ISSN 0711-5628

Lighthouse

JOURNAL OF THE CANADIAN HYDROGRAPHERS' ASSOCIATION

Edition No. 29, April, 1984

EDITION NO. 29 **LIGHTHOUSE** **APRIL, 1984**

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 5378, Station "F", Ottawa, Ontario, Canada, K2C 3J1.

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EDITORIAL

Talks at hydrographic conferences continue to centre on contracting out, or privatization but is there a slight smell of change in the air? Are government organizations beginning to realize that while contracting out has been more successful than they had originally thought possible, the long-term implications are only now becoming evident? That particular form of contracting, the chartering of ships, has long been questioned in terms of charter or ownership, but the long-term implications are not always evident in the first instance. The ship-building industry in Canada, as in other countries, is in poor shape and exists primarily on government contracts — to build government ships. Yet, a company contracting for government, even though it may be obliged to use Canadian flag vessels, has not been obliged to use Canadian-built vessels. Therefore one government policy is at odds with another. Contracting out the surveys themselves has many rewards. It adds flexibility, it ensures strong competition and consequently lowest costs and it gives hydrographers and other staff alternative sources of employment. On the other hand, if it is successful, it adds strength to the argument that more, and more, work should be contracted. Taken to the ultimate this is seen by some, that government agencies will become simply repositories of data and all surveys and all chart production will be by commercial contract. In papers given here and there it will be noted that the Chief Hydrographers are now beginning to say "whoa". We must retain excellence in the government services to ensure that the contracts are supervised and this means that some level of ongoing work must be maintained. It can be argued that this level of knowledge can be obtained in industry or alternately that supervisors themselves are contracted. This editorial does not dare to side with either those for contracting or those opposed but simply to suggest that we can expect to hear more and more government personnel begin to question privatization as the long-term implications become increasingly evident.

Message From The President

I took office in Victoria as your National President with a clear mandate from the National Executive to chart a new course for the Canadian Hydrographers Association. Many matters originating from the Task Force Report were discussed at length at two marathon sessions of the National Executive.

Committees have been established to come up with recommendations to present to the membership at large on the following subject matters: —

- The establishment of a National Office with a permanent mailing address for all CHA correspondence.
- The development of a budget before making a commitment to review and re-structure procedures with regard to the setting and the collection of dues.
- Revamp the Constitution and make it less cumbersome when changes are required.
- Re-define our requirements for membership.

These are some of the points raised in Victoria at the Annual Meeting of the National Executive and it may take time to implement some of these changes. I would also appreciate hearing your views as individual members on any points where changes are required in our Association. For those members not familiar with the Task Force Report, I would be willing to supply you with a copy of the Report on request.

In future Editions of Lighthouse, I intend to keep you informed on the progress being made by the various committees.

There are those members amongst us who do not want change but I feel constructive criticism is healthy and in the final outcome we will be a stronger Association.

For the next three years I am counting on receiving your guidance and support on all matters that concern all the disciplines of Hydrography.

In closing, I would like to thank the two past National Presidents, George Macdonald and Tony O'Connor, for all their help.

J. Bruce
National President
Canadian Hydrographers' Association

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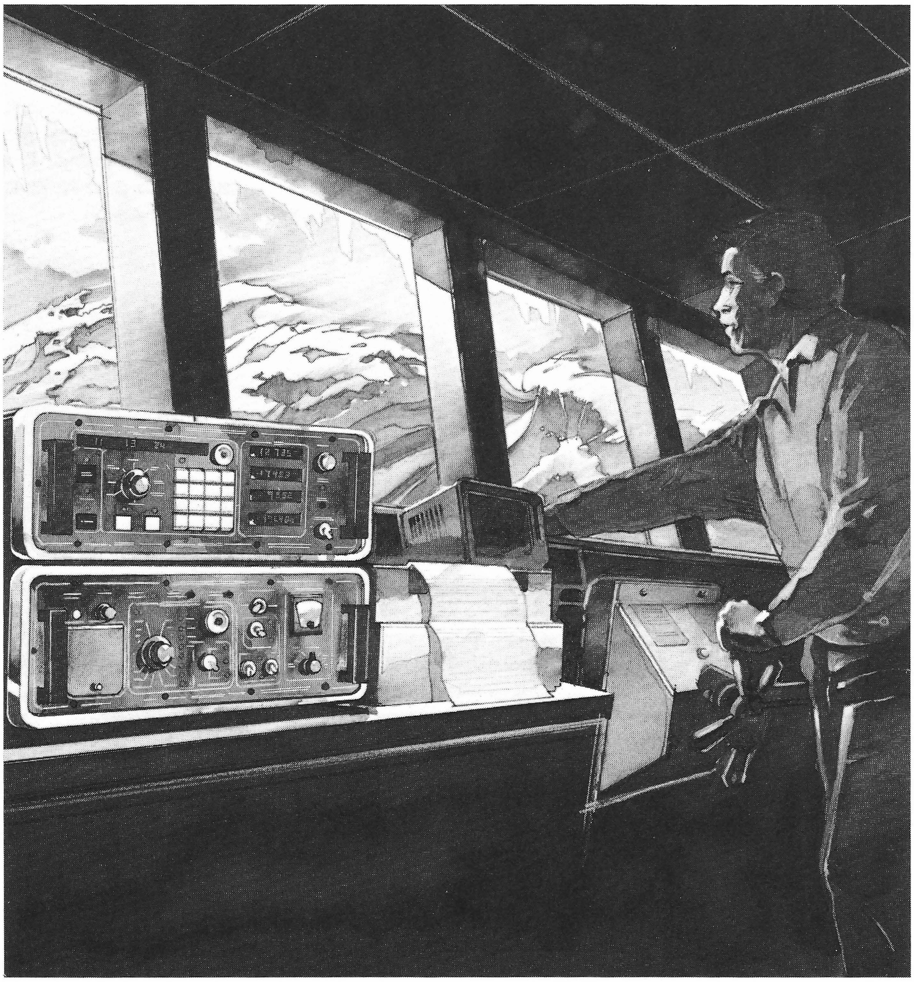

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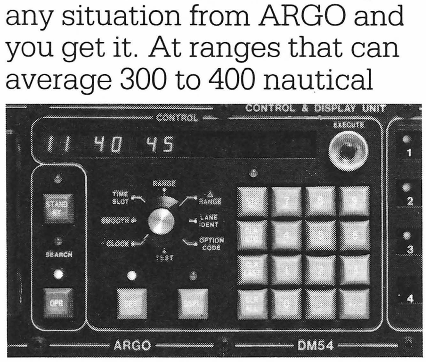

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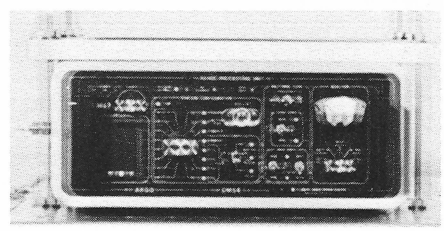

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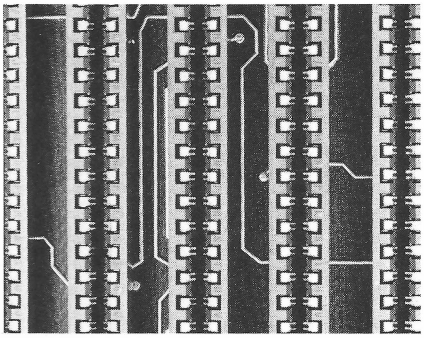

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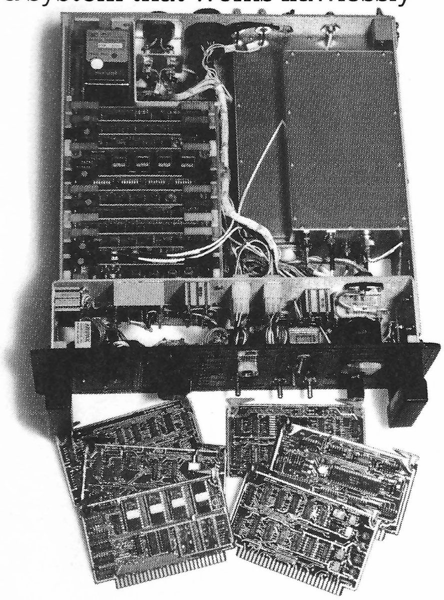

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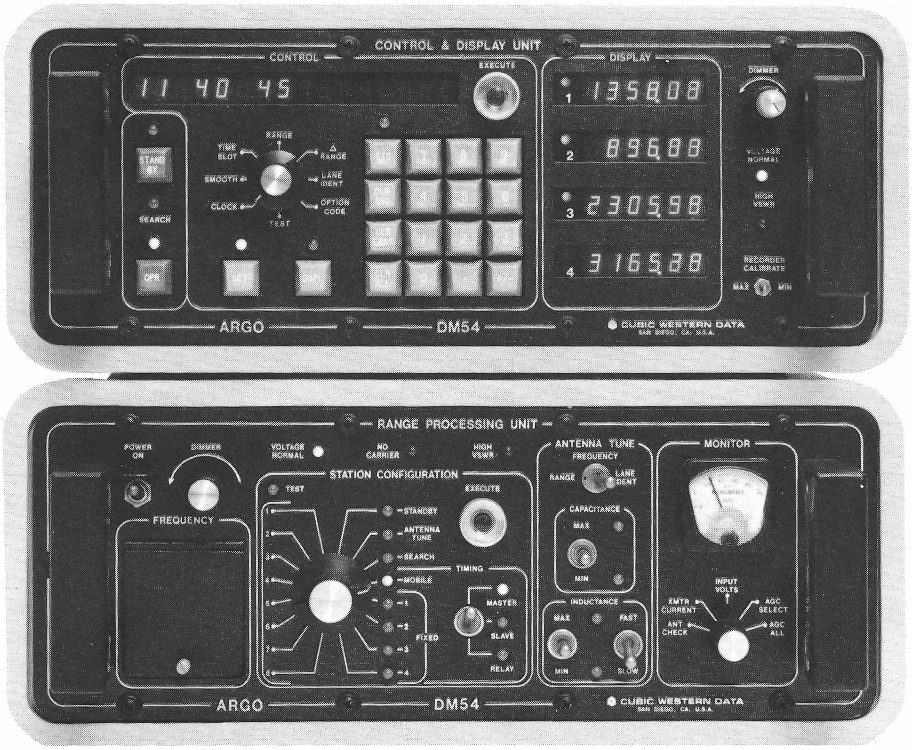

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Education Seminar

by Bruce C. Calderbank, Consultant

The first Educational Seminar organized by the Prairie Schooner Branch (PSB) of the Canadian Hydrographer's Association (CHA) was held at the Shell Centre, Calgary, on 25 November, 1983. It was well supported with over forty delegates, all from the private or academic sector. The objectives of the Seminar were to encourage the participation of all members in the activities of the Association, and to encourage new membership.

The speakers and their topics were as follows:

Mark Doucette:	Dome Petroleum, Vice President PSB — CHA "An Introduction to Hydrography and the Canadian Hydrographers Association"
Pierre Heroux:	Nortech Surveys (Canada) Inc. "Use of G.P.S. for Offshore Navigation"
Christy Thompson/: Tim Harding	Canadian Engineering Surveys Co. Ltd. "Surveying in Conjunction with Caisson Retained Islands"
Errol Leighton:	Dome Petroleum "Principles of Acoustic Positioning in Arctic Offshore Drilling"
Lunch	
Richard Good:	Offshore Surveys and Navigation Ltd. "An Overview of Offshore Site Surveys"
John Watt:	EDO Canada Ltd. "Hydrographer Know Thy Echo-sounder"
Dianne Hewitt:	Canadian Red Cross Water Safety Service "Small Craft Safety and Survival"
Barry Bishop:	Nagina and Bishop Surveys Ltd. "Cadastral Surveys in the Offshore"

The Convenor, Tom Lockhart of Cansite Surveys Ltd., opened the Seminar with a brief introduction and outline of the presentations to be given. The first speaker was Mark Doucette of Dome Petroleum and Vice-President of PSB — CHA. The CHA constitution and the history of the CHA were reviewed and related to the existing situation for the PSB. It was suggested that the PSB could provide the forum needed by private industry to make its views known to government and to improve its hydrographic skills.

Pierre Heroux of Nortech Surveys (Canada) Inc. stepped in at the last moment for Gerard LaChapelle and discussed the Global Positioning System (GPS) and Nortech's experience with the STI 5010 and the newer TI 4100. Although worldwide 24-hour coverage is not yet available, GPS has definite advantages over shore-based Radio Positioning Systems (RPS) in some particular instances. Overheads were used for technical clarification.

Christy Thompson and Tim Harding of Canadian Engineering Surveys Co. Ltd. (CES) discussed the survey services supplied by CES to support the Esso Caisson Project in the Canadian Beaufort Sea. The talk covered the surveying highlights of the Caisson Retained Island from conception to completion. Slides and overheads were used for technical clarification and to give the other participants a better appreciation for the work site environment.

Errol Leighton of Dome Petroleum gave an excellent paper on the principles and use of acoustic positioning in the Canadian Beaufort Sea. Three types of acoustic positioning systems have been tested in the Arctic, with long baseline systems providing the best overall reliability to date. Two types of sector scanning sonars have been used, both with good success. Floating oil exploration structures are typically positioned by navigating over the location by means of a pre-calibrated acoustic transponder array. In the case of well re-entries, confirmation of the final rig position is provided by sector scanning sonars. As with the previous presentation, slides and overheads were used to good effect.

After lunch Richard Good of Offshore Surveys and Navigation Ltd. discussed the increasing demand for offshore exploration and the consequent essential need for site specific surveys to prevent the loss of the well, drilling equipment, and most importantly life caused by shallow drilling hazards. The Canada Oil and Gas Lands Administration (COGLA) oversees oil and gas drilling activities on Canada Lands and has instituted appropriate guidelines. It was stressed that the onus was on industry to layout regulations for itself. Several handouts were made available at the conclusion of the presentation, as well as some material provided by McElhanney Surveying and Engineering Ltd.

John Watt of EDO Canada Ltd. with the aid of a series of overheads (and some good cartoons) discussed the operation of an echo sounder. Most of the pitfalls that befall the hydrographer were covered. The means to avoid these problems is by a thorough understanding of the machine itself and what it can do.

Dianne Hewitt of the Canadian Red Cross Safety Services stepped in at the last moment for Sue Phillips and gave a presentation on small craft safety and survival. A number of pamphlets were distributed which helped explain the correct procedures, methods and attitudes towards this essential aspect of a hydrographer's work.

Barry Bishop of Nagina and Bishop Surveys Ltd. discussed some of the problems associated with establishing cadastral boundaries offshore. The mass of information available can at times bury the real information and data required. The number of sources for information may be spread out over several departments and/or divided up between provincial or territorial governments and the federal government. Private industry should encourage the federal government to set up a data base of information for the offshore.

At the conclusion of the presentations a vote of thanks was given to the organizers, Barry Bishop and Richard Good, and to the convenor, Tom Lockhart. Ken Thompson of Shell Resources was thanked for arranging the use of the seminar facilities.

The standard of presentation at the Seminar was in general high. Discussion from the floor was at times lively. By exchanging information in this manner the individuals involved were advancing their technical and professional abilities, thus meeting the main aim of the CHA.

International Cartographic Association Marine Cartography Commission

Methods of Display of Ocean Survey Data

Second Seminar

A Second Seminar, to examine problems associated with the presentation of data collected by Sidescan Sonar, Multibeam Swath Mapping Systems and other remote sensing devices will be held at Le Centre Océanologique de Bretagne, Brest, France (by kind permission of Mr J Vicariot, Director) between August 22nd and 24th 1984

Seminar Address	Le Centre Océanologique de Bretagne (COB) B.P. 337-29273 Brest Cedex, France (COB is situated 7km from the centre of Brest)
Organization (France)	Establissement Principal de Hydrographique of Océanographique de la Marine (EPSHOM) 13, rue du Chatellier B.P. 426-29275 Brest Cedex, France Telephone: (98) 22.10.80
Organization (UK)	Ron Linton NERC Thematic Information Service Holbrook House Station Road Swindon Wilts SN1 1DE UK Telephone: 0793 40101 X471
Seminar Programme	3 Main Sessions Poster session Discussion Groups Visits to EPSHOM and COB All presentations, discussion etc will take place in English. There will be no translation facilities. The number of participants will be limited to 50.
Costs	There will be no registration fee. Participants will be expected to pay for lunches etc and the pre-seminar Dinner, if required. Hotel accommodation will be in Brest at approximately £16-£24 per night. Transport between COB and Hotels will be provided.

Further Information
For further details, programme etc and registration fees, please contact Ron Linton at the above address.

Note
Participants may wish to know that this Seminar immediately procedes the 25th Congress of the International Geographic Union which takes place in Paris from August 27th 1984. A Session on Remote Sensing and Cartography has been included.

LIGHTHOUSE AWARDS

The President of CHA is pleased to announce the 1983 Lighthouse awards.
For the best technical paper to David Monahan and Mike Casey for their paper: "Contours & Contouring in Hydrography".
For the best non-technical paper to Norman Gray for his paper "Reminiscences of a Retired Hydrographer".

While Memory Serves

Reminiscences of a Hydrographer Aboard a M.O.T. Icebreaker

For years the Canadian Hydrographic Service has been placing hydrographers aboard M.O.T. icebreakers, as an exercise to obtain hydrographic data on northern waters inaccessible to standard survey vessels. The results have been mixed — some good years, and some bad years. The season is short (two months), the ice conditions capricious, and all programs must generally be tailored to the unpredictable digressions of the icebreaker, and to support from the ship's captain. Yet much of the original Arctic bathymetry was derived from projects undertaken aboard icebreakers, and their contribution towards knowledge of the Arctic waters is significant.

One or two hydrographers are generally assigned to a capital M.O.T. icebreaker with the express intent of collecting track soundings, and surveying harbour areas where the icebreaker stops to deliver supplies. The hydrographers often carry their own survey launches, and periodically their own launch crews. Sometimes, however, they are dependent upon the goodwill of the captain for launch crews and helicopter support. Their plans must be very flexible as the proposed itinerary of the ship is often changed due to ice conditions and support priorities.

Hydrographers who have worked on the icebreakers are all aware of the tedium, frustrations, and sporadic moments of satisfaction which accompany these trips. Monotonous track sounding is relieved only by brief stops at Arctic villages, and interception of icefields, the approach of another ship, the sighting of Arctic fauna, or the "family feud" which seems to be "part and parcel" of ship life. Gallons of coffee are consumed, and the hydrographer spends his idle hours reading, watching "dog-eared", aged movies clatter unfocusable through an antiquated projector, or playing the inevitable rounds of bridge and crib. Sleep is easy on a ship, as cabins are usually poorly ventilated, cramped, and resonating always to a soporific drone.

Most hydrographers aboard M.O.T. icebreakers are taken on as peripheral baggage, — tolerated like the "bird watchers", but in true context "a nuisance on the bridge". The captain, rightly so, is concerned with managing the ship, dumping supplies, escorting oil tankers or tramp freighters, and anxiously waiting for the "return to base" message. Nevertheless, as part of a bureaucratic chain, he is saddled with scientists, P.R. types, weather technicians, and free-loaders whose assignments appear to him very vague, but often very demanding. In particular, he has to put up with numerous requests to alter course closer to an island or an iceberg, or to stop on a dime, or to pull into a settlement because an independent type is "fed up" and wants to fly home. The captain's lot is not easy, and it is understandable when he looks with bemused apprehension at the people boarding his ship. His task is to penetrate the northern ice fields, escort tankers and tramps into demanding communities, standby for search and rescue missions, and comply with vacillating demands from Ottawa. On top of this he has to manage a farm of disgruntled shipmates, plus cater to ouside invitees who have convinced someone that "their program" deserves field testing from an icebreaker.

The account offered below took place in the early sixties, when northern bound icebreakers were "dry", when the land masses were poorly positioned, and when depth information across much of the Arctic was spotty or unreliable. It must be remembered that at that time the hydrographic launch was the diesel equipped displacement type capable of 9 knots flat out, that the tellurometer MRA-2 was the "avant garde" of the distance measuring systems, that save for Decca there was no survey electronic positioning systems, that sounders incorporated the Kelvin Hughes wet and dry models, and that fixing was either by sextant or point-to-point on a photo. Indeed, there was no such thing as "overtime", you were expected to work around the clock, and you were rewarded with a flat $300 maximum bonus if you completed the cruise. The ice-breakers were boarded and loaded somewhere between Halifax and Montreal, in late July or early August. With launches and equipment aboard, the ship sailed towards Belle Isle straits, leaving behind the heat and bustle of suburbia. Ahead lay the unknown, for success or failure was an icy roll of the dice.

One's mind records only the amusing incidents of a cruise, and I have tried to describe them as I recall the events. In varying degrees, I am sure other hydrographers could recall similar experiences, perhaps with more candor and humour. It is very difficult to describe an incident without reflecting positively or negatively on the modus operandi of a particular episode or the personnel involved. My comments on persons and operations are strictly personal, — often from a limited perspective —, they are elicited only from the amusement factor of observing or participating in an episode, and are not intended to discredit or reflect negatively on persons or programs. I have purposely created fictitious titles in order to eliminate a direct reference to vessels or persons.

Underway

You never know quite what to expect when you board a government icebreaker. The captain meets you with a handshake, and after you have explained your program, he smiles, winks and says "I'll make sure the mate takes care of you." With that gesture of support, you are escorted to the door like an insurance salesman and told to find the chief steward in order to locate your room. The chief steward is rotund, flushed and apologetic. Over a glass of straight gin, he pores through his dishevelled file cabinet, looking for a personnel sheet. He finally takes your name on a cigarette box, and directs you to a small double-bunked cabin. Enroute, the labyrinth of steel corridors takes me past the ship's galley. A clamor of banging pans, hissing steam, and choice profanity echoes along the narrow corridors. The galley is steaming hot, and so is the temper of the cook. Roars of frustration and profanity sing through the ship, and his menacing swing of the meat cleaver does nothing to encourage a casual introduction. He eyes me suspiciously and tosses a wad of beef half way across the galley where it lands unerringly in a simmering frying pan. Lunch is being prepared and the cook has a hangover and a menacing disposition.

The chief engineer sits relaxed in his double cabin. Pictures of his family adorn the walls, and he is tinkering with a new camera he has purchased. Since becoming chief, he has rarely seen the engine room — and spends his time formalizing logs, ruminating through marine manuals, and preparing for photographic and fishing excursions ashore in the Arctic. With his feet propped up on his desk and his hands clasped behind his head, he listens to my program — cutting me off half way along with a rejoinder that "nothing goes amiss like a good program", but not to worry as anything mechanical can be looked after by his men. I explain the propulsion of the survey launch, and he sees "no problem" in assigning an apprentice engineer to make sure "she's always ready to go".

The chief mate is cordial and helpful. He provides a locker for much of the survey gear, and supervises the loading of the launch and equipment. From a dockside pad I watch ship's boom, pendulum swung onto the ship, steadied by a slap against a davit, and convincingly dropped into a ship mounted cradle. The survey equipment is net loaded, swung on deck, and disappears quickly below decks, in the hands of the ship's deck crew. "Fragile" and "this side up" bear scant attention as everything from theodolites to field sheets receives the over-the-shoulder bump and grind loading routine.

A successful northern trip can probably be described as one in which the ship returns safely to base with her propellers intact, and with all of the crew with which she started. Apart from dodging icebergs, and hoping that the vessel she is escorting will not ram her from behind, a captain's toughest task is keeping a crew intact after a wild night in Thulé or Churchill. From a crewman's point of view, nothing is more frustrating than arriving at Churchill on a Sunday, or passing Thulé without taking on bunkers.

My first northern ship assignment was aboard the Albert A. Funk in 1964. She was one of our premier ice-breakers, and when I sailed aboard her, she wasn't many years out of the shipyard. Beside carrying supplies for a number of Arctic communities, she was engaged in convoy icebreaking support and in probing the northwest passage.

Hydrographers are a strange breed, and are usually treated as such by respective captains. Upon joining the FUNK at Montreal, where incidentally, we split, unbeknownst, the northern cargo with the longshoremen, I was assigned half a normally small cabin with a junior engineer, and advised that I could also use the room for a drafting table, storage space, and as a general recreation facility. The paucity of space was mitigated to some extent by the engineer working a night shift while I worked a day shift. Nevertheless, space was "tight" as we left the port of Montreal.

On Friday night we boarded ship for an early morning cast-off. The ship was quiet, as most of the crew had headed up to Sherbrooke Street for one last fling. By midnight, the silence was intermittently broken by noisy taxis and their sodden occupants staggering, flat broke from a last shot at Montreal's gin mills, up the gangway onto the ship. The helmsman on watch gazed placidly at the returning bodies, and mentally noted the return of each crew member.

In the wee hours of the morning, the mate counted heads, we cast off the lines, and headed down river for the St. Lambert lock. The cool breezes of the river were a refreshing change from the stifling heat which clung to the cabin as the ship lay along side. The refineries, elevators and industrial areas of Montreal soon gave way to green fields and quaint church-spire festooned villages. The ship slid easily through the muddy St. Lawrence waters. I spent much time on the bridge, meeting unfamiliar faces, viewing the passing scenery, and observing the pilot as he complacently directed the ship downstream. The captain tinkered with the radar, occasionally flicked on the sounder, and made motions to the chief mate to secure the deck cargo and batten down the hatches. He peered caustically to the forecastle, where red faced seamen were tripping over lines and making all kinds of mistakes as they dried out from the Montreal binge.

Late in the day, the Plains of Abraham passed by, and next morning we had progressed to the Saguenay River. Up early in the morning, I flicked on the bridge sounder and casually compared depths with the charted track as we steadily progressed down river. The outside temperature rapidly cooled as the ship moved towards the Gulf of St. Lawrence. The captain arrived after breakfast and slowly paced the bridge, alternating between the chart table and the radar. At Les Escoumins the pilot departed, and we were officially bound northward.

Apart from the minimum ship's crew, the FUNK carried a radio operator, an electronic technician, a helicopter crew, and a contract medical doctor. These people played an important function in the cruise.

The radio operator's job was, in order of priority, to bang out the morning message to Ottawa, telling them where the captain thought he was and his proposed course of action; to log and deliver "nuisance" messages from Ottawa and elsewhere; to eavesdrop on other ship communications for "interesting tidbits"; and to run the weather fax machine for ice and weather maps. In between all this, he monitors the ship's gossip, and agrees and consoles with everyone who needs an amateur psychiatrist. Most radio operators are casual, pleasant, easy-to-talk to types. They are often the best read persons on a ship, as their hours on watch are often slack and uneventful. Every radio operator has a box below the radio console, stacked with pocket novels, detective magazines, and general reading material. With one ear cocked to the radio, and one eye on the Mufax, he sits relaxed through his watches consuming story after story, oblivious to time or the movements of the ship.

The electronic technician was a new fellow, fresh from technical school. His credentials were impressive. He confidently appraised the inventory as "routine stuff". Little did he know that he would spend most of the trip shuttling between the recalcitrant bridge radars. As predictable as the setting of the sun, the captain's parting words each evening to the mate were "leave a message for the technician to get on that radar first thing in the morning". And every day, a donut of spare parts debris surrounded one radar after another, and the technician developed a bewildered look in his eye, and the term "obsolete junk" was often overheard instead of "routine stuff". But there were respites from the radar quandary. The old projector required daily nursing, and the main radio had a habit of "Donald Ducking" just when the crux of a message was being delivered. And every crew member wanted his personal radio overhauled and "tweeked".

The helicopter crew played a vital role in maintaining peace, harmony and mental ballast within the ship's complement. While the "raison d'être" for the helicopter was ice reconnaissance to provide smoother, efficient ship manoeuvres, it really came to the forefront in delivering and picking up mail, spotting Arctic fauna, and making the odd trip to a "char" stream. The helicopter was the old Bell G-2 type, with a payload of a good bag of feathers, and the range of a wounded duck.

Every morning, the pilot, trim and poised, appeared on the bridge — anxiously awaiting the captain's call to service. The call seldom came, unless the ship was near a port of call or a mail drop off. Occasionally the captain, facing an unbroken horizon of ice, would send the helicopter out to review the situation, but more often than not, the helicopter recommendations were shelved in favour of the captain's personal instincts for penetrating an ice field, which after all is his prerogative. And so — while everyone watched the helicopter ascend for a "look-see", few believed that "what he saw" would influence the ultimate course of the ship. Nevertheless, the helicopter was being used — this looked pleasant in the log book —, and, if he happened to spot a polar bear, or a whale, the excitement generated certainly justified the flight anyway.

The ship's doctor was a young graduate set on a little adventure before getting tied down to a regular office business. In the early

going, he admired the health of the ship's crew, often commenting that dispensing aspirin to hypochondriacs would be the sum total of his medical performance. Little he realized, that booze, anxieties, and geriatrics were to keep him extremely busy for most of the trip. Indeed, at one point, business was so brisk that he converted a seaman to an assistant nurse. Apart from the ship's problems the doctor made shore calls and entertained business at the various ports-of-call in the Arctic. He was a consummate "birdwatcher" whose "business hours" seldom interfered with "binocular hours".

Two mornings out from Montreal, the ship passed south of Sept Isles heading for the Jacques Cartier Passage between the mainland and Anticosti Island. Clear skies and azure seas filled the horizon.

Numerous fishing boats were noticed, each one haloed by a donut of seagulls. Our first casualty occurred at this time. One of the engineers, a veteran Irish bachelor with many years experience on ships, succumbed to a heart seizure, and died. The incident was further aggrieved by the fact that his constant ship-board companion, a small dog, was left homeless. Arrangements were made to drop the body off at Cornerbrook, approximately one day's steam, and another engineer adopted the dog. Concurrent to this incident, the chief steward developed a complex medical phenomena which could not be treated locally, and so a replacement was requested for boarding at Cornerbrook. Such are some of the teething problems associated with a northern cruise.

Cornerbrook is a quaint little Newfoundland town nestled well inland at the mouth of a fiord-like passage. In late July, the mountain still evidenced snowy patches. The Bowater Pulp and Paper organization dominate the town, but because of Cornerbrook's deep channel access to the sea, its protected harbour, and its road and air facilities, it is a convenient victualling stop for vessels heading along the Belle Isle Straits. The ship over-nighted at Cornerbrook, and all aboard enjoyed the hospitality and libations proffered by the generous Newfoundlanders. The next morning we were underway again, and the following day the ship "turned the corner" at Belle Isle and headed northward paralleling the Labrador coast.

The trip northward from the Belle Isle Straits was pleasant and uneventful. Following the Labrador coast well seaward, one's daylight entertainment consisted of viewing the cold blue waters of the Labrador Sea, and the multi-hued mountains of the mainland. The occasional spotting of a whale and the frequent appearance of icebergs broke the monotony. The captain paced the deck, checking the radar and tinkering with the throttle controls. Coffee call and the clattering of the antiquated Kelvin Hughes 26B sounder were the only noises which distracted from the ship's thrust through the seas. Along the stretch of the journey, I began to continuously record, scale and ink soundings on collector sheets. As we headed north, I calibrated the sounder and prepared to amass volumes of data. Leaving the bridge at midnight, I requested the mate to "fix" the sounder every hour and let me know if anything was amiss. "We'll take care of it, my son" was his friendly retort, as he stooped over the radar, looking for icebergs. In the morning, when I emerged on the bridge, the sounder was still clacking away. Unfortunately, the paper spool had exhausted its resources about 3 a.m., and no one seemed too concerned about replacing it. "Nothing to worry about anyways" says the captain, "there's lots of water here — just look at the chart".

The days continued bright and the seas calm. Daylight extended nearby around the clock, with the sun setting about 10 in the evening, and rising about 3 the following morning. Scanning the horizon became the main preoccupation of all on the bridge. The sighting of a whale or a large iceberg broke the tedium of uneventful navigation. The captain traced a predictable path from the weather map, to the ice map, to the chart, to the radar, and back to his "personal" binoculars for a glance at the horizon. He said little and drank much coffee, but one could perceive that from a font of experience, he knew that the smooth sailing would shortly come to an end.

The chief mate, his face flush from working outside in the icy breeze, wearing hip rubber boots under an arctic parka, entered the bridge through the wing door. His main preoccupation on the voyage was to keep the eight crewmen busy, and so, after intense consultations with the bo'sun over coffee, the time honoured solution of "chipping outside in the good weather and painting inside in foul weather" had been adopted. Thus, the staccato of the electric chipping hammer reverberated often throughout the upper levels of the ship, disturbing sleep and annoying those working close by. But "painting and chipping" is as indigenous to ship life as steamed food, cramped quarters, and the dusty rattle of a released anchor. The mate's job is eased or aggravated by the quality of bo'sun at his disposal. The bo'sun on the FUNK was a "good one", a tough, rawboned denizen of Sable Island, who opened beer bottles with his teeth, used a marlin spike as a billy, and through gentle ministrations on the fantail deck with errant crew members, kept everyone "in line".

After two days' journey along the Labrador coast, we rounded Cape Chidley and headed west for Diana Bay. Swift currents, large tides, and menacing rocks which cover and uncover with the tides are standard fare in Diana Bay. Our destination was Koartak, where we were to unload 50 drums of diesel oil, 20 drums of gasoline, and, 2 barrels of wine for the local priest.

The hook was thrown about one mile offshore, and the two ship's barges lowered for loading. After some cranking and cursing, the barge diesels belched blue smoke and settled into a dependable clack. I went ashore with the first barge, which was pushed to the limit to stem the tidal currents and dodge the swiftly moving ice floes. Finally we bumped ashore, and were met by a mob of colorfully dressed Eskimo children and their curious parents. The whole community, consisting of the local priest, the local Hudson Bay store manager, and about two hundred Eskimos were on hand to greet the first boat of the season.

The parish priest, anxious to get his hands on the sacramental wine, greeted us with an enthusiastic blessing, and supervised transfer of the wine from the barge to the small mission house. I queried him on the immediate waters; however, little was learned except that the tide came in twice a day, the currents were quite strong, and the bay quite treacherous — all obvious facts.

In less than a day, all supplies were ferried ashore, and the captain, anxiously watching the ship swing in the currents was radio harassing the last barge to get back to the ship so we can get "to hell out of here". A few of the crew have disappeared into the Hudson Bay store, and patience is wearing thin as binoculars from the bridge scan the village for their return. Finally the barge departs for the ship, the mate starts hauling the hook, and soon we are underway for Resolution Island.

By the following day, the ship had penetrated Davis Strait, and altered course northerly towards Cumberland Sound. Large, unbroken ice fields intermixed with icebergs, soon occupied the horizon. The ice fields comprised decaying winter ice, broken into large loosely bound rubble chunks approximately eight feet thick, drifting southerly with the Labrador current. The ship could penetrate and pass through the fields, but at a cost of severe buffetting and discomfort, and at a risk of damaging the steering gear or propellers. The day was sunny and clear, the sea state calm with a slight swell, and the captain with an instinct for "smelling out" ice, had detected ice blink early. As the ship approached the field, its speed was reduced to "slow ahead", and the captain took over conning the vessel from the mate. The mate had meanwhile become inseparable from the radar, as he juggled ranges and searched for a break in the icefield. The chief mate came to the bridge and was ordered to send the helicopter aloft for an appraisal of the extent of the ice field. Passenger and crew crammed the forecastle and bridge, fascinated as the ship ripped through the "porridge" ice — seemingly unstoppable.

As this was our first taste of any heavy ice, it attracted much attention — and all authorized personnel jammed the bridge to watch steel and ice clash. Sun glasses were indispensible, as the sunlight reflected from the ice in glaring, changing levels of intensity.

Apart from a transfixion with the bridge action and our assault on the icefield, I was extremely busy watching the sounder and plotting radar fixes. Numerous course and speed changes kept me hopping from the sounder, to the radar, to the collector's sheet, —and the growl of ice passing beneath the ship developed blanks on the sounder chart.

Slowly the ice field tightened. Broken rubble ice, — easily shunted aside by the ship —, became denser, and the ship lurched and shuddered as it reluctantly plowed through the ice mass. The galley staff weren't happy. Each lurch and bump was accompanied by aggravated cursing amid pots and dishes hitting the galley floor. Nonetheless, the waiter conquered the stairs, and appeared on the bridge with coffee, sandwiches, and cookies. The captain leaned against the telegraph, binoculars in one hand, a sandwich in the other, while his coffee slashed back and forth in a window well: and thus we set about to bump our way northward.

Thrusting through ice, the ship pits its own speed-weight momentum against the dead weight reluctance of the ice to be moved or broken. The FUNK was very powerful, and had steel a foot thick in her bows. Nevertheless it took considerable punishment as it glanced from one large floe to another, and shuddered as the weight of the ice fought with the thrust of the propellers. Where the ship could not breach the broken ice, it slid up on the ice pan and its weight eventually crumbled the ice. During ice penetration, sleep was next to impossible, and a great deal of invective cascaded from the galley as unconsolidated food stuffs slopped out of containers or fell to the deck. But calm seas, sunny skies and clear air prevailed, and the "bump and grind" routine alleviated boredom.

A captain's dominating instinct is to stick to "the beaten path". No amount of ledgerdemain, chicancery or pleading will divert him from the established track. To make sure that the ship sails along a line of known soundings, is the ultimate desire, and woebetide the mate who strays from it. Although he will often point to "E.D.s" on the chart, and say laconically "there's nothing there", none will allow a conclusive proof. The "beaten path" provides a large measure of confidence to the captain, and although the revised chart may have the land re-arranged, and the old soundings re-patched as a best fit, a course is carefully laid along the line of most depths, and strictly adhered to. Thus, unless icefields force the ship to divert from a planned course, the hydrographer is often stuck with collecting soundings along a track of known depths, while the 90% remainder of the chart remains an unsounded unknown quantity of little concern to the captain.

The mate has, meanwhile, spotted an "island" which does not appear on the chart. A binocular argument ensues between the mate and helmsman over whether the island is an island, or just a pile of dirty ice. "Anyway" the ship will miss it by 8 miles, the radar fails to pick it up, and the captain settles the argument with a conclusive rejoinder that the island isn't an island and the mate's suffering from early stages of "ice fever".

By evening the FUNK was still slowly pushing through, but completely engulfed in ice. The captain was weary and ordered the ship to "heave to" for the night with engines on standby.

Engulfed in ice, an amusing incident happened which bears mention. The ship drew the attention of passing polar bears, who, attracted by the aromas of the galley, ventured close to the ship. Their appearance, naturally created interest from all aboard, and they became the delighted recipients of tasty morsels from the galley. As the bears stood on hind legs with mouths agape, they were rewarded by catching and swallowing in one motion numerous biscuits and scraps of food tossed from the lower deck. One mischievous seaman decided to reward their quick consumption of tossed food, by flicking his smouldering cigar butt as a food bit, and watching the reaction. The largest of the bears greedily "outnecked" the others, and in one gesture allowed the cigar butt to trajectorize straight down his throat. Naturally, the butt barbequed his tonsils on the way down, and with a mighty roar and leap, he took off across the icefloes like an olympic sprinter, followed shortly by the other bears. However, such is not the proper way to treat a bear, and the captain, watching from a deck where he could witness the feeding procedure, reprimanded the crew member for his actions.

The following morning we were underway, and by noon had broken free of the ice and started westward into Cumberland Sound for our next stop — Pangnirtung.

Pangnirtung fiord is a beautiful mountain-enveloped incision into Baffin Island. The snow-capped hills glitter with many hues of mineral pigmentation, and steeply descend into the deep, gelid waters of the fiord. Pangnirtung settlement lies a few miles up the fiord, as a community for Eskimo and administrative white personnel. The familiar white buildings of the Hudson Bay store, the mission, and the R.C.M.P. contrast with the sequestered rows of native dwellings. The FUNK had supplies for the settlement, and would require "three or four days" to discharge them. During this period, I was expected to sound "point to point", as much of the fiord as possible with crew assistance provided from the ship.

When an icebreaker is discharging supplies, all of the deck crew — especially the capable ones — are working feverishly loading and unloading the barges. Thus it is difficult to find a coxswain or someone with a remote knowledge of how to steer a launch. But; the mate will "fix me up", and so with "the best man available" and a load of 1:10,000 photo plots which stretch across 50 miles of open water, I head out amidst scattered icefloes. The 26B sounder bangs away merrily, and the diesel purrs, but suddenly there is a crunch. My "coxswain" has run into an icefloe just 500 feet removed from the ship. How he has managed this is unexplainable, since areas of open water surround the floe. Nevertheless, the binocular draped mates on the bridge, are rolling in laughter, and enjoying this comic feat of navigation immensely. Undeterred, I proceed on sounding. Daylight hours span eighteen parts of the clock, and so at a bustling speed of seven knots we zig-zag back and forth across the fiord. At dusk, we return to the ship where the captain props me up with a rum, and salutes my perseverance.

After four days at Pangnirtung, during which the captain and chief engineer have entertained the locals, partaken of some excellent char fishing, and allowed the local Eskimos to gorge themselves on pop, candy and cigarettes from the canteen, we proceed towards Cape Dyer. Heavy pack ice and numerous icebergs make progress very slow. By evening, the captain is fed up, so he shuts down the engines, and goes to bed for the night. The ship lies easily in the ice, and the mate takes periodic checks on the radar to observe the motion of numerous close icebergs. But distractions can be fatal. In the radio room someone is strumming a guitar, Playboy magazines appear, and conversation on mythical conquests is hypnotic. The mate gets tied up in jovial banter. On his next trip to the radar he does a double take, cranks frantically through another range setting to verify what he fears is happening, lets out a "for Christ's sake" curse, and runs for the phone. But — too late for the engines. A forty-foot high iceberg is heading straight for the ship and within minutes has struck the ship. Everyone stands transfixed. The six inch thick forward bulkhead steel takes the brunt of the collision and bends inward, as the berg locks onto the ship and slides sternward along the port side. Paint chips fly skyward and the ship groans. The berg, unfortunately, misses the hydrographic launch cradled on the port side. Falling astern of the ship, the berg flips over, revealing small fish and marine growth attached to its underside. Luck was with us. The steering system could easily have been twisted, but little damage emerged save the caved-in forward bulkhead. The mate mopped a sea of sweat from his forehead and went gingerly aft to advise the captain of the event. The following morning the captain observed the damage, shrugged his shoulders and returned to the bridge.

The ship worked slowly northward towards Pond Inlet and Arctic Bay. Daylight persevered around the clock, and grey, sullen skies predominated, intermixed with snow squalls. In between sounder breakdowns, and ice losses, I carefully extracted and plotted soundings, most unfortunately falling along the "beaten path". The helicopter made numerous flights, radioing back a confusing litany of "probables" to the captain. The ship plowed forward, bumping and grinding, veering and lurching until night when the captain would halt so that undisturbed sleep was possible. Soon we entered Pond Inlet where supplies were dropped. Once again, the natives greeted us ecstatically, indulging to their financial limit at the canteen — and offering furs and carvings at bargain prices. Much haggling took place, and a macho T-shirt, a carton of cigarettes, or a nip of demon rum could usually obtain a very good exchange item. The small village, a postcard of orange and white frame dwellings nesting along the beach at the foot of a large coastal mountain range, was bathed in horizon sunlight. The village winner was fisherman-cum-seal hunter who took possession of a forty foot Peterhead boat carried on the foredeck of the FUNK. He shelled out thirty thousand cash to the captain, and gleefully towed his possession ashore. Additional community supplies of fuel, sundries, two vehicles, and numerous skidoos were off loaded, prior to moving onward amid a farewell convoy of outboard canoes.

Then the ether brought messages that made the captain scowl and clench his fists tightly. Two package freighters, the Canadian Pioneer, and some other "damned tin can", were trapped in ice off of Clyde Inlet and were requesting assistance. After some choice expletives, the captain reluctantly turned the ship southward, with the mate advising the beset vessel that we should arrive in a day or so. Radio silence is golden to a captain, except for eavesdropping on other ship's dilemmas. Then, the bridge is a centre of conjecture, mirth, and "I bet Captain so and so is cursing", as a sister icebreaker is diverted from a pleasant routine patrol into assisting a vessel slowed by ice. Everyone likes to hear the radio crackle with action for others, but few want the action to appreciably divert themselves from a hasty north and south excursion. Nevertheless, should an unstrengthened vessel be "holed" by ice, or in immediate danger, the M.O.T. icebreakers would certainly be quick to respond in the fastest fashion. It's the "nuisance" calls that seem to raise the hackles of the captain, and most captains have an inbred sense for separating "needy" from "nuisance" in radio requests.

The next day we intersected the two ships beset in large ice field. After some terse radio communications, the FUNK put all engines on line, made a wide "tour de force" circle and was skillfully brought into position immediately in front of the stranded vessel. One avenue of debris ice was opened through the packed field, and the two beset vessels tagged close behind the FUNK until they reached open water close off Clyde Inlet. The exercise complete, respective captains exchanged radio courtesies, and once again the FUNK headed northward.

The next stop was THULÉ, mecca of the north, a drunken sailor's heaven, and a captain's nightmare. Pushing through ice consumes fuel faster than a government truck, and the FUNK needed bunkers. After three weeks at sea, Thulé was a great respite. This American military base had a duty free base store offering cameras, tape-recorders, watches and jewelry at Hong Kong prices. In addition, booze was plentiful and cheap, the officer's mess with live entertainment was opened to us, and one even got an occasional glimpse of an attractive military lady. One must remember that in these days before women's lib, ships were staffed totally by males, and it was thus refreshing to set foot on land and reaffirm one's suspicion that there was another sex.

As the last line of the FUNK was secured to the Thulé wharf, a mass exodus of personnel took place. Cheques were cashed, and a Klondike gold rush hysteria created a stampede towards the shops that dispensed duty free items and booze. Shortly, taxis returned laden with radios, cameras, tape recorders, and cases of spirituous decanters. The ship's displacement increased as much from hand carried fluids, as from the bunkers being steadily pumped into the fuel tanks. I had personally refurbished my medicine cabinet with two cases of Napoleon brandy and two cases of navy rum, purchased for under two dollars per bottle. The FUNK would take until the following morning to complete bunkers, and so the night off was consumed at the bar of the officers' lounge, watching pop singer Connie Francis entertain. In the small hours of the morning I returned to the FUNK. The ship was due to sail in two hours and crew members were scurrying aboard with additional cases of liquor. Parties were underway in various parts of the ship, often including local U.S. military personnel and native Eskimos. A scenario from "there's strange things done in the midnight sun" was unfolding with galloping abandon, and many bodies were reaching a status whereby they could not utter their name, their ship, or the year of our Lord.

The captain slept through much of the hilarity, and was up at six to get underway. Non-resident revellers were courteously or discourteously removed from the vessel, the mate rounded up a couple of yet mobile seamen, and the ship cast lines to head for Arctic Bay.

The ramifications of cheap access to cheaply distilled liquor can be very severe, and the FUNK had its share of problems. Fortunately, it had an "iron lung" aboard and a capable doctor. Nevertheless, a few examples stand out, which supercede the normal headachy hangover recovery applicable to the average person. A sturdy Cape Breton seaman, in his early twenties, whilst thumping his guitar and singing 101 verses of the North Atlantic Squadron, did consume so much Cadillac whisky that he suffered a heart attack and spent two days in the oxygen lung. Another example was an electrician who barricaded himself into his cabin, and while his liquor supplies lasted would emerge for neither work, food, nor counselling. Attempts to feed him by a straw siphon through the key hole failed, and it wasn't until he fell asleep two days later that the engineers were able to force his door and deliver him to the doctor.

Such were two isolated cases, but it must be remembered that drinking at a high level, amongst those of strong constitution, continued for days. Naturally, as the liquor supplies became depleted those in dire need paid extravagant prices to continue their habits, and a bottle of cheap whisky purchased at Thulé for one dollar was being sold by enterprising bootleggers for twenty dollars.

Slowly but surely the ship returned to normal. The mate worked the seamen outside as much as possible to "flush out their gills", the engine room slowly recovered from absenteeism, and the chief steward, unshaven and dishevelled was seen jerkily consuming a bowl of soup whilst sorting out the waiters. If there is an advantage to sailing in the Arctic, it is that a few breaths of gelid air normally dispenses the most cantankerous hangover, and thus the dregs of excess can normally be remedied in short order.

The trip to Arctic Bay was uneventful. The ship navigated around ice fields, and pushed steadily towards Lancaster Sound. September was approaching and the day shortened. The skies were often dull and foreboding. Numerous snow squalls passed through. During one of these, a dense flock of ptarmigan, blown offshore and lost in the snow storm, landed on the FUNK. Many were easily seized, and became used as objects of photography, personal pets, and not uncommon as the meaty part of a stew.

The FUNK reached Admiralty Inlet and proceeded southward to the community of Arctic Bay. Once again we were enthusiastically welcomed, and the ship lay two days off-loading supplies. Thanks to the generosity of the second mate, who accompanied me in the launch, I was able to track sound for twenty miles up Adams Sound. At the end of the Sound, a thundering water fall poured glaciated water into a pond which was alive with bearded seals frolicking in the spray. The appearance of the launch excited the curiosity of the seals, and over coffee boiled on the Coleman stove, the mate and I watched the hide and seek spectacle of the seals probing the launch. The presence of the seals probably foretold a good "char" hole, but the lack of time and fishing gear precluded such a diversion. The daylight portion of the day was becoming quite limited, and we hastened back to the ship, arriving there at four p.m. in darkness. The ship had discharged all Arctic Bay cargo, the local Eskimaux were making a final run on the canteen, and the captain was passively passing the bridge preparing to weigh anchor and sail.

From Arctic Bay we departed for Resolute Bay to discharge the remaining cargo. Brilliant moonlight reflected from frazil ice forming on stilled waters, and the ship plowed noiselessly northward through Admiralty Inlet. The following morning we anchored in Resolute Bay, and made a rendezvous with the Quebec icebreaker D'IBERVILLE, which had, coincident to my own program become the floating home of two hydrographic associates. The D'IBERVILLE needed water and fuel from our topped-up Thulé consignment, and arrangements were made for the two ships to secure to one another and transfer the liquids.

After some terse inter-captain conversation over the VHF radio, the FUNK moved slowly towards the D'IBERVILLE. The waters were still, the skies sullen, dark and close, as the FUNK inched noiselessly forward. The chief mate stood on the forecastle, where, wrapped in a parka he was stamping his feet and waving his arms to remain warm. Temperatures were near freezing, and rope hawsers had become stiff and unruly. Two seamen were preparing heaving lines, and a journeyman mechanic was busy loosening up a deck winch. From the bridge, the captain moved the ship ahead "dead slow" on the telegraph. Smoothly he inched the ship to intercept the anchored D'IBERVILLE. At last, the heaving lines were trajectorized onto the D'IBERVILLE, where enthusiastic seamen snagged the ropes and hauled aboard the hawsers of the FUNK. Winches banged furiously as the FUNK was laterally pulled into the D'IBERVILLE. Complements of both ships lined opposing decks to gaze with abstract curiosity at each other. Finally, a minor quake signalled the union of the two ships, and I prepared to go aboard the D'IBERVILLE with some libations of goodwill.

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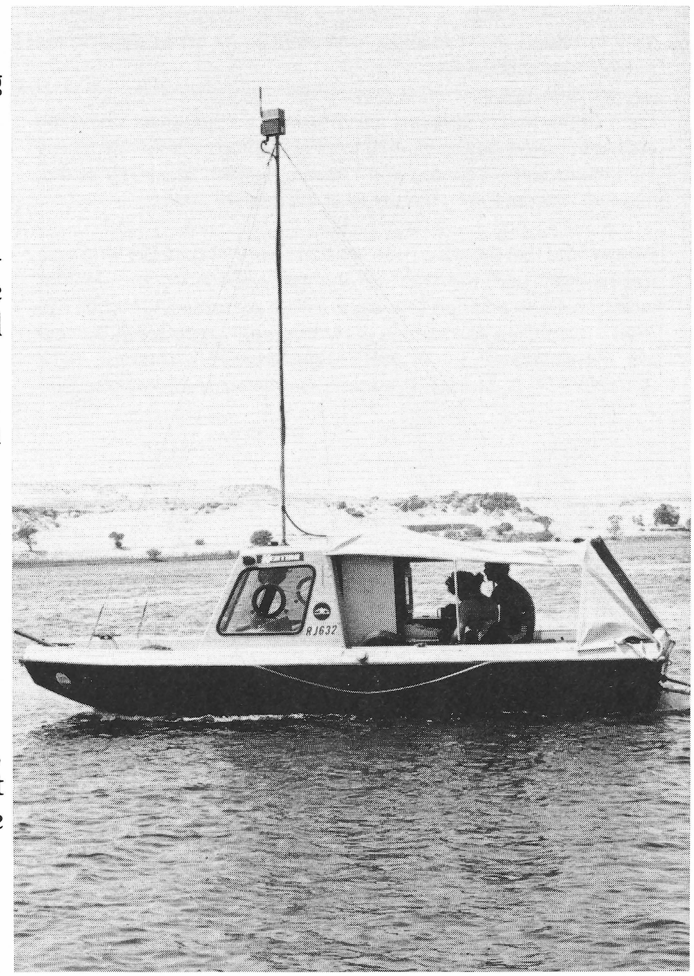

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1984 Canadian Hydrographers' Association Workshop

March 13, 14, 15, 1984
Victoria, B.C.

The attached article is intended for those members of CHA unable to attend the workshop, who want to be up to date on the subject matter covered.

Each of the twelve sessions was headed by a volunteer chairman who later gave a brief summary to all workshop participants. These summaries were recorded and I have attempted to condense that material without losing the sense of the subject matter.

Please note that the workshop sessions were 90 minutes long and, for the most part, too short for the many questions and debates which arose. In addition four papers were presented: CAHOSI REPORT (Canadian Association of Hydrographic and Ocean Surveying Industries) — T.D.W. McCulloch, Executive Director; SITE SURVEYS — G. Murray, President, Northwest Hydrographic Surveys Ltd.; NOMENCLATURE — E. Lischenski, Canadian Hydrographic Service, Atlantic Region; HYDROGRAPHY IN INDUSTRY — Hugh R. Stewart, Canadian Hydrographers' Association Vice President, Prairie Schooner Branch. Copies of these are available on request.

I would like to add that as a result of a Workshop Evaluation Questionnaire, letters received by the Chairman and verbal congratulations, this workshop is considered to have been a great success!!!

Sincerely,

Gail Ellison,
Chairman, 1984 CHA Workshop.

Session #1
Swath Survey Systems
Chairman: T. Mortimer
Pacific Region

Within this session we discussed swath systems that produce varying densities of sounding coverage which give a complete picture of bottom topography.

The Stern Tow project, developed in Pacific Region under the auspices of A. D. O'Connor and John Watt, is an improved copy of what is being used in Denmark.

Sea Marc II Trials system, which is a total swath side-scanning system, produces a graphic analogue record as well as a digital presentation after the data is processed.

Mr. Steve Forbes discussed a new survey vessel with a bottom sounder system used on inshore areas in the Atlantic Region. He also described the Dolphin system.

The massive amounts of data collected were addressed in different manners. Pacific Region is treating this like additional sounding data. Atlantic Region's approach is to pre-edit most of the data, allowing the computer to select what it will handle before the information is logged.

In summary, the experience gained with the swath systems has proven that they are mechanically and physically cumbersome with each having separate applications and are so specialized they are not ready for general use.

Session #2
Datums and Currents
Chairman: B. Tait
Ottawa

On the subjects of currents and current information, the most popular method of presenting the data to the Mariner, resulting from a user survey, was the Current Atlas. Emphasis was on the necessity of producing more of these using numerical modelling techniques. As more and better current information is required, due to the increase in the size and draft of vessels, it was recommended that field hydrographers become more involved with collecting current information.

Mr. Mike Woodward, Pacific Region, stated that although field hydrographers are able to collect current information using present equipment, there is a newly developed instrument which is simply deployed over the side of a survey launch (unit was on display). Of course, know-how to determine where and when to collect the data is a problem.

Discussion ensued on the hydrographer's role in collecting current data. It was suggested that requirements should be precisely stipulated in Field Project Instructions. A comment was made that perhaps field hydrographers are focusing too closely on the displays of the "Black Boxes" and not visually observing currents in the area of their survey.

Cartographers present expressed concern over the amount of current information shown on charts and the necessity to keep the current arrows from interfering with soundings. The reply here was: cartographers must trust the advice of tidal personnel when the information is provided. Where cluttering is too obvious another medium such as Sailing Directions should be considered.

On the subject of vertical datums, it was proposed that the datums in nontidal waters and tidal waters be identical.

Various advantages were cited in favor of the two-datum system. The principal one was clearances (under bridges, powerlines, etc.) would be referred to a high water datum which would show a minimal value. Other reasons included consistency of datum systems in nontidal and tidal charts, and the fact that only Canada uses a one-datum system.

On a positive note for retaining the present one-datum system, which uses the high water level to define coastline, very little change to the information presently shown on charts would be required for clearances and elevations. This speaker also pointed out that the use of a two-datum system would be confusing to the user.

The discussion then centered on the impact on the cartographer of adopting the two-datum system. The following questions were raised: What resources are required to convert inland charts to a two-datum system? How much impact would there be on the users of present charts and how long would it take to re-educate them? Is the information available to provide a safe vertical clearance even above the high water datum? Should there be concern over loads on transmission lines and the effect of ambient temperature? Also what of arcing lengths?

During this session one basic conclusion was reached; the matter of clearances requires much more attention.

Session #3
Notices to Mariners
Chairman: W. S. Crowther
Pacific Region

The panelists of this session reviewed the history of Notices to Mariners and expressed concern at the growing number of notices being promulgated annually. It was also expressed that many of the Notices to Mariners were applicable for the recreational boater, and it was necessary to clarify the procedure for the promulgation of Notices to Shipping and subsequent follow-up on Notices to Mariners. It was recommended here that the incoming Marine Reports be addressed a "point rating" to determine what information would be applicable to the Notices to Mariners.

The workshop participants agreed that CHS and Transport Canada should set out acceptable procedures to monitor the requirements of temporary and preliminary notices. It was also expressed that the present format for Weekly Notices to Mariners is too brief and should be reviewed.

Within the lengthy discussion that followed it was proposed that a separate set of Notices to Mariners, for recreational boaters, be considered.

Session #4
Training in the Canadian Hydrographic Service (CHS)
Chairman: J. Poudrier
Quebec Region

The first speaker in this session discussed the objective and purpose of Carto I and II courses, as well as refinements acquired within the past few years. Concern over the lack of communication between regional managers and training officers was expressed, and it was recommended a meeting between them be set up very soon to review and improve course content. This speaker ended with three questions to the audience: What are the cartographic requirements? What do the regions want? What are the expectations of the cartographic trainees?

The second speaker, Mr. Pete Richards, Head of Training, reviewed the refinements to the Hydro I and II courses which include meteorology, management and stress management. He then stated that Hydro II had been modified to fit the new Canadian Land Survey (CLS) requirements.

Our last speaker, a former training officer, felt the courses offered were good and would get better with more support from the regions. He suggested that it was the responsibility of each region to continue training of personnel after the Hydro courses.

Other suggestions resulting from this session were: better communications between regions and the Training Section on automated cartography, more interaction between Carto/Hydro courses, and a refresher course for HIC's (Hydrographers-in-Charge) in the fall.

Session #5
Sailing Directions
Chairman: R. W. Sandilands
Pacific Region

A suggestion at the Quebec Workshop (1982) that the front cover of the Sailing Directions Small Craft Guide show the area covered by the book, was implemented with some problems. In general, as CHS is competing against the "jazzy private enterprise", the readily identifiable standard colors established over the years helped to sell it and therefore should be maintained.

When the question of radar photographs arose, the consensus was there were too many variables such as height of antennae, atmospheric conditions on the surface etc., and this method might be misleading.

On the topic dealing with diagrams, the general consensus was that diagrams produced in CHS publications are acceptable but must be up to CHS standards. Therefore, it is the responsibility of the Regional Sailing Directions Officer to contact his cartographic counterpart and work out an agreement, where eventually over the years suitable diagrams could be built up.

The next presentation, "The Mariners Role Within the Hydrographic Service" raised many questions, one being, when the Sailing Directions Officer has specific queries should he consult a professional mariner? One attendee who had all his tickets said that "although legally he could take a supertanker to sea, he didn't feel he had the expertise to confer on the subjects at hand". From this came the question "Are we keeping up with needs and requirements of deep draft vessels?" A reply was that Sailing Directions Officers should keep fairly close touch and try to engender a relationship with the shipping community to keep abreast of its problems. It was also recommended that new recruits in CHS have more emphasis on seamanship and navigation during training.

The last presentation dealt with powerline clearances and elevations. One approach to this was that in future, when a power company applies for their clearances through the Navigable Waters Protection Act, that they be required to provide the engineering background, ambient temperature, how much sag under heavy load conditions, etc. as part and parcel of their applications.

The general feeling from a very lively discussion was there should be a Sailing Directions Officer with the Regional Field Superintendent at the time hydrographic instructions are being written.

Session #6
Echo Sounder Calibration, Speed of Sound

Chairman: P. Bellemare
Quebec Region

The purpose of this session was to discuss problems relating to the speed of sound in water.

The first speaker demonstrated that the speed of sound changed rapidly in the surface thermocline, found at approximately 50 metres. Any interpolation of the speed of sound within this thermocline will bias the depth measurement to where CHS accuracy standards would not be met. It is found that to obtain accurate depth measurements, one should apply an integrated speed of sound through the water column and also one must be careful when working at the mouths of rivers, as fresh water flow changes the scenario completely.

Mr. T. A. Curran, Chief of Engineering Services, Pacific Region, described a frequency synthesizer he is using which allows sounders to be set to a known speed of sound velocity, allowing portrayal of true depth on sounding traces. These circuits were produced by Analytic Systems Ware Ltd., Vancouver, B.C., at a cost of $1672.00 for 10 units.

Mr. Loschiavo, Pacific Region, described an echo sounder calibrator designed for the purpose of providing the hydrographer with a device that would inform him that his echo sounder was operating at the correct frequency. He also mentioned this device was not a replacement of the bar check.

Central Region presented a case where due to the lack of knowledge of the speed of sound profile, where velocity corrections were applied, errors of 1 metre in 60 metres of water were acquired.

Atlantic Region explained how their hydrographers were adjusting and calibrating echo sounders. It was mentioned that all sounders were adjusted to use the speed of sound at 1463 metres per second then bar checked to different depths, and afterwards correction tables were applied.

In spite of the many questions that went unanswered because of the time restrictions, there are conclusions we can draw from this session. The hydrographer must bear in mind when applying corrections for the speed of sound what exactly he is applying and measuring. This session also showed that CHS regions are calibrating the echo sounder in very different manners.

It is certain after hearing the various responses on echo sounder calibration that with the new technology applied this problem will soon be resolved.

Session #7
Computer Assisted Cartography (CAC)

Chairman: M. MacDonald
Central Region

This session on Computer Assisted Cartography was attended by representatives from across the country who expressed their success, frustrations and recommendations for changes with CAC.

Pacific Region, which presently operates and maintains two systems, has a library which includes 15 digital charts. Some advantages of CAC are: standard presentation, ease of data manipulation, production of chart series of varying orientations and having digital files for future use. CAC is meeting CHS requirements but there is room for improvement as the following list of frustrations with computerized charts will show: 25% downtime, slow response to suggested changes, reducing data for inclusion in a smaller scale chart and the lack of good generalizing programs. Suggestions for improvement of CAC were: using color graphics, improving line editing commands and selective windowing in GOMADS.

It was noted that hydrographic and cartographic requirements for field sheets were similar. Implementing GOMAD's would have the advantage of: digital field sheets, standard CHS graphic representation, simplified data based management system interfaces and compatible software.

Discussion was lively and candid. Questions were raised in areas such as: development priorities, acceptance of the digital field sheet concept by cartographers and hydrographers, national and regional policies, updates and training.

One conclusion which gave participants food for thought is that "automation is here to stay".

Session #8
Contours for Navigation

Chairman: S. Forbes
Atlantic Region

This session started off with concern over the 0-30 metre zone on metric charts and the lack of information using standard contouring guidelines. It was suggested here that charts be customized for user requirements by adding pertinent contours where there is not enough information provided by standard contouring.

Our first presentation was on the traditional versus contour style metric charts. Concern was expressed that lattices and contours cause cluttering, and would confuse the user. This was followed by a very enthusiastic discussion on other reasons why the user may not accept the metric contour format. The speaker suggested that some of the expressed advantages of the traditional charts be incorporated on the contour style metric charts.

The next speaker expressed surprise and concern that there is still a "missing link" between the collection of digital data by field hydrographers and its compilation onto a chart. He continued on by defining the requirements for machine contouring by the CHS; shoal biasing, honouring all data, field processing, barriers and consistencies.

The next topic was on the general algorithms used by Barrodale Computing Services Ltd. to contour field data. The speaker stated that the software for this package tries to solve all the user's requirements, but noted that the end product is dependent on manipulation of the input data. This speaker added that as the Barrodale is a very complex package, there were many variables used to determine what the output was going to look like.

Session #9
Tidal Instrumentation
Chairman: B. Tait
Ottawa

Mr. Jim Galloway, Pacific Region, opened this session by describing various applied acoustic projects that are underway within the Institute of Ocean Sciences.

Two of the more successful ones are a current meter that employs doppler sonar, and one that uses correlation sonar. These initiated a lively discussion, and great interest was shown in using these instruments to obtain navigational data and for measuring currents in rivers.

Mr. Pugach of Swan Wooster Engineering Ltd. in Vancouver stated that although the present Ottboro gauges in use were satisfactory, he would like to see a future tide gauge that was easily transported and installed, had a VHF data telemetry link, was easily serviced, was reliable, had ±5 cm accuracy and was reasonably priced or with lease opportunities.

Mr. Brian White, Central Region, is developing a new gauge that would store data digitally and support a telemetry link. He described the logistics involved in setting up and operating this new unit thus giving the hydrographers present a preview of what to expect in the future.

Session #10
Sailing Directions
Chairman: S. Dee
Ottawa

Within this session were three main topics for discussion. The first was a proposal to produce a Canadian Mariners Handbook. This publication would be similar to the British Mariners Handbook and include most of the information now in Chapter One of the Sailing directions, plus general information which would be of interest to the mariner.

Generally, this paper was well received although concern was raised as to whether or not this was a Coast Guard responsibility. It was recommended that Headquarters contact the Coast Guard in Ottawa and come to an agreement on providing such a publication.

The second item for discussion was the electronic chart. The speaker pointed out that the present Sailing Directions is not compatible with the proposals being made for an electronic chart or integrated navigation systems. He then described in detail, a comprehensive numbering system within chapters and paragraphs for easy extraction so they could be shown in conjunction with an electronic chart. There was a firm conclusion here to discuss the subject further.

The third topic presented was the Cruising Atlas, which in effect will be a combined Small Craft Guide and Small Craft Chart. A particular area discussed was Jervis Inlet and Desolation Sound on the British Columbia coast, where planning is underway for production in 1986. This Cruising Atlas will be maintained as the Small Craft Charts are at present, by Notices to Mariners.

One criticism of the atlas was the number of abbreviations it contained. A participant who is a council member of the British Columbia Yacht Club said he would take up this matter of abbreviations with the membership and report back to Pacific Region.

This session, as a result of the enthusiasm of the participants, was not only constructive but enjoyable.

Session #11
Data Logging and Processing
Chairman: R. Mehlman
Atlantic Region

Our first speaker outlined the acquisition and processing system at the Bedford Institute of Oceanography. He described high-nav position loggers, a semi-automatic scaler and the MX21 computer and then went on to describe new systems being examined; navtronic sweep system, Dolphin, and the Arch system. He then concluded by outlining problems encountered with data logging, reliable software and hardware, obtaining the right digitizer and overlays of field sheets from year to year.

The second speaker gave an historical background on data logging and processing, then described the Bubble and Cassette manuals being used in Central Region. He described three approaches in logging data: manual entry, electronic notebook and the electronic theodolite. In describing a new field data processing system using a PDP11-23 computer with a Winchester Disc Drive, this speaker concluded by saying that with this development, Canada Centre for Inland Waters has more systems being requested than can be made available.

Terry Curran then provided an excellent video on launch logging and data processing as being used by Pacific Region. This video is available upon request from Terry.

Session #12
Digital Data Bases
Chairman: S. Oraas
Pacific Region

Ron LeMeux, cartographer with CAC in Ottawa, has been working on a Digital Data Base project to find out if the work could be contracted out and found after two strict contracts that indeed it could. As no project is without its problems a few were noted: transferring the expertise needed to select appropriate soundings and contours; there is no short cut in producing a metric chart from the imperial one; if the concept of digital data bases proceeds, the role of the cartographer/hydrographer will change with regard to training and standard orders.

Tim Evangelatos of Ottawa stated that digital data bases are essential to cartographic progress and more digital data from the field is required to refine the system.

In addressing the problem of the "missing link" which includes interactive compilation, generalization, and automatic generalization, Ottawa is having extended sounding format, so soundings can be handled in an interchange format. The sounding will contain all data required by hydrographers, including launch data, time the sounding was collected, accuracy and a number of other details.

The electronic chart is now in operation and a prototype is being used on the Queen of Vancouver Ferry. This small unit ($50,000.00) is intended to reduce costs, enable better positioning around currents, and save money on fuel costs. When asked what CHS could do about electronic charts he replied "struggle to keep up".

Review — The Future of Hydrography
By Rear Admiral G. S. Ritchie

This polished-up version of a paper presented at the International Hydrographic Conference of 1982 outlines the future of hydrography as seen through the eyes of the outgoing President of the Directing Committee of the IHB and retired U.K. Hydrographer. The paper discusses recent progress of the IHO in meeting its objectives and then goes on to discuss historical developments in hydrographic technology. Covering this topic the paper is well written as we might expect from Steve Ritchie, who already has several books and numerous papers to his credit. To Canadian eyes the lack of referral to any Canadian work in technological development appears as an omission, in view of the very active role that has been taken by that country, particularly in areas of automated hydrographic survey systems. The paper does not pick up on a subject that is causing great unrest in some national hydrographic offices at present and this is the privatization of hydrographic work. Interestingly, although the author was a major force in establishing Commission IV of FIG, he has only addressed the accomplishment of that organization in training hydrographers and has not noted how FIG has clearly stolen a march on the IHO when it comes to arranging technical conferences and supporting technological advance. Perhaps since this paper was first presented at the IHO- sponsored conference this approach should be expected but we might look forward at some future date to another paper more broadly based covering advances both in the governmental and commercial sides of hydrography.

A. J. Kerr

REFERENCES

Ritchie, G. S. (1983) "The Future of Hydrography", Interdisciplinary Science Reviews, Vol. 8, No. 4, pp. 345-357.

Book Review

Hydrography for the Surveyor and Engineer (second edition), by A. E. Ingham, published by Granada Publishing Limited, 1984, 129 pages, price £12.50, hardcover

The first edition of Hydrography for the Surveyor and Engineer was published ten years ago. Since that time, hydrographic surveying has seen many technological changes. This second edition, while retaining the components of basic hydrography, encompasses these new advances.

A host of general information on how to prepare for and conduct a hydrographic survey is presented. Preference has been given to hydrographic surveys supporting the offshore oil and gas industry as well as engineering projects, rather than hydrographic charting programs. As such, systems which are presently under development or are of such a scale as to be viable for only very large companies or governments are glossed over. As was the author's intent, the problems involved with working in a marine environment as opposed to dry land are stressed.

The technical sections on both positioning systems and depth measurement are general in nature and quite concise. Measurement theory is presented in a non-detailed but very understandable approach. Some derivations of formulae for the computation of position and accuracy for the more common systems are provided. The relative merits of different types of positioning and sounding approaches are presented in a manner such that the application of each system is readily apparent. One or more technical specifications for a representative commercial product for most categories of systems is provided. Brief mention is given to those systems under development or which have not yet established a role in hydrographic surveying, such as LIDAR bathymetry for the former and Inertial Navigation System for the latter. The acquisition, processing and presentation of hydrographic, data, by both manual and automated techniques are outlined.

One chapter is given to parameters other than bathymetry which are collected and/or co-ordinated by the hydrographic surveyor. These include tides, currents, seismic profiles, bottom samples, temperature, salinity and water samples.

A comprehensive bibliography with a brief description of each publication is provided to facilitate more indepth study of hydrography. Included in the list is 'Lighthouse', described as "always interesting — though concerned chiefly with work for the national charting authority — and particularly useful for the concise trials reports on new equipment and frank progress and problems encountered in the Canadian Hydrographic Service".

This book, though slim, covers all aspects of hydrographic surveying, albeit somewhat briefly. As such, it gives a surveyor or engineer about to venture forth on a hydrographic survey for the first time, all of the right questions but not all of the answers. It is an invaluable introduction to the subject and provides a good reference guide to the vast assortment of equipment available to the hydrographic surveyor.

A. Kent Malone

Fisheries Sonar

R. B. Mitson

Fishing News Book Ltd.
1 Long Garden Walk
Farnham, Surrey, England
1983, ISBN 0-85238-124-7

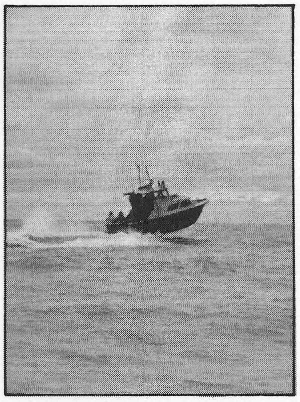
This book is in many ways an extension of D. G. Tucker's 1966 book "Underwater Observation Using Sonar". Mr. Mitson has incorporated much of Dr. Tucker's material and has done an excellent job of writing an up-to-date book on sonar and acoustic systems for gathering information in fisheries operations and research. It is one of the first texts on underwater acoustics to employ the SI system of units exclusively and in a section — Units, Symbols and Definitions the author has carefully and precisely explained all units employed. He has also provided a comprehensive Glossary of Terms.

The first three chapters of the book are concerned with obtaining information underwater, underwater acoustics theory and the basic principles of simple sonar systems. These three chapters will be of considerable value to educators as well as persons involved in designing and purchasing underwater acoustic systems. The author deals with the subject matter in a comprehensive and easy to read fashion avoiding for the most part highly mathematical derivations.

Chapters 4, 5, 6 and 7 deal with the processing of acoustic echos from fish, the use of fishing echo sounders and sonars as well as information on diverse systems. This section of the book contains interesting photos showing echo-traces of various species of fish and direct comparisons between colour displays and dry paper recordings.

The author also discusses the use and limitations of fishing echosounders, and acoustic methods for estimating fish populations. The book is up-to-date and will be a welcome addition to the libraries of those who are interested in underwater acoustics.

S. B. MacPhee
Director General
Canadian Hydrographic Service
April, 1984



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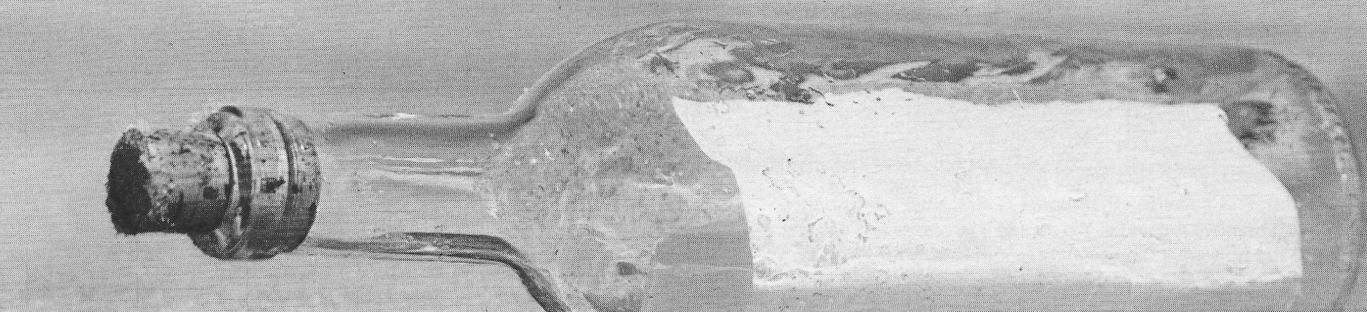

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Satellite Bathymetry — Fact or Fiction?

By David Monahan

In the last year or so, a number of papers and maps have appeared in both the popular press and the professional literature about new maps of the world oceans produced from satellite-based instrumentation. Depending on their authorship and location, their tone has ranged from scientific enthusiasm to press release euphoria. The oceans are now, for the first time, mapped properly, they all seem to suggest, and about time too. Is this really an advance or is it just another case of arm waving by those innocent of what has been done before? In this paper, an examination will be made of what the satellite maps do and do not show and point out their value and future developments.

The satellite-based maps are based on principles that are elegantly simple — simple that is once one has examined a lot of data and then worked backwards from those findings. At that point the whole thing appears so obvious that it seemingly should have been anticipated in the first place! But of course it was not. Let us examine those principles.

We are all taught in our teens that Isaac Newton messed around with apple trees and gravity. For physics exams we memorize the formula $Fg = \frac{Gm_1m_2}{d^2}$ and to a greater or lesser extent ignored the words that preceeded this formula, namely, "Every object in the universe attracts every other object in the universe with a force . . . For most of us, these words did not become real until we began surveying and discovered that plumb bobs do not always hang straight down. We found that they are attracted towards large masses, or mass excesses if you prefer, and being free to move to some extent, express that attraction in motion.

Another thing that is free to move, subject to some limitations, is sea water. If you consider any plumb bob-sized glob of water in the ocean, it will be attracted to mass excesses as would the plumb bob in air and will attempt to translate that attraction into motion. that All the other globs will attempt to do the same and the do occur net result could be a slight increase or diminishment of water depth as water masses move in response to gravitational attractions. Of course, many other forces also act to move water masses and they may be strong enough to overpower gravity. Further, any changes in depth that do occur will be very small; too small until now to measure. Gravity, of course, does not know that and just keeps on attracting.

Well, so what? Suppose we have a large extent of water with a flat bottom, and we are able to stop winds from blowing and currents from circulating. The water in other words is still. Now, using only gravity, we wish to move the water. We can do it in one of two ways. First suppose the bottom is homogeneous, that is, it is made up of the same material and therefore has the same density and mass everywhere. There are consequently no gravity gradients to help us and the direction of gravitational attraction will be same everywhere. Suppose we take a large piece out of the flat bottom and pile it elsewhere within our sea. In its new location we have created a mass excess, since the bottom is denser than the water it has replaced. We now have a gravity gradient and some of the water globs will be attracted to this pile of bottom and move towards it a little. Similarly, in the hole left when the large piece was removed, we now have water and, being less dense than the rock it replaced, it is not as powerful at attracting water globs as the surrounding bottom is. The net effect is that some water globs move away from the hole a little.

This is a reasonable model of what happens in the deep ocean. The ocean floor is reasonably homogeneous and mass excesses come from piling up of material above base level in seamounts and ridges, while there is a deficiency of material in trenches. We would thus expect to see some upwards bulging of the water surface over seamounts and ridges with a downward bulge over trenches.

But what if the bottom is not homogeneous? This is our second case. If the bottom is flat, density differences within the bottom will create gravity gradients and again the globs of water will be attracted by a mass eccess formed in this way. The continental shelves are the real world analogue of this, having a fairly flat surface and being made of rocks of widely differring densities. Our expectation would then be to see the water bulging upwards over the more dense rocks and deforming downwards over the lighter ones.

Fine. We have two neat theoretical models and two real world situations of which they appear as reasonable approximations. Now, how do we measure the small movements of the seawater and how do we get rid of the effects of the other forces also acting to displace the real water? It looks like both problems can be solved reasonably well if we measure the sea surface elevation from a satellite. Satellites can apparently be tracked to within a metre of elevation and pulsed radar altimeters allegedly have a resolution of $\pm$ 20 centimetres, so measuring the sea surface elevation along the satellite's path can be done fairly accurately. Since the satellite travels so quickly, it can repeat its measurements many times and the varying effects of tide, storm surge and wind push can be averaged out. However, the constant displacement effects of oceanographic phenomena will not be. This is what the SEASAT satellite was able to do and some very clever people have been able to convert the satellite's data into maps.

The SEASAT altimetry data consists of long profiles representing the distance from the satellite to the sea surface. Judicious filtering and detrending of these profiles leaves only the wavelengths of interest. These filtered profiles are converted to contour maps by fairly conventional means, the contour values being the averaged height of the sea surface above or below the theoretical geoid. Values exceeding four metres are observed, but most of the ocean deviates by less than one metre. The contour maps at small scale, when compared with conventional bathymetric maps, show a striking correspondence in many areas. There are also some striking differences, but these tend to be overlooked in the general elation induced by the positive correlations. However, when we examine the correspondences and differences a rather comforting picture emerges.

To do so we need more than a page-sized map which we can hold up near a wall-mounted GEBCO display. The GEBCO World Map at 1:35 million is at press but during its construction we were able to exchange copies of the contours for copies of SEASAT maps from the two principle producers to date, William Haxby at Lamont-Doherty Geological Observatory and Timothy Dixon at the Jet Propulsion Laboratory. These maps were especially produced to fit the GEBCO sheet and direct overlays allow rapid comparison. Making such an overlay is an extremely exciting event.

One is immediately struck by the strong, almost overpowering correspondence between the maps in the deep ocean areas. Almost everywhere where the sea floor rises, the sea surface rises and where they fall, they fall in unison. Quite obviously a correlation exists, and it is explained by our simple model of a homogeneous bottom with mass excess being provided by depth differences. It is this unexpected close similarity which has attracted the attention of the popular press.

Moving towards the continents, both bathymetry and SEASAT maps show the strong gradients of the slope. This is an easy area for discrepancies to pass unnoticed, but the general forms are in good agreement.

When we reach the shallow waters of the continental shelf, things at first glance go badly awry. There is virtually no correspondence between sea surface elevation and bathymetry. Further, the range of elevation of the sea surface over the shelf is as high as it is over the deep sea, though the range of depth variation is one to two orders of magnitude less. Panic — until we remember our model of the nonhomogeneous sea floor. On the continental shelves we should expect strong gravity variations from within the sea floor, the cause of the bodies not necessarily having any sea floor expression. If that is the case, then the sea level maps should correspond with free air gravity maps and in the two places where we have been able to make comparisons, that is Hudson Bay and the Grand Banks, they do. On the continental shelves then the sea water is being displaced by mass excesses within the sea floor.

We thus see that our two mechanisms work, on a global scale at least, and one manifestation of them is the elevation of the sea surface. Obviously one could postulate that a continuum of bottoms exist from strongly homogeneous to strongly subdivided. Further, the continuum of depths exists and we could draw clever graphs showing the effects of each and the points at which one or the other is dominant. We do not need to do so, however, since nature breaks the ocean into shelves and deep ocean, and the two are different enough that we need not quible over transitions. The continental slope, where the division takes place, is a difficult area at the best of times and the intermingling of the two mechanisms is hidden somewhere in the strong gradients that are shown to exist there on both types of maps.

What can we conclude from all this? First, that marine geoscientists and hydrographers are reasonably clever fellows, since we have produced from a data set that is inadequate, sparce, old, creaking, uncoordinated, unverified, and uncalibrated, a very good picture of the world's ocean floor, at least to the scale that the satellite data has been able to verify it.

Second, in the deep ocean, the sea surface data will be very useful in the future for refining bathymetric maps in areas lacking in echosounding data. The satellite data cannot yet determine the magnitude or location of features with any degree of precision, but they can confirm the presence of a feature, its general shape and trend. It may eventually be possible to read depth from the surface elevation but not until the sea floor density has been determined. At present, there are two unknowns, that is depth and density, but only one question.

Thirdly, on the continental shelves, the sea surface elevation will contribute little or nothing to bathymetric knowledge. They will, however, add considerably to gravity mapping. Indeed, the Earth Physics Branch's plan to map Foxe Basin by conventional methods is already benefiting from this input.

Finally, we can rejoice that an instrument developed to do one thing has yielded an additional totally unexpected product because some workers of great acuity and determination were able to see its possibilities and pursue them to a successful conclusion.


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Second International Hydrographic Technical Conference

The Hydrographic Society, in association with the Royal Institution of Chartered Surveyors (RICS), is to hold the second International Hydrographic Technical Conference at Plymouth, UK from 3-7 September.

The Conference, which will focus on the problems of developing maritime nations as well as the exploration and exploitation of EEZ's, is to be formally opened by the Secretary-General of the International Maritime Organisation, Mr C P Srivastava; joint Conference Presidents are Rear Admiral D W Haslam, CB, OBE, FRICS, Hydrographer of the Navy, and Rear Admiral J C Kreffer, President of The Hydrographic Society and former Hydrographer of the Royal Netherlands Navy.

Eight individual Conference sessions covering all economic, political and technical aspects of contemporary hydrography are scheduled, with papers being presented by leading international figures from Brunei, Canada, Finland, France, India, Ireland, Netherlands, Spain, Sweden, Thailand, UK and USA. The proceedings are being supported by an exhibition attended by major European and North American companies and organizations, including the US Defense Mapping Agency and the UK Ministry of Defence Hydrographic Department.

Organized at the request of The International Federation of Surveyors (FIG), the Conference follows the highly successful inaugural IHTC held in Ottawa in 1979. Further details are available from Vortex, 2 Chute Lodge, Chute Forest, Near Andover, SP11 9DG, UK (Tel: 026 470 777).

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The Largest Tides in the World

By Lung-fa Ku

Canadian Hydrographic Service

Introduction

The periodic variation of the tides of individual sites can be resolved into many components which are known as tidal constituents. Among them, O_1, P_1 and K_1 are the strongest in the diurnal frequency band, and N_2, M_2 and S_2 in the semi-diurnal frequency band. The maximum tidal range can be approximated by twice the sum of these constituents.

The amplitude and phase of the tidal constituents, obtained at many places around the world by various agencies in different countries, are collected by the International Hydrographic Organization (IHO) and archived in a computerized data bank by the Department of Fisheries and Oceans, Canada. From these data, areas have been identified where the five "largest tides in the world" occur twice. The selection of these sites are based separately on twice the sum of O_1, P_1 and K_1, the sum of N_2, M_2 and S_2, and twice the sum of all six constituents. The results are shown in Table 1 to 3, and the locations in Figure 1.

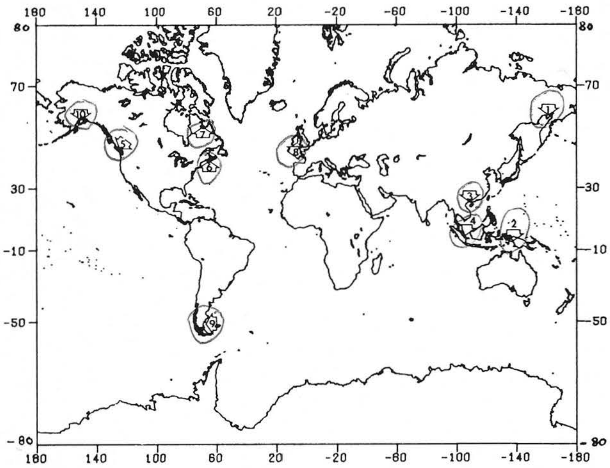

Figure 1: Locations of the largest tides in the world (1) Cap Astronomicheski (2) River Digoel (3) Pak-hoi (4) Muntok (5) Whaletown Bay (6) Cobequid Bay (7) Leaf Basin (8) Breachley Pier (9) Santa Craig (10) Anchorage

Table 1.
Semi-diurnal tides (meter/degree)
(The phase lag is with respect to GMT

Station Name (Latitude, Longitude)	O1	P1	K1	RANGE
Cap Astronomicheski (62°23'N, 164°30'E)	1.55/135	.84/167	2.52/168	9.82
River Digoel (entrance) (7°07'S, 138°45'E)	1.14/258	.43/295	1.30/295	5.74
Pak-hoi (21°29'N, 109°06'E)	1.13/300	.34/328	1.03/328	5.00
Mutok (2°05'S, 105°10'E)	.58/344	.28/310	.94/48	3.60
Whaletown Bay (50°06'N, 125°03'W)	.51/266	.31/288	.93/288	3.50

Table 2.
Semi—diurnal tides (meter/degree)
(The phase lag is with respect to GMT)

Station Name (Latitude, Longitude)	N2	M2	S2	RANGE
Cobequid Bay	1.06/105	6.12/129	.86/187	16.08
Leaf Basin (58°44'N, 69°50'W)	.92/35	4.33/36	1.37/104	13.24
Beachley Pier (51°37'N, 2°39'W)	.53/245	4.43/195	1.43/245	13.00
Santa Cruz, Punta Reparo (50°01'S, 68°31'W)	.99/33	3.90/60	.97/116	11.72
Anchorage Knik Arm (61°14'N, 149°55'W)	.60/75	3.58/106	.96/152	10.28

Table 3.
The sum of diurnal and semi-diurnal tides

Station Name	Sum (1)	Sum (2)	RANGE
Cobequid Bay	.38	8.04	16.84
Leaf Basin	.32	6.62	13.88
Cap Astronomicheski	4.91	1.86	13.54
Beachley Pier	.16	6.50	13.32
Santa Cruz, Punta Reparao	.57	5.86	12.86

Diurnal Tide

The largest diurnal tide is found at Cap Astronomicheski, at the head of the Gulf of Penzkinskaya, the Sea of Okhotsk, USSR. The sum of the diurnal tidal constituents at this site is 4.91 m. The amplitude of K_1 is .4 m on the east coast of Kamchatka and decreases to .3 m along the Kuril Islands, the north coast of Hokaido and the east coast of Sakhaein. It increases to .5 m along the north coast of the Sea of Okhotsk. The large increase in amplitude starts at the entrance of the Bay of Shelikhova and reaches its maximum of 2.52 m at Cap Astronomicheski. This large increase is due to the resonance of the diurnal tide with the natural oscillation of the Sea of Okhotsk which has a period of about 24 hours (Defant, 1961). The configuration of the Sea of Okhotsk system is similar to the Gulf of Maine and Bay of Fundy system except that the former is fenced at its entrance by the Kuril Islands. The change of K_1 in the former system is similar to that of M_2 in the latter system.

The second largest diurnal tide is found at the entrance of the River Digoel, on the south coast of Irian Jaya, Arafura Sea. The sum of the diurnal tidal constituents is 2.87 m. The amplitude of K_1 is generally less than .5 m in the Arafura Sea and its adjacent waters. The large increase in the amplitude starts from .4 m near the entrance of the Arafura Sea between the Aru Islands and Irian Jaya, and reaches its maximum of 1.30 m at the entrance of the River Digoel.

The third largest diurnal tide is found at Pak-hoi (Pei-hai) at the head of the Gulf of Tongking. The sum of the diurnal tide is 2.50 m. The K_1 tide in the Gulf is driven by an anti-clockwise amphidromic system centred near its entrance, and the amplitude increases northward along the coast-line and reaches its maximum of 1.03 at Pak-hoi.

The fourth largest diurnal tide is found at Muntok at the northern entrance of the Strait of Bangka, Java Sea. The sum of the diurnal tidal constituents is 1.80 m. The amplitude of K_1 increases from .4 m in the southern end of the South China Sea to .7 near Indonesian Archipelago, and .9 m in the Strait of Bangka.

The fifth largest diurnal tide is found in Whaletown Bay, Strait of Georgia. The sum of the diurnal tidal constituents is 1.75 m which is only slightly less than that found at Muntok. The amplitude of K_1 is about .4 m at the entrances of Juan de Fuca Strait and Queen Charlotte Strait, and then gradually increases to .95 m in Whaletown Bay.

Semi-Diurnal Tide

The tide in the Bay of Fundy is well-known to be the largest range in the world. The recent data indicate that the largest range is found in Cobequid Bay where the sum of the semi-diurnal tidal constituents is 8.04 m. The amplitude of M_2 increases from .5 m along the edge of the continental shelf near the entrance of the Gulf of Maine to 6.12 m in Cobequid Bay. This large amplification is attributed to the resonance of the tide with the natural oscillation of the Gulf of Maine and the Bay of Fundy system which has a period of 12.98 hours (Garrett, 1974). As in the Sea of Okhotsh, the amplitude of M_2 in the Gulf of Maine remains small, and the large increase starts near the entrance of the Bay of Fundy and becomes intensified toward the head of the Bay.

The second largest semi-diurnal tide is found at Leaf Basin, Ungava Bay near the entrance to Hudson Strait. The sum of the semi-diurnal tide is 6.62 m. The amplitude of M_2 is nearly 2 m at the entrance of Hudson Strait. This large amplitude is due to the natural resonant frequency of Ungava Bay being very nearly the same as the 12.8 hours (Platzman, 1975) ascillattion of the Atlantic Ocean. The large tide at the entrance generates a larger tide in the adjacent waters: 3.45 m at Frobisher Bay, 3.50 m at Lake Harbour in Hudson Strait, and 4.33 m in Leaf Basin.

The same resonance affect produces the third largest semi-diurnal tide. On the other side of the North Atlantic Ocean. At Breachley Pier, Bristol, at the head of Bristol Channel, the sum of the semi-diurnal tidal constituents is 6.5 m. The amplitude of M_2 is 1.2 m along the edge of the continental shelf, and increases to 3.14 m at Heysham in Morecamble Bay, Irish Sea, 3.69 m at Saint-Servan in the Gulf of St. Malo, English Channel, 4.17 m at Breachley Pier, and 4.43 m at Weston-Super-Mare in the same vicinity.

The fourth largest semi-diurnal tidal constituents is found at Santa Craig, at the head of Grand Bay, Argentina. The sum of the semi-diurnal tidal constituents is 5.86 m. The amplitude of M_2 is over 2 metres along the coast of Grand Bay and the maximum is 3.93 m at Ria Coig which is only slightly larger than 3.90 m found at Santa Cruz. This large amplitude is attributed to the resonance of the tide with the natural oscillation of the continental shelf which has a period of about 10.4 hours (Webb, 1976).

The fifth largest semi-diurnal tide is found at Anchorage, Knik Arm, in Cook Inlet, Alaska. The sum of the semi-diurnal tides is 5.14 m. The amplitude of M_2 increases from .95 at Kodiak outside the entrance of Cook Inlet to 2.21 m at Seldovia at the entrance and 3.58 m at Anchorage.

Total Tide Range

The five largest overall tidal ranges are given in Table 3. Except at Cap Artornomicheski, the tide at all other stations is semi-diurnal. Therefore, the most noticeable change in the tidal range is in the large tide near the time of full moon and new moon, and when the moon is near its perigee. These will be followed by a smaller tide during the quarter-moon and when the moon is in apogee.

At Cap Astronomicheski, the tide is mixed. It is predominantly diurnal when the moon is at its highest or lowest declination, and changes to semi-diurnal when the moon is on the equator. These changes are illustrated in the predicted tides shown in Figure 2.

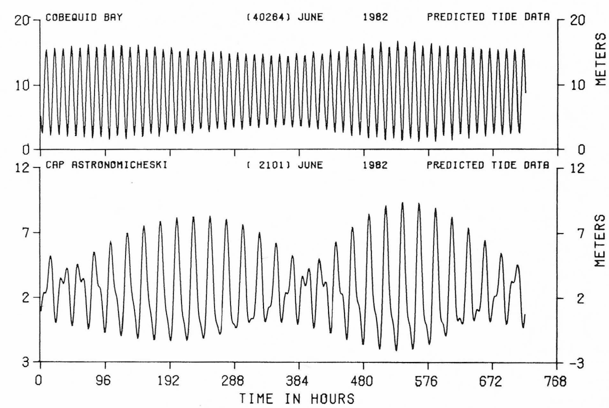

Figure 2: Tidal curves for Cobequid Bay (semi-diurnal) and Cap Astronomicheski (diurnal)

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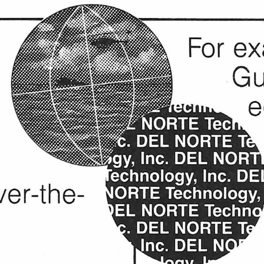

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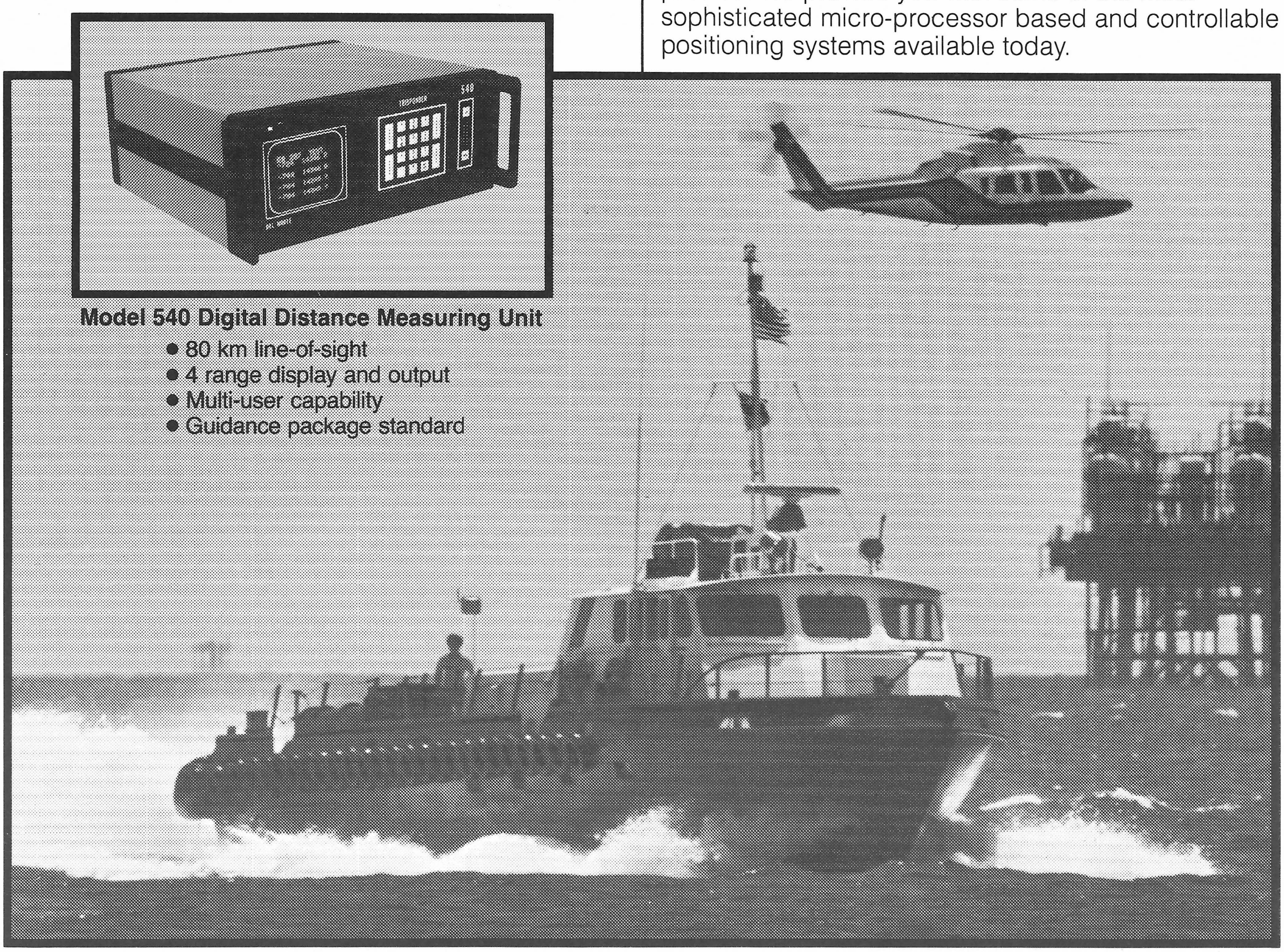

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Canadian Data Report of Hydrography and Ocean Sciences No.

April 1984

Field Testing of the Hewlett-Packard 7914 Winchester Disk Aboard C.S.S. Baffin

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Abstract

This report details the field tests of the H.P. 7914 disk drive conducted aboard C.S.S. *Baffin* from November 3 to 26, 1983. An H.P. 9836 computer was interfaced via the Hewlett Packard Interface Bus to the disk drive for the test. An H.P. printer was used to log any track errors or disk errors that occurred during the exercise period, and a pendulum device was used to monitor the motion of the ship. The results were portrayed on a Brush recorder. The disk survived a force of 1.35 times gravity in sway, 1.1 times gravity in heave, 0.7 times gravity in pitch, and equal to gravity in roll on November 26, 1983, possibly the worst weather of the cruise. Over the 23 day period of the operation, only one track error was recorded.

Sommaire

Ce rapport décrit des tests effectués sur l'unité de disque 7914 de Hewlett-Packard à bord du N.S.C. *Baffin* du 3 au 26 novembre 1983. L'unité de disque était alors reliée à un ordinateur H.P. 9836 au moyen d'un module d'interface de Hewlett-Packard. Une imprimante H.P. notait les erreurs de disque ou de piste durant cette période t'essai et un pendule d'enregistrement en continu Brush permettait d'illustrer les résultats. L'unité de disque fonctionna adéquatement lorsque soumis à une force équivalent 1.35 fois la force gravitationelle pour le mouvement latéral, 1.1 fois pour le soulèvement, 0.7 fois pour le torquage et égale à celle-ci pour le roulis le 26 novembre, probablement la journée des pires conditions météorologiques du voyage. Une seuls erreur de piste fut enregistrée durant la période de 23 jours.

The Bedford Institute of Oceanography utilizes an H.P. 1000 system on most of its research and survey vessels. Disks now in use are the H.P. 7900 and 7906, both of which have successfully tolerated the rigours of the marine environment. With the advent of larger capacity Winchester disks, the probability of disk crashes seemed to be higher since the heads would be floating closer to the disk surface. This raised questions about the Winchester's capability to function properly on a sea-going vessel. Consequently, the tests described here were performed.

Procedures

The C.S.S. *Baffin* ran lines from the southern coast of Nova Scotia to Georges Bank, well into the Gulf Stream. The disk was strapped to a large drafting table without shock mounts in order to maximize both the shock and vibration it would experience. An HP 9836 computer was interfaced via the H.P. Interface Bus to the disk drive (see Fig. 1). Test software was provided by Hewlett-Packard, and

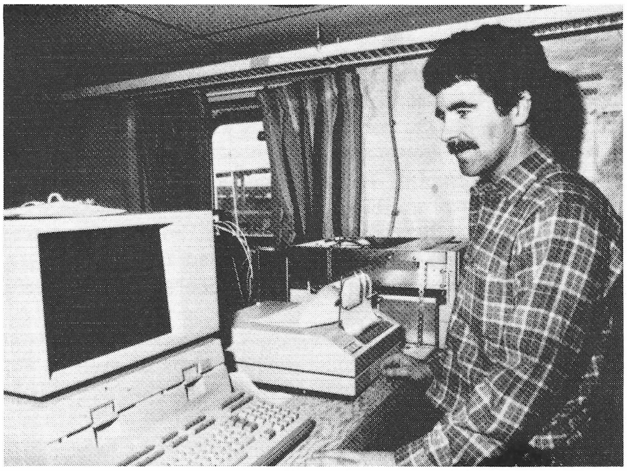


Figure 1

these programs were run all day throughout the cruise except for periodic shutdowns to run diagonistic software. These shutdowns were implemented during heavy seas when the ship underwent rolls of up to 25° and pitches of up to 15°. The motion of the ship was monitored by a pendulum device set up by D. McKeown and

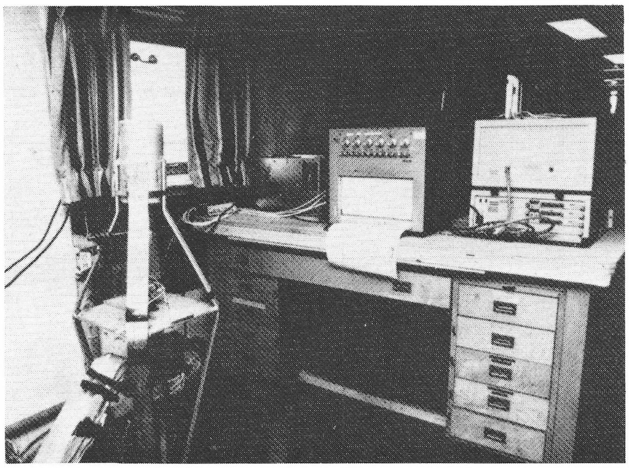


Figure 2

J. Dessureault (see Fig. 2). The software provided (program Write/Read) wrote 100 sectors onto the disk and then read the 100 sectors in a verification process. Any errors were reported on the H.P. printer. The other program "exercised" the disk by creating seeks (seeking between cylinders), which caused the head to move vigorously. This program was implemented when the ship was in rough seas. Shutdowns were also executed under these conditions in order for the head to return to the landing area of the disk. The disk drive was then immediately started up to see if it would come up to its optimum r.p.m. in spite of the ship's heave, roll, and vibration. The diagnostic programs were then run to show that the disk was operating at 100% efficiency. The Hewlett-Packard routines were implemented in order to check if the disk had any track errors. The controller circuitry in the Hewlett-Packard 7914 can "heal" disk damage to a certain extent. The controller sends the head over the whole disk surface when the disk starts up. In this process, it finds flawed sectors where data cannot be stored reliably, marks them so that future data will not be stored there, and moves endangered data to safer locations. This is done by writing endangered data on spare tracks. The H.P. 7914 has eight tracks that are used for effective track allocation and two that are used for maintenance tracks. In addition, it has two tracks reserved for future use.

Results

One track error actually did occur on November 25, 1983. The weather was extremely bad — waves up to 6 m high and winds gusting to 70 km/h. The exerciser routine was run 255 times with a "full volume read only test". On November 26, 1983, the last day of the cruise, the "exerciser" terminated and the printer output signified that an area of the disk was found where the media were damaged or faulty (no status bits were set). The Write/Read program was run and no status errors were printed. This implied that a bad track had occurred and had been reallocated to the spare tracks.

The reliability specified by most manufacturers is given as the M.T.B.F. (mean time between failure). This is an average of how long a hard drive is rated to run without breaking down. It is developed by taking the time of failure of components in a finite period and statistically weighting these times according to standard well-developed formulae. The M.T.B.F. for the hard disk is typically more than 10,000 hours of operation. This would give the H.P. or 7914 more than a year of 24 hour-a-day operation between breakdowns. On the *Baffin* these tests were performed for a period of only 578 hours. However, the conditions were far from ideal: out of

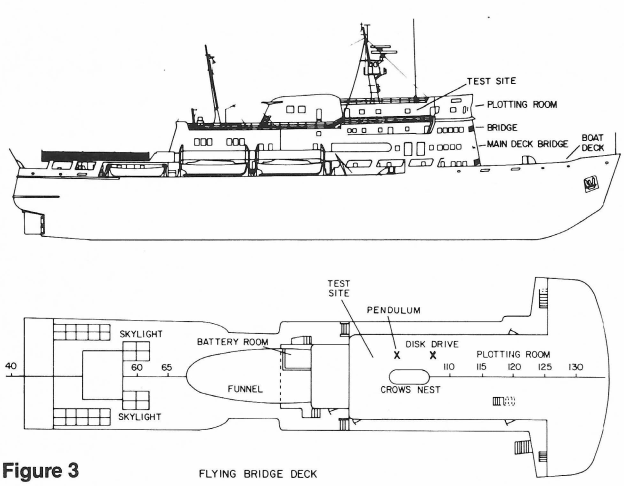


Figure 3

23 days, only four were considered calm and on the others severe electrical storms occured, winds gusted 50 to 70 km/hand sea heights were up to 6 m, causing the ship to be pitched up to 15°

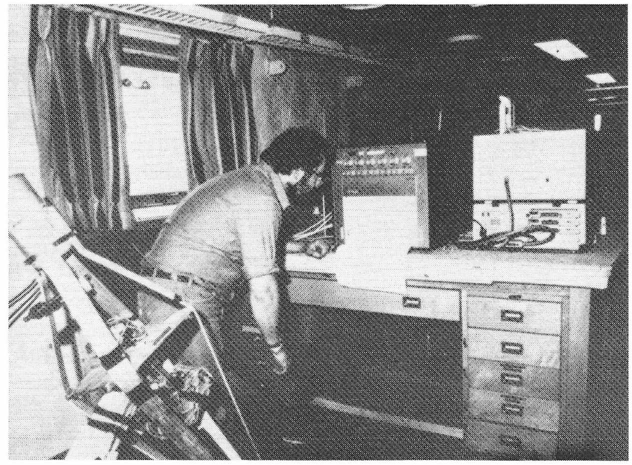


Figure 4

and rolled up to 28°. The plotting room was maintained at a constant 22° C. The H.P. 7914 was situated in the aft end of the plotting room beside the base of the mast (see Fig. 3). This position sub-

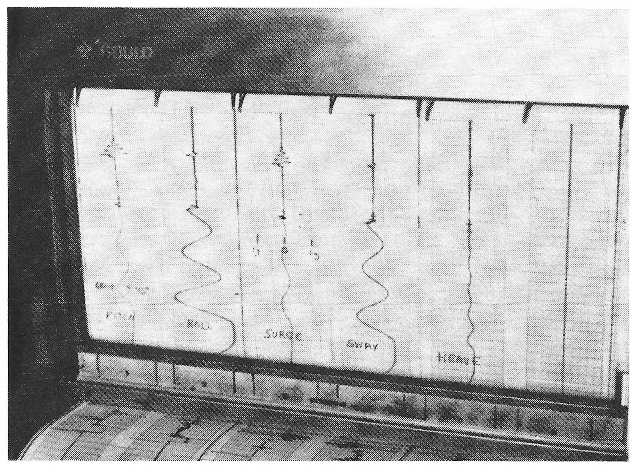


Figure 5

jected it to maximum motion and acceleration. These accelerations were monitored by a pendulum device, which gave readings of surge, sway, heave, pitch, and roll (see Fig. 4). (The roll accelerometer began to malfunction after 424 hours of operation).

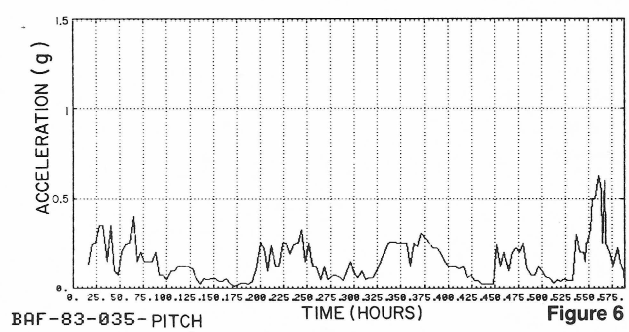


Figure 6

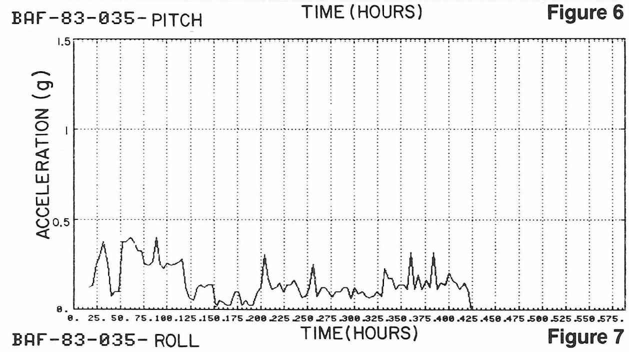
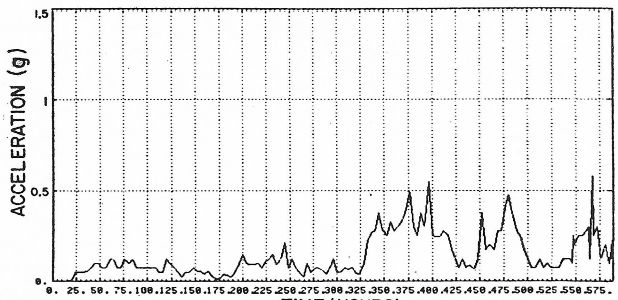
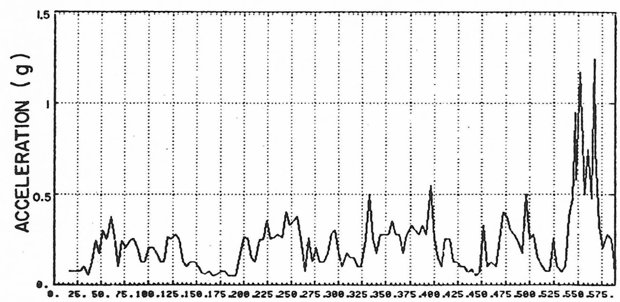


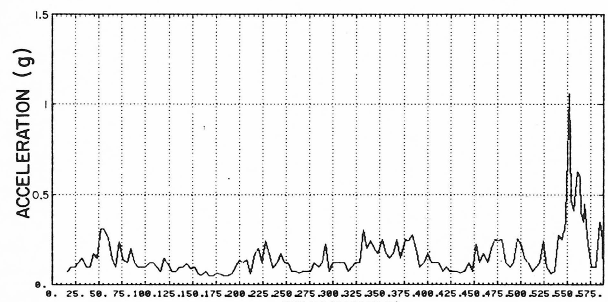
Figure 7



BAF-83-035- SURGE TIME (HOURS) **Figure 8**



BAF-83-035- SWAY TIME (HOURS) **Figure 9**



BAF-83-035- HEAVE TIME (HOURS) **Figure 10**

The readings on the brush recorder were calibrated at 0.25 the force of gravity per division. The disk survived up to 1.35 times gravity (g) in sway, 1.1 times g in heave, 0.50 times g in surge, and 0.7 times g in pitch (Figs. 6, to 10). The graphs depict the absolute value of the accelerations aboard the vessel, sampled every 4 h during the cruise. The roll acceleration could not be determined accurately since the roll accelerometer periodically malfunctioned. Since the rolls on the *Baffin* were monitored at 28° and the pitch at 15°, it can be roughly estimated that the maximum roll acceleration was well above the force of gravity.

Due to weather conditions the ship was hove to on three separate occasions, and the Hewlett-Packard 7900 and 7906 disk drives were shut down on the general purpose computer to minimize the possibility of a disk crash. It was under these conditions that the Hewlett-Packard 7914 was performing its exercise routines.

In conclusion, we have determined that the H.P. 7914 is a sturdy, reliable drive housed in one package (i.e., it has no external controller). It can be interfaced via the H.P. Interface Bus and has internal testing capabilities.

The H.P. 7914 disk has a storage capacity of 132 megabytes in comparison to the 5 and 20 megabyte H.P. 7900 and 7906 disks currently in use. This certainly will facilitate managing and processing the increasing digital data we collect.

There are several other conditions under which the disk should also be checked: its performance on a small vessel (i.e. C.S.S. *Maxwell*), its ability to function on a vessel traversing ice-infested waters, and also the effect on it of airguns firing on a cruise. These conditions have plagued various instruments aboard ships — for example, vibration loosened circuit boards out of their sockets on *Maxwell* during heavy seas. Lastly, although the drive was subjected to tests under extreme conditions, it was only for a period of 578 hours. It would be interesting to see its performance over a longer period of time on a smaller vessel.

Appendix A
Specifications of the H.P. 7914

The H.P. 7914A, a mass storage subsystem offering 132 megabytes of Winchester disk storage, is rated to: withstand 11 ms half-wave sine-shock with a peak amplitude of twice the force of gravity in any direction during operation; withstand a vibration of up to 0.25 the force of gravity in any direction; operate reliably between 10 and 40°c; withstand humidities of 20% to 80% with a maximum of 0.015 lb. of water per pound of dry non-condensing air. These rated specifications were tested during *Baffin* cruise 83-035.

Disc Performance	
Average Controller throughput time:	9.4 ms
Average seek time	27.4 ms
Average delay	8.3 ms
Average time to transfer 1 kilobyte	1.0 ms
Total average transaction time (excluding System Overhead)	46.4 ms
Maximum disc transactions per second, for 1 kilobyte transfer less overhead.	21.5 ms

Overall Characteristics:
Heat dissipation 925 Watts (3157 Btu/hr)
Electromagnetic emissions
Radiated and conducted interfaces
7914TD — for U.S.A. designed to meet FCC docket 20780 for Class A Computing devices

7914TD — For European designed to meet VDE0871 for Level A computing devices.

FTZ licensed on same H.P. systems.

Dimensions
Height = 311 mm (12.25 in.)
Front Panel Width = 482 mm (19.0 in.)
Width (Behind Front Panel) = 451 mm (17.75 in.)
Depth (Behind Front Panel) = 705 mm (27.8 in.)
Depth (Overall) = 752 mm (29.6 in.)
Net Weight = 67.2 kg (148 lb.)

Appendix B
Maintenance in the Field

All the control and Read/Write interface boards are easily accessible, which facilitates direct board replacement. Serviceability of the H.P. 7914 is enhanced by an extensive self-diagnostic capability resident in the controller. Troubleshooting of intermittent failures is facilitated by an error logging capability, which allows trained service personnel to detect failure patterns over time. In addition, an error-correction integrated-circuit corrects data errors in real time, without any degradation in the data transfer rates.

At sea, the hardest item to service is the sealed drive unit. There are two chief concerns: (a) the user must worry about the possibility of a fixed-disk failure. If the disk crashes at sea, it can be replaced only by a trained technician working in a sterile environment. Most of the disk problems we encounter are due to soft or hard disk crashes that ruin either the heads or the disk surfaces. It is very seldom that electronic-card failures are encountered. Therefore, it is imperative to have backup Winchester drives on long voyages. (b) the sealed disk would not have as high a likelihood of suffering a soft or hard crash due to a dusty or salty environment as would an ordinary disk. Nevertheless, Hewlett-Packard is also marketing a repair service kit with an enclosed disk to facilitate repairs in remote environments.

Appendix C
A Dissertation on the Winchester Disk

Since 1973, the Winchester drive has been the chief hard disk in use. This was the code name of the 1973 I.B.M. project that yielded the first commercial disk drive. The project name was coined from the fact that the first drive came in a 30+30 megabyte combination of two disks: one was a fixed backup for the first. This reminded someone of a Winchester 30,30 repeating rifle.

The disk drive taken aboard C.S.S. *Baffin* was not of the above vintage; rather it was a single disk system, purporting 132 megabyte storage, with a streaming cartridge system incorporated into the unit. The disk was the Hewlett-Packard 7914 R.

When viewing the top of the Winchester, one does not see much. One shielded box houses the power supply which transfers the line current into the low voltage which the drive requires. This supply is enclosed to reduce shock hazard and to shield the rest of the system from stray currents. Nearby are printed circuit boards which consist of the drive controller (the intelligence of the drive) and the disk motor controller (the heart of the drive). The disk itself, with its associated read/write head mechanisms is sealed in another housing.

The streaming cartridge system of the disk requires two tapes to back up the entire disk. These systems are called "streaming tape drives", or simply "streamers" because they read data in a continuous stream from a disk. Since these streaming tape drives lack block identifiers, data are stored on the tape in one large chunk. The computer cannot go to the tape drive and find a specific piece of information. It is, therefore, necessary to reload the data onto the disk and instruct the disk controller to locate the information one is looking for. Since the streamer will be used for archiving and backup, the relative inaccessibility is not a real problem. For selective backup there are software techniques (i.e. "Reader/Saver") which will copy specific files onto magnetic tape. These types of backup procedures will probably be used more often in lieu of the streaming option due to the time (two hours) involved to back-up an entire disk. Not only will this capability speed up the backup procedure, but it will also organize the files which in turn will facilitate recovery from magnetic tapes.

In previous years, when using H.P. 7900 and 7906 drives, one had to wait for the computer and disk driver to communicate with each other and to transfer data back and forth. One also had to handle the disk carefully to prevent damage especially since one often shuffled them in and out of the respective disk drives, going from one set of data to another. More importantly, one had to break large data files into separate disks because one disk could not handle all the information that had to be manipulated, especially in the realm of bathymetry where it is possible to collect up to half a million soundings in one year alone. With the advent of the sweep system, this volume will be increased substantially. The storage capacity of the Hewlett-Packard 7914 R gives the user the capability to handle a great amount of data with speed and efficiency which opens up new vistas for such applications as large inventory systems, data base management systems, and data analysis applications.

Winchester hard disk assemblies are put together in sterile and dirt free surroundings where even microscopic dust particles cannot get on the disk surface. The air gets into the disk's sealed housing via a special filter that maintains the clean room conditions inside the disk head assembly. This practically dirt free environment is required to keep the drive from damaging itself in operation. The Winchester drive uses a Read/Write head to record data onto the particle coating by selectively magnetizing these particles. A reversal of this process lets the head read the data which the drive then amplifies and sends to the computer. The physical phenomenon which is the basis of these operations is called magnetic induction. It is an inherently weak process, thus the smaller the distance involved between head and platter, the better it works. The platter itself is rotating at approximately 3600 r.p.m. To allow these speeds, the head must be lifted up off the surface of the disk a miniscule amount. To move the head this microscopic distance above the disk surface, the head is carried on a little wing. As the disk spins, friction between the disk surface and the air around it drags the air along with the disk. The air, passing over the wing on which the head is mounted, causes the aerodynamic lift, making the head actually fly over the disk. During Read/Write seek operation, the Winchester head flies over the surface on an air cushion supported by carefully balanced aerodynamic forces. As the disk starts or stops, the head takes off or lands in a silicone lubricated landing area. When the disk is not spinning, the head rests on, and actually contacts the landing zone on the disk. An ultra-fine coating is used to fill in the minute valleys in the coasting for aerodynamic perfection. The problems that plague Winchester disks, and the reasons why they are assembled in a clean environment is that, at the speeds and clearances involved, a speck of dust would smack the Read/Write head like a pebble hitting the windshield of a car moving at 100 m.p.h. This would cause minute damage to the head. A series of these soft crashes would ultimately lead to a hard disk crash. Since Winchester disks operate in a sealed environment the sealed design makes the disk almost indifferent to the external environment. Therefore it is virtually impossible for contamination to get into the sealed compartment and these disks do not need to be cleaned.

Winchesters do not like thermal extremes. If the temperature inside the drive housing gets significantly high, the heat can damage the drive's electronics. Therefore, all Winchesters have heat sink units or large masses of metal that transfer heat to the ambient air.

Utilization of Doppler — Inertial Techniques for the Establishment of Survey Control for Hydrography

by

J. F. McLellan
G. H. Eaton
K. W. Schuurman

Abstract:
In February, 1983, McElhanney Surveying and Engineering Ltd. was contracted to the Canadian Hydrographic Service to establish 17 shore control stations for a planned hydrographic survey off the Yukon Coast, west of Herschel Island to the Alaska border. Due to the adverse weather conditions, which are predominant during March, it was decided that a combination of Doppler and Inertial Survey techniques would be the most expedient way to complete the survey. This was the first time the Canadian Hydrographic Service had utilized inertial surveying techniques for establishing shore control.

The framework for the survey was established using 5 Magnavox MX 1502 Geoceivers. The inertial survey was then completed using a Litton Auto Surveyor Dash II mounted in a Jet Ranger 206 B helicopter. The survey operations are described and the results are presented.

1.0 Introduction
Sparse sounding data exists in the Beaufort Sea between Herschel Island and the Yukon-Alaska Boundary. Knowledge of the ocean floor has come from track soundings provided by vessels entering and leaving the Beaufort Sea and spot soundings taken through the ice by the Canadian Hydrographic Service. Discoveries of oil and gas, in the Beaufort Sea Area, have emphasized the need for hydrographic surveys to modern standards.

The primary purpose of a planned hydrographic survey in this area was to produce charts aiding safe navigation of deep draft vessels. It is also interesting to note that jurisdiction over an area of the continental shelf at the junction of the U.S. and Canada is still in question.

2.0 Survey Control Requirements
The scale of the hydrographic survey, in this case 1:100,000, dictates the accuracy at which survey vessels must be positioned while obtaining soundings. Included in the CHS inventory is a Cubic Western ARGO system that will provide multi-range fixing adequate for this scale. A chain (Figure 1) with stations located on Herschel Island, the Yukon/Alaska Border and near Komakuk Beach would ensure good positioning throughout the survey area except where position line intersections are poor along the coast. An X-Band Del-Norte Trisponder system was to be used for this inshore work as well as for calibrating the ARGO system. Trisponder sites (Figure 1), were selected along the coast and on mountain tops near the shore with sufficient density to fill any holes left with ARGO.

Coordinates, an order of magnitude better than the survey vessel's fixing requirements, are desired for the positioning system's antenna sites. Unless the control is in the order of 1-2 metres in accuracy, the ARGO system will start detecting network distor-

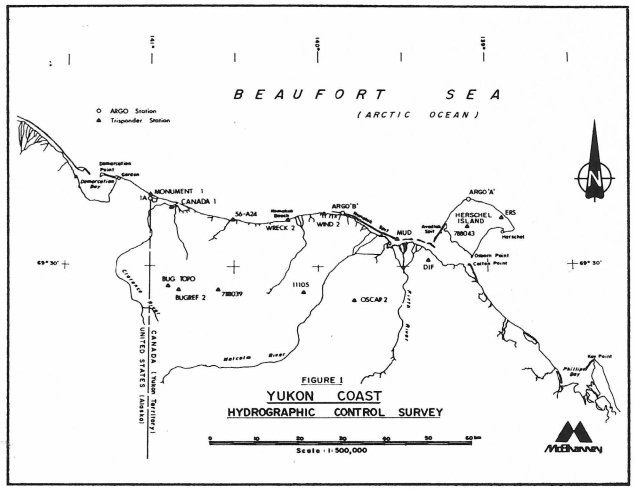
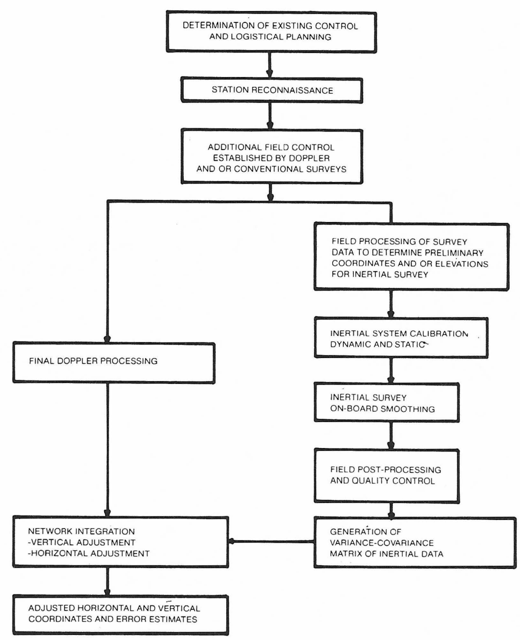


Figure 1

tions. Problems of this sort are often difficult to resolve and are a time consuming nuisance during sounding operations. For these reasons, along with the harsh March environment found at these



Inertial Survey Flowchart

Figure 2

latitudes, a combination of Doppler satellite and inertial techniques were chosen to establish an adequate control network. Figure 2 is a flow chart of how the Doppler-Inertial Survey was carried out.

Five Magnavox MX 1502 Satellite Receivers were used to establish coordinates for the stations where ARGO towers were erected. The trisponder stations were surveyed using the Litton Auto Surveyor Dash II.

3.0 Field Operations

3.1 Monumentation
In any extensive survey which incorporates a control framework, monuments have to be established to preserve the control net and enable subsequent surveys to be related to it accurately, reliably and conveniently.

A joint effort was made by McElhanney and CHS personnel to locate and utilize existing monumentation where possible. New monuments established consisted of an aluminum alloy cap mounted on a one metre aluminum alloy rod specially designed for use in permafrost.

It was a major task to install permanent monuments in the permafrost. A HILTI drill with a 1¼ inch auger and a 1000 w Honda generator were used to drill required holes. Favourable results in placing monuments were obtained with this drill.

3.2 Doppler
Following site selection and monumentation, Doppler satellite observations commenced. Before initial deployment, the receiver's oscillator had been warming for at least 48 hours. The MX 1502 is designed for unattended operation in the field so that the only tasks required of the operator were site initialization and site completion. Prior to collecting data at each site, a self-test was performed on the receiver. Malfunctions, if any, were detected by the receiver. The initial coordinates, receiver serial number, antenna height, etc. were entered into the receiver and recorded on the cassette. Before leaving the station, it was ensured that at least one pass had been tracked and recorded by the receiver.

Temperatures below -40°C were common during March, thereby creating problems for batteries and equipment. The standard MX 1502 transit case was used on site with pieces of 2 inch styrofoam inserted between the unit and the packing foam to provide insulation. The power and antenna cables were fed through a small hole in the side of the transit case. In addition to the insulation, 30 watt global generators were used with the MX 1502's to provide heat and to also keep the two 12 volt (90 amp) lead acid batteries charged. A wind break was then placed over the entire transit case, batteries and global generator. These measures generally prevented the MX 1502 temperature from falling below -20°C, thereby allowing successful operation of the equipment in this environment.

Using the MX 1502 Doppler Satellite receiver and micro-processor, majority voting of orbital data is done on a pass by pass basis and stored on the data cassette. On-site point positioning three dimensional coordinate computations were carried out for each station.

4.0 Inertial

4.1 Introduction to Dash II System
The inertial positioning system is envisaged by surveyors as the "black box" in that it will instantaneously provide position when set down at any point on the earth's surface. It requires no line of sight clearance, no towers, and is unaffected by refraction and other atmospheric conditions. It can be operated day or night during hot or cold weather, rain or shine, and with the speed of a motor vehicle or a helicopter. It must be realized that an inertial system is the product of a very highly advanced aerospace technology and as such, it requires well-trained personnel to operate and, more importantly, to service it. To obtain results and to utilize the full potential of the system, very careful pre-planning and execution of the survey within well defined guidelines is necessary.

The six major components of the Litton Auto Surveyor Dash II are:

1. Inertial Measuring Unit (IMU)
2. Control and Display Unit (CDU)
3. Computer
4. Power Supply (PS)
5. Digital Tape Recorder System (DTS)
6. Mounting Base

The mounting base is a rack which allows for the attachment of all units of the DASH II system (See Figure 3). The entire assembly is called the Primary Pallet and weighs 106 kg. The system in its shipping case weighs 187 kg.

LITTON AUTO-SURVEYOR™ SYSTEM II
Litton

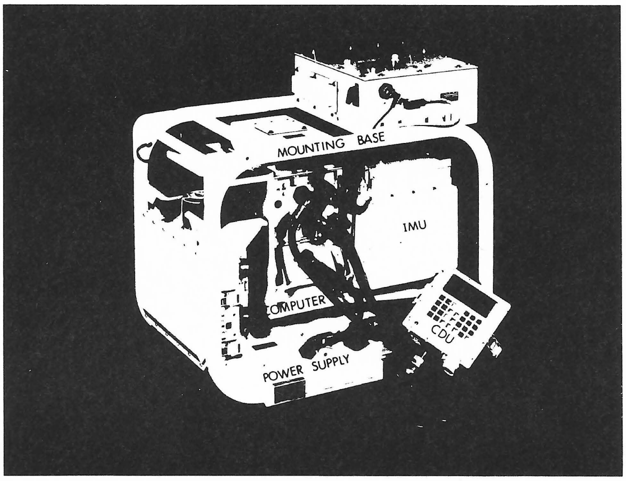


Figure 3

4.2 Field Operations
Prior to the commencement of the inertial survey, a reconnaissance of the entire survey network was made. Where possible, existing monuments were utilized and where necessary, new ones were established. All the stations were marked, flagged, photo identified and plotted on 1:50,000 and 1:250,000 topographical maps. A waypoint tape was then made using scaled coordinates. This waypoint tape was used during the inertial operations to allow the helicopter pilot to fly the most direct route between two stations.

The inertial system was calibrated at the start of the job since system variables are subject to minor changes which may affect the survey accuracy. These variables include aging effects, gyro constants, accelerometer biases and scale factors, quantizer characteristics, and analog-to-digital converter outputs. The calibration procedure is a technique to determine and alter, if necessary, the system constants such that system performance is optimized. Both static and dynamic calibrations were performed. The static calibration verified the accuracy of the gyro and accelerometer biasing and operation. This procedure took approximately three hours. The values obtained from the static calibration were compared with those previously stored in the system. A calibration tape was made after completing the static calibration.

Table 1
Coordinate List

Station	Latitude	Longitude	Elevation	Description
ARGO-A	69 38 08.167	−139 08 01.049	49.03	MSEL Doppler
ARGO-B	69 35 50.054	−139 46 59.383	8.64	MSEL Doppler
BUG-REF2	69 28 40.798	−140 50 25.214	455.49	MSEL Doppler
BUG-REF2	69 28 40.844	−140 50 26.561		Published
	DEL = 0.046″	DEL =−1.347″		
BUG-TOPO	69 28 37.818	−140 54 48.770	443.08	Smooth # 1
BUG-TOPO	69 28 37.839	−140 54 48.759	443.22	Smooth #2
	37.826	48.765	443.15	Mean
BUG-TOPO	69 28 27.836	−140 54 50.142	439.27	GSC Doppler
	DEL = 0.007″	DEL = 1.377″		
Canada 1	69 37 54.171	−140 50 37.642	10.66	Smooth # 1
Canada 1	69 37 54.141	−140 50 37.687	10.88	Smooth # 2
Canada 1	69 37 54.170	−140 50 37.672	10.87	Smooth # 3
	54.161	37.667	10.80	Mean
Canada 1	69 37 54.210	−140 50 39.099		Published
	DEL = 0.049″	DEL =−1.432″		
DIF	69 30 21.325	−139 17 38.573	32.29	Smooth # 1
DIF	69 30 21.358	−139 17 38.636	31.22	Smooth #2
	21.342	38.604	32.76	Mean
11105	69 29 36.270	−140 06 55.661	632.59	Smooth # 1
11105	69 29 36.338	−140 06 55.699	632.24	Smooth # 2
	36.304	55.680	632.42	Mean
788043	69 35 21.871	−139 07 48.372	178.05	Smooth # 1
788043	69 35 21.888	−139 07 48.349	177.33	Smooth # 2
	21.880	48.361	177.69	Mean
788043	69 35 22.031	−139 07 49.468	177.16	Published
	DEL = 0.151″	DEL =−1.107″		
56-A24	69 35 50.011	−140 30 31.374	12.78	Smooth # 1
56-A24	69 35 49.991	−140 30 31.357	13.43	Smooth # 2
56-A24	69 35 49.973	−140 30 31.441	12.96	Smooth # 3
	49.992	31.391	13.06	Mean
56-A24	69 35 50.051	−140 30 32.770	10.64	Published
	DEL = 0.059″	DEL =−1.379″		
MON-1A	69 38 45.584	−140 59 51.043	8.96	MSEL Doppler
MON-1A	69 38 45.598	−140 59 52.575		Published
	DEL =0.014″	DEL =−1.532″		
MUD	69 33 39.727	−139 33 56.191	6.76	Smooth # 1
MUD	69 33 39.707	−139 33 56.314	7.02	Smooth # 2
	39.717	56.253	6.89	Mean
MUD	69 33 39.866	−139 33 57.410	4.87	Published
OSCAR2	69 26 20.831	−139 47 08.899	587.49	Smooth # 1
OSCAR2	69 26 20.907	−139 47 08.986	586.66	Smooth # 2
	20.869	08.943	587.08	Mean
OSCAR (A-24)	69 26 20.901	−139 47 09.855	584.60	Published
788039	69 29 05.369	−140 34 40.220	590.09	Smooth # 1
788039	69 29 05.429	−140 34 40.208	589.57	Smooth # 2
	05.399	40.214	589.73	Mean
788039	69 29 05.442	−140 34 41.577	586.05	Published
	DEL = 0.043″	DEL =−1.363″		
TUNDRA	69 35 23.976	−140 58 30.891	31.83	Smooth # 1
TUNDRA	69 35 23.977	−140 58 30.888	32.00	Smooth # 2
	23.977	30.890	31.92	Mean
TUNDRA	69 35 23.988	−140 58 32.416	28.35	Published
	DEL = 0.011″	DEL =−1.526″		
WIND2	69 36 47.181	−139 55 44.402	4.93	Smooth # 1
WIND2	69 36 47.174	−139 55 44.367	5.15	Smooth # 2
WIND2	69 36 47.132	−139 55 44.338	4.85	Smooth # 3
	47.178	44.369	4.98	Mean
WIND	69 36 47.515	−139 55 52.106		Published
WRECK2	69 35 35.270	−140 12 30.403	8.10	Smooth # 1
WRECK2	69 35 35.278	−140 12 30.405	8.37	Smooth # 2
WRECK2	69 35 35.245	−140 12 30.438	7.78	Smooth # 3
	35.264	30.416	8.08	Mean
WRECK2	69 35 35.363	−140 12 31.745		Published
	DEL = 0.099″	DEL = −1.329″		

Subsequent to the static calibration, a dynamic calibration was performed. This was carried out to check for any changes, such as the alignment and scale factors of the east and north accelerometers and also the vertical accelerometer misalignment. The dynamic calibration consisted of testing the system's performance over a known survey course with north/south and east/west legs which were approximately 10 km long. Each line was surveyed in both directions and the misclosures were recorded. It is to be noted that these runs were completed without an update. If the results show that the system is out of adjustment, then corrections are made to the system accordingly. This will ensure that the real time misclosures will be small and the system can be used to check the fixed station coordinates. The inertial system had just been shipped from the Litton factory prior to the survey, where it had undergone extensive testing and calibration. For this reason no changes were required after the calibration.

A lever arm parameter test was completed prior to the beginning of the survey. The parameters are X, Y, and Z distances from the IMU to the selected lever arms. In the helicopter this consisted of a skid and an antenna. The test was accomplished by centering the lever arm over an arbitrary point on the helipad and reading its coordinates. The helicopter was then turned 180 degrees and the lever arm was again centered over the point and the coordinates read once again. If the coordinates are not the same then corrections must be made to the XYZ offsets and the test repeated.

At the beginning of each day of operation the inertial system required a warm-up and alignment phase. This required 90 minutes at 70° latitude.

Prior to actually starting the inertial survey each day, the system was run between two known survey points approximately 10 km apart. This is done to get the Kalman filter working properly, which ensured more accurate real time results.

The system was then flown to the end point of the line where it was updated. An UPDATE may consist of entering known latitude and longitude, azimuth and elevation. Any one of these values or all three may be entered at an UPDATE. The survey then progressed, periodically performing zero velocity updates (ZUPT) at 3 to 5 minute intervals. The ZUPT's were required to permit improvement of the system performance by providing an accurate measure of the velocity error for the Kalman filter processing.

At each of the survey points measured along the traverse line, a MARK was performed in addition to a ZUPT. A MARK recorded the horizontal and vertical position of the IMU at that point. Traverses were run in both directions to enable a comparison between the runs.

5.0 Processing and Final Results

5.1 Processing Procedures

One of the MX 1502's used on this project was equipped with a translocation board. This allowed the computation of coordinates, accurate 3 to 5 m, in the field office to aid in the inertial survey.

The final processing of the Doppler satellite data was performed on a DEC PDP 11/44 computer using the GEODOP series of programs. All stations were translocated with respect to the geodetic survey station TUK DOPPLER located at the airport in Tuktoyaktuk.

The inertial data recorded on cassette tape during the survey mission was reprocessed using an HP 87 computer. The data was transferred from data cassettes to hard disc and was then recorded on floppy discs for back-up purposes. The HP 87 software allows a change of MARK points to UPDATE points and to also modify the coordinates of the UPDATE points. The offsets of the vehicle reference points relative to the IMU and the measured offsets from the vehicle reference point to the MARK or UPDATE point can also be modified. The data can then be reprocessed and results printed and stored on floppy disc.

Normally, in the case where there would be a network of inertial traverses, they would be adjusted by least squares since this process facilitates the effective removal of certain biases through mathematical modelling. The apriori variance — covariance matrix of the inertial data required by the least squares adjustment is generated by the program ISSPOS. This program was developed by Geodetic Survey of Canada and has been implemented on McElhanney's in-house computers. The smoothed inertial data output by the HP 87 computer would then be transferred to our in-house computer and formatted as input for the horizontal and vertical adjustment programs ADJUST and LEVEL. These two programs output adjusted horizontal and vertical coordinates.

5.2 Final Results

Table 1 shows the results of both the forward and reverse runs in addition to a comparison of the results determined by Doppler and Inertial to previously published values. Although the differences in longitude between the published values and those determined by McElhanney appears large, they are consistant with the predicted movements of the NAD 83 readjustment.

6.0 Summary

All the survey project was completed as requested. The inertial system proved to be a swift and economical method of surveying on the tundra. Discussions with Ottawa revealed that the distortions shown in Table 1 agree very closely with the predicted movement between TUK DOPPLER and the area surveyed.

The inertial system also served as a useful tool for finding monuments which were previously thought to be destroyed. It proved very useful in areas where two and three monuments had been established on a single mountain top.

It is hoped that the inertial system may be used more frequently on these types of jobs. The Litton Auto Surveyor Dash II is recognized by many as state of the art equipment as far as inertial surveying goes today.

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Impact of the Global Positioning System on Hydrography

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Presented at the
Canadian Hydrographic Service Centennial Conference
Ottawa
April 5-8 1983
and published in the 1983 Conference proceedings

Abstract

The Navigation Satellite Timing and Ranging (NAVSTAR) system, also known as the Global Positioning System (GPS) is scheduled to be fully operational by the end of this decade, and will be capable of providing real-time continuous positions accurate to about 10 metres. Policies regarding what GPS accuracy will be made publicly available, and which of the other navigation systems supported by the U.S. government should be shut down (and when) once GPS is available, have been proposed in the recent U.S. Federal Radionavigation Plan. In this paper we discuss the impact of GPS on hydrography from four points of view. First, we describe GPS performance today in its partially-implemented state, and discuss its near term (pre-1990) impact on hydrography. In particular, we describe our joint project to develop a GPS/BIONAV system for arctic hydrography. Secondly, we adopt an optimistic stance, assume that something close to the full GPS capabilities will be publicly and inexpensively available, and explore the usefulness of GPS for various hydrographic surveying tasks. Thirdly, we discuss the implications of the pessimistic scenario, in which GPS capabilities are sharply curtailed to the general public. Finally we explore various possibilities for using GPS differentially to improve the accuracy available.

Resume

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Introduction

NAVSTAR/GPS is a military navigation system being developed by the U.S. Department of Defense (USDoD). However GPS will also have a double impact on civilian navigation.

In the first place, GPS is capable of accurate (10 metre), four-dimensional (three coordinates plus time), continuous, realtime, all weather position fixing. No other present or planned navigation system has all these attributes. However, the full performance of GPS may not soon be available to civilian users.

In the second place, navigation systems which are presently freely available, such as TRANSIT, LORAN-C, and OMEGA, will eventually be shut down once GPS satisfies most military navigation needs.

Hydrographers (and other civilians requiring precise positioning) will be critically affected by the relationship between the timing of these shutdowns and the timing of civilian access to full GPS performance.

Before discussing these future uncertainties, and their impact on the use of GPS for hydrography, we first summarize the present status of GPS, and some results we have already obtained using GPS. These are the outcome of a joint agreement involving Nortech Surveys (Canada) Inc., the University of New Brunswick's Department of Surveying Engineering, and the Bedford Institute of Oceanography. The goal of this NUB (Nortech/UNB/BIO) project is to develop an offshore GPS marine navigation capability, to be used in hydrographic surveys of Baffin Bay, starting in 1984. So far, three NUB sea trials have been conducted in BIO ships using Nortech GPS equipment (see Figure 1). Further tests are planned.

Present Status of GPS

The principles of GPS are similar to those of rho-rho LORAN-C. A GPS receiver makes time-of-arrival measurements on signals from several (usually four) GPS satellites. The resulting pseudorange observations are then used to compute both position and the time bias between the satellite and receiver clocks. For marine navigation, and if we carry a cesium clock aboard ship, four kinds of solution are possible. The unknown parameters can be

(1) latitude and longitude only (height and time bias held fixed)
(2) latitude, longitude and time bias (height held fixed)
(3) latitude, longitude and height (time bias held fixed)
(4) latitude, longitude, height, and time bias.

The values to which we hold the height or time bias fixed must be close to their actual values, or the position fix will be corrupted. Sufficiently accurate ellipsoid heights can easily be obtained from available geoid maps, or geopotential coefficient sets. Establishing a sufficiently accurate synchronization between a shipboard cesium and the GPS satellite clocks is a little more difficult, but possible.

The signals used can be either of two binary coded modulations on the GPS carrier — the "P-code" or the "C/A-code". The higher frequency P-code yields higher position fix accuracy (10 to 25 metres). Details of GPS signals and operation are described in ION [1980] and Wells et al. [1982].

GPS can be used today, but the coverage is incomplete. Prototype GPS satellites were launched in 1978 and 1980. Four such satellites (which we designate here as Space Vehicles (SV) numbers 5, 6, 8 and 9) are currently operating, with a fifth (SV 4) scheduled for launch in June 1983. Three more prototype satellites are available, and it is likely they will be used to maintain a five-satellite constellation between 1983 and 1986 [Kruh, 1983]. Between 1986 and 1989 these prototype satellites will be replaced by 21 production model GPS satellites (18 operational plus 3 active spares). Despite warnings that GPS signals may be unreliable and inaccurate until the production stage [Healy, 1981], many months of tracking by Nortech and others indicate that GPS signals and ephemerides are almost always stable, consistent and accurate.

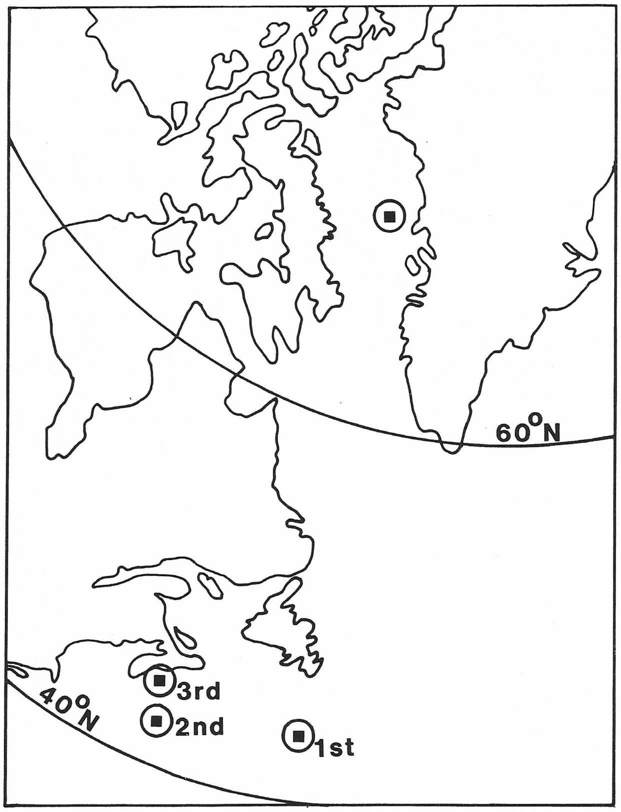

Figure 1. Location of the Baffin Bay test point, and of the first three NUB sea trials, held in November 1981, June 1982 and November 1982 respectively.

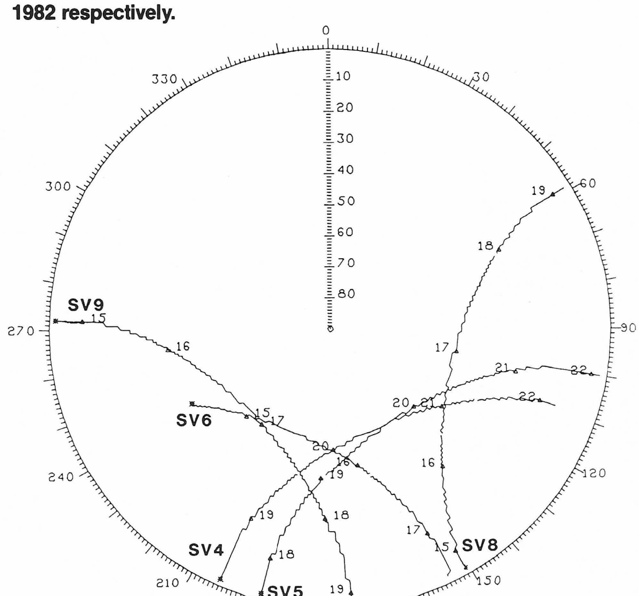

Figure 2. Polar plot of GPS satellites (azimuth and elevation relative to Baffin Bay test location, for 1982 November 16).

GPS satellites have orbital periods of nearly 12 hours, so that coverage nearly repeats from day to day. Typical coverage for Baffin Bay is shown in Figure 2. In order to translate a particular satellite configuration into position fix accuracy, we introduce the concept of Dilution of Precision (DOP). This is a simplistic conversion factor from range measurement accuracy to position fix accuracy. For example, if the range measurement error is 8 metres, and the DOP factor is 2, the position fix accuracy would be 16 metres. The DOP value reflects the geometrical strength of the satellite/user configuration, however it also depends on which of the four kinds of solution listed above is being computed. We will use the following kinds of DOP:

(1) HDOP (Horizontal DOP) for latitude, longitude solution;
(2) HTDOP (Horizontal/Time DOP) for latitude, longitude, time bias solution;
(3) PDOP (Position DOP) for latitude, longitude, height solution;
(4) GDOP (Geometrical DOP) for latitude, longitude, height, time bias solution.

The DOP value at a given location will vary over a 24 hour period, but will nearly repeat from day to day. Comparisons between these various DOPs are shown in Figures 3 to 6. Figures 3, 4 and 5 show predicted values for DOPs for three different satellite constellations (the present four-satellite, the expected five-satellite, and the final 18-satellite constellations, respectively). Until the final constellation is in place, it is clear that there are significant advantages to using an externally synchronized cesium clock: HDOP is below six for 11 hours per day in Figure 3 (four satellites), and is below ten for 16

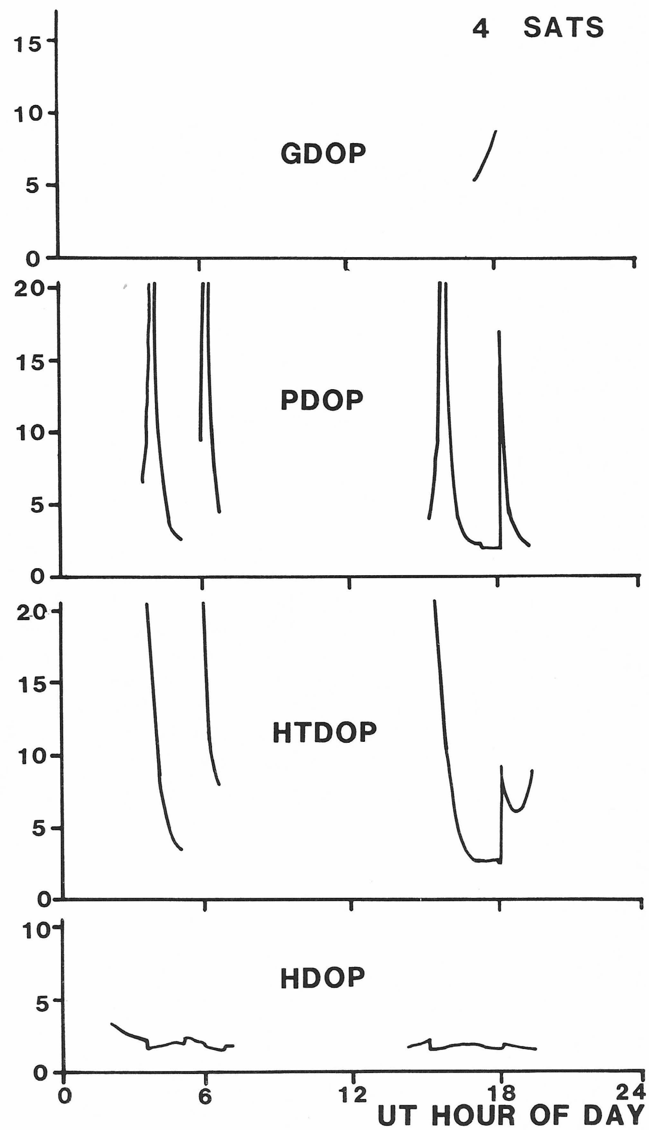

Figure 3. Predicted dilution of precision (DOP) values for Baffin Bay test point, for November 16, 1982, using the present four fully operating GPS satellites.

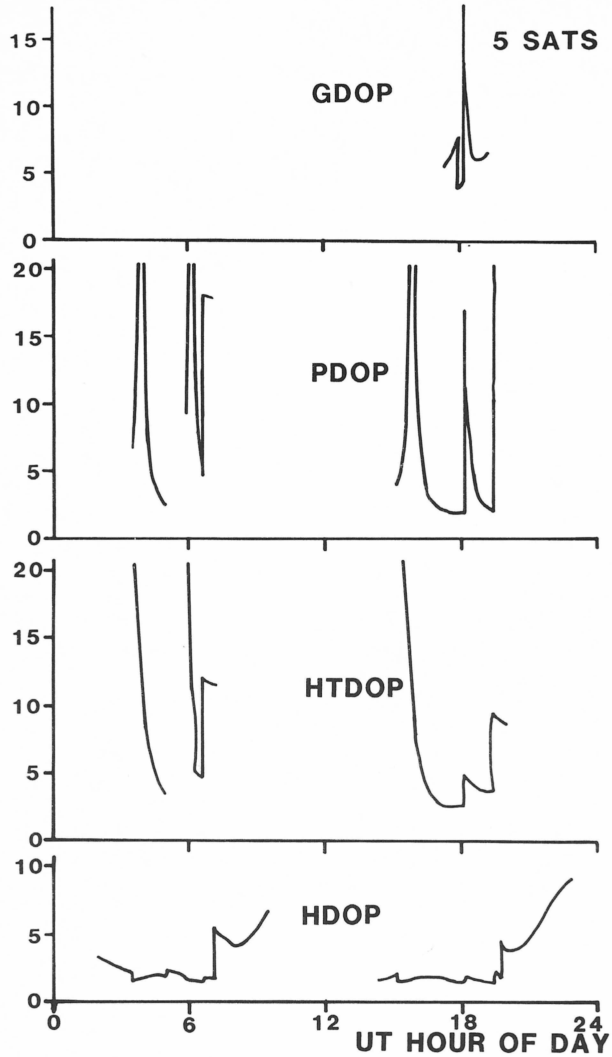

Figure 4. Predicted dilution of precision (DOP) values for Baffin Bay test point, for November 16, 1982, using the five GPS satellites expected to be available from June 1983.

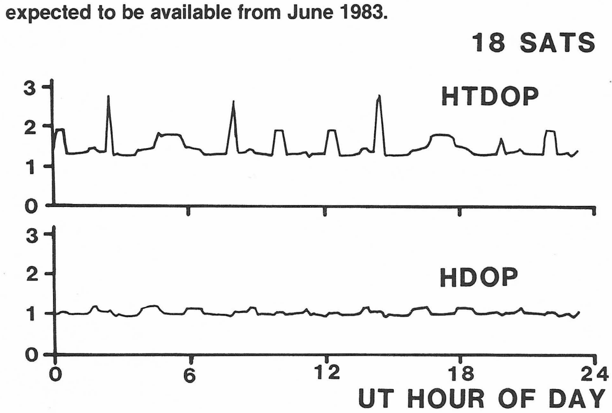

Figure 5. Predicted dilution of precision (DOP) values for Cape Race, assuming a complete GPS 18-satellite constellation.

hours per day in Figure 4 (five satellites). Figure 6 corresponds to the same satellite constellation as Figure 4, but represents actual DOP values at Halifax rather than predicted values in Baffin Bay. HDOP at the two sites are remarkably similar, indicating that the sea trial results should represent GPS performance in Baffin Bay.

The number of GPS receivers presently available to civilian users is limited. The three NUB sea trials so far have used the Stanford Telecommunications Inc. 5010 P-code receiver acquired by Nortech in mid-1980 and described in Lachapelle and Beck [1982].

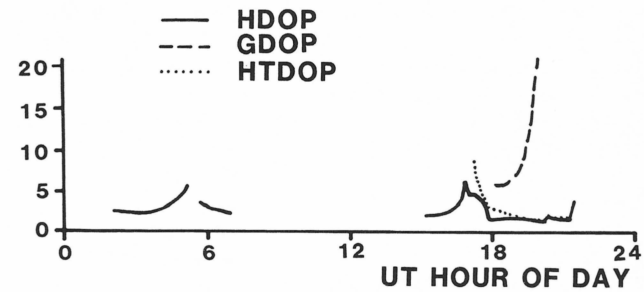

Figure 6. Actual dilution of precision (DOP) values for Halifax for November 1, 1982 (four GPS satellites available).

This is a bulky piece of equipment, weighing 550 kg, and is a single-channel receiver (capable of measuring ranges to only one satellite at a time), requiring 50 to 70 seconds to switch between satellites. In order to use this receiver for marine navigation, it must be used in conjunction with ship's speed and heading data. This limitation should be removed, now that a portable, fast switching receiver is available — the Texas Instruments 4100 multiplexing receiver shown in Figure 7 [Ward, 1982]. Nortech has acquired two of these receivers, and they will be used for NUB trials during 1983.

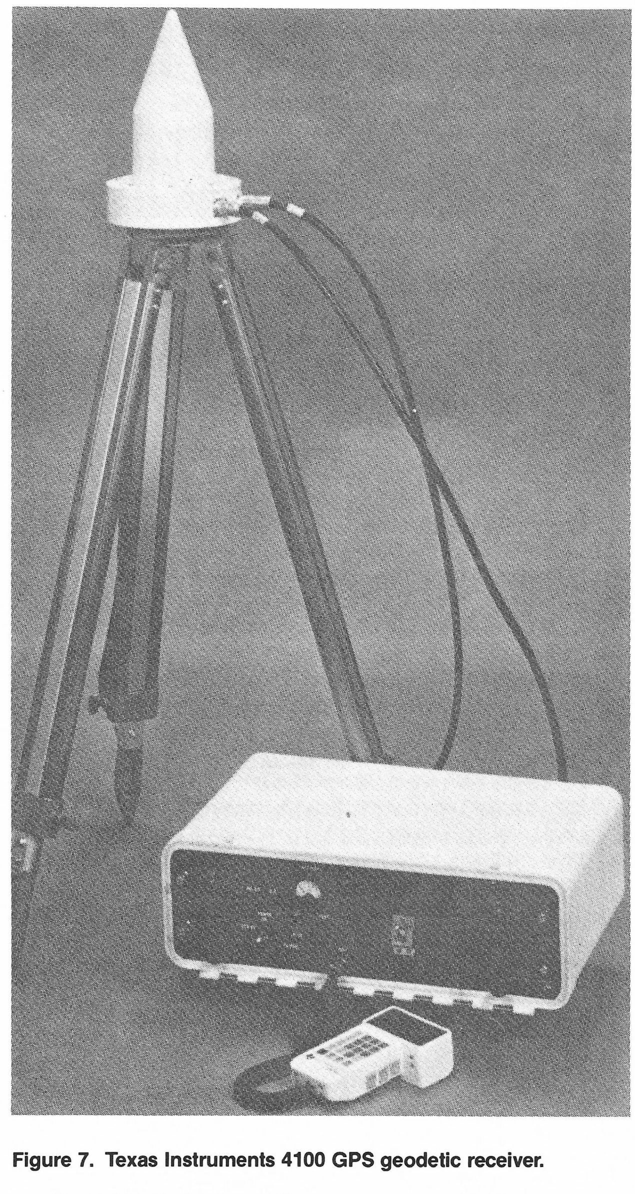

Figure 7. Texas Instruments 4100 GPS geodetic receiver.

Current GPS Marine Navigation Capabilities and Results

We will summarize results obtained in the NUB trials so far. These results are fully described in Wells et al. [1983] and Lachapelle et al. [1983].

As already mentioned, the STI 5010 GPS receiver used in these trials must be used with ship's speed and heading data. The accuracy of the combined GPS/dead reckoning system will be affected by both errors inherent in GPS and noise in the ship's log and gyro data used to estimate the ship's displacement between successive GPS pseudo-range measurements. In order to evaluate the inherently GPS error component, the quasi-instantaneous accuracy of GPS position fixes were studied with the receiver static. Position fixes were computed using series of two to four pseudorange observations to different satellites over time intervals of two to five minutes to obtain a series of independent fixes. Typical results are shown in Figure 8. Similar accuracy and repeatability has been

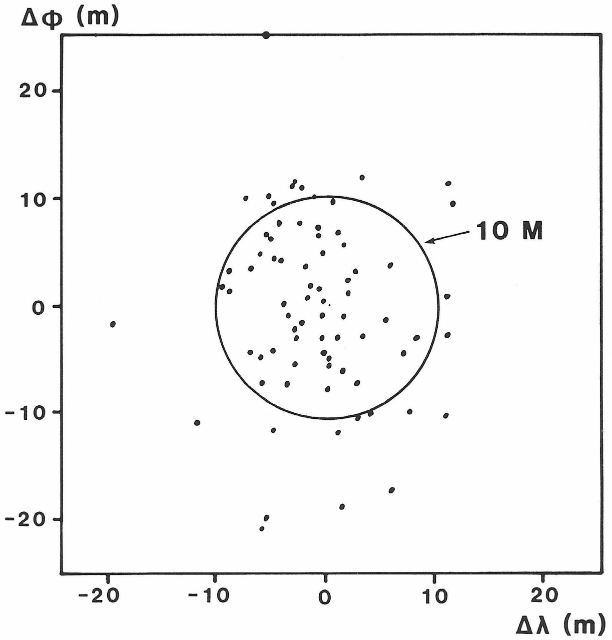

Figure 8. Scatter plot of 75 quasi-instantaneous two dimensional GPS position fixes, collected over a four day period in May 1982 at the Bedford Institute of Oceanography. P-code pseudoranges from the Nortech STI 5010 GPS receiver were used.

obtained consistently over the past three years by Nortech [Lachapelle and Beck, 1982]. The accuracy of 16 metres quoted earlier for an HDOP of 2 was obtained not only 50% of the time (as implied by GPS specifications) but consistently for 80% to 90% of the time. Using the TI 4100 receiver, this static accuracy and repeatability should also apply in the dynamic mode.

The integration of STI 5010 pseudorange observations with ship's speed and course was carried out in realtime using three different types of algorithms, namely a TRANSIT type, a sequential type, and a Kalman filter; these are discussed in more detail in Wells and Delikaraoglou [1982] and Lachapelle et al. [1983]. Positions derived from this aided GPS navigation system were compared with positions derived using other navigation systems, such as LORAN-C and Miniranger. Typical results obtained during the second NUB sea trial, in June 1982, are shown in Figure 9. The TRANSIT type algorithm was used in this case to combine pseudoranges with speed and course. The unknowns consisted of latitude, longitude and time bias (at least three satellites were available). The track of the ship was relatively smooth during this period. LORAN-C was estimated to be accurate to 50 m, hence the rms difference of 50 m

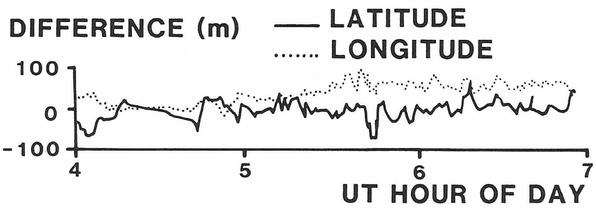

Figure 9. GPS marine navigation performance, using LORAN-C as a reference. From second NUB sea trial, June 3, 1982. Transit-type algorithm used for GPS.

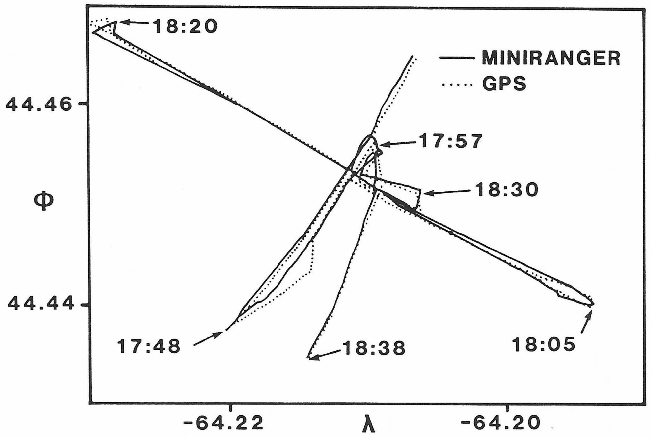

Figure 10. GPS and Miniranger track plots during a buoy check on the third NUB sea trial, November 17, 1982.

to 75 m between GPS aided and LORAN-C derived positions is excellent. Figure 10 shows both Miniranger and GPS position fixes during a buoy test conducted as part of the third sea trial in November 1982 in Mahone Bay. Several 180° course changes were made, and an adaptive Kalman filter was used to combine GPS

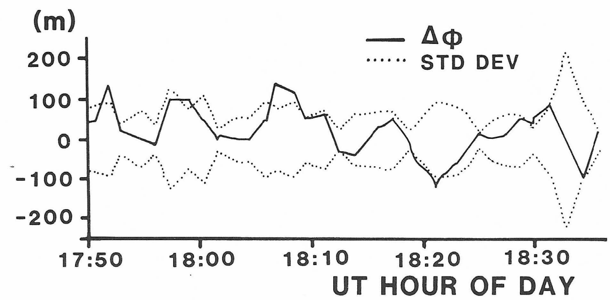

Figure 11. Difference between GPS and Miniranger latitudes from Figure 10. The longitude differences were similar. Also shown is the GPS standard deviation estimated by the Kalman filter used.

pseudoranges with speed and course. Figure 11 shows the position difference in latitude together with the standard deviations estimated by the filter. Within straight segments of the path, rms differences are of the order of 25 m. The larger position differences that occur during sharp turns are attributed to delays in recording and processing log and gyro data; this problem was due to the particular hardware configuration used during the test and has since been rectified. The estimated standard deviations of latitude and longitude are consistent with the position differences, indicating that a realistic weighting scheme was used in the filter. Variations in the standard deviations are due to the variable system noise of speed and course (during turns), and to changing GPS geometry as the receiver sequences through the four satellites available during the test.

Future Uncertainties in GPS Performance

GPS is principally a military system, but will be available as well to civilian users. This brings into contention the two concerns of military security and civilian economic benefits. Originally it was expected that the more precise P-Code signal would be available to military users, and the C/A-code signal (expected to be an order of magnitude less accurate) to civilian users. However, early experience with the two codes showed C/A-code position fixes were only about a factor of two less accurate than P-code fixes. Consequently new concepts have been introduced: distinction between the two GPS signals has been replaced by distinction between the two services to be provided by GPS — these are the "Precise Positioning Service (PPS)" and the "Standard Positioning Service (SPS)". PPS is intended for military (and selected non-military) users and will provide full P-code GPS accuracy. Access will be controlled by encrypting the P-code signal, and an annual user's fee to non-DoD users of $3700 per receiver will be enforced through sale of these encryption devices. SPS will be available for general worldwide use, but will provide less than the full C/A-code accuracy.

The authoritative statement regarding SPS accuracy is the Federal Radionavigation Plan [USDoD/DoT, 1982], in which three accuracy specifications are given:

> **Predictable Accuracy:** The accuracy of a position with respect to the geographic, or geodetic, coordinates of the earth.
> **Repeatable Accuracy:** The accuracy with which a user can return to a position whose coordinates have been measured at a previous time with the same navigation system.
> **Relative Accuracy:** The accuracy with which a user can measure position relative to that of another user of the same navigation system at the same time. This may be expressed also as a function of the distance between the two users. Relative accuracy may also refer to the accuracy with which a user can measure position relative to his own position in the recent past. For example, the present position of a craft whose desired track forms a specific geometric pattern in search operations of hydrographic survey, will be measured generally with respect to a previously determined datum.

Referring to SPS, the FRP states that it is policy to

> make the NAVSTAR GPS Standard Positioning Service (SPS) continuously available worldwide for civil, commercial and other use at the highest level of accuracy consistent with U.S. national security interests. It is presently projected that a *predictable* and *repeatable* accuracy of 500 meters (2 drms) horizontally and 820 metres (2 sigma) vertically will be made available during the first year of full NAVSTAR GPS operation with possible accuracy improvements as time passes.

and

> the *relative* accuracy will be 10 m (2 drms) horizontally and 16.4 m (2 sigma) vertically.

The "2 drms" accuracy level quoted is the radius of a circle containing 95 percent of all possible fixes that can be obtained with the SPS at any one place. In addition to this Denial of Accuracy concept, there is also a userpay policy for SPS which will be enforced by encrypting the signal for SPS as well, and charging an annual fee of $370 per receiver for the necessary SPS encryption device.

The FRP also describes how GPS may affect other U.S. government supported navigation systems. The present policies are to

(1) phase out DoD use of TRANSIT between 1987 and 1992, after which the system will be shut down for all users.

(2) phase out DoD use of LORAN-C between 1987 and 1993. Civilian use will continue at least to 2000. Coverage may increase if LORAN-C is adopted for aviation use. On the other hand, LORAN-C may be phased out in favour of GPS.

(3) phase out DoD use of OMEGA between 1987 and 1992, except for U.S. Navy use, which will continue. However, OMEGA too may be phased out in favour of GPS.

The FRP describes two key events in the process of determining what the impact of GPS will be on these other systems. In 1983 DoD/DoT will make a preliminary recommendation on the future navigation system mix. Four years (1983-1986) are scheduled for consultations with other nations, NATO, IMCO, and ICAO. Then in 1986 DoD/DoT will formulate final decisions.

Differential GPS

Noting that the SPS *relative* accuracy will remain undegraded, it is natural to ask whether using the SPS *differentially* would permit civilian users to recover much of the full C/A-code accuracy. Figure 12 represents this concept. We have studied some aspects of differential GPS navigation, in particular changes in the geometrical

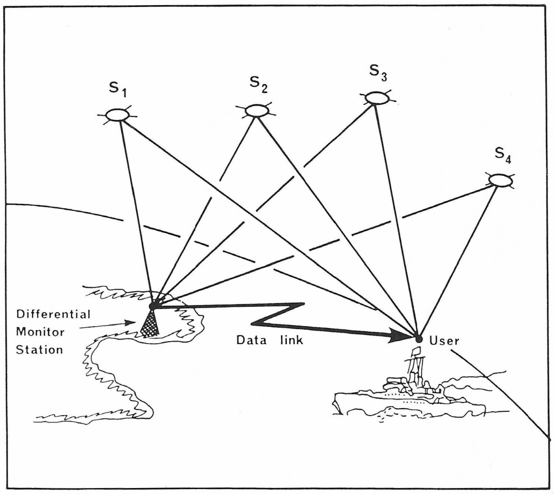

Figure 12. Differential GPS navigation concept. Variations in GPS ranges or coordinates are measured by monitor and sent to users over data link, to correct their positions.

effect as the user moves further away from the monitor [Mertikas, 1983]. We postulated that the C/A-code accuracy may be degraded to meet the above SPS specifications in one of three ways; by adding errors to the broadcast satellite ephemeris parameters, to the broadcast clock parameters, or to both. The monitor station was postulated to continuously measure either the variation in its coordinates, or variations in the biases in the measured ranges to

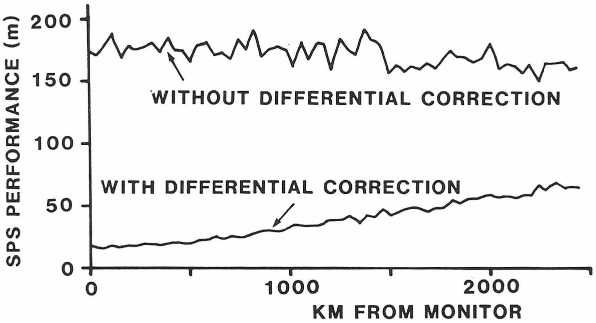

Figure 13. Typical differential GPS results. SPS performance is measured by the 50th percentile of the radial deviations from the "true" positions.

each GPS satellite in view, and to transmit these variations to users in realtime. Typical results are shown in Figure 13, for the case of clock parameter degradation; measured range biases; and a user solution for latitude, longitude and clock bias. These results indicate that the differential technique may be useful up to several thousand kilometres from a monitor. Many questions remain regarding differential GPS, some of which we intend to study during the 1983 NUB trials.

Impact of GPS

A great advance in positioning for hydrography has been the post-World War II development of radio navigation, from DECCA and LORAN-C through Hi-Fix to Miniranger and Syledis. In GPS we may see the final step in that revolution.

Every one of our present radio positioning methods has problems. With LORAN, DECCA and Hi-Fix, where we make the measurement using groundwaves that follow the earth's curvature, we suffer from range errors due to propagation over land or ice, and interference from skywaves. Direct propagation microwaves reflect from the sea surface to give range holes, and VHF signals propagated by diffraction reflect from hillsides and buildings. All these problems go away if instead of battling to transmit a signal along the earth's surface we transmit straight down from a satellite.

From experience one suspects that nothing is going to be perfect: signals from satellites are very weak and so subject to interference, but because they use very high frequencies, they can be coded to overcome this. There probably will be some snags with precise satellite navigation, but nothing we have seen so far suggests serious problems. It looks likely that GPS, and its successor systems, will eventually replace all our terrestrial radio navaids leaving terrestrial laser systems to satisfy the highest accuracy requirements.

There will be some years of uncertainty for this final stage of the radio positioning revolution to sort itself out, and as this period will extend over the next decade it is important that some effort is put into considering how it will affect hydrography. Let us consider three possible cases, when GPS is fully operational, and look at the impact of each on hydrography.

Worst case. In this case, SPS accuracy is degraded in such a way that we cannot recover it using differential techniques, and we are left with 500 m positioning. Most mariners, and many oceanographers are quite well served, but hydrographers are worse off than at present.

The FRP states that LORAN-C and TRANSIT will be phased out once GPS is operational. If this happens while GPS is still at the 500 m accuracy level, we will be worse off than at any time since 1969. With no LORAN-C or TRANSIT we will be unable to fix accurately beyond the 300 nautical mile range of Accufix transmitters.

Probable case. In this case, SPS accuracy is degraded in a manner that allows us to recover by differential operation. The degree of recovery may not be complete, and will be some function of distance from the differential reference receiver. For SPS Denial of Accuracy to be effective, it must obviously change at intervals, perhaps even continuously. That means we must broadcast corrections to the survey vessel continuously, in real time. We have the technology to do this, but it will take effort and money to set it up.

Best case. In this case, DoD decides not to apply any Denial of Accuracy. We get full access to the C/A-code (20 m accuracy) and perhaps the P-code (10 m accuracy). We may pay a user fee, which seems a very reasonable requirement.

Summary

At present, GPS is in the development stage, and we have full access to all its codes. It will become fully operational towards the end of this decade, and at that time, or possibly even earlier, some as yet unspecified form of deliberate accuracy degradation will probably be applied, in order to deny the enemy full use of this military system.

At present four or five satellites are up and, with their 12 hour period, these give two fix periods per day, each lasting between three and eight hours, depending on location. Fix accuracy is about 50 m. It will cost about $1,000 per day to rent a receiver.

Under this limited time coverage, applications are limited to special uses, such as an urgent requirement to survey Baffin Bay, where there is no LORAN coverage. GPS would cost about one third the amount required to put in our own Accufix (portable LORAN) transmitters and would avoid the uncertain logistics of that operation in a very hostile environment. However, GPS at present provides fixing for one third to one half of the day. Keeping a ship usefully employed for the remainder of the day is a tricky problem.

If we can find one convenient site on shore where we can put a single Hi-Fix or Accufix transmitter, then the range from this can be integrated with the range from a single GPS satellite (as long as it gives a good cut) to further extend the time of hybrid GPS coverage.

We plan to test GPS thoroughly under the NUB agreement during the runup to full deployment. We expect to have the experience to know what performance and limitations to expect. We will know, for instance, whether we need to operate a monitor receiver in the survey area to verify accuracy, by fixing on the same satellites, using the same broadcast ephemeris, and under the same fix geometry, as the survey vessels. Until full GPS deployment, and the consequent SPS Denial of Accuracy, there should be no need for real time transmission.

At that stage we can decide whether to pension off LORAN, Hi-Fix, Miniranger and Syledis in favour of GPS.

Acknowledgements

Ray Banks, Norm Beck and Pierre Heroux at Nortech, Demitris Delikaraoglou at UNB, and Steve Grant and Mike Ruxton at BIO have all contributed to development of the algorithms, software, data collection, and results described in this paper. The UNB contribution to this work was funded in part by operating and strategic grants from the Natural Sciences and Engineering Research Council of Canada, and in part by the Bedford Institute of Oceanography.

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Obituary

Cyril George CHAMP 1928-1984
The many friends and associates of Cyril Champ were saddened by his sudden death on 5 April, 1984.

Cyril was born on 19 April, 1928 in London, England. On completing elementary school education, he won a scholarship to Hendon County Grammar School. He joined the Ordnance Survey in 1944 and after training, was employed as a lightkeeper and booker on secondary and tertiary triangulation.

On 6 June, 1946 Cyril enlisted in the Royal Engineers and after completing basic military and field engineer training, he was assigned to the Survey Training Centre (now School of Military Survey). After training, he was posted to Middle East Survey Directorate, was promoted to Sergeant and given the task of overhauling the Map Library.

In August, 1948 after release from military service, Cyril joined No. 1 Survey Production Centre R. E. and was made Librarian in charge of the Trigonometrical and Technical Libraries.

In October, 1956 Cyril responded to a competition poster for a "Curator of Hydrographic Documents" in the Canadian Hydrographic Service. He was offered the post, accepted it on 14 January, 1957 and with his wife Paula arrived in Ottawa on 1 April, 1957. Although Cyril was hired as a Chart Curator, he spent much of his time as a key assistant to the Superintendent of Charts and other senior hydrographic personnel.

In 1962, he became a Technical Assistant to the Superintendent of Charts and in 1965 Technical Assistant to the Dominion Hydrographer.

In 1971, Cyril left the Hydrographic Service to become Executive Assistant to the ADM (Water Sector), Department of the Environment, but in 1974 Cyril returned to CHS as Staff Assistant to the Dominion Hydrographer. He continued in this position until his sudden death, except for a period of eighteen-months as Staff Assistant to the ADM (Ocean Science and Surveys), Department of Fisheries and Oceans in 1980-81.

Cyril will be remembered for his tireless effort on behalf of the Canadian Hydrographic Service, for his excellent memory and his willing manner. He was a true and valued colleague and will be dearly missed by his many friends and associates. Our sympathy is extended to his daughters, Heather and Claire.

Retirements

Atlantic Region held a dinner dance at the Royal Artillery Park Officer's Mess on March 31st to bid farewell to three of its OLD-TIMERS: Milt Hemphill, Ralph Cameron and Leamond Hunter who are retiring later this spring. With their departure the Atlantic Region will be losing some 103 years of experience.

Milton "Junior" Hemphill
Milt first saw the light of day in Pictou, Nova Scotia in 1929. He progressed through the local school system and joined the C.H.S. as a seaman in 1950. He transferred to the hydrographic side in 1952 and worked his way up to the H.I.C. level. Milt is a legend within his own right in the C.H.S. The only thing predictable about Milt was that he would start at least two arguments each day so he would get the opportunity to argue both sides. The typical Milt was in evidence a few years back when at a workshop in Victoria he gave his opinions on development and automation.

Ralph Cameron
Ralph first peeked out behind a lump of coal in 1922 in Springhill, Nova Scotia. He served in the R.C.A.F. from 1941 to 1945. He followed this by three years at Mount Allison University. He then decided that the Canadian Hydrographic Service was preferable to the coal mines and joined as a field hydrographer in 1951.

At this time, the Hydrographer-in-Charge was second only to God and when one of the senior H.I.C.'s directed him to go fetch an item and Ralph replied, "Go get it yourself. You are closer than I am!", you can imagine what followed. Ralph was not heard from for ten years, but he finally emerged as an H.I.C.

When Ralph was asked what he was going to do upon retirement he said, "Make honey!" When questioned how he was going to do this, especially at his age, he replied that he was going to raise bees and a few chickens. This is typical of Ralph who after seven children decided to learn something about the birds and bees.

Leamond Hunter
Leamond "the Demon" first emerged from the coal dust in Springhill in 1925. He also served in the R.C.A.F. from 1943 to 1945. This was followed by a one-year stint at Mount Allison University and then to the Nova Scotia Land Survey Institute where he graduated with his Nova Scotia Land Surveyors Commission.

He joined C.H.S. in 1948 as a field surveyor. Lea is one of the few in C.H.S. who can truly call himself a "Chartmaker". He became an H.I.C. in 1953 working mainly on the east coast. In 1970, he transferred to the cartographic side of chartmaking.

Lea is a cocky little guy who always gives as good as he takes. This is typified by the time the Executive Assistant to the Dominion Hydrographer who was twice Lea's size, blasted him for spelling his name wrong and pointed out that it was on his door. Hunter's reply was, "That's nice, but I didn't have your damn door in the field with me."

Unfortunately, Milt and Agnes Hemphill could not attend due to illness; however, they were ably represented by their son, Mark and his wife, Heather.

Telegrams were received from Steve MacPhee, Ross Douglas and Ken Williams and read by Chris Rozon and Burt Smith.

Chris presented the three ladies Heather Hemphill, Maria Cameron and Vera Hunter with a bouquet of roses and a bottle of fine champagne. Chris advised the ladies that the contents of the bottle should be used to fight off the frustrations that their husband's retirement would cause and if this didn't work then use the bottle.

Burt Smith on behalf of C.H.S./C.H.A. presented Milt, Ralph and Lea with a ship's clock and a hydrographic plaque.

The highlight of the evening was when some of the staff decided that Lea who had managed to get their goat at some time or another during their career should have one of his own and presented him with a six-month old billy goat.

It was a fitting send off for these old troopers with an excellent roast beef dinner, topped off by cheap booze and a loud band.

Godspeed.

CHA/CHS Social News

Atlantic Branch

A dance was held on March 31st in honour of Ralph Cameron, Milt (Junior) Hemphill, and Leamond Hunter. All three are retiring this spring. The dance was a great success although we were sorry that Junior Hemphill could not attend due to a recent illness. However, Junior's son Mark was there to accept his retirment gifts. All three received brass barometers, CHS plaques, and the highlight of the evening was the presentation to Leamond, from fellow cartographers, of a live goat. We wish all three the best of luck in their future endeavors and we'll miss them all.

Congratulations to Sean Duffey and Linda MacMillan for winning the two permanent job positions of data processors. Welcome aboard!

We also congratulate Shawn Keyes and Mike Collins on being extended for another year as field hydrographers.

Some of the field hydrographers decided to venture into warmer climates this winter. Dave and Josephine Roop spent two weeks in the Bahamas, Chris Rozon spent eight days in Hawaii, and Linda MacMillan and Kirk MacDonald spent two weeks in Jamaica.

Speaking of warmer climates, Dale Nicholson and Ann Ryan are enjoying the pleasanter climate of Sidney, B.C. while they continue Phase II, field training, of their Hydrography I course.

Congratulations to Gary Rockwell, Julian Goodyear, and Paul McCarthy for successfully completing their M.E.D. course. Ernie Comeau and John Ferguson are still busy studying on their S.E.N. I course. These courses are essential for their watchkeepers tickets.

Rumour has it that Maurice Bastarache will be spending this summer working with Mike Eaton and the navigation group. Although a Maritimer, Maurice spent two years with our Pacific Region before deciding to go back to school for his survey engineering degree. Maurice is presently completing his second year at U.N.B., as is Gerard Costello. Both Maurice and Gerard will be joining their field parties on or about the middle of May.

Congratulations to Charlie and Colleen Stirling on the birth of their daughter Lindsay on April 13.

Cathy Schipilow had a baby boy in November and returned to work in March.

Congratulations to Phyllis Hamilton and Patrick Cook on their recent marriage. Phyllis and Patrick will be moving to Missisauga and we wish them all the best.

All field parties will be departing BIO on May 1st. Good luck to all of the field staff!

Jim Ross is back for the summer after completing his first year at university.

Central Branch

We are pleased that (Robery) Danny Mahaffey has recovered and returned to work after his unscheduled meeting last summer with another auto.

Jack Wilson and Dick MacDougall have been promoted within CHS Central Region.

Lifetime CHA memberships were given to Gerry Wade and Ab Rogers for their years of service to both the CHA and CHS.

We may have some additional CLS's around a year or two down the road as Arnie Welmers, Bob Cove, Raji Beri, Bob Langford, Jon Biggar, and Dave Pugh were successful with a variety of schedule III exams at the last sitting.

The 13th annual H20 Bonspiel was held this year at the Grimsby Curling Club on February 19th. Over the past years the H20 Bonspiel has become a very popular winter event and it was with regret that not all entries were able to curl. Due to limited ice, only 32 participants were fighting it out for the coveted "A" and "B" Event trophies. Next year's bonspiel will have more ice. Central Branch was pleased to have the Marinav Offshore Survey Group from Ottawa enter a team. The team members were Tom Zentner (skip), Pierre Pagé (vice), Bill Mayers (second), Clyde Raynard (lead). We would like to extend an open invitation to all Branches to come and curl.

This year's winners are:

"A" Event: Phil Elliot, Marie Solvason, John Dixon, Mike Smith.

"B" Event: Ron Solvason, Barry Little, Joanne Tinney, Rick Jack.

This year's bonspiel co-ordinator Brian Power would like to thank all those who helped to make the days curling a success, with special thanks to Marie and Ron Solvanson for their efforts in arranging the meal and morning coffee. The H20 Bonspiel's popularity and success is due to the many companies who have supported us over the years. Central Branch would like to acknowledge our thanks to:

— Marinav Offshore Survey Group, Ottawa, Ont.
— Norman Wade Company Ltd., Hamilton, Ont.
— Wild Leitz Canada Ltd., Willowdale, Ont.
— EDO Canada Ltd., Clagary, Alberta
— Port Weller Dry Docks, St. Catherines, Ont.
— Klein Associates Inc., Salem, New Hampshire, U.S.A.
— Tracked Vehicles Repair, Mississauga, Ont.
— CHA Film Club, Burlington, Ont.

Ottawa Branch

The new CHA executive for 1984 is:

Vice-president	— Terry Tremblay
Secretary/Treasurer	— Thérèse Jollcoeur
Executive members	— Clay Fulford
	— Rolly Gervais
	— Roger Landriault
	— Ken Peskett
Past Vice-president	— Harold Comeau

Congratulations to Jim Bruce who was recently elected President of the CHA and is the first cartographer to head this association. Sheila Acheson will assist him as National Secretary/Treasurer.

The Hydrographic Data Processing Seminar slated for Feb. 20-24 had to be postponed. It is being reviewed for possible presentation in the fall of 1984. You will be informed of any future action.

Jim Dillon retired March 16, 1984 after 43 years of public service, the last 18 of which were spent in the CHS. He was presented with scrolls, plaques and best wishes by Steve MacPhee, as well as golf "woods" by his many friends.

Gerry Dohler shocked H.Q. staff by announcing his retirement effective September 19, 1984.

Jacques Dupras was promoted to Supervisor of the Chart Sales Office.

Congratulations are in order on the recent marriage of the always dynamic and bubbly Ginette Dorion to Al Yuzak. Unfortunately, the new Mrs. Yozak will soon be leaving us.

Pat Bell proudly announces the loss of 2 pounds. Anyone knowing their whereabouts are asked to keep it to themselves.

And the SAGA continues — in our last episode, Ken and Jackie Peskett's new home burned to the ground, was rebuilt and they moved in. However, they have recently been burglarized and their car subjected to a "hit and run". Join us again in the next issue of Lighthouse when we fine out "Can Ken and Jackie find happiness living among thieves and will their vicious watchdog King be stolen next !!!".

The 1983 version of the annual Christmas Dinner was held at the Skyline Hotel. Considered a huge success, as over 150 people attended, it affords the chance to get reacquainted with some retired CHS personnel as well as the chance to wish the best of the season to friends.

The CHS was saddened recently by the deaths of two active long service friends. André Chartrand, Supervisor of Chart Sales passed away after a short illness, and Cyril Champ, Staff Assistant to the Director General, died unexpectedly in early April.

Pacific Branch

The new CHA executive for the upcoming year is:

Vice-president	— Barry Lusk
Secretary/treasurer	— Ray Chapeskie
Executive members	— Pete Milner
	— Ernie Sargent
	— Carol Nowak
	— Fred Stephenson

Congratulations to past Vice-president Doug Popejoy for a job well done.

Bill VanDuin has officially resigned to greener pastures. All the best to Bill and Cindy.

This branch extends a warm welcome to its newest members. We look forward to your continued presence and involvement within our membership.

Congratulations to Ken Halcro for successfully completing the Hydrography 2 course.

Congratulations also to Pete Milner and to Bryon McGregor on the recent additions to their families.

L. M. (Rikki) Wakefield of Sailing Directions was married on April Fools Day. Hearty congratulations.

Ernie Sargent has announced his engagement to Kathleen Creighton — the wedding is set for November.

There is a scheduled farewell on May 19 for Pete Browning, who is retiring. Pete is the guest speaker at a special luncheon being held at the Brentwood Inn — his topic is "Vignette Hindsights". Also, Sid Wigon is retiring as Pacific Tsunami Advisor. We wish both Pete Browning and Sid Wigon good fortunes in their futures.

A special congratulations is extended to Gail Allison and her committee, who worked hard to make the 1984 workshop a very successful and rewarding event. We look forward to the next CHA conference in Calgary.

This year Chart Production is sending only one cartographer (Bernard Kenny) into the field. Bernard will be assigned to Barry Lusk's field party at Shuswap Lake.

The first annual golf tournament is scheduled for May 4.

Ernie Sargent was quite adamant that we shouldn't mention that a certain curling team he plays on, which is skipped by Willie Rapatz and includes fellow hydrographer Barry Lusk, was trounced twice in league play by a team skipped by Alex Raymond with stallwarts John Larkin and Graeme Richardson.

Prairie Schooner Branch

The new executive for 1984 is as follows:

Vice-president	— Hugh Stewart, Gulf Canada
Secretary/Treasurer	— Ken Simpson, Shell Oil
Executive members	— Eroll Leighton, Dome Petroleum
	— Tom Lochart, Cansite
	— Ian MacMillan, Telefix Canada

Region du Québec

Les élections annuelles ont eu lieu en décembre et voici les résultats:

Vice-président	— Paul Bellemare
Secrétaire-trésorier	— J. M. Gervais
Conseiller	— Alain McDonald
	— Richard Sanfaçon

P. Bellmare, J. P. Racette, J. M. Gervais, R. Lepage et J. Y. Poudrier ont participé aux ateliers de travail en hydrographie à Victoria.

Félicitations à Lynda, la femme de Parick Hally qui a donné naissance à une petite fille nommée Vivia. Patrick a semblé bien assumer son rôle de père.

Il y a eu un réunion de l'exécutif de l'A.C.H. le 21 mars dernier et plusieurs point ont été discutés, notamment l'ausmentation de la cotisation pour 1984.

Aussi le 28 avril prochain, un cours d'introduction à la photogrammétrie sera offert aux membres en collaboration avec l'Université Laval.

Quebec Region

Our annual elections were held in December and here are the results:

Vice-president	— Paul Bellemare
Secretary/Treasurer	— J. M. Gervais
Executive members	— Alain McDonald
	— Richard Sanfaçon

P. Bellemare, J. P. Racette, J. M. Gervais, R. Lepage and J. Y. Poudrier participated in the Hydrographic Workshop held in Victoria.

Congratulations to Lynda, Patrick Hally's wife, who gave birth to a little girl whom they named Vivia. Patrick seems to be adjusted well to his new role as a father.

The branch executive held a meeting on March 21. The year's activities were discussed and the branch will increase its dues for 1984.

Next April 28 an introductory course in photogrammetry will be offered to our members. This will be done in collaboration with Laval University.

News from Industry

EPSCO

Westwood, Mass. (November 4, 1983) — EPSCO, Incorporated (O-T-C) announced the appointment of George Lariviere to Marketing Manager, EPSCO Marine. In his new position, Mr. Lariviere will be responsible for and will direct all marketing and sales activities of EPSCO Marine. Mr. Lariviere has over fifteen years of Commercial Marine Electronics experience in both technical marketing as well as direct field sales activities. Most recently, as General Manager of EPSCO Marine's Gulf Coast sales and distribution office located in Harahan, Louisiana, Mr. Lariviere was successful in building a broad marine electronic dealer base for the Company. In March, 1983, his marketing and sales responsibilities at EPSCO Marine were expanded to include both East Coast and Gulf Coast geographic territories.

Mr. Lariviere is a native of Maine and presently resides with his family in Marshfield, Massachusetts.

EPSCO, Incorporated designs, manufactures and markets marine navigation equipment, avionic systems, microwave instruments and special test and simulation equipment for military and commercial customers.

QUBIT

New Operations Manager: Patrick Brougham has been appointed Operations Manager at Qubit Ltd. Based at Aldershot, his responsibilities include day-to-day logistics in support of the mobilisation of the company's integrated navigation and survey systems.

Mr. Brougham has over 11 years experience in commercial hydrographic surveying. He joins Qubit having spent the past six years in Asia and the Far East as a senior surveyor with several leading international survey companies.

Further details of the appointment are available from Qubit Ltd., 251 Ash Road, Aldershot, Hants, England.

Senior Hydrographer: Dr. John Hunter has recently taken up a post as Senior Hydrographer at Qubit Ltd., manufacturers of integrated navigation, surveying and data collection systems. He will be responsible for technical direction and consultancy, with special emphasis on systems for hydrographic surveying and oceanographic applications. He will be based in the Austrailian office with regular periods at Qubit's European, and SE Asian establishments.

Dr. Hunter joins Qubit from University College, North Wales, Unit for Coastal and Estuarine Studies.

Klein Associates, Inc., Receives President's "E" Award

At a recent meeting of the New Hampshire International Trade Association, Martin Klein was presented with the President's "E" Award by Frank O'Connor, District Director of the U.S. Department of Commerce. The award is given by the President through the Department of Commerce to firms that exemplify excellence in exporting. The award dinner was hosted by the First New Hampshire Merchants National Bank.

To be considered for the "E" award, a firm must substantiate a sizeable increase in exports made each year during a three-year period. Klein Associates, Inc., currently exports equipment to over fifty countries throughout the world.

MAGNAVOX

Senior Vice President: James Litton has been appointed senior vice president. In addition to his new appointment, Litton will continue as General Manager of the Marine and Survey Systems Division and as a member of the MAPSC Board of Management.

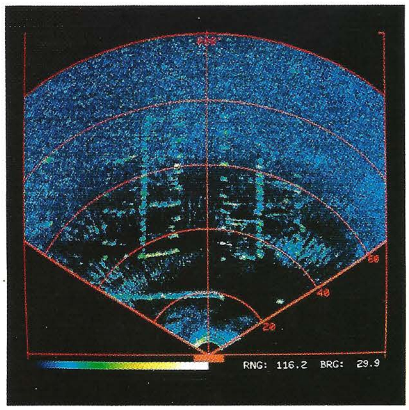
Litton joined Magnavox in 1966 and has served as Senior Systems Engineer, Manager of the Research Operation, Vice President and Director of Engineering and Research Operations, Vice President and Director of the Marine Systems Operation, and most recently, Vice President and General Manager of the Marine Survey Systems Division.

General Sales Manager: The Marine and Survey Systems Division of Magnavox Products & Systems Company has announced the appointment of Emile W. Achée as General Sales Manager. Achée will have responsibility for the Management of the Division's territorial sales team and U.S. Domestic and International Sales and Service Network of over 200 representatives.

Achée was formerly Director of Venture Planning with Rockwell International's Autonetics Division. He has more than 25 years experience in Military and Commercial Electronics, and is a graduate of the United States Naval Academy and the University of Southern California's Managerial Policy Institute.

NO OTHER SONAR COMES CLOSE.

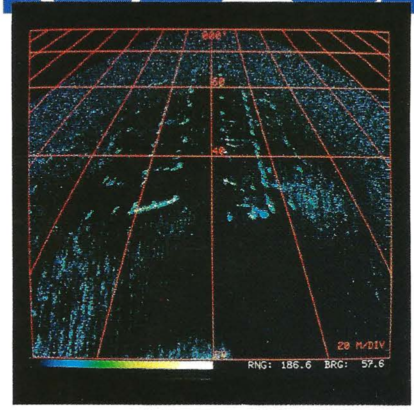
You need the best imaging sonar available. This is it — the 971. A colour imaging, multi-purpose miniature sonar. Best because it displays the widest range of signal levels. Because each of its 128 distinct colours represents a precise sound level. Because it has the highest definition — ¼ million pixels — to show the finest details. And because the colours and high definition produce breathtaking images.



Sector Mode: For Obstacle Avoidance

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

With the 971, you can 'see' as far as 100 metres. Compare that to a few metres with your eye or TV. Add the feature of five operating modes/display formats and you have an unrivalled versatility. For instance, the narrow sonar beam of the Sector Scan will detect even the smallest hazards and the display will reveal them. Perfectly. Switch to the unique Per-

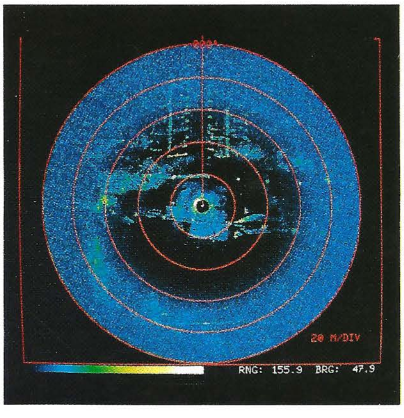


Perspective Mode: For Pilotage

spective Mode for Pilotage and a sound image of the outside world is presented with stunning realism. You 'fly' into the scene guided by the perspective grid.

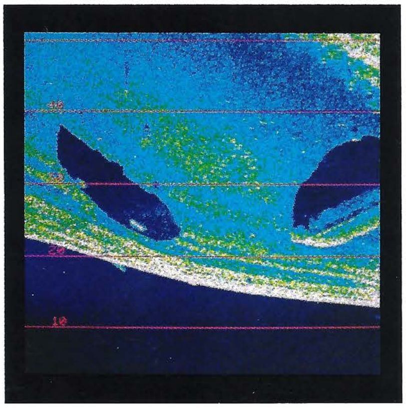
Switch to the Polar Scan Mode for General Surveillance. If a job calls for monitoring and controlling traffic at an oil rig, this mode will guide divers and vehicles directly to a rendezvous or work station. Constant monitoring can be achieved with an NTSC or PAL converter and a standard video recorder.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

Polar Mode: For General Surveillance. . .



Side-Scan is well known, but the 971's high definition colour display adds a completely new dimension. Surfaces are recognized by their signal strength, as shown by their colour. And targets which you miss with a regular sonar's limited on-screen range show clearly on the 971.

This much performance would normally require a rack full of equipment. Not so with the 971. The on-board processor is com-



Side Scan Mode: For Large Area Surveys. . .

pact, the Sonar Head is small and yet light enough to fit any ROV. Or to pass through drill strings, casings and sea chests.

Performance, versatility, size, value. Now you know.

No other sonar comes close.

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