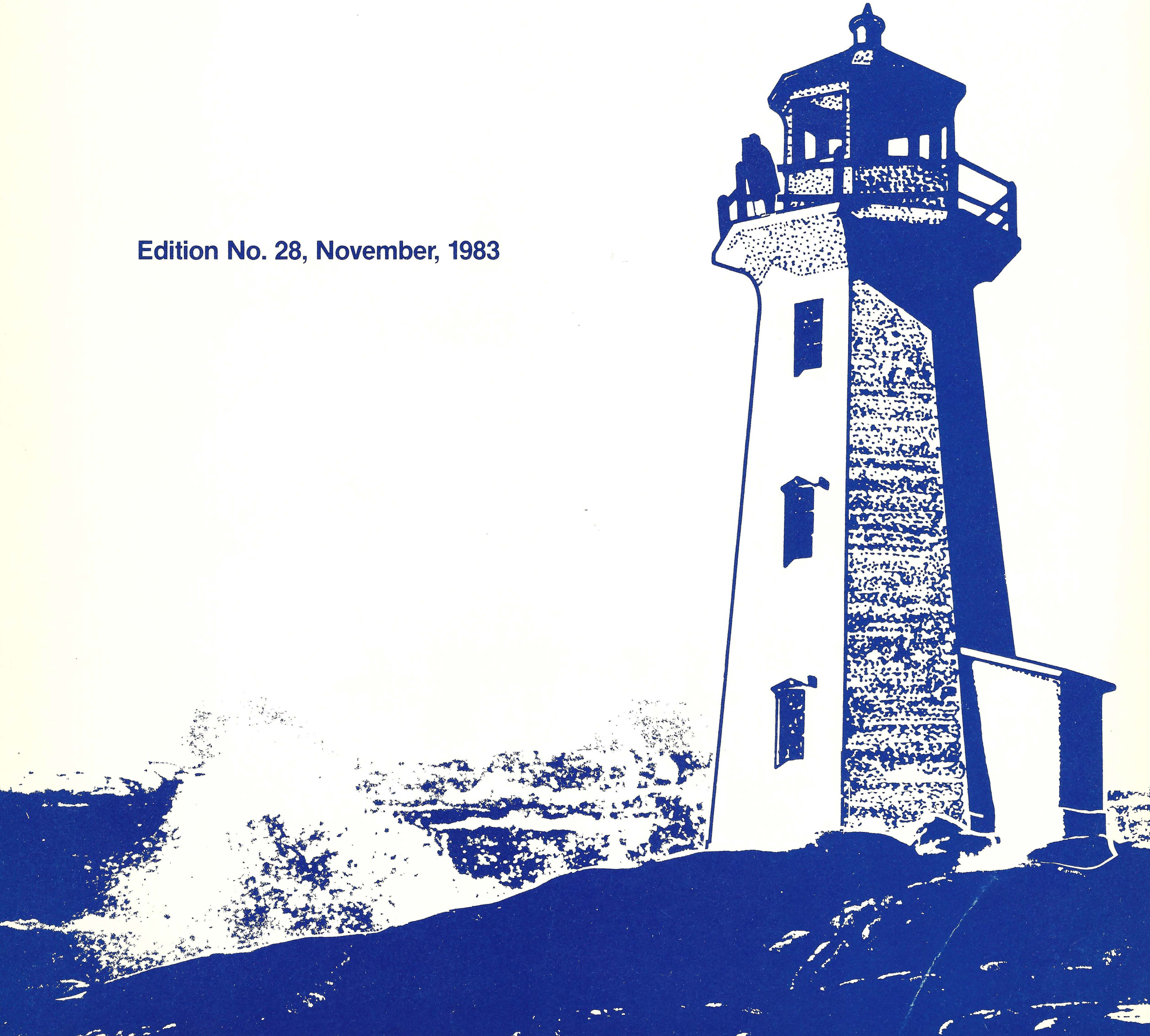
ISSN 0711-5628

Lighthouse

JOURNAL OF THE CANADIAN HYDROGRAPHERS' ASSOCIATION

Edition No. 28, November, 1983



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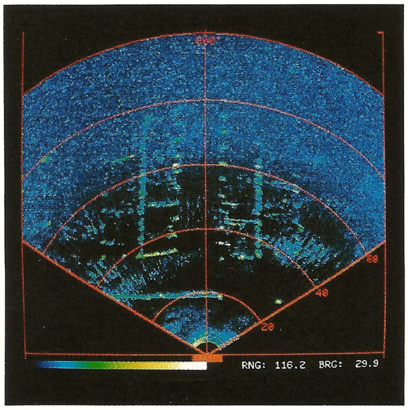

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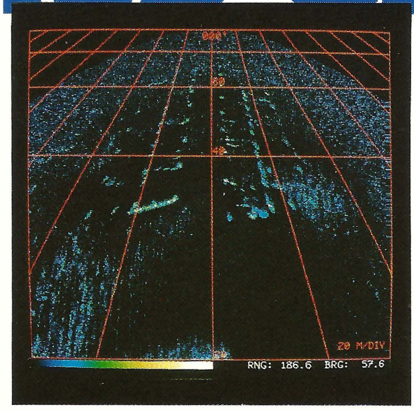

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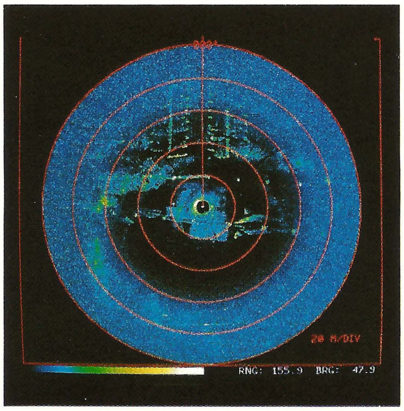

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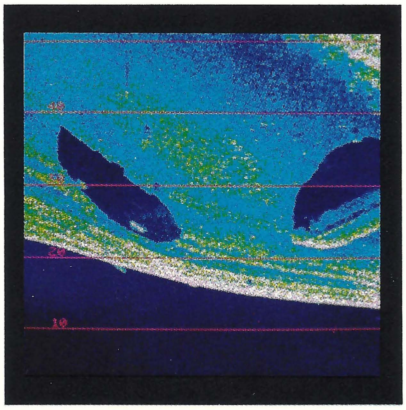

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EDITION NO. 28

LIGHTHOUSE

NOVEMBER, 1983

JOURNAL OF THE CANADIAN HYDROGRAPHERS' ASSOCIATION

LIGHTHOUSE is published twice yearly by the Canadian Hydrographers' Association and is distributed free to its members. Yearly subscription rates for non members who reside in Canada are $10. For all others $15, payable by cheque or money order to the Canadian Hydrographers Association.

All correspondence should be sent to the editor of **LIGHTHOUSE,** c/o Canadian Hydrographers' Association, P.O. Box 1006, Dartmouth, Nova Scotia, B2Y 4A2.

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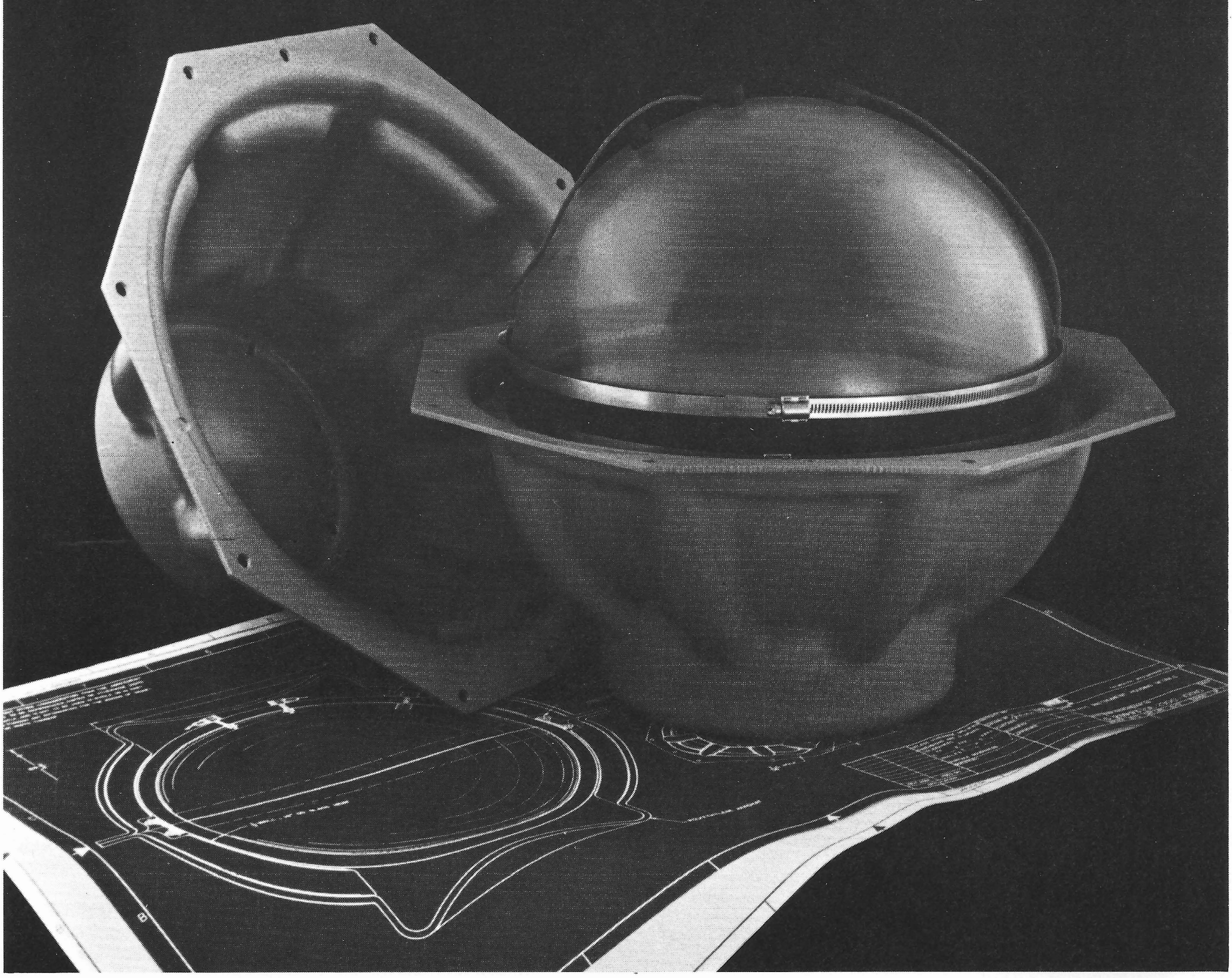
A Reliable Alternative

O.R.E. Glass Instrument Housings



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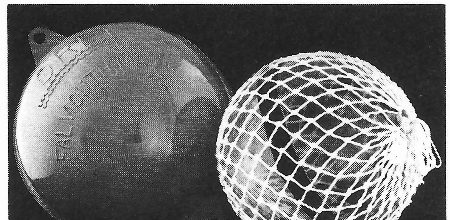

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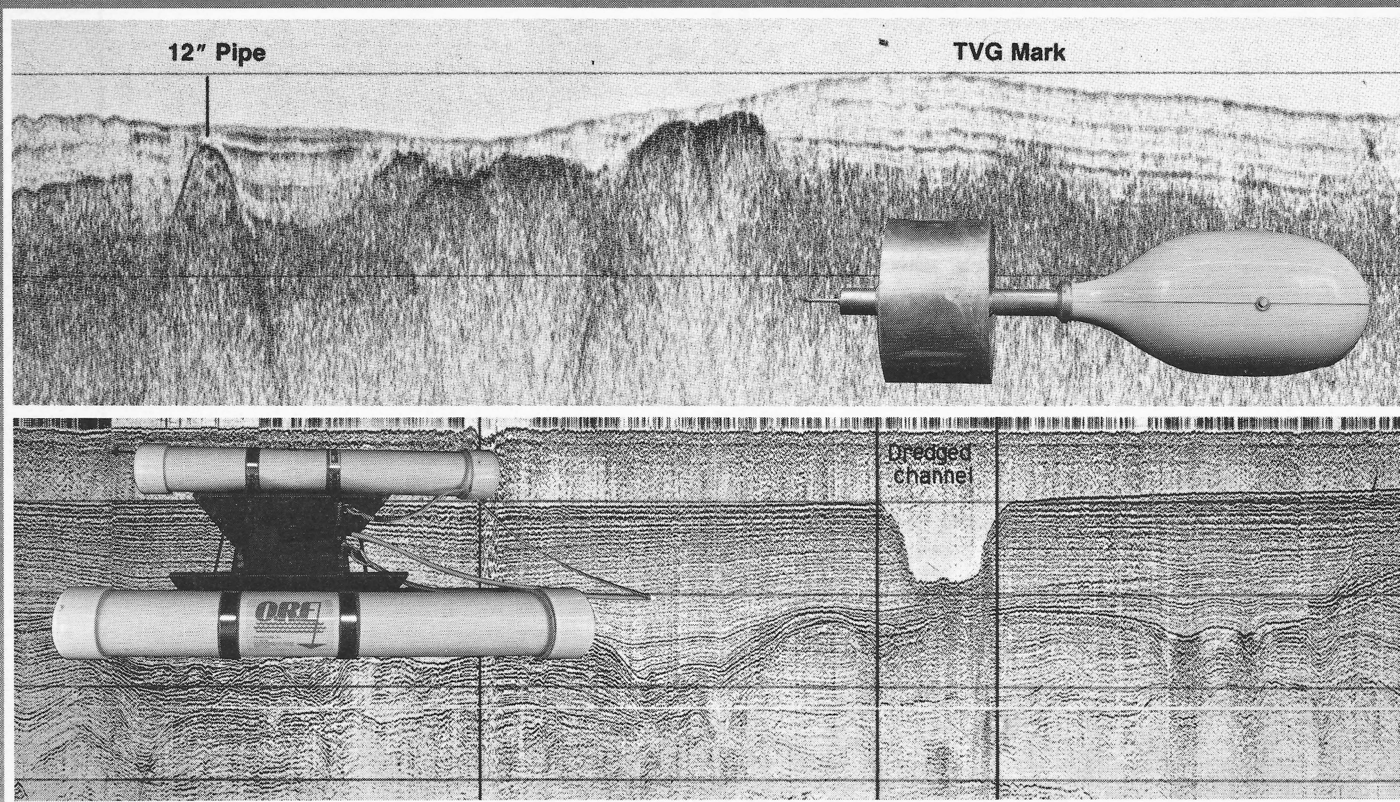

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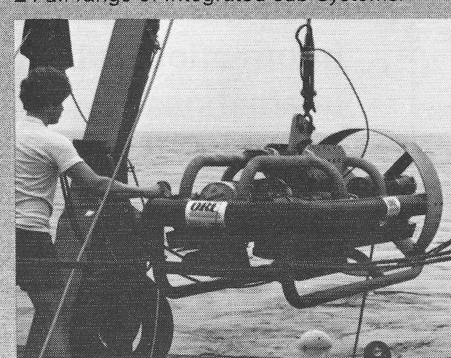

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EDITORIAL

The question so often asked in these days of tight financial restraint is "When will the charting be completed?" To this I use three replies. One, hydrography is not like land surveying. Hydrographers cannot photographically see all the area they must measure. "Air photography" of the seafloor in the form of acoustic imagery is still very crude, and the breakthrough seems to be a long time coming. The second reply is that surveying and mapping is iterative as we can see from the land-oriented part of the discipline. When the first explorers came to Canada they surveyed and charted or mapped the narrow strip of land along which they travelled, either the sea coastline or along the rivers and lakes. As the land became developed there became a need to map more extensively as in the case of the prairies. Still later there was a need for larger and larger scales of maps until today we will find city plans mapped at scales of greater than 1:1,000. This we must anticipate will be the direction of sea surveying and charting. It is particularly relevant with respect to offshore oil exploration as the need arises for pipeline rig-site surveys. The third reply is that in certain parts of the coast the seafloor does change frequently with the processes of erosion and deposition. Furthermore industrialization results in many man-made changes to the coastal features. All this requires repetitious surveying and charting. And so, there is perhaps no end to the task of the hydrographer whether he be in government or industry and on that note we may all wish to rest contented. But, if we compare hydrography with other ocean sciences, it must be considered to have reached middle age and some of the thrill has gone out of "discovery". In marine biology, for instance, there is still a whole world to be discovered — new bugs to identify, new processes to understand and above all else, to understand the precise factors which affect the links in the food chain. Hydrographers, on the other hand become excited today when they discover a new shoal, for in many parts of the world there is enough general knowledge of seafloor morphology that the majority of shoals have already been detected. The excitement in hydrography today lies mainly in technology, and it is in this area that one tends to find all the bright young minds. The day-to-day slogging of experienced hydrographers and cartographers in carrying out systematic, detailed surveys and producing yet another edition of an existing chart tends to be underrated. Yet the meticulous professional care applied to this task is the very essence of our reputation and must not be forgotten.

Message From The President

My three year term of office will soon expire, how time flies! A further measure of the passage of time is that my successor will preside over the twentieth Birthday of the Canadian Hydrographers' Association.

Since its inception in 1966 our Association has enjoyed many successes and continues to grow, attracting new members from all disciplines in government and industry, at home and abroad. However, success can breed complacency which in turn can reduce a healthy organization to just another organization. We cannot afford to lose our momentum. As your President, I appointed a Task Force to step back and take a critical look at CHA, and to report their findings.

The Task Force Report includes observations;

> " ... Prairie Schooner Branch ..... a new vitality" ...
> " ... Lighthouse .... an internationally respected journal ..... "
> " ... CHA is not as healthy as it might be at this time ... there are ways in which it could be improved internally and that not to do anything would be the worst mistake of all .... "

makes suggestions:

> " ... change the Constitution" ......
> " ... raise individual dues" ....
> " ... Executive Director" ....

and concludes,

> " ... without change the CHA will whither and die" ....

The CHA is indebted to the Task Force for their efforts, now it is time to pick up their "ball" and run with it.

The full Task Force Report is now in the hands of all Branches. I urge all members to study, discuss and constructively criticize that Report. I hereby call a special General Meeting to take place at 0900 on March 4, 1984 during the CHA Workshop in Victoria, B.C. This meeting will provide an open forum for the discussion of the issues raised by the Task Force. Following the General Meeting will be a National Executive Meeting at which decisions on our future will be taken. I welcome all members to attend the General Meeting, I request all Executive Members to attend prepared to debate, and to act. We cannot miss this opportunity to plot our course into the future.

The Canadian Hydrographers Association is almost at the twenty, lets not fumble the ball.

We can win this ballgame.

A. D. O'Connor,
President,
Canadian Hydrographers Association,

28 October, 1983
Sidney, B.C.

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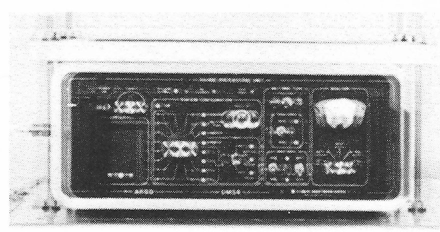

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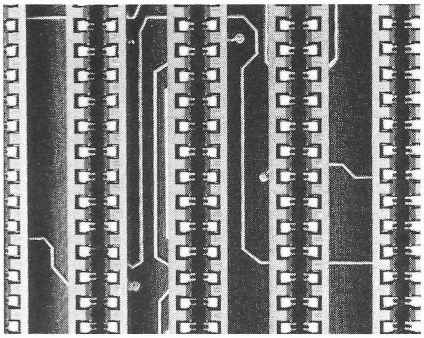

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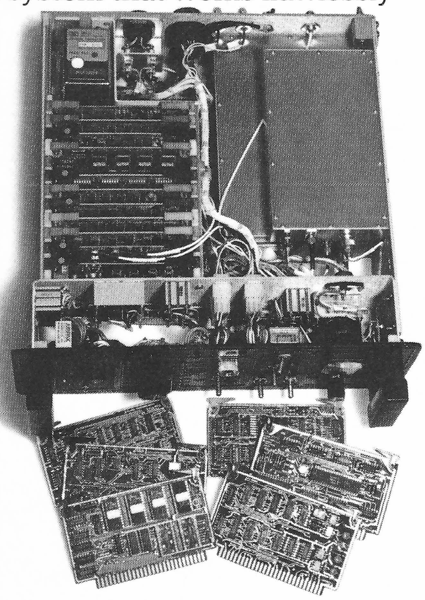

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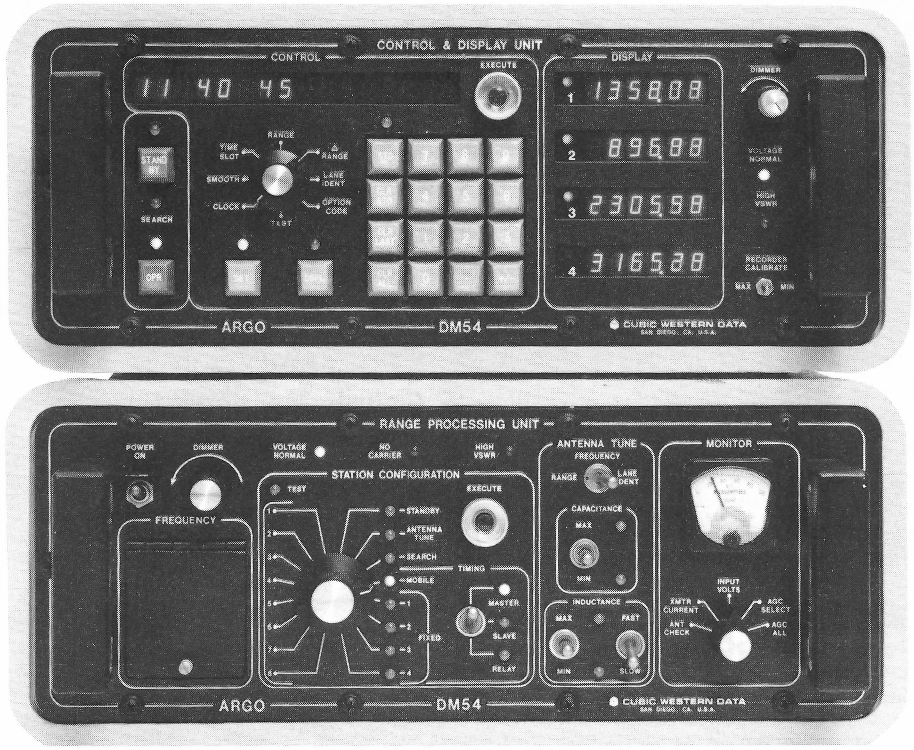

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Bubble Memory — A Reliable Recording Medium in a Harsh Environment

By
Gavin McLintock

Targa Electronics Systems
Ottawa, Ontario

And
George Macdonald

Canadian Hydrographic Service
Burlington, Ontario

Introduction

All hydrographers are familiar with the frustrations caused by the failure of equipment in the field. In recent years, the push for increased productivity has resulted in the attempt to use more complex, computer-controlled equipment. Although the new equipment has an increased capability in some respects, the added complexity often results in a lower mean time between failures and a resultant increase in lost field time.

Modern, solid-state electronic equipment can be made to function with a high degree of reliability under hydrographic survey conditions, if proper attention is paid to design and packaging requirements. Until recently, permanent storage of data under field conditions had to rely on electro-mechanical mechanisms such as those incorporated in tape recorders and printers. The inherent limitations of this equipment when used under field conditions such as vibration, humidity, mechanical shock and temperature variation, often meant that the weakest link in the chain of sophisticated survey equipment was the data storage device.

Solid-State Memory Technologies

Recently, the development of solid-state memory components which retain data when power is removed (called non-volatile) has opened the possibility of replacing tape recorders and disk drives with data storage systems that have no moving parts. The inherent ruggedness and reliability of these systems translates to an overall improvement in hydrographic system availability and productivity in the field.

The solid-state technologies which are currently considered for such applications include: Complimentary-Metal-Oxide-Silicon (CMOS) random access memory which requires a small battery to maintain memory, Electrically-Eraseable-Programmable-Read-Only-Memory (EEPROM), Eraseable-Programmable-Read-Only-Memory (EPROM) which requires ultra-violet light to erase, and magnetic-domain-memory which is popularly known as bubble memory. These technologies are compared in Table 1.

In addition to the requirements for rugged and reliable hydrographic field equipment, other important considerations are: size, weight, power consumption, ease-of-use, minimum maintenance and cost. Data capacity of a storage system should be adequate for an average field day. Considering all of the device and application factors, bubble memory appears to be the most suitable for hydrographic data storage applications at this time. It provides the most compact data storage with acceptable operating temperature range, access times and data transfer rates. There is no maintenance to perform, as compared to battery servicing for CMOS. Write times for EPROM and EEPROM limit them to relatively slow data rates which may be limited for some applications. EPROM is inconvenient and time consuming to erase on a regular basis. At this time EEPROM is more expensive than bubble memory.

How Bubble Memory Works

A magnetic bubble memory stores data in the form of cylindrical magnetic domains in a thin film of magnetic material. The presence of a domain (a bubble) is interpreted as a binary 1, and the absence of a domain as a 0. Bubbles are created from electrical signals by a bubble generator within the memory, and reconverted to electrical signals by an internal detector.

An external rotating magnetic field propels these cylindrical domain bubbles through the film. Metallic patterns or chevrons deposited on the film steer the domains in the desired directions. Transfer rates, once started, are in the tens of thousands of bits per second, but because the data is circulated past a pickup point where it becomes available to the outside world, there is a latency averaging tens of milliseconds before data transfer can begin. In these respects, magnetic bubble memories compare to serial high-density storage devices like electro-mechanical tape recorders or disk memories. However, in a disk or tape the stored bits are stationary on a moving medium. In a magnetic bubble memory the medium is stationary and the bits move.

Magnetic domains are found in all kinds of magnetic materials: iron bars, the coating on magnetic tape, ferrite toroids (the most common form of computer memory in the 1960's). Each domain is a group of atoms with parallel magnetic orientations. When the material in bulk is unmagnetized, the domains are oriented at random in three dimensions. When the material is magnetically saturated, most of the domains have the same orientation. Magnetization to a level less than saturation orients some of the domains to a common direction, but leaves many of them randomly oriented. When a domain orientation changes, usually by imposing an external magnetic field, the domain itself does not physically move, but boundaries between domains that have different orientations move or disappear altogether.

In an extremely thin film, less than .025 millimetres thick, the domain orientations may be constrained to two dimensions. In some kinds of material (orthoferrites and garnets), with proper crystallographic orientation, the domain orientations are always perpendicular to the film. When these materials are not in a magnetic field, some domains are oriented upward and some downward (north magnetic poles of some domains are on top of the film, and those of other domains are on the bottom). In these materials, the magnetic domains tend to be long and snakelike in the absence of an external field (see figure 1). When a weak magnetic field is applied perpendicular to the film, the domains that are oriented opposite to the applied field become substantially narrower. As the applied field, called a bias field, is made stronger, the length continues to decrease until it becomes approximately the same as the width. Each domain is now cylindrical, magnetized in an opposite direction to the applied field, and immersed in a much larger domain that is magnetized in the same direction as the field.

Table 1
Comparison of Solid-State
Non-Volatile Memory Technologies

Technology	CMOS RAM	EPROM	EEPROM	Bubble Memory
Material	Silicon	Silicon	Silicon	Garnet
Largest Available Chip Capacity	64 k bit	256 k bit	64 k bit	1024 k bit
Access Times	10s of nanoseconds	100s of nanoseconds	100s of nanoseconds	10s of milliseconds
Read Times (note 1)	10s of nanoseconds	100s of nanoseconds	100s of nanoseconds	10 microseconds
Write Times (note 1)	10s of nanoseconds	10 milliseconds	10 milliseconds	10 microseconds
Typical Voltages Required	3 to 5	15 to 21	5 or 5 and 18	5 and 12
Write Cycles	unlimited	100,000	10,000	unlimited
Best Available Temperature Range (note 2)	-55 to +125 C	-55 to +125 C	-55 to +125 C	-20 to +85 C
Data Retention (note 2)	3 years	10 years	10 years	too long to measure

Note 1:
The 10 microsecond read/write times quoted for the bubble memory reflect the 100,000 bits per second continuous data transfer rate after the bubble device access.

Note 2:
The CMOS RAM temperature range of -55 to +125 C does not take into account limitations which may be imposed by available battery technologies. The data retention time may be strongly affected by the temperature environment.

These small domains are the bubbles, generally less than three micrometers in diameter. When they are viewed from above, only the round shape is apparent, giving the domains the appearance of bubbles. If the bias field were to be made still stronger, all the bubbles would shrink and then disappear altogether, and the entire film would be magnetized in the same direction as the bias field. The effect is reversible. If the bias is removed, the domains return to snakelike form.

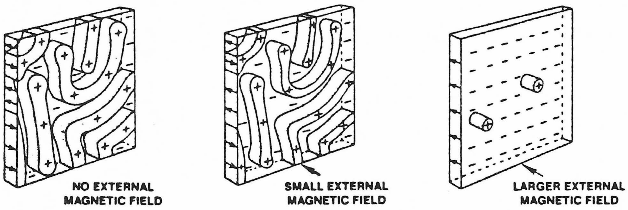


Figure 1: Magnetic Domains in Thin Film Under Increasing Magnetic Bias Field.

Magnetic bubbles will move if they are in a magnetic field gradient. For instance, they will move from a region of lesser maganetic field strength to a region of greater strength. This is similar to the way a nail is pulled to the end of a bar magnet when it gets close to the magnet.

In bubble memory, a magnetic film pattern is overlaid on the layer of bubbles. When this layer is magnetized it pulls the bubbles to the points of greatest field strength (the poles). The bubbles could then be moved if the pattern elements were moved.

A more easily controlled magnetic field is generated by two coils wrapped around the bubble layer and magnetic film pattern. With appropriate specification of the current in two coils positioned at right angles, the direction of the poles on the stationary elements can be changed in a controlled manner. Various shapes for these metallic patterns have been used by different manufacturers to control the movement of the bubbles. The most commonly used patterns today are asymmetric chevrons.

In a magnetic bubble memory system, the bias field in which the bubbles exist is generated by a pair of permanent magnets. The substrate, bearing the thin film and its bubbles, is mounted between these magnets and is continuously subjected to the bias field. The currents in the coil wrapped around the substrate are generated by electronic circuits that are part of the magnetic bubble memory system. These currents generate a rotating field that propels the bubbles through the film. No mechanical motion is involved.

If power fails, the circuits stop operating, the rotating field disappears, and the bubbles stop moving. The bias field, generated by the permanent magnet, is not affected. Therefore, the bubbles and the data that they represent are maintained in the film. When the power is restored, the data is again accessible.

Bubble memories are produced in a process that resembles semiconductor manufacturing in many ways. Magnetic bubble technology differs from semiconductor technology in the materials used and in the complexity of the process. Semiconductor circuits use eight or more layers of silicon doped with various materials that affect its electrical characteristics, compared to about three layers of essentially pure metallic and insulating material in bubble technology. These materials are chosen for their magnetic rather than their electrical properties.

Data Recorder Development History and Field Experiences

In 1980, magnetic bubble technology had progressed to the point where the Canadian Hydrographic Service felt it was suited to data recording applications. The advantages of high recording density, non-violatility and solid-state technology could be put to good use in a harsh operating environment.

Two prototype units were delivered in March of 1981, and were used on a production survey in Lake Huron. Each recorder contained one megabyte of memory (enough for over 33 hours of data at current rates of one position and one depth each second). The field tests proved the feasibility of bubble technology, and led to the production of four modified prototypes, each with 500k bytes of memory (enough for almost 17 hours of data). These new units addressed problems of size, weight, packaging and removable media. Although still fairly large, they were used with great success on the 1982 Lake Huron survey. They were extremely reliable, and the box-within-a-box concept made it easy to remove the recorder and carry it ashore to transfer the data to the processing system.

In the summer of 1982, the first bubble memory recorder with a removable data cartridge was tested on the St. Lawrence River. In the spring of 1983, four units, and eight cartridges, were delivered to the Canadian Hydrographic Service. They have proven to be highly reliable, and solve all of our recording needs. There were no data losses or hardware failures during the 1983 field season. Problems of equipment reliability and data integrity, so prevalent in previous attempts to record data in the field, have been resolved by using bubble memory.

Data Recorder Description

The bubble memory data recorder was developed by Targa Electronics Systems Incorporated of Ottawa, with the co-operation and financial and technical assistance of the Department of Fisheries and Oceans, Bayfield Laboratory, and the National Research Council. The recorder features a removable bubble memory cartridge (presently available in 128 k byte and 256 k byte capacities), a choice of operating voltages (12 and 24 volts DC and 110 and 240 volts AC), RS-232C and IEEE 488 interfaces, a small liquid crystal display for mode and status indication and rugged construction suitable for hydrographic and other harsh environments. The system is small (21 × 33 × 9 centimetres), light (5 kilograms) and typically draws 5 watts while in operation.

A feature of the overall recorder design is the ability to use memory cartridges containing EEPROM, EPROM, CMOS RAM with battery, larger capacity bubble memory or any other non-volatile solid-state memory technology when, and if, it becomes reasonable to produce them. The basic investment in the recorder system is protected to a large extent against the advance of technology in the forseeable future.

The recorder consists of a cartridge holder, cartridge interface, controller board display module and power supply (see figure 2). The controller board is a versatile computer with external communication through both RS-232 serial and IEEE 488 parallel interfaces. The software protocols for communication through each interface are controlled by programs stored in EPROM. These protocols can be adapted to suit individual applications. At present, the software protocol on the IEEE 488 bus emulates a Hewlett-Packard 82902 floppy disk drive. This allows the recorder to hook up directly to most models of Hewlett-Packard desktop computers and operate without the need for special programming.

On the RS-232 interface, two protocols are available. The first emulates a Digital Equipment Corporation TU-58 cartridge tape recorder and allows the recorder to communicate directly with many DEC computers running RT-11 or RSX-11. The bubble memory recorder operates much faster than the YU-58. The second RS-232 protocol is a serial tape recorder emulation which behaves much like a normal cassette tape drive. Data is stored in a record-and-file format. The recorder keeps track of where it is on 'tape' by means of pointers stored in the bubble memory. The pointers are redundant so that unexpected power failures at random times can only result (in the worst case) in a loss of the most recent record. In most cases, no data will be lost other than incomplete records that were being transmitted at the time of power failure.

Other Recorder Applications

In addition to uses in hydrographic surveying, the recorder (see figure 3) is finding a number of other applications in a wide range of industries. Major auto manufacturers are using the system to store data during vehicle tests. The recorder is being used to gather data in a large metal processing operation. It is being engineered into a system which controls and monitors oil well drilling

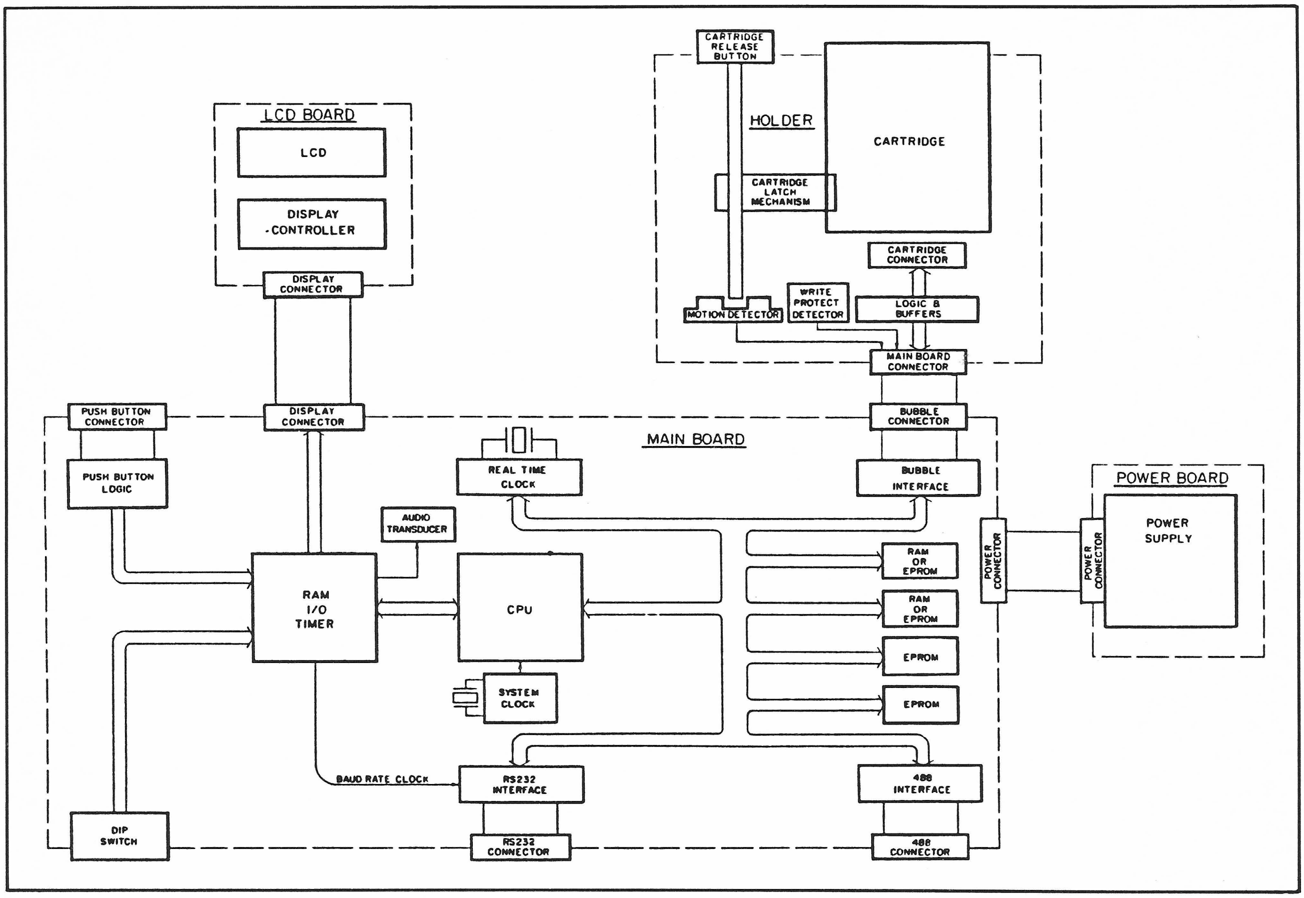


Figure 2: Targa Bubble Memory Recorder Block Diagram

Figure 3: Targa Bubble Memory Recorder and Cartridge

operations. In electronics testing, military equipment, aerospace and process control applications, the recorder is proving to be a reliable, versatile and rugged system.

Conclusions

As in most areas of electronics and computer technology, developments in the bubble memory field are occurring rapidly. In the near future data capacities will increase by a factor of four, prices will be significantly reduced, and performance will be extended, especially in terms of low and high temperature operation. The bubble memory recorder, already extremely reliable and versatile, can only improve with age.

Dolphin: On Trial

By
K. MALONE

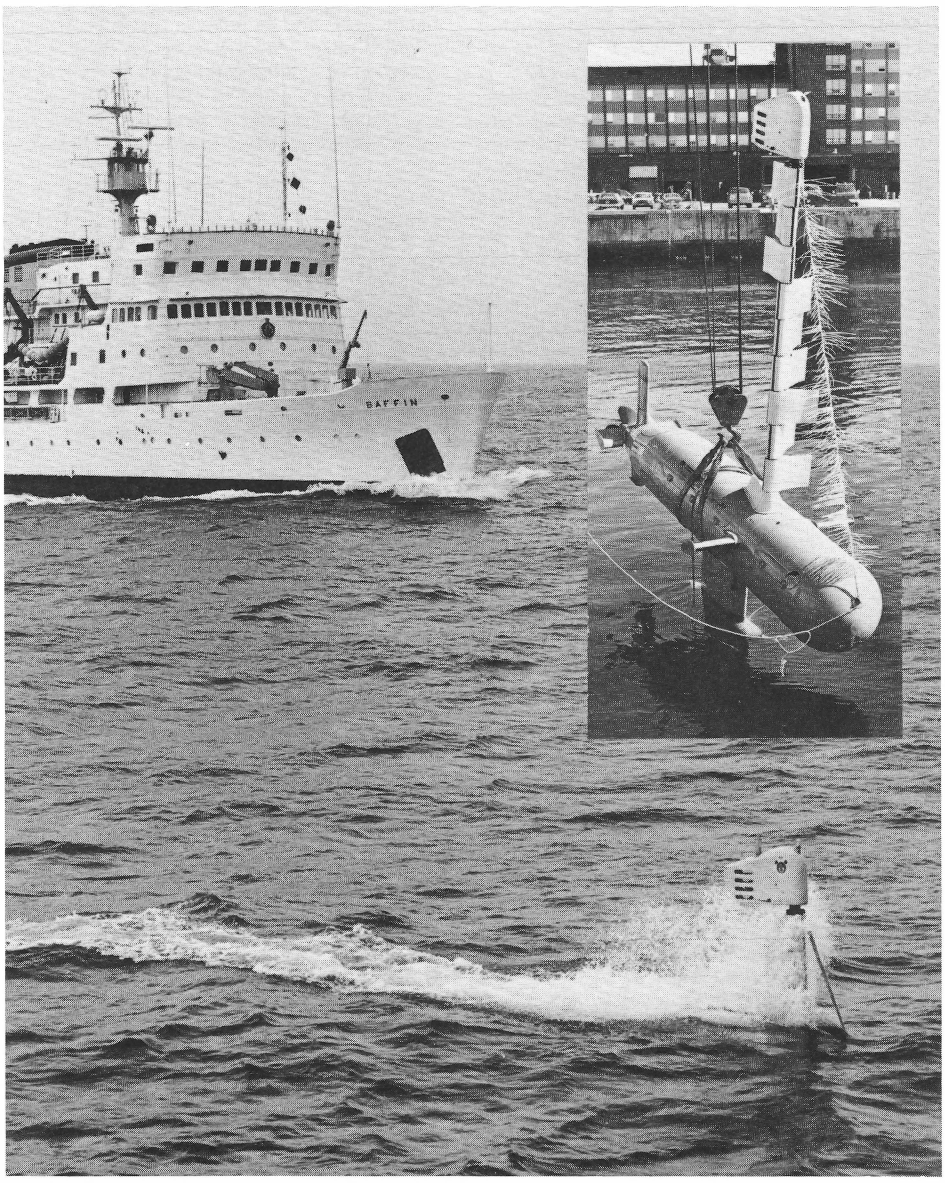
C.H.S. Atlantic

The DOLPHIN, acronym for Deep Ocean Logging Profiler with Hydrographic Instrumentation and Navigation, arrived at B.I.O., Dartmouth on September 8th for the first set of trials to be conducted by the Canadian Hydrographic Service.

The DOLPHIN is an unmanned, remote controlled, semi-submersible vehicle. The intended use is to deploy 6 (or more) vessels at one time running parallel tracks, 3 either side of a mother ship. Each vessel will house a sounder the thus, seven parallel profiles of bathymetry will be collected at one time. The vessels will be used on offshore surveys and typical separation between vehicles would be 1 km.

The trials to date have been conducted in Halifax Harbour and environs. The DOLPHIN has been launched at the B.I.O. jetty and has been steamed to the area of operation, followed closely by a launch housing the controlling equipment. The vehicle has operated well in seas as large as 1.5 metres. In this environment there is no noticeable roll and barely detectable heave. From these brief trials it would seem that the vehicle is a very stable platform for conducting sounding operations. Maximum speed recorded to date has been a respectable 13 knots. As with any other prototype, the trials have not gone without incident but the problems have tended to be minor.

Trials are continuing as this brief report is being written. In December of this year, the DOLPHIN will be placed onboard the C.S.S. BAFFIN for a week of offshore trials. At the conclusion of that cruise, a more detailed report will be written.



Contours & Contouring in Hydrography
Part I — The Fundamental Issues

D. Monahan
M. J. Casey

"If you don't know where you are going,
any road will get you there"
The Koran

Prologue
In the final analysis, mapmaking is a graphic **art** — not a science. This is a notion that must be constantly reinforced. It is the final product which defines the nature of a particular enterprise and in hydrography our business is producing charts. The use of modern methods in arriving at that end product is a secondary issue. Behind all the computer printouts and reels of tape sit the artists. When one hydrographer speaks of another's professional calibre he doesn't speak in cold objective terms but measures him out in the quality and beauty — or lack of it — in his collegue's work.

We raise this issue immediately for it will arise throughout our discussion of contours and contouring in hydrography. It is our intention to bring forward the issues as we see them, the advantages and disadvantages of taking yet one further step along the trail of mechanization — a one-way road with its origin in the industrial revolution and its end unseen and unknown. We are braced at the bottom of yet another hill to climb — the mechanization of contouring. It can be done — has been done elsewhere. The momentum of automation could easily carry us over this hill. To stop now would seem artificial and arbitrary. Yet this **is** a good place to stop for the moment and to re-examine what it is that we are trying to do. What do we hope to gain with this next step, what is the payoff? What will it cost us and what will we lose? These are the issues which must be confronted if we want to control progress. We should be stimulated by new technology, not pushed by it.

Machine contouring is a current issue within CHS. Three regions have small study groups experimenting with off-the-shelf contouring packages. Trials are being conducted using hydrographic data of varying density and pattern to study these effects. A fully contoured field sheet complete with shoreline and title has been prepared in Central Region in an exercise to study, among other things, the impact of this format for error checking and general quality control. The interface between the digital field sheet and the compiled chart is being studied to see if the new format offers advantages in streamlining the compilation process. CHS have a contract with Barrodale Computing Services Ltd. of Victoria to revamp a contouring package with hydrographic requirements in mind. The talents and energy of many individuals are being expended on this project. We need to ask why.

It is our intention in these discussions to raise questions and to answer some of them. Why should we contour at all? If we contour what does machine contouring offer? How do we do it — what are the mathematical structures on which it is built? What are the assumptions made and how valid are they? How can we err safely? What are our limits and our constraints? What are our musts and what are our wants? What issues are relevant and which irrelevant? How do we measure the effectiveness of machine contouring in the field and in the office? How do we maintain our standards of excellence in field sheets? Finally, what are the side effects that this step will introduce and are we prepared to accept them?

These are the issues that must be addressed before we can go forward with confidence. The purpose of these discussions is to shed some light on the road ahead.

1.0 Introduction
Charts — indeed all maps — are caricatures. A chart **does** distort reality — just as the cartoonist distorts the facial features of some well-known personality. Yet the intent is always clear — we know instinctively who or what is being portrayed despite or perhaps because of the distortion. But to do this well calls for a careful distortion of just the right features. One sees a cartoon featuring Jimmy Carter's smile, not his ears, Duranté's nose and squinting eye, not his bald and shining pate. A good caricature has an uncanny precision behind the distortion — so it is with the chart.

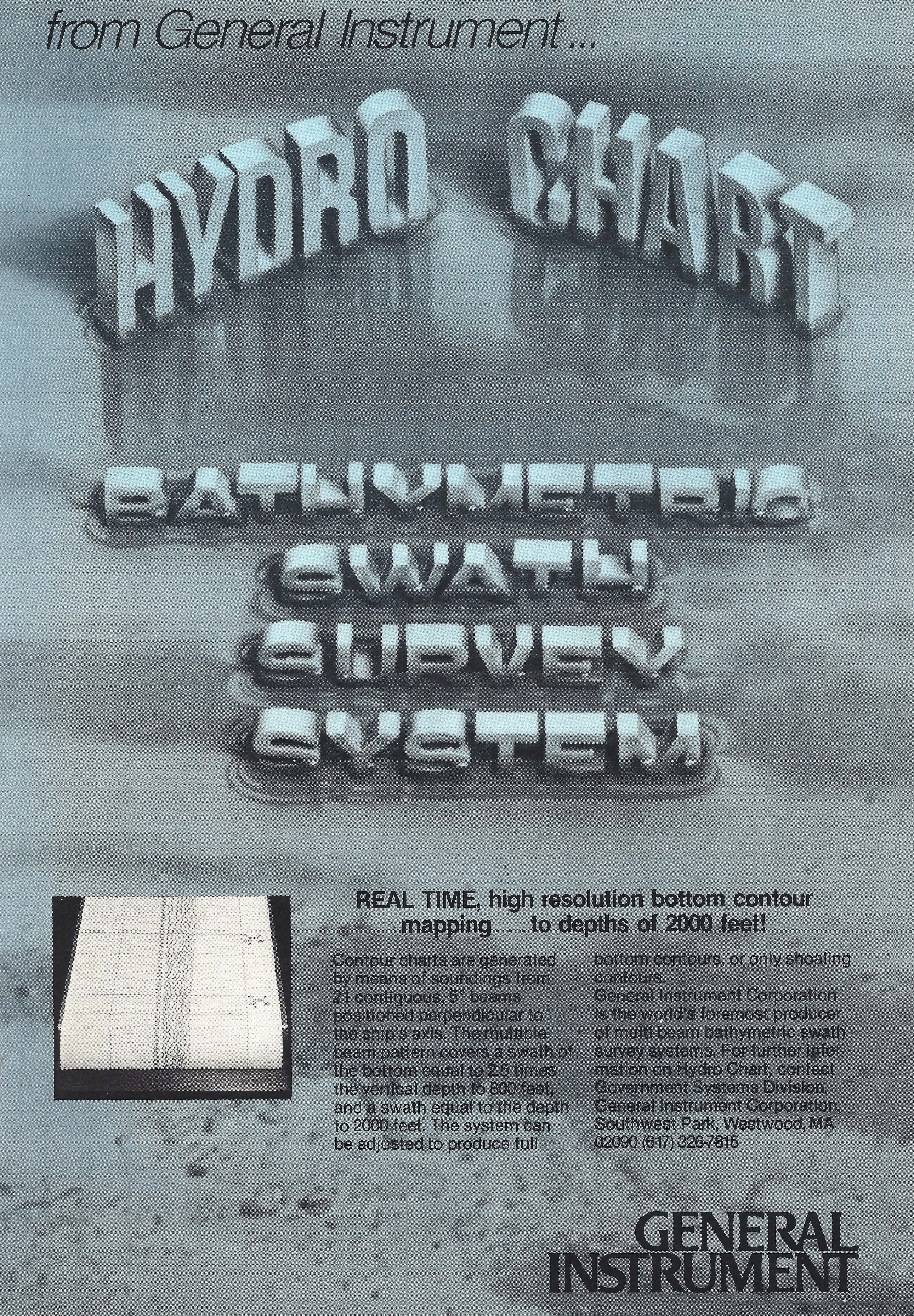
A chart includes a summation of a large munber of measurements carefully distorted and designed to give its main user — the mariner — an unambiguous image of the problems he faces. At least that is what it should be, that is the intent. In a traditional compilation it is often the density of the soundings which draws the eye towards the dangers. A sudden cluster of soundings in a clear and uncluttered portion of the chart means one thing only — danger. This is more of an historical artifact than good cartography, a remnant from the days when every sounding measured made its way onto the chart. A more modern compilation shows the danger ringed with contours and surmounted with one critical sounding. There seems to be general agreement that the latter approach gives a better image of the feature and serves equally well in drawing attention to the danger. But contouring is only one of several cartographic devices which could serve equally well. We need to have some guidelines in order to find out which techniques will best serve us and our customers.

In this introductory article we wish to examine some of the more qualitative issues in contouring. We propose to examine the Why, Where and When, postponing for the moment the question of How. It is often more preferable to answer the How of such issues. Like most technical problems there is a nut at the heart that must be cracked before success is achieved. The cracking of the nut is often mistaken for the objective. This is human nature. But the business of CHS is producing charts not developing systems.

2.0 Why Contour?
Contours help us perceive the shape of the surface we are measuring but hardly ever see. They are a means of portraying a 3-D object on a 2-D medium. They are not however the only method available for doing this.

It is the colour shading on the GEBCO charts which serves as the predominant mechanism for transferring to the user the image of the ocean bottom. The contours, subdued as they are, serve only to add the detail information. It is colour which highlights the deeps and the shallows, the ridges and the trenches.

Highlighting and shadowing are often dramatic techniques for showing relief. The ruggedness of mountainous areas can be particularly well displayed in this manner.



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GENERAL INSTRUMENT

Perspective or trimetric plots which show a surface as viewed from a particular angle can give a very effective image of the bottom surface. Though not particularly useful as maps for navigation they are excellent vehicles for displaying complex surfaces.

A thematic map would make an ideal chart if only all ships were alike or at least all had the same draught. Consider a simple two-colour chart, red and green. The green areas are safe, i.e. there is more water than the ship needs to navigate safely. The red signifies danger and marks off the area of potential grounding. Such charts would be cheap to produce and maintain and this format might be particularly well suited to the "electronic" charts of the future, but at the moment would be of limited value.

The field sheet is an example of a Digital Terrain Model (DTM), a device high in detailed data content but very low in its ability to transfer an image to the user. It serves reasonably well as a surveyor's tool but it comes to us by custom and tradition rather than by choice. The 1980's field sheet emulates the lead-line field sheets of the 1880's despite the modern methods used in obtaining and processing the data contained on it.

Finally we have contours. They serve reasonably well as image transfer mechanisms, particularly for an experienced map-reader. They are also high in detail content, i.e. the ruggedness of the terrain will result in contours which weave back and forth with each of the surface's undulations. The inclusion of more contours on modern charts was a fairly "soft" change for the new appearance is not radically different. From the surveyor's point of view they are appealing for they can incorporate high density survey data as well as low. For instance a shoal area can be crossed by many survey lines, each line refining the map-image. All of this sounding data can be accessed for the position of critical contour intercepts allowing for a very precise portrayal of the shoal's outline. The chartmaker will therefore have more information to work with when deciding how to portray the shoal on the chart. Contours also appear to be more amenable to other non-traditional uses of charts such as engineering, environmental monitoring, fishing etc. On the other hand contours imply a certain continuity of information which is often unwarranted.

2.1 How Is Survey Quality Transferred To The Chart?

All the above techniques must be evaluated for their ability to display the quality of information on which the image is based. A contour map of a smooth area based on a high density survey will not look radically different from that of one based on a much lower density survey. Yet survey density is an important criterion in evaluating the survey quality. The DTM, on the other hand, explicitly shows the differences in survey density. Furthermore, it makes no implicit assumptions as to the nature of the surface between data points whereas the unadorned contour map implies a continuity of information at least along the contour. In hydrography this is seldom, if ever, valid; traditionally hydrographers aim to intersect the contours at a point, thereby obtaining good information on the contour's location but nothing on its direction.

The following figure shows a contour line with its confidence region. At each survey line the region is narrowest and conforms to

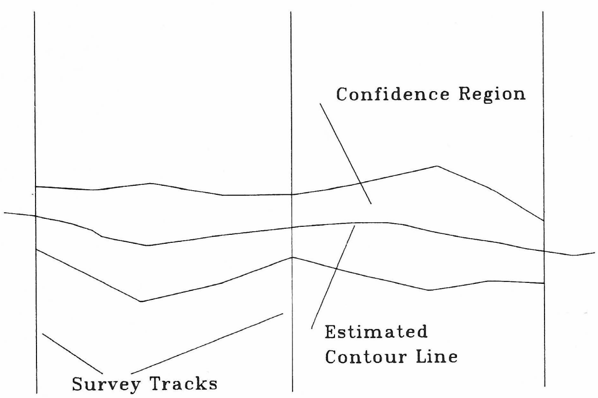


Figure 1

the confidence region associated with individual soundings, say ± 1 m. Between lines the region expands since we are now interpolating between two measurements. The maximum uncertainty occurs midway between two lines.

Unfortunately the survey tracks are not included on the chart so the user has no means of gauging the quality of the survey work. Many new charts partially overcome this drawback by including a source diagram and indicators of survey quality. A chartmaker must make it clear somehow where information is adequate and where it is not.

In evaluating the different methods of image portrayal we need to keep in mind the attributes of a nautical chart. A chart has three main attributes. Firstly it should have detail information which is readily transferred to its user. For instance, we should be able to point randomly at the chart and say "how deep is it here". Secondly it should be able to transfer an image of the bottom quickly and ambiguously. This is necessary for route planning and other strategic purposes. The navigator must be able to see at a glance the outline of a route which will minimize his sailing time and his risk. Finally the chart must be easy to use, clear, unambiguous and of real value to its owner. We refer to this as its utility.

The relationship of these attributes is shown in the following graphic.

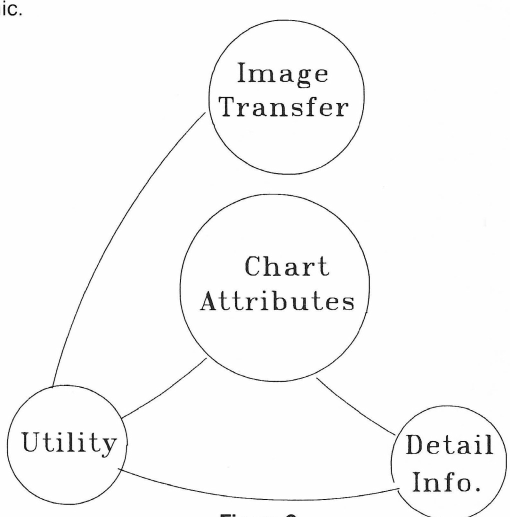


Figure 2

The following graph attempts to rank the order of merit of the various techniques by measuring their success in meeting the desired attributes. Although ranking is in general highly speculative and each of these particular scores debatable, we have found it useful to force some measure on the unmeasurable. The following graph represents to us a reasonable compromise.

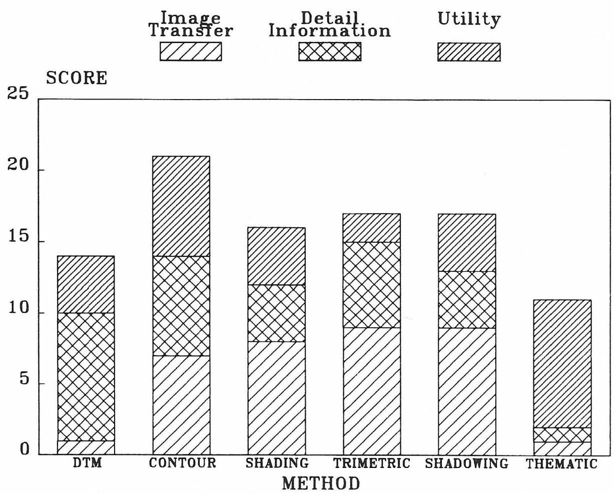


Figure 3

Not surprisingly no one method is good at everything. Contours appear to be a good compromise. It is this universality which has made contours so appealing to a cross section of hydrographers and cartographers within CHS. If the contour format is the way of the future the question becomes "can and should we mechanize this process?"

3.0 The Digital* Age

3.1 Why Do We Mechanize?

Mechanization's main purpose is to help us perform a task more efficiently. It allows us more time to spend on tasks which are not particularly suited for machines, tasks which require some creative thinking. A combine-harvester is an example of good mechanization. Its efficiency gives the farmer freedom to choose the optimum moment for harvesting. The player-piano is an example of bad mechanization. It is a good example of the "if-we-can-do-it-we-should-do-it" school of engineering. We don't want to mechanize those tasks which require some qualitative interpretation or are judgemental.

It often isn't clear whether a task can or should be mechanized. A digital echo-sounder mechanizes the scaling of the echo-gram. This is a well-defined repetitive task seldom calling for interpretation or judgement. Nevertheless at regular intervals it is not obvious, at least to the casual or novice observer, just where the noise ends and the bottom begins. It would be difficult to define the procedure that the scaler performs in these questionable areas. The information at his disposal is immense. He can look forwards and backwards in time. He can examine the echo-grams from adjacent lines. He can peer into the noise and detect subtleties in its density which he can interpret as the bottom. Weeds, schools of fish, soft mud bottoms, etc., all give different acoustic signatures which the scaler detects and uses to help define the depth. Even "smart" digitizers cannot approach this level of skill and it is precisely in these noisy areas that the digitizers break down (or "fail reliably" as the optimists call it). Nevertheless the digitizers work well the vast majority of the time and as long as the total time spent in editing out the bad depths is less than the equivalent scaling time we are ahead.

3.2 Digital Field Sheets

Dozens of field sheets have been completed using digital data. Except for the consistency of the machine-inked soundings, these sheets appear no different from their non-digital predecessors. The line information, including shoreline and contours, is still added manually using the principles laid down 100 years ago. The contour intervals are selected according to IHO standards. By using the field sheet as the point of departure a sheet can also be drawn with many more contours than are prescribed by convention. Such a field sheet would be called contour-intensive to differentiate it from its more traditional brother. A very nice looking contour-intensive field sheet was prepared recently in Central Region for research purposes. The contours were all drawn by hand. It was a painstaking piece of work performed by a craftsman and the result is an impressive document. The contours were all drawn using the traditional "safety-first" rule of hydrographic contouring.

This is one approach to a contour-intensive field sheets but even it's creators would argue that it was not an effective way of using digital data. Their purpose was to create a bench-mark standard to which a computer-contoured sheet would be compared. This is clearly an important criterion for a system to meet — it should be as good as the system it replaces. But there are other things a system must achieve.

The field sheet is, and will remain, the chief vehicle for survey quality control we have. The process of creating a field sheet is in fact a system, complete with checks and balances designed to highlight inconsistencies — the pointers to potential trouble spots. We must maintain this system or replace it with a better one. So the mechanization of contouring cannot simply take the form of pushing sounding data into a machine and pulling off the plotted sheet. If we mechanize this process we must design in sufficient checks and balances, both manual and automatic, that preserve, if not enhance, the quality of our field sheets. We need to have our ideas clear on this before we take the next step.

4.0 The Relevant Issues

4.1 Why

What is the payoff if we adopt machine contouring? Why should we do this? A great variety of reasons have been advocated.

4.1.1 Argument #1 — It Is Objective

The computer is alledged to be unbiased; it responds to one data set exactly as it would respond to another. In general this is seen as being a good thing. Why, for instance, should Smith's survey data be treated differently than Baker's provided they are from similar areas and at similar scales? In fact the computer system is not unbiased. It may be impartial but it **is** biased. This bias comes from the objectives and constraints placed upon the creator of the computer software. For instance, the mathematical algorithm chosen for interpolation can have a dramatic effect on the shape and course of the contours.

In our study we have come across dozens of contouring algorithms — each claiming to be optimum. The optimized characteristic is different in each case. Some minimize a statistical parameter, others computing-time or-space. Each author argues that his algorithm is in some way superior to the others. Clearly each user must decide what characteristics or attributes he wants from a system —but this process could hardly be called objective.

4.1.2 Argument #2 — It Is Consistent

Consistency is widely considered to be a desirable attribute. Two hydrographers given the same data will manually contour in a slightly different manner and the results will have many detail differences. This phenomenon is readily apparent each fall as the field sheets go forward to a checker who invariably points out numerous areas where he feels the contour interpretation is wrong. A computerized system is seen as a solution to this inconsistency.

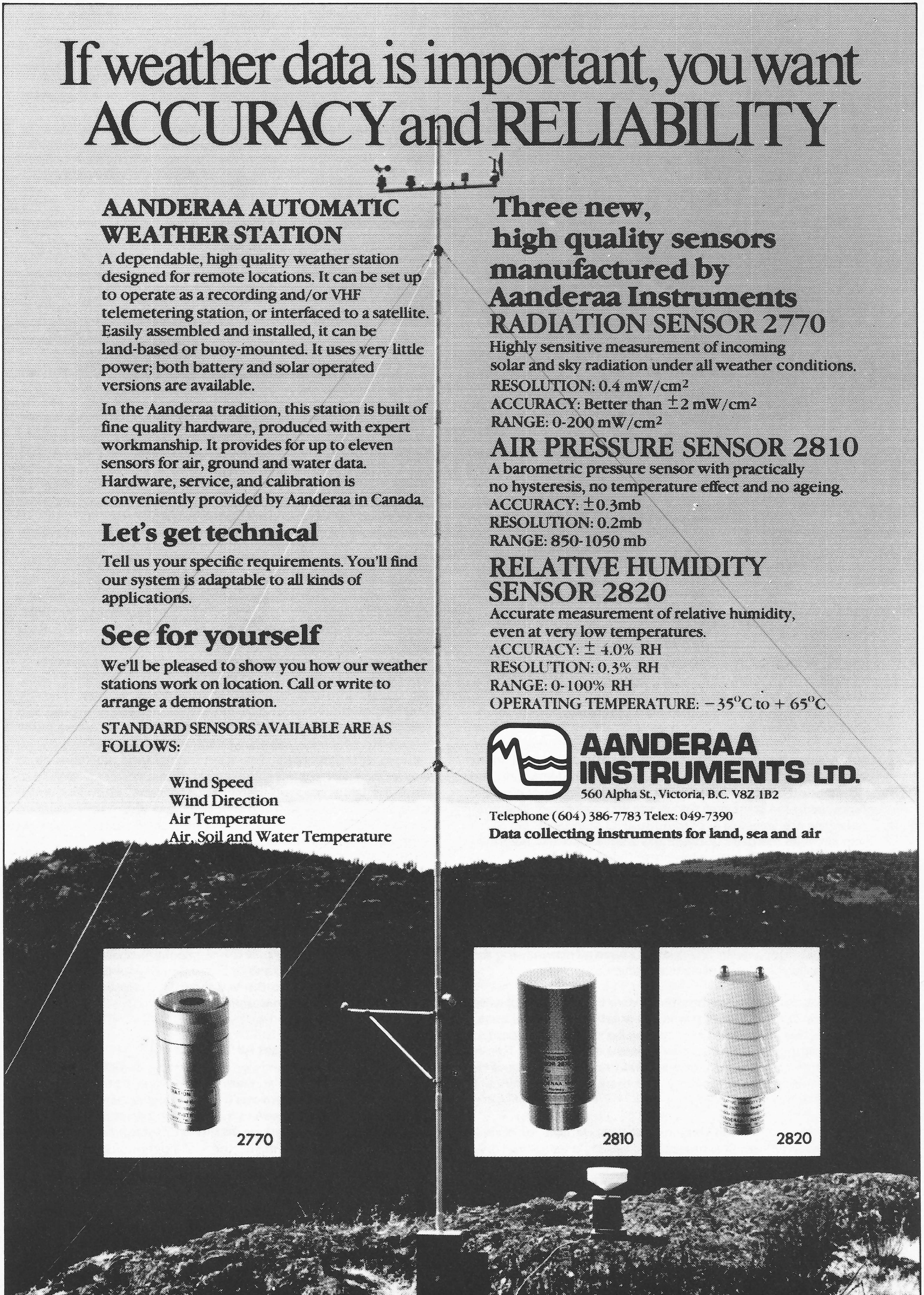
In fact the contours generated by computer can vary a great deal even given the same data and the same algorithm. In some cases the order in which the data is loaded has a strong bearing on the final look of the contours. In order to make their packages more general, authors have designed in parameters which can be varied to suit the tastes and requirements of the user. The variation of these parameters has a strong effect on the shape of the computed contours. Which "interpretation" is correct is left up to the user. So the problem of inconsistency is not solved.

In fact inconsistency is not necessarily a problem but an artifact of the way in which we conduct our surveys. If a sounding is measured more than once it is rarely done on the same day. This alone would add an uncertainty or variance to the measurement due to the day-to-day variations in water level, speed-of-sound, vessel squat, EM propagation etc. If the subsequent observations were made by a different vessel and operator then vessel-to-vessel variation would add further to the variance. The effect this will have upon the contour location is unknown.

4.1.3 Argument #3 — It Uses All The Data

All of the contouring systems we have investigated assume that the input data is in point form and randomly distributed throughout the survey area. The measurements therefore are assumed to be samples from a discrete measuring system with no information available between the observations. In the hydrographic case we have much more information in the form of continuous observations along parallel tracks. This is a feature we exploit in both our manual and digital methods for finding local extrema on a line. These critical soundings are then plotted and the contours derived from this reduced data set.

*By Digital we mean machine-readable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To improve on this a method would be required to extract from the continuous record the point at which the desired contours were intercepted. This has been done manually in the past (Quirk, 1967) when surveying narrow channels. To emulate this process would call for new software to derive both critical sounding and contour intercepts from the raw data. This sub-set would then form the input to a contouring system. This could be done but would double or triple the number of data points selected for contour processing. This in turn might have enormous repercussions on the editing function since all of this data must be screened and erroneous depths removed. Editing is already a formidable problem.

Consider the following example. Here we have a contour defined about a shoal. The original shoal indication came from sounding lines and a check line. The shape and scope of the feature was further refined by a shoal examination. Observations were made on three different days and on two different launches. Contour intercepts were extracted, plotted and joined to define the final contour shape.

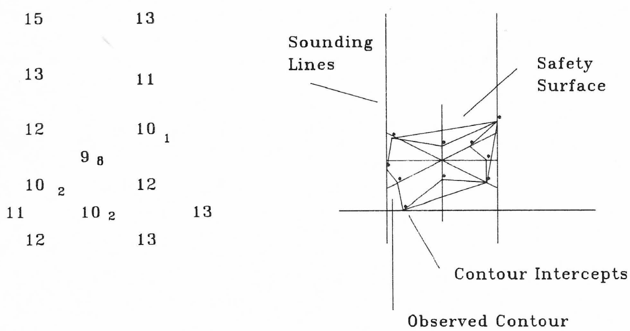


Figure 4

Clearly some form of "smoothing" must be performed on the observed contour. At the same time allowance must be made for the "safety-first" rule. This might be accomplished by first defining the maximum area defined by the intercepts (the "convex-hull") and then smoothing or "generalizing" this line. Such a process can be mechanized but places an increased burden on the system. At present this operation is done manually and in an evolutionary manner as the data becomes available and is inked onto the sheet. It works rather well.

4.1.4 Argument #4 It Integrates Well Into The Automated Cartographic Process

Postulate for the moment a scenario wherein the hydrographer at the completion of his work turns over to the cartographer a contour-intensive field sheet in a digital form. This is then mounted onto a cartographic work-station and flashed on to the screen. The cartographer's function now is to select the most appropriate contours and critical soundings directly from the given data set. Some further generalization will be required to smooth out those contours which, due to a scale reduction, are no longer cartographically acceptable. Other than that the interface between the contour field sheet and the contour chart seems remarkably smooth. If all the field data for a new chart was available in this form then the process would offer clear gains.

Unfortunately the vast bulk of our data is non-digital. If we move towards contour-intensive field sheets only a small fraction of the data available to cartographers for new chart compilation will be in the desired format. This state of affairs will exist for many years. What are the contingency plans for new charts in this change-over period?

Existing digital field sheets could be contoured either by hand or machine. Non-digital sheets could be hand contoured or digitized and contoured by machine. The manual contours would then have to be digitized, verified and edited as necessary and added to the digital data base. Each of the operations adds time to the compilation of the chart. As discovered in the Central Region experiment, manual contouring is a slow, painstaking process requiring high skill and, most importantly, a dedication to excellence. The payoff from this form of automation will be slow in coming.

4.2 Where And When Should We Contour

If the field sheets are to be prepared in a contour format when and where should this be done? There are two avenues of approach.

Procedures could remain as they are. In this approach the procedures now in use on "automated" surveys would continue to be used. At the completion of the survey the verified data would form the input to a contouring package and the resultant contours would form the basis of the new field sheet. In this technique all of the existing quality control procedures developed over the years could be applied. Soundings would be used to verify and justify the machine contours. In this case then the contouring would be done in the office on a main-frame computer **after** the field survey.

Alternatively the contouring could become part of the field processing. Hydrographers could see the image of the object they are measuring develop as their survey progressed. Shoals and other features such as narrow channels which need careful contour definition could be refined as the hydrographer saw fit. Quality control on the contours might be easier in the field where new survey lines could be run to clear up questionable areas.

Contour processing in the field makes sense from the survey point of view. If the hydrographer's objective is to measure contours then he should see them as soon as it is technically feasible. Can they be processed on field computers? Although nearly all commercial contour packages are designed to run on main-frame computers there seems to be no underlying reason why they could not be run on computers of, say, the power of PDP-11. So it appears that machine contouring can and should be done in the field if done at all.

4.3 Safety

Throughout this discussion we have mentioned the safety-first principle in chart-making. How can we preserve or enhance this principle if we move to contour format field sheets?

Firstly, it is imperative that we do — this is our responsibility.

Secondly, we must realize that no existing contour package has navigational safety as a design consideration. We will have to devise our own package or extensively modify an existing one. If we do there are two top-level design considerations we must include: we must preserve or enhance the current level of quality control in the field sheet; in contour interpolation we must strive to err on the side of safety. The convex hull approach of figure 4 is an example of erring safely.

Safety is not an attribute that can easily be added to an existing contour package. It is a concept which must be considered throughout the package design.

4.4 Accuracy

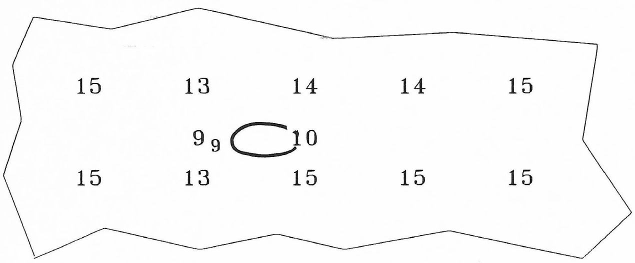
In order to preserve the present level of accuracy in our surveys as reflected in the resulting field sheets we must not only consider the issues of quality control and deliberately erring safely, but also the processes involved in the machine generation of contours. In particular we must consider the mathematical considerations which affect contour accuracy.

The machine-derived contour is an interpolated line. The interpolation is controlled by the spacing between soundings and by the choice of an interpolation algorithm. Although we postpone for the moment (to Part II) an investigation into the mathematics of interpolation there is one high level issue that needs to be addressed. Should the observed data be "honoured"?

By definition an interpolated surface honours the observed data points when all points fall **on** the surface. Generally this approach would be used when the data is assumed to be error-free. If the data contained large anomolies or outliers then the surface would be grotesquely distorted to accommodate the points. This might be useful as a tool for searching for rogue soundings. The fact that the surface is obviously distorted acts as a safety-valve preventing perhaps otherwise unseen errors from escaping correction.

An algorithm which does not honour the points generally fits an analytical surface to the data, usually minimizing the differences between observed depths and the interpolated depths. In contrast to the above case one might assume that the data is not error-free. Rogue soundings will still distort the interpolated surface but not to the same extent. This approach is by far the most common in use and generally results in smooth-looking contours. Since this technique has also found a secure niche in the market place, contour packages of this type are usually more refined and easier to use than the more experimental packages which honour the data points. Optional line widths, contour smoothing and labelling are some of the options which produce a product with high visual appeal and sales.

They can also produce contour lines which pass on the wrong sides of observed depths. In the example in the following figure the 9.9 m depth has a relatively small weight on the interpolated contour since it is overwhelmed by the deeper depths surrounding it. One could argue that there is a statistical justification for this contour interpolation. No measurement is exact, each observed depth has a random error associated with it and one must use classical techniques such as least squares to fine the contour's "most-likely" location. This is the philosophy hydrographers use in adjusting their horizontal control or for solving for vessel position when given redundant LOP's. There seems, however, to be a genuine reluctance to apply this same reasoning to depth measurements. Few hydrographers would be persuaded that this interpolation is correct. Data honouring is an important safety issue particularly in shallower depths.



FIELD SHEET FRAGMENT

Figure 5

4.5 Usefulness

How useful are contours for the task at hand? In particular how useful are they at the survey stage?

Many hydrographers extensively contour their field data as a measure of quality control. This serves a number of purposes. It highlights inconsistencies which must be clarified and shoals which must be examined. Unacceptably wide gaps are apparent. Finally, noise on the data surface becomes obvious. Hydrographers become doubly familiar with their inked soundings which in turn decreases the chances of allowing a rogue sounding to pass through the system.

Machine contour plots can be prepared in the field for the same purpose. The personal contact with the individual soundings however is lost and with it the opportunity of examining the soundings in the spatial context. Consequently it must be replaced with a mechanism with the same degree of quality assurance. Machine contours have a high utility in chart compilation provided a high percentage of the data base for the chart is in this form. If it is not then the utility quickly fades away as more and more of the non digital-contour data is transformed.

5.0 Irrelevant Issues

In our investigation into machine contouring we have found a preponderance of articles dealing with issues which, by and large, we feel have nothing to do with mapmaking. We call these the Irrelevant Issues and list them here.

5.1 Computer Limitations

5.1.1 Processing Speed

A great number of contour packages claim fast throughput as one of their chief attributes. This might be a result of the commercial nature of the EDP business but we need not concern ourselves with this consideration. We will not be buying a service from an EDP group for contour processing. We want a package which runs on our own computers in the field. It should not be a burning issue with us whether a program runs in 30 minutes or 60 minutes. We will be there regardless. We want **reasonable** throughput but place a much higher priority on the excellence of the output.

5.1.2 Memory Constraints

Early contour packages were limited in their ability to contour large areas in one pass due to their inability to store the observed data in "core" in any great quantity. Modern 32 bit proccessors make these limitations a thing of the past. Desk top computers now have multi-megabyte addressing capability. Ultra-fast Winchester disk drives move mega-bytes of data into and out of computer storage enabling these small computers to outperform the main-frames of only a few years ago. Minimizing computer storage in our case makes no sense. If we do not fill it, it will remain empty.

5.2 Aesthetics

Commercial contour packages place a high emphasis on the visual appeal of their output. The contour lines are smooth and clear of ripples — "realistic" in the view of their proponents. Contour labelling is automatic and nicely executed.

Aesthetic attributes like this can have a negative impact on the quality of a map. The smoothing over of wriggles on a contour line nullifys the hard fought effort in obtaining resolution of that order. The least smooth line on a field sheet is usually the shoreline. Ironically this is the one contour line that we do know — and it is seldom smooth! So much for realism.

What is the effect of smoothing on the size and shape of shoaling contours. They might shrink in size. We cannot risk safety for the sake of aesthetics. Beauty must remain a secondary issue.

6.0 Conclusion: Our Musts and Wants

If we decide we should move towards a contour format field sheet we must state in advance what we want. We conclude with attempting to define what items we must have in a contour system and what we can live without — in other words our musts and our wants.

6.1 Musts

6.1.1 Shoal Biasing

This is the safety issue. The method we use to ensure it is not as important as the assurance that it has been done.

6.1.2 Data Points are Honoured

If the depth at a point is measured only once then that measurement is our best estimate of the true depth there. This holds despite our knowledge that it is surely in error to some degree.

6.1.3 Field Processing

To have the greatest utility and to retain our high standards of charting accuracy the contouring must take place in the field where it can be monitored by the Hydrographer In Charge. This means the contour program must be compatible with existing field processing systems.

6.1.4 Inclusion of Barriers

In order to prevent soundings on one side of a point or small island affecting the course of a contour on the other side barriers must be included in the data structure to prevent inappropriate interpolation. Similarly the course of a contour line at the foot of an underwater scarp must not be affected by soundings taken at the top —despite their apparent proximity.

6.2 Wants

6.2.1 Exploits Linearization

Hydrographic data typically comes from sounding lines. We should exploit this feature. We can do this in the following ways.

6.2.1 Use All The Data

All significant local minimums and maximums along the sounding lines should be extracted and used in the contour process.

6.2.1.2 Use Contour Intercepts

The intercepts should be extracted and used to control the course of the contours. As with honoured soundings, if we measure a contour intercept only once then that is our best estimate of its true location.

6.2.2 Works On A Variety Of Data

We have high density and low density surveys. The contour system should be able to handle both types of data.

6.2.3 Confidence Intervals Available

A quantitative measure of the goodness of the contour interpolation should be provided for quality control purposes. This is a non-trivial request but can be done with some approaches such as Kriging.

6.2.4 Interacts With User

In order that the hydrographer remains firmly in control of the operation some system interaction is required. Unacceptable contours must be moved or deleted. Erroneous data must be removed and the contours recomputed. This interaction must be easy, unambiguous, accurate and fast.

6.2.5 Minimum Edge Effect

Running contours out to the edge of the soundings coverage causes weak interpolation. The results are often undesirable contour perturbations — artifacts of the interpolation algorithm used. Some algorithms seem more forgiving than others.

6.2.6 Unstable Areas Marked

In very flat areas the contour algorithm is often unstable resulting in contours running wildly over the sheet. The contour intercept method would be particularly sensitive to this. Imagine the course of a 20m contour in an area where the bottom was flat at about 20m and there was a lm swell running when the soundings were taken. The resulting contour would be heavily affected by the waves.

7.0 Summary

Contouring by machine could literally lead to disaster unless performed in a very careful manner. We are, in general, against any method or system which moves hydrographers further away from their data. Contouring can be mechanized in such a fashion that it works well nearly all the time. We have to be very clear as to where and when it will break down. Interactive procedures will then have to be engaged to use the skill and judgement of the people who actually acquired the data.

Machine contouring might prove to be the best link between the field-survey data-base and the cartographic work-station. But the consequences of a bad design are far worse than the problems involved in smoothing out the bumps in our cartographic processes.

REFERENCES

Quirk, A.; "Accenting The Contour"; Technical Report, Canadian Hydrographic Service, Central Region, February, 1967.

Wild Goose Association Press Release

October 13, 1983
The Wild Goose Association, a professional organization of individuals and organizations having a common interest in Loran (long range navigation) made awards at its twelfth annual convention in Washington, D.C. today, as follows:

Medal of Merit to R. Michael Eaton, Head of the Navigation Group at the Bedford Institute of Oceanography, Dartmouth, Nova Scotia, for his work in hydrographic surveys using Loran-C in precision modes, and his testing, analysis and planning assistance in the expansion of Loran-C in the Canadian area.

Best Paper Award to James R. McCullough, Woods Hole Oceanographic Institution, Barry J. Irwin and Robert M. Bowles, U.S. Geological Survey, all in Woods Hole, Massachusetts, for "Loran-C-Latitude-Longitude Conversion at Sea: Programming Considerations", presented at the 1982 WGA Technical Symposium.

Service Awards to David A. Carter, JAYCOR, Inc., 1982 WGA Convention Chairman and David H. Amos, U.S. Coast Guard, 1982 WGA Technical Symposium Chairman.

Robert L. Frank
Awards Committee Chairman
30795 River Crossing
Birmingham, MI 48010

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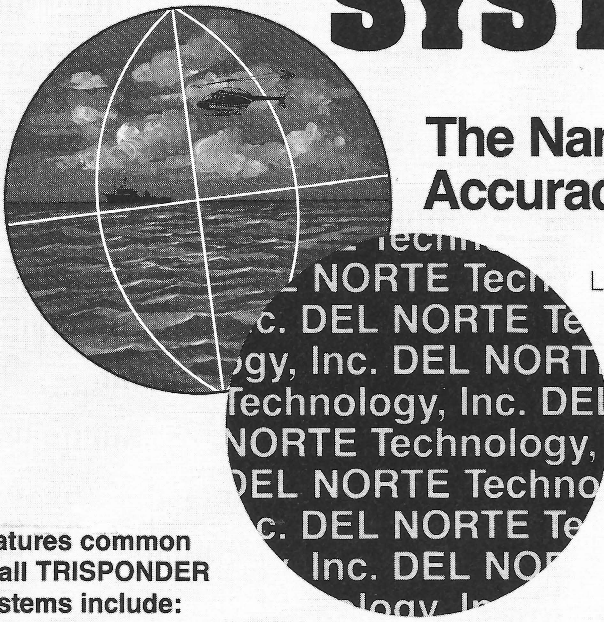

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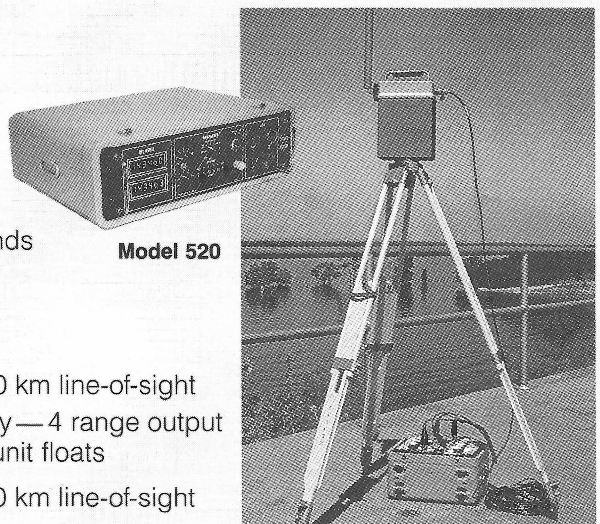

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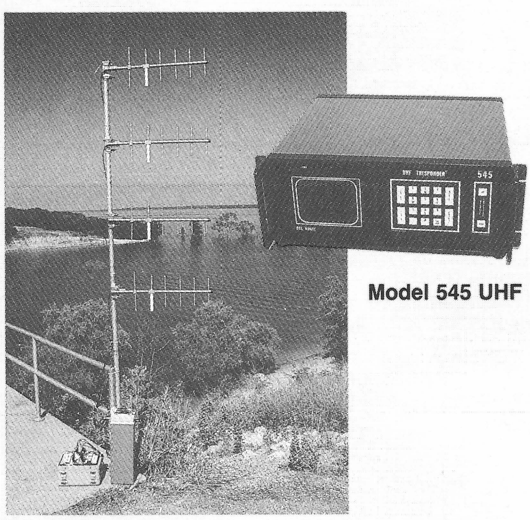

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Airborne GPS Trials

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CCRS, Ottawa

All surveyors are by now quite familiar with the promise of the Global Positioning System (GPS). The literature is filled with articles explaining the theory of GPS, error models, computer simulations and speculations on accuracy, availability cost and its impact on the way we do surveying. So it will come as a surprise to many that GPS is in fact here now-and being used.

The story told in these pictures is of a recent Scanning Lidar experiment off the Bruce Peninsula in Lake Huron. Several different experiments were in fact carried out as part of this exercise but the one of most immediate interest to hydrographers was concerned with the use of GPS equipment both in the aircraft and on the ground.

Figure 1: Nortech's Pat Fenton holds the TI4100's Visual Display Unit (VDU) which displays the position via LED's. The actual receiver shown here at the bottom of the rack. Above it lies the HP9826 microcomputer.

Figure 2: The conical GPS antenna can be seen mounted on the roof of the DC-3.

Figure 3: The Trisponder 540 DDMU is seen here on the lower right. To its left is the low-light-level video tape-recorder. Above it is the floppy disc drive (HP9121).

GPS can be used as a stand-alone system, in partnership with a second receiver (Differential GPS) or with an independent system (Integrated GPS). We used the system in its stand-alone and differential guise. As with the NNSS (NAVSAT), differential operations offer increased point position accuracy due to the cancellation of several unmodelled effects in the position computation. Differential GPS also offers one solution to the yet unresolved issue of P-code denial.

The US Department Of Defence, the owners and operators of the GPS, need some assurance that their system does not get used for strategic purposes by unfriendly nations. Clearly a system which


Figure 4: The installation of the Trisponder antennae. Two antennae are used. An antennae switching unit (seen here to the left of the Master R/T) switches back and forth between the two antennae — one mounted through the roof and the other through the floor of the aircraft. Distances are measured to both antennae but only the shorter distance is used. This arrangement alleviates the problem of range-holes and wing-shadowing.

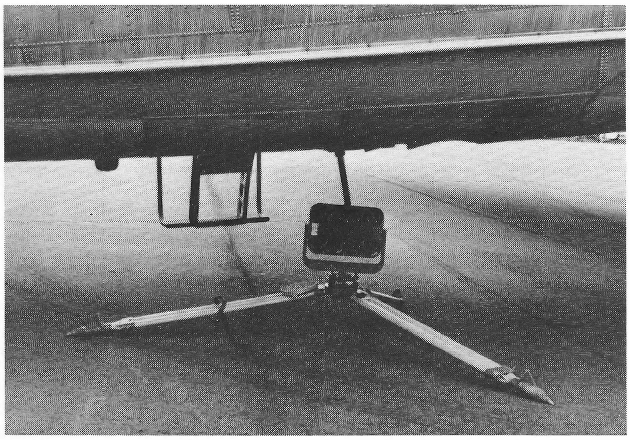

Figure 5: The Trisponder was calibrated daily with a WILD Distomat DI20.

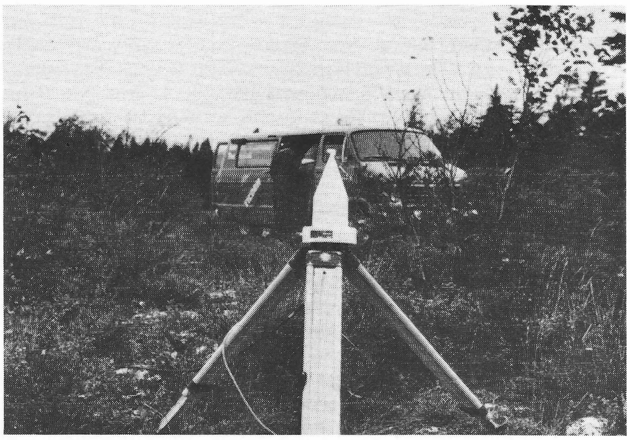

Figure 6: The second GPS receiver was deployed at a known survey station on shore. In the foreground can be seen the GPS antenna. In the background sits the van containing the TI4100 receiver.

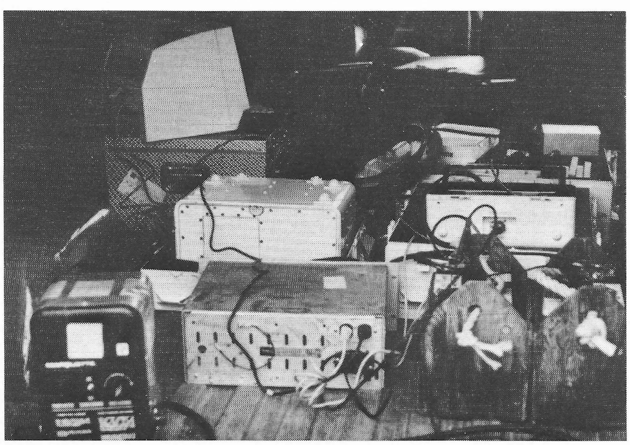

Figure 7: Inside the van. In addition to the TI4100 and its tape recorder is a Cesium Frequency Standard and associated power supplies.

supplied continuous 3-D positioning anywhere on the globe has many strategic uses. The proposed solution to this problem is to deny access to the most precise GPS signals (the P-code). Such a denial would reduce the expected accuracy considerably — from about 10 metres to about 200 metres. Non-approved users would still have clear access to the less accurate C-code. Differential GPS however will (apparently) recover all of the lost accuracy. That is, two GPS receivers would simultaneously record C-code positioning data. One at a known station the other either mobile or at another (but unknown) station. The position differences recorded at the known station would become correctors for the unknown station(s). This is a simplistic description of the process but in essence this is how it will work. And this is why in our trials we had the two receivers — even though we still have (and apparently will have for the next 5 years) access to the P-code.

The purpose of this experiment was to verify the expected accuracy of the GPS against a well calibrated and well known conventional positioning system such as Trisponder. The transponders were arrayed along the shoreline to give good geometry for typical Lidar flight lines as well as to test differential operations at distances as great 60 Km from the reference station. The system was deployed so that three good ranges were available at the aircraft throughout the test zone. Aircraft altitude information was acquired with the Lidar. The GPS and Trisponder data was acquired by a HP9826 micro and recorded on floppy discs. Two Trisponder and one GPS position were recorded per second.

In order to solve for the position (x, y, z) of the aircraft plus find the receiver's clock bias four satellites are required. Since the GPS is currently in its development stage a full constellation of satellites is not available for full 4-D fixing 24 hours per day. For these trials four satellites were available (i.e. visible) for a period of only about three hours in the afternoon. At the reference station a Cesium Frequency Standard was used as the receiver clock so that only three satellites were necessary for its 3-D fix. This extended its operational period for about another hour.

A variety of flight lines were flown. Some were typical of what we expect Lidar flight lines to be like once that system is operational in 1985. Other flight lines had a number of manoeuvres performed to test the GPS receiver's ability to track the aircraft through some tight turns. Box-shaped lines were flown as were sweeping S-bends, both vertical and horizontal.

Since the data is currently being analyzed it would be inappropriate to draw conclusions on the GPS accuracy. We can say that GPS is remarkably easy to use and requires little in the way of operator interaction or set-up time. The data is available in the form of Latitude and Longitude every second and sufficient quality control indicators are available to judge the individual fix quality. In addition software is built into the TI4100 to perform straight-line navigation.

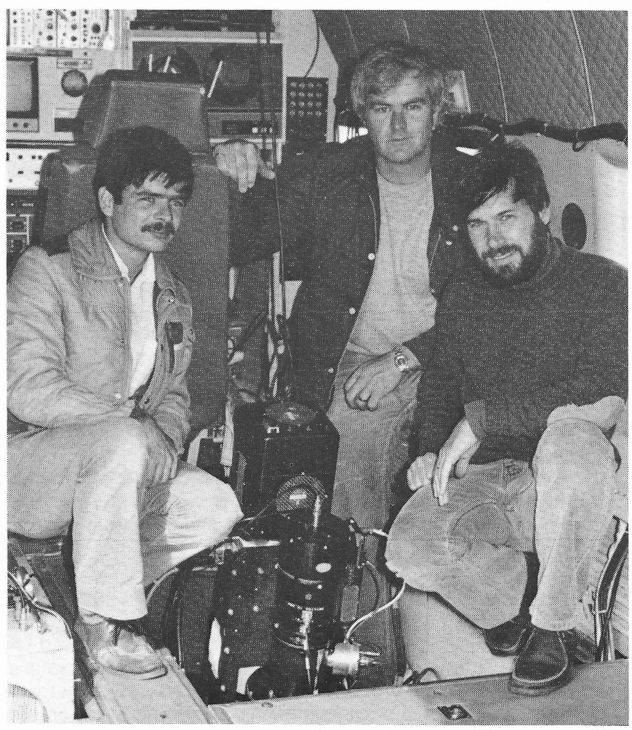

Figure 8: Three Aerial Hydrographers; Kent Malone, Dick MacDougall and Mike Casey with the new 26 Hz Lidar.

Annual Report 1982-1983

A. D. O'Connor, President

Canadian Hydrographers Association

1982/1983 was a successful year for C.H.A. Our membership continues to expand and our activities on the Branch, National and International levels continue to diversify.

In February 1982 the Quebec Branch co-hosted, with the Canadian Hydrographic Service, the first of what will become a biennial event, a National Hydrographic Workshop. This extremely successful workshop was held in Quebec City and participants attended from across the country. The purpose of this workshop was to promote discussion between hydrographers and it certainly achieved its aims, full credit should go to Chairman Ron Saucier and his organizing committee from Quebec Branch.

In April 1982 I was pleased to represent C.H.A. at the C.I.S. Centennial Conference in Ottawa and to convey our members' congratulations on the C.I.S. 100th Birthday and best wishes for a successful second century. At a meeting of the C.I.S. Hydrographic Technical Committee it was proposed that the Committee and the Canadian Hydrographers Association co-sponser, if demand warranted, a workshop on Electronic Positioning Systems from the User's Point of View. Central Branch volunteered to host the workshop and proceeded to ascertain that a demand existed and to organize the workshop. Dick MacDougall, George Macdonald and Central Branch are to be commended for the fine job of organizing this workshop which was held in Toronto in January 1983. The workshop was over subscribed and was very successful both technically and financially.

Meanwhile in December 1982 I represented C.H.A. at the Hydro 82 Symposium at the University of Southampton in England. This symposium was cosponsored by C.H.A. and the Hydrographic Society. While attending this event I was invited to participate in a series of meetings of the Hydrographic Society to discuss the International development of the Society. Branches are in existence in the U.S. and the Netherlands and requests have been received from groups of hydrographers in other countries who wish to form Branches. One of the items on the agenda was affiliation with existing organizations such as the Canadian Hydrographers Association and the Japanese Hydrographers Association. C.H.A. members Mike Casey and George Macdonald who presented papers at the symposium kindly attended these meetings to give support. Unfortunately the affiliation question was not raised as discussions centred around the organization of a council or governing body of the Hydrographic Society if and when more International Branches are developed. Presently 28 members of the Hydrographic Society reside in Canada. Certainly the question of affiliation or perhaps the formation of a Canadian Branch is going to be raised in the not too distant future. I would like to see some discussion on these possibilities in "Lighthouse" because when the question is raised we should be prepared to answer.

In April 1983 the C.H.A. co-sponsored with C.H.S. the Centennial Conference of the Canadian Hydrographic Service. This event was held in Ottawa and over 500 delegates attended. Unfortunately due to business commitments I was unable to attend, however Past President George Macdonald kindly consented to act for me on your behalf.

So concluded a busy year for C.H.A. and 1983-1984 promises more of the same. Ottawa and Pacific Branches are considering organizing workshops, a new branch is in the making in Alberta, and I am discussing the co-sponsorship of the Second International Hydrographic Technical Conference with the Hydrographic Society. This conference will be held in England in 1984.

In closing I would like to thank the Branch Vice Presidents and their executives for their support and hard work over the past year. Secretary-Treasurer Ray Chapeskie's work is greatly appreciated as is that of Dick MacDougall on the Toronto workshop. My duties as your President have been made much easier thanks to the continuing support of Past President George Macdonald. I must also thank my employer Terra Surveys Ltd. for their generous support of my activities on your behalf.

Hydro 82 Proceedings Published

Proceedings of Hydro 82, The Hydrographic Society's fourth international biennial symposium held at the University of Southampton last December which was attended by delegates from 16 countries, have been published.

They comprise four volumes consisting of a series of 28 specialised technical papers presented by leading hydrographic authorities from Canada, Denmark, Norway, West Germany, the UK and US. Vol 1 deals with Acoustic Navigation and Control; Vol 2, Specialist Technical Papers covering contemporary echo sounding methods, heave compensation, inertial positioning for submersibles and the disposal of high level radio active waste in the oceans; Vol 3, Data Acquisition and Processing; Vol 4, Civil Engineering.

Volumes at £40 per set or separately at £12 each are available post free from The Hydrographic Society, Asta House, 156-164 High Road, Chadwell Heath, Romford, Essex RM6 6LX (Tel: 01-599 9991). They may also be obtained from The Society's Netherlands and US branches at equivalent currency rates.

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Loran-C Calibration of Large Scale Charts

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Introduction

Loran-C is a low frequency radio-navigation aid that in recent years has become a popular offshore navigation tool around the globe. However its absolute positioning accuracy has been limited by the ability to predict the phase lag associated with overland groundwave propagation. This "Additional Secondary Factor" (ASF) problem is especially critical in the hazardous near shore region where the LF signal is subject to local anomalous land path effects.

During the last five years over a dozen calibration data sets have been gathered around Atlantic Canada aboard ships such as the C.G.S. Narwhal and the C.S.S. Maxwell. Nearly all of these tests were designed to check and develop models for predicting ASF phase lags by using the time of arrival (TOA) observations. Thus, each observed true ASF contains land path effects from only one of the transmitters. Unfortunately this is not the case with time difference (TD) observations. However, the TD observations can be used to verify ASF models by gathering large amounts of calibration data without the need for expensive TOA receivers, cesium standards and mini-computers.

This paper will briefly describe the method employed by the Navigation Group of the Canadian Hydrographic Service (Atlantic) during the summer of 1983 for the calibration of ASF phase lags on large scale nearshore charts. This new two man operation performed by the authors was used to calibrate the large scale charts in the Halifax, Saint John and Grand Manan Island areas of Atlantic Canada.

Equipment Preparation

The first attempts at a local calibration, at the mouth of Halifax Harbour, were performed by simultaneous sextant angles aboard a 46 foot fishing type boat. Despite two days of satisfactory results it was decided to attempt an alternate method of calibration because the plan for the remainder of the season was to allow two summer students to perform similar surveys in the Saint John and Grand Manan Island areas of the Bay of Fundy.

The boat chosen was a 18 foot Avon Sea-Rider rubber inflatable with a double fiberglass hull. This model proved to be quite safe and sea-worthy and afforded the extra luxury of being quite manoeuvrable when landing ashore. These were the three main requirements as the work would be carried out in areas that experience abrupt changes in sea conditions. The Avon boat also offered conveniences in transportation, launching, loading, receiver protection, antennae placement, fuel storage and equipment handling.

The next step was to choose an alternate positioning method because sextant fixing in a low open boat, with strong tide currents and hazy conditions would be very difficult. The Mini-Ranger System I was chosen because it could meet the accuracy requirement, provide the range needed and was portable enough for landing ashore with a small boat.

The remainder of the calibration work in the Halifax area was used to test the new equipment and method for its practical merits.

CALIBRATION REQUIREMENTS AND PROCEDURES

The given accuracy requirements were to be $\pm$ 0.2 μs in Loran-C and $\pm$50 m or better in position. Three positioning methods were used in the following order of preference:

1) At sea, by two MRS ranges, with a check range or sextant angle wherever possible, and at least every 6 km.
2) At sea, by two sextant angles, with a check angle or a MRS range wherever possible and at least every 6 km.
3) on land, on a coordinated point or by position identification of a point map-spotted to $\pm$1 mm at 1:50 000 scale.

The measurement procedure would begin with stopping the boat in an area where calibration data was necessary and letting the Loran-C receivers settle for about four to five minutes. The Decca 1024 Loran-C receivers (as do most) have a second order tracking loop which compute the TD's in advance of the boat when in motion. This avoids any lag in TD readings between reception, processing and display of the signal.

Simultaneous readings of MRS ranges and Loran-C 5930 chain TD's were recorded as one set of observation. This was usually performed three times at each point. This provided a visual check against any gross errors as each set would show a steady decrease or increase in ranges and TD's as the boat would drift due to the tide currents and wind. Loran-C 9960 chain was also recorded when the receiver could lock onto the weak master signal.

DATA PROCESSING

With only hand-held calculators available in the field only one set of observations at each point was processed. However this still allowed sufficient monitoring of the data to ensure that accurate and reliable results were being obtained. Usually performed on bad weather days, these calculations did not consume any time that could have been used to take measurements.

The observed MRS ranges were reduced to geographical coordinates using programs written for the HP41CV and the **predicted** TD's for these points were calculated using a TI 59 calculator.

The **observed TD's** at these known points were subtracted from a pair of total sea water path **predicted TD's** to obtain the **observed ASF corrections**. The signs of these corrections were changed to give **observed ASF errors.** By subtracting **predicted ASF errors** from **observed ASF errors** one obtained the **residual ASF errors**. It is these residuals ASF that are used to indicate the reliability of present models used for predicting ASF phase lags.

At the end of the project the entire collection of data was entered into the HP 2100 mini-computer at the Bedford Institute of Oceanography for a more complete analyses and processing.

PRELIMINARY RESULTS

Figure 1 shows the coastline of the Halifax Harbour and Vicinity calibration area and the groundwave transmission directions of the 5930 chain.

A series of typical observed and residual ASF-X error values were taken from the Halifax data and plotted along line A in Figure I. This line was chosen to be in the same direction of the Caribou, Maine master signal so that any changes due to land path would occur on the Nantucket, Mass. signal only.

The graph of observed ASF-X values in Figure 2(a) shows a steady increase in ASF error of 1.0 μsec moving away from the shore. This large gradient is a combined result of a master signal phase recovery, a decrease in local land shadow of the slave-X signal (Figure 1) and a decrease in total land path along the Nova Scotia coastline from Nantucket.

The graph of residual ASF-X values in Figure 2(b) indicates the inadequency of present models for prediction ASF errors in the nearshore regions. However, the consistency of the residuals indicate that local models for corrections to be applied to presently predicted ASF errors may be possible.

COST AND LOGISTIC CONSIDERATIONS

To properly judge the success of the calibration project using the Avon boat, a brief comparative cost analyses should be made against other possible methods of operation. No attempt will be made to assign dollar values, rather relative quantities will be used

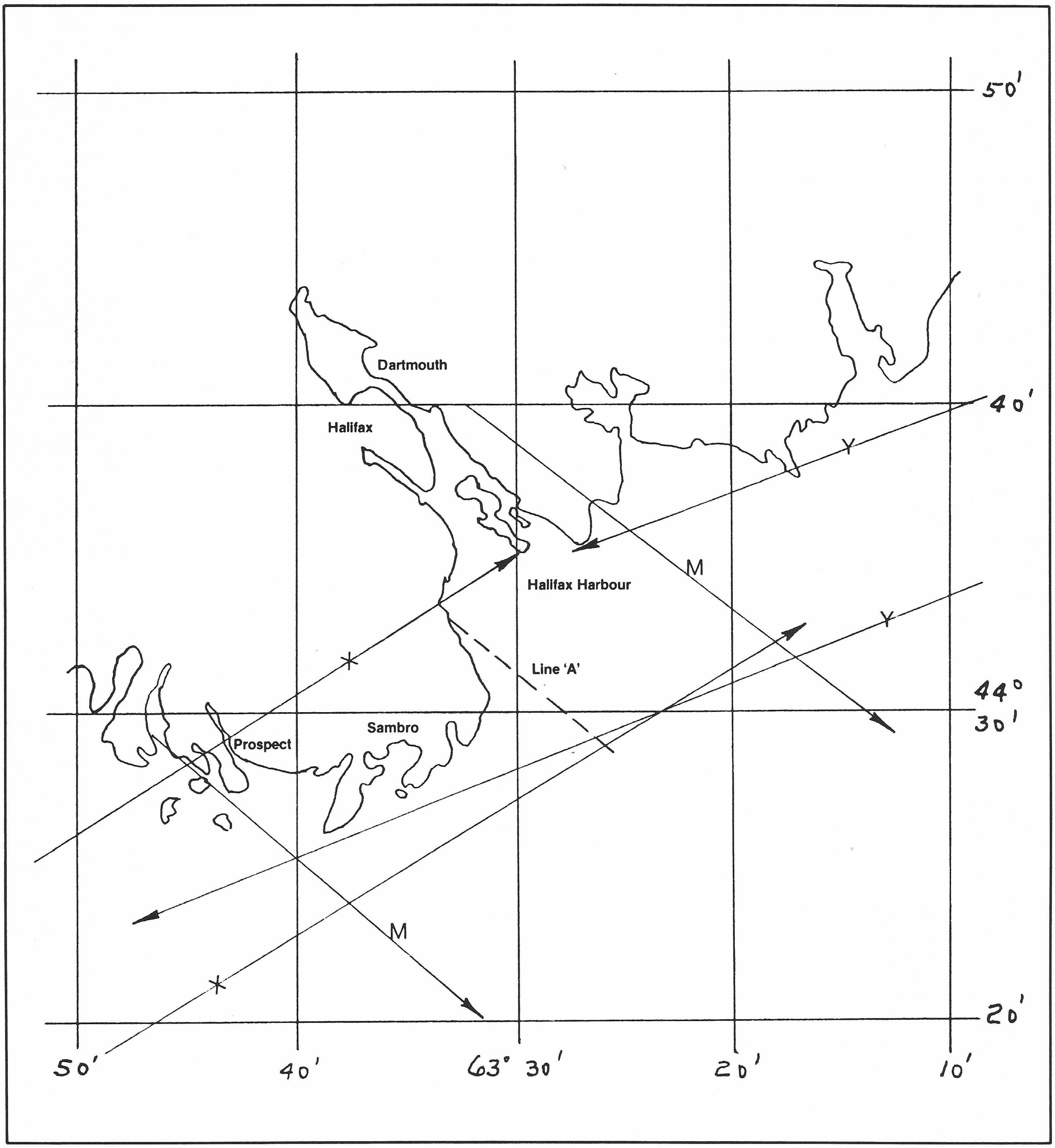

Figure 1
Halifax Harbour and Vicinity
5930 Chain

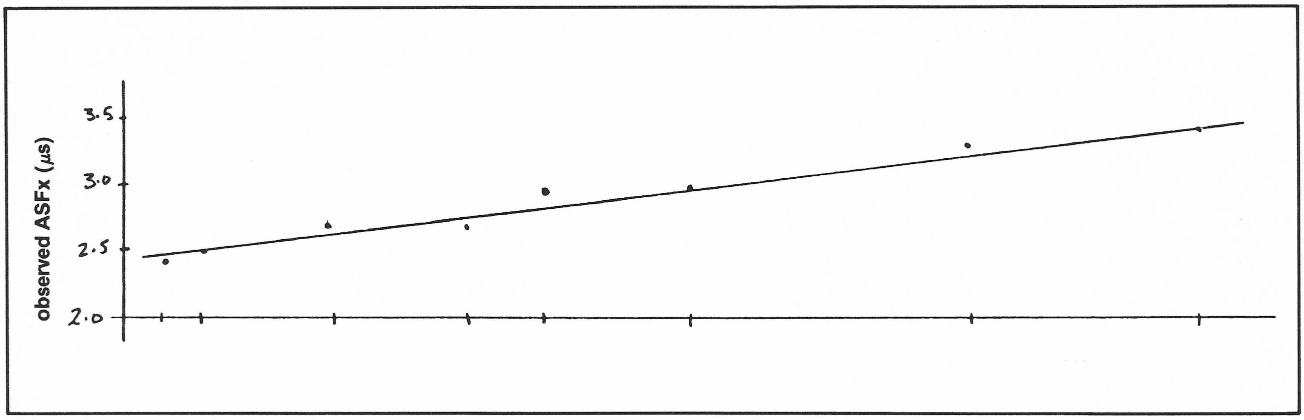

Figure 2a
Observed ASFx Line 'A'

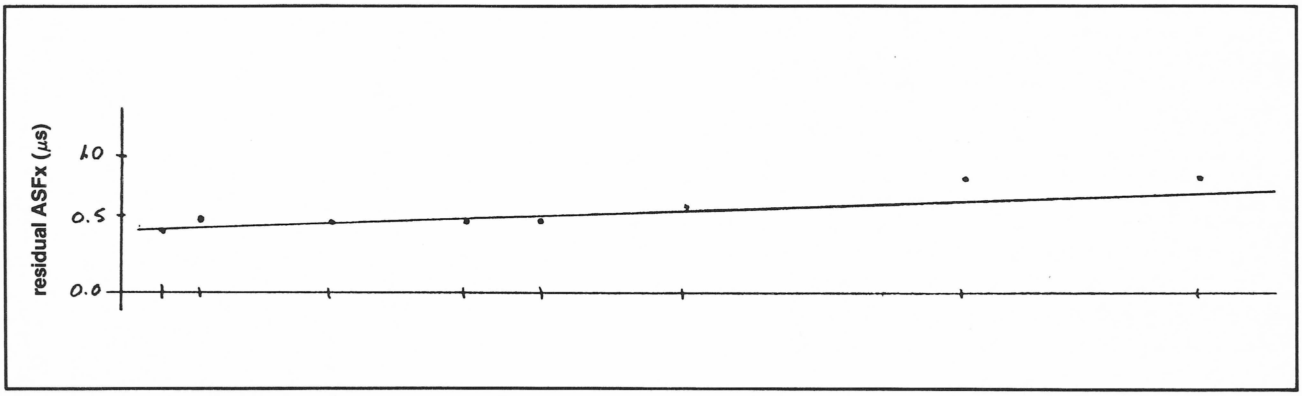

Figure 2b
Residual ASFx Line 'A'

to obtain an indication as to which would be more cost effective. At the same time there are intangible costs and benefits that must be included.

Two important facts to be noted about the Avon boat operation are firstly, that working hours were evenly split between setting up and carrying out the survey with the boat and working on land with reconnaissance, shore observations, data processing, bad weather and equipment down time. Secondly, only about one quarter of the time with the boat was actually spent taking observations, as the rest was used for reconnaissance, setting up and maintaining the MRS I transponders.

One alternate operation would be to use a 32 foot hydrographic launch. However, the only true cost advantage here would be possibly the ability of take observations on days unsuitable for the Avon. This is a minor consideration due to the small amount of time spent collecting data. Some of the intangible advantages here would include such things as extra protection for the receivers, comfort and the extra safety factor due to the increased size of the boat.

Disadvantages would include transportation of the launch over long distances, increased fuel and maintenance costs, as well as extra salary, overtime and expense costs for a coxswain. The slower speed and decreased manoeuvrability would also slow the progress of the survey compared to the Avon, the launch would not be practical for landing ashore and thus a smaller portable craft would have to be carried, further complicating and slowing the process.

As in the past the calibration could be performed in conjunction with the regular duties of a large survey vessel. However, this would severely limit the freedom of the survey operation. This method offers no more advantages than using a launch while at the same time it presents higher costs and logistic problems. It appears totally unsuitable for a dense local calibration operation described in this paper.

Another possible alternative would be the employment of a helicopter to do the survey. This would certainly decrease the time spent in reconnaissance, setting up and maintaining MRS transponders. The observation time could also be decreased with the increased speed of the helicopter. However, will saving operation time offset the high costs of helicopter rental, pilot's salaries, expenses and downtime due to bad weather? This method certainly deserves a more detailed analysis to fully evaluate it's potential as a possible alternative.

CONCLUSIONS

Despite the need for a thorough computer processing to properly analyse the consistency of the data, the preliminary results seem to indicate two important points. First, the scatter of the observed ASF's appears to have fallen within the ± 0.2 μsec accuracy guidelines and second, the residual ASF's have shown some consistent trends in each area which will allow easier modeling of the offsets required for the predicted ASF's.

Finally, after indicating the cost and logistic differences with each alternate method, some mention should be made of the role that the individual calibration areas play in choosing the best operation. Each area will offer specific advantages and disadvantages to each alternative. For example, how many different MRS transponder setups will be required and how accessible are the best locations for them? This will determine the ratio of the amount of time spent dealing with the transponders and the time spent actually taking the observations. This has a bearing on the best method to be used in the calibration. However, the method incorporating the use of the Avon seems to have been quite successful on its first attempt.

The Microfix 100C: A Preliminary Evaluation

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Institute of Ocean Sciences
Canadian Hydrographic Service
Sidney, B.C.

Introduction

In January of 1983, the Canadian Hydrographic Service, Pacific Region, purchased two Microfix 100C instruments. These are lightweight, microwave based E.D.M.'s and require a pair of units for a distance determination. They were purchased as a possible replacement for an aging collection of MRA3's.

The testing of these instruments was conducted over a two month span from February 22 to April 20, on a variety of different lengths, surface reflectivities and meteorological conditions.

Instrument Details

The Microfix consists of a small (22 cm × 22cm × 12cm) measuring unit with a NiCd battery pack attached to bottom, mounted in a yoke assembly with horizontal and vertical adjustment clamps. An antenna cone (standard configuration) is screwed on the front, and the battery and handset are plugged into the back (see Figs. 1 and 2). All operations are carried out using the handset which incorporates a keypad, liquid crystal display, microphone, speaker and on/off switch.

Each carrying case comes with above plus a spare battery, battery charger, external power cable (12v D.C.) and user manual. All parts are encased in hard plastic and are rainproof. The batteries are stated as lasting 3 to 4 hours in continuous operation, with a 12 to 14 hour charging time for fully discharged batteries. Operating temperatures are listed as ranging from -20° C to +50° C.

There is a variety of secondary functions available on the handset including voltage level, index of refraction input (determined from a nomogram), antenna code input and a two second beep. The beep feature is a means of alerting the other operator that voice communication is desired. This arrangement is necessary because of the low volume telephone-like configuration of the handset.

Figure 1.

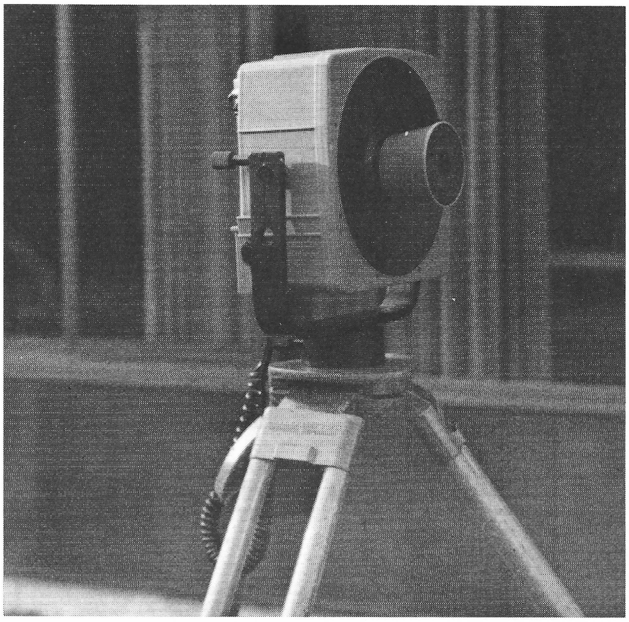


Figure 2.

One of the selectable options is that of multiple fine readings resulting in a mean of between 1 and 16 fine measurements.

As the production of these instruments has only recently begun, not all of the proposed software was available for our units. We therefore were unable to test all the intended features which include a dynamic mode operation, a slope to horizontal reduction, an index of refraction correction calculated directly from meteorological readings, and a means of transferring information over the line via a carrier modulated data channel.

The Microfix utilizes a carrier wave of 16,250 MHz with a power output of approximately 20 mW. A measurement sequence consists of an automatic and rapid run through 18 frequencies, each of which differs from that returned by the remote by 15.625 KHz. These are combined in pairs for 9 resulting frequencies. The 9 corresponding wavelengths range from about 2 m to 153 km. The distance is derived from the phase difference between transmitted and received modulations at the master end.

There are three antennas available; the short (permanently mounted) antenna with a 45° beamwidth and 14 dB gain, the standard antenna (shown in the photograph) with a 6° beamwidth and 26 dB gain, and an optional long range antenna with 3.5° beamwidth and 31 dB gain.

The specified ranges are:

short to short antenna:	10 m-2 km
short to standard antenna:	20 m-8 km
standard to standard antenna:	30 m-30 km
standard to long antenna:	40 m-45 km
long to long antenna:	60 m-60 km

The manufacturer claims an instrumental accuracy (with standard or long range cones) of ± 15mm ± 3 ppm (means square error) for a single determination of distance.

Operation

After turn on, one operator selects his end to be master, whereupon the instruments automatically tune each other in, an operation that lasts less than two seconds. There is no warm-up time and duplex voice communication is available as soon as the machines are tuned.

The instruments are then pointed for maximum signal strength, which is displayed by both a bar graph (coarse signal strength) and a 2-3 digit number (fine signal strength).

Distance measurement can now commence. If a different refractive index N value (default = 325), or a different antenna code (default = 22 for standard-standard), or a different number of fine readings (default = 1) is desired, the appropriate settings should be entered at this point.

After the measurement sequence is completed, the distance is displayed showing seven digits. The mm digit is shown if the distance is less than 10 km and cm digit if greater.

Testing

Tests were conducted to determine the following objective:
— is the accuracy within specifications
— what kind of repeatability can be obtained
— how many observations should be taken at one end
— should observations be taken at both ends
— will it measure up to the maximum range specified
— how does it perform in heavy rain
— how critical is the pointing
— is there any ground swing effect over seawater
— how long do batteries last
— what kind of results are obtained when one or both cones are off

Trials with different numbers of fine readings were conducted on a 2.5 km baseline set up at Victoria International Airport. Observations were made using both instruments (Nos. 141 and 142) alternately as master. Fifty observations each (36 in one case due to a dead battery) of 1 fine, 8 fine and 16 fine readings were made. Meteorological corrections were not necessary for comparison graphing and were only applied to the means later on, (meteorological readings were taken throughout the trials and showed negligible change). A zero correction for each unit (+17 mm for #141, +26 mm for #142) was applied to all observations to account for a constant bias in the instrument's electronics. The manufacturer hopes to eliminate this on future models.

Figures 3a, 3b and 3c show the zero corrected distance observations for the three groups, and Figures 4 and 5 show the variation of the mean and standard deviation respectively.

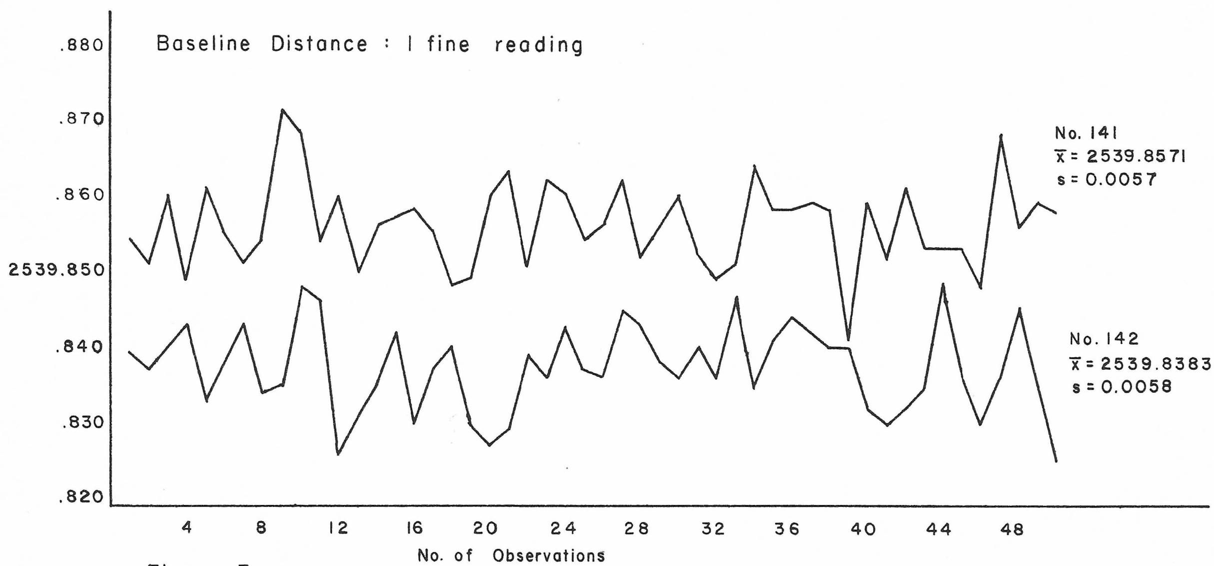


Figure 3,a

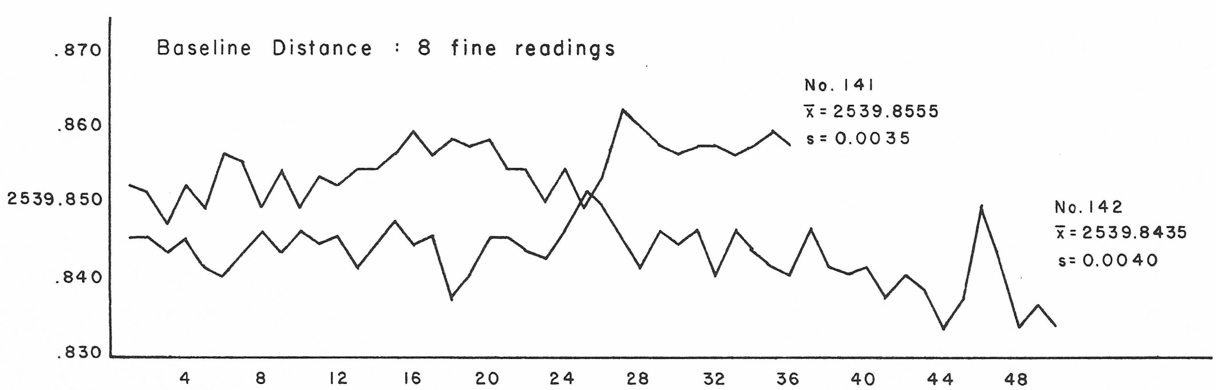
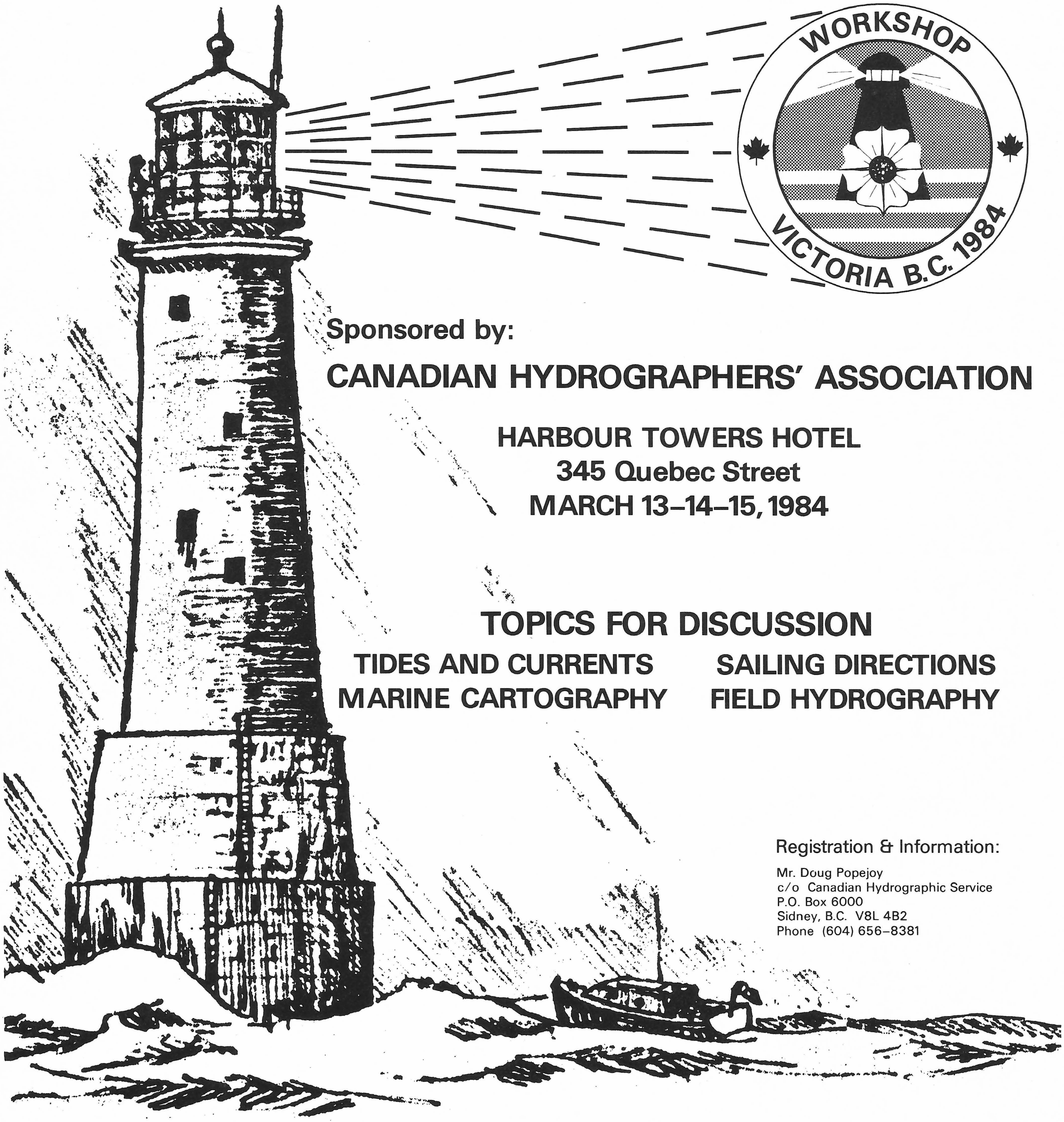


Figure 3,b



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HARBOUR TOWERS HOTEL
345 Quebec Street
MARCH 13–14–15, 1984

TOPICS FOR DISCUSSION

TIDES AND CURRENTS — SAILING DIRECTIONS
MARINE CARTOGRAPHY — FIELD HYDROGRAPHY

Registration & Information:

Mr. Doug Popejoy
c/o Canadian Hydrographic Service
P.O. Box 6000
Sidney, B.C. V8L 4B2
Phone (604) 656-8381

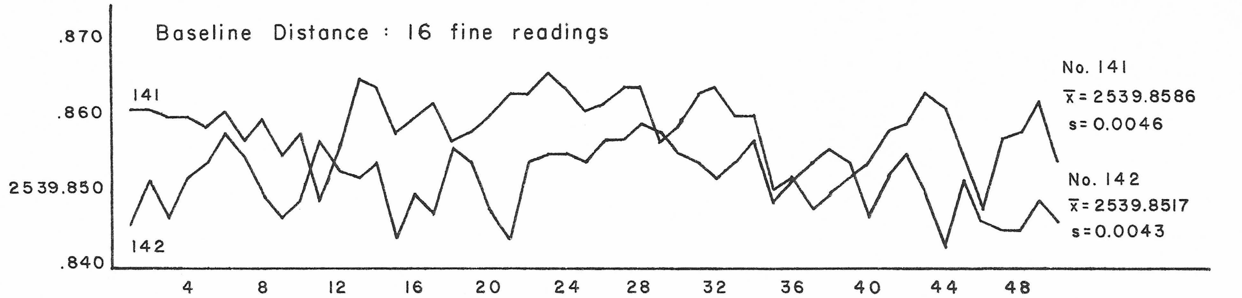


Figure 3,c

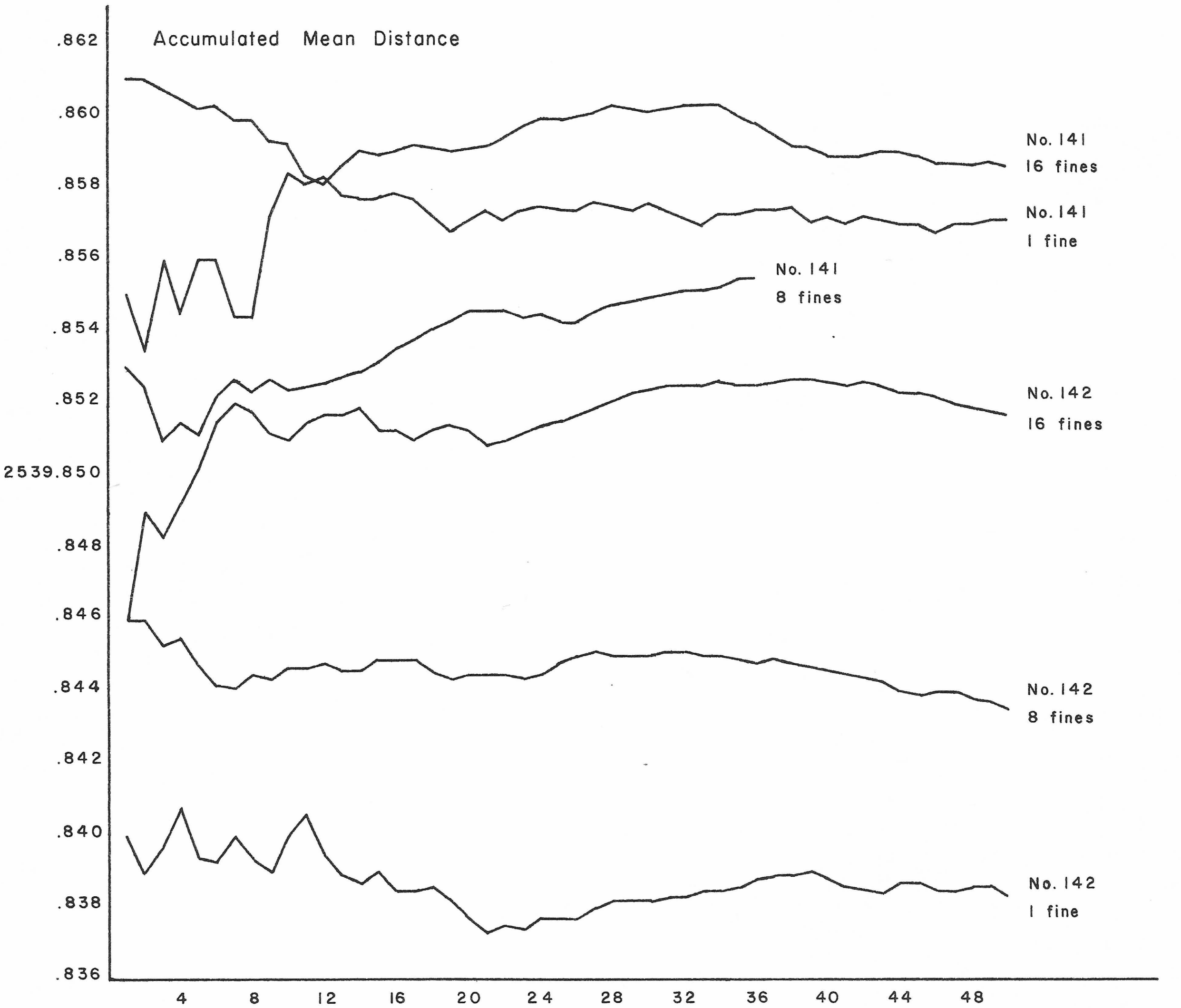


Figure 4

As expected, means of 8 fine readings are significantly better than one, but means of 16 fine readings show little improvement over 8. The data also show that for the 8 and 16 fine readings, the means settle down after 6 to 8 observations.

The difference between the two instruments seen here is typical of observations in general, and ranged from approximately 5 mm to 2 cm. The size and sign of the difference did not appear to be consistent.

Testing for measurement accuracy was done on various lengths of lines ranging from 70 m to 32 km. Table 1 shows the line measured, the number of observations made each way (each observation consisting of 16 fine readings), the mean distance of the two units and their difference, the G.S.C. or computed inverse distance with Microfix difference, Geodimeter distance with Microfix difference, and the mean data spread and standard deviation of the readings. The AGA Geodimeter was a model 122 and was used in the automatic update mode for two minutes to give a mean of either 24

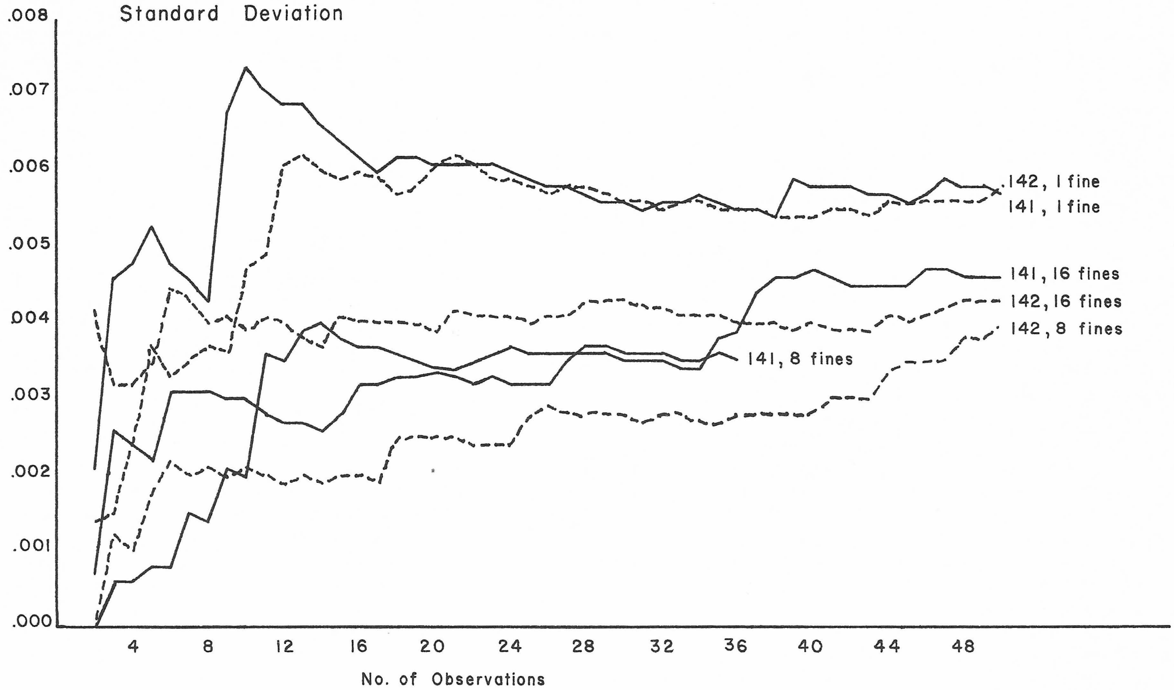


Figure 5

TABLE 1

Line	No. of Obs.	Microfix 100C Mean Dist.	Microfix 100C Diff. 141-142	Established G.S.C. Dist. or CHS Inverse	Microfix -G.S.C. Diff.	Microfix -AGA Diff.	AGA Geodimeter 122	Microfix 100C Mean Spread	Microfix 100C Mean Stnd. Dev.
Sta.1-Sta.2 : Slope	10	70.9039	.0023	70.888	.016	.0174	70.8865	.003	.0007
I.O.S.#3 : Slope	10	177.6757	.0115			.0091	177.6666	.002	.0007
I.O.S.#2 : Slope	10	294.6593	.0099			.0101	294.6492	.004	.0010
I.O.S.#1 : Slope	10	432.7984	.0098			.0461	432.7523	.003	.0010
Sta.A-Sta.B : Slope	5	664.4415	.0120			.0217	664.4587	.003	.0013
PAT-NEIL : Slope	10	666.060	.0020	665.962	.098	.0335	666.027	.010	.0031
Sta.1-Sta.4 : Slope	10	1024.6420	.0126	1024.617	.025	.0217	1024.6203	.013	.0039
Sta.0-Sta.5 : Slope	30	1811.5075	-.0199	1811.402	.106	.0993	1811.4082	.099	.0203
Vic.Airport : Slope	50	2539.8374	.0069			.0427	2539.7947	.017	.0045
DIE-PHA : Slope	20	3157.6182	-.0020			-.0539	3157.6721	.007	.0018
TOLMIE-DOUG : Slope	20	4328.6921	-.0017	4328.678	.014	-.0550	4328.7471	.018	.0051
TOLMIE-DOUG : Slope	10	4328.7034	.0083	4328.678	.025	-.0410	4328.7444	.012	.0040
TOLMIE-DOUG : Slope	10	4328.2826	.0054	4328.256	.027			.009	.0033
-0.422m : Slope									
TOLMIE-SPEEDY: Slope	20	4808.9512	.0187	4808.939	.012	-.0004	4808.9516	.039	.0115
CAL.-SAAN.WF : Slope	10	4837.7835	.0061			-.0371	4837.8206	.004	.0014
DOUG-SAANICH : Slope	20	5794.3815	.0248	5795.04		-.0752	5794.4567	.049	.0119
PAT-PHA : MSL	20	5963.616	.0109	5963.574	.042	-.015	5963.631	.043	.0134
DOUG-SPEEDY : Slope	20	8986.5291	.0228	8986.559	-.030			.047	.0131
DOUG-CAL : Slope	20	17012.198	-.005	17012.217	-.019			.04	.010
DOUG-BRUCE : MSL	20	32678.798	-.034	32678.973	-.175			.03	.008

readings (less than 1 km) or 12 readings (1 km to 6 km). All observations have been zero corrected, meteorologically corrected and, where necessary, reduced to mean sea level.

Some of the larger discrepancies are the result of interferring reflections. This is indeed the case with the Station 0-Station 5 line where the main lobe is encountering heavy highway traffic. The Station 1 — Station 4 experienced traffic interference to a lesser degree.

The PAT-NEIL and DIE-PHA lines were measured over seawater and seem to indicate a ground swing problem.

The CAL-SAAICHTON WHARF line was also measured over seawater and gave surprisingly smooth readings despite the added effect of being measured during a heavy rainstorm.

The huge discrepancies in the DOUG-SAANICH line remains a mystery.

In general, the data indicate accuracies of third order for lines less than 2 km and mainly first order for lines greater than 2 km (with respect to the DEMR "Specifications and Recommendations for Control Surveys and Survey Markers" publication).

One line of 4.3 km. TOLMIE-DOUG, was measured twice on two separate occasions a few days apart and resulted in a mean difference of 11 mm. Instrument #142 was then moved 0.422 m closer to #141 and the subsequent remeasurement indicated a change of 0.421m.

Over all lines measured, the standard deviation ranged from 1 mm to 13 mm, with a corresponding data spread of 2 mm to 5 cm.

In tests looking for ground swing, a 3 km line, DIE-PHA was measured 20 times for each of 16, 8 and 1 fine reading. While observing in the 8 fine reading mode, an unusual increase of 5.5 cm in distance was noted (Figure 6) and so 50 observations were made. This increase in distance was accompanied by a substantial drop in signal strength (43 to 34). The readings level off after the 29th observation but have noticeably more jitter. The following set of 1 fine readings show a downward trend. The heights of the instruments were 6 to 7 metres above water level and during the time span of measurements, the tide rose 0.2 m. The sea state was calm to slightly rippled. Several days later, the line was measured with the Geodimeter and it is interesting to note that its readings correspond to the Microfix readings when they were high.

In has been suggested by the marketing company that the problem of ground swing could be dealt with by moving the instrument vertically in increments of 2 decimetres, readings noted, and a curve plotted and measured. While this procedure may indicate if ground swing is present, it is a somewhat impractical solution in the field due to the number of incremental heights necessary for a proper determination of the ground swing cycle.

Tilting the instruments up may reduce the multi-path effect, but could introduce a pointing error. This was noted on line CAL-SAANICHTON Wharf, where a slight upward tilt, resulting in a signal strength drop from 36 to 24, produced an increase of 2 cm in measurement. In a similar experiment on line A-B, the instruments were pointed away from each other in the horizontal plane. A signal strength drop from 55 to 37 was noted and the distance increased by 5 cm.

In other tests, the short antenna was used to see what effect the removal of the standard cones would produce. On line A-B (0.6 km), with the standard cone on the master and removed on remote, there was an increase of 13 mm. With standard cone on remote and removed on master, there was a decrease of 4 mm. With both cones off, a decrease of 6 mm was noted. In all cases, the appropriate antenna codes were supplied. Since it is assumed that the short cones are primarily for dynamic positioning, the small differences seen here are inconsequential.

Conclusions

The manufacturer's claim of an accuracy of ±15 mm ±3 ppm (mean square error) for a single determination of distance is for instrumental error only and of course cannot include errors associated with reflective interference or meteorological inconsisten-

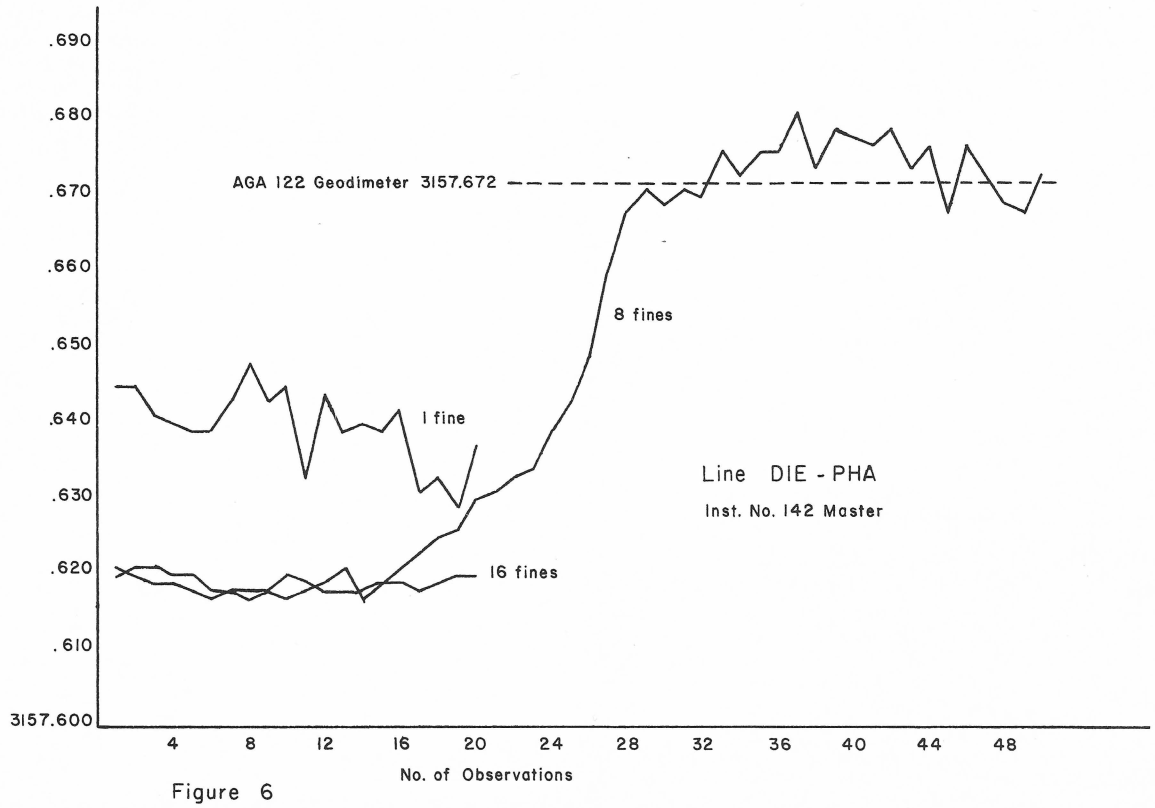


Figure 6

cies along the measured line. Considering therefore, the number of measurements taken which had a total error of less than or slightly greater than the specified instrumental error, the stated accuracy specifications cannot be refuted. It is however, the author's recommendation that at least 6 to 8 observations of the maximum number of fine readings (16), at each end, be made. As each observation takes only 12 to 13 seconds, this presents no difficulties.

The instruments performed well at the maximum range for standard cones (30 km) in good weather, and were not seriously affected at shorter distances by operating in poor weather.

Considering the demands placed on the batteries during the tests, and the few battery failures experienced, it is expected that a fully charged battery pack should easily last throughout a day of normal field survey measurements.

The problem of ground swing still persists and it is unclear from these tests how extensive this error can be. It is an old problem for hydrographers and no doubt they will have to live with it for a while longer.

The pointing of the instruments seems to be quite critical and therefore the present method of achieving maximum signal strength, by physically moving the unit by hand and clamping it, is unnecessarily clumsy. A pair of tangent screws would be a worthwhile improvement.

Two complaints concerning the handset have been made. One is the lack of a volume control, and the other is the sometimes awkward problem of not being able to communicate with the other operator and view the display simultaneously. It should be noted that this problem has been addressed by the Microfix factory, and newer models will be equipped with a lightweight plug-in headset.

In light of these tests, plus a successful field season in which the instruments were extensively used, the Microfix 100C appears to be a precise, reliable, fast and easy-to-operate measuring device. It certainly presents a major improvement over existing microwave based distance measuring instruments currently in use by the Canadian Hydrographic Service.

New Bathymetry for the Queen Elizabeth Islands

By
John Warren

C. H. S. Headquarters

Abstract:
The Canadian Hydrographic Service has produced a bathymetric map covering a portion of the Queen Elizabeth Islands, specifically the Sverdrup Basin, at a scale of 1:1,000,000. This map is presently in the Geological Survey of Canada open file system, where it will remain until it is published in the regular National Earth Sciences Series of maps.

Bathymetry data for this map come from the Canadian Hydrographic Service, Department of Fisheries and Oceans; and from two private oil industry consortia — the Arctic Islands Exploration Group (AIEG) and the Arctic Islands Offshore Group (AIOG).

Introduction
Map NT 12-16-B, Belcher Channel, is one of a new series of geoscientific maps; the National Earth Sciences Series (NESS). These maps are intended to provide much needed regional coverage for bathymetry and the following geophysical parameters: topography, gravity, magnetics, bedrock geology, mineral occurrences, and radiometry.

This map provides bathymetric coverage for most of the Sverdrup Basin, in the Queen Elizabeth Islands, an area rich in hydrocarbon resources. This area has come under intense scrutiny by the oil industry. The hydrocarbon potential has been explored, mainly through seismic surveys conducted by private industry. The potential hazards to engineering, related to the exploitation of these resources require improved seafloor information including bathymetric maps.

Map NT 12-16-B brings together bathymetric data collected by the Canadian Hydrographic Service (CHS), and by the Canadian oil industry.

The CHS data have been collected by the Polar Continental Shelf Project during more than 20 years of through-the-ice hydrographic surveys.

The oil industry data represents more than 10 years of through-the-ice seismic surveys. Suncor has collected seismic data on behalf of AIOG, and Panarctic Oils has collected data on behalf of AIEG.

Previously, the Queen Elizabeth Islands bathymetry data were mapped for inclusion on map 5.17, part of the world-wide series of charts called the GEBCO (General Bathymetric Chart of the Oceans). The data were mapped at a scale of 1:6,000,000 and included only CHS data collected prior to 1969.

Within the map area, CHS data exist in graphic form, on hydrographic field sheets at scales ranging from 1:500,000 (small scale) to 1:20,000 (large scale). CHS data consist of individual soundings collected on a square grid scheme (spot soundings) with spacing of data ranging from 6 km (on small scale field sheets) to less than 0.5 km where shallow water was encountered on proposed tanker transportation routes.

Oil industry data, provided by AIOG, and by AIEG, are in digital form representing soundings collected on through-the-ice seismic surveys. Soundings are spaced every 1.5 km apart on seismic gravity lines spaced 2.5 km apart.

Industry data and government data are complementary in some areas. CHS data exist in the Arctic Ocean, Prince Gustaf Adolf Sea, and Peary Channel, where there are few oil industry data. However, oil industry data provide more detail in MacLean Strait, Belcher Channel, Hazen Strait, Lougheed Island Basin, and Norwegian Bay.

Digital data were plotted to compare with the graphical and bathymetric contours were compiled at a scale of 1:500,000.

Discussion:
With the recent acquisition of oil industry data, the early CHS data were confirmed, especially in areas where the CHS spot depth data had indicated a rough seafloor surface, and in areas where early survey positioning systems had been used in less than optimum conditions.

AIEG, AIOG, and CHS data agree well where data exist at common location points. Closely spaced oil industry data help define the contours around Lougheed Island and in Belcher Channel as well as Grinnell Ridge. Byam Martin Channel and Cameron Island Rise; Berkely Trough; Wellington Channel, Hassel Sound; Kristoffer Bay and Danish Strait are features that are now better defined by incorporating oil industry data.

Bathymetry contours must be considered as preliminary due to the absence of data in some areas (Sverdrup Channel; Strand Bay and Strand Fiord; May Inlet, Young Inlet and Sir William Parker Strait); and in Jones Sound); and to the scarcity of data in other areas (Peary Channel; the Arctic Ocean; Prince Gustaf Adolf Sea; and Erskine Inlet). The 50 metre contour remains poorly defined throughout most of the map area due to a scarcity of near shore data.

Summary
Map NT 12-16-B is an example of close cooperation between the Canadian Hydrographic Service and the Canadian oil industry. The use of oil industry data has helped to verify the value of early CHS spot sounding data, as well as to improve the bathymetry coverage in the Canadian Arctic.

This map should aid both the public and private sectors in planning for future research and exploration.

Oh Say can you see?

by
John Cookson

If you have just had some slides made, you probably shouldn't read this article.

The subject of this article is of such a nature as to be totally unsuitable for presentation as a paper at a conference. If it was given near the opening of a conference it might cause a lot of uneasiness with subsequent speakers and if given near the close it could be considered downright criticism of previous speakers.

What is the subject? Slides, both overhead and 35 mm.

How often have you attended a lecture during which the lecturer presents slides which are fuzzy, undecipherable, blinding white images or copies of typewritten pages containing a mass of information and, how often have you heard a speaker apologize because his slides cannot be understood?

The originators of such poor graphic slides must be in league with eye specialists who are desperate for patients with eye strain or partial blindness.

A slide presentation is supposed to carry an impact message intended to support or highlight what the lecturer is saying and is not for reading in detail. Slides should have a minimum of information in terms of words. The text of lecture should be delivered by the lecturer, not by a slide.

Cartographers are often called upon to produce essentially non-cartographic projects such as illustrations or graphs for conversion into overhead or 35 mm slides. In the interests of making the producers task a little easier and the product a lot better there are some simple rules which can be followed and can spare a lecturer a lot of embarrassment by having a good presentation.

Determine what the final requirements will be, either for yourself or for customer/lecturer. Are the slides to be overhead slides only or 35 mm only or both? How many times has a request been made for one type of slide or the other and later after completion of the work it is made known that both types are required? Now it is found that the original drawing is not suitable for the second requirement and must be redrawn. Don't despair. There is a way to get one jump ahead of changing requirements.

Rule 1
Make a guide on a piece of cronaflex by drawing a rectangle 240 mm × 180 mm. This rectangle is the limit of the work area for the illustration and when reduced 8 times becomes 30 mm × 22.5 mm which is ideal for fitting into a standard 35 mm slide holder. Overhead slide holders are usually 245 mm × 200 mm. (See illustration).

Rule 2
Keep text to a minimum. Remember a slide is an impact message.

Rule 3
Use lower case lettering as much as possible. Lower case letters are more distinguishable than upper case letters which are inclined to be similar in shape e.g. H N R K E F.

Rule 4
The minimum size of type should be 1/60th the width of the drawing i.e. 4 mm using lower case ascenders such as an "h" for sizing. Note: this is done because some type styles do not have lower case ascenders with the same height as upper case letters (CAPITALS).

Rule 5
Use negative slides wherever possible in order to "Kill" as much ambient light as possible. Regular black and white film does the job very well and is of course cheaper because of the fact that there is no processing involved other than the initial photography.
However a much more eye pleasing effect can be obtained by using the diazo duplicating films. These films come in a variety of colours and some interesting results can be obtained. Green is the most pleasant viewing colour and is easier on the eyes of the viewers.

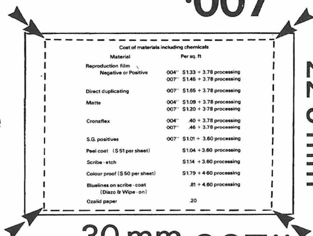
Rule 6
Use line widths no finer than 1/200th the width of the original drawing.

Rule 7
35 mm coloured slides to show chart information cannot be made from more than a 175 mm × 112 mm portion of a chart in order to be readable by an audience.

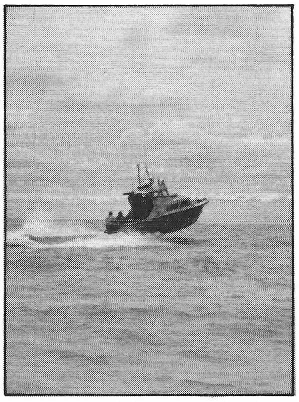
180 mm

Cost of materials including chemicals

Material		Per sq. ft
Reproduction film		
Negative or Positive	·004″	$1.33 + 3.78 processing
	·007″	$1.45 + 3.78 processing
Direct duplicating	·007″	$1.65 + 3.78 processing
Matte	·004″	$1.09 + 3.78 processing
	·007″	$1.20 + 3·78 processing
Cronaflex		.40 + 3.78 processing
		.46 + 3.78 processing
S.G. positives	·007″	$1.01 + 3.60 processing
Peel coat ($ 51 per sheet)		$1.04 + 3.60 processing
Scribe - etch		$1.14 + 3.60 processing
Colour proof ($ 50 per sheet)		$1.79 + 4·60 processing
Bluelines on scribe - coat (Diazo & Wipe - on)		.81 + 4.60 processing
Ozalid paper		.20



240 mm



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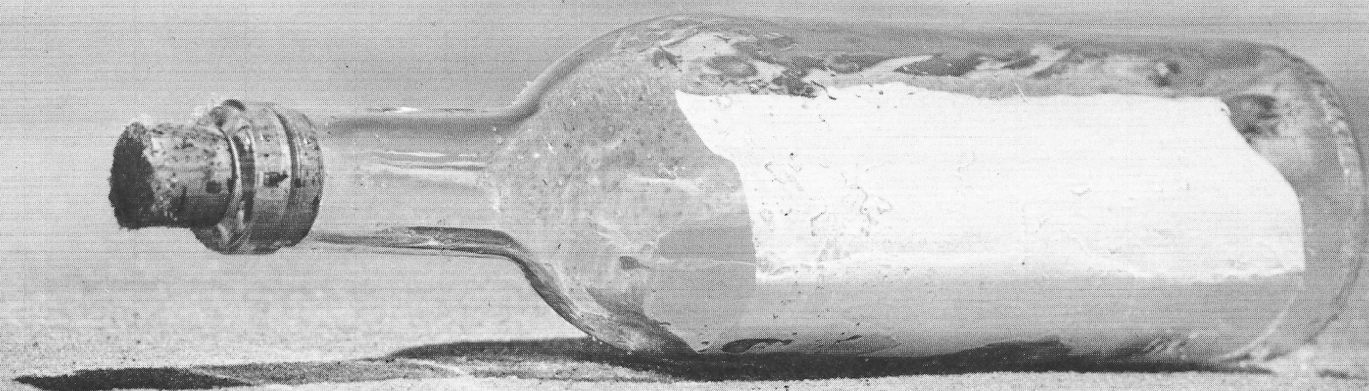

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Recovering Datum Reference

By
Richard Palmer

CHS, Atlantic Region

Introduction

Benchmarks are established during a hydrographic survey to serve as a permanent elevation reference from which future hydrographers, surveyors and engineers can reestablish the elevations of chart datum, high and low water and mean sea level. A recent one month survey by the author of 84 sites listing 253 benchmarks proved that problems exist between the intent and the practice of preserving datum. The area checked was mainland Nova Scotia, along the Fundy coast, the South Shore, and the eastern seaboard to Country Harbour. Seventy-five benchmarks (30%) were found to have been destroyed by construction, or covered by fill, asphalt and house siding. This resulted in the loss of all reference to chart datum at eleven sites (13%), including Walton, a former tidal reference port, and Burntcoat Head which has the highest tides in the Bay of Fundy. In this brief report a number of the problems that were discovered in the Canadian Hydrographic Service (C.H.S.) benchmark network are discussed. In many cases these problems could have been avoided by strict adherence to the procedures in the Canadian Tidal Manual.

Problems with Benchmark Descriptions

The various items used as benchmarks included brass tablets, brass pins with chisel marks, brass pins with flat sides, stamped eye bolts, stone door sills, chisel cuts in large boulders, and foundations of monuments. It was sometimes uncertain, from the description, whether the correct benchmark (B.M.) was recovered. For example, a drill hole is all that remained of BM "TS 1-1965", Baxter's Harbour, which was described as a stamped brass tablet; a brass tablet stamped "Water Resources Branch of Canada" had replaced a brass tablet stamped "TS 2-1965" at Cape D'Or; and a Geodetic Survey of Canada (G.S.C.) brass tablet stamped "69N019" had replaced a brass tablet stamped "TS 3" at Parker's Cove. At Fort Anne, Annapolis Royal, B.M. "1943 H.S. est" was described as the "highest point of base, at junction with monument on the north corner." As illustrated by Figure 1, there were four choices for the base. At Diligent River, the benchmark book listed two B.M. tablets stamped "T.S. 2-1965" (G.S.C. elevation of 6.28 m) and "T.S. 3-1965" (G.S.C. elevation of 4.10m). Only two G.S.C. brass tablets were recovered; tablet 69N244 (G.S.C. elevation of 5.79m) and tablet 69N245 (G.S.C. elevation of 3.81m). This latter tablet had been worn smooth and featureless by the gravel that shifts over this beach. The C.H.S. and G.S.C. descriptions are almost identical. Before using the chart datum assigned to these two G.S.C. tablets, another one month tidal record will be needed at this site.

Figure 1

At Scot's Bay, B.M. "2-1960" was described as a "bronze tablet placed vertically in cliff". A tablet or pin set vertically has it's shaft aligned vertically. The area was passed twice before the tablet was noticed, set horizontally in the cliff.

Many tablets were difficult to find from the description given. Most areas have changed greatly in the last twenty years, especially near wharves. Fort Lawrence was last checked in 1901. Two wharves, two railways, roads and sheds had become a featureless cow pasture. A path described at Tiverton **was** several feet wide but in twenty years became indistinguishable from the surrounding woods. Without local help, these tablets at Tiverton, which were one mile from the road, would not have been found. Burntcoat Head was another site that could not have been located without local assistance from the former lighthouse keeper. The area had been bulldozed flat and was completely overgrown.

Good and Bad Reference Points for Descriptions

Throughout the many descriptions certain features were always recoverable:

- the intersection point of a wharf or breakwater with the high water line
- concrete building foundations
- the centerline of roads
- conspicuous natural features such as streams and boulders.

Features that frequently could not be recovered included:

- edges and corners of concrete caps on wharves and breakwaters
- edges of roads (which had been widened)
- houses without concrete foundations, red houses that become white and the first house west of the wharf that had become the third house west of the wharf
- trees and lilac bushes

Descriptions of a tablet that included one of the features in the first list together with a distance and bearing (making certain to indicate magnetic or true bearing) were unquestionably the most accurate and useful. The tablet was either found or could be verified as destroyed, because the description was precise enough to indicate an exact spot. BM "3-1960", a brass tablet at Lunenburg was found by digging at the indicated spot. BM "3-1960", a brass tablet at Scot's Bay, could not be found, as it would have taken too long to clear an entire ridge of tidal debris. It could not be assumed or stated that the tablet was destroyed. A bearing and distance from a non-permanent feature is not useful. For instance, at Indian Harbour the description read "B.M. 1 is vertically on a large boulder 225 feet from the tide staff." No bearing was given and the tide staff position could not be recovered.

In several cases the general area itself was difficult to find. For example "Deep Cove" on chart 4396 is "Board Cove" on topographic sheets and road maps and the Department of Highway's sign on the road pointed to "Culloden Wharf". At Scot's Bay the general area was known but neither the sketch nor the description indicated which one of several small coves was being referred to. It took three hours to check them all.

The Effect of Construction and Unstable Structures

All reference to datum was lost in many cases when the feature the benchmarks were in shifted or was destroyed. The breakwater at Port Maitland, figure 2, is a typical example of a feature that seventeen years ago (1967) had three good benchmarks. Only one unstable tablet was recovered. Vertical shift of a tablet is not always apparent. The photo of BM "2" at Deep Cove, Figure 3, illustrates how a tablet may appear useful when actually it had dropped by 0.3 metres. Large boulders on shore are not stable unless they are bedded below the frost line. A large boulder, roughly two metres in diameter sits **on** the shore at Boutilier's Point with B.M. "T5 1-1968" cemented in it's top. This tablet has been found unstable as a result of repeated levelling at this former reference station. B.M. "TS 2-1968", also at Boutilier's Point and unstable, is cemented into a concrete boat ramp which has lifted as a result of frost heave.

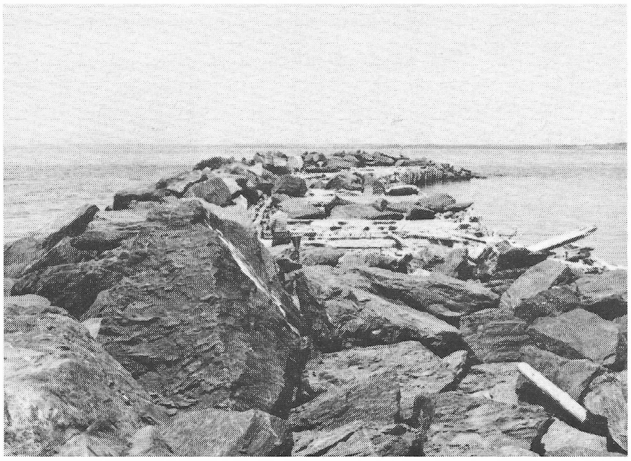


Figure 2

Modern construction near wharves tend to be on a larger scale than twenty years ago. At Walton, all reference to datum was lost due to heavy construction near the start of the wharf. Reference to datum was lost at Burntcoat Head because the four tablets were too close to each other. These tablets were in the lighthouse and storage shed which were bulldozed under. On the other hand, at Krant Point, even greater construction efforts had reworked the entire point, but one tablet remained. B.M. "B-1977" was set back from the wharf-fish plant area. It took a couple of extra set-ups to level to this tablet, but the original effort had been worthwhile. Eleven sites lost all reference to datum. Six of those sites would have retained some reference to datum if the same extra effort put into Krant Point had been put into them.

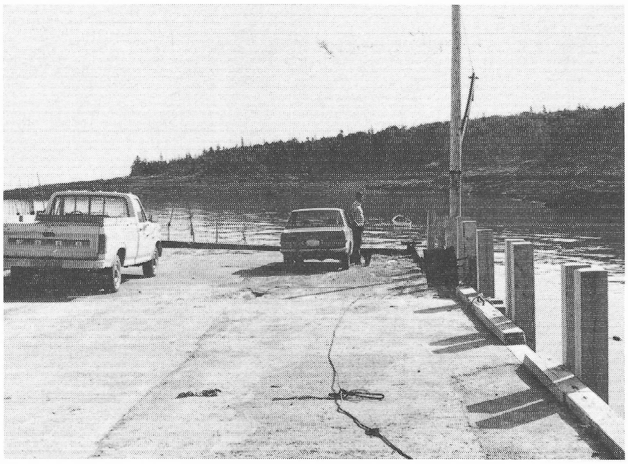


Figure 3

Summary and Conclusions

The benchmarks surveyed revealed that 30% of the listed tablets were destroyed and 13% of the sites completely lacked datum reference. Natural collapse of structures with time, and modern large scale construction techniques were the main factors in the destruction of tablets. These two conditions also rendered most descriptions outdated.

Surveyors placing and describing new tablets in future surveys should bear these conditions in mind. There are no set rules but if all tablets had been at least 70 meters from each other and no two in the same feature, as recommended in the Canadian Tidal Manual, many of the major losses encountered would have been avoided. It took extra time to set tablets this way but it was the only way that datum reference was reliably preserved. Individual tablets were still lost regardless of the best procedures. Periodic benchmark tablet surveys could have replaced these before a second and then a third tablet was destroyed.

Reminiscences of a Retired Hydrographer Lake Superior

N. G. Gray

Dominion Hydrographer, 1957 to 1967

The Lake

Lake Superior, the largest body of fresh water in the world is situated near the heart of the North American Continent and covers an area of 31,820 square miles.

When the C.G.S. "Bayfield" worked in this area in the 1930's, the offshore waters were crystal clear and very cold; the Chief Engineer of the "Bayfield" reported that the temperature of the Lake never went above 45° F during the entire summer. With the many safe havens for small craft, and the magnificent scenery, Lake Superior must be one of the finest and most interesting cruising waters in Canada.

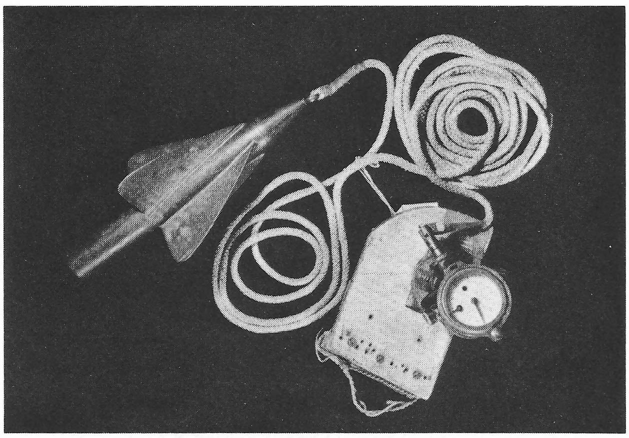
Early Reconnaissance Mapping (1)

From the middle of the 17th century to the end of the French regime in Canada a century later, this mapping was based on the explorations and discoveries of the first French explorers, missionaries, furtraders and couriers des bois; the first Europeans to explore the shores of Lake Superior. In the Public Archives of Canada there is a reproduction from the original map of Lac Tracy (Lake Superior) believed to be the work of the Jesuit Fathers in 1670, and there is also a cartographic map of Kamanistigoya, in Lake Superior's Nipigon Bay drawn by the King's Engineer in New France. Of special note is a significant map drawn about 1735 of the entrance to Lake Superior and the St. Mary's River that shows soundings and other hydrographic detail. By 1740 French military officers had begun mapping strategic areas in the North Channel and Lake Superior.

Admirality Surveys (3)

The first hydrographic survey of Lake Superior was made by Lt. H. W. Bayfield (later Admiral Bayfield) in the years 1823, 1824 and 1825.

Henry Wolsey Bayfield was born in Hull, England on 21 January, 1795, and entered the British Navy at 11 years of age. He served in a number of ships, and was involved in several naval engagements — acquitting himself well as reported by his senior officers. On 3 March, 1815 he was promoted to lieutenant, and during that summer was assigned to Capt. Owen who was conducting a survey in Lake Ontario. Capt. Owen returned, to England in 1816, and the following year on 17 June, 1817 Bayfield, at the age of 22, was appointed Admiralty Surveyor for Canada.



Boat log — similar to one used by Lt. Bayfield for his survey of Lake Superior. Note the register attached to the wooden piece that fitted between the frames at the gunwhale of a pulling boat.

His method of survey was to establish small bases approximately one-quarter mile long every twenty or thirty miles, and to triangulate the land features. In flat featureless country, ships and boats were moored offshore as temporary triangulation stations. Inshore soundings were taken from small boats rowed from point to point with the sounding interval determined by a boat log.

The ultimate scale of the chart was determined by latitude and longitude and not from triangulated distances. The marvellous skill of Bayfield as an observer was indicated by the fact that his position of the time-ball on the Citidel in Quebec City was retained into the 20th century. The time-ball was used until 1930 and was only discontinued with the advent of radio for time signals.

In 1823 he began the survey of Lake Superior using the Hudson Bay Co. schooner "Recovery", the only vessel on the Lake at that time. Midshipman P. E. Collins, R.N. was his assistant and sailing master was Lanphere whom Bayfield's voyageurs called L'Enfer. (It has been stated that this name was indeed warranted.)

Headquarters for the survey was established at Fort William (now Thunder Bay). He surveyed much of the coastline on ice during the winter, living with his French voyageurs in Indian camps. Considering the rough life and hardships he must have experienced, one can only admire the personal tenacity and technical quality of the work Bayfield produced under such trying conditions.

Bayfield retired in Charlottetown on the 18th October, 1867 and died there in 1885 at the age of 90.

Copies of charts produced as the result of Bayfield's surveys are available for examination at the Map Room of the National Archives in Ottawa.

Canadian Surveys 1902-1920 (4)

Admiral Bayfield's charts surveyed in 1823-1825 were adequate for many years, but with an increase in shipping traffic and the transition from sail to steam in the latter part of the 19th century, it was realized that better charts were urgently required.

The first Canadian survey was done in 1902 by Mr. Wm. J. Stewart on the eastern coast of the Lake from Coppermine Point to Cape Gargantua. He used the C.G.S. "Bayfield" 1 (formerly "Edsell") and this was the last season for this ship on hydrographic survey as she was sold out of government service in 1903. C.G.S. "Bayfield" 2 (formerly "Lord Stanley" and purchased in 1901) was available in 1903 and carried out charting in Thunder Bay and Nipigon Bay. Mr. Stewart's last field season was in 1904 where he extended the work of the previous year.

In 1904 the hydrographer sections of Public Works and Railway and Canals were amalgamated with the Great Lakes Survey in the Department of Marine and Fisheries.

During the next four years, 1905 to 1908, Capt. F. Anderson with assistants Mr. G. A. Bachand and Mr. R. J. Fraser charted areas in Thunder Bay, Nippigon Bay and Approaches, and from Lamb Island to Jackfish Bay.

No surveys were carried out in Lake Superior during the years 1909, 1910 and 1911. In 1912 Mr. Chas. Savary and Mr. R. J. Fraser charted areas around Caribou Island and from Copper Island to Lamb Island. The C.G.S. "LaCanadienne" was assigned for this survey, but was damaged on passage to Lake Superior and Mr. Savary had to resort to small boats and launches for his surveys.

During the years 1913 to 1919, Mr. H. D. Parizeau had as assistants Messrs. G. A. Bachand, J. U. Beauchemin, H. L. Leadman, N. Wilson and M. A. Mackinnon and the areas covered during this period included Caribou Island, Copper Island to Lamb Island, Jackfish Bay, Schreiber Point to Pic Island. Otter Head and Michipicoten Island. He also extended charting in Nipigon and Black Bays. For a number of years the "LaCanadienne" was used on these surveys but in 1916 she ran aground in Black Bay and was sold out of government service in 1918. After "LaCanadienne" was damaged, charting was continued using the launch "Ransom" until "Bayfield" was returned from Naval Service at the end of World War I. Mr. Parizeau was transferred from the Lake Superior Survey to the West Coast Office early in 1920.

It has been reported that after a survey officer examined a shoal —lead line only at that time, Mr. Parizeau would run the ship over the shoal. Knowing this the survey officer ensured that his examination was accurate and complete.

In 1920, Mr. R. J. Fraser with assistants Messrs H. L. Leadman, N. Wilson and M. A. MacKinnon charted Gargantua Harbours and the coast to Point Isacor, the last Canadian charting on the Lake for this decade.

Up to 1920 the Canadian surveys provided sharts for all of the Canadian coastal areas with soundings running offshore to depths of 100 to 150 fathoms. The remainder of the Canadian section of the Lake north of the International Boundary was at that time considered to be all deep.

Canadian charts up to 1930 were printed with a large blank area north of the International Boundary whereby the U.S.A. charts were completed right up to the Boundary.

C.G.S. "Bayfield" Survey 1930

In the late 1920's a report was received at Ottawa of shallower water in the unfinished offshore area in the Lake. Consequently the C.G.S. "Bayfield", which was based at Charlottetown, was fitted with the latest echo sounding gear and dispatched to Lake Superior in 1930 to complete the survey of the Lake.

"Bayfield" was a steel ship of 276 gross tons, 140 feet in length, 24 foot beam and depth of 11 feet built by D. W. Henderson of Glasgow in (6) 1889. She was coal fired steam with two triple expansion engines developing 160 H.P. One interesting feature of this twin screw ship was the fact that the screws overlapped — one fitted forward of the other.

She was purchased by the federal government in 1901 and christened "Lord Stanley", however she was later renamed " Bayfield".

The survey boats carried on the ship consisted of two gigs — a 26 ft and 28 ft with a centre board, a 24 ft launch with a Thornycroft engine and a dingy with a 10 H.P. outboard engine.

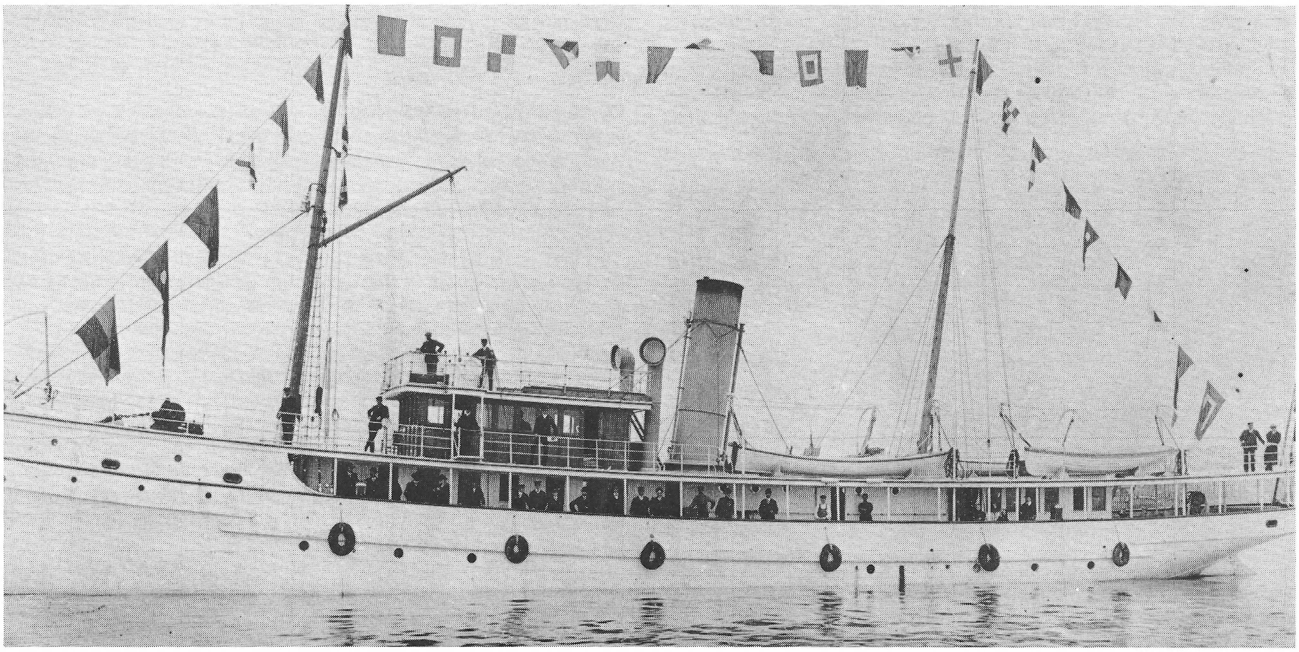
During 1930 and 1931 Bayfield charted in Lake Superior, Magdalene Islands and Gulf of St. Lawrence. The ship then remained at Charlottetown until she was sold out of government service in 1935. Her end came in 1949 when wrecked in St. Mary's Bay, Newfoundland.

In 1930 the Survey officers were Mr. H. L. Leadman in charge assisted by Messrs. R. E. Hanson, L. M. Clarke and N. G. Grey. (Incidentally Hanson, Clarke and Gray were all graduates in mining engineering). Ship's officers were D. M. Snelgrove Master, H. Anderson Mate, S. A. Robson Chief Engineer, and MacDonald Second Engineer. Prior to my appointment to the Canadian Hydrographic Service I had been employed on geological and metallurgical work, however, having grown up in a family associated with salt water it was easy to fit into shipboard life.

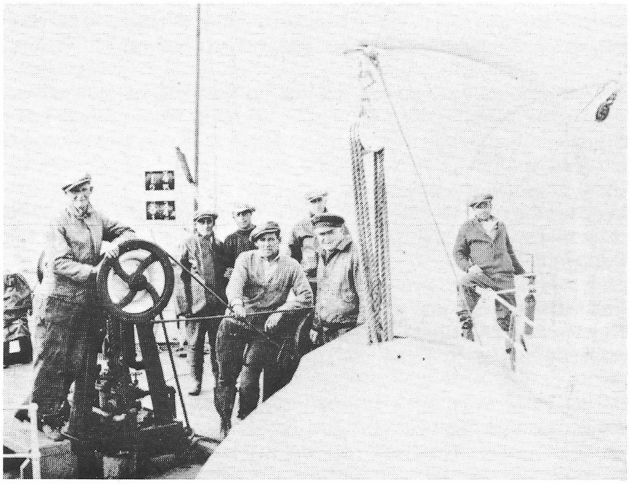
Shipboard Survey Equipment

Echo Sounder

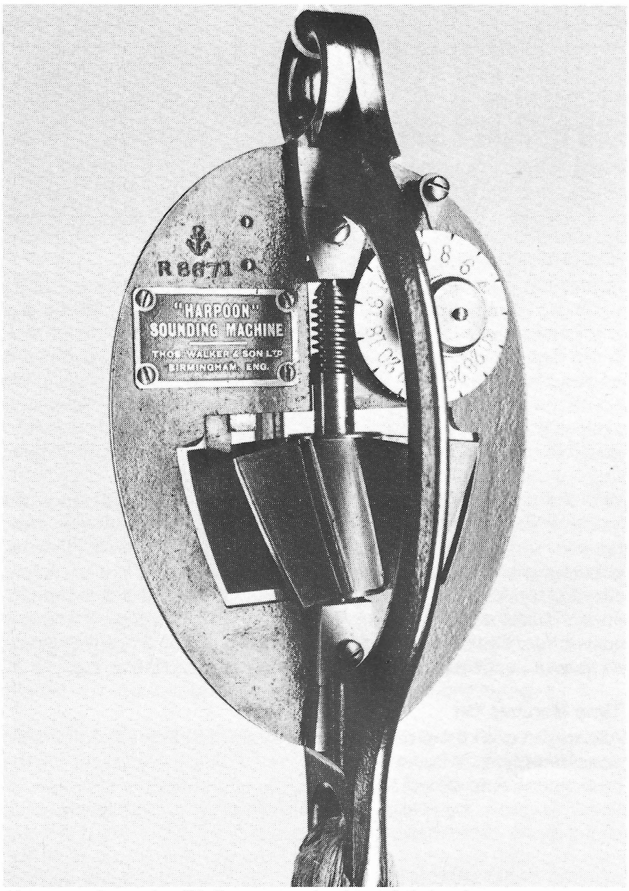
Prior to leaving Charlottetown in 1930, the latest sounding device was fitted to "Bayfield". It was an electrical mechanical equipment consisting of a pair of covered steel tanks welded to the bottom skin of the ship and filled with water. In one tank the transmitter consisted of an electrically actuated hammer operating at 90 strokes per minute. The receiver was fitted in the other tank, and connected through an electrical circuit to a set of headphones worn by the sounder operator. The operator manually turned a dial calibrated in fathoms and when a distinctive sharp pitch was evident in the headphones the equipment was tuned to the proper depth and the depth read off the dial. As often happens with newly designed equipment, many "bugs" developed and consequently the sounder did not prove to be too satisfactory. A very few years later this system was supplanted by recording sounders.



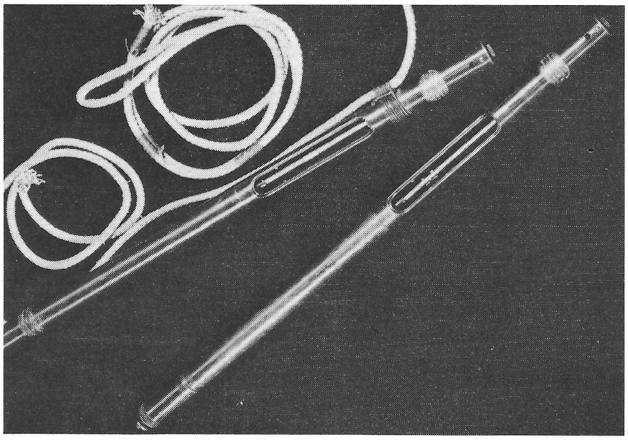
C.G.S. "Bayfield" in Jackfish Bay on 1st July 1930 (5)



Steam Pony and Wire Reel
A wire reel driven by a steam pony was fitted to the upper deck at the port quater. A 70 lb. lead was attached to the end of the wire with the recording device fastened immediately above the lead. When taking a sounding the reel was allowed to run free and as the lead struck bottom (evident from the slack of the wire) the brake was applied and the sounder and lead hove board. The interval between soundings was taken from the ship's log.



Harpoon Sounder (7) Rope attached to 70 lb lead
This sounder consisted of a small vertically mounted four blade propeller, about two inches in diameter and having a very coarse pitch. As the sounder plunged downward through the water, the propeller rotated driving a wheel through a worm gear. The number of rotations of the propeller was recorded on the wheel which was calibrated in fathoms of water passed through. After striking bottom a clapper flipped down between the blades of the propeller stopping any further rotation while the sounder was hove aboard. The depth was read directly off the gear wheel.



Pressure Tube Sounder (8)
A pressure tube sounder was used aboard the "Bayfield" in the same manner as the harpoon sounder for depths of less than 100 fathoms. It was a pressure as a factor of depth device, and was calibrated to a maximum depth of 105 fathoms. On the 1930 Lake Superior survey it was of limited value as the depths were greater than the capacity of the sounder.

Fore and Aft Gear
Although this method of sounding could not be used in Lake Superior due to the great depths it was used for sounding Pleasant Bay, Magdalen Islands, in 1931.

A boom was rigged near the bow on the port side of the ship. It was placed well forward, suitably guyed, with a block attached to the outer end. The wire, with a 70 lb. lead attached, rove through the block to the reel driven by the steam pony.

Attached to the 70 lb. lead was a marked lead line, **not rove through the block,** but leading directly to the leadsman aft on a sounding platform. When the lead was dropped (it reached bottom before passing the position of the leadman) he would take in any slack of the leadline and read the depth as it passed his position. Once the depth was taken the lead was hove to the block on the boom ready for the next cast. About 20 fathoms depth could be sounded with the ship steaming at 5 knots.

Submarine Sentry
Although this equipment was aboard "Baysfield" in 1930, it was not used in connection with this survey. The description of the unit is from Hydrographic Surveying by the late Rear Admiral Sir Wm. J. Wharton, K.C.B., 4th edition, p. 406.

By means of a single stout wire, the sinker, an inverted kite called a "sentry", can be towed steadily for any length of time at any required vertical depth down to 40 fathoms. Should it strike bottom through the water shallowing to less than the set depth, it will at once free itself and rise to the surface, simultaneously sounding an alarm on board, thus giving instant warning.

The vertical depth at which a sentry sets itself when a given length of wire is paid out is not changed by any variation in speed between 5 and 13 knots, and is read off a graduated dial plate on the winch. The towing wire is secured to the sentry by a wire bridle — the short leg is released when the trigger touches bottom, and the sentry rises to the surface.

1930 Surveys
Superior Shoal
Mr. H. L. Leadman had been assistant to Mr. H. D. Parizeau charting various areas in Lake Superior from 1913 to 1920 and therefore had a very good knowledge of the Lake.

On passage from Charlottetown three buoys were made up using gasoline drums fitted with tall masts and black and white cotton at the top for visibility.

On arrival at Superior Shoal the buoys were placed at strategic positions to control the detailed soundings. Position of the shoal was determined by a three point fix using two geodetic points Schreiber Mountain, Tip Top, (both of which were visible from the shoal on a clear day) and a true bearing of the sun.

Sounding lines were run over the shoal in a north south direction by compass, with the spacing interval determined by the ship's log. The method of starring on a buoy common in hydrographic work for the shoal examination was also used. Sometimes it was possible to use horizontal sextant angles when the buoys were visible and in a suitable configuration to provide a firm fix. Depression angles between the horizon and a buoy proved useful for short distances. At the ends of the lines it was necessary to resort to dead reckoning, to secure the necessary coverage.

To fill the unsounded blank area long lines were run by D. R., with a position determined at the ends of the lines which allowed the line to be adjusted accordingly. Fortunately there were no tidal currents to contend with and searches offshore did not present a problem.

It is interesting to note on Page 98 of the 1979 C.H.S. activity report, that C.S.S. "Bayfield" using Accufix, Loran C and INDAPS successfully completed the offshore survey of Lake Superior. This will enable the existing charts to be updated. Of interest is the **confirmation of the depth and position of Superior Shoal** surveyed in 1930 by Mr. Leadman.

For most of the summer the ship was able to anchor on the Shoal and only once can I recall that it was necessary to run for shelter between the islands at the entrance to Nipigon Bay. Weather during that summer was remarkably good.

Superior Shoal and the offshore soundings in the Lake were completed by about mid August. After coaling at Sault St. Marie the ship proceeded east to salt water and completed a survey started the previous year for a chart of Caraquet, Shippigan and Miscou on the north-eastern part of New Brunswick.

The Welland Canal was under construction at the time and eventually 7 locks plus a guard lock replaced the 25 locks of the old canal. The old canal operated so the upbound and downbound ships would pass underway in a passing basin betwen the locks. After each ship left their respective locks the masts of each ship would be lined up until nearly the middle of the passing basin — then each ship simultaneously altered course at the last minute so that they would pass with only feet to spare between the vessels. This was rather a hair raising experience for a salt water man accustomed to adequate sea room.

Place Names

The names of a number of hydrographic staff are perpetuated in the Slate Island Group off Jackfish, Leadman Islands, Delaute, Dupuis, McGreavy, are all well known to we old timers. LaCanadienne Point was named after the survey vessel that charted various areas during the years 1912 to 1916.

Around the 1880's the C.P.R. put the railway through north of Lake Superior. In the north-east angle of the Lake is Peninsula Harbour. It has a small island close inshore on which lived a number of ladies whose business it was to entertain the labourers in their off time; hence the name "Skin Island". which appears on the charts today.

Here and There

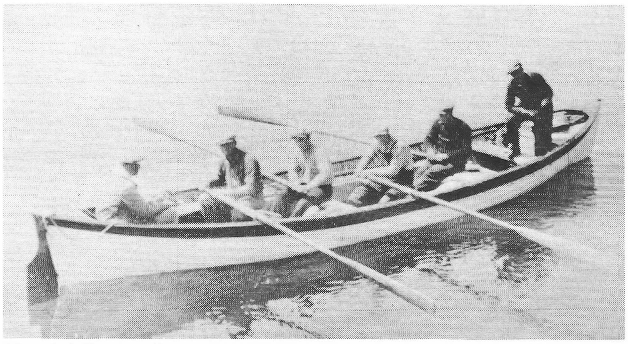
A favourite anchorage for "Bayfield" in 1930 was in Otter Cove. Entry to this Cove was along the southerly side of Otter Island to the eastern end and through a narrow S channel to an ideal anchorage in the middle of the Cove.

Two trappers lived in the Cove and they came aboard at every opportunity. The last time we were in the Cove was in early August, and the one trapper who boarded the ship informed us that his partner was ill. Capt. Snelgrove went ashore and surmised that the man had appendicitis. As he was no better that evening it seemed urgent that he be taken out for medical attention to the port of Peninsula Harbour, 45 miles northward, where the C.P.R., was available to transfer him to the hospital at White River. For a number of years I wondered whether the trapper had survived.

My assignment in 1938 was assistant to Mr. M. A. MacKinnon on the 45 foot launch C.H.L. "Boulton", to survey Heron Bay in Lake Superior. On passage from Sault St. Maire to Heron Bay, we again stopped at Otter Cove during bad weather and held up there for three days. During this period a visit was made to the light house keeper, who remembered the "Bayfield" deing there in 1930, and he informed me that the trapper had survived and his partner was still living in the Cove.

Later that summer the Otter Cove trapper contacted me at Heron Bay to express his gratitude for taking his partner out for medical attention.

Jackfish Bay was a weekend anchorage for the "Bayfield" and this small community provided entertainment for all aboard the ship. A dance was arranged every Saturday night which always ran well into Sunday morning. Jackfish was at one time a coaling depot for the C.P.R. and the company had levelled off an area east of the village for coal storage. At that time it was unused and made an excellent base ball field, where the ship's crew took on the locals every Sunday afternoon.



"Bayfield" sounding gig (9)

Before the days of echo sounders all the inshore areas including harbours were charted from small boats with hand lead for depths and horizontal sextant angles to establish the position of the boat. A gig carried one survey officer in the stern who observed both angles and plotted the fix on a boat board, recorded the angles, the depth at the fix sounding line, laid off the sounding line range and steered the boat. A sail was always carried aboard, and it was often possible to sail from the ship to the area to be sounded and return.

With the advent of the power boat around 1906-1907 the only use made of it was to tow the gig from the ship to the survey area, however it was later used for sounding which speeded up the work substantially. With two survey officers in a launch it was unnecessary to stop for a fix — each man read an angle, one plotted the fix and checked the range, the other recorded the angles and the soundings. The officer plotting the fix always read the left angle so as to avoid confusion; the first lesson a new recruit learned.

Time Marches On

Although equipment, methods and instrumentation has changed considerably over the span of 50 years it is still necessary for the hydrographer to go out in small boats, often under austere conditions, to chart the water depths necessary for safe passage of ships; as we did in those days many years ago.

ACKNOWLEDGEMENTS

1. Soundings 1966 O.M. Meehan
2. Photo of Boat Log courtesy C.H.S.
3. Transactions Literary Society Quebec, Session 1908-1909 No. 23
4. Data for Canadian Surveys, O.M. Meehan
5. Photo "Bayfield" courtesy C.H.S.
6. Usque ad Mare, T.A. Appleton, D.O.T. 1968
7. Photo Harpoon Sounder, Courtesy C.H.S.
8. Photo Pressure Tube Sounder, courtesy C.H.S.
9. Photo Sounding Gig, courtesy C.H.S.

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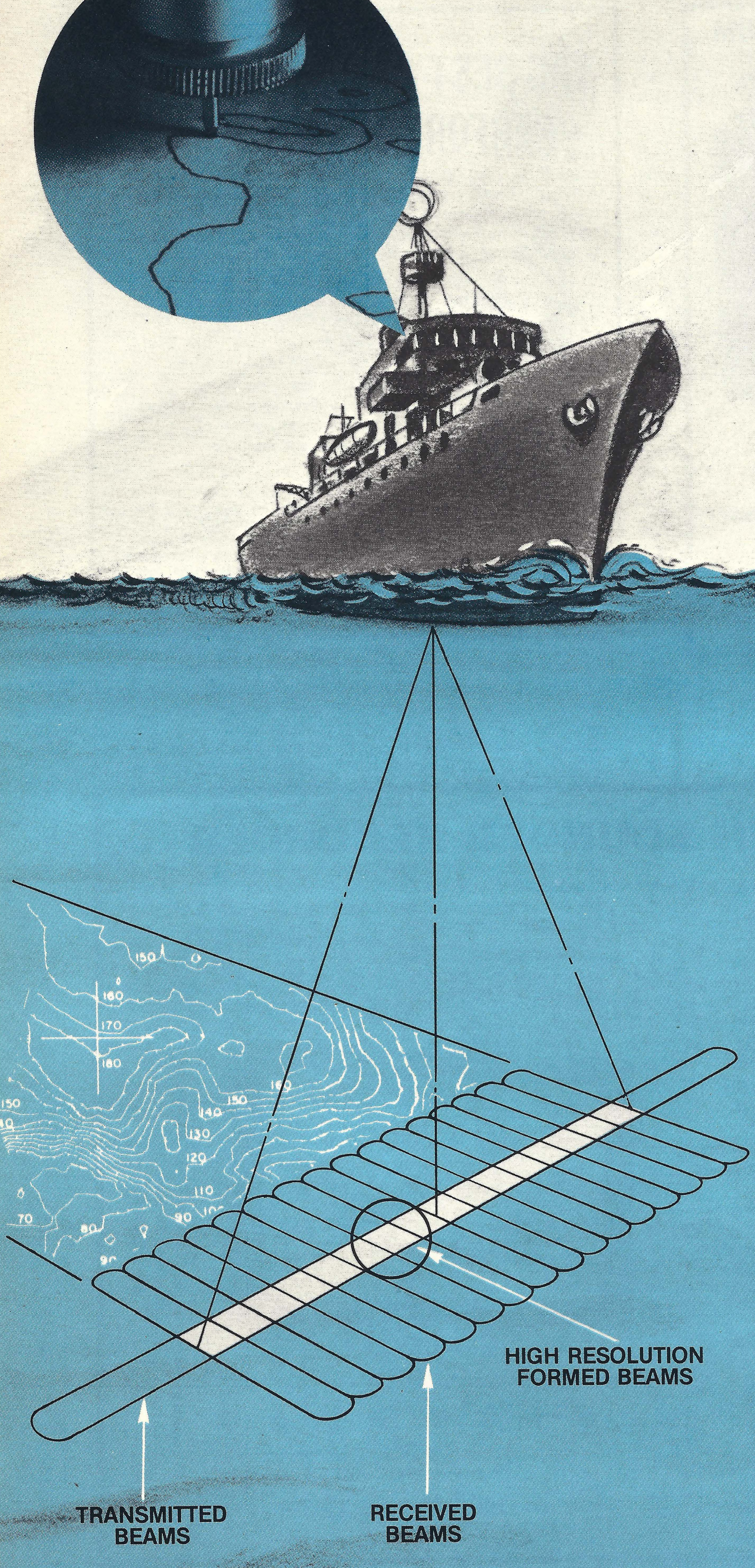

Sea Beam is a high-resolution bathymetric survey system which processes soundings from 16 formed beams positioned perpendicular to the ship's axis to generate bottom contour charts in real time.

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For further information on Sea Beam, contact Government Systems Division, General Instrument Corporation, Southwest Park, Westwood, MA 02090 (617) 326-7815.

GENERAL INSTRUMENT

"Gazetteer of Undersea Feature Names 1983"

Published for the Advisory Committee on Undersea Feature Names
Canadian Permanent Committee on Geographical Names
By the Department of Fisheries and Oceans
Ottawa — 191 pages

Part of Canadian Hydrographic Service Chart 810 "Relief diagram of The Continental Margin of Eastern North America". (cartography by David Monahan; published 1971)

This perspective representation shows the "Scotian Shelf" as viewed from the south. The two main banks illustrated are "Sable Island Bank" to the west and "Banquereau" to the east, separated by "The Gully". The continental slope in the foreground is dissected by canyons, for example, "Logan Canyon" and "Shortland Canyon" on either the southeastern part of Cape Breton Island and a small corner of mainland Nova Scotia.

This first edition of the Gazetteer was published by the Canadian Hydrographic Service, Department of Fisheries and Oceans, Ottawa. Its production was guided by Stephen MacPhee, Dominion Hydrographer and Chairman of the Advisory Committee on Undersea Feature Names (ACUFN). The names, types of features, and chart data were assembled by Thérèse Jolicoeur, Secretary of the Advisory Committee, with the assistance of her associates Jeannette Desparois and Patricia Bell.

Under the guidance of established standards of the Canadian Permanent Committee on Geographical Names, the Advisory Committee On Undersea Feature Names was organized in 1967 to accept or reject names for undersea features in Canadian waters and in areas of interest to Canada. The Advisory Committee was also delegated to establish and define suitable undersea generic terminology. Decisions of this committee are approved on behalf of the Minister of Energy, Mines and Resources by the Chairman of the CPCGN.

The Gazetteer includes the description, composition, and function of the Advisory Committee, and gives guidelines for standardization of naming and designating undersea features. Geographical names usually contain specific and generic elements. In English, the specific (often a descriptive or geographical designation) is usually followed by the generic term (indicating the nature or type of feature), for example Browns Bank. In French, on the other hand, the generic more commonly precedes the specific, as in Bonnet Flamand. Names used for many years may be accepted, regardless of their conformity or nonconformity to modern guidelines. Although several names may be in general use, the selection of one official name (or possibly different English and French forms) is made for any given feature.

All features named by the Advisory Committee must have measurable relief on the ocean floor or seabed and be submerged at low tide. The Advisory Committee has no mandate to consider aproving names for sub-seabed features, such as geological structures that are without seafloor expression.

Guidelines for choosing names are provided in the Gazetteer. Suggestions include naming after ships, constellations and well-known and relevant geographical features. In addition, brevity is advised and blasphemous, racial, or derogatory designations should be avoided.

Contained in the Gazetteer is an important section on undersea generic terms, giving, in both English and French, their definitions.

Using The Digital Data Base To See Between The Lines

By
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Region de Quebec

Abstrait:
Cet article explique un processus par lequel une analyse par ordinateur peut s'effectuer sur les donnees hydrographiques digitales. Cette analyse pourrait nous permettre de dessiner les "enveloppes de confiance" autour de nos lignes de sondages et par consequent tirer plus d'information utile de nos donnees.

Introduction:
In recent years a lot of development has gone into the technology which is now producing our digital data base. This work could basically be divided into two categories; the collection of hydrographic data and the presentation of hydrographic data. A third, and potentially very rewarding, avenue of development exists which has yet to be explored: analysis of hydrographic data.

What is meant here by analysis? An example gives the best definition: We can analyse a horizontal control network to establish the error ellipses for its points. These ellipses express a standardized measure of uncertainty which can be attached to the position of any given point in the network. Applying this thinking to hydrography we can introduce the concept of a zone of confidence surrounding each individual sounding selected for portrayal on a field sheet. The standardized confidence expressed by this zone will be: that no shallower sounding exists inside a soundings confidence zone. The logic used in the analysis of this confidence zone is based on the following piece of common sense: If the hydrographic sounding selected is taken over rough bottom terrain, its confidence zone is small. If the sounding is taken over smooth terrain, its confidence zone is large.

What are the potential rewards of such an analysis? The first reward is greatly improved efficiency in data collection. This will result due to a better matching of line spacing to the bottom topography.

Proper line spacing must be dense enough to fully define the bottom to an accepted level of confidence. If the spacing is denser than need be then time and money are being wasted and if the spacing is not dense enough then the job is not being done thoroughly. Current practice determines line spacing using very much of a "one size fits all" approach. Line spacing is tied directly to survey scale: 0.5 cm at scale. This standard has more to do with the graphical limitations of jamming numbers onto drawing film than it does with the efficient collection of data.

Chart schemes establish scales over vast areas, cartographic considerations in turn demand constant survey scales (and thus constant line spacing) over vast areas. The trouble is that the different types of bottom topography are relatively local phenomena. On virtually every field sheet there are some areas that are either flat or of constant slope and other areas where shoal structures exist. It is only with 20/20 hindsight that we can look at a completed field sheet and realize, that over considerable areas of it, the line spacing was inconsistent with efficient data collection.

The theoretically ideal situation would have an infinitely variable line spacing expanding and contracting over the whole surface of the field sheet to fit the varying needs of the bottom topography. Obviously this is impossible due to the physical constraints of sounding. However the following proposal, by exploiting the nature of the hydrographic digital data base, presents a method by which the ideal can be more closely approached.

Method Proposed:
The collection of all data in digital form makes feasible the computer analysis of all the soundings. The extent of the zone of confidence for each sounding selected for the field sheet is calculated by analysing the bottom topography in the vicinity of that sounding. Since the confidence along the sounding line is infinite the value calculated translates into an across track distance for which the sounding has the standard confidence. Since each sounding along the line has its unique confidence the result is a series of across track distances which will define a "confidence envelope" for each line. The confidence envelope of each sounding line varies in width along the line as the topography changes. Using the program described later in this paper, the series of envelopes are calculated and plotted on an overlay of the field sheet.

To use the method, survey scale is selected in the normal way. However instead of running sounding lines at 0.5 cm intervals, the lines are double spaced at l.0 cm. The confidence envelope overlay is plotted and placed over this double spaced field sheet. The hydrographer then has before him a standardized plan of where interlines should be run and where they should not. Where the adjacent confidence envelopes touch or overlap no interlines will be required. Using this plan the field sheet is sectioned into areas requiring interlining and those that do not.

In a very rough patch of shoals the confidence envelopes would be so narrow that, even by interlining, they could not overlap. For these areas the hydrographer would create a large scale inset. The soundings obtained on the original double spaced lines would be re-plotted on this supplementary field sheet provided that the positioning system used was accurate enough for the larger scale. This supplementary sheet would then be double interlined or triple interlined as needed to obtain sufficent confidence.

The overall effect of this method would be to focus the sounding effort where it is most needed.

The Program:
As stated earlier the analysis of a soundings confidence zone is based on the roughness of the bottom in the vicinity of that sounding. With this in mind, if we look at our digital data record, we can see that there is a wealth of information which until now has literally been waste data. Along the track sounded we obtain a sounding every 1/2 second or so thus obtaining a continuous record along the line and infinite confidence. A full sized field sheet can contain over 70,000 inked soundings. However, this hydrographic data set: S, must be selected from a total data set: D, containing many millions of individual soundings. The algorithm used for the selection of hydrographic soundings chooses only the shallowest soundings and the rest of the data is forgotten. Obviously this data should be put to good use. Figure 1 illustrates the point. Two bottom profiles are shown which will result in exactly the same hydrographic soundings being selected but which should have different confidence envelopes.

The non hydrographic data set cannot be represented graphically on the field sheet. It can however, by numerical analysis, be represented mathematically and used as one factor in the calculation of the confidence envelopes. Before looking at this step, let's first consider the format required for reading our data into the computer.

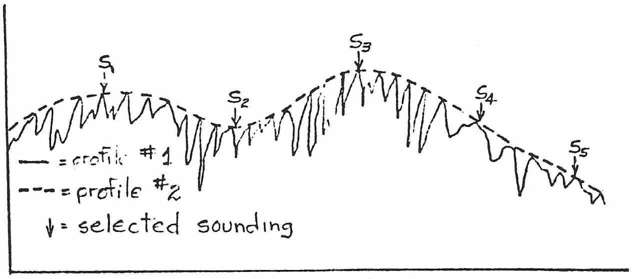


Figure 1

Automated surveys imply straight line navigation of the sounding vessels. If we observe the resulting field sheet from a few feet away we can perceive a striking characteristic: the grid layout of the soundings resembles the row and column layout of a matrix. We will take this hint and equate our field sheet to a giant matrix: $\underset{(m,n)}{S}$.

If we presume that the lines are run in a north-south direction the dimension of $\underset{(m,n)}{S}$ is:

> m = number of rows = number of soundings selected along a line
> n = number of columns = number of sounding lines.

Using this matrix format facilitates future computations as the computer is very efficient at performing matrix operations. Of course the real positions of the soundings on the field sheet do not form a perfect grid as represented by the matrix. There will be slight variations from the model since the sounding lines are not perfectly straight nor are the soundings selected at perfectly equal distances along the lines. However this program does a statistical analysis of depths, not positions, thus the matrix approximation will be valid. We are presuming here that the sounding lines are run in a north south or Y direction, thus the final output of the program is a series of confidence values in the X direction which form the plot of the envelopes. As long as these x values are referenced to the real positions of the soundings which form $\underset{(m,n)}{S}$, the interim statistical calculations can be performed on the matrix. The first part of the program is an input routine which, by looking at the real positions of the soundings, pigeon-holes each depth into its closest matrix position.

The Roughness Factor:

The matrix $\underset{(m,n)}{S}$ is formed using the selected hydrographic soundings for its elements. As $\underset{(m,n)}{S}$ is being formed a second matrix $\underset{(m,n)}{R}$ can also be formed. The elements of $\underset{(m,n)}{R}$: r_{ij}, are the roughness factors corresponding to each sounding in $\underset{(m,n)}{S}$: s_{ij}. The subscripts i and j indicate the row and column position of each element in the matrix. To analyse a roughness factor the section of the total data record D from which each sounding is selected must be isolated. This can be done by counting the number of soundings that occur between selected soundings and dividing up D in the manner illustrated in figure 2.

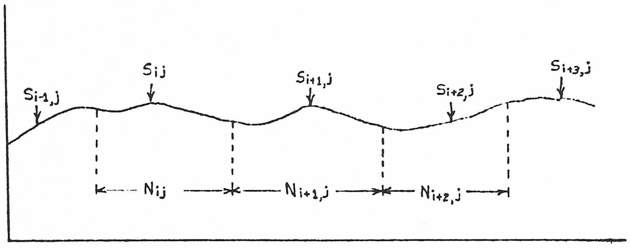


Figure 2

The ratio of total soundings to selected soundings will vary as the X component of our graph is compressed or expanded: a high speed launch working at large scale might result in 1 sounding in 25 being selected, a ship sounding at small scale might only use 1 sounding in 200.

Let's look closely at the calculation of a roughness factor for s_{ij} in figure 2. We see that s_{ij} was selected from N_{ij} soundings. Between any two values of d_p (depths within the interval N_{ij}) we will have a value of Δd_p ($\Delta d_p = d_p - d_{p+1}$). This series of subtractions will result in N_{ij}-1 values of Δd_p varying in sign and magnitude depending on how fast the depth is getting shallower or deeper. A roughness factor can be calculated by simply taking the standard deviation of the Δd_p values.

$$\sigma_{ij}\Delta d_p = \sqrt{\frac{\Sigma(\Delta d_p - \overline{\Delta d_p})^2}{N_{ij}} \quad \text{where } \overline{\Delta d_p} = \frac{\Sigma \Delta d_p}{N_{ij}-1}}$$

This will yield an effective indicator of roughness since the general slope of the bottom will not affect the value calculated. This value of $\sigma_{ij}\Delta d_p$ must however be corrected for two distortions.

The first distortion occurs due to the effect of launch velocity on the values of Δd_p. Over a given stretch of bottom topography, the higher the launch velocity the greater the values of Δd_p will be. Thus we must standardize the launch velocity to some fixed arbitrary value, let's say 20 kph. To do this, each value of Δd_p in the interval N_{ij}-1 is multiplied by the factor $\frac{20(\text{kph})}{V(\text{kph})}$ before the standard deviation function is evaluated.

The launch velocity V is easily calculated since we have logged the position and time of the first and last depth (d_1,d_{nij}) of the interval N_{ij}

$$V(\text{Kph}) = \sqrt{\frac{\Delta N^2 + \Delta E^2}{\Delta T(sec)}} \times \frac{3600}{1000}$$

The second distortion of $\delta_{ij}\Delta d_p$ arises from the following characteristic: $\Delta_{ij}\Delta d_p$ is an index of the dispersion of Δd_p but it gives no indication of the topographical value of this dispersion. For example; three 2 dm. bumps give the same value of $\delta_{ij}\Delta d_p$ as one 6 dm bump, four 2 dm bumps = one 8 dm bump, three 3 dm bumps = one 9 dm bump, four 3 dm bumps = one 12 dm bump etc. For hydrographic purposes, the more bumps there are in a given stretch of bottom profile, the less significant is its roughness factor. Thus a correction can be applied by simply dividing $\delta_{ij}\Delta d_p$ by the number of bumps. The bumps are easily counted by observing the sign of Δd_p. At the top of each bump Δd_p changes from +ve to −ve and vice versa in the trough between bumps. Thus the bump count:

$$BC = \frac{\Sigma +/- \Delta d_p}{2}$$

and the corrected standard deviation:

$$\sigma_{ij}{}^1\Delta d_p + \frac{\sigma_{ij}\Delta d_p}{BC}$$

We can use this corrected value as our roughness factor. Thus:

$$r_{ij} = F(\sigma_{ij}{}^1\Delta d_p)$$

where F is arbitrary function to be discussed later.

Before considering the next step in the program a practical observation should be made concerning $\underset{(m,n)}{R}$. The roughness factor will be very sensitive to wave action on the sounding vessel. To prevent heavy seas from inducing a false bottom roughness the new wave eliminator option offered for the Atlas sounder should be considered. This option might also be adapted to fit other C.H.S. sounders as it is simply an accelerometer driving the sounder's draft control.

The Shoal Factor:

Creating $\underset{(m,n)}{R}$ constitutes a microscopic look at the roughness of the sounding record along the line of selected soundings. To properly evaluate the confidence envelope we must also take a macroscopic look at soundings further along the line and on adjacent double spaced lines. This can best be done by working with the selected soundings on the field sheet matrix $\underset{(m,n)}{S}$. Each sounding s_{ij} will be analysed by forming a 3×3 submatrix with s_{ij} as the center element. By indexing the values of i and j, this 9 element matrix $\underset{(3,3)}{M_{ij}}$ can be made to travel over the whole surface of the field sheet $\underset{(m,n)}{S}$. In practice, for a complete examination of the field sheet, the matrix, $\underset{(m,n)}{S}$ must extend one sounding further than the field sheet limits on all four sides.

We will call this macroscopic roughness factor the shoal factor h_{ij} and as we calculate it we will create a third matrix: $\underset{(m,n)}{H}$. Each shoal factor h_{ij} is an indication of whether the sounding s_{ij} is a shoal or not, better yet we'll make it represent the degree of "shoalness" of s_{ij}. To see how h_{ij} is calculated we'll consider our roving matrix $\underset{(3,3)}{M_{ij}}$ positioned over the sounding s_{ij} somewhere in the field sheet matrix $\underset{(m,n)}{S}$, thus:

$$\underset{(3,3)}{M_{ij}} = \begin{bmatrix} m_{11} & m_{12} & m_{13} \\ m_{21} & m_{22} & m_{23} \\ m_{31} & m_{32} & m_{33} \end{bmatrix} = \begin{bmatrix} S_{i-1,j-1} & S_{i-1,j} & S_{i-1,j+1} \\ S_{i,j-1} & S_{ij} & S_{i,j+1} \\ S_{i+1,j-1} & S_{i+1,j} & S_{i+1,j+1} \end{bmatrix}$$

Thus the sounding being considered: s_{ij}, is surrounded by its eight adjacent soundings. The shoal factor h_{ij} is calculated by analysing this matrix $\underset{(3,3)}{M_{ij}}$.

Before analysing $\underset{(3,3)}{M_{ij}}$ we can make use of some data we have already calculated: the roughness factors of the eight adjacent soundings. In calculating x_{ij}, r_{ij} will be one of the three principal factors used. However the adjacent roughness factors can also be used as a weighting matrix $\underset{(3,3)}{W_{ij}}$ in the calculation of the shoal factor: h_{ij}. The logic used is this: if the adjacent soundings are taken over rough terrain then x (the confidence zone) should be smaller, if they are taken over smooth terrain then x should be larger.

Determining h_{ij} has to be based on the depth difference between m_{22} and the eight adjacent elements of $\underset{(3,3)}{M_{ij}}$. This presents an elegant way to apply the weighing matrix. The roughness factor is already expressed as a depth. If we simply add the roughness factors of the adjacent depths to the adjacent depths themselves then the "shoalness" of the center depth will be accentuated and our logic will be satisfied. Thus:

$$\underset{(3,3)}{M_{wij}} = \begin{bmatrix} m_{w_{11}} & m_{w_{12}} & m_{w_{13}} \\ m_{w_{21}} & m_{22} & m_{w_{23}} \\ m_{w_{31}} & m_{w_{32}} & m_{w_{33}} \end{bmatrix} = K\underset{(3,3)}{W_{ij}} + \underset{(3,3)}{M_{ij}}$$

$$= K \begin{bmatrix} r_{11} & r_{12} & r_{13} \\ r_{21} & o & r_{23} \\ r_{31} & r_{32} & r_{33} \end{bmatrix} + \begin{bmatrix} m_{11} & m_{12} & m_{13} \\ m_{21} & m_{22} & m_{23} \\ m_{31} & m_{32} & m_{33} \end{bmatrix}$$

where K is an arbitrary constant to be discussed later.

We can now analyse $\underset{(3,3)}{M_{wij}}$ to obtain the shoal factor h_{ij}. To do this we'll look at the slope of the bottom between m_{22} and each of the adjacent eight elements of $\underset{(3,3)}{M_{wij}}$. Figure 3a shows the relative positions of the elements of $\underset{(3,3)}{M_{wij}}$ as they would be inked on the field sheet (minus the slight variations caused by the matrix approximation) when the proposed 1.0 cm line spacing is used.

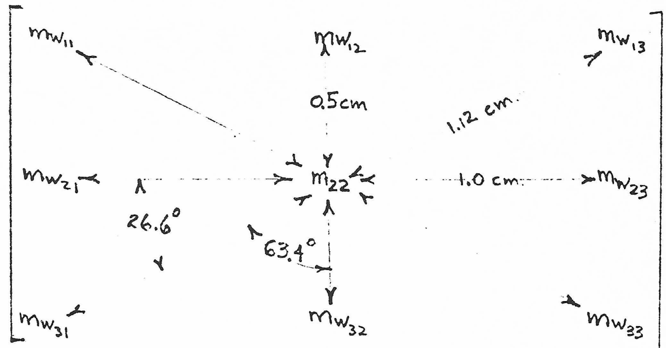


Figure 3a

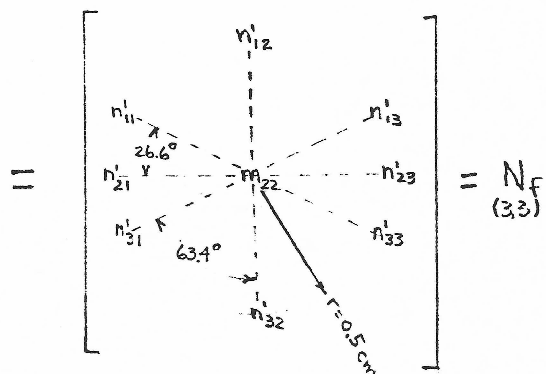


Figure 3b

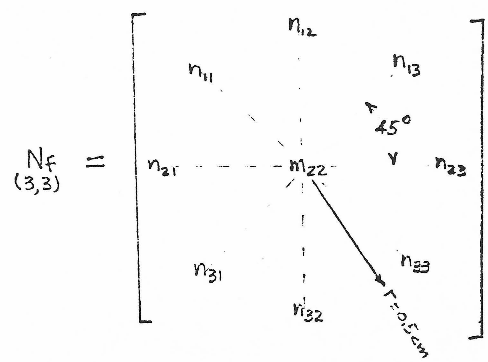


Figure 3c

Figure 3a = Figure 3b = $\underset{(3,3)}{Nf}$ = Figure 3c

There are three path lengths (vertical, horizontal and diagonal) between m_{22} and the eight adjacent soundings. These distances occur in the ratio 1:2 :2.24. Since we want to look at the slope in all eight directions we must normalize the adjacent soundings to compensate for the different distances. Thus we will create a normalized matrix $\underset{(3,3)}{N'}$ whose elements are derived by a linear interpolation of the depth between m_{22} and the adjacent soundings. These elements (represented by figure 3b) are the soundings which would occur at a radius of 0.5cm based on the data available.

Figure 4 shows a superimposed profile of the three different distances which can occur.

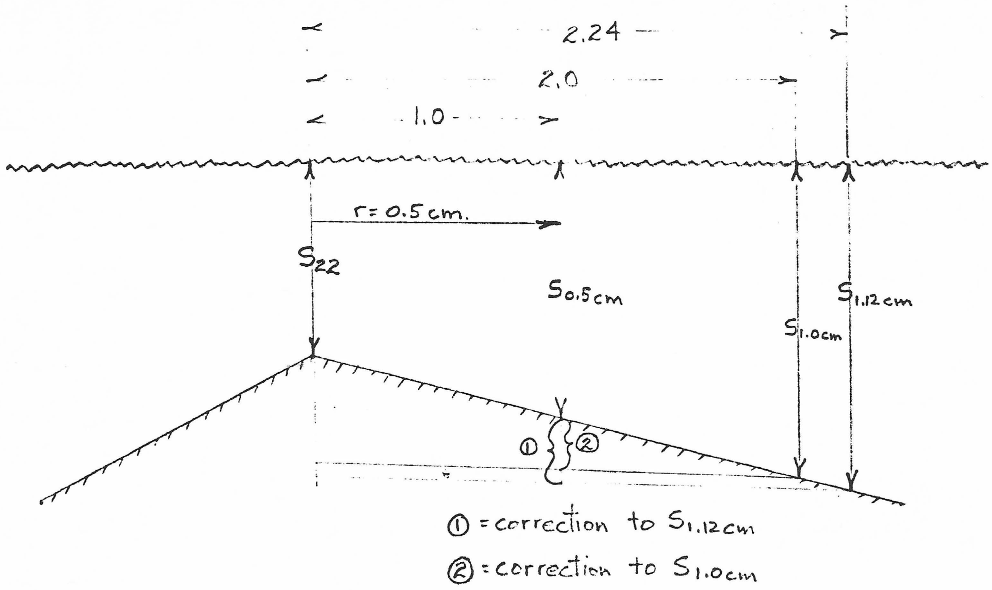


Figure 4

By applying the similar triangles to reduce the soundings on the horizontal and diagonal paths we can calculate the elements of $\underset{(3,3)}{N'}$ using:

$$\underset{(3,3)}{N_{ij}} = \begin{bmatrix} n'_{11} = m_{w_{11}} + \dfrac{(m_{22} - m_{w_{11}})}{1.8} & n'_{12} = m_{w_{12}} & n'_{13} = m_{w_{13}} + \dfrac{(m_{22} - m_{w_{13}})}{1.8} \\ n'_{21} = m_{w_{21}} + \dfrac{(m_{22} - m_{w_{21}})}{2} & n'_{22} = m_{22} = S_{ij} & n'_{23} = m_{w_{23}} + \dfrac{(m_{22} - m_{w_{23}})}{2} \\ n'_{31} = m_{w_{31}} + (m_{22} - m_{w_{31}}) & n'_{32} = m_{w_{32}} & n'_{33} = m_{w_{33}} + \dfrac{(m_{22} - m_{w_{33}})}{} \end{bmatrix}$$

We now have reduced the grid pattern of $\underset{(3,3)}{M_{ij}}$ to a circular star pattern. This star pattern cannot however be easily used as a rigorous conic model of the shoalness of m in its present form. If we view figure 3b as a plan view of a cone with n'_{22} as its summit we can see that the rays between the summit and the eight adjacent soundings are not equally spaced: the angle between rays being either 63.4° or 26.6°. To give equal weight to all eight adjacent soundings, the angle should be 45° in all eight cases. This can be accomplished by doing a second linear interpolation. This depth interpolation will move the "corner" elements of the now circular $\underset{(3,3)}{N'_{ij}}$ towards the vertical elements (n'_{12} and n'_{32}) so as to correct the angles to 45°. Another interpolation will rotate the "corners" away from the horizontal elements (n_{21} and n_{23}). The average of these two interpolations will give the closest approach to a perfectly symetrical cone model of the center sounding being considered. Thus we can produce a final normalized matrix $\underset{(3,3)}{N_f}$ whose elements are represented by figure 3c.

$$\underset{(3,3)}{N_{vert}} = \begin{bmatrix} n_{v_{11}} = n_{11}' + ((n_{12}' - n_{11}') \times \dfrac{18.4°}{63.4°} & n_{v12} = n'_{12} & n_{v_{13}} = n'_{13} \times ((n'_{12}\, n'_{13}) \times \dfrac{18.4°}{63.4°} \\ n_{v_{21}} = n'_{21} & n_{v_{22}} = m_{22} = S_{ij} & n_{v_{23}} = n'_{23} \\ n_{v_{31}} = n'_{31} + ((n'_{32} - n'_{31}) \times \dfrac{18.4°}{63.4°} & n_{v_{32}} = n'_{32} & n_{v_{33}} = n'_{33} + ((n'_{32} - n'_{33}) \times \dfrac{18.4°}{63.4°} \end{bmatrix}$$

$$
N_{hor\,(3,3)} = \begin{bmatrix} n_{h_{11}} = n'_{11} + ((n'_{11} - n'_{21}) \times \frac{18.4^\circ}{45^\circ} & n_{h_{12}} = n'_{12} & n_{h_{13}} = n'_{13} + ((n'_{13} - n'_{23}) \times \frac{18.4^\circ}{45^\circ} \\ n_{h_{21}} = n'_{21} & n_{h_{22}} = m_{22} = S_{ij} & n_{h_{23}} = n'_{23} \\ n_{h_{31}} = n'_{31} + ((n'_{31} - n'_{21}) \times \frac{18.4^\circ}{45^\circ} & n_{h32} = n'_{32} & n_{h33} = n'_{33} + ((n'_{33} - n'_{23}) \times \frac{18.4^\circ}{45^\circ} \end{bmatrix}
$$

and $$Nf_{(3,3)} = \frac{N_{hor\,(3,3)} + N_{vert\,(3,3)}}{2}$$

If we examine the three dimensional geometry of the symetrical cone represented by $N_{f\,(3,3)}$, we will see that the average of the eight adjacent soundings defines the depth of an average plane at the position of the center sounding whose shoalness we wish to establish. Thus the shoal factor h_{ij} is simply the depth difference between the average plane and the sounding n_{22}:

$$h_{ij} = G\,(n_{22} - \overline{N}.)$$

where $\overline{N}$ is the average of the eight adjacent elements in $N_{f\,(3,3)}$, and G is an arbitrary function to be discussed later.

Before leaving the shoal factor we will digress a bit to look at two very practical uses for this shoal factor routine (aside from its ultimate use in calculating confidence envelopes).

The routine assigns an index of shoalness to every sounding on the field sheet $S_{(m,n)}$. It could be easily modified to decide if each sounding on the field sheet is either a shoal or not a shoal. The decision criterion could be: is s_{ij} shallower than the average depth of its adjacent soundings by more than 10%. This modified routine would then refer these selected shoal soundings back to their original true positions and plot them on an overlay of the field sheet.

Until now, in this paper, we have referred to $S_{(m,n)}$ as a giant matrix slightly larger than the entire field sheet. Of course no portable computer can work with a matrix that might contain over 35,000 elements. In practice $S_{(m,n)}$ would have to be treated using a much smaller moving submatrix. In writing the confidence envelope software package the following criterion would be kept in mind: The confidence envelope overlay and the shoals discovered overlay should be produced as part of the end of day data processing. If this is done, then at the start of the next day the hydrographer will have all the information needed for maximum economy of movement. Before continuing the double-spaced lines he can finish the previous days sounding by filling in the necessary interlines as indicated by a lack of confidence envelope overlap. If only 50% of the area requires interlining then the hydrographic dollar has been stretched by 25%. The shoal exams and bottom sampling could be integrated into the interlining thus giving further savings in transit time between shoals and sample sites.

The second practical shoal factor use is a cartographic one. The shoal factor routine could write the shoalness of each sounding into the data record of each sounding. During automated chart construction the cartographer would then have a powerful aid in selecting chart soundings. Soundings tagged as shoals of a certain magnitude could be made to flash when displayed on the interactive terminal. He could vary this display criterion depending on the area being looked at. Large shoals would be the first to be displayed and as selection progressed the criterion would be made smaller and smaller. Eventually the +1 dm shoals would be flashing to draw attention to themselves on the flat areas.

Calibrating the Program:
Let's look at what we now have available for the calculation of $X_{(m,n)}$ (the series of across track × values which define the confidence envelopes). The roughness factor $R_{(m,n)}$ and the shoal factor $H_{(m,n)}$. As stated at the outset, the confidence envelopes X are inversely proportional to the general roughness of the bottom in the vicinity of each sounding $S_{(m,n)}$. We can also introduce here another factor affecting the confidence envelopes: depth. Common sense (and C.H.S. standing orders 70-4 and 78-3) indicate that the deeper the water is, the less stringent the confidence requirement becomes. Thus we have:

$$X_{(m,n)} = Z_{(m,n)}\,(R_{(m,n)},\ H_{(m,n)},\ S_{(m,n)})$$

where Z is an arbitrary function to be discussed now, along with the other arbitrary functions referred to.

An analogy can be drawn between our program and a sounder. The sounder we are considering has its draft and speed of sound controls completely out of adjustment. In the analogy these controls correspond to the undefined functions used in the program (F,K,G and Z). By playing with the sounders controls it can be made to give an infinite variety of graphs for the same sounding line i.e. it has no metric value. By varying the four functions in the program, an infinite variety of meaningless confidence envelopes could be drawn for the same field sheet. Some combinations would be so conservative that all interlines would have to be run, at the other end of the scale no interlines would be run. There exists a unique combination which will give the desired results: efficient data collection.

To calibrate the sounder a physical standard is used: the barcheck. We need a corresponding physical standard to calibrate the functions F,K,G and Z in the program.

The standard to be used is the digital data base itself. Automated surveys carried out to date use a single spaced, 0.5 cm, line spacing. Every second line on these surveys is a physical standard against which the confidence envelopes of the other lines can be calibrated.

The writing of the software to draw confidence envelopes is basically a straightforward task. The calibration of this program on the other hand would be a long term iterative process requiring a lot of judgement and consensus. The approach to calibration is as follows. Many field sheets, covering a wide cross section of scales and bottom topography would be reviewed. Each field sheet in this data base would have every second sounding line removed and set aside. Thus two copies of each field sheet could be produced; one with interlines and one without. The double spaced field sheets would have their confidence envelopes plotted using many different combinations of F,K,G and Z. Eventually a best guess at a master combination of the four functions would be formulated and calibration could begin.

This master combination: C, will produce a set of confidence envelopes which indicate the areas that need interlining. The second copy of the field sheet, with all interlines sounded, can now be used to check how accurate the initial guess at C was. By iterating this process a final C would be developed, representing a hydrographic standard.

Two guidelines would be helpful in the long process of checking the results of each refinement of C against the standard. The first is that the confidence envelopes generated should be conservative enough that the contour details won't be significantly degraded. The two sheets being compared should be contoured at 1 metre intervals to accentuate any differences. If the interlining eliminated by a proposed C does not significantly alter the contours from those on the standard sheet, then the C would be tentatively accepted and then tested at other scales and on different bottom topography. Just what constitutes "significant" would be cause for debate however the tolerance allowed would have to be at least as large as the contour movement caused by the sum of other accidental errors (positioning, scaling, direction of lines, weather etc).

The second guideline would have all shoals on the standard sheet identified as targets. A proposed C would either detect these targets by demanding that the targets interline be sounded or else miss the target. By examining many different sheets with a given C a significant statistical conclusion could be reached concerning the C in question: a percentage confidence that all shoals have been detected by the confidence envelopes. For example a certain C might detect 99% of target shoals, another might save more time on interlining but only detect 90% of the shoals. This introduces the second potential reward offered by the method proposed in this paper. The first was increased efficiency of data collection, the second is a more evolved standardization of hydrographic surveys.

Standardization:

Hydrographic surveyors could profit by employing a concept developed by geodetic surveyors for standardizing their surveys. Control surveys have quantified standards applied to both the methods used in data collection and to the quality of the final output of the survey. The residuals of a least squares adjustment are used to define the quality (the error ellipses) of the resulting controlled points. It is the combination of these two types of standards (methods and results) which allow geodetic surveys to be classed as 1st order, 2nd order etc.

Hydrographic surveys can presently be divided into two classes; old surveys and those "surveyed to modern standards". The modern standards referred to are all standards relating to the methods employed in collecting data. The idea being that if we have an accurate position and an accurately measured depth then we will have a high quality resulting survey.

But what is the result of a hydrographic survey? It surely should be more than accurate numbers on a piece of plastic film. The hydrographic survey gives the same result as a topographic survey on land: a "picture", be it graphical or digital, of the shape and size of features on the bottom. The fidelity of this picture with the real world is the standard by which the picture or survey should be judged. This judgement should be rendered independent of some arbitrary survey scale.

By far the most important factor in the fidelity of the hydrographic survey is the relationship between the bottom topography and the sounding density. Position and depth accuracy can easily be held within tight limits and have only a minor effect on the focus of our picture. Line spacing on the other hand varies drastically due to many arbitrary factors (budget restraints, time priorities, draft of shipping etc) meanwhile mother nature lies unchanging on the bottom waiting to have her picture taken.

Clearly a meaningful standard for hydrographic surveys must combine standards imposed on the method of data collection together with a standardized input from the result of the survey i.e. the nature of the local bottom topography. The confidence envelopes described in this paper could provide the needed input. If we calibrate the program with a very conservative C then more interlining and more large scale insets would be required to satisfy the envelopes and a first order hydrographic survey would result. When surveying less critical areas a less demanding C could be used for the sake of economy however a lower order survey would result.

Conclusion:

The approach outlined in this paper would be a logical extension of the digital data base. By using a computer analysis; the maximum amount of useful information could be extracted from our data, the data collection process itself could be streamlined and the quality of the resulting product could be better evaluated.

The Canadian Hydrographic Service (Atlantic) Sweep Program

A Status Report

By
R. Burke

INTRODUCTION paragraph 3

". . . for vertical acoustical sweeping . . ."

should read

". . . for vertical **acoustic** sweeping . . ."

SWEEP SYSTEM OVERVIEW paragraph 1

". . . Sweep System of two . . ."

should read

". . . Sweep System **is comprised** of two . . ."

". . . for deployment of the array of transducers . . ."

should read

". . . for **the** deployment of the **transducer array** . . ."

DEPTH PRE PROCESSOR paragragh 2

". . . 18 MCS-1B . . ."

should read

". . . **16** MCS-1B . . ."

paragraph 4

". . . operator by aware . . ."

should read

". . . operator **be** aware . . ."

PATH GUIDANCE UNIT paragraph 1

". . . time of day and depth of course . . ."

should read

". . . time of day**,** depth **and** course . . ."

SOFTWARE paragraph 2

". . . chart (field sheet) perplot, data list . . ."

should read

". . . chart (field sheet) **preplot,** data list . . ."

paragraph 4

". . . survey vessel exists the . . ."

should read

". . . survey vessel **exits** the . . ."

THE BOOM paragraph 3

". . . feature on the Arctic . . ."

should read

". . . feature **for** the Arctic . . ."

". . . where sources such as . . ."

should read

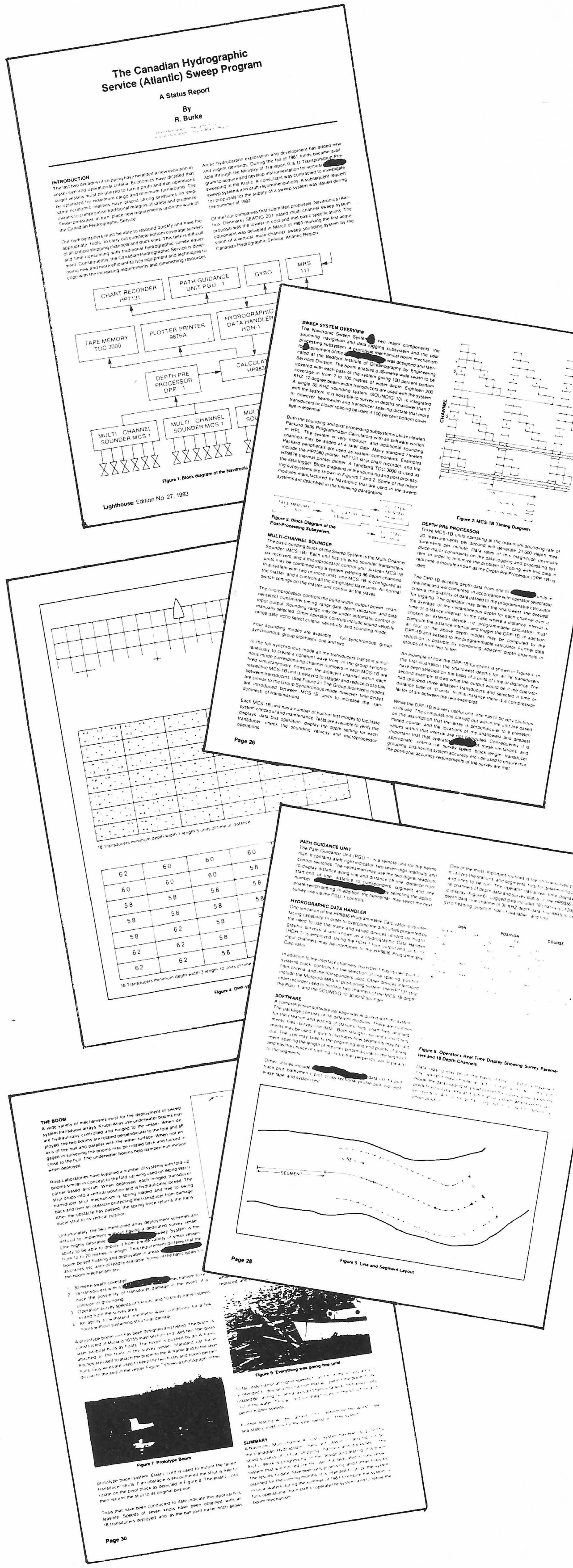
". . . where **resources** such as . . ."

paragraph 4

". . . breakaway or foolsafe mechanism . . ."

should read

". . . breakaway or **failsafe** mechanism . . ."



CHA/CHS News

ATLANTIC REGION

Steve Grant attended the FIG Conference in Sophia Bulgaria in June and visited various tidal offices in England.

Elizabeth Crux Cook was also a visitor to England this summer vacationing there for a month.

Kirk MacDonald attended the Association of Can. Map Librarians in June and visited the facilities at Sydney, B.C.

Congratulations to Sandy Weston for winning the Assistant Chief of Chart Production position in Atlantic Region.

We welcome back Judy Lockhart, Karen Coates and June Senay for another term assignment.

Allan Smith was on a diving assignment for Tidal Section in the eastern Arctic.

Congratulations to Rick and Sharon Mehlman on the birth of their daughter Elizabeth Ann.

Jim Ross our first cartographer accepted for U.T.P. begin studies in September at St. Mary's University.

Hank Boudreau, Walter Burke and Gerard Costello also returned to University to continue their studies.

Congratulations to Kent Malone on his admission to the Association of Professional Eng. of Nova Scotia.

We welcome Chris Archibald who will be with us for four months while Carol Ann Beals is in Word Processing.

Frank Miller and Alex Hantzis attended the Carto II Course in Ottawa.

Bert McCorriston, Roland Perrotte, Steve Forbes and Adam Kerr attended the Sixth International Symposium on Automated Cartography in Ottawa, Hull.

Grant MacLeod has announced he is abandoning his bachelor ways sometime in May.

Mike Eaton, Head of the Navigation group of the Atlantic Region of the Canadian Hydrographic Service (OSS Atlantic at BIO), was honoured by the annual Medal of Merit by the "Wild Goose Association" at its 12th Annual Symposium: in spite of its name, this is the association of more than 600 professionals who work to develop LORAN navigation systems. Their citation read, in part:

> "The Medal of Merit . . . . . is awarded to R. Michael Eaton in recognition of his extensive contributions to the development and fostering of LORAN. His work in the use of LORAN-C in hydrographic surveys, his advocacy of LORAN-C in the rho-rho mode for calibration and propagation measurements, and his testing, analysis and planning assistance in the expansion of LORAN-C in the Canadian area have all helped the advancement of LORAN."

CENTRAL BRANCH

Tom McCulloch, Director General O.S.S., has been seconded to CAHOSI (Canadian Association of Hydrographic and Oceanographic Surveying Industries) as Executive Director for a period of one year.

Ross Douglas will be Acting Director — General, Ocean Science and Surveys, Department of Fisheries and Oceans, Burlington.

Central Branch executive members Al Koudys and Sean Hinds each lost an airborne launch (Bell 206B) to the 'hard' waters of Yelverton Bay, one eventful week last March.

Jim Statham has left his position with Marshall, Macklin and Monaghan and accepted a position as General Manager, Geodesy Division with Wild Leitz Canada Ltd.

Bob Moulton has left his postion as Hydrographic Instructor at Humber College and is now the Southwestern Ontario Sales Representative for Wild Leitz Canada Ltd.

Danny Mahaffey was involved in a car accident during the summer, on his Revisory Survey. He is presently at home recuperating, and we would like to wish him a speedy recovery.

The C.H.A. 'Shipheads' completed the Burlington Road Race in May with a time of two hours, five minutes and twenty-two seconds for a 16 mile race.

The smiles indicate this was a prerace photo. Postrace pictures are unavailable for comment.

Dennis St. Jacques — George Macdonald — Bruce Richards — Brad Tinney

OTTAWA BRANCH

Hydrographic Data Processing Seminar

The Ottawa Branch of the CHA is sponsoring a Seminar on Hydrographic Data Processing during the week of February 20-24, 1984. This seminar will follow along lines similar to the one held in Toronto by CHA (Central). Anyone interested in this seminar should write to Jim Bruce, Vice President, CHA, Ottawa Branch, 615 Booth St., Ottawa, Ontario, K1A 0E6 or phone (615) 995-4651.

There have been a few temporary staff assignments here in Ottawa.

— Diana Pantalone has joined the Training and Development section for a year to work on some audio visual material on the CHS.
— Ron Lemieux has joined the Planning section until June 1984.
— Michel Wolfe has transferred to the Geoscience Mapping unit for a year.

Tom Cassidy, Aurele Rochon and Ron Tamerande attended the recently completed Carto II course held here in Ottawa.

A warm welcome to Ken Williams who has recently joined us from Quebec Region, and to Charlie Doekes from Burlington. Charlie has rejoined the CHS after a stint with the Oceanography Branch at Bayfield Institute.

Ken Peskett and his family moved into their rebuilt (bigger and better!) home this summer.

Two of our past year summer students enjoyed their time with us so much that they have rejoined the CHS as term employees. Colin Bromfield is now with the Cartographic Development unit, and Bob Clarke is with the Planning unit working on co-ordinating external funded R&D work.

Brian Tait spent a couple of weeks in August in Hamburg, Germany participating at the I.U.G.G. Conference. He was part of the working group on Ocean Tidal Measurement.

Dave Black is now a permanent employee with the Aids to Navigation section, and Pauline Lafluer is on term with the same section.

P. G. Tremblay just received his certificate for 25 years of government service.

Congratulations to Della (Ketch) and Jack Mailloux who were married in early September.

Barry Brouse retired on September 24 after 32 years with the government.

Harvey Blandford retired on October 31, after 31 years with the government.

Jim Dillon will have completed 43 years of government service when he retires next year on March 16, 1984.

Congratulations to Michel and Monique Wolfe on the birth of their third child, Dominic.

Dick Cashen is the CHS representative at the 11th meeting of the NATO working party — maps and charts, October 17-21 in Brussels.

We are sorry to report the death of Enid Hardy, a long time past employee of CHS.

Jim Bruce attended the Canadian Power Squadron Annual National Conference in Banff, October 21-23.

Gary Kosowan and his wife Ann just became parents for the first time. Amy Lynn Kosowan was born in September.

PACIFIC BRANCH

Murray Farmer spent three months on exchange visit with the U.S. National Ocean Survey office in Rockville, Maryland. Before returning to Victoria he renewed old acquaintances in Atlantic and Headquarters regions.

Richard Naito of U.S. National Ocean Survey spent a similar amount of time here in Pacific Region.

Over 60 golfers participated in the Thirteenth Annual Hydrographic Invitational Golf Classic held July 22nd at Prospect Lake Golf Course. Alan Douglas turned in the best round of the day with a nine hole score of 37. The most honest golfer proved to be Linda Hock with a score of 87. A steak barbecue and prize ceremony followed the tourney at the clubhouse.

Members of the Ontario Institute of Chartered Cartographers in British Columbia recently formed an organization called the Pacific Institute of Cartographers Society. Sev Crowther is presently Vice President of this new organization. A newsletter is published regularly, presently at issue number 7. The group has hosted a computer cartography workshop at Simon Fraser University. Anyone interested in learning more about this society can do so by writing to Box 6133, Postal Station "C", Victoria, B.C. V8P 5L4.

Congratulations to Bill van Duin who was married this October, having survived a season on the "Polar Circle". The wedding was attended by George Eaton and Doug Popejoy, who wore matching chiffon and organdy outfits, coloured blue and pink, to complement their beards. Both George and Doug are survivors of the "Polar Circle".

George Eaton found his boat intact on returning from his season in the Arctic. However, it was infested with a plague of cats; he welcomes suggestions for their disposal.

"PRAIRIE SCHOONER BRANCH OPENS"

This letter is to formally announce the formation of the "Prairie Schooner Branch" of the Canadian Hydrographers' Association (CHA).

The Branch is resident in Calgary, Alberta and will draw its membership from all three of the Prairie Provinces and the N.W. Territories. Dependent on demand, "Satellite Branches" may be opened in Edmonton, Regina and Winnipeg.

The CHA encourages the advancement and professional ability of Hydrography through cooperation and the free exchange of information and ideas. The Association claims as its members, Professional Engineers, Certified Technologists, Alberta Land Surveyors, Canada Land Surveyors, Hydrographers, Researchers and Scientists. The Prairie Schooner Branch is presently 45 members strong. Anyone interested in joining the Association or requesting information on the CHA is asked to contact:

Mr. M. Doucette, V.P.
c/o Dome Petroleum
P.O. Box 200
Calgary, Alberta
(403) 260-2241

Mr. I. McMillian, Secretary/Treasurer
JMR Instruments
8-6320, 11th St. S.E.
Calgary, Alberta
(403) 255-6667

QUEBEC BRANCH

On the 17th of September the Association organized a cruise to initiate people on marine scenery and navigation. The cruise left Quebec in the afternoon to proceed up to Batiscan. The return trip took place during the night. It was considered a success even if the temperature was not too mild.

A lunch talk on the navigational problems in the Arctic was organized with Mr. R. K. Williams' collaboration, who presented a slide show about the Arctic trip of the Manhattan. It was a most instructive lunch talk.

Mr. R. K. Williams, Regional Director, Hydrography for the Quebec Region since 1979 has been assigned to new functions in Ottawa. A party was organized in his honor in order to wish him good luck in his new functions. A 5 to 7, a dinner and fair weather were on the menu.

REGION DU QUEBEC

Le 17 septembre l'association organisait une croisière d'initiation à l'interprétation du paysage marin et à la navigation. Cette croisière partit de Québec dans l'après-midi puis remonta jusqu'à Batiscan. Le voyage de retour se fit dans la nuit. Ce fut une réussite malgré la température peu clémente.

Un dîner-causerie sur les problèmes de navigation dans l'Arctique fut organisé grâce à la collaboration de monsieur R. K. Williams qui a montré un diaporama sur le voyage du navire Manhattan. Ce dîner-causerie fut des plus instructifs.

Monsieur R. K. Williams, Directeur régional de l'Hydrographie de la région du Québec depuis 1979 a été assigné à de nouvelles fonctions à Ottawa. Une soirée fut organisée en son honneur pour lui souhaiter la meilleure des chances dans ses nouvelles fonctions. Un 5 à 7, un souper et une petite touche d'été étaient de la soirée.

Retirement

H. R. Blandford

On 19 October over one-hundred friends and colleagues gathered at the Crow's Nest in Ottawa to pay tribute to Harvey and Helen Blandford, as he retired from the Canadian Hydrographic Service.

Harvey was born in Burin, Newfoundland in 1924 and was educated in Saint John's. He joined the Canadian Merchant Marine in 1940 and the Royal Canadian Navy in 1943. He had an exciting war service with the 1st Canadian Motor Torpedo Squadron in the English Channel leading up to "D" day. He was amongst the naval forces providing support to the Canadian Army when they stormed Walcharen. After the war he returned to the merchant service and served world-wide.

In May, 1952 Harvey scored a hat-trick, he earned his certificate as Master (Foreign Going), married Helen, and joined the Canadian Hydrographic Service. His first assignment was to CSS ACADIA under Colin Martin, on the east coast of Newfoundland. His fellow hydrographers were Mike Bolton, Ralph Cameron, "Dusty" DeGrasse, Dick Lelievre and Larry Murdock. It is doubtful if many other field parties in that era had as many hydrographers that stayed the course. After a second year on Acadia, Harvey began to spread his wings; in 1954 he was assigned to the USS BURTON ISLAND and played a major role in the first joint Canada-U.S.A. hydrographic survey in the Canadian Arctic — in the northern portion of Prince of Wales Strait. In 1955, Harvey was the hydrographer on board HMCS LABRADOR as she surveyed the routes in the previously unknown eastern portion of Foxe Basin for the construction of the Dewline. In 1956 and 1957, he was senior assistant on CSS FORT FRANCES then on CSS BAFFIN for some of the early Decca surveys. In 1958, he was in charge of the shore party, established by CSS BAFFIN, which surveyed Pike-Resor Channel in Frobisher Bay. A survey that taxed his seamanship to the full with 7m tides, five-knot currents driving ice floes back and forth and a slack water which is only "a short period of turbulance between tidal streams". Life in a wooden sounding launch with a top speed of 5 knots must have been exciting, to say the least.

In 1959, Harvey went north for more pioneering as the first hydrographer assigned to the Polar Continental Shelf Project when fixed wing aircraft or skidoos were the only method of transportation and soundings were obtained by drilling or blasting a hole in the ice and using a Lucas sounding machine to lower a lead weight. On his return south, he put in a regular five month field season as Officer-in-Charge of CSS CARTIER.

In 1964, Harvey carried out another first when he was Officer-in-Charge of CSS BAFFIN when she carried out the first multi-parameter survey where the hydrographers were joined by scientists from Energy, Mines and Resources and gravity and magnetic data were collected simultaneously with soundings. 1965 was the last year Harvey spent in the field in the placid waters of the Trent Severn Waterway.

In 1968, Harvey was appointed to the newly created position of Assistant Regional Hydrographer, Central Region. He returned to Headquarters in 1972 as Chief, Hydrographic Planning and Development, and in 1975 became Chief, later Director, of Navigation Publications and Maritime Boundaries.

The breadth of Harvey's experience and the number of friends he and Helen have made over the years, was clearly shown by the number of guests present and the presentations made by Atlantic, Central, Pacific and Quebec Regions, Headquarters, the Surveys and Mapping Branch of DEMR, the Canadian Coast Guard (DOT), and the Mapping and Charting Establishment of DND. All those present join in wishing Helen and Harvey a long and happy retirement.

Lighthouse Awards

I am pleased to announce that the selections have been made of the best articles in the 1982 editions of Lighthouse (Editions 25 and 26). David Monahan, Mike Casey and Dick MacDougall will share the award for the best technical article — "Comparisons Between Acoustic and Active and Passive Optical Depth Measuring Systems". In the non-technical category, Lt. Cdr. Alan D. Anderson and Capt. Wayne L. Mobley will share the award for their article — "Hydrographic Surveying Under Adverse Conditions". My congratulations are extended to all of these authors and to all others who have contributed to Lighthouse during this period. Because of these writers, Lighthouse continues to be a publication of which we can be proud.

A. D. O'Connor, President C.H.A.

Obituaries

F.C.G. Smith (1890-1983)

Frank Clifford Goulding Smith, the last of the early giants of the Canadian Hydrographic Services, died on 27 November, 1983.

F.C.G. as he was commonly known, but never to his face, was born in Montreal in October, 1890 and was educated there before going to Acadia University for his diploma in Engineering and where he met his wife. He worked for Canadian Pacific Railways, Mackenzie Mann & Co., contractors for the Great Northern Railway, and O'Brien Mines, Cobalt, Ontario before joining the Canadian Hydrographic Service in September, 1914 where he was assigned to the Automatic Gauging (now Tidal) Section. In 1915, he was assigned to CGS ACADIA for surveys of the Gaspé Coast.

In November, 1914 he joined the Canadian Railway Construction Corps and went to France. In November, 1917 he was commissioned as a Lieutenant with the Royal Naval Volunteer Reserve and was posted to HMS HEARTY, part of the Naval Surveying Service, and spent the rest of the war carrying out surveys for mine-laying until demobilized in 1919. These two years gave him an admiration for the methods of the British Admiralty which still influenced him thirty years later. From 1920-27, he worked as an assistant hydrographer on the CARTIER and ACADIA primarily in the Gulf of St. Lawrence. In 1925, he spent a season on CGS LILLOOET on the Pacific Coast.

In 1928, he was in charge of a small party that established control and a tide gauge in Churchill in preparation for the 1929 survey from CGS ACADIA of the harbour and approaches, chosen as the terminus of the Hudson Bay Railway. In 1928, F.C.G. surveyed the south shore of Great Slave Lake to enable the Hudson Bay Company to begin barge operations on the Mckenzie Waterway. In 1930, he returned to Hudson Bay as first Assistant on CGS ACADIA, equipped for the the first Canadian echo sounder surveys of the coastal approaches to Churchill.

From 1931-35, he was officer-in-charge of the Hudson Strait survey, during which the south coast from Cape Prince of Wales to Cap Weggs, the north coast from Lower Savage Islands to Shaftesburg Inlet, an the western approaches were surveyed. Taken north each year by the ice-breaker N.B. McLEAN, Smith had to establish a camp, an astronomical position and triangulation. Soundings were carried out from the 27′ half-decked launch DISCOVERY and the 35′ HENRY HUDSON, complete with a tiller bar in the stern. To complement the charts, F. C. G. wrote the first Canadian sailing direction to the Hudson Bay route. His last field season was 1937 when he used a 44′ launch BOULTON in a survey of the Saguenay River.

That fall he was appointed Superintendent of Charts, which involved preparing the specifications for all charts and their final checking. There are still a few senior cartographers who remember that in fact F. C. G. did a major part of the selection of soundings to be shown, much of it during his lunch time. During the war, it was his job to see that the numerous demands for charts were met if need be by printing Admiralty Charts using the "reserve proofs" held for such needs. In 1947, he suprvised the production of the first two recreational charts of the Rideau Canal, based on a quick reconnaissance survey. He also began the task of rationalizing the chart schemes that had grown rather haphazardly since 1883.

The major challenge after the war was to start charting the Arctic to meet the needs that had arisen during the war and to make use of the new maps, based on tri-metrogan aerial photography. It must be remembered that as late as 1944, the only charts available were those produced by the Admiralty from the Franklin searches, a century earlier.

In September, 1952 on the retirement of R. J. Fraser, he was appointed Dominion Hydrographer. In May of that year, he was the first Canadian representative to attend an International Hydrographic Conference, for Canada had joined the IHO in 1951.

It was under F. C. G.'s direction that CHS began its major postwar expansion. Much of this was devoted to surveys required for mineral development in the north, particularly the iron ore deposits on the east coast of Ungava Bay, which have yet to be brought into production. He also coordinated with the U.S. Navy during the period 1955-57, the surveys of the shipping routes and landing sites required for the construction of the Dewline. In 1955, he was also able to start the surveys in Georgian Bay and the North Channel that were eventually used in the first Canadian recreational charts.

The major organizational change implemented by him was to amalgamate the Tide and Current Survey Division and the Precise Water Levels Division into Tides, Currents and Water Levels. On the technical side, he introduced Two-Range Decca, the earliest electronic positioning system, which presaged as major a revolution in hydrography as the advent of the echo sounder in 1930. One of his last innovations was the use of the helicopter and the tellurometer.

It is likely that he himself would see CSS BAFFIN as his major monument. Commissioned late in 1956, she was the first Canadian hydrographic ship designed for use in the Arctic, carrying six launches and a helicopter and Two-Range Decca.

F. C. G. Smith retired after forty-three years service in June, 1957 and moved to Annapolis, N.S., where he died in 1983. He is survived by his wife Marie who he married in May, 1917. The sympathy of the Canadian Hydrographic Service goes to her. It may be some consolation to know that he is still remembered with respect and we do not expect to see his like again.

Bill Glennie

Hydrographers working with the Canadian Hydrographic Service will be saddened to hear of the death, last June, of Bill Glennie, who for a number of years was in charge of the helicopter flight operations in the Ministry of Transport. Bill and his crew of pilots and engineers have made a major contribution to the success of modern hydrographic field operations.

News from Industry

McElhanney Surveying and Engineering Ltd.
McElhanney's most recent marine service to it's clients is the M.V. Arctic Prowler. The vessel has been equipped to carry out underwater pipeline route studies; seabed obstruction searches; underwater photography, harboursite construction and dredging studies; submarine power and cable routes; current metering and oceanographic instrument deployment; hydrographic surveying and coring/sediment sampling.

For more information on the Arctic Prowler and the services available, call John Allen in McElhanney's Vancouver office; Dave Danyluk in the Calgary office; or Tom Windeyer in the Halifax office.

N.B.A. (Controls) Ltd.
NBA (Controls) launch a new Microprocessor based wave recorder.

The new unit known as the DNW-5M measures and records wave height, wave period and tidal variations. The instrument operates by sampling the pressure head of water above the transducer at a pre-programmed rate and recording the acquired data on magnetic tape. It has been designed to be mounted on the sea bed or fixed to an underwater structure.

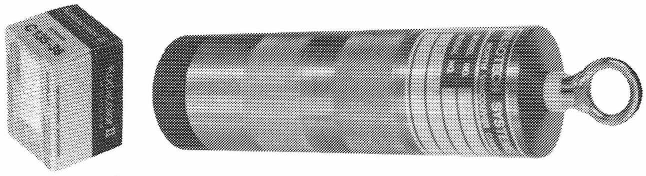
For further information please contact Jim Wylie, Telephone No. Farnborough (Hants) 0252 514335.

GEOMARINE ASSOCIATES LTD.
Cost effective sidescan mosaics within regions of relatively flat seabed are currently being produced by Geomarine Associates Ltd. of Halifax, N.S., using simple modifications to standard, off-the-shelf, replay equipment.

Although a minimal distortion is still present in the data, a good representation of the seabed is produced with a small investment of time and reproduction cost. The mosaics produced are representative of a pseudo aerial photograph of the seabed over the site.

INTERNAV
Internav is pleased to announce that CANADA I, the Canadian entry in the America's Cup yacht race carried the LC 300 Loran C computer, built in Nova Scotia, in the training in tactics and manoeuvers off the U.S. East Coast.

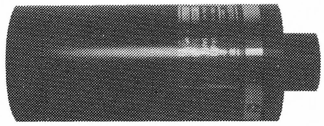
Mesotech Systems Ltd.
Mesotech announces two new lines: Model 216/218 Miniature Pingers and Model 201-RC Crystal Beacons. Also details of the Model 808 RS232-C output Echo Sounder Module, and news of the Model 971 Colour Imaging Sonar.



Model 216/218 Low cost pinger

Model 216 is a compact low cost pinger, powered internally by 2 (user replaceable) standard MN1604 9V alkaline batteries. Dimensions of the aluminum unit are 51 mm diameter × 173 mm long (211 mm over eyebolt), weight 0.2 kg in water and pressure rating 600 m. Transmitting one 8 ms pulse per second, Model 216 has an approximate range of 0.4 km for 180 days operation, while Model 218 achieves 1 km for 30 days.

Model 201-RC Beacon transmits 5 ms pulses at 1 per second on a frequency of 27, 29 or 31 kHz, all crystal controlled to ± 20 Hz. These beacons operate to 600 m depths, are 90 mm diameter × 229 mm long, and weigh 0.7 kg in water. External batteries for 15



Model 201-RC Crystal Beacon

to 180 days operation are available, and range is 2.5 to 4.0 km approximately.

Model 808A Echo Sounder Module uses an RS232-C interface to externally select ranges of 20, 50, 100 or 200 m and to transmit digital depth data. Appearance is the same as Model 807 (Lighthouse #27, p 59), and depth rating is 2000 m. Option 2 mounts the connector at the side of the unit, for reduced overall height.

Model 971 (Lighthouse #27, p 59) acquired instant success when it located a wellhead for Canterra Energy, offshore Labrador. It has been chosen as standard equipment for Perry Oceanographics Inc. and Offshore Maintenance and Inspection Services (OMIS); approval is expected shortly, for use in drillsite clearance surveys in U.K. and U.S.A. Hydrographic potential includes tailing and dredge plume studies, total area survey (particularly where side scan is unsuitable), erosion/scour studies etc. More information from David Friedman, Marketing Manager, Phone (604) 464-8144, Telex 04-353637.

Krupp Atlas-Elektronik Bremen
Atlas Desoscript, an add-on, low cost microprocessor-based annotator unit for use with the established DESO 20 hydrographic survey echo sounder, has been developed by Krupp Atlas-Elektronik. The unit in effect converts the DESO 20 to a fully automated data logger or mini-survey system by supplementing a normal echo trace with the simultaneous annotation of range, distance, time and digital depth information on the same recording paper.

The new unit this provides dual-channel interfaces for accepting inputs from auxiliary survey systems such as a laser range-finder, sonar doppler log or radio position fixing configurations. Conversely, it may also be used to facilitate digital depth output in either metres or feet from the DESO 20 itself. Connection to on or off-line computers and keyboards for the manual or automatic annotation of alpha-numeric characters is also possible.