cartography.

Offshore Systems Ltd., 1988. "Develop and Evaluate an IHO ECDIS/CHS Pilot Electronic Navigation Chart (ENC)", Unsolicited Proposal to Department of Supply and Services Canada.

RTCM, 1988. "RTCM Recommended Standards for Electronic Chart Display and Information Systems", Third Draft Report of Special Committee No. 109, March.

RTCM, 1988. "RTCM Recommended Glossary of Terms Associated with Electronic Chart Display and Information Systems", Report of Special Committee No. 109, February.

Universal Systems Ltd., 1987. "An Introduction to Topological Processing", Technical Document No. USL 87-08-28.



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ASF Chartlets: A Picture is Worth a Thousand Numbers

by

D. H. Gray and R. M. Eaton

Abstract

After five years of producing chartlets that show the Additional Secondary Factor (ASF) only where it was actually observed in the field, the Canadian Hydrographic Service (CHS) is in the final preparation stages of publishing the ASF corrections in a contoured map format throughout most Canadian Loran-C waters. This paper discusses the method of calculating the theoretical ASF (based on certain electrical properties) and then the incorporation of 100,000 data points of observed ASF data, as well as the visual presentation in map form. The impact and usefulness of such a product will also be discussed.

Background

During 1980 and 1981, the Radio Technical Commission for Marine Services' (RTCM) Special Committee No. 75 met to discuss the minimum performance standards for Loran-C coordinate converters. One of the most significant realizations of those meetings was the need for information about the Additional Secondary Factor (ASF) of each Loran-C rate. The Defense Mapping Agency (DMA) undertook to prepare booklets of ASF predictions throughout the coastal waters of the United States. Although Canada was not bound by any recommendation of the RTCM, the Canadian Hydrographic Service felt that providing similar information to Canadian mariners was necessary. However, after discussions within CHS and with several ship's captains, we considered that a map presentation was more useful than a digital one. Our reasoning was based on such points as:

- Correction tables of Decca Fixed Errors (which are roughly akin to Loran-C ASF) published by CHS were poorly received by the maritime public to the extent that they were not used,
- the Decca Company's publication of the same Decca Fixed Errors in map form was far more readable,
- the information needed to be condensed (particularly since we intended to go 200 miles offshore),
- areas of rapid change needed better portrayal than areas of no change, and
- mariners probably have a better idea of where they are on a map than in a matrix of tabulated values.

One consideration was that we did not have a sophisticated ASF prediction package such as our colleagues at DMA had, but to more than offset that disadvantage we had an extensive data collection of observed ASF. By that time the Loran-C public was well aware of the pitfalls of using only ASF predictions as was demonstrated by the early large-scale charts near Los Angeles. We now know that phase recovery is underestimated off a rocky, low conductivity coastline and that the models also assume geometrical straight line propagation rather than wave propagation. This is particularly serious in the case of a transmission path grazing a coastline.

We had already begun making chartlets showing the actual observed ASF in the areas that we had surveyed for internal inventory purposes. Therefore, it was a relatively easy matter to improve the cartographic quality of these diagrams for publication. Over the past five years we have continued to add the new survey data to these chartlets and to publish them in a relatively timely manner.

Nevertheless, we felt that observed ASF chartlets were only an interim measure until we could provide a contoured format for the ASF correction. Now is the time to get away from interim measures and do the job properly!

Great Lakes

In the Great Lakes, we have extensive ASF observations throughout Lake Ontario, Lake Erie, Lake Huron and Georgian Bay, including the North Channel, and adequate information in Lake Superior. We also have National Ocean Survey and/or U.S. Coast Guard data provided by DMA in Lakes Ontario, Erie, St. Clair, Huron, Michigan and some very sparse data in Lake Superior. We were able to fit mathematical polynomials to this relatively dense data and present them in a contoured format on the chartlets. The preparation of the chartlets brought forth a problem that had been identified earlier in the 9960-Z ASF in Lake Huron near Point Clark where the American and Canadian data sets differed by about 1 microsec. That prompted a resurvey of the area in 1988 which has not completely resolved the problem.

Atlantic Coast & Gulf of St. Lawrence

Our data base of observed ASF in Atlantic Canada is probably our most extensive since this is a vast area; we have surveyed a great deal over a nine year period, including detailed observations in some test areas for special studies. Our surveys include the whole coast of Nova Scotia (including Sable I.), New Brunswick, Prince Edward Island, the Gaspé Peninsula, St. Lawrence River estuary, the Magdalen Islands, the Strait of Belle Isle, and selected areas of the coasts of Newfoundland. Along with this data, we also have GPS-positioned data on Georges Bank and Doppler satellite-positioned data scattered throughout the Scotia Shelf and Gulf of St. Lawrence. We have also received U.S. Coast Guard data from New York City to Grand Manan.

In support of our off-shore multi-discipline surveys which were positioned by using rho-rho Loran-C/Doppler Satellite/Doppler Sonar Log fixing, we developed an on-line Millington's Method ASF computation using the CIA digital coastline. We brought this ASF computation program into the office and improved it. We realize that there are perhaps more sophisticated ASF prediction techniques, however by using this method we have found that there is usually a systematic residual difference, around 0.5 microsec., between the computed and observed ASF that is almost a constant over a large area.

We are exploring the fact that the shape of the ASF surface is roughly correct but that the surface must be tacked down with groups of real ASF data. Because of this relationship between computed and observed ASF, we have developed a routine for applying this residual difference to the computed ASF values and to use these adjusted values as input to a lattice routine or for contouring the ASF chartlets. Subjective judgment and experience are necessary in the application of the expected differences in areas where there are no observed data. The geographical variation of conductivity, the varying amount of land, and a wrong estimate of the conductivity cause only slowly varying residual differences which can be easily handled. What cause us more trouble are:

1) the fact that our prediction model underestimates phase recovery within a few wavelengths of a rocky coast, and
2) the fact that the model treats propagation as being in a straight line rather than wave motion which bends around corners.

Pacific Coast

Our data includes detailed surveys in Georgia, Juan de Fuca and Hecate Straits and the approaches to Prince Rupert as well as off-shore data based on Doppler satellite fixing. We also received from DMA detailed surveys in Juan de Fuca Strait and off-shore data presumably based on Doppler satellite fixing. During the off-shore surveys, using the same rho-rho Loran-C/Doppler satellite positioning system, it was found that the Millington's Method ASF computation routine sometimes gave unreliable answers because of the many fiords and islands. Also the topography contributed to significant delays that were not accounted for in the ASF computations. By using only the observed ASF data, we have been able to use the same methodology as in the Great Lakes; namely, the use of polynomials to express the ASF. For satisfactory results, the data upon which the polynomial is based must be adequately distributed over the region of interest and may not be adequate for prediction in areas with no surveys and is definitely not valid close in-shore where the ASF changes rapidly due to phase recovery. There is also the inability of the chartlets to show all this detail close to shore. Therefore, some areas have been identified with the note, "Insufficient data" and have also been ear-marked for surveys.

Publication

The observed ASF diagrams have been published in a Canadian Coast Guard publication "Radio Aids to Marine Navigation" which is required on board ships under the Charts and Publications Regulations promulgated under the Canada Shipping Act. The following contoured style ASF chartlets will supersede the observed ASF diagrams in Radio Aids to Marine Navigation:

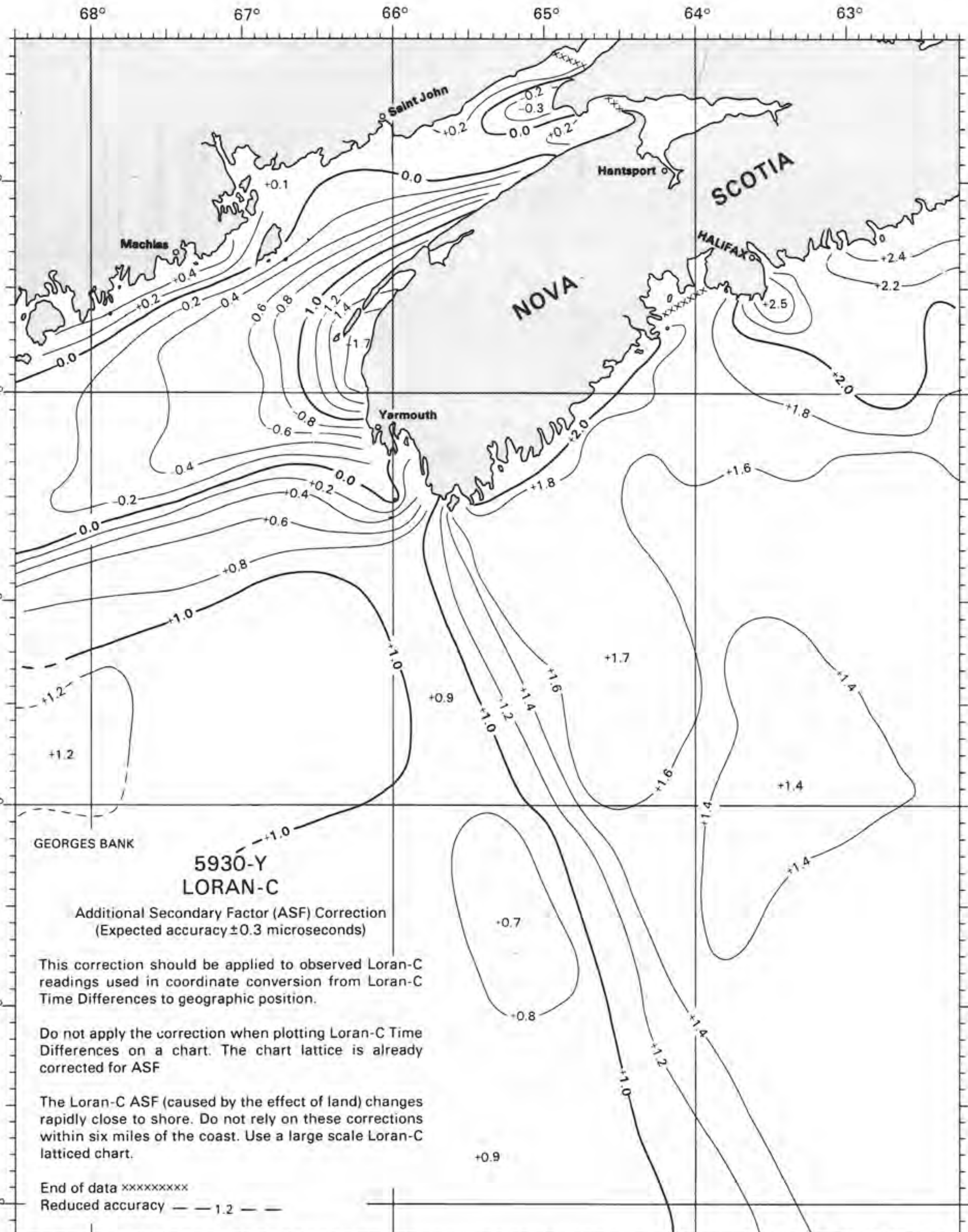
Loran-C Rates	Area
5930 X & Y	West end of Nova Scotia,
5930 X & Y	South of Sable Island,
5930 X, Y & Z	Halifax to SW Newfoundland and to PEI,
5930 X, Y & Z	West part of Gulf of St. Lawrence,
5930 X, Y & Z	East part of Gulf of St. Lawrence,
5930 X, Y & Z	Southeast of Newfoundland,
5930 X, Y & Z	East of Newfoundland,
5990 X, Y & Z	Juan de Fuca and Georgia Straits,
5990 X, Y & Z	West of Vancouver Island,
5990 X, Y & Z	Queen Charlotte Sound,
5990 X, Y & Z	Hecate Strait & Dixon Entrance,
7930 W	Halifax to SW Newfoundland and to PEI,
7930 W	West part of Gulf of St. Lawrence,
7930 W	East part of Gulf of St. Lawrence,
7930 W & X	Southeast of Newfoundland,
7930 W & X	East of Newfoundland,
7930 W & X	Northeast of Newfoundland,
8970 X & Y	Lake Superior,
8970 X & Y	Lakes Huron & Erie and Georgian Bay,
9960 W & X	West end of Nova Scotia,
9960 W & X	West part of Gulf of St. Lawrence,
9960 W,X,Y & Z	Lakes Huron, Erie & Ontario and Georgian Bay

At present, only a few of the chartlets have been prepared and are available for constructive criticism, which we would be glad to receive. We have learned that it is best to have prototypes available for such a purpose since we do not necessarily think of all aspects on the first drafting.

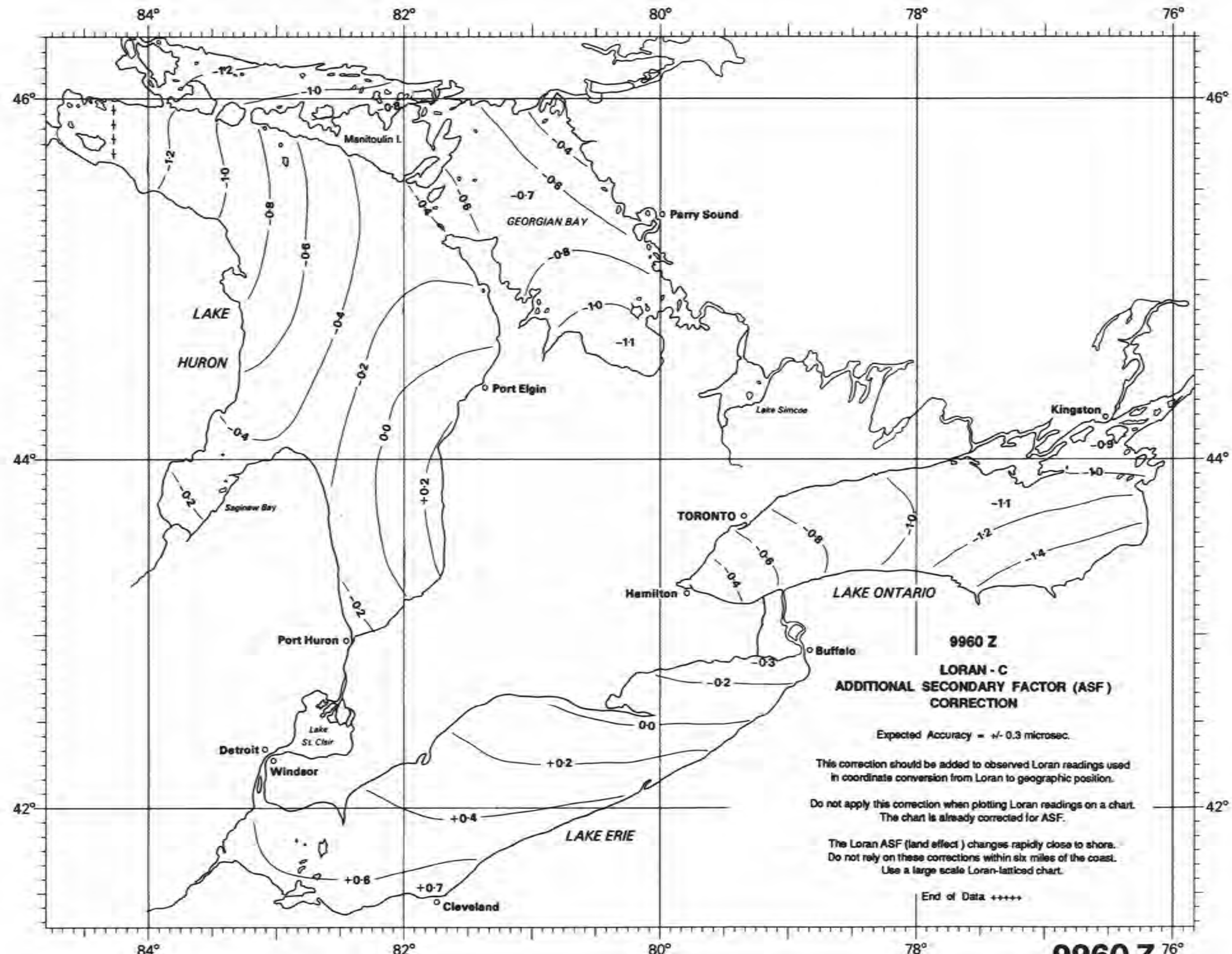
Technical Concerns

We, the authors, are very concerned with the derivation of ASF and the use of it. We are looking at Loran-C as providing a positioning capability that will complement GPS - which we believe it is capable of doing in many areas. We also foresee that at least some of the future user public will have Electronic Chart Displays and that there will be a Loran-C coordinate converter as part of the positioning system. It therefore follows that ASF data is necessary to calculate the correct position. Consequently, accurate ASF is needed to produce a position without systematic biases that can be used in conjunction with GPS data. Therefore, such matters as the knowledge of the horizontal datum of the survey, error-free survey data, the integrity of the receivers used, the Loran-C transmitters and controlling TD's being correct have to be confirmed.

We are also concerned that the prediction techniques used by CHS and by others are not sufficiently realistic. The conductivities are selected very subjectively, topography is neglected, and dispersion, because there is a faster propagation path than the geodesic line, is never considered. Yet they all degrade the accuracy unless they are thoroughly mapped and appreciated. Even after an accurate position is determined, that position may be very wrong when applied to certain charts - at least in Canada and possibly elsewhere too. This is because a number of CHS charts are based on very old surveys and the geographic grid on those charts is not consistent with any geographic grid used today - be it North American Datum of 1927 or 1983, or World Geodetic System of 1972 or 1984. In fact, we are so concerned with the possibility that a user will use Loran-C correctly, apply the ASF correction correctly and determine an accurate position but will apply that position on one of these old charts and come to grief because of the inaccuracy of the horizontal grid of the chart, that we plan to warn him that


68°
67°
66°
65°
64°
63°
45°
44°
43°
42°
41°
40°
Saint John
Hantsport
Machias
HALIFAX
Yarmouth
NOVA SCOTIA
GEORGES BANK
5930-Y
LORAN-C
Additional Secondary Factor (ASF) Correction
(Expected accuracy ±0.3 microseconds)
This correction should be applied to observed Loran-C readings used in coordinate conversion from Loran-C Time Differences to geographic position.
Do not apply the correction when plotting Loran-C Time Differences on a chart. The chart lattice is already corrected for ASF
The Loran-C ASF (caused by the effect of land) changes rapidly close to shore. Do not rely on these corrections within six miles of the coast. Use a large scale Loran-C latticed chart.
End of data xxxxxxxxx
Reduced accuracy — — 1.2 — —

5930-Y


9960 Z
LORAN - C
ADDITIONAL SECONDARY FACTOR (ASF)
CORRECTION
Expected Accuracy = +/- 0.3 microsec.
This correction should be added to observed Loran readings used in coordinate conversion from Loran to geographic position.
Do not apply this correction when plotting Loran readings on a chart. The chart is already corrected for ASF.
The Loran ASF (land effect) changes rapidly close to shore. Do not rely on these corrections within six miles of the coast. Use a large scale Loran-latticed chart.
End of Data +++++
LAKE HURON
GEORGIAN BAY
LAKE ONTARIO
LAKE ERIE
Lake Simcoe
Lake St. Clair
Saginaw Bay
Manitoulin I.
Parry Sound
Port Elgin
Kingston
TORONTO
Hamilton
Buffalo
Port Huron
Detroit
Windsor
Cleveland
84°
82°
80°
78°
76°
46°
44°
42°
9960 Z

the ASF is INACCURATE so that he is duly cautioned. Of course, the mariner using GPS will have to be similarly cautioned.

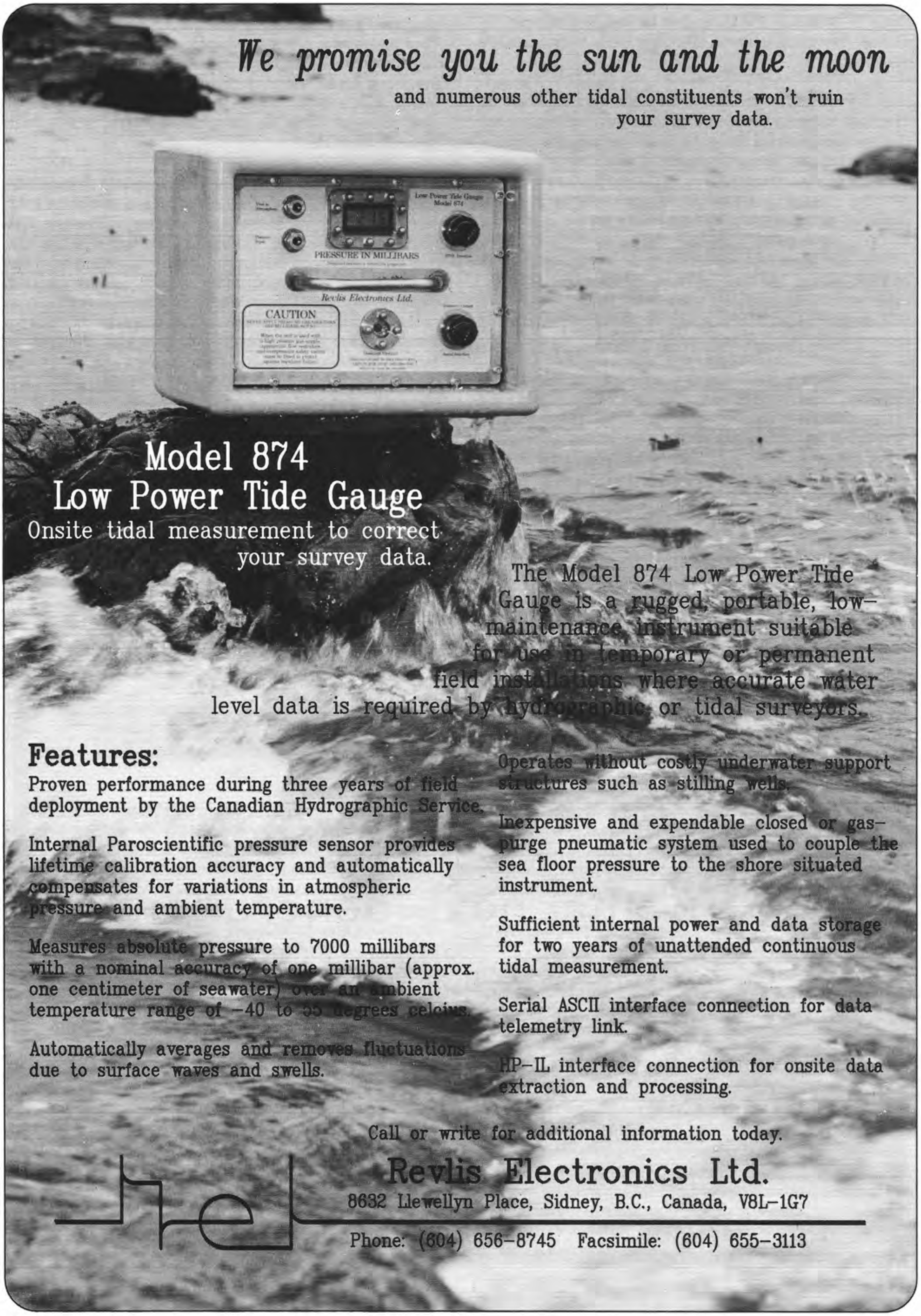
We also realize that we are preparing these chartlets at a scale of about 1:2,500,000 and at that scale we cannot display the intricacies along the coast line because detail is suppressed and some resolution is lost. Our tests have undeniably shown that there can be a rapid phase recovery near the coast of up to a full microsecond greater than that predicted by Millington's Method. Hence we are planning a caution note to go on each ASF chartlet for the near-shore effects. We suggest that the large scale latticed charts should be used instead because the rapid change in the ASF has been included closer to the shore in the lattices than in the ASF chartlets. Also, the mariner might be induced to use his radar or make visual fixes.

There is a concern that is independent of chartlet scale. It is accepted mathematical practice that the accuracy of a contoured map is plus/minus half of the contour interval 95% of the time. Therefore, by the properties of a Gaussian distribution, the standard deviation is a quarter of the contour interval; or in the case of the area from Cape Sable to LaHave River (southwest of Halifax, N.S.), the 5930-Y ASF is 2.0 microsec ± 0.05 microsec. That accuracy is equivalent to 10 metres! Or, in other terms, the thickness of a lattice line on a chart of 1:5,000 scale. This scares us because we would not think of latticing a chart at that scale! Therefore, an expected accuracy of ± 0.3 microsec is stated in the title block of each diagram. That value roughly accounts for the seasonal stability of the pattern, prediction techniques, and calibration survey accuracy. We are concerned that the mariner will select the wrong Time Difference pairs, but we also acknowledge that some manufacturers are writing sufficient software into their converters that the converter will know which Time Differences to use.

We invite you to make your comments on our presentation of the ASF data known to CHS and to express your suggestions on other forms of presentation of this data that might be useful to you. To those of the audience that are thinking of improving the Loran-C system by getting rid of the controlling monitors, we ask that you consider the fact that we have eleven years of TD calibration data at stake. Any change to the method of controlling the timing would change the location of the line of position which, in turn, changes its location on large scale charts. Also, because a timing change would allow users to select whatever station pairs they choose, there would be the additional work-load of providing the ASF chartlets for the extra station pairs.

Conclusion

The Canadian Hydrographic Service will be publishing a whole new series of chartlets in the Radio Aids to Marine Navigation publication that will show Loran-C ASF in a contoured format. We believe that the data are accurate since they are based on surveyed ASF values and that they are provided in a meaningful yet compact manner for the user.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Managing Change: A Challenge of the Information Age

by

J. R. MacDougall

Abstract

Managing the changes that will result from the Information Age as well as managing the changes that must occur to make the Information Age a reality, will present a far greater challenge to developers than the associated technical solutions. These changes are far reaching, from policies defining digital data, access to data, use of data, management of data and the dissemination of data, to the technical standardization of data bases for external access and networking, to the infrastructure needed to support such a network of Information Systems. Added to the above is the fact that change affects people, and the commitment of those affected must be secured in order to successfully implement change. All of these aspects must be considered, the required changes identified and the impact of each as well as the cost / benefits of the overall concept evaluated.

Introduction

"The majority of cases where data management efficiency did not improve as a result of data base management systems installed between 1975 and 1981 can be attributed, not to the technical limitations of the systems, but to the failure of organizations to change their mode of operation to efficiently use the new technology" [Martin, 1982]. And who controls the mode of operation of organizations? - People. The reaction of the people affected by change always contains some degree of resistance to change, fear of the unknown and emotional arguments against change that must be addressed or the most logical technical solution can still fail.

This paper will examine, from a non-technical viewpoint, the concept of data bases networked together to form Information Systems and Information Systems networked together to form Information Networks. It will examine what has been called "the infrastructure of the Information Age" and the scope of this infrastructure. It will identify some of the changes that must be addressed to make the transition from the point where it is technically feasible to create Information Networks to arrive at a level where the infrastructure is in place to support users and suppliers of data are cooperating and sharing information. The latter includes addressing the changes that affect the manner in which such Information Networks and the infrastructure needed to support them are viewed by governments, agencies with data bases and the users.

The Information Network Concept

The concept of integrated Information Systems, that allow access from any one point and almost instantaneous access to combinations of data from different data bases without the user needing to know where the data bases are located or details about data storage in these data bases, is all part of the Information Age.

What is required to make this concept a reality? Technically, it requires a communications network and data bases containing standardized data sets that can be accessed without time-consuming processing. In general, the more user-friendly the "user interface", the more complicated the underlying structure. It is technically feasible to do all of this now.

It is unlikely that comprehensive Information Networks will emerge following a purely market-driven, user-pay approach. In that scenario, data of importance to customers willing to pay for the data will be available while there will not be sufficient demand for other data to justify including it in the network. However, this other information may be crucial in presenting decision-makers in government (and industry) with the information required to make informed decisions about important issues such as the environment and sustainable resources.

Infrastructure

The overall concept does become feasible if such an Information Network is viewed as "infrastructure", similar to highways, railroads and utilities. These facilities were and are created and maintained, not to show a profit, but to be used by society as a whole and to achieve such goals as fostering commerce. These facilities are "infrastructure", paid for by taxpayer's dollars and built and maintained for the "good of all".

One high-level general analogy that has been used to promote the concept of Information Networks as infrastructure is a comparison of the situation with data bases and Information Systems NOW, and the introduction of electricity in North America in the 1920's and 30's.

D/C POWER (isolated use) (power loss over lines hence could not distribute over long distances)	**COMPUTERS** (digital files) (files tied to computer systems and applications)
A/C POWER (solved power loss) (local use-LAN)	**DBMS** (flexible & durable data storage) (various types-optimized)
STANDARDS (120V, 60 Cycle, A/C) then was technically feasible to distribute widely	**STANDARDS** -need for standards for content -need for interchange

(still no wide spread use)	standards -need for security standards
INFRASTRUCTURE	**INFRASTRUCTURE**
GOV'T used job creation to: -built roads -build hydro electric plants -build distribution lines -build DBs and Information Systems	(Can we do same for info. systems?) to build infrastructure: -develop info system standards -convert data to standards -build Information Networks (Once built: can user fees pay operating costs?)

If the standards and infrastructure issues related to Information System creation are examined, it is clear that all the agencies that collect, store and use data in the hydrographic community are a long way from standards as simple as 120 Volt, 60 cycle A/C. What can be done? With so many agencies affected, is it unrealistic to expect these agencies to arrive at standards on their own? Can these standards be considered infrastructure as can the creation of data bases and the networking of these data bases? If so, standards can be coordinated by the federal government but strong cases must be made to support this approach.

The adoption of national and international standards is probably more political than technical. In the past, the development of standards has always lagged behind the technology. In fact, they usually did not evolve until there was a large enough number of users of a technology to demand that the vendors standardize their products. In the world of Information Networks, standards are much more than technical compatibility among Information Systems. They also include data content, qualifying the data, access, security, accreditation for the use of someone else's data and a number of issues that involve people and organizations and the way each operates.

One avenue worth exploring is qualifying, quantifying and describing each data set and Information System in sufficient detail to allow interfaces to be made from a generic network to each. This can be a less threatening approach to the people managing each data base than trying to get agreement on "ONE STANDARD" for all systems that are a part of an Information Network.

In the interim, while standards are being developed, individual organizations that collect data can make an effort to ensure that data are defined as independently as possible from particular computer systems and applications. This should protect the integrity of the data contained in individual data bases and facilitate the adoption of future standards.

The idea of recognizing the creation and operation of data bases and Information Systems as infrastructure is a catchy one, and when it is combined with "job creation", it should be politically attractive. It is not difficult to generate enthusiasm about the idea of information and various combinations of information being instantaneously available to users to permit products to be made and decision makers to make more informed decisions. It is also easy to think of innovative uses for different combinations of digital data in the production of new and marketable products. The potential for creating a value-added industry can also be a selling point for treating this data base creation and Information System networking as infrastructure.

To date, the focus has been on selling the "INFRASTRUCTURE" concept at this very general level. In so doing it is far too easy to overlook the impact of this concept on the various agencies responsible for the creation, maintenance and operation of individual data bases. Even with "JOB CREATION" funding to build these data bases, the maintenance and operation of these data bases is going to have a significant impact on the manner in which these agencies now conduct their businesses. If these agencies do not have an incentive to implement the organizational and data policy changes needed to support these expanded functionalities, then the concept is doomed.

Another aspect of managing these changes that must be addressed is the availability of government assistance to data base holders and users in the conversion of data to whatever new standard is adopted. This is also infrastructure and is an additional effort that these data managers may have to make to satisfy the concept of Information Networks that they may not have had to make to satisfy their own mandate.

Impact On Organizations

Let us examine this impact. At the level of individual data bases, there is a tendency to view the ever-increasing volume of digital data to be managed as an overwhelming problem. When the ability to collect more and more data about any one subject is combined with new and unanticipated uses of the digital data, the data managers of individual data bases are faced with a number of dilemmas, such as:

- how much data must be stored?
- why should certain data be stored?
- who are or will be the users of these data?
- where do I find the computers, software & communications facilities?
- who will manage the data? -be the system operators?
- who will pay for the cost of this data management?

The last issue is of great importance to these people and must be considered when infrastructure is addressed. It is particularly relevant when we, who have a vision of a future integrated Information System, must sell those agencies who are responsible for the individual data bases on the "future benefits" of expending extra effort to collect, store and manage more data now than is needed to fulfil their immediate mandate, just because these data may be useful to others in the future.

Policy and Procedures

To have individual data bases standardized and networked to support the level of service envisioned by this Information Network concept, it is necessary to consider not only the cost and effort required, but also the policies, procedures and possible organizational changes within each agency that will be required to adjust the current mode of operation and existing mandates to meet this challenge.

What is the magnitude of the "INVESTMENT IN THE FUTURE" required to make the concept work? It is possible to identify specific requirements for each task, if the tasks are divided into the following headings and expanded. The issues raised may or may not apply to individual situations but they are raised to emphasize the breadth of the issues to be considered.

Data Collection

Policies may be required to define the "official" status of digital data relative to the hardcopy products such as a return of survey plan, or a cruise report, or the results of analysis on the data that are the "official" output of these agencies now. Procedures will be required to define how to accomplish the tasks that must be performed to fulfil the policy requirements.

Data Validation

The old saying, "garbage in-garbage out" applies more than ever to the digital world. Validation must be recognized as a major but essential task, if users of an Information System are to have confidence in the integrity of the data. The achievement of this objective may require policy changes to identify such issues as including accuracy factors, the power of validating teams to accept or reject data and new data superceding old. Procedures may be required to define how a policy such as "superceding" will be applied and who will apply the policies. Identifying resources to do these tasks may require an examination of the organizational structure of agencies and a possible re-allocation of resources.

Computer Systems

There are a number of important issues to be considered regarding the hardware and software associated with data management. The normal emphasis is placed on storage, speed of processing, number of users and performance expectation of users. There are also cost factors that should be weighed when deciding how an agency will operate in the Information Age. These include the cost to purchase hardware and software, an annual maintenance cost (between 10% and 15% of the purchase price of the hardware and software), amortizing the cost of the system over 3 to 5 years, and planning for replacement hardware as well as identifying the resources required to maintain and operate the system.

For example, if a $500,000 hardware and software system is purchased for data management, maintenance will cost $50,000 to $75,000 a year, $100,000 a year should be set aside for replacement costs at the end of 5 years, and operators will cost in the range of $90,000 annually. These annual costs of $240,000 to $265,000 must be considered when establishing policies regarding the number of sites to install as well as whether to purchase, lease or use service bureau systems. Once distributed sites are established, communication costs must also be considered in addition to similar annual costs for each site.

Data Management

Hydrographic Offices must address a number of technical data policy and organizational issues associated with the management of data. These include: what data will be stored, what data will be kept on-line and off-line, what level of access will be supported, and what performance level (response time) the system will support. Polices and procedures are required to define how and when the data bases will be updated and the superceded data archived. Once again the most important issues are organizational:

- Where does data management fit into the organizational chart?
- Can personnel be re-allocated / retrained to support data management?
- What is the impact on other projects of re-allocating resources to data management?

Access / Preparation

For a digital data base (or Information System) to be useful, it must be possible to extract the data required and to prepare them in the form of an end product such as a map, chart or report that is required by the end-user. How much of this preparation is done by the Hydrographic Office is a policy issue. It is possible to say to end users - "here are 1,000,000 soundings, some shoreline, etc. Take it away and make your product at your own scale, projection and density". Or, the Hydrographic Office may want to retain control over compilation of "information bases" for specific products such as the Electronic Navigational Chart (ENC). How will these data be disseminated? Who will update these information bases and the resulting products? Will external access be supported? Will Ad Hoc queries be supported? Policies and procedures are required in this area.

The decisions made regarding the issues raised above will impact the policies and procedures required to support the chosen level of response and the resulting resource re-allocation. Are there resources now being expended to support a similar function in the analog world? Can they be moved and retrained to support the Information Network concept in the digital world? The technical support of the management of digital data bases and Information Systems must also be addressed.

The Canadian Hydrographic Service considers Data Validation and Preparation routines and procedures as having equal importance with Data Management. No matter how elegant the data management process becomes, it will be of little benefit without a means of ensuring that valid data are entered into the systems and that data can be extracted and manipulated into information products in a form acceptable to the user.

Magnitude of Effort

The number of data bases shown in Figure 1 indicates the number of times the effort required to address the issues raised above must be multiplied to build an Information System for even one organization such as the Canadian Hydrographic Service (CHS). If this is then multiplied by the number of Information Systems that must be networked nationally into the concept of an Information Network, it is possible to get a feel for the magnitude of the effort required to set up and operate such a network. In the case of CHS more than 10 data bases were identified for inclusion in an Information System to support the current product, the paper chart.

The networking of these data bases is further complicated by the fact that not all fall under the jurisdiction of CHS. Some of these external sources are digital, others are not. While the actual interfacing of these data bases is a technical problem, convincing other agencies to supply validated, up-to-date digital data implies inter-agency negotiations regarding policy and all the side issues associated with this, such as:

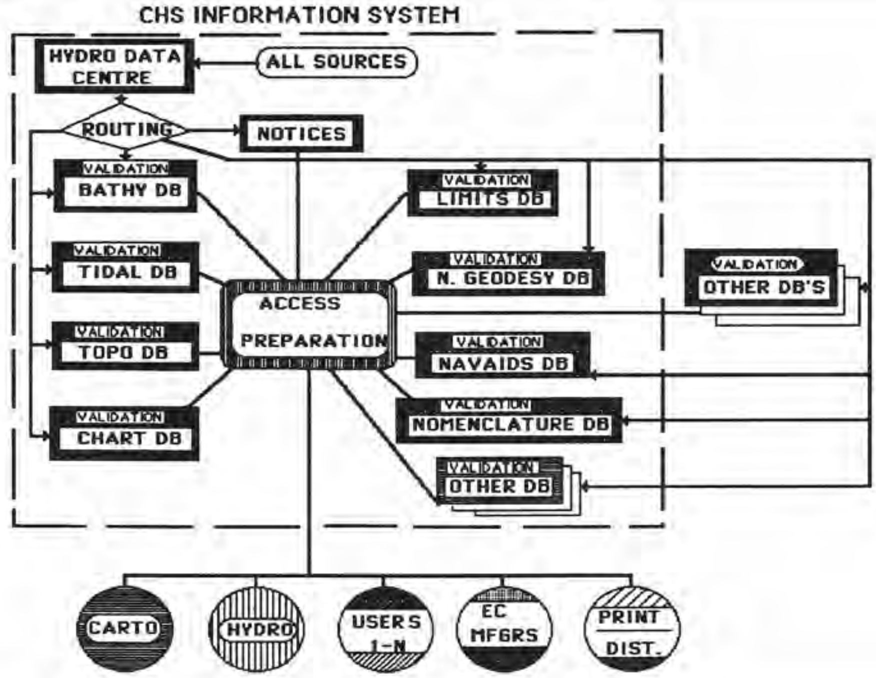

Figure 1

- protection of turf
- differences in data management philosophies
- different operational requirements
- different mandates
- who pays the cost of making these data accessible?

It is possible to draw a number of analogies related to digital data and data management. The problem of managing an ever-increasing amount of digital data has been compared with the slaying of a multi-headed dragon [Kerr & Varma, 1987]. However, from an organizational and policy point of view, it is possible to think of data management not as a knight out to slay the dragon but more as an octopus (Figure 2) with arms extending into all parts of an organization and even into other organizations. As such, data management tends to cross internal political boundaries and perhaps even extends to external data bases, thus encroaching on areas of responsibility and possibly treading on a few toes along the way.

To successfully implement an Information Network implies agreement among the various components of each organization regarding such issues as the use, liability for value-added products, and availability of data. When multiple agencies are involved, the complications could result in increased resistance to the concept and its implementation. Therefore, diplomacy and negotiation skills are at least as important as technical "might" in meeting the challenge of the Information Age.

Conclusions

The concept of national and international Information Networks that can be accessed by many users is exciting and the benefits of such networks in supporting applications such as informed decision making, a value added industry and integrated end products can all be identified. This is technically feasible now. A plan needs to be developed to secure the financial and organizational support required to make this concept a reality.

One approach to financing such a network is the concept that Information Systems are INFRASTRUCTURE. Infrastructure must include the adoption of standards for both data content and data interchange and it must also be extended to the conversion of data to standard forms and the creation and operation of individual data bases. Without this support, the task of coordinating standards and convincing people to change their mode of operation will be most difficult.

This paper has pointed out the level of effort needed to support individual data bases to illustrate the possible impact that the concept of Information Networks may have on organizations such as the CHS. These costs and benefits must be weighed and decisions made as to how to best manage change. If the agencies affected recognize that these changes are infrastructure and promote that fact, it can lend support to the overall concept.

A major challenge in managing the changes identified will be convincing governments at all levels that data are assets that should be managed, and because access to information will permit them to make more informed decisions, there will be long term benefits to building this information infrastructure. Because such an Information Network will benefit all society, governments have a responsibility to fund the creation, operation and maintenance of these data bases and communications networks.

The policy, procedural and organizational changes needed to support data management are as important as the technical solutions to networking data bases into Information Systems or Information Networks.

In the long term, information must be regarded as as an asset and this asset must be managed. Policies are required NOW to ensure that the necessary steps are taken

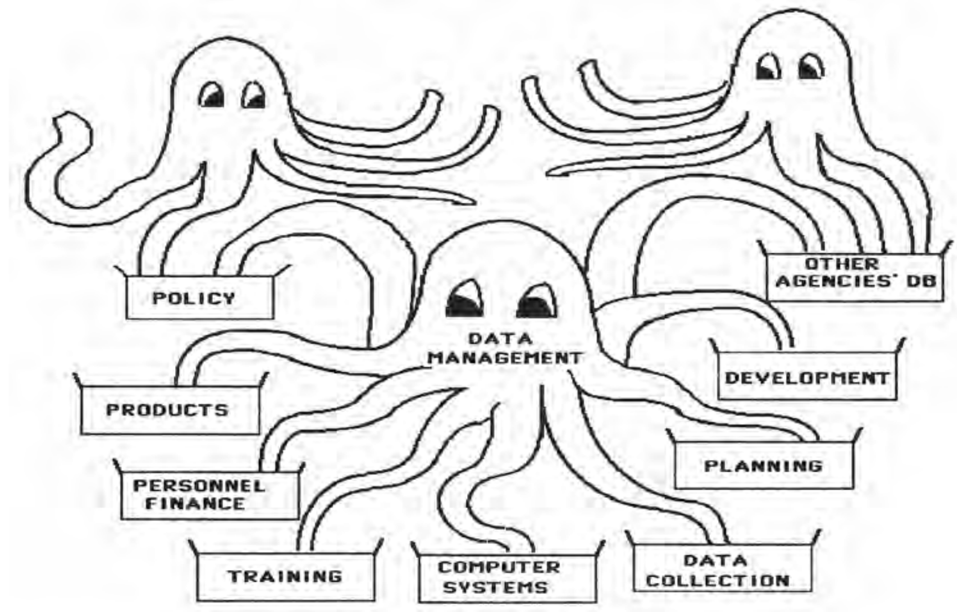

Figure 2

to make these data accessible and useful for future applications. It is recognized that there will be an added cost today, but it must be regarded not as a burden but as an investment in the future.

The commitment of the people involved in the organizations that will be a part of this Information Network must be obtained if the concept is to succeed. One way of gaining that commitment is for management to show leadership by clearly stating a belief in the concept and enacting the policies and procedures necessary for its implementation. This should be accompanied by involving the people affected in the planning and implementation of the changes so that the project will become their project. Selling the concept to these people involved at the detailed level may well be more of a challenge than promoting the overall concept at a more general level.

References

MARTIN, JAMES, "Corporate Data Base Strategy", James Martin Advanced Technologies Video, DELTAK, 1982.

KERR, A. and VARMA, H., "Hydrography and the Digital Era", 13th International Hydrographic Conference, IHO, May 1987.

Lighthouse Puzzler

by

B. Weller

Four exceedingly senior hydrographers (one of them is Tony) are doing surveys using various ships. As it happens each of them chose to use a different positioning system. The Dominion Hydrographer wants to know their full names and who is using which positioning system on the various ships but he's lost the memo. Can you tell him?

The clues:

1. Denis (who does not use Sat-Nav) is on the Bayfield.
2. Earl and Power and the hydrographer who used the Baffin all like beer.
3. Only one hydrographer has the same first and last initial.
4. Elliott and the man with LORAN-C and the Baffin all left the dock at the same time.
5. Paul and Dixon and the hydrographer who is on the Bayfield don't use Navitrack.
6. The ship with Sat-Nav and the Bayfield and Thorson all stop for lunch.
7. The Loran-C that Earl used was not on the Tully.

Good luck! If you need help with the solution, turn to page 45.

	Dixon	Elliott	Power	Thorson	GPS	LORAN-C	Navitrack	Sat-Nav	Baffin	Bayfield	Tully	Lauzier
Denis												
Earl												
Paul												
Tony												
Baffin												
Bayfield												
Tully												
Lauzier												
GPS												
LORAN-C												
Navitrack												
Sat-Nav												

Denis ______________ used ______________ on the ______________

Earl ______________ used ______________ on the ______________

Paul ______________ used ______________ on the ______________

Tony ______________ used ______________ on the ______________

Canadian Preparations For The Swath Sounding Era

by

P. Kielland and P. Hally

Abstract

A brief review of some of the measurement principles used in acoustic total bottom coverage sounding is presented. The advantages and disadvantages of multibeam and interferometric swath sounders are discussed and their complementary nature is highlighted. Canadian developments in swath sounding hardware and their integrated deployment are reviewed. The systems described include the LARSEN laser bathymeter, the F.G. SMITH dedicated sweep vessel and the swath guidance options of the ISAH data logger. Improved methodologies for total bottom coverage sounding surveys are discussed which involve the application of geostatistics, image processing and expert systems to field sampling techniques and data processing.

Introduction

The Canadian incentive for using total bottom coverage (swath) sounding techniques is similar to that affecting any other maritime nation: the well-managed and safe exploitation of our natural resources. Within this global goal are a number of sub issues where swath sounding technology can play an important role.

Our continental shelf is one of the largest and potentially richest in the world. Surveying this immense area is complicated by the northern ice pack which severely limits the navigation season and this in turn demands that surveys must be extremely productive if the job is to be completed in a reasonable time frame.

A problem with traditional hydrographic surveys is that not only are they slow, but they don't measure enough physical parameters to fully assess the natural resources. For this reason, multi-disciplinary survey cruises are required in order to take full stock of maritime resources. To maximize the benefit of the multi-disciplinary approach, total bottom ensonification from swath sounders is required since this allows profile data from oceanographic and geophysical measurements to be interpolated with the greatest degree of certainty.

Total bottom coverage sounding is also necessary in shallow waters so as to provide the security to navigation without which the exploitation of any of the offshore resources would be impossible. The combination of GPS positioning and powerful microcomputer display systems will soon make electronic charts a practical reality. This will be a mixed blessing for hydrographic services around the world since the new navigation and display technology will perhaps inspire navigators to have too much confidence in the old hydrographic data which underlies their new electronic chart. The only course of action open to the hydrographic community is to upgrade the quality of the hydrographic data set to meet modern confidence requirements. Swath sounding provides the ultimate means of providing the required safety margin at an acceptable cost.

General Principles of Swath Sounding

Before touching on some of the swath sounding developments that we are working on, a short generic comparison of the different types of swath (multibeam) sounders is in order.

When all the available swath sounders are presented in a comparative table, they can be roughly grouped according to one of two measurement principles as well as according to their depth capability.

Depth capability is mainly a function of the acoustic frequency since absorption in the water column increases with the square of the radiated frequency. Thus we see that low frequencies (10-15 kHz) are used for deep ocean penetration, medium frequencies (30-90kHz) are used between 500 and 1500 metres and high frequencies are used for shallow water work. The main advantage of high frequency sounders is the relatively small transducer size that can be used to achieve the degree of beam forming required to achieve a desired bottom resolution.

The two basic swath sounding measurement principles in use are multibeam and interferometric. The multibeam sounding principle is conceptually simple, however the transducer engineering required to achieve today's high performance beam forming is anything but simple. The multibeam principle has stood the test of time and has produced accurate and reliable bathymetry.

The other design principle is that of the interferometric swath sounder. This is a relatively new and untested principle however the initial results are very promising indeed [3][4]. In a nutshell one could say that the interferometric swath sounder is simply a side scan sonar that can detect the angle of arrival of incoming acoustic energy.

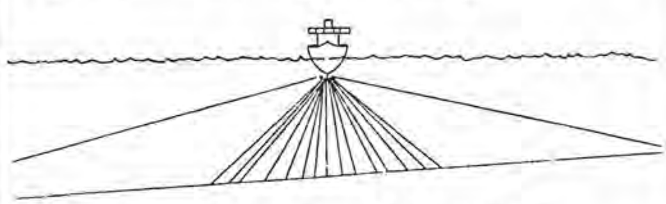

Figure 1: Fan-shaped Acoustic Beam
From: SIMRAD Subsea A/S, Preliminary Information on Interferometric Extension for the EM-100, March 1988

A side scan sonar emits a fan-shaped acoustic beam. This pulse is reflected by the bottom topography and returns to the transducer where it is seen as a waveform. This waveform represents the reflectivity of the bottom along the ensonified profile. The time of arrival along the waveform represents the slant distance to each point along the scanned profile while the intensity of the waveform indicates the bottom reflectivity (a function of angle of incidence and bottom material).

The side scan sonar cannot measure depths since only one polar coordinate (range) is available for each point along the waveform. The angular coordinate needed to position each point along the waveform can be supplied by using an interferometer to rapidly measure the angle of the acoustic energy as it arrives back at the transducer. The interferometer senses the instantaneous difference in phase of the acoustic energy. The depression angle theta is observed by observing when reinforcement occurs between the hydrophones. For reinforcement to occur, $n\lambda = d \sin \theta$. The phase ambiguity n can create some headaches, however by differencing multiple interferometers from three hydrophones this ambiguity can be resolved and the depression angle measured to within about 15 minutes of arc.

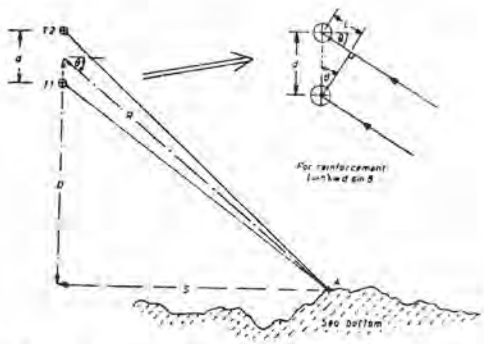

Figure 2: The geometry of an acoustic interferometer to measure the depression angle θ

From: Cloet, R.L., Dr. S. L. Hurst, Dr. C.R. Edwards, P. S. Phillips and A. J. Duncan, 1982, 'A Sideways-looking Towed Depth-measuring System, Oceanology International, Brighton, pp 411-420

A fairly serious drawback to the geometry of the interferometric principle is evident. Directly underneath the transducers, the bottom echo returns from many points at virtually the same time. This time-compression of the sidescan return renders discrete sampling of the waveform impossible and thus creates a blind zone near the ships track extending out perhaps 30° either side. The interferometric angle measurement becomes possible further away from the ship's track since the return from each target along the profile arrives in sequential order and can thus be discreetly sampled.

Both the multibeam and interferometric measurement principles are subject to errors due to un-modeled refraction. Angular measurement errors produced by both systems degrade the depth accuracy as the cross-track distance increases. And the maximum cross-track range of both systems is ultimately limited by lack of a backscattered signal due to a small incidence angle.

The multibeam sounder is generally hull-mounted which makes positioning of the bathymetry and manoeuvring the survey vessel in shallow water quite straightforward. Interferometric sounders are generally mounted on a towfish. This complicates the positioning of the bathymetry as well as the manoeuvring of the survey vessel however it also means that the equipment is easily transported from one survey vessel to another.

The interferometric swath sounder has a few other potential advantages over the multibeam sounder. The cross-track resolution is limited only by how fast the received waveform can be sampled and processed. This high resolution capability is a mixed blessing since very intensive number crunching is required to handle all the incoming phase observations.

Another benefit of the interferometric principle is that a side scan image of the surveyed swath is also produced in conjunction with the bathymetry. This map of reflectivity can be registered with the bathymetric contours and together they provide an excellent interpretive tool for identifying targets and bottom composition.

Perhaps the most attractive benefit from interferometric swath sounders is their potential for sounding very wide swaths. Swaths up to 8 times the water depth have been measured in shallow water using the interferometric principle whereas multibeam swaths are limited to 2 or 3 times the water depth. Since survey productivity is directly proportional to swath width, this is a crucial statistic.

It should be noted however that the inherent simplicity and proven track record of the multibeam sounder might be considered to produce more accurate results than the interferometric sounder. Since the multibeam sounder measures close to the ship's track and the interferometric sounder provides data further from the ship's track, the ultimate solution would be to combine the two complementary principles in a single survey instrument.

Development Efforts and Future Plans in Canada

CHS has carried out two major development projects over the last decade which have resulted in new swath sounding hardware. The first is the Larsen laser bathymeter and the second is the dedicated acoustic sweep vessel: the F.C.G. Smith. Both of these systems are now performing production surveys and meeting or surpassing their work quotas. It is not our intention here to provide a lot of detail on either of these systems since they have been presented in previous papers [5][6].

The Larsen bathymeter was developed largely in response to the need for very rapid surveying during Canada's brief arctic summer. The Larsen is basically an airborne multibeam swath sounder. A single laser beam is rapidly scanned from side to side as the aircraft advances firing 25 times per second. Each laser "ping" traverses the air column, the water column and back to the aircraft where the reflected waveform is sensed. Ninety thousand such waveforms are digitized per hour which when analyzed provide depth accuracies comparable to acoustic sounders down to about 30 metres in clear water. This results in a horizontal groundspacing of about 30 metres between soundings. We are planning to upgrade the laser firing rate from 25Hz to 100 Hz which will increase the sounding density.

The F.C.G. Smith uses thirty-three echo sounders mounted on extendable booms and across its catamaran hull to give a 44 metre wide total bottom coverage. A typical day's work for the Smith might involve logging up to half a million soundings. This has been the third field season for the F.C.G. Smith and is the first time that it has been used in conjunction with the Larsen laser bathymeter.

These two systems appear ideally suited for working together for rapid coverage of complex inshore areas. The Larsen coverage can very quickly identify shoal areas but the 30 metre sample spacing obviously provides insufficient confidence that the shallowest depths have been surveyed. The Smith is deployed so as to acoustically sweep the shoal areas identified by Larsen thus providing 100% confidence in the results.

The complex processing involved in reducing the laser return waveforms makes it desirable to have high quality ground truthing for the laser bathymetry, particularly until we gain more operational experience with the Larsen system. As the Smith travels from shoal to shoal in the area scanned by the Larsen, it maps out narrow bands of ultra high density data which are ideal for verifying the relatively sparse Larsen data. It also provides an opportunity to obtain soundings in areas where the laser scans couldn't penetrate to the bottom.

The Canadian Hydrographic Service has purchased a Simrad EM-100 multibeam sounder which is currently being installed aboard the 37 metre survey ship L. M. Lauzier. Since the transducer represents only about 10% of the total system cost, a second transducer has been purchased and will be installed aboard a new 51 metre survey ship which is presently under construction. Installing a transducer in each survey vessel makes it feasible to deploy the sweep system aboard either ship simply by transporting the electronics modules.

Next field season we expect to deploy the EM-100 in conjunction with the Larsen and/or Smith. The Simrad's role will be to complement and extend the coverage provided by the Larsen and Smith systems into deeper water (up to 500 metres).

One interesting new option which has recently been announced by Simrad is the Interferometric Sonar Extension for the EM-100. The ISE option combines the advantages of multibeam and interferometric sonar into one hull-mounted unit and almost quadruples the total bottom coverage width in shallow water from 2.3 times the water depth to 8 times the water depth. Once we have gained sufficient experience with the basic EM-100, the ISE upgrade will be seriously considered.

Another Canadian hardware development which can be used to facilitate swath sounding is the ISAH data logger. This is a highly ruggedized logger which incorporates a Motorola 68020 microprocessor and 68881 math coprocessor. A variety of real-time navigation functions are performed in conjunction with very flexible input/output and logging capabilities. We could have over 40 of these loggers by next field season which will continue the standardization of methods used within CHS and facilitate the training of personnel.

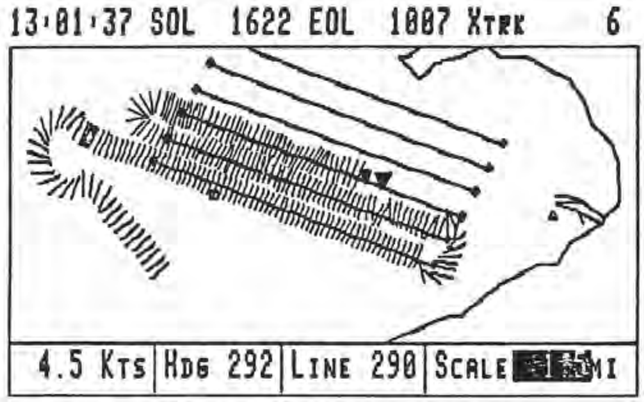

Figure 3: ISAH screen dump
From: Quester Tangent Inc.

The helmsman has at his disposal a real-time display. In this particular display mode (see figure 3) pre-digitized coastline can be shown on screen as well as shore control, targets from a database, waypoints and survey grids. Three other screen modes are provided. One is optimized for following a single line. Another mode displays a polar plot which allows the hydrographer to instantaneously plot the current depth onto the helmsman's screen in a sort of real-time version of cartography. A "virtual buoy" can also be instantly thrown on to the screen to aid the helmsman in examining a target. The other available screen mode allows the error ellipse which results from a least squares solution of up to 16 LOPs to be plotted in real-time.

The feature of interest for this discussion of swath sounding is the real-time swath coverage which can be displayed to the helmsman. The width of the cross-hatching shows the swath coverage and is presented at the correct scale with respect to the actual bottom coverage being obtained. If a constant swath width is being obtained, such as in the case of a survey using the Larsen or the F.C.G. Smith, then the user can enter the fixed swath width and it will plot correctly. If a depth-dependant system such as the Simrad EM100 is being used, then the plotted swath width is dynamically adjusted to port and starboard based on the latest EM100 data record. As the ship enters shallower water the plotted swath width will decrease so the helmsman can take immediate action to steer the vessel for optimum swath overlap. The ISAH can also handle two separate vessel icons on screen at the same time: one for the track and coverage of the main survey vessel and the other for that of a towfish if one is being deployed and positioned.

Geostatistics and Processing Developments

Having had some experience with hardware capable of total bottom coverage sounding, it quickly became apparent that perhaps the biggest challenge was not collecting swath bathymetry but knowing what to do with it once it was measured. The over-redundant nature of total bottom coverage sounding is a double-edged sword in that while it does indeed vastly improve the confidence that we have in the bathymetry, it is easy to be overwhelmed by the sheer volume of the numbers. The word "confidence" is the keyword here and has caused CHS to become interested in the field of geostatistics.

We see geostatistics as a possible method of ensur-

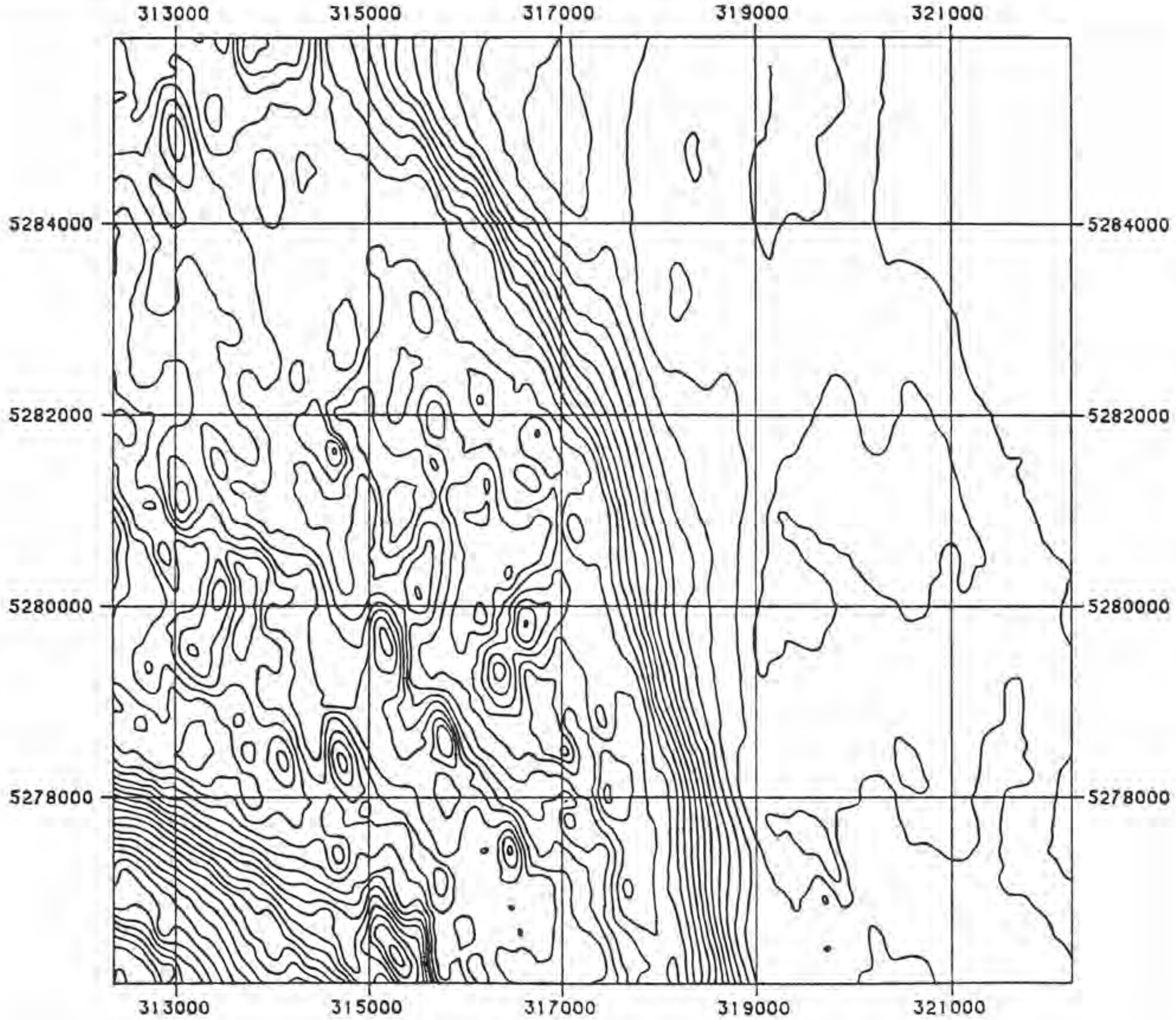

Figure 4: Map of the test area (Iles-de-la-Madelaine)

ing that we are not simply generating a large quantity of numbers but that we are generating a certain number of numbers, each with a quantified and realistic level of confidence. In this way hydrographic surveys could be planned and classified in much the same manner as geodetic surveys. For example, by employing geostatistics and appropriate sampling techniques, first order hydrographic surveys might provide an uncertainty between the soundings of ±2dm. while a third order hydrographic survey might only provide a confidence of ±5dm.

The field of geostatistics was developed largely in response to the needs of the mining industry. The mining industry has a lot in common with hydrography in that they also are using sampling techniques to map out geological features. In our case we are interested in seafloor topography whereas mining engineers are interested in the topography of an ore body. Since each "sounding" made by a mining engineer is a bore hole costing thousands of dollars, they were driven to find a way to optimize the density and placement of their sample points so as to obtain the maximum information from the minimum number of samples. The technique they developed is known as "kriging", named after Mr. Krige who invented the technique. French mathematicians have done much of the development work in kriging and the French Hydrographic Service has been involved in some pioneer efforts in applying kriging to hydrography [7][8].

Overview of Kriging

Kriging is an optimal estimation technique used to interpolate between discrete sample points of a semi-random type of surface (such as topography, bathymetry, ore sample data and meteorological data). Of interest to hydrographers is the fact that kriging honours the data points. This means that the observed depth soundings are held fixed and not adjusted to fit some ideal mathematical surface.

The concept of kriging is based on using subsets of the observed spatial data (soundings for instance) to evaluate the "roughness" of any given piece of terrain. This roughness evaluation is expressed through the semi-variogram. The curve of the semi-variogram graphs the distance from any of the observed data points (the X axis) against the expected accuracy with which a value could be interpolated at that distance (the Y axis).

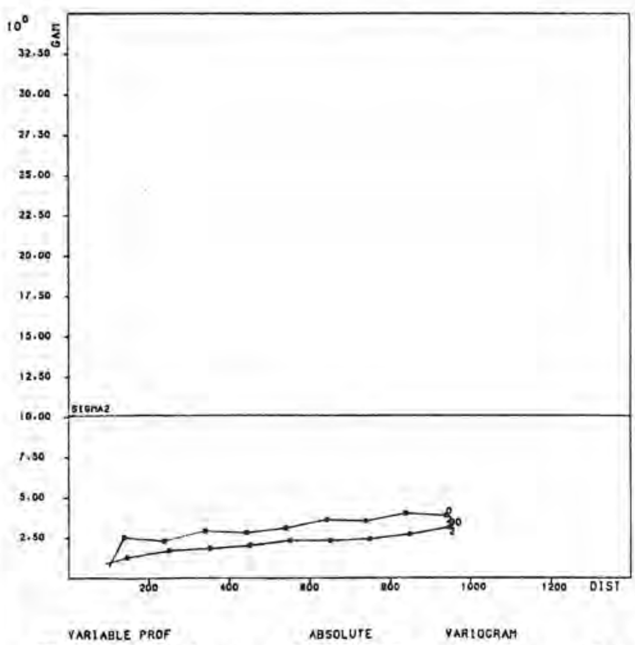

Figure 5: Variograms from E-W and N-S reconnaissance lines (1600 metres apart in the shoal area)

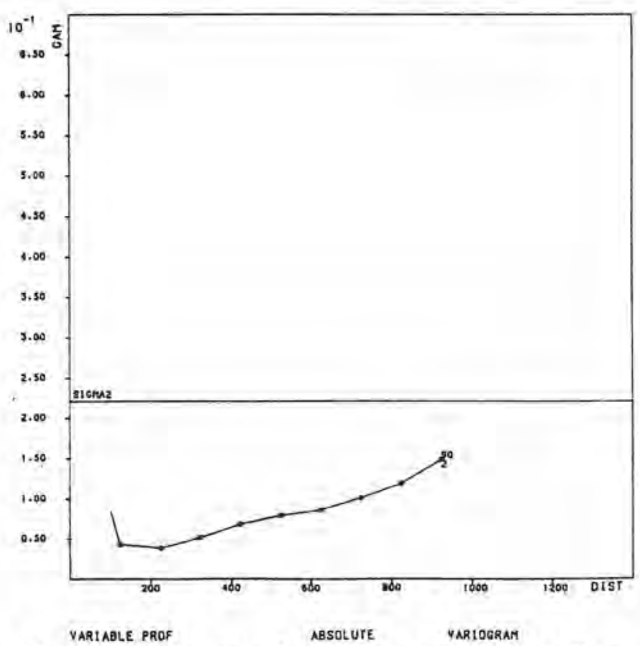

Figure 6: Variograms from N-S reconnaissance lines (1600 metres apart in the flat area)

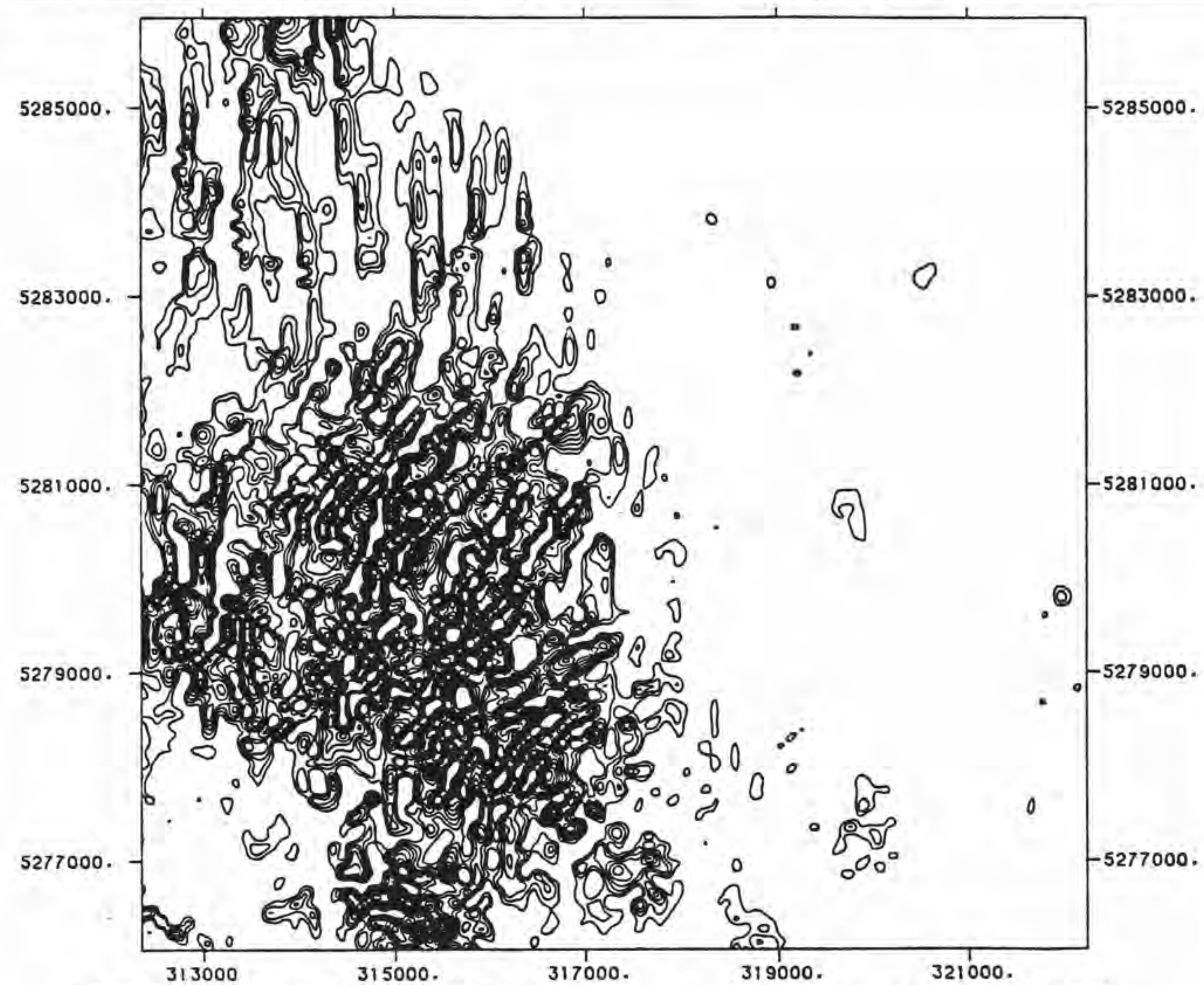

Figure 7: Variograms from E-W and N-S reconnaissance lines (1600 metres apart in the shoal area)

Figures 4 through 7 From: Dagbert and David: Report on geostatistical trials with bathymetric data from CHS, Geostat Systems International, July 1988

The semi-variogram is of interest to hydrographers since the danger of shoals going undetected between the sounding lines increases as the terrain gets rougher. The value of the semi-variogram can be used to quantify how "dangerous" a given line spacing is at any given location. Conversely, the semi-variogram can be used to determine what line spacing is appropriate for a given sample area in order to arrive at predetermined confidence levels as expressed by the estimation variance.

Figures 5 and 6 show semi-variograms computed from recent hydrographic data obtained in two adjacent regions near the Iles-de-la-Madeleine in the Gulf of St-Laurence [13] described in Figure 4. Figure 5 shows two semi-variograms computed in the NE-SW direction and the NW-SE direction using a small set of data from a zone of rough terrain. The different levels of uncertainty are due to pronounced anisotropies in the area (ridges running NE-SW). Figure 6 is the semi-variogram sampled from smooth bathymetry a few kilometres away. The estimation variance is about 3 times as high in the zone where many shoals were present as in the area where virtually no shoals were present yet our standard survey sounded both zones using the same 100 metre line spacing. These graphs simply quantify what hydrographers know from common sense: sounding effort was wasted in the smooth area that would have been better spent in the rough area.

Line Spacing	*Standard Error of Depth Estimation (shoal Area)*	*Standard Error of Depth Estimation (FlatArea)*
3000m		0.5m
1600m	1.9m	0.4m
400m	1.6m	0.2m
200m	1.5m	0.1m
100m	1.1m	0.1m

The mechanics of interpolation by kriging employ a combination of deterministic and stochastic elements to arrive at each interpolated value. The deterministic element is simply the interpolated value which would result from an unweighted least-squares surface fit to the data points. The stochastic element is furnished by the value of the semi-variogram at the grid position where we wish to estimate a value. The variances read off the semi-variogram are used to create a realistic covariance matrix derived from the actual roughness of the area being considered and thus propagate good error estimates for each of the interpolated values.

Therein lies the attraction of kriging to hydrographers. The estimation variances which result from kriging can give an excellent and objective indicator of the completeness of the observed subset of the bathymetry with respect to the total bathymetry. Each interpolated depth value has a computed estimation variance or confidence value associated with it which can be mapped and contoured in exactly the same way as the interpolated depth values themselves.

Figure 7 shows the map of actual errors that would have occurred for the Iles-de-la-Madeleine survey if we had used a 1 kilometer line spacing throughout the whole survey area. It results from differencing the kriging-interpolated depth grid from the total surveyed data set. The two different zones of bottom texture are clearly discernable in this map. It's clear that the semi-variograms of figures 5 and 6 would have been useful in selecting appropriate line spacings for each zone.

Potential Applications of Kriging

(1) Adaptive Sampling

The potential for using kriging to improve both the quality and the efficiency of any type of field survey is considerable. Most hydrographers would agree that the present method of establishing sounding density is dogmatic and often can result in either over-sounding or under-sounding any given area. Line spacing is tied directly to survey scale which in turn is closely tied to chart scale. It's often the graphical limits imposed by chart scale rather than the actual complexity of the local terrain which determines how dense the regular sounding lines will be.

A more efficient method of running a survey would be to let sounding density be determined totally independent of either "survey scale" or "chart scale". The confidence in the data, as expressed by the kriging-derived maps of estimation variance, could tell a hydrographer how to progressively and selectively densify soundings until a desired confidence is achieved. Standards could be more objective and survey instructions could be issued based on desired confidence levels rather than the traditional "survey scale".

One could argue that the use of kriging for adaptive sampling would only be applicable to conventional surveys where unsurveyed gaps exist between the sounding profiles. If a total bottom coverage survey ensonifies 100% of the bottom, then the estimation variance between the sample points is zero and the term "adaptive sampling" has little meaning. This is perfectly true however one must consider the enormity of the task of totally swath sounding large offshore areas. For Canada 100% ensonification everywhere might take 50 to 100 years, which of course is unrealistic. If we think of swath sounding coverage as simply being a network of "thick lines", then it's obvious that adaptive sampling based on geostatistics could still be very useful. Kriging of widely spaced initial swath lines could be used to determine those particular zones in an area which actually require 100% bottom coverage in order to attain the desired confidence in the bathymetry.

(2) Automated Contouring

Kriging sounding data is essentially interpolating grid points between the measured depths. This interpolated grid of depths can then be used directly to produce the contours through a straightforward "connect up the dots" procedure. If the sounding coverage is very dense, such as in the case of total bottom coverage sounding, the interpolated grid is very similar to the measured grid. It would matter very little whether kriging or some other interpolation method were used since a measured depth will always be very near to a grid node.

Where kriging would hold some potential advantage over other interpolation methods would be in automatic contouring specifically for the marine cartography environment. The cartographic problem in automated contouring stems from the need to both generalize and safety-bias the contours. Most contour packages interpolate "the best" grid values using a strictly deterministic approach (linear interpolation or curve fitting to the data points). These values are meant to be the most exact interpretation of the data, not necessarily the safest interpretation of the data. The very word "safety" implies a probabilistic or stochastic element which compensates for some uncertainty or danger. In the case of hydrography, this safety factor can be best evaluated through geostatistics (kriging).

The benefit of a kriging-based contour package could be realized by safety-biasing the grid values which guide the drawing of the contours rather than moving the contours themselves. This approach is truly numerical rather than graphical. For example, a particular interpolated depth value might be estimated by kriging at 15.2 metres ± 3dm. If the uncertainty attached to this depth is 3 dm. then a logical means of safety-biasing the contour would be to simply subtract this uncertainty value from the depth which would otherwise be used. In the example just mentioned, the grid value used for drawing the contour would be safety-biased at 14.9 metres. This logic is certainly not the same as that used in hand contouring but it might produce similar or equally valid results.

Another, perhaps more orthodox, method exists for safety-biasing the contour grid by using kriging. The semi-variogram can be determined, or at least modeled, in such a way as to exaggerate the roughness of the bottom. This sub-optimal semi-variogram will attribute stronger weights to closer data points during the kriging solution. The result, while not the optimal solution, will ensure that spikes in the data are more influential in the estimation of grid point values. The drawn contours will reflect this exaggerated influence from the shoals.

Whatever method is used, safety-biased contours tend to become shallower. This can pose real concerns to ship owners who want to load to maximum draft. Obviously the estimation variances must not be overly pessimistic, otherwise a needless penalty would be imposed on commercial shipping. Of course, in practice, any channel which is shallow enough to affect the draft limits of shipping should be swept or swath sounded so as to provide a guaranteed minimum depth. In such cases, the 100% bottom coverage will create a zero estimation variance situation which would not affect contours.

Nevertheless, to ensure that the kriging package is not pumping out unrealistically shallow contours, a complete verification and calibration would have to be performed during the survey. Areas that have been swath sounded would act as calibration zones. Estimation variances computed from a subset of the total soundings could be compared to the actual measured values. Discrepancies would have to be eliminated by adjusting the kriging parameters. Kriging would by no means provide a push-button solution to hydrographers. Hydrographers would have to exercise at least as much good judgement as they do when using uniform survey grid spacing. All that geostatistics could provide would be some helpful number-crunching to help them make their decisions.

Generalization is a sophisticated smoothing operation. Generalization requires real intelligence since the graphical deformations of the contours must reflect the priorities of the navigator as well as the esthetics of the printed chart. Smoothing, on the other hand, is less context-sensitive. Different degrees of smoothing can be applied using mathematical rules. Smoothing has the effect of simply removing or averaging graphical complexity. By numerically safety-biasing the grid prior to drawing the contours, the job of contour generalization would be easier to automate since the graphics involved would become much more of a smoothing operation.

Another potential advantage of safety-biasing using kriging is that the entire set of data values is biased and not just those values which happen to fall on the contour interval. On the current paper chart this is of minor importance since all contours are 2m, 5m, 10m, 20m, etc. However, on a functional electronic chart, arbitrary and user selected contours must be displayed. Applying tidal corrections in real time would require that the contours continuously move to reflect the changing water level. If the entire grid of depth data has been safety-biased using kriging, then each of these moving contour lines would be faster and easier to draw than if graphical generalization had to be performed each time the contour moved.

(3) Data Decimation

Apart from use in adaptive sampling and automated contouring, geostatistics holds some promise for reducing the amount of storage necessary for the tremendous quantities of data generated by swath surveys. A number of authors have addressed the problem of data overload and how to cope with it [6][9][10][11]. One must find a way to discard over-redundant measurements while retaining a sufficiently detailed description of the bathymetry.

Generally this data reduction is accomplished through a gridding process whereby some grid size is imposed on the total bottom coverage data. The grid size is generally arrived at by considering the graphical scale of some product for which the data reduction is aimed. "Binning" of the data is then performed in each of the squares of the grid so as to eliminate redundant data. In each bin we might only retain the average depth, the maximun depth, the minimum depth and perhaps the standard deviation of the depths within the bin. This very straightforward approach is probably an optimal method of reducing the data given a certain grid size however it is in determining the ideal size of the data reduction grid that geostatistics may be of service.

It is obvious that for archival purposes, the size of the bins imposed on the data should be determined more by the complexity of the bathymetry rather than some graphical constraints related to the scale of the published chart. Since the storage space required is inversely proportional to the square of the grid dimension the grid size used for data reduction can be an important consideration.

The semi-variogram of a particular region could be used to determine the optimal grid size for reducing the volume of swath data based on how rough the bottom is. The data base created with such a scheme would be more flexible and more compact than one loaded with data aimed at a certain chart scale.

Tools for High Density Data Analysis

As part of the overall response to increased government priority on a Canadian ocean development policy, a research grant has recently been awarded to the Surveying Engineering Department of the University of New Brunswick. Support has also been secured for a new chair in the department dedicated to other research projects in ocean mapping.

The three year research project, funded by the Natural Sciences and Research Council of Canada, will deal mainly with issues directly related to the very dense bathymetric data available from total bottom coverage surveys. This is an ambitious project whose outline is as follows [12]:

(A) Data Formats:

Three conceptually distinct but essential formats will be used:

1. non-standard digital data format ("raw" survey data);
2. Standard irregularly-spaced digital bathymetric data format (position and depth data after standard field processing);
3. Standard regularly-spaced digital bathymetric data format (rasterized bathymetric data).

(B) Basic Transformations:

Different algorithms for interpolating bathymetric data into raster format will be studied.

(C) Visualization, Image Analysis and Image Editing Tools

Database Tools

1- A spatial indexing system for real-time applications

A spatial indexing system is one that can be used to quickly retrieve objects within a spatial window. The problems of spatially indexing the different data bases in this project and the possibility of new indexing systems will be examined.

2- Pictorial query system

A good database query language directly affects the user-friendliness of the system. Standard database query languages are not ideal for spatial applications because of the awkwardness of using written language to describe spatial relations. Querying pictorial databases will be examined in this project.

Image Processing Tools

1- Geometric transformation and resampling

Specific applications for these operations include the mutual registration of hydrographic data sets originating from different sources and the spatial orientation of bathymetric data sets.

2- Structural matching of raster data

Well defined, discrete point features are usually absent in bathymetric data. Therefore mutual registration of different data sets must be accomplished by matching line forms.

3- Enhancement techniques

Preprocessing of bathymetric data by contrast and edge enhancement is an important preliminary step to feature extraction.

Editing and Visualization Tools

1- Advanced hill-shading techniques for univariate maps

The purpose here is to create fast algorithms to apply an illumination model, together with surface coloring and texturing to allow optimal visual detection of seabed features.

2- Techniques for viewing bi-variate maps

It is often desirable to be able to compare two maps which overlap spatially. A typical problem might be to allow the simultaneous visualization of depth information together with error information. Another is the comparison of two sets of measurements taken at different times or using different techniques.

3- Interactive graphics editors

Direct manipulation techniques which allow graphics objects to be controlled using a mouse are proving to be extremely easy to learn and use. This approach will be investigated for such tasks as the interactive alignment of total bottom coverage data, the combination of multiple swaths in a mosaic and the correction of errors.

Expert System Tools

1- Rules for error detection and correction

The purpose here is to investigate ways in which an expert system may be used to encode the expert knowledge currently used in the treatement of bathymetric data. It is envisaged that a two-level approach will be used with the expert system providing top-level reasoning and the lower-level data processing being provided by functions written in C.

2- Rules for feature extraction

An open research question is that of using expert system technology for feature extraction from a high volume spatial database. Expert systems have been used for feature extraction in the computer vision domain but not for the high volume of spatial data of the type considered here. What type of knowledge/data scheme is appropriate? Can the methods discovered for the computer vision domain be applied here?

3- Tools for automatic script generation

The possibility exists that once experience is gained using the visualization and image-processing tools the automatic rule-based generation of scripts may be feasible.

(D) Scripts

In order to maintain data integrity, it is important that a single representation of the data be designated as a master. All other data representations can be obtained from this by means of transformation. These transformations may be "basic" in the sense described above, they may also be the result of image processing, the application of an expert system or human editing. The record of all such transformations can be stored in a log or "script" which enables the reconstruction of a particular image from the master files and which also provides a record of the decision sequence involved in the construction of a particular image.

Conclusion

Hydrographic organizations today are facing multiple challenges. Digital information will soon be made accessible to a much wider user base through the electronic chart. This new reality is forcing the implementation of a database-oriented organizational structure rather than the product-oriented structure of only a few years ago.

The advent of total bottom coverage sounding technologies was necessary to meet the safety requirements of navigators and the data aquisition requirements of scientists. Swath sounding has put us closer to the hydrographer's dream of 100% bottom coverage, however this has also created our biggest challenge: the huge amount of data that has to be processed, managed and interpreted to produce useful information.

Canada is putting strong emphasis on the implementation of these technologies. Several steps have already been taken to develop effective swath sounding hardware and the information tools necessary to make full use of them. Some new routes are also under investigation and through a concerted R&D effort we hope to push forward our capability for ocean exploration.

References

[1] MOUSTIER C., "State Of The Art In Swath Survey Systems", International Hydrographic Review, vol LXV(2), pp 25-54.

[2] ANDREASEN C. and D. PRYOR, "Hydrographic And Bathymetric Systems For NOAA Programs", Marine Geodesy, vol 12 pp 21-39.

[3] CLOET R.L. and C.R. EDWARDS, "The Bathymetric Swath Sounding System", The Hydrographic Journal, vol 40, pp 9-17.

[4] HUSSONG D.M., J.G. BLACINTON, J.F. WILLIAMS, D. HILLS, and J.G. KOSALOS "First Results Of High Resolution Seafloor Acoustic And Bathymetric Swath Mapping System Using The SeaMARC/S System", Trans Am. Geophys. Union, EOS, vol 67, no. 44,1986, p1001

[5] CASEY M.J. and J. VOSBURG "Airborne Hydrographic Surveying In The Canadian Arctic", International Hydrographic Review, vol 64, pp 111-122.

[6] BURKE R.G., S. FORBES and K. WHITE "Processing 'Large' Data Sets From 100% Bottom Coverage 'Shallow' Water Sweep Surveys", International Hydrographic Review, vol LXV(2), pp 75-89.

[7] CHILES J.P. and P. CHAUVET "Kriging: A Method For Cartography Of The Seafloor", Proceedings Oceanexpo 1974.

[8] ROYLE A.G., F.L. CLAUSEN and P. FREDRERIKSEN "Practical Universal Kriging And Automatic Contouring", Geo-Processing, 1(1981, pp 377-394.

[9] HERLIHY D.R., S.P. MATULA and C. ANDREASEN "Swath Mapping Data Management Within The National Oceanic and Atmospheric Administration", International Hydrographic Review, vol LXV(2), pp 55-74.

[10] MIDTHASSEL A., E. SØLVBERG and F. PØHNER "Data Management Of Swath Sounding Systems", International Hydrographic Review, vol LXV(2), pp 91-116.

[11] CLOET R., L. "Swath Sounding Data Base Management", International Hydrographic Review, vol LXV(2), pp 127-144.

[12] WELLS D.E. et al. "Proposal To The Strategic Grants Program", Natural Sciences and Engineering Research Council, May 27 1988.

[13] DAGBERT M and M. DAVID "Report On Geostatistical Trials With Bathymetric Data From CHS", Contract Report from Geostat Systems International, July 1988.

[14] CLOET R., L., Dr. S. L. Hurst, Dr. C. R. Edwards, P. S. PHILLIPS and A. J. DUNCAN "A Sideways-looking Towed Depth-measuring System", Oceanology International 1982, Brighton, pp 411-420.

Editor's Notes

This is the third edition of Lighthouse produced by the present editorial staff. Some changes have been made since the spring of 1988. The page layout is done on a Macintosh computer. Page boxes and title bars have been added. The cover page has gone from a 5-colour to a 4-colour production and the paper weight has been reduced, both of these to keep printing costs down. A poet's corner has been added; Lighthouse puzzles will appear regularly. In this issue, an "About the Authors" section has been added, to describe why each paper was written and to elaborate on the author's affiliation. With the exception of the National President, who has his own reasons, no one has written to the Editor to say whether any of these changes are good or bad, necessary or unnecessary.

We have had one response to the Lighthouse Puzzler in the Fall 1988 edition. Dave Bunyon, Superintendent of Chart Maintenance with the Hydrographic Department in Taunton (UK) writes, "There are of course a further infinity of possibilities over ... those you give in your second solution ... - the circle around the south pole can be of any circumference of length 10/N km, where N is an integer: you then sail N times around it before heading back north to the buoy!" Thanks for the letter, Dave.

Any time a ship runs aground, hydrographers sit up and take notice. Such was the case when the Exxon Valdez spilled oil off the coast of Alaska. Although it is not a pretty sight, left alone, mother nature will take care of it in time. In March of 1978 a rudderless oil tanker named the Amoco Cadiz drifted on the rocks and the resulting pollution was distributed along the coast of France. Eleven years later, that stretch of coast has recovered. There are more subtle, more serious and more permanent environmental changes going on around us. The depletion of the rain forest, and of our own Canadian forests; the contribution of exhaust fumes to acid rain; the effect of underarm deodorant on the ozone layer; the undeterred dumping of pollutants into the Great Lakes and other waterways; the piles of garbage that disappear from our front yards only to end up in somebody elses back yard. While the high-profile events like the Valdez incident tend to focus our attention on the environment for a short while, let us not lose sight of the continuing process of environmental disruption that is affecting all our lives. Can we turn the process around before it's too late?

The production of a journal like Lighthouse can't be done by the editorial staff alone. Your contributions in the forms of letters, comments, criticisms and articles are not only welcome but necessary to maintain a quality journal. Please keep them coming.

And lastly, the hydrographic surveys are heading for the field and I am greeted by a row of empty offices each morning. I feel a certain longing to pack my bags and join them. I think I'll go lie down until the feeling goes away.

Book Review

by

J. B. Ross

Cartographical Innovations: An International Handbook of Mapping and Terms to 1900
edited by Helen M. Wallis and Arthur H. Robinson, Map Collector Publications, Herfordshire, England,
353 pp, maps, illus. (ISBN 0-906-430-04-6)

Cartographical Innovations, edited by Helen M. Wallis and Arthur H. Robinson, is a compilation of widely scattered sources of the history and development of cartography to 1900. The project was sponsored by the International Cartographic Association and represents the contributions of about one hundred recognized experts in various cartographic fields.

Cartographical Innovations contains chapters on types of maps, human activity maps, natural phenomena maps, reference systems, symbolism, duplication methods and atlases. Each entry consists of three sections. The first section is the definition, which is referenced to the Multilingual Dictionary of Technical Terms in Cartography (MDTT), 1973 edition. The second section contains an elaboration on the development and use of the particular entry. The third section is a bibliography.

Of particular interest to marine cartographers and hydrographers are the entries on charts, coastal charts, harbour charts, nautical charts and portulan charts. The latter originally referred to written sailing directions and later became associated with atlases and charts. Another interesting entry concerns the history of imaginary or fantasy maps, such as Robert Louis Stevenson's map of Treasure Island and the maps of Lilliput and Houyhnhnms land in Jonathan Swift's "Gulliver's Travels."

Two omissions stand out. Cartographical Innovations contains no individual discussion of map projections or of scales and graphic scales.

The book is not a definitive research piece. However, Wallis and Robinson have done an adequate job of referencing their material, and of providing bibliographies. As a result, Cartographical Innovations provides a good starting point for historical cartographic research. Although the book cannot be described as a page turner, it does have general appeal. The format lends itself to random reading because each entry or chapter does not build on the preceding.

Poet's Corner

Maritime Chant

My minstrels are the wind and sea.
Their lays are true, their songs are brave.
Together they will sing for me
Of fair domain and island tree
And glint of sun upon the wave.

The mountains of the west are grand.
Prairie sunsets will exalt.
But still there is a mistic land
Somewhere, bound by ocean strand
Fragrant with the smell of salt.

There the wind shall cradle me...
Cure deception, right all wrongs...
Roll across the mighty sea,
Chant an endless rhapsody:
Hers, I think, is the song of songs.

She shall gather us at last
And scatter us like human dust.
Oh, I will not shrink from tempest blast
But play my lute beneath the mast
And sing of faith and hope and trust.

James Michael Chapeskie 1975

News From Industry

The Hydrographic Society

The Proceedings of Hydro 88, The Hydrographic Society's sixth biennial international symposium, have now been published. This symposium was held in Amsterdam in November 1988, and had registered delegates from some 38 countries.

Topics covered included the Electronic Chart; International Cartography; International Co-operation; Engineering and Special Projects; Coastal Observations; Bathymetric Surveys and Positioning. The Hydrographic Society tells us that the poster session presentations made during the Symposium are also included in the 256 pages of the Proceedings.

Copies are available at 35 pounds sterling (members of HS) and 50 pounds (non-members), or $60 and $90 from the Society's US Branch.

Captain C. William Hayes, President of International Industries Inc., has been elected President of the Hydrographic Society of America, one of the five national branches of the London-based Hydrographic Society.

Geotronics

Industrial News Service of Sweden tells us that Geotronics of Sweden is now marketing their Geodimeter 140T. This is a complete measuring station with automatic tracking, locking on to its target with an infrared beam and a prism reflector. The instrument can track a target moving at speeds of up to 30 km/hour, being aimed with a joystick. The range is given as being up to 4 km.

An interesting feature is that if the signal is broken by a passing ship, for instance, the system continues to track in the same direction for a few seconds and can again lock on to the prism when the signal reappears.

The photos show the Geodimeter being used for continuous positioning of an oil production platform and in use on a lake bed restoration survey.

Krupp Atlas Elektronik

Krupp Atlas Elektronik have been selected to supply the Hydrosweep multi-beam echosounding system for the Indian National Institute of Oceanography at Goa. This will be installed on their 100 m research vessel "Sagar Kanya".

The Hydrosweep permits coverage of 2 X 45 degrees using 59 preformed beams, with swath width equal to about twice the water depth, allowing significant increases in productivity.

The system is fully automatic and self-calibrating, with real-time correction for sound velocity on depth and slant angle. Post-processing with the Atlas Hydromap interactive hydrographic mapping system also allows 3D imaging as well as generation of colour isoline charts in conjunction with digital terrain models.

The system being supplied to Goa also includes the Atlas HECO 10 heave compensation system. A system has also been ordered for the ice-breaker "Polarstern" based at Bremerhaven.

General Instruments

Undersea Systems Division of General Instruments announce that they will be installing their Sea Beam 2000 Bathymetric Swath Survey System on the R/V Meiyo for the Japan Maritime Safety Agency.

The Sea Beam 2000 is the culmination of nearly 30 years of multibeam technology developed by General Instrument, and is the new generation of systems designed to replace the standard Sea Beam system.

The Sea Beam 2000 will enable the JMSA to create contour maps of the ocean bottom for scientific research.

Andrews Hydrographics Ltd.

Andrews Hydrographics Ltd. have recently completed a large scale survey of a 14 mile stretch of the Cromarty Firth in Scotland.

The problem was to accurately plot any obstructions and thus ease the over-winter "parking" of semi-submersible oilrigs and platforms. Each of the dozen rigs already overwintering there has eight to ten anchors, with their 500 m long cables laid spider-web fashion across the firth.

Using advanced single-point Artemis to position depth readings, the survey was carried out to accuracies of 1 metre. It was supplemented by sidescan sonar and covered an area from the drying line out to depths of 55 m.

The survey area was eventually up to 2 miles wide in places, and the resulting charts clearly showed the positions of all the known wrecks, including seven barges, a flying boat, and the First World War battleship HMS Natal. The survey also clearly showed the absence of other large obstructions, thus opening up areas for future overwintering use.

Qubit

Qubit is installing scientific data logging and processing systems in Australia's new antarctic research ship "Aurora Australis" now being built in Newcastle NSW.

The systems include Qubit's TRAC intergrated navigation system for the collection and analysis of water depth, temperature and chemical composition, as well as charting the ocean floor and carrying out some biological studies.

Raw data will be linked to a Qubit plotting system and the ship's VAX computer offering on-line printing of charts.

The instrument package includes Transit and GPS satellite navigation, electromagnetic log, two gyros, ARPA radars, precision depth recorders, search sonar, and doppler current profiler as well as other oceanographic and meteorological equipment.

ICOD

Mr. Garry A. Comber has been appointed to fill the newly-created position of Vice President of the International Centre for Ocean Development (ICOD). A graduate of the University of London and Sir George Williams (now Concordia) University in Montreal, Mr. Comber comes with many years of managerial experience with the Canadian International Development Agency (CIDA), recently managing aid projects in Bangladesh and Guyana.

Since being established as a Canadian Crown Corporation in 1985 ICOD has initiated, encouraged and supported co-operation between Canada and developing countries with some 150 projects in the field of ocean resource development.

Aanderaa Instruments

Aanderaa Instruments have developed a new compass. Originally designed for use with their Aanderaa Recording Current Meter, it is also ideal for use in drillholes, deep ocean research and other hostile environments.

This Aanderaa Compass model 1248 has a clamping coil and contact wire mounted on the compass magnet assembly suspended in a sealed bath of silicon oil. A wire-wound potentiometer is mounted in the casing above the free end of the contact wire, the magnet being free to swing between readings. When a reading is taken a current passing through the coil locks it in position and makes the contact with the potentiometer. Compass bearings are given as potentiometer readings accurate to ± 1 degree.

The compass is encapsulated in an epoxy resin casing and the whole unit is only 52 mm [2 inches] in diameter and weighs just 75 g. It needs a 6 Volt 15 mA clamping current at the moment of reading but draws no current between readings.

Aanderaa also tell us about two other recent products: their Seawater and Freshwater Conductivity Sensors, Models 3200 and 3201. These are lightweight cable-borne units to measure absolute conductivity of the water.

Each sensor consists of a twin-toroid inductive conductivity cell. A current is induced by the first toroid and read by the second. The current is digitized and can be clocked into any Aanderaa scanning or display unit.

The conductivity cell and electronics are encapsulated in epoxy resin and the electrical connections are made by a watertight plug.

Surnav

Surnav announce that they now have the new 4000ST tripod mount GPS receiver from Trimble Navigation. The 4000ST evolved from the original 4000S series receivers and its TRIMVEC PLUS software has similarly evolved, being controlled from menus by mouse or keyboard. This new software includes a satellite visibility package and other improvements but maintains 4000 series compatibility.

The 4000ST includes an internal antenna with external/kinematic antenna option, and its battery module (6 lbs) provides 8 hours of operation. The receiver can also be remotely controlled via modem.

Surnav tell us that they now have the Del Norte Pulstrac positioning system. We had a full article on Pulstrac in Lighthouse recently [Edition 36, November 1987], so suffice it to say that this is a portable 12 to 32 Volt network-type system for an unlimited number of users. It is self calibrating with accuracies of about ± 2 m.

Maritime Research Institute Netherlands

A recent Marin Report (Maritime Research Institute Netherlands) tells of a study on hull forms to reduce fuel consumption. We all know of the intriguing efficiencies of the bulbous bow, but what about the other end of the ship? This study indicates that a certain asymmetric hull shape near the propellor will improve its efficiency by improving the flow of the water past it.

Standard propulsion tests on hull shapes for a new 140,000 tdw tanker indicate that variations on the asymmetric stern would make the propellor 3% to 5% more efficient than with the conventional symmetric shape.

Institut maritime de Quebec

The Institut maritime de Quebec now has a program of 12 courses in hydrography. These courses are designed for mature students who are already working in the fields of geodesy, cartography or navigation, and the program conforms to the standards of IHO.

The Institut is the only agency in Quebec authorised to offer post-secondary courses in maritime studies, and as well as using their own staff they are drawing on other local specialists to respond to this particular identified need for hydrographic training.

As well as offering programs of courses for ships officers and engineers (and now hydrography), the Institute has for some time also offered courses in navigation for pleasure boaters, and since January 1988 over 1,000 people have enrolled in these courses.

Coming Events

Colloquium V

Colloquium V will be held in the Calgary Convention Centre from October 4 to 6, 1989.

This conference is being jointly sponsored by the Canadian Petroleum Association, Canadian Institute of Surveying and Mapping, Alberta Land Surveyors Association and Prairie Schooner Branch of the Canadian Hydrographic Association. This three-day conference will be preceded by two one-day courses on the Global Positioning System (GPS), and papers will cover such topics as GPS, Remote Sensing, GIS/LIS, and Hydrographic and Exploration Geophysics technologies.

The program will consist of invited papers by experts in each field, ensuring widespread and relevant coverage of the selected topics. For more information, contact: Diana Parnell of the CPA at 3800 150 Sixth Avenue, Calgary, Alberta, Canada, T2P 3Y7.

HYDRO 90: Call for Papers

The Hydrographic Society is to hold its seventh biennial international hydrographic symposium, HYDRO 90, at the University of Southampton from 18 to 20 December 1990. Proceedings are to be supported by an exhibition of equipment and services

Symposium themes will be wide-ranging and include the Environment, Legal Aspects, Dredging Surveys, Electronic Charts, GPS and GLONASS, Oceanography, Remote Sensing, Hydrology, Mean Sea Level, Ship Behaviour, Coastal Zone Management, Laser Sounding and Case Histories.

Original papers on these and other suggested topics are now invited for presentation, with 500 word abstracts required for submission by no later than 31 August 1989. They should be forwarded to the Organizing Committee, HYDRO 90, The Hydrographic Society, North East London Polytechnic, Longbridge Road, Dagenham, Essex, RM8 2AS, United Kingdom.

1989 Rate Card Information

POSITIONING

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

MECHANICAL REQUIREMENTS

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

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

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CLOSING DATES

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RATES (All rates are quoted in Canadian Funds)

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		Spot*	Four
Outside Back Cover	NA	NA	950
Inside Cover	250	300	750
Body, Full Page	225	275	600
Half Page	150	200	600
Single-page Insert	225	275	600
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All advertising material should be directed to:

Mr. D. St. Jacques
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Telephone: (416) 336-4857

About the Authors

HYDROSTAR: A Computer Program For Accurate GPS Real-Time Kinematic Differential Positioning

Gérard Lachapelle is currently professor of hydrography and geodetic positioning at the University of Calgary. He was involved in many GPS software development projects during the period 1980 to 1988, when he was vice-president of research and development at Nortech Surveys (Canada) Inc. Bill Falkenberg has been working on GPS software with Nortech Surveys since 1984. Mike Casey and Peter Kielland both work with the Canadian Hydrographic Service (CHS). They have been involved with many CHS development projects including GPS.

The paper is a result of a GPS software development project undertaken by Nortech surveys for CHS between 1986 and 1988. It was presented on November 17, 1988 at HYDRO 88 (the 6th Biennial International Symposium ofThe Hydrographic Society) in Amsterdam, and is published in the Proceedings. For further information, please contact:

G. Lachapelle
Department of Survey Engineering
The University of Calgary
2500 University Drive N.W.
Calgary, Alberta
Canada T2N 1N4

ECDIS Development In Canada

George Macdonald, Steve Grant, Dick MacDougall and Brent Beale work for the Canadian Hydrographic Service. Mike Eaton worked with CHS until his retirement in 1988. Together with Peter Leenhouts of the Canadian Coast Guard, they were members of the Canadian Electronic Chart Working Group when the paper was written. The paper is a result of ongoing development work with ECDIS in Canada. The paper was originally presented on November 15, 1988 at HYDRO 88 (the 6th Biennial International Symposium ofThe Hydrographic Society) in Amsterdam, but does not appear in the Proceedings. For general information, please contact:

T. Evangelatos,
Chairman, Electronic Chart Working Group
Canadian Hydrographic Service
615 Booth Street
Ottawa, Ontario
Canada K1A 0E6

For information on the ENC Pilot Project, please contact:

B. Beale
Canadian Hydrographic Service
867 Lakeshore Road
Burilington, Ontario
Canada L7R 4A6

ASF Chartlets: A Picture Is Worth a Thousand Numbers

Since Dave Gray first used a LORAN-C coordinate converter in 1980, he has seen the need to provide full ASF data to mariners. Many calibration surveys have been conducted since 1984 to obtain the required data. For Dave, who works for the CHS in Ottawa, the pending publication of ASF chartlets is a dream come true. Mike Eaton, who retired from CHS in 1988, has been extensively involved with navigation systems off the east coast. For more information contact:

D. Gray
Canadian Hydrographic Service
615 Booth Street
Ottawa, Ontario
Canada K1A 0E6

Managing Change: A Challenge of the Information Age

Dick MacDougall works with the CHS in Ottawa. He wrote the paper to identify some of the detail involved in creating, operating and maintaining an information network. Surveyors and managers need to think beyond the high-level concept of networks, to consider the implementation of policy, procedural, organizational and funding changes. He feels that these issues are at least as important as technical solutions, and probably present a far greater challenge. For more information, please contact:

J. R. MacDougall
Canadian Hydrographic Service
615 Booth Street
Ottawa, Ontario
Canada K1A 0E6

Canadian Preparations For The Swath Sounding Era

When this paper was written, Peter Kielland and Patrick Hally worked for the Canadian Hydrographic Service in Mont Joli. (Peter has since moved to Ottawa to work at CHS Headquarters.) The paper is a result of recent efforts within CHS to implement sounding techniques that will result in total bottom coverage. For more information, please contact:

P. Hally
Service Hydrographique du Canada
Quebec Region
Institut Maurice Lamontagne
CP Box 1000
Mont Joli, Québec
Canada G5H 3Z4

Other contributors

J. B. Ross is a cartographer with the Canadian Hydrographic Service in Dartmouth, Nova Scotia.

Beth Weller is happily married to Sam Weller (vice-president of Central Branch CHA). She lives and works in Burlington, Ontario.

James Chapeskie is a poet from Barry's Bay, who now lives with his wife in Kingston, Ontario. The poem is printed with permission.

News From Industry is gleaned from correspondence and news releases which have been received by the Lighthouse Editor. If your company has new developments that are of general interest to our readers, please send along the details.

CHS/CHA News is a composite of submissions from each of the Branch Vice-Presidents. Sam Weller has edited the text.

CHA/CHS News

NEWFOUNDLAND BRANCH

In January 1989 we started a Branch of CHA in Newfoundland after receiving the go-ahead from the National and the other regional Branches.

An election was held with the seven members transferred from the Atlantic Branch all taking part. These elections resulted in:

Vice-President	Richard Palmer
Secretary/Treasurer	Dale Nicholson
Executive Member	Graham Rankine

A membership drive was started. Posters were distributed to the local survey institutes and the University as well as those organizations practising any form of mapping or surveying in the province.

On February 27 1989 George Yeaton of Nautical Geodesy in Ottawa gave us an informative and well attended talk concerning NAD83. Our first Newsletter was also ready at this time and was distributed to encourage membership. The newsletter is planned to be a bi-monthly event. We would like to thank the Atlantic, Central and Pacific Branches from whom we borrowed profusely in designing a cover.

Our membership now stands at twelve with another dozen people interested enough to have requested membership application forms. Further talks are being planned to continue this drive.

ATLANTIC BRANCH

On December 12 1988 the Annual CHA General Meeting for the election of 1989 Branch Executive officers was held. The results are as follows:

Vice-President	Galo Carrera
Secretary/Treasurer	Glenn Rodger
Executive Members	Peter Barr
	Dave Lombardi
	Charlie O'Reilly
	Chris Rozon
	Geoff Wright

From November 14 to December 16, eight CHS personnel attended a five-week Seamanship Course given by the Nova Scotia Nautical Institute. Three weeks were spent at the new school facility in Port Hawkesbury on Cape Breton Island, and two weeks were spent here in Halifax for the MED A2 course and radar simulator. Our eight "seaworthy" personnel were Bob Hause, Mike Lamplugh, Bruce MacGowan, Chris Rozon, Bert McCorriston, Dave Fleming, Alan Smith and Graham Lutwick.

John Cunningham was married in November.

Frank Burgess and John Cunningham are presently taking the MED II Course.

From January 9 to February 10 Paul Parkes, Bert McCorriston, Dave Fleming, Alan Smith and Graham Lutwick attended the new re-vamped five-week Hydrography course in Ottawa. Paul and Graham are still in the nation's capital continuing with the new re-vamped Cartography course.

The Canadian Hydrographic Service booth at this year's Annual Atlantic Boat Show held February 23 to 26, was a huge success. Adding to its success were free CHS balloons for the kids, free CHS pencils for the "big kids", and the "Practical-Tactical Test" to get a free "Order of the Bent Prop" certificate. A special "thank-you" and "Congratulations for a job well done" go out to Gary Rockwell, Walter Burke, Mike Lamplugh and Ed Lischenski for designing and constructing a new oak and brass display desk for the show.

Friday February 24 was the successful return of the CHA Bowlerama night. Fortyfive CHA members showed up and bowled up a storm. High single winner was Gary Rockwell, high triple went to Gordon Stead, Ernie Comeau was best dressed (?), most improved went to Odette Nadeau. High single for the ladies was awarded to Betty Broking, the door prize was won by Mike Ruxton, and - last but not least - the coveted booby prize was won by Paul Bellemare.

Since last fall several of our CHS personnel have made one-week trips to Fredericton to learn about CARIS. These people include: Stu Dunbrack, Glenn Rodger, Ed Lischenski, Debbi Hepwich and Grant MacLeod.

SECTION DU QUÉBEC

L'assemblée générale annuelle de la Section du Québec s'est déroulée a Rimouski, le 3 décembre. Le conseil d'administration pour l'année 1989 se compose de:

Président régional	Richard Sanfaçon
Secrétaire-trésorier	Bernard Labrecque
Conseiller spécial	Yvon Boulanger
Conseiller	Patrick Hally
Conseiller	Roger Cote
Conseiller	Bernard Arseneau

Mentionnons, qu'au programme de cette journée figurait une conférence de Jean-Marie Gervais de SHC portant sur la recherche de l'épave du bateau Le Coudre de l'île. L'Association dévoila également à ses membres le kiosque et le vidéo de promotion réalisés au cours de l'année. Ledit kiosque a d'ailleurs été présenté lors du Salon nautique de Montréal et à la Conférence hydrographique canadienne tenue à Vancouver.

Depuis le début de l'année, la Section du Québec a organisé deux conférences. L'une de celles-ci portait sur l'habitat du béluga, elle fut présentée par Pierre Biland, président de l'Institut national d'écotoxicologie. Un autre conférencier, André Audet gestionnaire régional de la division Recherche at sauvetage de la GCC, traite des activités de le Garde côtière principalement dans la région des Laurentides.

Le programme annuel d'activités de la Section de Québec est des plus prometteurs. Il comporte en effet plusiers activités d'intérêt. Mentionnons notamment, une conférence sur les glaces, une visite au Centre canadien de géomatique de Sherbrooke ainsi que sur le site d'un levé hydrographique. L'Association prévoit également organiser une activité sociale en août et visiter les installations d'un bateau de la GCC foncionnant avec la carte électronique.

La version anglaise du vidéo "L'hydrographie" a été produite récemment. Ce vidéo d'une durée de près de dix minutes fait un survol des différentes composantes de l'hydrographie. Des copies sont disponibles en version VHS, Beta et 3 4 po.

La Section du Québec compte soumettre des projets au cours de la prochaine année. Une demande a déjà été addressée au Programme de création d'emploi pour étudiant, Défi 89 et une autre fut présentée dans le cadre du programme Article 38. Le conseil d'administration travaille actuellement sur la possibilité d'obtenir une subvention de Science et Culture Canada afin d'organiser un événement d'envergure.

Notre section collabore occasionnellement à la revue de l'Ordre des arpenteurs-géometres du Québec en lui fournissant des articles sur différents aspects de l'hydrographie. Cette initiative semble plaire à plusiers membres de cet organisme.

La section du Québec est en pleine période de recruitment afin d'augmenter et de diversifier son membership. La campagne se poursuit et le conseil d'administration compte bien atteindre ses objectifs.

OTTAWA BRANCH

At the 1988 Ottawa Branch Annual General Meeting the following executive was elected for 1989 :

Vice-President	Dick MacDougall
Secretary/Treasurer	Sheila Acheson
Directors	Marilyn Van Dusen
	Clay Fulford
	Ilona Hilbert-Mullen
	Terry Tremblay

We would like to thank Diana Pantalone for her participation in the 1988 executive; Diana has always been a willing helper in the CHA and it was great to have her on board in a more official capacity.

Branch Events

Seminars & Films

Thanks to the continuing efforts of Marilyn Van Dusen the Branch held a number of interesting and well-attended seminars and films in the fall of 1988 :

Mr. Kevin Smith, a visiting cartographer from New Zealand, presented an overview of the New Zealand Hydrographic Service, followed by an introduction to some of the sites and attractions of his country, Nov. 17, 1988.

Mr. Henry Hengveld, of Environment Canada, presented a noon hour seminar on the Greenhouse Effect, Nov. 24, 1988.

Films :
"Acid Rain - New Bad News", Nov 22, 1988.
"Greenhouse Effect", Nov. 29, 1988.

CISM Open House

The Branch participated in the Canadian Institute of Surveying and Mapping's (CISM) Campaign for Public Awareness at Algonquin College on November 17, 1988 by setting up an information booth. This booth featured the very impressive CHA banner that was loaned to us by Quebec Branch.

Christmas Luncheon

Diana Pantalone is to be congratulated for organizing the annual Christmas Luncheon, held at Alexander's on the Island on Thursday, December 15, 1988. Once again we benefitted from the generosity of the firms who donated door prizes :

- Bytown Marine Limited
- Terra Surveys Ltd.
- IDON Corporation
- Universal Systems Ltd.
- J.M. Ellis
- AGFA
- Dupont

CIDA Projects

As part of the Malaysia Project,three members of the Royal Malaysian Navy participated in the Cartography I course presently underway at CHS headquarters. They are Lt. (H) Zaaim Bin Hasan, LS Razalini Bin Ruji and AS Mohd Rosli Bin Abdul Aziz.

Activities by Members

Terry Jolicoeur, a past Secretary Treasurer of the Ottawa Branch and Head of the Nomenclature Unit of CHS, retired in December 1988 after having spent 38 years in the Public Service. Terry joined the Department of Health and Welfare in 1950 as a typist and then transferred to the Department of Mines and Technical Surveys in 1951. She started as a compiler of topographic maps in 1956 and in 1976 she moved to the Canadian Hydrographic Service as a names compiler. . In 1977 Terry became head of the CHS Nomenclature Unit. Best Wishes Terry, your smile and cheerful voice will be missed.

Dick Cashen, the Chief of the Quality Control and Services section at the CHS headquarters, retired at the end of March, 1989. In his 40 years as a cartographer with the CHS Dick developed a level of expertise and excellence that will be hard to match. Dick's skills and energies were not all devoted to the cause of hydrography; he has been a key figure in Ottawa's amateur sports world. In the 1950s Dick was awarded the Athlone Trophy as Ottawa's best cricket player and in 1963 Dick was named Cricketer of the Year. It's only within the last few years that Dick has given up cricket; he can now concentrate all his efforts on fishing. We all wish Dick many happy years of retirement.

After 25 years as the CHS's Chief of Notices to Mariners, Jim Bruce has accepted another position at CHS headquarters. We wish Jim well in his new job as Chief of Sailing Directions.

Welcome to Peter Kielland who is moving to Ottawa as a development officer with the Planning and Development Section of CHS Headquarters.

Dick MacDougall, Jim Bradford, Mike Casey, Ross Douglas, Neil Anderson, Dave Monahan, Don Vachon and John O'Shea attended " Discovery '89", the Biennial Canadian Hydrographic Conference held in Vancouver, March 6-10, 1989. SURNAV Corporation participated in "Discovery '89" as one of the exhibitors. Congratulations to Captain Vancouver Branch on their successful conference!!

Tim Evangelatos chaired the session "GIS - Digital Exchange Standards" at the national conference, "Challenge for the 1990s - GIS", held in Ottawa, Feb. 27-March 3, 1989. Neil Anderson was a member of the Conference Steering Committee; Dick MacDougall also participated in the conference.

P.K. Mukherjee spent 3 weeks in Jamaica in February 1989 on an IMO assignment to advise and assist the government of Jamaica in preparing their maritime legislation. While in Jamaica PK met with Noel Francis, another member of Ottawa Branch. P.K. came back to Ottawa briefly and then was off to Ghana to review their maritime legislation for the IMO.

Mike Casey, Dick MacDougall and Neil Anderson attended the "Position, Location and Navigation Syposium" in Orlando, Florida in November 1988.

Ross Douglas and Tim Evangelatos attended Hydro 88 in Amsterdam, Nov. 15-17, 1988.

While in Europe Tim Evangelatos also participated in an IHO-sponsored workshop on the exchange of digital data. Tim also visited the Shiphandling Simulation Facility in Hamburg where he discussed a proposed joint development project using their existing Electronic Chart system , along with CARIS and MACDIF.

Mike Casey participated in the Geomatics Atlantic '88 Workshop, October 25-26, 1988.

Personal Notes

Congratulations to Don and Kim Vachon on the birth of their daughter Sarah Kimberly, born on November 16, 1988.

Ottawa Branch is saddened by the death of Richard Lambert and our condolences are extended to his wife Suzanne and to his two daughters. Richard was a Programmer/Analyst with our Cartographic Development unit and came to Headquarters quite recently from Quebec Region.

Sustaining Member

Ottawa Branch began 1989 by gaining a third sustaining member : IDON CORPORATION, 875 Carling Ave., Ottawa, Ontario K1S 2E9, Tel. No. 613 - 722-8101, Fax. No. 613-722-2991. Contact Mr. Herbert Bown or Mr. James Feeley.

Incorporated in 1983, IDON has a growing national and international reputation based on the completion of more than 170 successful contracts in the information technology field.

IDON's objectives are to apply its unique knowledge and skills to the innovation, creation, and application of information technology and to the cooperative exploitation of business opportunuities. Within this context, the principals and staff of IDON are engaged in research and development, contracted product development, consulting, and information resources services.

The principals and staff of IDON CORPORATION have over a hundred years in senior positions in federal and provincial departments, in research and development centres, in educational institutions, and in high-technology R&D and manufacturing companies.

One of IDON's long-term projects has been the development of a Map and Chart Data Interchange Format (MACDIF) in cooperation with the Department of Fisheries and Oceans, the Department of National Defence, Department of Communications, the Ontario Ministry of Natural Resources, and the United States National Oceanic and Atmospheric Administration. MACDIF involves the design, implementation and testing of a standardized format for encoding telecommunication of mapping and charting digital data.

CENTRAL BRANCH

At our Annual Meeting in December we elected our 1989 Executive:

Vice-President	Sam Weller
Secy.-Treasurer	Terese Herron
Executive Members	Jim Berry
	John Dixon
	Sean Hinds
	Brian Power
	Boyd Thorson
	Keith Weaver

This is the first year we have had an Out-House repesentative on our executive, and Jim Berry promises to shake us up.

All in all our Branch has a lot of fun, and thanks to a committed and active Branch Executive our program is interesting and varied. M embership continues to grow nicely. Our newsletter gets minutes of meetings out in good time and keeps members in touch, and it is also sent to all International Members of CHA. [If you are an International Member and are somehow not on our mailing list, please let us know.] Central Branch ended 1988 with a record 78 paid-up members: 35 in private industry or students, and 43 with CHS in Burlington. Our progranm tries to serve both of these groups, with our meetings held alternately at CCIW (where most of us work) and at a member's home in the evening with beer and pizza and a guest speaker.

Since our last report in Lighthouse we have added several new members to the Central Branch rolls. We take this opportunity to extend a warm welcome to Sean Chard, Frank de Vree, Ryk Karczuga, Ray Kowalchuk, Brad Robinson, Peter Fox and Guenter Bellach.

Branch Activities

Our Branch was again vigorous this past year and we continued our program of interesting events. the Seminar Series continues, and during 1988 we had six invited speakers:

- Ralph Moulton (Great Lakes Waterlevel Communication Centre) on "Water Levels: Cause and Effect";
- Farrell Boyce (National Water Research Institute) on "Physical Limnology and the Hydrographer";
- Dr. Norman Rukavina (one of Canada's leading sedimentologists) discussed Fixed Transducer Systems;
- Len Faulkner (International Joint Commision) with a video on the removal of a barge from Niagara River;
- Richard Hancock (commercial photographer and former hydrographer) on photography in the field;
- Jim Statham (OLS Hydrographic Committee) on the new OLS admission requirements and Grandfathering.

Our summer barbecue hosted by Jo Anne and Bruce Richards was lots of fun - we all ate [and drank?] far too much and had a ball. Thanks again, Bruce!

And we were delighted to hear that both of the 1988 Lighthouse Awards were won by Central Branch members! The $100.00 prize for Best Non-technical Article was presented to Ryk Karczuga, and the $100.00 prize for the Best Technical Article went to the team of G. Fenn, B. Tinney, D. St.Jacques and P. Millette. Congratulations! Now let's do the same in 1989...

Ryk Karczuga accepts Lighthouse Award from Sam Weller

Incidentally, we were especially pleased with Ryk Karczuga's award because the article published in Lighthouse was the winning entry for the G.E. Wade Essay Award and had won the First Prize of $100.00 for the 1987/88 Competition. Originally it had been written as an assignment on Marine Law in his Hydrographic Survey course and was submitted to us by his instructor at Humber College. Way to go, Ryk.

Our annual H2O Bonspiel is a major event on our calendar, and this is the wrap-up report by Boyd Thorson who was the 1989 Bonspiel Coordinator:

H2O Bonspiel

The Grimsby Curling Club was the scene for Central Branch's 18th Annual H2O Bonspiel held on Sunday, February 12th 1989.

Forty-eight curlers took to the ice in search of the prestige and glory that surrounds winning this popular event's two trophies. Prizes for all participants, through generous donations by the contributors, was greatly appreciated by both the organizing committee and the rock throwers.

All the marbles this year went to Michele Clarke's rink of George Duncan, Jeff Kennedy, and Kathy Boich. The second event winner was Richard Tkacz's team of Greg Colbeck, John Walker, and Yvonne Roland.

A serving tray and a pair of binoculars were door prizes donated by Norman Wade. Lucky winners of this draw were Brian Power and Gerry Bengert. CHS's contribution of a copy of The Chartmakers went to George Duncan and the Two Tickets to Pittsburgh draw was won by Jeff Kennedy.

A "Turkey Shoot" run by Brian Power and Bob Covey ended in much controversy, with Bob winning the shoot out with 11 points over his nearest rival, Janice Fowlie's 8 point production.

H2O Bonspiel

The Coordinator and Participants of this years 18th 'Spiel would like to acknowledge and thank the following Companies for their generous contributions, they are:

- R C Marine, Dartmouth, N.S.
- Terra surveys ltd, Sidney, B.C.
- Terra surveys ltd, Ottawa, Ont.
- Quester Tangent Corporation, Sidney B.C.
- Surnav Survey Navigation System, Nepean, Ont.
- Klein Associates Inc., Salem, N.H.
- Norman Wade Co. Ltd., Hamilton, Ont.
- J.M. Ellis Ltd., Metcalfe, Ont.
- McQuest Marine, Burlington, Ont.
- Canadian Hydrographic Service, Burlington.
- Canadian Hydrographic Association, Burlington.

This year's entertainment committee again persuaded Norman Wade's Bill Dorion to present his once a year only "Triple Lutz" without skates performance. The judges gave it a 5,8. The Hog line offenders donated $25.91 indicating 50 hogged rocks, enough to handle the engraving expenses for the next three years. Thanks to all the Competitors for making this year's bonspiel a success.

See you next year!

International Membership

International Membership in the CHA is available to people who are interested in hydrographic and cartographic developments in Canada but are not resident here. The annual dues for 1989 remain at $30.00 [or equivalent in US or Sterling], and these members have all the rights and privileges of other members of the Association.

Our National President has arranged for International Membership matters to be handled by Central Branch, and all International Members (unless they request to be attached to another Branch as is allowed in our by-laws) receive their copies of Lighthouse directly from Central Branch as well as copies of the Central Branch newsletter and other mailings from time to time.

We are very aware that keeping in touch is especially important for International Members. Between editions of Lighthouse they may hear little of CHA activities or their fellow members and the newsletter with its newsy items about CHA members and its occasional notes about the activities of other Branches helps fill this need.

The International Members of CHA form a select group of people interested in the CHA and hydrography in Canada and present members include students, practising hydrographers and surveyors, heads of several national hydrographic departments, instructors at survey schools, and research scientists. Their ranks also include one or two Canadian surveyors who spend much of their time working abroad.

We extend a warm welcome to several recent new International Members: Trudy Kamphuis, a surveyor working in Alberta and abroad; Randall Franchuk, a surveyor with Wimpole in Houston; 'Etueni Tupou, Inspecting Surveyor, Ministry of Lands & Surveys, Tonga; Charles Griffith, Chief Surveyor, Lands and Surveys Dept, Bardados; and Noel Francis, Assistant Director of Surveys, Jamaica.

Two of these people were already Branch members: Noel Francis "graduated" from Ottawa Branch, and Randall Franchuk from Central. Welcome aboard!

PRAIRIE SCHOONER BRANCH

We have a new executive for 1989. The members are:

Vice-President	Andrew Brebner
Secretary/Treasurer	Patrick Eddy
Executive Members	Frank Colton
	Don Roberts

Activities relating to offshore exploration "ran aground" in Calgary over the last couple of years. Our membership which at one time was over 120 people dwindled dramatically.

We must thank the previous executive of Dave Thomson, Bruce Calderbank, Bob Ireland and Hal Janes for keeping together a nucleus of interested people and making sure that the Branch survived.

We are now in the process of letting folks know that we still exist and are once more rejuvenating a viable and interesting Branch in Calgary.

On Monday February 20 we held an informal luncheon meeting at the Rose and Crown pub which was well attended by old members. Four students from the University of Calgary who were present at the luncheon meeting were given application forms and a brief overview of our aims and objectives.

On October 4 to 6 1989 the Canadian Petroleum Association is sponsoring Colloquium V in Calgary. This is being co-sponsored by Prairie Schooner Branch of CHA as well as ALSA and CISM. The theme of this Colloquium is "Petroleum Surveying and Mapping in the 1990s", and preceding the colloquium there will be a two-day course on GPS.

People around town:

- Patrick Eddy and Hugh Stewart are looking forward to an active season in the Beaufort and Chukchi Sea.
- Bruce Calderbank was awarded Professional Associate status by the Royal Institution of Chartered Surveyors in June 1988. Bruce has been working in the North Sea and India, and the near future will see him on his way to Tunisia.
- Peter Button is with INTERA and is collecting and processing SAR data from Indonesia.
- CES, Exploration Service, and many more of us will soon be gearing up for what we hope will be a busy summer season.
- Brian Cutting of Nortech, Gulf Canada and the University of Calgary will be showing Calgary hospitality to a group of hydrographers and surveyors from SE Asia and the Pacific Rim, sponsored by CIDA and the CHA on March 15 1989.

CAPTAIN VANCOUVER BRANCH

The Captain Vancouver Branch held three meetings in the past year. The first meeting was in February 1988 when an informative report was presented on the Fraser River System. This report was jointly presented by the Canadian Coast Guard Pacific Region and by the Department of Public Works.

The second meeting was held in October. Two topics were presented, the first on the North Sea Project and the second on Surveying in Brunei. We were delighted to welcome K.T. Cheang to this meeting. An offshore surveyor based in Brunei, "KT" is an International Member of CHA and managed to fit in a visit to our Captain Vancouver Branch while he was in town.

The third meeting was held in January 1989 and was our Annual General Meeting. An overview of planning progress on the rapidly-approaching Canadian Hydrographic Conference was presented, and our 1989 executive elected. The result of our elections:

Vice-President	Robert Lyall
Secretary/Treasurer	Rick Bryant
Executive Members	Warren Williams
	Alex Fakedis

Total paid-up Branch membership now stands at thirty six, and our anticipated membership for 1989 is forty five.

The major activity and concern this past year for Captain Vancouver Branch has been the organization of the Canadian Hydrographic Conference: Discovery '89. This Conference was held at the Pan Pacific Hotel in Vancouver in March 1989 and by all reports was a great success.

Our feelings in Captain Vancouver Branch now that the Conference is all over? Tired but happy!

PACIFIC BRANCH

The Pacific Branch executive for 1989 is:

Vice-President/Seminars	John Watt
Secretary	Carol Nowak
Treasurer/Lighthouse	John Larkin
Social	George Schlagintweit
Newsletter	Mike Bolton
Membership	Fred Stephenson
Past V-P	Mike Woodward

Seminars and Activities

During the later part of 1988 Branch activities included a presentation and demonstration by Bill Cooke of Forest Technology Industries Ltd of data telemetry links in combination with cellular and conventional telephone systems. A seminar on the Canadian Meteorological Buoy Network was given at a Branch meeting by Andrew Wood of Seakem Oceanography Ltd.

The n-th annual CISM-CHA BBBB [Beer, Bun & Bellowing Bash] was held jointly with the Victoria Branch of the CISM. A great time was had by all with the treasured trophy for overall proficiency at Darts, Crib and Shuffleboard going to the team of Trish Kimber and John Watt.

To date, 1989 has brought a high level of activity to the Pacific Branch with the following highlights:

The Second Annual H2O Bonspiel

On March 12, 52 of Canada's finest curlers took to the Glen Meadows ice in our second annual H2O bonspiel. After 6 hours of grueling and gut-wrenching action a new champion was declared, along with a number of curling stories which can only get better with time.

The declared champions were Ann Marie and Bruce Lewis along with Kathleen and Ernie Sargent. Their victory was largely attributable to an embarrassing seven ender scored against the team of Sue and Bill Hinds and Shelly and Joe Linguanti. According to Bill it would have been a classic 8 ender if Ernie had not missed an easy shot. National President Barry Lusk and his cohorts (their names have been deleted to protect the innocent) ended up in second place [from the bottom].

Terra Surveys attempted to win the trophy with sheer weight of numbers, having eight players on their team. While the numbers did little to enhance the curling performance, they certainly contributed to the club's bar profits.

Following the curling action all enjoyed a superb buffet dinner along with the trophy and prize presentation. Special thanks to the generous donors of prizes.

Presentation by Greg Foster

"Discovery Reenactment '92, Northwest Bicentenary Expedition": The Discovery Reenactment Society (Canada) is organizing a program to reenact portions of the survey voyages of HMS DISCOVERY in celebration of the Bicentenary of the voyages of Capt. Vancouver in his surveys of the waters of the Pacific Northwest. Greg Foster provided an entertaining overview of the program and asked for the assistance and support of the CHA to help assure the success of this "hands-on-oars" illustration of hydrographic history. Pacific Branch intends to support and to participate in this reenactment which represents an important celebration of our professional heritage.

Emerging States Study Program

Mike Bolton orchestrated the Victoria leg of a CHA sponsored, CIDA funded program which involved bringing eight personnel from developing nations to Western Canada for a two and a half week period. The purpose of the visit was to inform the participants of the developments and technological changes in hydrography, both in the public and private sectors.

During the three day visit to the Vancouver area the eight sponsored people from developing countries were exposed to various facets of Canadian hydrographic techniques and technology with visits to Aanderaa Instruments Ltd., Quester Tangent Ltd., Terra Surveys Ltd., and to the Institute of Ocean Sciences which is the Pacific Region's federal facility for hydrography and oceanography, a component of the Dept. of Fisheries and Oceans.

Mike Bolton reported that the participants deemed the tour highly informative and very successful, and he commended the organizations involved: Aanderaa, Quester Tangent, and Terra Surveys from the private sector, and IOS from the public sector, and the Canadian Hydrographic Association for providing free and frank exchanges of technology and generous hospitality to the visitors.

Major field programs - CHS Pacific Region

This coming season will see three survey parties in the field. The first to sail will be the barge PENDER bound for the west coast of Vancouver Island. Assisting HIC Mike Woods will be Peter Milner, Mike Ward, George Schlagintweit, Rob Hare and later in the season Janet Lawson. The surveys are a continuation of modern surveys of areas where the present charts are based on lead line and early echosounder surveys of the 1930's. They will commence in the Ahousat, Hot Springs Harbour area and later in the season will round Estevan Point into Nooka Sound.

Second off will be CSS RICHARDSON with Vern Crowley in charge assisted by Ron Woolley. Their work this season will see a commencement of modern surveys in Milbanke Sound and then to the southern end of Queen

Charlotte Islands for surveys in Houston Stewart Channel, Louscoone and Flamingo Inlets.

The CSS JOHN P. TULLY will be making another run to the Beaufort Sea. HIC George Eaton will be accompanied by Kal Czotter, Alex Raymond, Ernie Sargent, George Schlagintweit and a team of term employees. The area being worked is in the vicinity of Amauligak where Tully has been working for the last two years.

Knut Lyngberg has a choice assignment this year going on a rotation to the Norwegian Hydrographic Service for a stint on board the LANCE charting debris in North Sea fishing grounds using Klein sidescan and EM100 multibeam echosounder. Later in the season he joins the OLJEVERN 04 on a coastal survey equipped with KONMAP II automated surveying system.

Lighthouse Puzzler Hint

One of the clues mentions all four survey teams! This is your starting point because it tells you something about each survey party. Mark X in each of those spaces then work by elimination. The solution will appear in the fall edition of Lighthouse.

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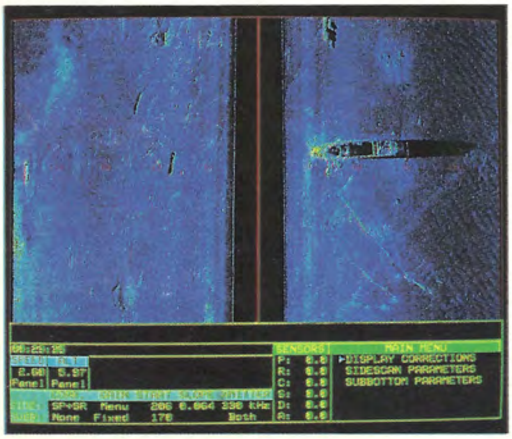

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