Fisheries and Oceans | Pêches et Océans

"FROM LEADLINE TO LASER"

The Centennial Conference of the Canadian Hydrographic Service

1883-1983

Ottawa
April 5th to 8th

Canada

CANADIAN HYDROGRAPHIC SERVICE

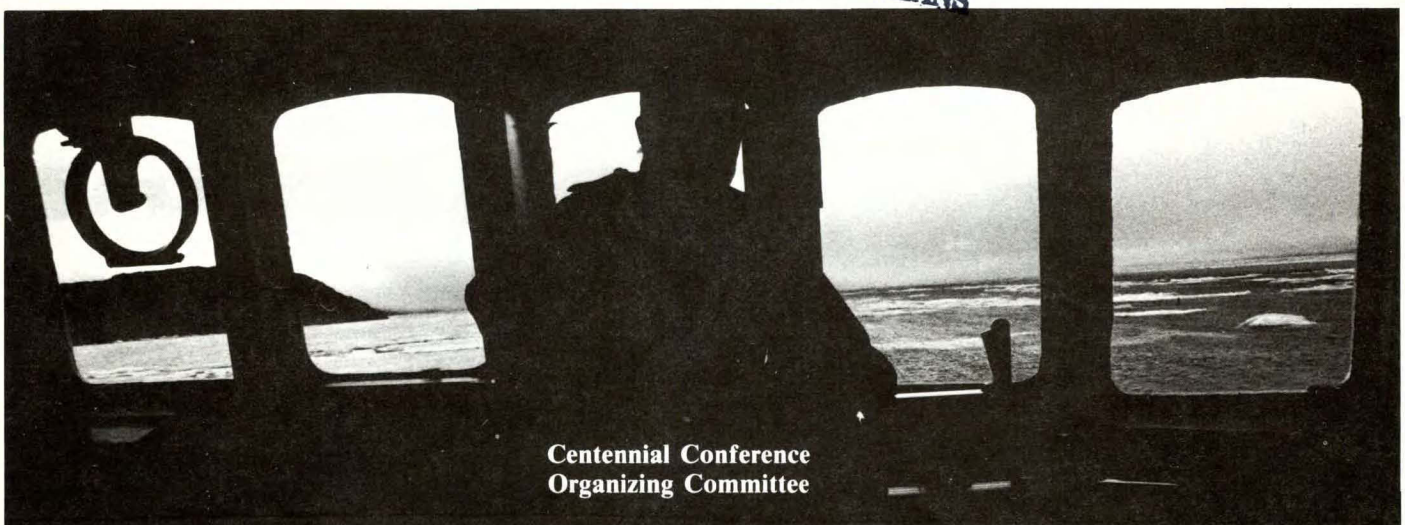

PHOTO: MIKE FOSTER

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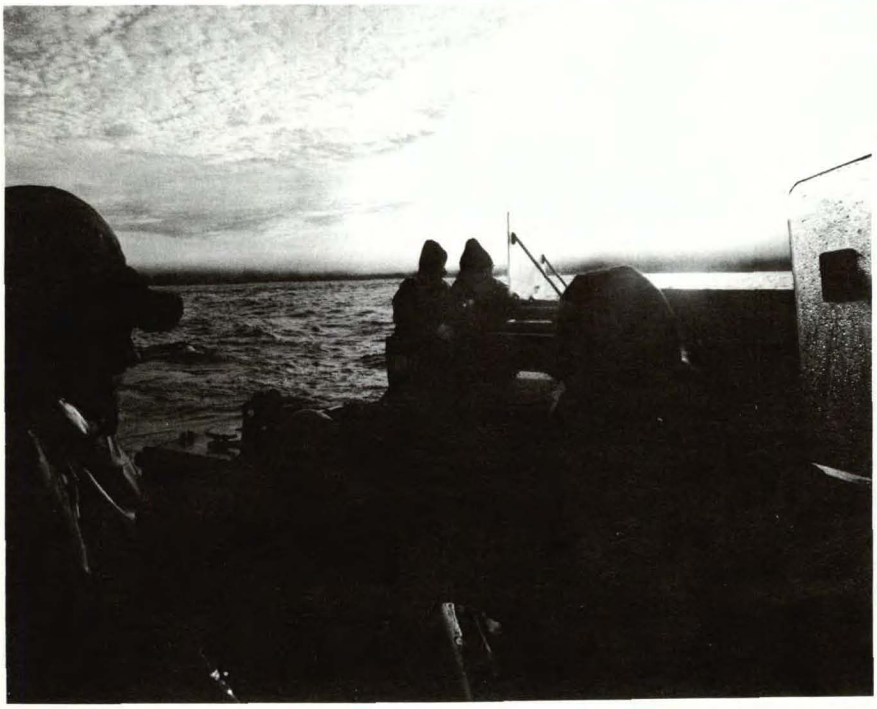


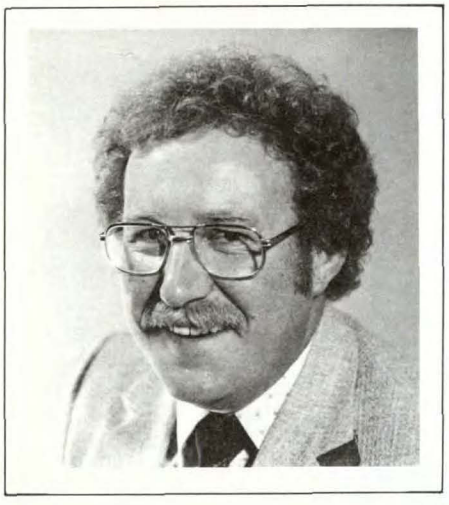
PHOTOS: MIKE FOSTER

WELCOME

It is my pleasure to welcome you to Centennial Conference of the Canadian Hydrographic Service. Like Canada, the Canadian Hydrographic Service has changed and grown over the past one hundred years. When you leave the conference, I think that you will have a better appreciation of what has been accomplished during the last century and a better idea of the direction that hydrography will take in the future.

May your deliberations be both interesting and fruitful.

Hon. Pierre De Bané,
Minister of Fisheries and Oceans



On behalf of the members of the Canadian Hydrographers Association, welcome to this Centennial Conference.

The Canadian Hydrographic Service is celebrating its 100th birthday at this conference and the Canadian Hydrographers Association is pleased to co-host this celebration.

The theme of this conference is "From Leadline to Laser".

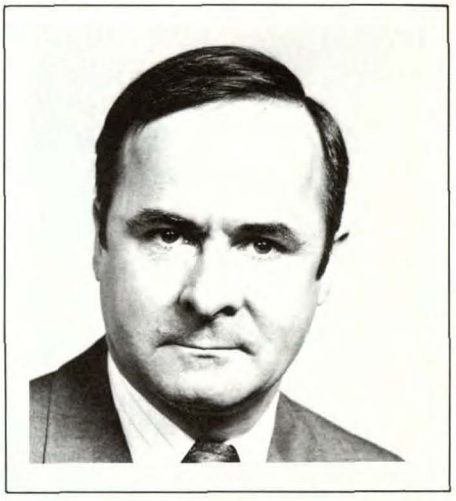
The technological distance between the leadline and the laser, while both enjoy solid-state reliability, is enormous. Hydrographers have travelled that distance by discussing their ideas, their experiences, their successes and their failures, at meetings such as this around the world.

This conference provides a forum for the exchange of information necessary to enable hydrographers to continue to travel through the next 100 years.

As hydrography and hydrographers advance into the era of laser depth sounding and beyond, it is typical and somewhat reassuring to see that they bring their leadlines along.

Thank you for coming, and welcome.

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



It is a great pleasure to formally welcome you to Ottawa and to the Centennial Conference of the Canadian Hydrographic Service. As was the case for our previous five conferences, we are pleased to co-host this event with the Canadian Hydrographers Association.

I would like to extend a special welcome to our foreign delegates and hope that you find all aspects of the conference educational and enjoyable. I am also pleased to welcome delegates from other government agencies, from the private sector and from the academic community. I also welcome the exhibitors, who contribute a great deal to the success of these conferences.

I wish to acknowledge the sterling efforts of Peter Richards and Jim Bruce, the Conference Co-Chairmen, and the Conference Committee. There is a great deal of work involved in organizing a conference of this nature and the Conference Committee are to be commended for their efforts.

To all delegates, welcome and thank you for coming. I wish you a happy stay in Ottawa and hope that each of you leave with fresh ideas and fond memories.

S.B. MacPhee, Director General
Canadian Hydrographic Service

CONFERENCE PROGRAM

Tuesday, 5 April

1600 - 1900	Registration, Government Conference Centre
1830 - 2100	"Icebreaker" Party Main Lounge, Government Conference Centre

Wednesday, 6 April

0830	Registration, Government Conference Centre
0915	Opening Ceremonies Main Hall, Government Conference Centre Conference Chairman P.D. Richards Official Opening of the Conference Hon. Pierre De Bané, P.C., M.P. Minister of Fisheries and Oceans Welcome by A.D. O'Connor President, Canadian Hydrographers Association Welcome and Review by the Director General Canadian Hydrographic Service S.B. MacPhee Opening of Exhibits Assistant Deputy Minister (Ocean Science & Surveys) Fisheries and Oceans G.N. Ewing
1000 - 1030	— Coffee —
1030	SESSION I — S.B. MacPhee (Chairman) Paper 1 — Three Centuries of French Hydrography in Canada. Ingénieur général de 1ere classe de l'armement J. BOURGOIN (Service hydrographique et océanographique de la Marine), France
1100	Paper 2 — The British Contribution to the Hydrography of Canada in the 18th and 19th Centuries. Rear Admiral D.W. HASLAM, C.B., O.B.E., FRICS (Hydrographic Department, Ministry of Defense), U.K.
1130	Paper 3 — Vignettes from Hydrography's Past. R.W. SANDILANDS (CHS Pacific Region), Canada
1200 - 1400	— Ladies Luncheon —
1400	SESSION II — R. Marshall (Chairman) Central Region, CHS Paper 4 — Improved Techniques of Short Period Tidal Analysis. A.S. FRANCO and J. HARRARI (Instituto de Pesquisas Tecnologicas do Estado de São Paulo) Brasil

1430	Paper 5 — Legal Liability of the Chartmaker. P.M. TROOP (Asst. Deputy Attorney General, Department of Justice) Canada
1500 - 1530	— Coffee —
1530	Paper 6 — Tidal Surveys in Canada. B.J. TAIT and L.F. KU (CHS Headquarters), Canada
1600	Paper 7 — Chart Latticing — Past, Present and Future. D.H. GRAY (CHS Headquarters), Canada
1630	Paper 8 — Global Positioning System Navigation — Offshore Canadian East Coast. G. LACHAPELLE (Nortech) D. WELLS (University of New Brunswick) and R.M. EATON (CHS Atlantic Region), Canada
1700	Paper 9 — Exploring Arctic Seas — today and yesteryear. A.J. KERR (CHS Atlantic Region) and N.M. ANDERSON (CHS Headquarters), Canada
1730 -2030	— Beer Seminar — Main Lounge, Government Conference Centre

Thursday, 7 April

0900	SESSION III — G.W. Henderson (Chairman) Atlantic Region, CHS
	Paper 10 — Surveying a Shipping Corridor Through the Beaufort Sea. J. VOSBURGH (CHS Pacific Region), Canada
0930	Paper 11 — Side Scan Sonar — An Alternative to Wire-Drag for Item Investigations. Lt. D.H. PETERSON (National Ocean Survey) United States
1000 -1030	— Coffee —
1030	Paper 12 — UNITED STATES NAVAL OCEANOGRAPHIC OFFICE Hydrographic Survey Operations, 1972-82. M.F. VAN NORDEN (NAVOCEANO, Bay St. Louis, Mississippi) United States
1100	Paper 13 — Airborne Hydrography Techniques — An Evaluation. D. MONAHAN and Aerial Hydrography Project Team*, Canada
1130	Paper 14 — Beginning of the Second 100 Years — The Laser Sounder. M. CASEY and the Aerial Hydrography Project Team*, Canada
	* N.M. Anderson, CHS Headquarters P. Bellemare, CHS Quebec Region M. Casey, CHS Central Region K. Malone, CHS Atlantic Region R. MacDougall, CHS Central Region D. Monahan, CHS Headquarters R. O'Neill, Canada Centre for Remote Sensing S. Till, Canada Centre for Remote Sensing
1200 - 1400	— Lunch — Ladies Luncheon, The Courtyard Restaurant Byward Market

1400	SESSION IV — W.S. Crowther (Chairman) Pacific Region, CHS
	Paper 15 — Bathymetry and Its Utilization to Define Short-Term Events on the Upper Amazon River. J.B. FITZPATRICK (Acres International), Canada C. GAMARRA, Peruvian Navy, Peru.
1430	Paper 16 — Report on DMA's Prototype Graphics From Enhanced Landsat Imagery for Application to Hydrographic Charting. A. NAYLOR and W.H. LaFOLLETTE (U.S. Defense Mapping Agency), United States
1500 - 1530	— Coffee —
1530	Paper 17 — Multiparameter Surveys in the Offshore: Broadening the Dimensions of Hydrography. R. MacNAB (Atlantic Geoscience Centre), Canada
1600	Paper 18 — Automation Today — Scratching the 19-Year Itch. G. MACDONALD (CHS Central Region), Canada
1630	Paper 19 — Dr. Dorsey's Electronic Leadline. Capt. C.W. HAYES (National Ocean Survey), United States
1900 - 0100	— Dinner Dance — Nepean Sportsplex
	Buses start to leave the Mackenzie Street Entrance to the Chateau Laurier at 1830 hours and start to return from the Sportsplex at 2300 hours.

Friday, 8 April

0900	SESSION V — P. Bellemare (Chairman) Quebec Region, CHS
	Paper 20 — A Scientific Research Approach to Effective Design for Nautical Charts. R. PERROTTE (CHS Atlantic Region), Canada
0930	Paper 21 — The Measurement by Acoustic Telemetry. Dr. S.D. MORGERA, C. COLE and K. REUBEN (Concordia University), D.F. DINN (Atlantic Oceanographic Laboratory). Canada
1000 - 1030	— Coffee —
1030	Paper 22 — Common Datum Charts of the Straits of Malacca and Singapore. K. YASHIMA (Hydrographic Department), Japan
1100	Paper 23 — The Electronic Chart. N.M. ANDERSON (CHS Headquarters), R.M. EATON (CHS Atlantic Region), T.V. EVANGELATOS (CHS Headquarters), Canada
1130	Paper 24 — The Use of Loran-C in the Canadian Fishing Fleet. F.H. KOLLS (Integrated Geoscience Mapping Services) and D.E. WELLS (University of New Brunswick), Canada
1200 - 1400	— Centennial Luncheon — Main Foyer, National Arts Centre
	Guest Speaker — His Excellency, the Honourable Edward Schreyer Governor General of Canada

SOCIAL PROGRAM

An "Icebreaker" party will be held on Tuesday, April 5, in the Main Lounge of the Government Conference Centre, between 1830 and 2100 hours. Wine and cheese will be served. It is not necessary for delegates to register before attending this welcoming party.

A bus tour of Ottawa will leave the Mackenzie Avenue entrance to the Chateau Laurier on Wednesday, April 6 at 0930 hours and will be followed by lunch.

A "Beer" Seminar will be held in the Main Lounge of the Government Conference Centre between 1730 and 2030 hours on Wednesday evening. A commemorative tankard will be presented to each delegate attending the seminar. Tickets for this event cost $6.00.

A walking tour of the historic Byward Market area will start from the Ladies Hospitality Suite in the Château Laurier at 1000 hours on Thursday morning. It will finish with lunch at the restored Courtyard Restaurant. There will be no charge for the tour but those attending will pay for their own lunch. A bus will leave the Mackenzie Avenue entrance again at 1500 hours for tea at the residence of the Governor General.

A Dinner Dance, sponsored by the Canadian Hydrographers Association, will be held on Thursday, April 7 starting at 1900 hours in Salons A and B of the Nepean Sportsplex. After dinner, Admiral Bayfield will reminisce on the trials and tribulations of a pioneer hydrographer on the Great Lakes in the early 19th century. Dance to the music of Omnibus, a five-piece orchestra from 2100 hours to 0100 hours. Tickets cost $25.00 per person.

Buses will leave the Mackenzie Avenue entrance to the Château Laurier at 1830 hours, picking up delegates at the Lord Elgin and Skyline hotels. A service back to the hotels will start at 2300 hours.

On Friday, April 8, there will be a tour of the National Arts Centre leaving from the Ladies Hospitality Suite at 1100 hours.

The Centennial Luncheon of the Canadian Hydrographic Conference will be held in the foyer of the National Arts Centre from 1200 to 1400 hours on Friday, April 8. A cash bar will be open at 1200 hours. The guests of honour will be their Excellencies, the Governor General, the Honourable Edward Schreyer and Mrs. Lily Schreyer. His Excellency will be the after-luncheon speaker. The tickets for the luncheon cost $15.00.

There will be a hospitality suite for all delegates in the Château Laurier. It will be open during the lunch breaks on Tuesday and Wednesday, and from 1700 to 1830 hours on Thursday.

The Ladies Hospitality Suite in the Château Laurier will be open for coffee from 0830 to 0930 hours on Wednesday, from 0900 to 1000 hours on Thursday and 0930 to 1045 hours on Friday.

PHOTO: MIKE FOSTER

"FROM LEADLINE TO LASER"

In 1882 during a violent storm, the steamer Asia foundered in Georgian Bay with the loss of 150 lives. Originally it was thought that the ship had struck an uncharted shoal and a strong case was made that the charts surveyed 50 years earlier by Lt. Bayfield were no longer adequate for the much larger iron steamers then in use.

Staff Commander J.G. Boulton was loaned to the Canadian government by the British Admiralty and in 1883 single-handedly began a new survey of Georgian Bay. The next year he was joined by Wm. J. Stewart, newly graduated from the Royal Military College. In 1893, the Canadian Tide and Current Survey was established under Dr. W. Bell Dawson.

Until 1903, the surveys were engraved as Admiralty Charts. The first Canadian chart was drawn and printed in 1903. In 1904, the Canadian Hydrographic Service was formally established and later that year began to take over responsibility for coastal surveys from the Admiralty. The last British survey ships were withdrawn from the Pacific Coast in 1911 and the Atlantic Coast in 1912.

The Canadian Hydrographic Service is now an element of the Ocean Science and Surveys sector of the Department of Fisheries and Oceans. Its headquarters is in Ottawa and there are four regional centres: Bedford Institute of Oceanography, Dartmouth, Nova Scotia; Champlain Centre for Marine Science and Surveys; Gare Maritime, Quebec City, Quebec; Bayfield Laboratory for Marine Science and Surveys, Canada Centre for Inland Waters, Burlington, Ontario; and the Institute of Ocean Sciences, Patricia Bay, B.C. It is an active member of the International Hydrographic Organization headquartered in Monaco.

The main task of hydrographers is to survey Canada's navigable waters.

They also collect data on current speed and direction, obtain samples of the sea floor and check the positions of fixed and floating aids to navigation.

In cooperation with scientists from the Department of Energy, Mines and Resources, offshore surveys are carried out to collect information on bathymetry, the roughness and composition of the bottom, gravity and the earth's magnetic field, all of which are vital in the search for offshore resources.

PHOTO: MIKE FOSTER

Permanent water level gauges are maintained along Canada's coastal and major inland waterways to provide a continuing record of tides and water levels. The Canadian Hydrographic Service also maintains two telemetering gauges on the west coast which are a vital part of Tsunami (tidal wave) Warning System.

The Canadian Hydrographic Service has published over 1,000 navigation charts and sells 500,000 annually through a dealer network that covers the world.

Charts are updated through Notices to Mariners published weekly by Transport Canada. These notices report changes in aids-to-navigation, such as new buoy positions, newly discovered dangers to navigation, and dredging. New editions of charts are issued as new information is obtained from new or revisory surveys or is supplied by other agencies, including numerous MAREP reports received from members of the Canadian Power Squadrons.

Canadian Hydrographic Service Sailing Directions and Small Craft Guides contain supplementary information to charts such as photos of harbours, distance tables and details of harbour and marine facilities. The Service also issues annual Tide and Current Tables for the coasts of Canada and a monthly Water Level Bulletin for the Great Lakes and connecting waterways.

Natural Resource maps or charts are also published showing bathymetry, gravity and magnetic field over Canada's continental margin. Other charts showing the composition or morphology of the bottom are also issued.

The Canadian Hydrographic Service has just completed the publication of the Fifth Edition of the General Bathymetric Chart of the Oceans (GEBCO). Sponsored jointly by the International Hydrographic Organization and the International Oceanographic Commission of UNESCO, the 18 sheets are most authoritative data available showing man's knowledge of the deep oceans.

ABSTRACTS OF PAPERS

1 THREE CENTURIES OF FRENCH HYDROGRAPHY IN CANADA

Jean Bourgoin, Ingénieur général, Service hydrographique et océanographique de la Marine, Paris, France

French hydrography in Canada can be divided into four phases:

— the first phase (1500-1605) is related to the discovery of the New World and the conquest of Canada by France. Influenced by the Dieppe school, the cartography is marked by charts at a very small scale and by route surveys along the main river arteries;

— the second phase (1605-1665) which begins with colonisation is characterised by uncoordinated exploration;

— the third phase (1665-1775) is marked by the acceptance of responsibility for hydrography by the state and major technical progress. This resulted in charts compiled from better surveys based upon more accurate positions;

— the fourth phase (after 1775) saw the general adoption of modern techniques for French and British chart-making in Canadian Waters.

2 THE BRITISH CONTRIBUTION TO THE HYDROGRAPHY OF CANADA IN THE 18TH AND 19TH CENTURIES

Rear Admiral D.W. Haslam, C.B., O.B.E., F.R.I.C.S. Hydrographer of the Navy

Abstract not received

3 VIGNETTES FROM HYDROGRAPHY'S PAST

R.W. Sandilands, Canadian Hydrographic Service, (Pacific Region)

This paper takes a non-technical and humorous look at our predecessors in Canadian hydrography. It touches on the value of history to the modern hydrographer and from historical records and personal correspondence of the day shows that the problems faced by yesterday's hydrographers are frequently the same as those faced today by the field-man, the cartographer, Ship Division management and administrators.

4 IMPROVED TECHNIQUES OF SHORT PERIOD TIDAL ANALYSIS

A.S. Franco and J. Harrari, Instituto de Pesquisas Tecnologicas do Estado de Sao Paulo S.A./Instituto Oceanografico da Universidade de Sao Paulo, Brasil

Spectral methods of tidal analysis used in Brazil from 1971 onwards have been improved to analyse short tidal records. In addition, a cross-analysis of short spans with the predicted tide of another place proved to be very fast and accurate enough to justify its current use. The predicted tide for Cananeia was used as driving function in cross-analyses with the observed tide in Ubatuba for several spans. The two places are about 300 km apart and have very different topography. Notwithstanding, high coherences were found even for the frequency corresponding to shallow-water constituents.

5 THE LEGAL LIABILITY OF THE CHARTMAKER

Peter M. Troop, Assistant Deputy Attorney General, (Admiralty and Maritime Law), Department of Justice, Ottawa, Ontario

Recent developments in the law have imposed increased liability and responsibility on government departments and agencies providing services to the public. The Canadian Hydrographic Service as the Crown agency providing reliable information to the marine navigator must be aware of the legal responsibilities and duties and the extent to which the Crown may be liable for shipping casualties and other marine accidents.

The degree of reliance placed on charts and other nautical publications of the C.H.S. potentially expose the Government of Canada, under the *Crown Liability Act* to claims by ship and cargo owners for damages ranging up to many millions of dollars based upon misleading or inaccurate charts. Members of the C.H.S. need to be aware of this responsibility and take all necessary measures to protect and to limit this potential exposure of the Government of Canada. The importance of the C.H.S. establishing standards of excellence and providing for mechanisms to ensure that these standards of excellence are met is emphasized. Special reference is made to the legal problems associated with contracting out of surveys and other scientific investigations and the manner by which the Crown can discharge its responsibility and limit its liability therefore.

The heavy reliance by government and the marine public on the hydrographer's credibility and expertise is also described as well as the use to

which the information and results are put. The legal problems associated with changing technology, new procedures and the updating of older charts and publications to meet modern charting standards are reviewed and discussed.

6 TIDAL SURVEYS IN CANADA

B.J. Tait and L.F. Ku, Tides, Currents and Water Levels, Canadian Hydrographic Service, Ottawa

This paper will present a perspective of the history of tidal and tidal current surveying in Canada, highlighting the development of surveying techniques, instrument technology, data processing and archiving procedures, and analysis and prediction methods. Individuals making prominent contributions to the above fields will be mentioned. Major organizational changes that have taken place over the years will be described. The present-day status of tidal surveying in Canada and the perceived future needs for this type of work will be presented.

7 CHART LATTICING — PAST, PRESENT AND FUTURE

David H. Gray, Canadian Hydrographic Service, Ottawa

Hyperbolic radio navigation systems have been shown on Canadian Hydrographic Service charts since the 1950's. The author traces the development of the various systems: Loran-A, Decca and Loran-C and the draughting methods by which they were drawn on charts. The accuracies of these systems, alternate systems presently available and future systems are compared. The author foresees the demise of the present-day latticed chart with the advent of other positioning systems and with the commercial production of automatic co-ordinate converters and plotters and the possibility of charts displayed in video screen images.

PHOTO: MIKE FOSTER

8 GLOBAL POSITIONING SYSTEM NAVIGATION — OFFSHORE CANADIAN EAST COAST

G. Lachapelle, Nortech Surveys (Canada) Inc., D. Wells and S. Mertikas, University of New Brunswick, R.M. Eaton, Atlantic Region, CHS
Abstract not received

9 EXPLORING ARCTIC SEAS — TODAY AND YESTERYEAR

Neil M. Anderson and Adam J. Kerr, Canadian Hydrographic Service, Headquarters and Atlantic Region

The surveys of beaches and routes in preparation for landing supplies for the Dewline set off a new wave of Arctic hydrographic exploration. This was followed by the unique through-the-ice sounding operation with the Polar Continental Shelf Project and more recently the major surveys carried out in the Beaufort Sea and throughout the Northwest Passage in preparation for the transportation of oil and gas through these Arctic Seas. Hydrographers on all these surveys have followed in the footsteps of the British Navy expeditions in the nineteenth century. Survey bases have often been established on the same plot where those early explorers had wintered, such as at Winter Harbour where Lieutenant Parry spent the winter in 1822 and at Beechey Island from where Franklin set off on his ill-fated voyage. This paper discusses the surveys both old and new, comparing the conditions under which the hydrographers worked and the results they achieved.

10 SURVEYING A SHIPPING CORRIDOR THROUGH THE BEAUFORT SEA

J. Vosburgh, Canadian Hydrographic Service, Pacific Region

Canada's Arctic island gas and Beaufort Sea oil have provided the impetus for major hydrographic undertakings in search

of safe navigational routes to the southern refineries and markets. The projected VLCC and LNG traffic scenarios to remove the hydrocarbon resources have demonstrated an inadequacy in our existing Arctic charting. This paper deals with Pacific Regions's commitment to surveying a shipping corridor across the shallow Beaufort Shelf against a backdrop of submarine pingo-like-features, artificial islands, and drillships.

11 SIDE SCAN SONAR — AN ALTERNATIVE TO WIRE-DRAG FOR ITEM INVESTIGATIONS

Lieutenant David H. Peterson, NOAA, Hydrographic Surveys Division, National Ocean Survey, NOAA, Rockville, Maryland

Since 1906, the National Ocean Survey (NOS) and its predecessors have mainly relied on standard wire-drag methods for conducting investigations to verify or disprove the existence of reported dangers to navigation. While generally a tried-and-true method for covering the large search areas involved, wire-drag is often a time-consuming operation. Because of this, it usually proves to be inefficient when prosecuted by vessels and parties not specially equipped for it. As a consequence, many investigations, particularly for offshore items, are deferred to the special wire-drag vessels, RUDE and HECK, reducing the number of investigations completed during a field season.

To alleviate the continued deferral of these investigations, NOS has recently approved the use of side scan sonar by all hydrographic ships and field parties as an alternative to wire-drag for conducting searches to locate reported dangers. A new surveying policy has also been established which permits the acceptance of negative side scan sonar searches as presumptive evidence of a reported danger's nonexistence. This paper describes the present NOS policy and procedures for using side scan sonar when investigating dangers.

12 U.S. NAVAL OCEANOGRAPHIC OFFICE, HYDROGRAPHIC SURVEY OPERATIONS, 1972-1982

Maxim F. van Norden, U.S. Naval Oceanographic Office, Bay St. Louis, Mississippi 39522

The U.S. Naval Oceanographic Office (NAVOCEANO) located at the National Space Technology Laboratories, Bay St. Louis, Mississippi, conducts oceanographic, geophysical, and hydrographic survey operations with 12 Military Sealift Command ships (MSC) under NAVOCEANO technical control and three specially modified P-3 Navy aircraft operated by Squadron VXN8. Since 1830 when NAVOCEANO began as the Depot of Charts and Instruments, the Office has been in the forefront of hydrographic survey practice.

1972 marked the beginning of a new era in hydrography for the U.S. Naval Oceanographic Office. First, chart compilation, production, printing and distribution functions were separated from NAVOCEANO and combined with similar Army and Air Force mapping functions to form the Defense Mapping Agency (DMA). This reorganization left NAVOCEANO with the responsibility to collect the hydrographic data. Second, two new ships, USNS CHAUVENET and USNS HARKNESS, began hydrographic survey operations. These ships, unlike previous Navy hydrographic ships which had military crews, are crewed by civilian mariners employed by Military Sealift Command (MSC) with an embarked Navy Oceanographic Unit (OCEANOUNIT) to conduct survey operations.

This paper will discuss the world-wide hydrographic survey operations conducted by the U.S. Naval Oceanographic Office from 1972 to 1982 including the resources and programs used to collect hydrographic data. The operations and programs described will include those by USNS CHAUVENET and USNS HARKNESS; the Hydrographic Survey Assistance Program (HYSAP) which provides participating countries with technical resources and advice to conduct their own surveys and produce charts; the Hydrographic Contracts (HYCON) program which uses private contractors to survey selected areas where it is cost-effective to the Navy; national and international cooperative surveys in the Caribbean area; and independent survey teams using other Navy ships, portable boats, or locally hired vessels. Furthermore, this paper will describe the expansion of NAVOCEANO's survey resources and capabilities including the implementation of such systems as the Hydrographic-Oceanographic Data Acquisition System (HODAS), Global Positioning System (GPS), the Hydrographic Airborne Laser (HALS), the Sea Beam Multibeam Sonar, the Hydrographic Information Handling System (HIHAN) and the Active/Passive Multi-Spectral Scanner (A/PMSS).

13 AIRBORNE HYDROGRAPHY TECHNIQUES — AN EVALUATION

The Aerial Hydrography Project Team
N. Anderson, CHS Headquarters
P. Bellemare, CHS Québec Region
M. Casey, CHS Central Region
K. Malone, CHS Atlantic Region
R. MacDougall, CHS Central Region

D. Monahan, CHS Headquarters
R. O'Neill, Canada Centre for Remote Sensing
S. Till, Canada Centre for Remote Sensing

The Canadian Hydrographic Service has to date tested the following airborne techniques: Conventional Photography, fixed baselength simultaneous photogrammetry, photo-interpretation, multi-spectral scanning and the laser sounder. This paper outlines the successes to date and points the way to a fully operational, integrated system, obtainable within the next few years.

14 BEGINNING THE SECOND HUNDRED YEARS — THE LASER SOUNDER

The Aerial Hydrography Project Team
N. Anderson, CHS Headquarters
P. Bellemare, CHS Québec Region
M. Casey, CHS Central Region
K. Malone, CHS Atlantic Region
R. MacDougall, CHS Central Region
D. Monahan, CHS Headquarters
R. O'Neill, Canada Centre for Remote Sensing
S. Till, Canada Centre for Remote Sensing

The Airborne Laser-based Lidar Sounder is, at this Hundredth Anniversary, sufficiently advanced in design and testing to indicate that it represents viable technology for some time into the second one hundred years of hydrography in Canada. It offers advantages of speed and mobility over a vessel-mounted echo-sounder in much the same way as the acoustic echo-sounder offered speed and mobility over the leadline. This paper presents an overview of the system now flying, an evaluation of results to date, and indicates the future development and deployment of this second-century device.

15 BATHYMETRY AND ITS UTILIZATION TO DEFINE SHORT-TERM EVENTS ON THE UPPER AMAZON

James Barry FitzPatrick, Acres International Limited, Niagara Falls, Ont. Lt. Carlos Gamarra, Directorate of Hydrography and Navigation, Peruvian Navy

The importance of the Upper Amazon in the long-term role to the economic growth of the region has warranted the initiation of a hydrological data-collection program with the view of predicting efficient utilization of specific areas of this dramatically changing river system. The Peruvian city of Pucallpa on the Ucayali River is one of three sites which have recently received joint Canadian/Peruvian-designed port installations. The predicted siltation that has occurred close to the port has materialized and concentrated monitoring of the river bottom was therefore included in the first phase of the program. Utilizing excellent bathymetry has resulted in the opportunity to examine chronologically, recent events in this part of the river. Flows of nearly 20 000 m^3/per sec (about 4 times that of the Niagara) and sediment loads of nearly a half-million tons per day were measured. This paper describes the first phase of this ongoing project which is being financed by the World Bank and carried out on behalf of the Directorate of Water Transport (DGTA) of the Peruvian Ministry of Transport and Communications. The Canadian author acted as advisor to the program and worked closely with the Directorate of Hydrography and Navigation (DHNM) of the Peruvian Navy who were contracted by DGTA to carry out the field measurements.

16 REPORT ON DMA'S PROTOTYPE GRAPHICS FROM ENHANCED LANDSAT IMAGERY FOR PRESURVEY AND CHART MAINTENANCE SUPPORT

A. Naylor, Defense Mapping Agency, and W.H. LaFollette U.S. Department of Defense, Washington, D.C.

The Defense Mapping Agency (DMA) is currently developing prototype graphics from remotely sensed imagery for support to hydrographic survey planning and DMA's nautical chart maintenance program. The imagery for these prototypes is Landsat scenes that are enhanced by digital image processing techniques, or processed totally in an analog mode for quick response requirements. This paper discusses these processing approaches within the framework of the prototype efforts. Landsat's multi-spectral scanner imagery in the Makassar Strait of Indonesia is computer-enhanced to highlight hydrographic information such as shoals, uncover areas, land-water boundaries, and shallow water depth intervals. These enhancements are graphically presented in a variety of scales, formats, and color assignments representing three approaches to computer enhancements:

1. Colour enhanced density slicing performed by DMA.
2. Relative water depth interval calculations performed by the Environmental Research Institute of Michigan for DMA.
3. Optimized portrayal of shallow submerged features performed by the Earth Satellite Corporation.

To produce quick-response graphics, the analog approach to enhancement involves the use of a colour-additive viewer and multi-scale projector/viewer for analysis of multi-spectral/multi-temporal

Landsat film. The prototype graphics using this approach were developed to support DMA's chart-maintenance program, but could be used as a tool for survey planning in shallow waters.

17 **MULTIPARAMETER SURVEYS IN THE OFFSHORE: BROADENING THE DIMENSIONS OF HYDROGRAPHY**

Ron Macnab, Atlantic Geoscience Centre, Dartmouth, N.S.

For nearly two decades, the Canadian Hydrographic Service has collaborated with components of the Department of Energy, Mines and Resources in the conduct of multiparameter surveys in offshore waters. These surveys have expanded the hydrographer's traditional role of measuring water depth to include the measurement of marine gravity, magnetics, sediment thickness and reflectivity. Combined operations have significantly enhanced our capacity to gather information with only a modest increase in cost. For instance, a typical ice-reinforced vessel equipped with echo-sounder, navigation equipment, and computer facilities can cost upwards of $25,000 daily; adding a gravimeter and magnetometer can cost as little as $2,000 per day, including the services of one maintenance technician.

Since the inception of the program, survey cruises have collected on the average 23,000 line-kilometres of data per year in Canada's east coast offshore. This data is published in a variety of forms (including the Natural Resource Map series) and contributes to studies that describe the history and characteristics of the submerged part of the Canadian landmass, and of the adjacent ocean floor. Studies based on such data sets include those concerning the opening of Labrador Sea, structure of the Scotian margin, and offshore extension of the Appalachians. The success of combined operations has been due in part to the relative ease with which the skills and training of hydrographers have been broadened to include geophysical surveying, as well as to the discipline and enthusiasm of field hydrographers who have been assigned to the program.

18 **AUTOMATION TODAY — SCRATCHING THE 19-YEAR ITCH**

George Macdonald, Canadian Hydrographic Service, Burlington, Ontario

For 19 years the Canadian Hydrographic Service has used computers to collect or process hydrographic data. Early attempts to use computers in the field were not well accepted because logging methods were not dependable, sounding data contained errors, processing methods were slow and cumbersome, and equipment was large and heavy. Recent low-cost, mass-produced, small, easy-to-use computers have had an impact on automation from the space race to the automotive industry, from banking to weaving. Children use computers every day in schools, and a home computer is becoming less the exception and more the rule.

Still, for the hydrographer, the computer has often appeared to stand in the way of production. Experiences with early systems may have led to scepticism and a reluctance to try the next generation of hardware. Software-processing techniques have been relatively stable, but after 19 years of trying, less than ten per cent of the hydrographic surveys being conducted in Canada today are automated. So why automate?

The paper will attempt to analyse the rationale behind efforts to automate hydrographic data collecting and processing techniques, while taking a critical look at the existing automation scheme. Recommendations on methods of assimilating automated systems into present hydrographic field programs will be offered.

19 **DR. DORSEY'S ELECTRONIC LEAD LINE; THE U.S. COAST AND GEODETIC SURVEY'S HYDROGRAPHIC SURVEY ECHO-SOUNDER DEVELOPMENT 1924-1939**

Capt. C. William Hayes, NOAA, Associate Director, Marine Surveys and Maps, National Ocean Survey, NOAA, Rockville, Maryland 20852

The development of the hydrographic survey echo-sounder by the U.S. Coast and Geodetic Survey (USC&GS) was the outgrowth of antisubmarine warfare technology developed during World War 1. Today the echo-sounder is the backbone of hydrographic survey operations worldwide. This paper is based on a long-forgotten file spanning the years from 1924 to 1939, the anecdotes and rememberances of some old-timers and the official journals and documents of the National Ocean Survey's predecessor, the USC&GS. The excerpts from the file are often humorous and historically enlightening. The technology itself is for the most part primitive and is described briefly in that context. Probably the most significant aspect is the cooperative relationship between industry and government which achieved the objective with a minimum amount of paperwork, specifications, and contract squabbles. Oh, for the good old days.

20 A SCIENTIFIC RESEARCH APPROACH TO EFFECTIVE DESIGN FOR NAUTICAL CHARTS

Roland Perrotte, Cartographic Research Unit, Canadian Hydrographic Service Atlantic Region

The need for improved nautical chart design has recently been identified. Cumulative addition of various data and the resulting visual clutter are examples of actual problems calling for studies in this field. As has been demonstrated in studies of aeronautical charting, effective communication of navigational information can be achieved through the choice of appropriate graphic solutions. Research on effective graphic encoding should permit optimization of information transfer from the cartographer to the navigator and other users. Cartographic communication theory can provide an organized framework to initiate studies on improved chart encoding. In the past, cartographers' personal impressions and experience have led the way in nautical chart design. Such indirect research methods were lacking in objectivity. Some limited improvement followed with users' satisfaction surveys about the product (the chart). Although more oriented towards direct research methods, which involve consulting users, such inquiries were still overcast by subjectivity. Better ways must now be sought and a cartographic communication approach relying on objective evaluation should lead the way. Since there is no single universal way to display any given topic on the chart, experimentation will often bring numerous alternative designs. However, the final choice and standardization of a graphic solution for publication should be considered improper without adequate assessment. Thus, practical measurement of the reliability of proposed chart designs must be achieved through systematic testing with subjects. Close examination of confirmed cartographic theories and concrete results from other fields of cartographic communication will also provide solid ground for efficient design by extending these previous findings to the nautical chart when justified.

Adoption of direct research methodology will bring the marine cartographer to the realm of scientific research since the successive steps of scientific experimentation are closely followed. The normal chart-use conditions are then investigated and simulated to measure the perceptual reactions of the users on specific problems needing investigation. Eventual chart-design recommendations resulting from this type of research will benefit from scientific enhancement.

This paper introduces these concepts in relation to the nautical chart and shows how two typical chart-design characteristics (sea floor representation and the use of colour) could be investigated through this approach.

PHOTO: MIKE FOSTER

21 TIDE MEASUREMENT BY ACOUSTIC TELEMETRY

Salvatore D. Morgera, Cedric Cole and K. Reuben, Concordia University, Montreal, Que., and Donald F. Dinn, Bedford Institute of Oceanography, Dartmouth, N.S.

A significant disadvantage of measuring with bottom-mounted tide gauges is that tidal information can be obtained only upon recovery of the instrument at the completion of the survey. This disadvantage may be overcome by the use of a bottom-mounted tide gauge which can transmit to the survey ship, on demand, the tidal data gathered over a period ranging from days to several weeks. A device of this type allows the hydrographer to maintain an up-to-date account of corrected soundings and greatly expedites the progress of a hydrographic survey, especially in the Arctic.

To this end a prototype acoustic telemetry system has been developed and tested by Concordia University for the Bedford Institute of Oceanography. This system is described in two parts: Part I: Tide Measurement by Acoustic Telemetry — The Bottom Unit, and Part II: Tide Measurement by Acoustic Telemetry — The Deck Unit. The

system described meets the following requirements: (1) To interface with standard tide gauges, (2) To operate reliably in shallow water where severe mulitpath conditions exist, (3) To be self-powered (bottom unit) with a lifetime of > one year, (4) To transmit data at > 30 bps, (5) To achieve bit error rates of $< 10^{-5}$, (6) To acoustically communicate over ranges of $\leqslant$ 1 km, and (7) To be operable from a ship, launch, or helicopter (deck unit). Test results and actual system performance are also discussed. The concepts designed into the equipment readily lend themselves to applications other than hydrographic surveying and oceanography. Because of the high data quality possible, the system can be adopted to a number of civil and military uses. These include the control of seafloor instruments associated with oil exploration and extraction, submarine cable performance monitoring, pollution or water quality monitoring, and the control of submersible vehicles used in ocean exploration and defense.

22 COMMON DATUM CHARTS OF THE MALACCA AND SINGAPORE STRAITS

Kunio Yashima, Hydrographic Department, Tokyo, Japan

The Malacca and Singapore Straits provide an important route for maritime traffic. On the existing nautical charts, however, discrepancies have been found in geographical positions due to the different geodetic systems being used on the Peninsular Malaysia-Singapore side and the Indonesian side of the Straits.

In 1977, Indonesia, Japan, Malaysia and Singapore agreed to produce jointly charts of the Straits based on a common datum point to eliminate such discrepancies. This project comprised Phase I and Phase II. In Phase I from 1977 to 1979, three sheets of the Common Datum Charts, two on a scale of 1:50,000 and one on 1:75,000, were produced to cover the Singapore Strait. In Phase II from 1980 to 1982, three other sheets each on a scale of 1:200,000 covering both of the Straits were produced by utilizing the results of a satellite geodetic survey carried out by a joint team.

23 THE ELECTRONIC CHART

R.M. Eaton, T. Evangelatos, Atlantic Region CHS
N.M. Anderson, Headquarters,

The Canadian Hydrographic Service began its involvement in collecting and processing digital hydrographic data in the late 60s. During the intervening years the Service has been actively involved in the development, testing and implementation of digital data acquisition systems for the recording and processing of hydrographic data and the processing of digital data in the chart production process. So far the orientation of the overall process has remained towards the eventual production of the conventional nautical chart. The value of the digital data itself for the maintenance of the charts and possibly its eventual use on the bridge was of course recognized.

Today the technology push is towards the increase of microprocessor technology in the instrumentation packages. Electronic positioning systems facilitate computer processing for real-time navigation information. Display technology, particularly video displays now make possible the graphic presentation of data stored within a digital database. Coincidentally marine traffic is increasing and the costs of marine disasters are escalating. Therefore it is reasonable to assume that there will be a demand to integrate positioning and collision avoidance radars with navigational information contained on the nautical chart. This paper will review this technology and consider the future role of information contained on the nautical chart as it will be used in the electronic systems on the bridge.

24 THE USE OF LORAN-C IN THE CANADIAN FISHING FLEET

Fred J. Kolls, P. Eng., Integrated Geoscience Mapping (IGM) Services Ltd., Fredericton N.B.
Dr. D.E. Wells, Technical Surveys, University of New Brunswick, Fredericton, N.B.

Since its introduction, Loran-C has played an increasingly important role within the Canadian fishing fleet. Four different economic factors have been responsible for this changing role: diminishing receiver costs, higher vessel operating and purchase costs, diminishing catches, and less expensive, more effective sonar systems. The number of fishing vessels using Loran-C is estimated, based on licensing data available on the Canadian fleet. Equivalent estimates are made for the U.S. fishing fleet. Features now available on the newest Loran-C receivers provide a hint of what can be expected in integrated navigation systems in the near future. The possible impact this may have on CHS charts (digital or otherwise) is discussed. Finally, the constraints affecting the amount that vessel owners would be willing to invest in upgrading their Loran-C systems is outlined.

A SHORT CHRONOLOGY

Canadian Hydrographic Service's First Century of Marine Surveying 1883-1983

1882 S.S. Asia foundered in Georgian Bay.

1883 Department of Fisheries and Marine established the Georgian Bay Survey under the command of Cdr. John G. Boulton, on loan from the British Admiralty.

1891 Wm. J. Stewart, Boulton's assistant, surveyed Vancouver Harbour, the first Canadian coastal survey.

1893 Canadian Tide and Current Survey established under Dr. W. Bell Dawson.

1894 Wm. J. Stewart succeeded Cdr. Boulton as officer-in-charge of the Georgian Bay Survey.

1895 Name changed to Great Lakes survey on completion of surveys of Georgian Bay and North Channel.

1903 Chart of Lake Winnipeg was first chart to be drawn and printed in Canada.

1904 Canadian Hydrographic Service (CHS) formed as a division of the Department fo Fisheries and Marine, incorporating hydrographic units from the Department of Public Works and Department of Railways and Canals. Wm. J. Stewart appointed Chief Hydrographer in March.

In July the British Admiralty asked that Canada assume responsibility for charting all of its navigable waters.

1908 CSS Lilooet built for surveys on the Pacific Coast.

1910 First gasoline-powered survey launch used.

CSS Cartier built for surveys in Gulf of St. Lawrence and Maritimes.

PHOTO: MIKE FOSTER

1913 CSS Acadia built for surveys in Maritimes and Hudson Strait and Bay. These were the first three ships for surveys in Canadian waters.

CSS Acadia carried out first northern surveys to open up the Hudson Bay route.

CHS took over from the British Admiralty the printing of charts resulting from the Georgian Bay and Great Lakes Survey.

1928 Air photos used for the first time in delineation of coastline.

1930 First echo sounder installed on CSS Acadia.

1933 Fort Brabant (now Tuktoyaktuk) surveyed; the first Canadian surveys in the Arctic.

1938 Pacific Region office opened in Victoria on full time basis. In 1979 it moved to the Institute of Ocean Sciences at Patricia Bay.

1939-45 World War II: all ships except for Wm. J. Stewart taken over by navy.

First surveys in Newfoundland to meet national defence requirements. Only CSS Stewart and Acadia found suitable for further use in 1946.

1949 First northern surveys using chartered ships.

1949 Newfoundland entered Confederation adding Newfoundland and Labrador to responsibilities of CHS.

1953 First surveys intended for recreational navigation in Georgian Bay and North Channel.

1954 HMCS Labrador commissioned. Team of hydrographers assigned. First use of helicopters.

1955 First use of two-range Decca for electronic positioning out of sight of land.

1955-57 Construction of Dew Line gave major impetus to Arctic surveys.

1957 Tide and current tables computed and printed for first time in Canada.

1957 CSS Baffin commissioned as first Canadian ship designed for Arctic surveys and to carry a helicopter.

First use of tellurometer for distance measuring.

1957-58 Completion of construction of St. Lawrence Seaway opened Great Lakes to ocean-going shipping and required complete recharting of the Seaway.

1959 Decca introduced as official electronic positioning system on Atlantic coast.

Polar Continental Shelf Project started surveying through the ice.

Atlantic Regional Office opened in Halifax and then moved to Bedford Institute of Oceanography in Dartmouth, Nova Scotia, in 1961.

1961 CHS took over responsibility for charts used for Dew Line resupply.

1962 First use of Minifix, the first accurate electronic positioning system which could be used for inshore surveys; over the next ten years it replaced the sextant as the primary tool of the hydrographer.

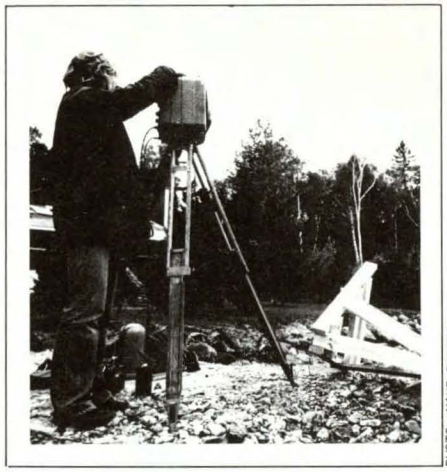


PHOTO: MIKE FOSTER

1964 First charts of Canadian Territorial Seas and Fishing Zones published.

Chart 2202, Port Severn to Parry Sound, published. The first strip charts specifically designed for use in small craft.

Central Region established in Ottawa. It moved to Burlington in 1969.

1966 First use of high-speed fibreglass launches for sounding.

1967 Development began of a computer-assisted cartographic production system.

1969 Hovercraft used for sounding in Beaufort Sea. First metric charts of Arctic produced.

1970 Development of first automated data acquisition system on launches.

1974 Development of an aerial hydrographic system using a laser, inertial guidance system and air survey camera.

1976 Quebec Region established: decentralization of cartographers from Ottawa.

First four charts in contoured, metric, bilingual format issued.

1977 First Canadian Loran-C chain commissioned on Pacific Coast.

1979 First operational trials of Aerial Hydrography Project in Thousand Islands.

First chart completely compiled and drafted using computer-assisted techniques.

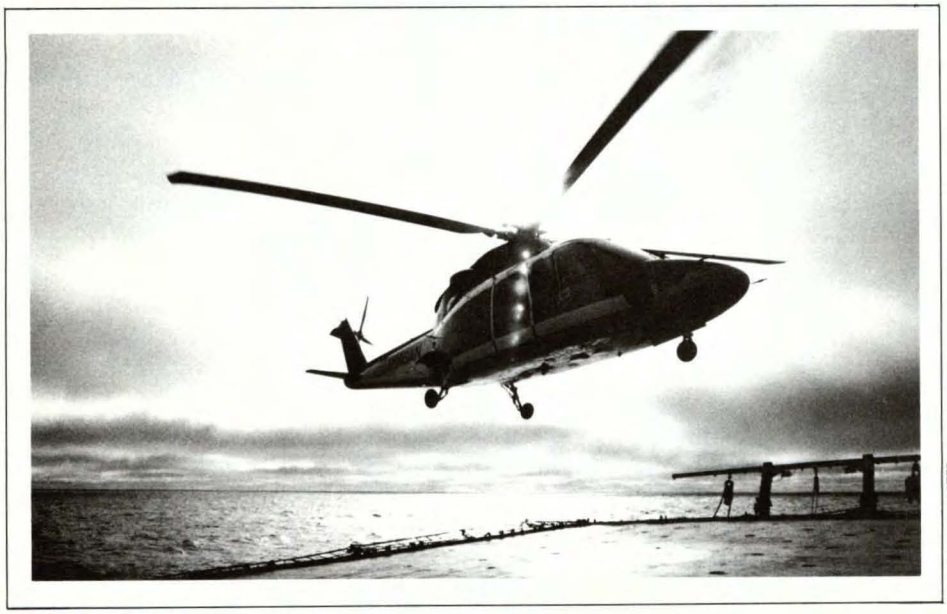


PHOTO: MIKE FOSTER

EXHIBITS

COMMERCIAL

MAIN LOUNGE (Room 103)

1. Terra Surveys Ltd.
107 A - 9865 W. Saanich Road
Sidney, B.C. V9L 3S1

2. Marshall Macklin Monaghan Ltd.
275 Duncan Mill Road
Don Mills, Ontario M3B 2Y1

3 InterOcean Systems Inc.
3540 Aero Court
San Diego, CA 92123

4-5 Cubic Western Data
5650 Kearny Mesa Road
San Diego, CA 92111

6-9 Telefix Canada
50 Doncaster Ave., Unit 8
Thornhill, Ontario L3T 1L4

SUSSEX LOUNGE (Room 104)

10 Raytheon Ocean Systems Company
Risho Ave.,
Westminster Park
East providence, R.I. 02915

11 Targa Electronics Systems Inc.
P.O. Box 8485
3101 Hawthorne Road
Ottawa, Ontario

12 Cardion Electronics/
D.G. Instruments
Division of General Signal Ltd.
308 Legget Drive
Kanata, Ontario K2K 1Y6

13 Internav Limited
P.O. Box 1261
Sydney, N.S. B1P 6J9

14 Moniteq Ltd.
630 Rivermede Road
Concord, Ontario L4K 1B6

15 Kodak Canada Inc.
3500 Eglington Ave. W.
Toronto, Ontario M6M 1V3

16 Nortech Surveys (Canada) Inc.
Century Square III, (2nd Fl.,)
309 — 2nd. Ave. S.W.
Calgary, Alberta T2P 0C5

17 Ross Laboratories Inc.
3138 Fairview Ave. E.
Seattle, WA. 98102

18 McElhanney Surveying and Engineering Ltd.
1495 Venables Street
Vancouver, B.C. V5L 2G3

SUSSEX ROOM (Room 106)

19 Kenting Earth Sciences Ltd.
380 Hunt Club Road
P.O. Box 8250 Terminal P.O.
Ottawa, Ontario K1G 3H7

20&21 Racal-Decca Survey Inc.
10401 Westoffice Drive
Houston, Texas 77042

22 Motorola Limited
492 McNicoll Avenue
Willowdale, Ontario M2H 2E1

23&24 Marinav Canada, Inc.
1140 Morrison Drive
Ottawa, Ontario K2H 8S9

25 J.M.R. Instruments Canada Ltd.
8-6320 11 Street S.E.
Calgary, Alberta T2H 2L7

26 Klein Associates Inc.
Klein Drive
Salem, New Hampshire 03079

27&28 AGA Geodimeter of Canada Ltd.
41 Horner Avenue, Unit 5
Toronto, Ontario M8Z 4X4

ROOM 175-179

29 Gentian Electronics
P.O. Box 1240
Stittsville, Ontario K0A 3G0

30 Bernsten Inc.
P.O. Box 8666
Madison, Wisconsin 53708

31 Northway Gestalt Corp.
1450 O'Connor Dr.
Toronto, Ontario M4B 2V2

ROOM 178

32&33 M.S.E. Engineering System Ltd.
265 Canartic Drive
Downsview, Ontario M3J 2N7

ROOM 113

34 Canadian Engineering Surveys
800 10310 Jasper Ave.
Edmonton, Alta. T5J 2W4

ROOM 115

35&36 NAVITRONIC A.S.
Marselis Boulevard 175
DK-8000 AARHUS C
DENMARK 7, 722-8432

NON-COMMERCIAL

Ante Room

A Canadian Hydrographic Service
615 Booth Street
Ottawa, Ontario K1A 0E6

B Department of the Navy
U.S. Naval Oceanographic Office
NSTL Station
Bay St. Louis, Mississippi 39522

C Canadian Association of Hydrographic and Oceanographic Surveying Industries (CAHOSI)
c/o Mr. T.D.W. McCulloch
P.O. Box 5050
Burlington, Ontario L7R 4A6

D Canadian Hydrographers Association
615 Booth Street
Ottawa, Ontario K1A 0E6

Entrance to Tunnel to Chateau Laurier

E Environment Canada
Inland Waters Directorate
WATDOC
Ottawa, Ontario

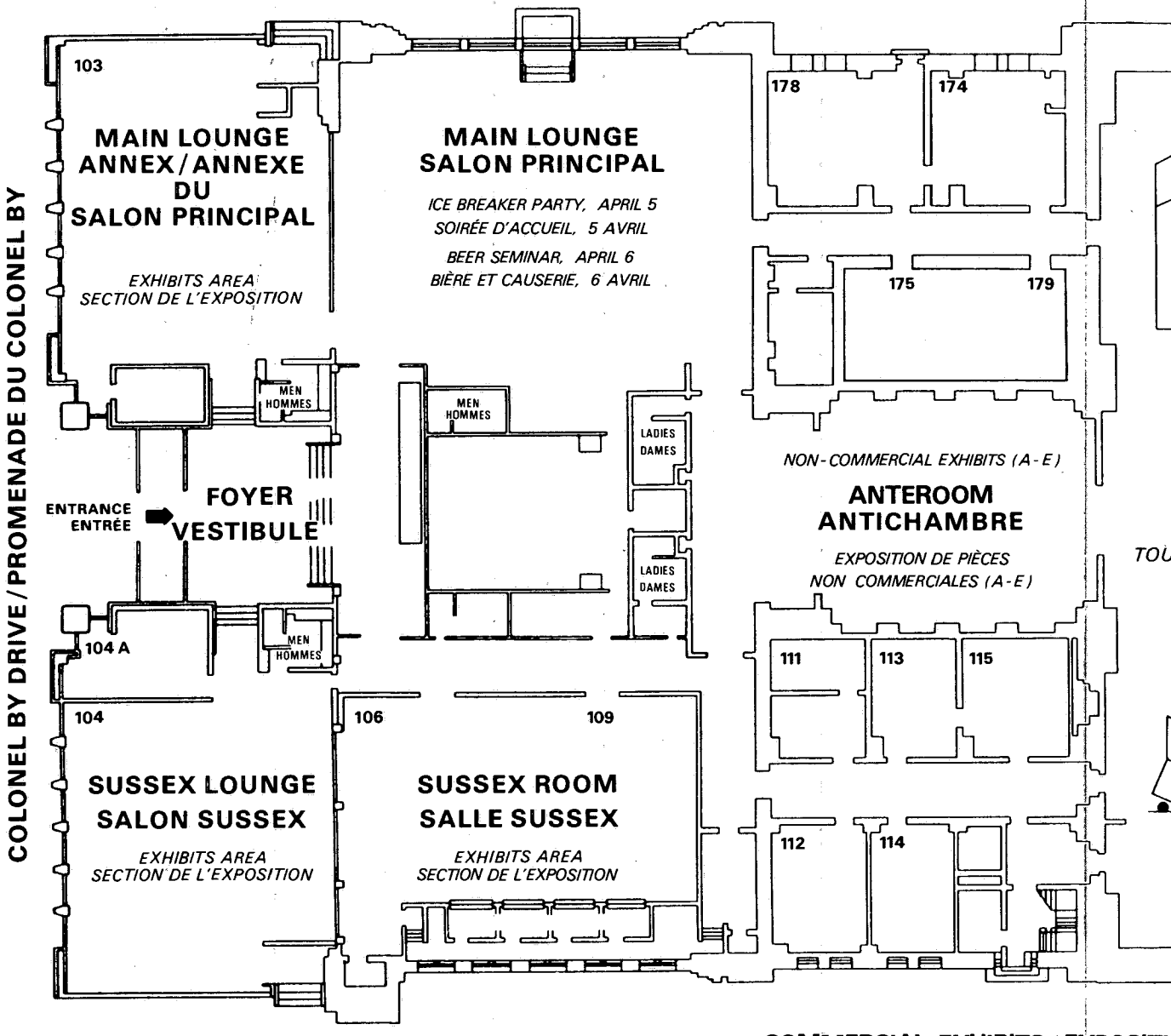
F FÉDÉRATION INTERNATIONAL DES GÉOMÈTRES (FIG)
c/o Mr. T.D.W. McCulloch
Director-General,
Central Region
Ocean Science and Surveys
867 Lakeshore Road
P.O. Box 5050
Burlington, Ontario L7R 4A6

G Metric Commission
255 Argyle
Ottawa, Ontario K1A 0C9

H Hydrographic Technology
Humber College
205 Humber College Blvd.
Rexdale, Ontario M9W 5L7

CONFERENCE CENTRE/CE

FIRST FLOOR/REZ



COMMERCIAL EXHIBITS / EXPOSITI

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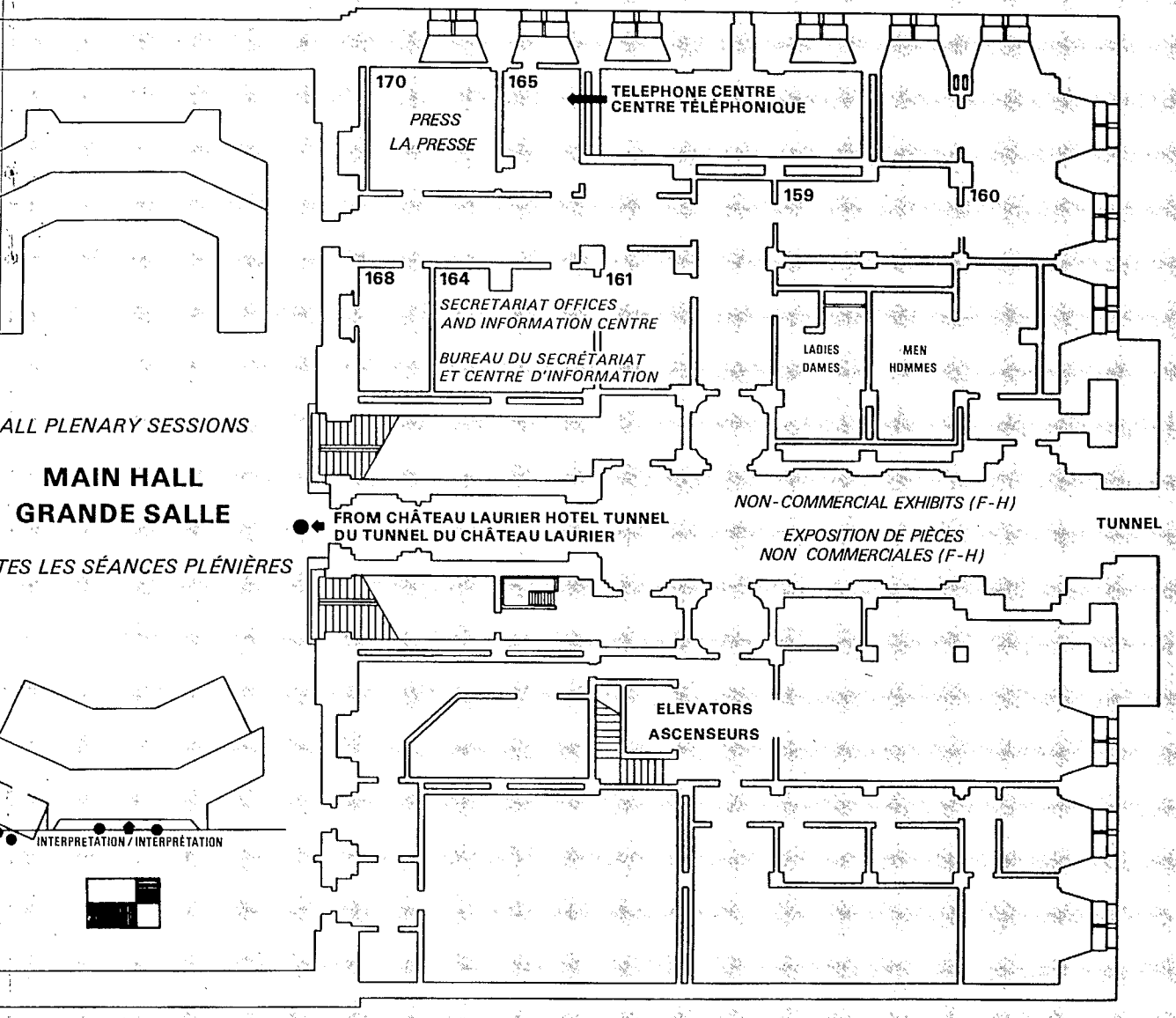
1 TERRA SURVEYS LTD.
2 MARSHALL MACKLIN MONAGHAN LTD.
3 INTEROCEAN SYSTEMS INC.
4-5 CUBIC WESTERN DATA
6-9 TELEFIX CANADA

SUSSEX LOUNGE / SALON SUSSEX (ROOM / SALLE 104)

10 RAYTHEON OCEAN SYSTEMS CO.
11 TARGA ELECTRONIC SYSTEMS INC.
12 CARDION ELECTRONICS / D.G. INSTRUMENTS
13 INTERNAV LIMITED
14 MONITEQ LTD.
15 KODAK CANADA INC.
16 NORTECH SURVEYS (CANADA) INC.
17 ROSS LABORATORIES INC.
18 McELHANNEY SURVEYING AND ENGINEERING LTD.

NTRE DE CONFÉRENCES

DE-CHAUSSÉE



ALL PLENARY SESSIONS

MAIN HALL
GRANDE SALLE

TES LES SÉANCES PLÉNIÈRES

ON DE PIÈCES COMMERCIALES

SUSSEX ROOM / SALLE SUSSEX
(ROOM / SALLE 106)

19 KENTING EARTH SCIENCES LTD.
20-21 RACAL-DECCA SURVEY INC.
22 MOTOROLA LTD.
23-24 MARINAV CANADA, INC.
25 J.M.R. INSTRUMENTS CANADA LTD.
26 KLEIN ASSOCIATES INC.
27-28 AGA GEODIMETER OF CANADA LTD.

ROOMS / SALLES 175, 179

29 GENTIAN ELECTRONICS
30 BERNSTEN INC.
31 NORTHWAY GESTALT CORP.

ROOM / SALLE 178

32-33 M.S.E. ENGINEERING SYSTEM LTD.

ROOM / SALLE 113

34 CANADIAN ENGINEERING SURVEYS

ROOM / SALLE 115

35-36 NAVITRONIC AS