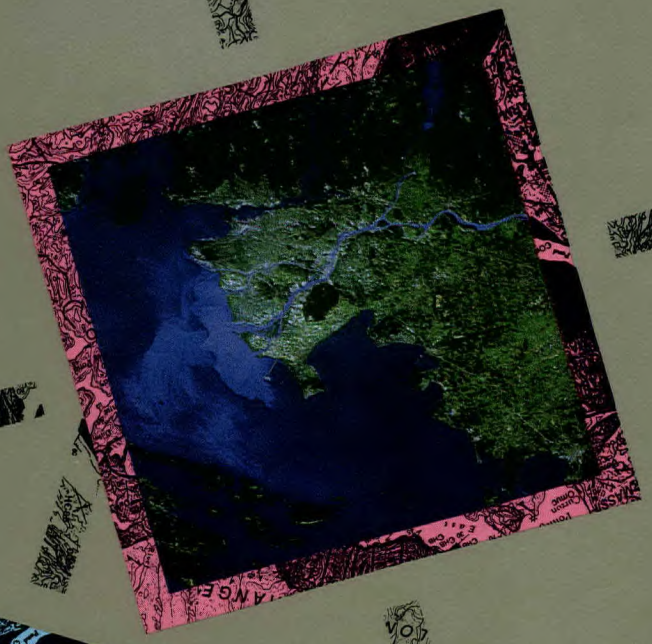
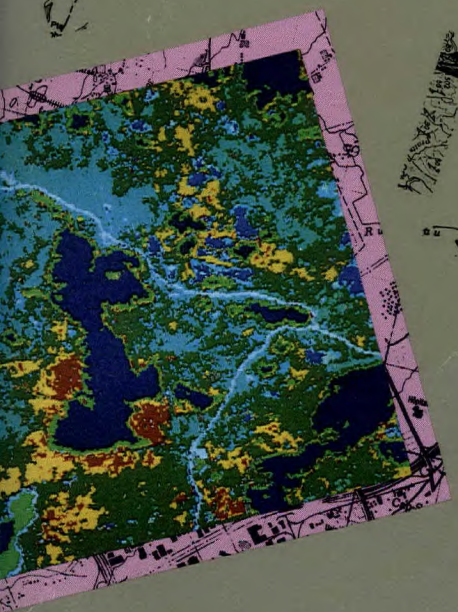
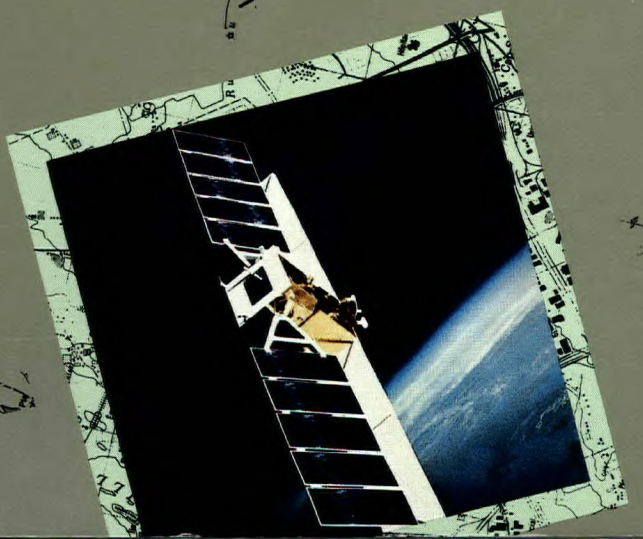
THE CANADIAN GEOMATICS INDUSTRY

A SECTOR OVERVIEW







External Affairs and International Trade Canada

Canada

This sector overview outlines the resources and skills of the Canadian geomatics industry, government and academia in surveying, mapping, remote sensing and geographic information systems (GIS).

Geomatics Products and Services for World Markets, a companion computer diskette, provides corporate profiles of about 100 Canadian exporting companies. Each profile describes the firm's products and activities in surveying, mapping, remote sensing and geographic information systems. Information on how to make contact with the company and names of those responsible for handling export enquiries are also included.

Among the firms listed on this diskette are:

manufacturers of:
- satellite ground receiving stations, airborne and spaceborne instruments, mapping systems, positioning systems, geographic information systems;

developers of:
- software for applications in surveying, mapping, remote sensing, and geo-information processing;

service companies and consultants in:
- surveying, mapping, remote sensing, and geographic information systems;

consultants in:
- corporate and project management; academic and industrial training; data gathering, processing, analysis and management.

Exporting companies range from very large, multi-disciplinary engineering consulting groups to smaller firms of highly specialized experts, from new firms to established organizations that have been exporting for many years to as many 80 countries. In addition, many offer services or products for more than one type of application.

Canada's companies provide a range of export services as well. Training is offered in Canada or abroad, while many firms can communicate with buyers in various languages. Moreover, technology transfer and skill sharing have always been an important part of Canada's service exports.

For further information concerning geomatics products and services, please contact:

Information Technologies and
Electronics Division (TDE)
External Affairs and
International Trade Canada
125 Sussex Drive
Ottawa, Ontario
Canada K1A 0G2
Tel: (613) 996-1893
Telex: 053-3745 TDE
Fax: (613) 996-9288 TDE

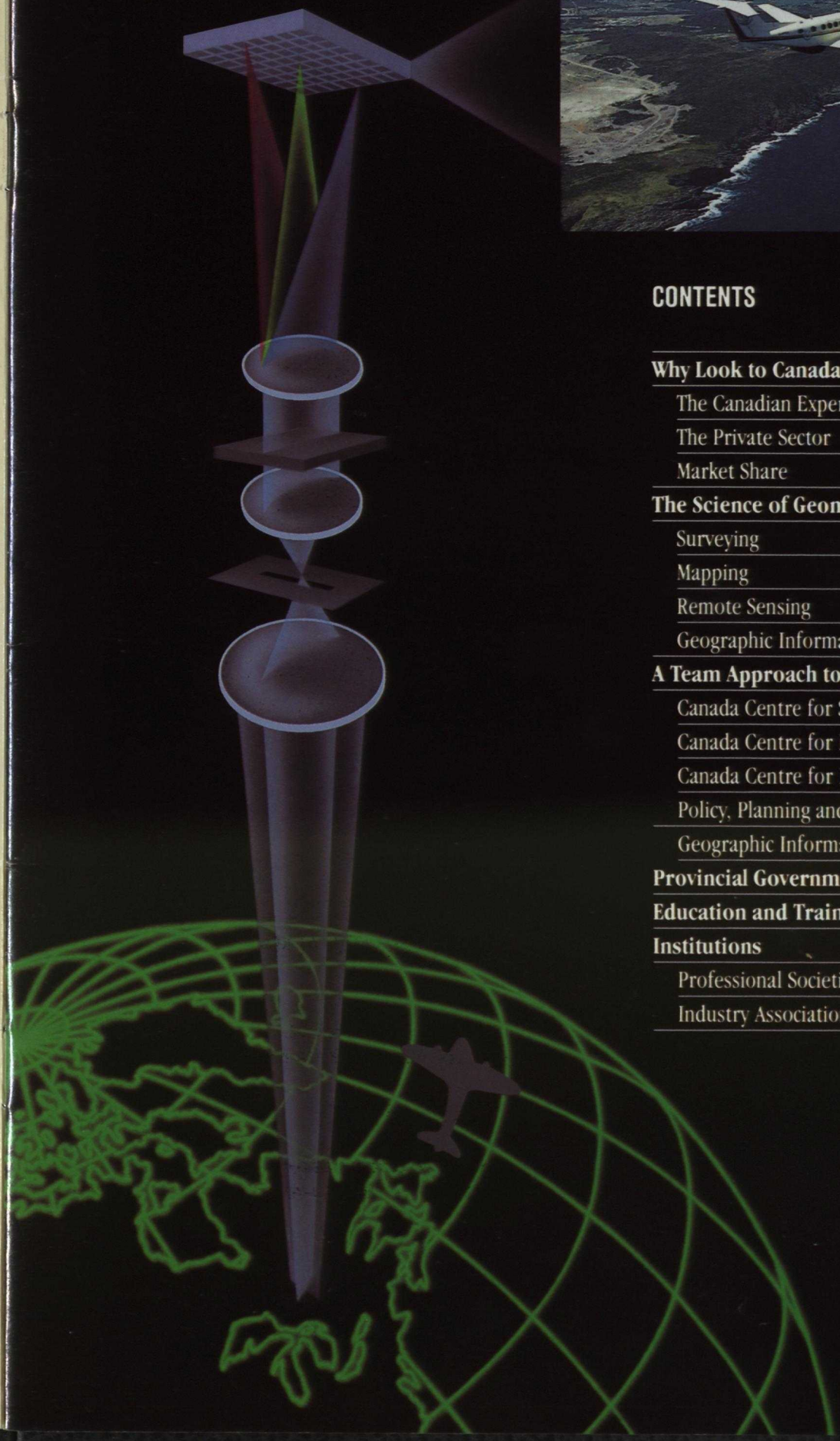
or

Surveys, Mapping and
Remote Sensing Sector
Energy, Mines and Resources Canada
580 Booth Street
Ottawa, Ontario
Canada K1A 1E4
Tel: (613) 996-5971
Telex: 053-3117 EMROTT
Fax: (613) 995-0842

Flying an aerial mapping mission. ▶

Aerial Mapping & Photography Ltd.

(Publié également en français)



CONTENTS

Canada is a world leader in the development of new technologies for remote sensing. The fluorescence line imager is an outstanding example.*

*Reproduced with permission of the Department of Fisheries and Oceans.

External Affairs and International Trade Canada (EAITC) is responsible for international trade. The department promotes Canadian products by providing closely integrated and focused services to Canada's business community and to businesses abroad through Canadian posts in major cities worldwide.

New international marketing units based on industry sectors provide business clientele with the total market picture; they offer timely information about markets around the world and across the spectrum of exportable products and services. Within EAITC, the International Trade Development Branch works closely with International Trade Centres across Canada, the EAITC geographic divisions and EAITC trade missions in major markets abroad.

EAITC personnel in Canada and abroad are available

- to provide specialized commercial information;
- to co-ordinate and enhance the use of the trade mission planning systems;
- to identify market opportunities;
- to update and utilize the WIN Exports database to identify suppliers; and
- to provide an industry-specific information service.

The department's central aim is to offer exporters and potential exporters easy, co-ordinated access to programs and services.

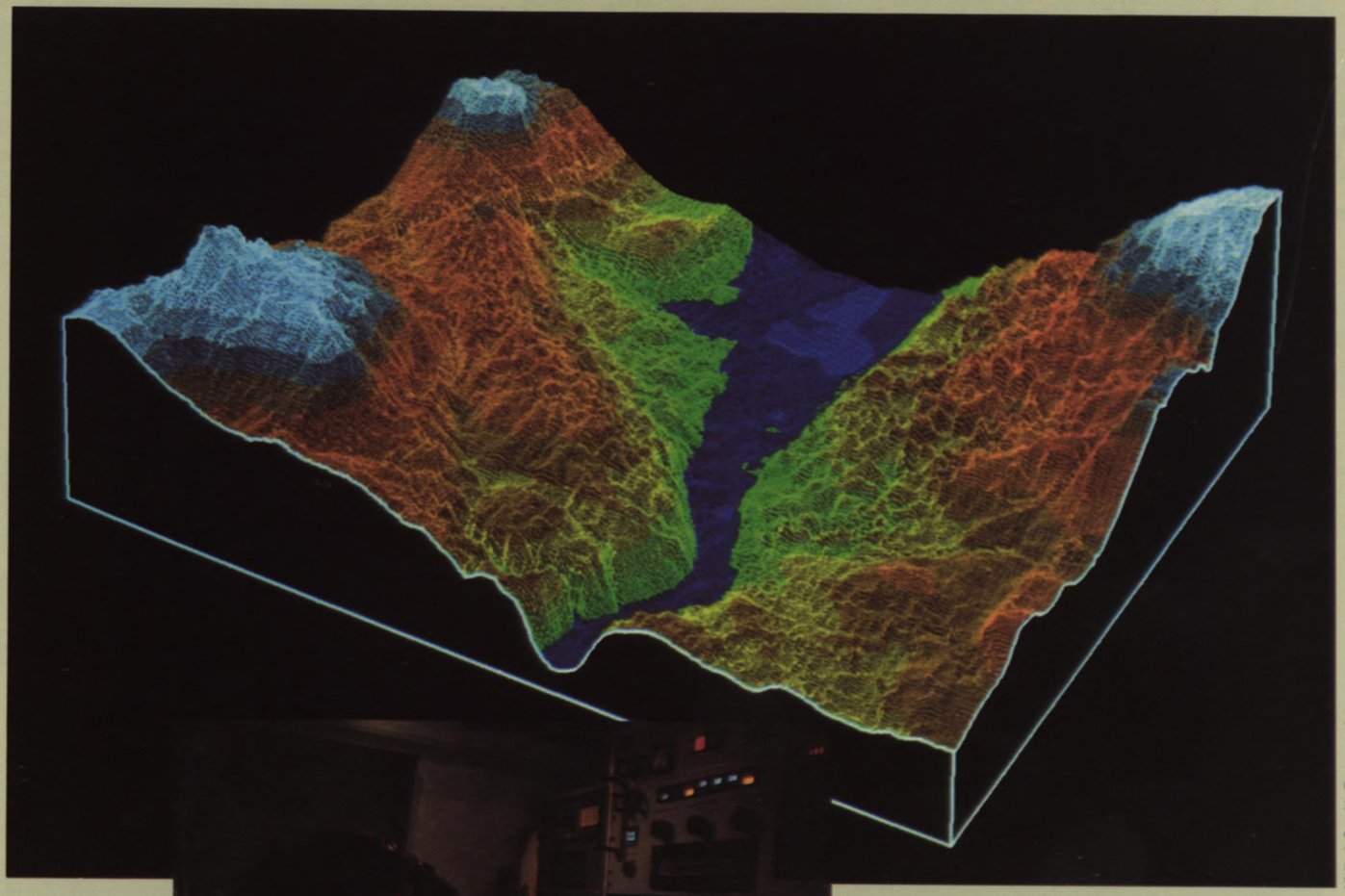
This digital terrain model was prepared using Visitech Graphic's INSIGHT surface modelling system. ▶

Real-time hard copy display of CAL's Side-Looking Airborne Radar SLAR 100 System operating on board the Canadian Atmospheric Environment Service's de Havilland Dash-7 reconnaissance aircraft. ▶

EAITC gratefully acknowledges the contributions made toward the completion of this publication by Energy, Mines and Resources Canada and the Geomatics Industry Association of Canada.

THE CANADIAN GEOMATICS INDUSTRY

A SECTOR OVERVIEW



Visitech Graphic Resources Inc.

Canadian Astronautics Limited

A guide for foreign buyers to Canadian capabilities in surveying, mapping, remote sensing and geographical information systems

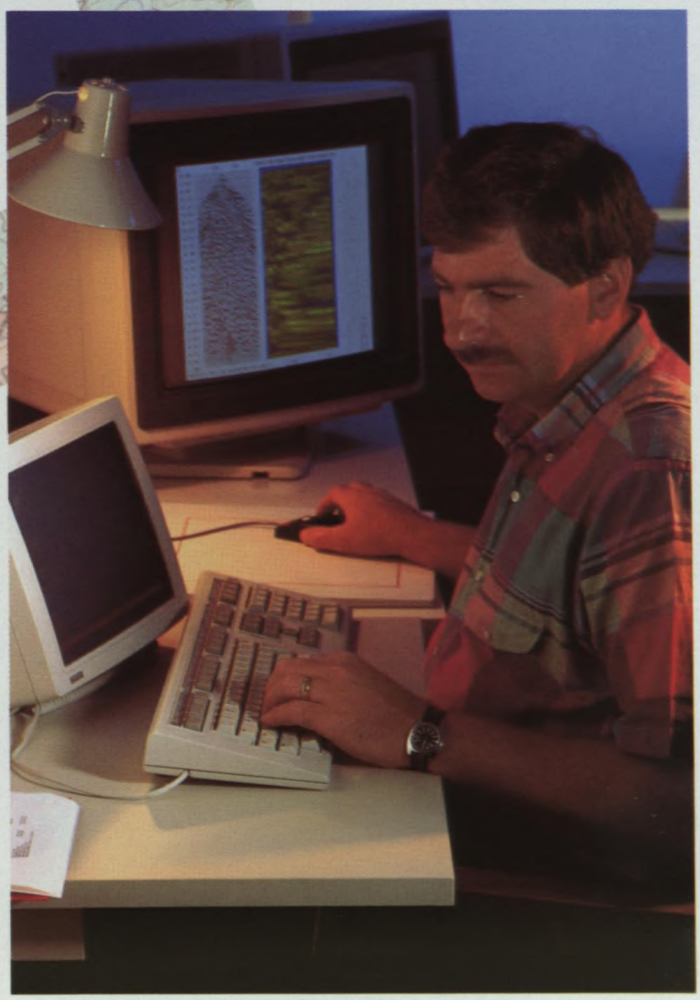
Energy, Mines and Resources Canada

This experimental image map of central Ottawa was produced by the Cartographic Information and Distribution Centre and Scitex America Corporation.

WHY LOOK TO CANADA

Modern society is facing stresses that were unheard of and unforeseen in centuries past. Rapid population growth, changing climates, the loss of forests, and air and water pollution are all stressing the environment and changing traditional methods of coping with and managing such problems. At the same time, increasing demands are placed on the world to sustain humanity. Agriculture, mining, gas and oil exploration, forestry and urbanization are just some of the activities that an already taxed planet is being asked to support.

The challenge is to reconcile the protection of the environment with the need to use its resources. Already we have the will to manage our resources and our people sensibly for the centuries ahead. What so many of us lack are the tools and the technology to put our will effectively into practice.



BSR Resource Data Corporation

BSR Resource Data offers satellite and airborne image analysis as well as geophysical and seismic processing services.

The Canadian Experience

Every industrial nation was once a developing nation. For many countries, the process of development took centuries. For Canada, the process took but one. Canada's remarkable shift in so short a time has given it an acute appreciation of the problems faced by emerging countries. Perhaps better than other nations, Canada can understand and help cope with those problems since its own period of development is still recent.

Canada's 10 million km² land mass, the second largest in the world, has a comparatively small population of 26 million people. The country's vast distances embrace mountain ranges and prairie desert, warm fertile coasts and frozen Arctic lands, enormous forests and numberless lakes.

Canada's coastline is the longest in the world. It borders the Atlantic, Arctic and Pacific oceans and, including islands, runs for 243 797 km. Canada also has the world's largest fresh-water supply, including its portion of the Great Lakes, hundreds of thousands of inland lakes, and some of the world's mightiest rivers and watersheds.

Canada's own recent development together with the vast geographical challenges it faces have helped this country become a leader in the development and export of geographic information processing technology.

Moreover, Canadians who work with that technology have a special awareness of the needs and concerns not only of other industrial countries but especially of emerging and developing nations.

MacDonald Dettwiler and Associates Ltd.

Landsat-5 image of Vancouver, Canada, processed on MacDonald Dettwiler's MERIDIAN, an integrated image analysis and mapping system.

Geomarine Associates Limited

M/V CHAPERA, a Panamanian shrimp vessel outfitted for a high-resolution marine geophysical survey on the Pacific coast of Panama.

The Private Sector

For the past 30 years, Canada has had strong private-industry capability in all facets of geomatics, including land, airborne and hydrographic surveys, mapping, remote sensing, and geographic information systems (GIS). The federal government especially has sponsored continuing research and development in the private sector and has assisted the growth of many new companies.

Today, more than 11 000 people are involved in the geomatics industry. The services and products they offer supply the critical tools needed to manage agriculture, forestry, fisheries, mining and hydrocarbon exploration, fresh waters and oceans, land use and the environment. Many firms maintain offices and support capabilities abroad to meet the needs of other countries.

Canadian companies have been quick to pass on their skills to the resource managers of developing countries. This sharing is taking place with the active support of Canada's federal government, whose agencies provide support for the technology transfer, training and education so urgently needed abroad.

Market Share

Canada's position of leadership in the surveys, mapping, remote sensing and GIS industries is evident by its export record: Canada currently exports about $100 million worth of geomatics products and services annually.

Canadian geomatics products and services, including consulting, customizing and training, have been bought by governments and corporations around the world. Canada currently supplies some 90 per cent of the world's most advanced, high-resolution airborne radar systems, the electronics for half of all satellite data ground-receiving stations and 25 per cent of all image processing systems. "Made in Canada" equipment and services have been tested and proven in domestic and international markets by both industrialized and emerging nations.

International customers for Canadian solutions and services include agencies of the United States government, the international exploration industry, public and private utilities, forestry organizations, and federal, provincial, state, regional and municipal governments.

As well, Canada's international assistance programs have made the purchase of these technologies and skills easier for nations with critical resource-management needs but without the necessary financial or professional infrastructures.

THE SCIENCE OF GEOMATICS

Computers have radically changed how geographically referenced information is gathered, stored, managed and analysed. Technological developments such as total stations, global satellite positioning, digital photogrammetry and image processing have also had a profound influence.

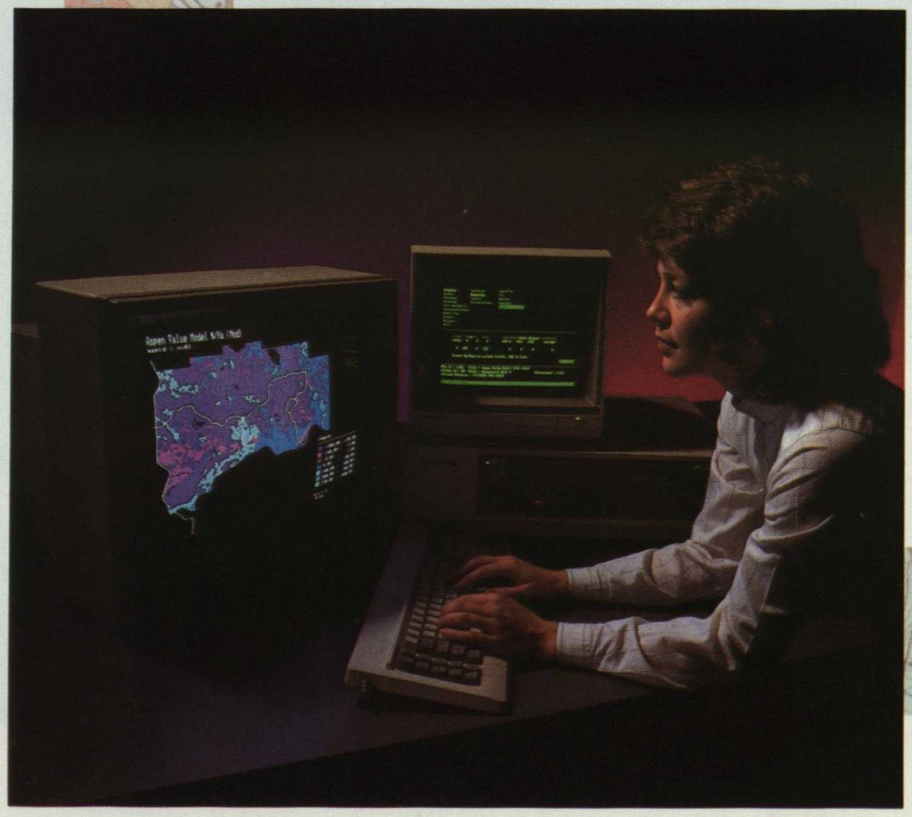
New technologies have resulted in new and more data, ways of interpretation and ultimately derived information. They have also brought increased specialization. Where once the surveyor and the map-maker produced paper maps, there are now experts in each area of geographic data management collecting, processing and producing a vast array of digital geo-referenced data, from geometrically generated urban survey plans to remote images of ocean current patterns.

Together these techniques and technologies constitute the science of geomatics in much the same way as the science of medicine is made up of its constituent specialties. Through the study and use of geomatics, all the different available technologies can be employed to create geo-referenced information systems and the expertise to use them effectively.

Some areas of geomatics are involved with data gathering, such as surveying, mapping and remote sensing. Some address the production of data in readable form, such as cartography and spatial database design. Others involve analysing the data, such as for land and resource management.

With the technologies and techniques of geomatics, geo-referenced information systems can be designed that address a wide range of applications.

- Municipal systems help with effective administration and planning for public works, growth, fire and police, land use, water supply, tax assessment, sanitation and sewage, health, and so on.
- Forestry systems aid in silviculture, harvest planning, yield predictions, future-growth modelling, recreation and wildlife planning.
- Agricultural systems provide crop yields, soil types, climate conditions, rotation, acidity, irrigation data, and modelling techniques for analysis. Similar systems monitor water quality, flow, sediment patterns and currents.



Tydac Technologies Incorporated

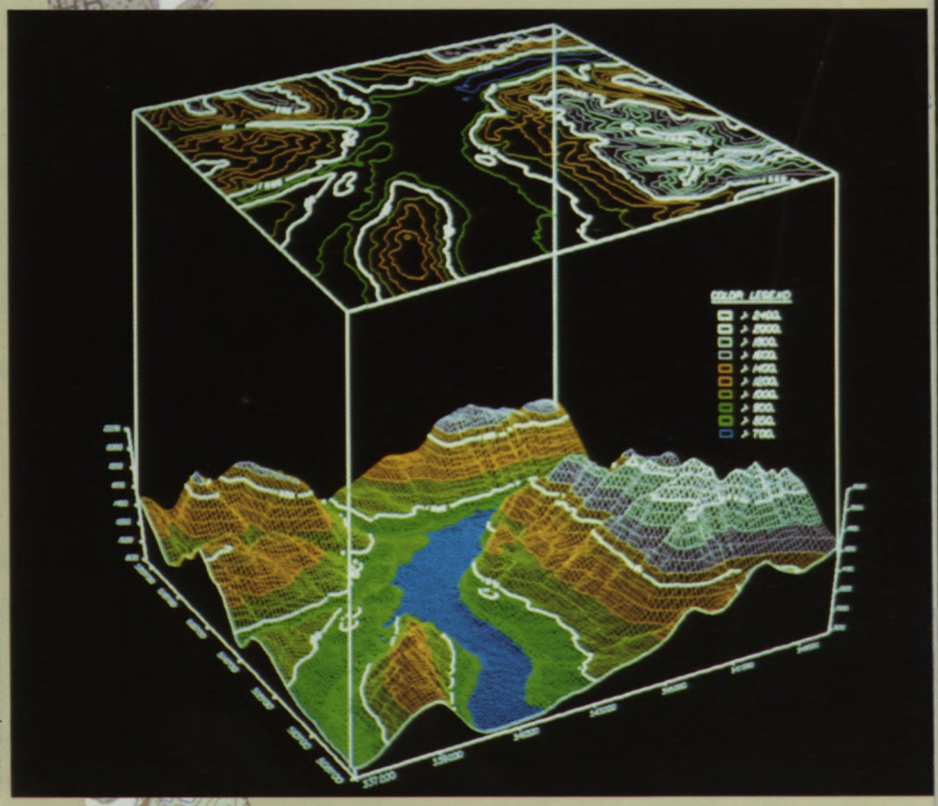
Tydac Technologies has developed software serving applications such as land use planning, environmental analysis and resource development.

With geomatics, systems can be created to collect, manage and analyse any type of geo-referenced data. Up to 80 per cent of the information used by governments is related to geographic location, and up to 300 clearly identifiable government tasks rely directly on geographically based information. Applied geomatics provides the ability to perform these tasks more effectively, more quickly and more inexpensively than traditional manual methods.

The structural relationships among the specialties within the industry are changing. As the science of geomatics becomes more complex, the degree of specialization also increases; the same complexity also creates greater inter-dependence among various areas, such as land and geodetic surveying, photo-grammetry, remote sensing and hydrography.

The result of this process has been a multi-disciplinary approach to geomatics in Canada. The federal government has recognized this consequence and recently established the Canada Centre for Geomatics to foster research and the growth of expertise, as well as the Inter-Agency Committee for Geomatics to co-ordinate activities among various federal departments.

The education of geomatics professionals in Canada, too, has stressed the need for a broad understanding of geomatics principles and technologies. This generalist principle has led to a professional community that can provide a comprehensive and far-sighted view of the problems and the solutions needed by those facing sensitive and urgent land and water issues. The Canadian geo-matics industry is an invaluable planning resource for the growth and responsible stewardship of our common world.



Visitech Graphic Resources Inc.

A perspective view of an area in northeastern B.C. generated by Visitech using the INSIGHT surface modelling system.

Surveying

Surveying has long been considered a basic part of geomatics, and hence a key aspect to building a geo-referenced data system. The accuracy of referencing data for geographic information is crucial to how usable that information will be. Inaccurately geo-referenced data will result in a compromised system.

Surveyors establish the positions and dimensions of, as well as the relationships among natural and cultural features. Surveying provides the basic positional information for:

- topographic maps;
- provincial and international boundaries;
- property boundaries;
- engineering projects;
- air and marine navigation; and
- calibration lines for testing satellite receivers.

These positional data are key to:

- management of natural resources and the environment;
- GIS applications; and
- the continuing study and understanding of the Earth.

In the past decade, traditional surveying techniques have given way to more sophisticated data gathering technologies, such as satellite positioning, laser distance measurement, total stations and other high-precision survey measurement techniques.

© UPDATA Inc.

Surveying provides basic positional information.

Terra Surveys Limited

Terra conducts a control survey in Bhutan.

Both Canada's governments and private industry have made major contributions to leading-edge technology through research and development. The Canada Centre for Surveying has earned international attention through its work on the Active Control System, which combines the NAVSTAR (Navigation Satellite Time and Ranging) global positioning satellite navigation system with Canadian data communications and computer technology. Canada's private industry was one of the first to employ doppler satellite positioning, inertial surveying, and more recently, global positioning system technologies.

Canada's sheer size has presented problems for surveyors in the past as they travelled the country laying out a national precise elevation network. In response, Canadian surveyors have adapted motorized levelling techniques to the task. Canada is also working with international partners to design and build a motorized, trigonometric levelling system based on state-of-the-art laser and refraction determining technology.

Each of the country's 10 provinces is responsible for its own cadastral system, and there are several land registration systems in Canada. Most are based on the Torrens systems under Common Law, whereas Quebec's system follows the French Civil Code. Over the last few decades, several factors, such as rapid city growth, the need to protect farm lands, the depletion of non-renewable resources and environmental concerns, have greatly increased the need for land information. Traditional land records have been unable to meet the variety of needs and to supply the amount of information required. Today, there is a need for more comprehensive property rights information, which requires better land information systems. In response, survey and property rights data have been integrated with resource information to create public- and private-sector information systems for a wide range of applications through programs and initiatives co-operatively conducted by industry, government and academia.

Hydrographic Surveys

Hydrographic surveying also plays an important role in Canada's resource management as well as its export activities. Canadians have surveyed and charted such major systems as the Nile River in Egypt and the Mekong watershed in Southeast Asia. New Canadian-developed instruments have cut the costs of conducting such projects by speeding up data collection, the transfer of digitized data to cartographers, and the production of the highest-quality charts.

Moreover, the early partnership between the federal Canadian Hydrographic Service (CHS), a unit of Fisheries and Oceans Canada, and private firms has sponsored the transfer of these technologies and skills to other nations, and established a variety of high-technology commercial and export capabilities.

A hydrographic survey being carried out in the Arctic.

Terra Surveys Limited

Mapping

Collected data are not useful until they have been produced in forms that can be read and interpreted. Historically, the fine art of map-making, or cartography, reproduced geographic information on paper maps, a process limited by the amount of data that could be included and the length of time it took to make a map.

Now, however, the volume and complexity of data have made traditional methods obsolete. While paper maps will always be used, the advent of digital data stored and managed by computer has changed how maps are made, and, perhaps more importantly, has added the digital map to the tools used for analysis.

With digital technology:

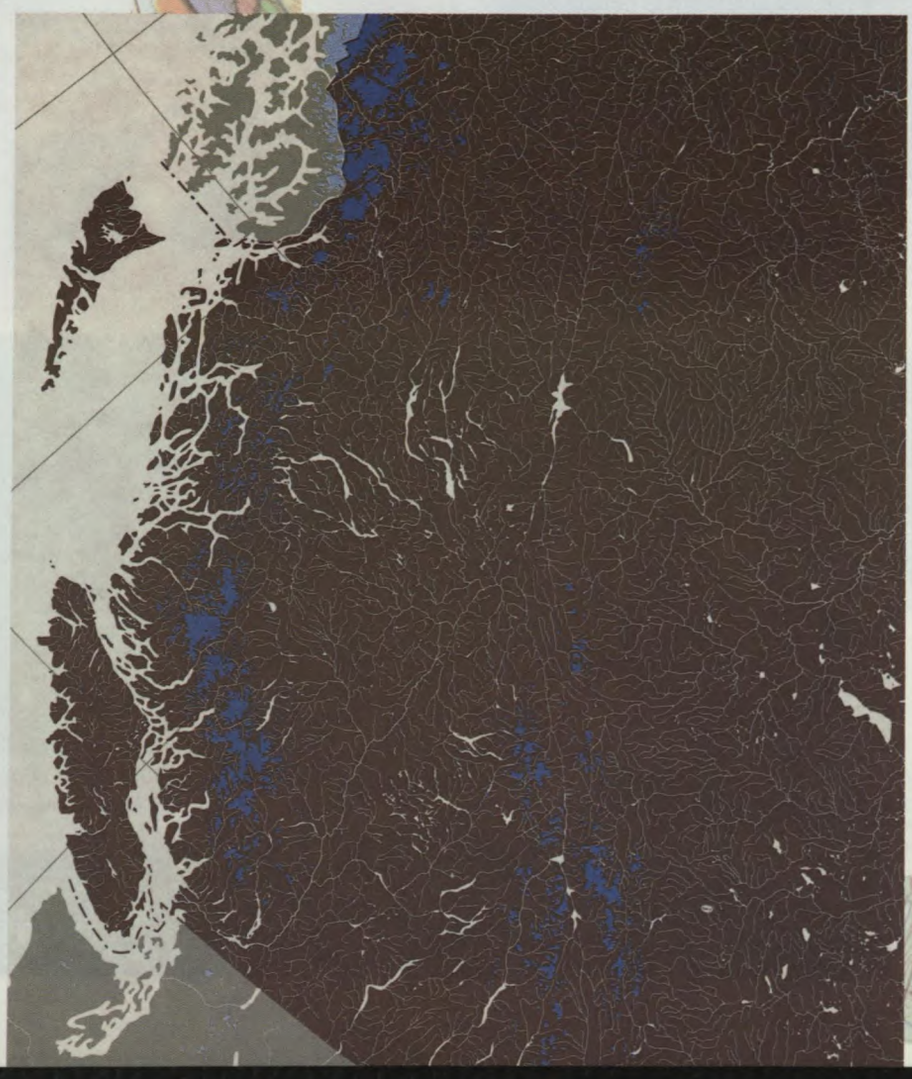
- maps can be more easily updated and produced;
- topology can be used to examine the relationships and interactions among geographic features;
- future and hypothetical situations can be modelled;
- new data can be uncovered through analysis and overlays which would otherwise be hidden; and
- data can be combined in various ways for analysis and processing.

For the past several years, Canada's mapping industry has been an authority on capturing digital geographic data and especially on converting existing analogue data into digital form. The federal Canada Centres for Mapping and for Geomatics are also leaders in these processes. Canada's National Topographic Data Base will contain topographic data covering all of the country's land mass and coastal waters digitized from existing topographic maps, as well as new digital data gathered by airborne photography. The complete series of 917 topographical maps at 1:250 000 scale was completed in digital form in 1989.

Work continues on the 12 922 topographic maps at 1:50 000 scale, which are scheduled for completion in digital form by the turn of the century.

This database will provide the foundation for future mapping activities and GIS development for federal and provincial governments and the private sector. However, the public and private sectors are already realizing benefits during the building of the database, including the development of new techniques, standards, formats and database uses as the project evolves.

Most important, perhaps, is the co-operative strategy being used. The federal government is working with provincial governments and private industry to capture data and convert existing analogue maps. As a result, national standards and data exchange formats have been developed that are already having a substantial effect on the accuracy and usefulness of all data being used for mapping projects. Canadian knowledge of and experience in designing and building shared digital databases is a valuable international resource available to other nations that use geomatics tools for planning and decision-making.



This map showing drainage patterns on Canada's west coast is an impressionistic overview of the hydrographic network. Glaciers appear in blue.

Energy, Mines and Resources Canada

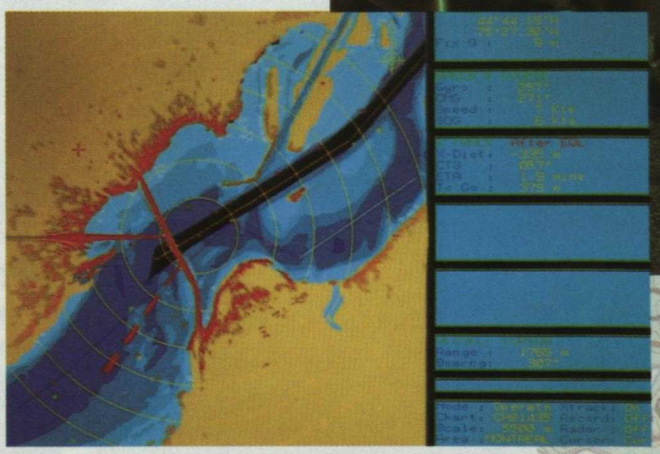
Canada's geomatics community has always had an excellent record in applying and adapting new technologies. Private industry in particular has been an active participant in Canadian foreign aid projects providing mapping services to emerging nations. Mapping firms not only create and supply the digital maps, but also provide valuable consulting services to foreign agencies on the use, maintenance and application of the data.

Canadian mapping firms are also world leaders in developing photogrammetry and image-analysis techniques. Current Canadian developments in digital mapping, analysis software and information systems are rapidly expanding Canada's industry expertise and export markets.

Hydrographic Charts

Hydrographic mapping also reflects Canada's innovative approach. For example, Canadian industry has developed technologies and systems for real-time operation of electronic chart displays aboard ships, enabling accurate navigation at night, in crowded waterways, and in any weather condition. Electronic charts are already installed on British Columbia ferries and Canadian Coast Guard icebreakers operating in the St. Lawrence River to allow year-round access to the Port of Montreal.

Gregory Geoscience Limited



Offshore Systems Limited

Working electronic charts with real-time display of ship's position have been developed by OSL. Here, matching of chart and radar image overlay eliminates most position ambiguities.

PROCOM-2, a geographic information system developed by Gregory Geoscience, projects a Landsat image onto a map for interpretation by analysts.

Remote Sensing

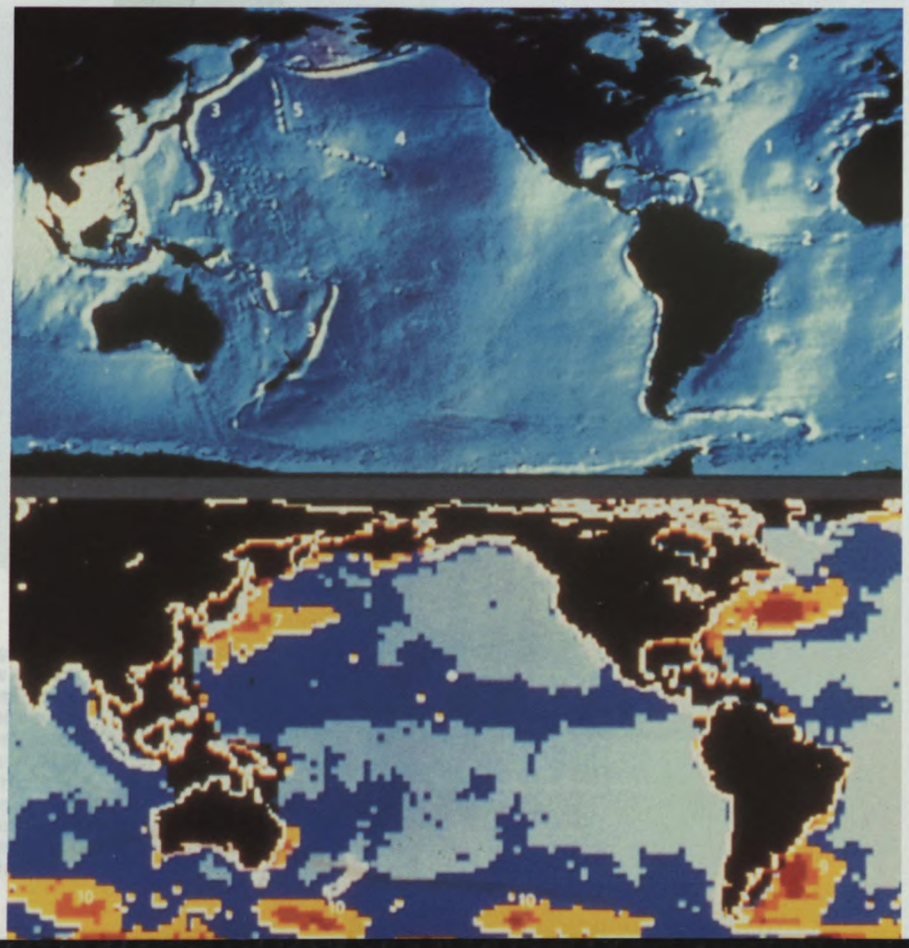
The value of geographic analysis depends on the quality of the data it uses. Accurate, current data are crucial to good decision-making. For that reason, Canadian industry, government and research institutions have long viewed data collection as the most important task in developing information systems.

Traditional methods such as surveying and aerial photography are still basic to data gathering and geo-referencing. However, remote sensing by airborne and satellite data-collection systems can do what the human eye and aerial photography cannot; by recording image data of huge areas changing over time, remote sensing gives a view of the world that is not possible from the surface. Large natural systems such as ocean currents, climate patterns or land formations become identifiable and, therefore, become factors that can be dealt with. In the past, such systems were at best randomly knowable, and at worst merely theoretical.

Canada's size and small population have meant that remote sensing has become a particularly important part of land and resource management tasks. As a result, Canada is now an international leader in the development, design and manufacture of remote sensing systems. Moreover, because Canada realizes the importance of remote sensing to other nations, indeed to the world, Canadians have made a real effort to export technology and expertise.

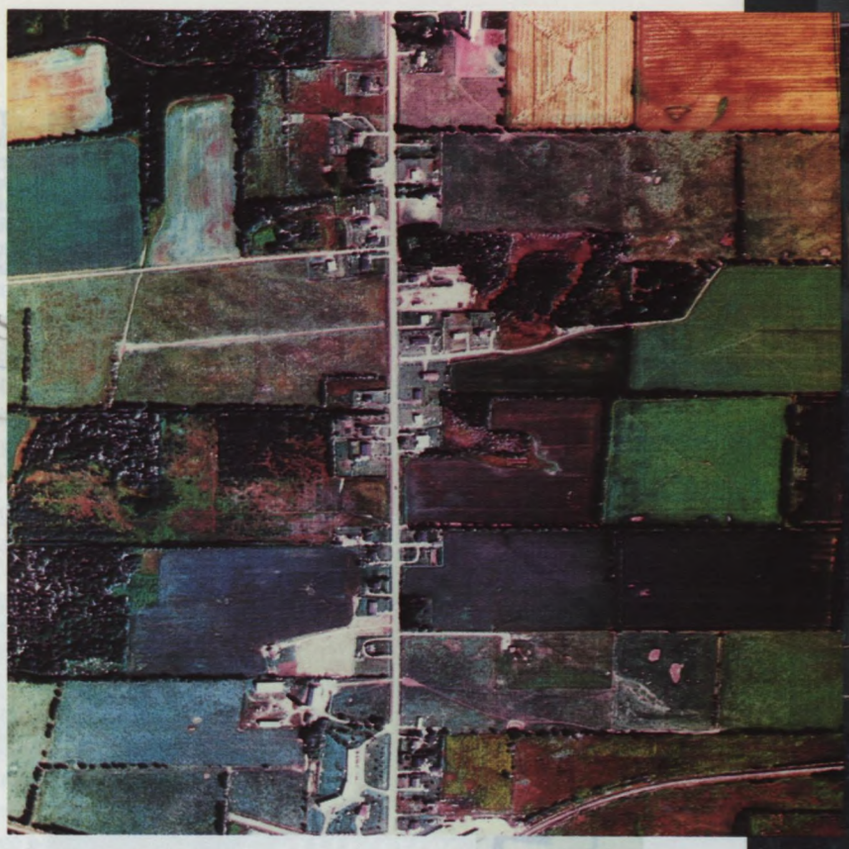
In the 1950s, Canada became a world leader in exporting surveying and mapping products and services. Since then, Canada has become a leader in developing and exporting airborne sensors, satellite data ground-receiving stations and data processing and imaging systems — from the launch of Canada's *Alouette I* satellite in 1962 to the projected launch of the RADARSAT observation satellite in 1994.

Canada now has remote sensing customers in more than 100 countries and maintains close relationships with many others. Receiving stations in Canada now download from LANDSAT, France's SPOT satellite and from Japan's MOS-1. Canada is also a partner in ERS-1, the European earth observation satellite. As a testament to its contribution to remote sensing, Canada was elected to head the International Society of Photogrammetry and Remote Sensing, which comprises 77 member countries.



UPDATA Inc.

SeaSat sea surface topography.



A high-resolution enlargement from the strip.

Imagery acquired from an airborne pushbroom sensor, the Multispectral Electro-optical Imaging Scanner (MEIS), mounted in a CCRS aircraft operated by Innotech Aviation.

Innotech Aviation Enterprises Limited

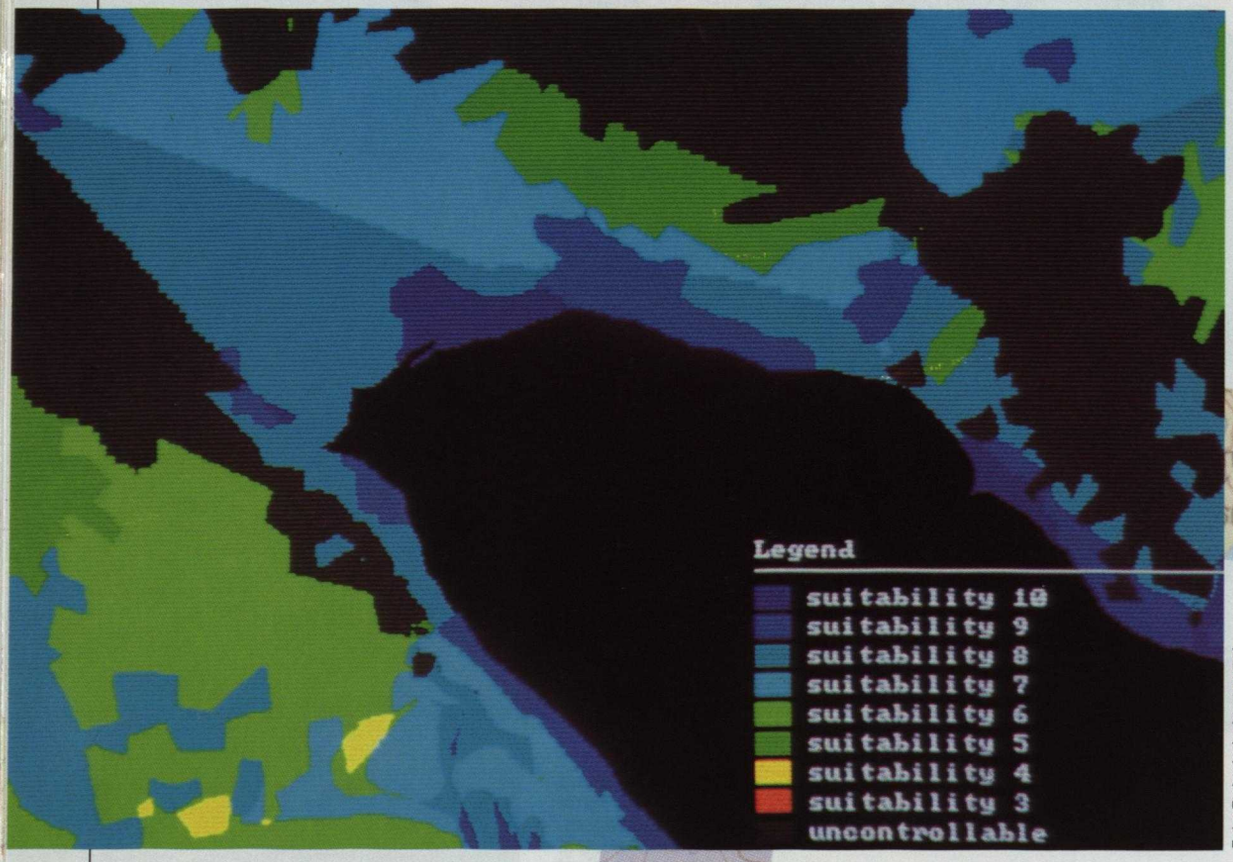
Land Use

Perhaps the first and most important management issue facing any nation, whether industrialized or emerging, is deciding how to use its lands. By mapping land use through remote sensing and aerial photography, planners and decision-makers can study how land is used, how those uses change over time, and how such uses affect the environment. As a result, they can ultimately plan uses that are compatible with present activities, the environment, economic need and resources.

Remote sensing can provide images of land use over extremely large areas. Further, a single set of remotely sensed images can serve a wide variety of applications. Biophysical mapping, surficial geology, forest mapping, agriculture management and environmental damage assessment are a few examples.

Land is the most basic asset, a finite, non-renewable resource. The land-use planner must protect this asset, allocate resources, choose sites for development and balance current and future needs.

Remote sensing technology supplies the land-use planner with an invaluable tool for analysing, planning and modelling. Canada's varied topography has resulted in equally varied land uses, from strip mining to protection of sensitive arctic environments. To support inventories and planning, the Canadian remote sensing community has developed and tested powerful and reliable instruments, software and image analysis systems, which are available to users in other countries.



Tydac Technologies Incorporated

The suitability of terrain for rice growing in Indonesia is shown using Tydac's SPANS spatial analysis systems and software.

Agriculture

Agriculture is any nation's most important renewable resource and its number one land use. Having current information on conditions affecting food production, such as soils, crops, acreage, moisture, crop health, weather and harvest timing, is essential to effectively manage agriculture.

Remote sensing data from airborne and satellite overflights, verified against known conditions, record conditions unobservable at ground level. Moreover, through repeated flight passes, changes over time can be noted and acted upon. The results provide information on a scale not previously possible. Agricultural information for an entire country or for a single farm or field can be gathered with remote sensing imaging.

Agricultural applications of Canadian remote sensing software include:

- crop inventories and early acreage estimates;
- automatic inventories and updating;
- early yield prediction and forage production estimates;
- soil uses;
- crop optimization and crop stresses evaluation;
- desertification and shrub encroachment;
- drought;
- ground-water salinity stress;
- wetlands classification;
- erosion potential; and
- irrigation mapping.

Through Canadian-developed geographic information and imaging analysis systems, data from many sources can now be integrated with that gathered by remote sensing. Topographical maps, theme maps, geophysical inventories and field observation data can be combined with remotely sensed data to produce complex images reflecting realistic conditions at ground level. For example, images indicating areas sensitive to crop failure can be overlaid on theme maps showing acid rain patterns or continental drought conditions to study causal relationships and help solve the problem.

Canada is one of the world's leading agricultural producers and exporters. That leadership is maintained by constant research at all levels of the agricultural process, including testing new remote sensing systems and techniques on a broad range of crops and in a variety of climatic and topographic conditions.

Forestry

Canada is a world leader in the forestry industry, accounting for more than two-thirds of the world's exports of forest products. Remote sensing plays an increasingly important role in Canada's own forestry resources management. Of the tools available, remote sensing is becoming one of the most versatile and effective.

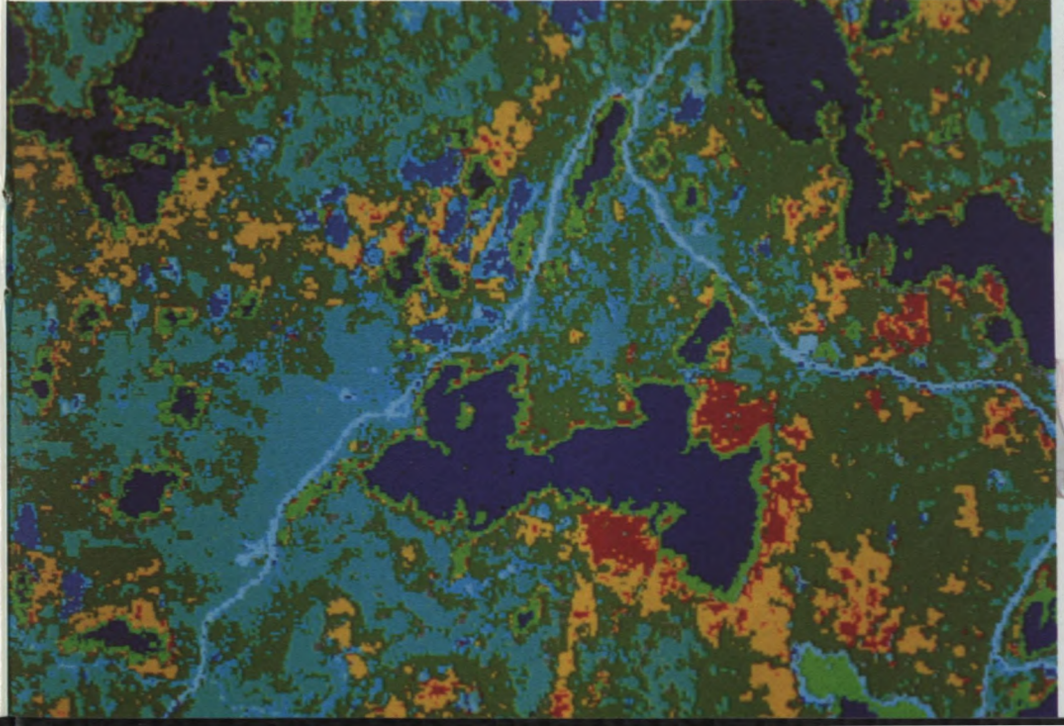
Conventional aerial photography is still a key source of forestry data. Now, however, overview satellite data combined with detailed information gathered by airborne remote sensing instruments allow forest resource managers to see the forest despite the trees. With remote sensing technology, forests can be managed as cohesive units, rather than as random groups of patches.

As is true in agriculture, responsible forest management requires data from different sources. GIS can integrate remotely sensed data with theme data for sophisticated analysis. Information on such factors as soil surveys, vegetation, surficial geology, landform, demography and climate can be overlaid to display the real condition of a forest over time to support effective management applications, including:

- forest type mapping;
- cut-over/depletion mapping;
- forest health monitoring and disease inventories;
- fire hazard monitoring and fire mapping;
- timber and harvest volume estimates;
- silviculture planning; and
- timely map updating.

Canadian companies and governments have supplied remote sensing technology, services, data and education for forestry management to more than 60 countries.

Forest clear cuts, logging roads and related management details are readily available from Thematic Mapper images.



NORDCO Limited

Mineral and Fossil Fuel Exploration

Government, corporations and even individual prospectors carry on the search for minerals and fuels buried beneath the earth's surface. Today, remotely sensed images have been added to traditional methods and more conventional aero-magnetic and electromagnetic surveying as a valuable exploration tool.

Satellite data can show landforms, vegetation and soils that indicate the possibility of minerals or fuels lying underneath. Canadian geologists and remote sensing professionals have developed ingenious computer processing techniques for satellite and airborne radar data.

Canadian-developed programmable multi-spectral imagers and multi-detector electro-optical imaging systems are available to make new exploration surveys from small aircraft cheaper, faster and more accurate. Features include real-time airborne data processing, high radiometric sensitivity, variable spatial resolution and variable scan rates.

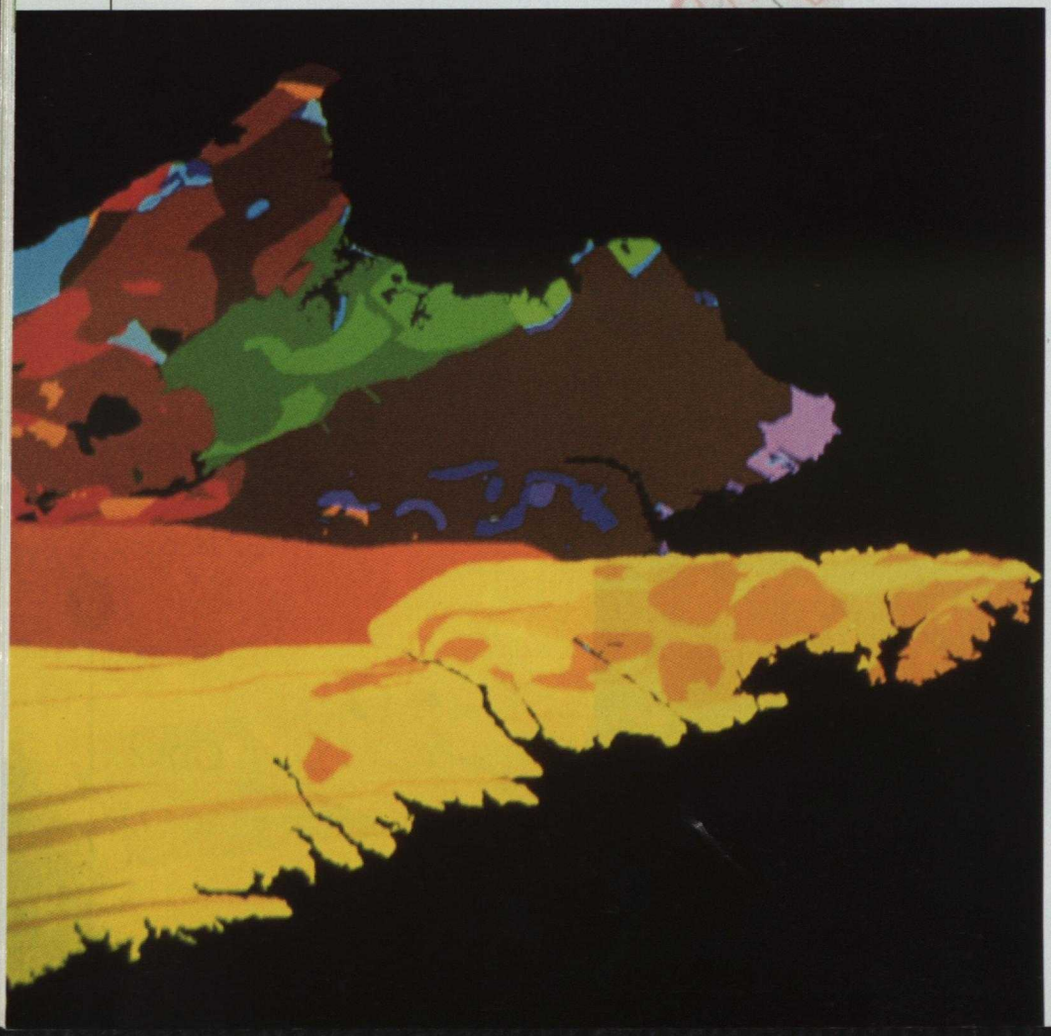
Canadian geometric correction software permits accurate positioning so that remotely sensed images can be geocoded with data from other sources. Canadian built and developed Side-Looking Airborne Radar (SLAR) systems and Synthetic Aperture Radar (SAR) systems are being used worldwide for geological and geophysical exploration. These available technologies are cost-effective alternatives to conventional aerial photography and have a wide range of applications in addition to those for mineral and fuel exploration.

Exploration companies in Canada have also used the methods developed by the Canada Centre for Remote Sensing for the application of satellite data to geology in a variety of environments. These methods as well as the analysis and applications services of several Canadian firms are available to users in support of their remote sensing activities and Canadian remote sensing technology and equipment.

Oceans

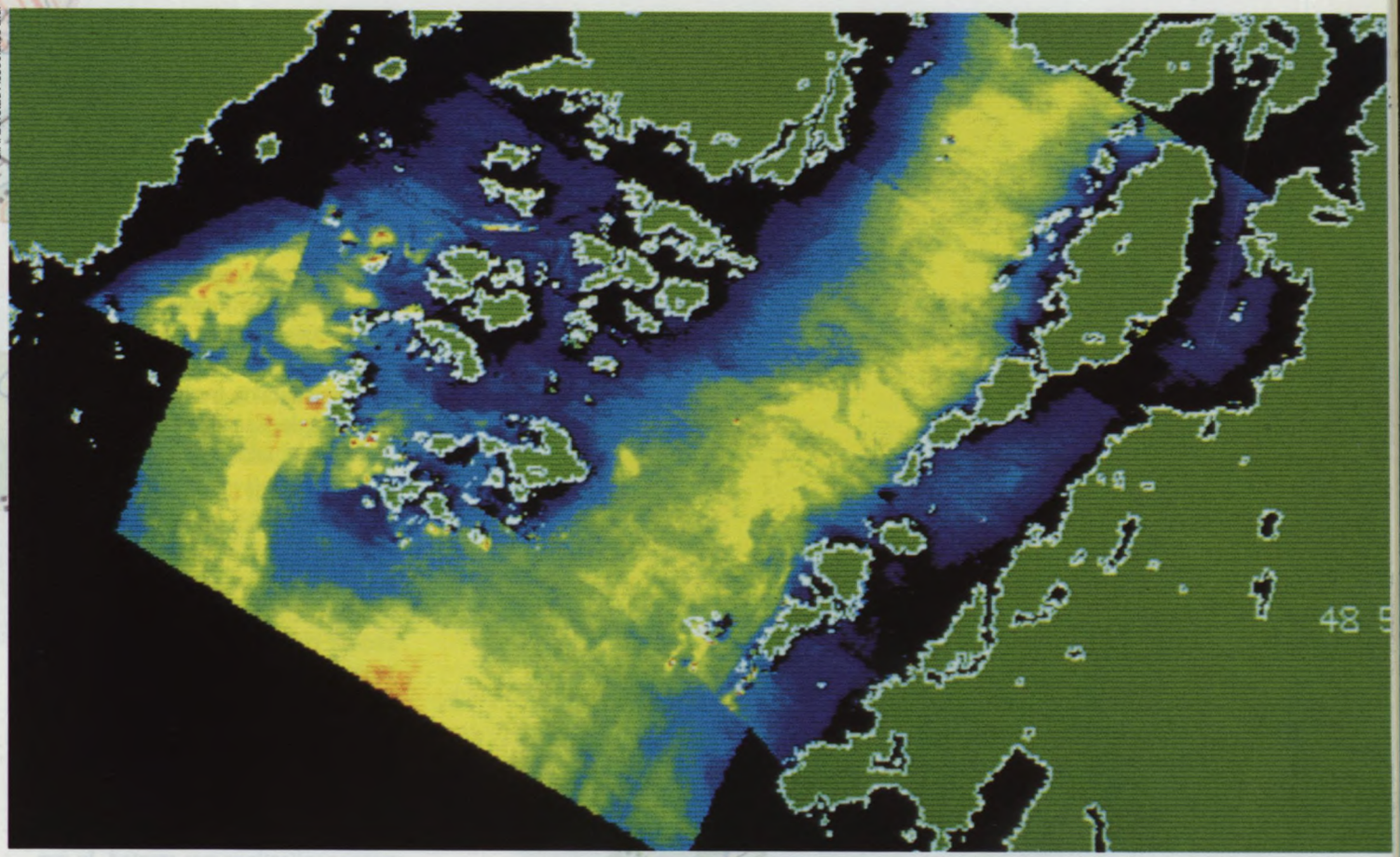
Canada has a small population and the world's longest coastline. The problem of using and responsibly managing the resources of three bordering oceans has led Canada to produce effective and appropriate solutions for a number of ocean environments, from temperate to arctic.

The establishment of Exclusive Economic Zones (EEZs) means that coastal nations are taking a more active responsibility for managing their ocean resources, including fisheries. In most cases these zones are not surveyed and mapped to modern standards — charts from the nineteenth century are still used. The tools and techniques of airborne and satellite remote sensing are now available for up-to-date surveying and monitoring of coastal and deep-water zones for critical ocean resources and protection applications. Canada is one of the few countries with international capabilities in nautical charting and shares these skills and technologies with others.



Tydac Technologies Incorporated

A geological application of Tydac's SPANS spatial analysis systems and software. Various bedrock groups are depicted by the colours.



Distribution of phytoplankton on the B.C. coast was mapped using the Fluorescence Line Imager (FLI), an airborne imaging spectrometer.

Using such tools as multi-spectral imagers and lasers developed in Canada, as well as airborne infra-red radiometers and scanners, Canadian companies are flying oceanographic missions for many countries to determine data that are otherwise unobtainable.

For example, water's colour "signature," obtained by capturing as many as 288 colours in up to 8 spectral bands, gives information on the availability and distribution of phytoplankton, the primary food for marine life. Images of water-colour variations can also be used to infer biological productivity at higher tropical levels. Sea surface temperature can be interpreted for water column stratification and circulation. Inorganic sediments and land-originated dissolved materials can be measured to locate and trace water masses and currents.

Canadian remote sensing companies use laser beams from aircraft to carry out coastal hydrographic surveys more quickly and cheaply than ever before. Laser radar, termed LIDAR (Light Detection and Ranging), is used to detect water depth and quality, a technology particularly appropriate for tropical maritime nations. Other applications include atmospheric diagnostics, pollution monitoring, terrain profiling, wave height measurement and range finding.

Canada's world-class oceanographic technologies and expertise are matched by outstanding accomplishments in hydrography and cartography. Moreover, the newest Canadian remote sensing instruments and services are typical of the cost-effective and valuable innovations Canada offers on the world export market.

Geophysics GPR International Inc.

GPR uses remote sensing techniques to locate underground water and evaluate its potential.

Fresh Water

Canada is blessed with more than 20 per cent of the earth's fresh water supply. Huge waterway systems, such as the Great Lakes and the St. Lawrence Seaway, reach deep into the North American continent. One province alone has more than 250 000 lakes.

This abundance created the need to develop not only forward-looking management techniques and principles, but also the methods of gathering and analysing data on freshwater resources. For example, Canadians pioneered aerial surveying of inland waterways.

With the advent of remote sensing, Canada was quick to use the unique data available from satellite and airborne imaging. Government led the way by providing the ground receiving stations and the core of the technical capabilities to receive, process, display and interpret the information.

Government was also careful to ensure a transfer of expertise to the private sector. As a result, a commercial industry that focused on remote sensing for freshwater applications was created. In continuing co-operation with government agencies, this industry exports its technology and expertise in water resource applications to every continent.

Applications range from entire national water-resource assessments to watershed planning at the local level. Such problems as erosion, sedimentation, flood analyses, shoreline changes and coastal zone management can now be effectively addressed and solved with the assistance of Canadian remote sensing techniques and equipment.

Geographic Information Systems (GIS)

The principles of GIS were first developed by a group of Canadians more than 20 years ago; the Canadian geomatics industry has been a pace-setter in GIS technology ever since. A number of Canadian GIS companies are directly involved in GIS research, development and consulting. In addition, the Surveys, Mapping and Remote Sensing Sector of Energy, Mines and Resources Canada has a GIS Division that co-ordinates the development of GIS at the federal level, bringing together some 17 other federal departments, agencies and individual users. Canadian systems can be found worldwide in the private sector and in all levels of government.

Like any science, geomatics focuses on a purpose beyond itself. Just as medicine is the art of healing, geomatics is the art of creating geo-referenced information systems.

For that reason, the divisions within geomatics are interconnected: data gathering, reproduction and analysis come together as facets of the same ultimate task. And no technology has united the fields of geomatics or had as profound an effect on how we handle and analyse spatial data than geographic information systems (GIS).

By combining sophisticated computer graphics techniques with advanced database management systems, GIS provides the computer tools that allow us not only to capture and store digital data, but also to integrate and relate data in ways that provide information about the environment that we would not have easily discovered in any other way.

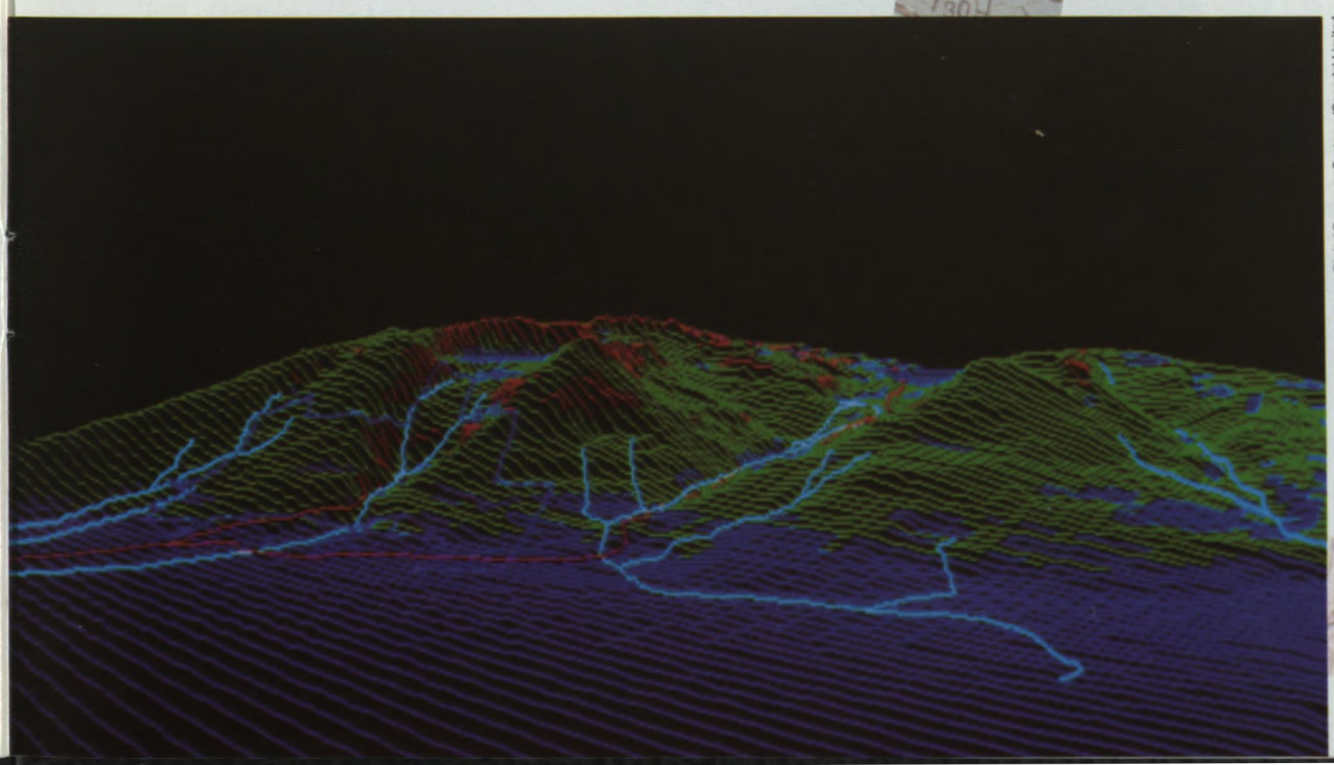
A GIS contains a spatial component and a tabular component: the first stores physical features according to geographic position, while the second stores attribute information for each of the features within a database management system. Thus, a digital map created with a GIS not only represents features graphically, but also stores any amount of information about each feature as well as the physical relationships among them. As a result, a GIS-based information system can perform complex analysis tasks, such as prediction modelling or overlaying.

GIS Applications

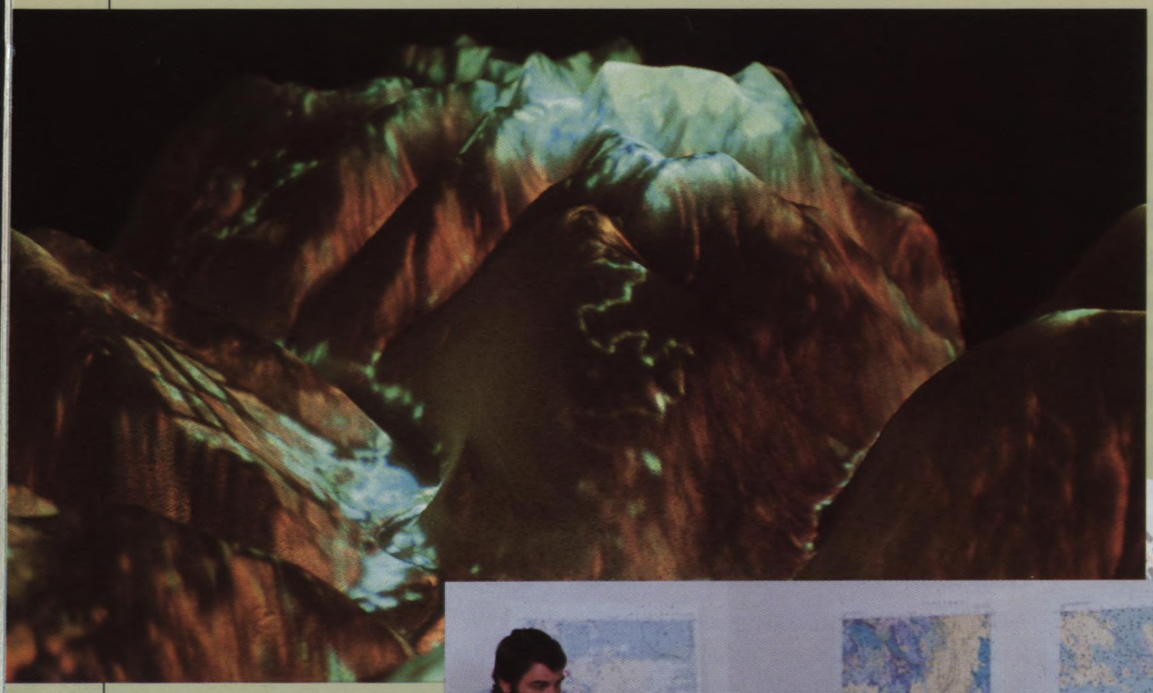
The flexibility and potential of GIS are reflected in the steadily increasing number of applications based on the technology. GIS can:

- perform timely map updates with satellite imagery;
- integrate and analyse information on landmass and subsurface formations for mining and fossil fuel exploration;

TerraSoft Digital Terrain Model (DTM) illustrates slope class by colour: red - 15% and greater; green - 5% to 15%; blue - 0% to 5%. Roads in red and rivers in light blue appear over the DTM.



Digital Resource Systems (Canada) Limited



Gregory Geoscience Limited

Perspective view of the Revelstoke area in B.C.; a 3-D model formed by projecting a Landsat image onto a topographical model using the PROCOM-2 system developed by Gregory Geoscience.

PAMAP Graphics Ltd.

PAMAP's geographic information system serves a wide variety of applications.

- plan new utilities facilities and networks, and incorporate environmental protection issues into the system;
- identify and manage high-risk environmental and wildlife areas through various criteria, such as plants, soils, animals, and areas that are susceptible to damage;
- predict overall crop yields using information on soil conditions, rainfall patterns and yearly crop conditions;
- manage forest inventories and predict forest fire hazard;
- perform networking and routing tasks such as real-time emergency vehicle dispatch, garbage collection, school bus planning, hospital and firehall siting, and so on; and
- plan future urban growth and land use according to agricultural needs, city infrastructure support, water supplies, health and sanitation, official plans, zoning and flood plains.

The type and amount of information that can be put in a GIS to assist in planning, modelling and decision-making are virtually limitless.

A TEAM APPROACH TO GEOMATICS

Canada has taken a national approach to geomatics issues. Industry, federal and provincial governments, and academia work together as a team to co-operatively share, exchange and develop technology, information and expertise.

The strengths of this strategy are especially beneficial to Canada's export clients. Whether dealing with a private company, a government agency, or a university, the efforts and experience of the other team players are wrapped up in the products and services.

Moreover, Canada's experience can be tapped in establishing co-operative geomatic strategies and issues, including setting national standards and exchange formats, encouraging co-operation, establishing communications programs and setting up financial incentives.

A key player in Canada's team approach to geomatics is the Surveys, Mapping and Remote Sensing Sector (SMRSS) of the federal department of Energy, Mines and Resources Canada (EMR).

SMRSS is responsible for federal surveying, mapping, remote sensing and GIS activities, including research, development, training and administration. As part of its role as the key federal component of the Canadian geomatics community, it is in a special position to foster a co-operative approach among governments, industry and universities.

This co-operative approach includes contracting out and close technical co-operation with the private sector. Initiatives, such as the Geographic Information Technology Development Program, provide the structure for fostering data and task sharing at all levels of the geomatics process. The SMRSS works closely on export market development in co-operation with the Canadian International Development Agency, External Affairs and International Trade Canada, and other Canadian and international agencies.

The GIS component of the Canadian geomatics scene is of particular interest. A National Digital Topographic Database (NDTDB) serves as an important information base for GIS technologies and GIS-based information systems for all participants in the geomatics community.

The prime role of the SMRSS is to provide a reliable system of surveys, maps, remotely sensed data and geographically referenced information covering the Canadian landmass in support of national sovereignty, defence, the environment, socio-economic development and the governing of Canada.

In providing geographic data to users and geomatics professionals at all levels of the private and public sectors, an archive of hundreds of thousands of satellite images, maps and aerial photographs is maintained as a vital support for national and international environmental monitoring and resource planning and studies, including such areas as:

- acid rain;
- global environmental change and ozone depletion;
- desertification and drought;
- flood risk;
- vegetation damage;
- sediment movement in water;
- natural radiation;
- oil spills and toxic substance accidents;
- smoke plume movement; and
- settling pond seepage.

Technology development and enhancement are also key to national efforts. The further linking of remote sensing, mapping and GIS technology and the study of the proposed Active Control System (ACS) for Global Positioning System (GPS) technology in Canada are two current technological priorities. Also important is an Automated Canada Lands Information System (ACLIS) that will use GIS and database management technology to manage cadastral information on national parks, native lands and Canada's northern territories.

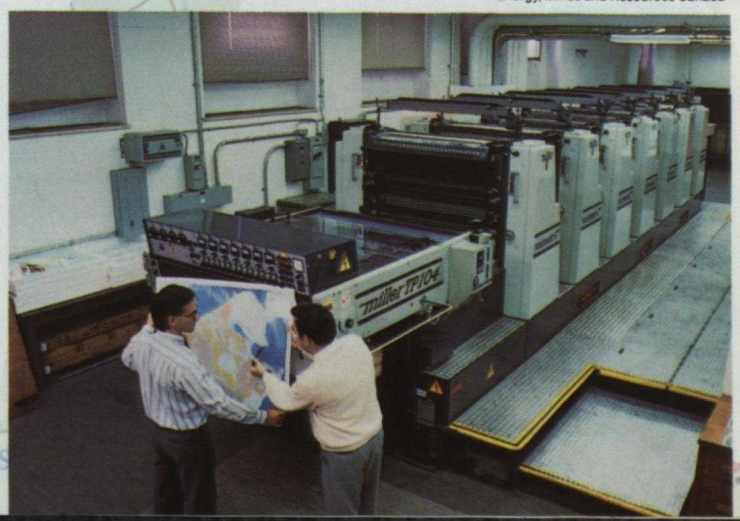
EMR's geomatics activities are conducted by the Surveys, Mapping and Remote Sensing Sector through the Canada Centre for Surveying, the Canada Centre for Mapping, the Canada Centre for Remote Sensing, the Policy, Planning and Services Branch and the Geographic Information Systems Division.

Canada Centre for Surveying

The Canada Centre for Surveying (CCS) is the national agency for surveying, providing the national survey framework. The Centre's Legal Surveys Division is responsible for performing and regulating all legal surveys of Canada's lands

A multi-colour map from a seven-colour computerized press.

Energy, Mines and Resources Canada



Energy, Mines and Resources Canada

A satellite Global Positioning System (GPS) site and receiving antenna centred over a geodetic marker.

and registering interests and rights in those lands, particularly those of Canada's aboriginal peoples. The Geodetic Surveys Division establishes and maintains national networks of geodetic control and the Centre's International Boundary Commission is responsible for the survey of national boundaries.

The Canada Centre for Surveying has always had a close working relationship with the private sector and professional associations. Projects conducted by the Centre and the private sector include studies on geoid models, instrumentation and developing satellite positioning applications. Satellite positioning projects form a large part of the Centre's international involvement. Recently, technical assistance has been provided to such nations as Indonesia, Zimbabwe, Egypt and Tanzania.

Canada Centre for Mapping

The Canada Centre for Mapping produces and manages national topographic maps and the related computer databases. The Centre is responsible for aeronautical charts, geographic maps, Canada's National Atlas, publication of geographic names and electoral maps. Research and development in cartographic technology is undertaken through the Canada Centre for Geomatics.

The Centre for Mapping is very active in developing national standards for topographic and geographic digital mapping. The availability of widely adopted standards is essential to realizing the economic benefits of co-operatively managing and sharing digital cartographic data.

Canada Centre for Remote Sensing

The mandate of the Canada Centre for Remote Sensing is to improve remote sensing technology, to acquire and distribute remotely sensed data and to work with the rapidly growing remote sensing industry in Canada. In addition to its 120 staff members, the Centre has another 100 persons on contract from Canadian industry working on various developmental and technology transfer projects.

The Centre is responsible for remote sensing research and development within the Government of Canada. It was particularly responsible for the Radarsat Planning Office (RPO) at its inception. This office is currently planning the launch of the satellite-based C-band radar in 1994. The current focus of the Centre is on radar technology and applications, and on preparing for ERS-1, RADARSAT and other planned radar satellites.

Policy, Planning and Services Branch

The Policy, Planning and Services (PPS) Branch performs many corporate functions for the sector. Amongst them are co-ordinating the sector's activities, including external relations (domestic and international), providing policy and planning services and managing the reproduction and distribution of maps and charts, air photographs as well as marketing of cartographic products in digital and analog/video formats.

The Branch distributes topographic maps, aeronautical charts, geographic maps including those of the National Atlas of Canada. It provides reproduction services to private companies for use as base material for value-added products and has assisted a wide variety of agencies and firms in designing and producing such products.

Geographic Information Systems Division

The importance of geographic information systems has led the sector to establish a Geographic Information Systems Division. The division's mandate is to develop and maintain national GIS standards; conduct GIS research and support the development of the Canadian GIS industry; establish long- and short-term national policies and strategies; and promote and co-ordinate the development and application of GIS within the federal, provincial, and municipal governments.

PROVINCIAL GOVERNMENT ORGANIZATIONS

In Canada, provincial governments are responsible for natural resources management and land administration for jurisdictions that are individually larger than many countries. Thus, the 10 provinces and 2 territories have developed advanced resource monitoring and land administration programs suited to their unique combinations of resources and needs.

During the past decade, largely as a result of the huge amount of data now available and the need for computerized methods of handling and analysing it, several provinces have initiated programs to develop land information systems. New technology has greatly improved methods of collecting, processing, storing and distributing land information. New surveying and mapping techniques, such as global positioning and remote sensing, make it possible to quickly collect large amounts of information about land. Furthermore, computers can also process and store large amounts of information and distribute those data by electronic communication.

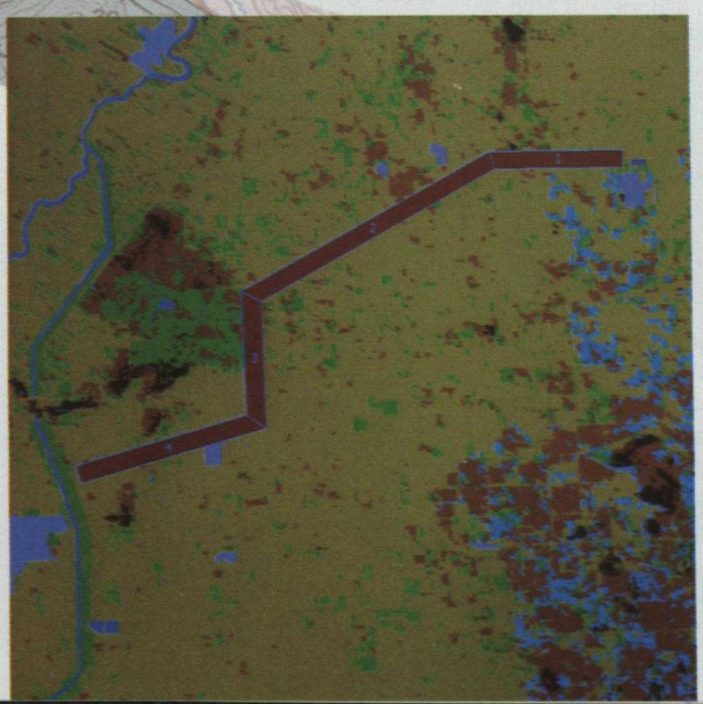
With the development of GIS, all these diverse kinds of land information can be integrated within a land information system. This system is generally perceived as a way of organizing the collection, processing, storage and distribution of land information in order to create applications that serve a variety of users.

Canada took a lead in land information systems with the establishment of the Land Registration and Information Service (LRIS) for Canada's Maritime Provinces. The service, now known as the Maritime Provinces Land Information Corporation (MAPLINC), has provided a learning experience not only for Canada but also for the international land information community.

New Brunswick has become an acknowledged world leader in the application and management of land-related information. The province currently has under way an initiative that uses computers to integrate geographically related information on forestry, transportation, earth sciences, agriculture, the coastal land and sea environment, and municipal services. Nova Scotia is home to the College of Geographic Sciences, an internationally renowned technical college specializing in geomatics. Prince Edward Island, Canada's smallest province, is involved in advanced remote sensing methods as they apply to coastal and agricultural resource management. Newfoundland has been working in geomatics, developing the use of remote sensing and advanced mapping technologies for forest mapping and fisheries management.

Quebec's Ministry of Energy and Resources is concentrating on two major areas: participation in implementing the provincial government's geomatics plan, which proposes a single geographic reference, in this case at a scale of 1:20 000, and reassessment of the cadastral reform program. The proposed program will involve updating and producing digital cadastral and topographic maps and strengthening the basic geodetic network.

The Government of Ontario began designing and implementing improvements to the province's Land Registration System in 1980. The improved system, the Province of Ontario Land Registration Information System (POLARIS), uses digital property mapping files and digital title index files. The survey and property boundary information in the property mapping files is separated into layers and related to the provincial grid, and the property mapping is tied into the Ontario Base Mapping. A unique property identifier (PIN) is created for each property. The PIN is the label under which the property title information is stored, allowing federal, provincial and municipal digital land databases to be referenced to ownership parcels and topographic features.



Applied Terravision Systems Inc.

Remote route selection using LANDSCAN's Corridor Analysis Module. LANDSCAN is a digital image analysis system designed by Applied Terravision Systems.

SPAR Aerospace Limited

Artist's concept of RADARSAT spacecraft.

The Government of Manitoba has embarked on a digital base mapping program and is studying the development of a province-wide land-related information system. A report by the Association of Manitoba Land Surveyors identifies the property parcel as an important building block in developing a provincial land information system and suggests that the surveying profession can make a significant contribution to the building of the system by connecting legal surveys to the geodetic survey framework.

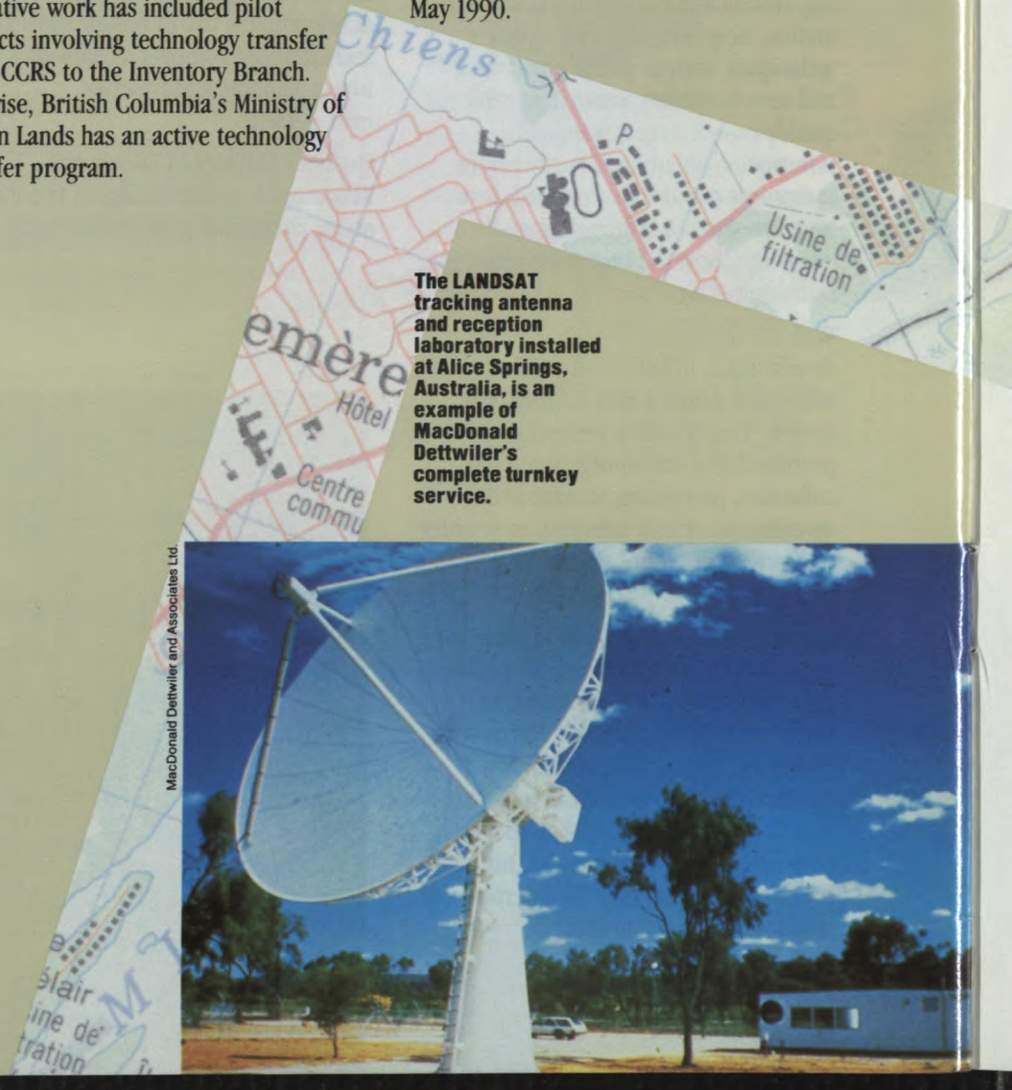
Saskatchewan's Central Survey and Mapping Agency (CSMA) leads that province's geomatics activities, particularly user co-ordination and data generation. A strategic GIS plan that sets out products, procedures, scheduling and costs associated with the GIS model that best suits Saskatchewan's situation has recently been formulated.

Alberta's survey control network has been completed. All but nine municipalities with a population over 2 500 fall under the province's Integrated Surveying and Mapping Program. The provincial digital base mapping program, accomplished in partnership with the Alberta mapping industry, is nearing completion now. Major Alberta programs in support of provincial natural resource management include resource inventory and analysis, thematic mapping and geoprocessing. In co-operation with the Canada Centre for Remote Sensing, the province is also working under the Technology Enhancement Program on a variety of projects to demonstrate the application of remote sensing techniques to resource management and monitoring. An automated database is under development to support the Alberta Vegetation Inventory Project. Other accomplishments include land classification projects, climatic data collection and wildlife habitat mapping.

In British Columbia, the private sector in partnership with the provincial government is undertaking a digital base mapping program. The province's Ministry of Forests has set up an ambitious GIS remote sensing program. In co-operation with the Canada Centre for Remote Sensing (CCRS) and local industry, the ministry's Inventory Branch has pioneered the monitoring of forest depletions by integrating GIS and satellite image analysis techniques. This co-operative work has included pilot projects involving technology transfer from CCRS to the Inventory Branch. Likewise, British Columbia's Ministry of Crown Lands has an active technology transfer program.

Ontario, Quebec, Alberta, Saskatchewan and Manitoba have also been actively involved in developing a broad range of applications of remote sensing, mapping and geographic information systems for non-renewable and renewable resource monitoring. Applications cover such areas as civil engineering, range management, agricultural crop monitoring, land use changes, forest depletion mapping, environmental monitoring, and mineral and oil exploration.

The Yukon and the Northwest Territories serve as active test sites for the development of economic, large-area mapping methods. The two territories participate in remote sensing monitoring of such diverse phenomena as offshore ice, placer gold mining, and wildlife habitats. The Northwest Territories was chosen as the host for the first circumpolar conference on remote sensing held in May 1990.



MacDonald Dettwiler and Associates Ltd.

The LANDSAT tracking antenna and reception laboratory installed at Alice Springs, Australia, is an example of MacDonald Dettwiler's complete turnkey service.

EDUCATION AND TRAINING

Canadian universities and technical institutes have adapted to more complex needs and advancing technologies to ensure a steady flow of qualified graduates entering the geomatics professions. More and more, surveyors and mappers are becoming information gatherers and managers, working with planners, geographers, engineers and computer scientists in multi-disciplinary teams. Education and training in Canada address the need for a solid team approach to preparing future professionals.

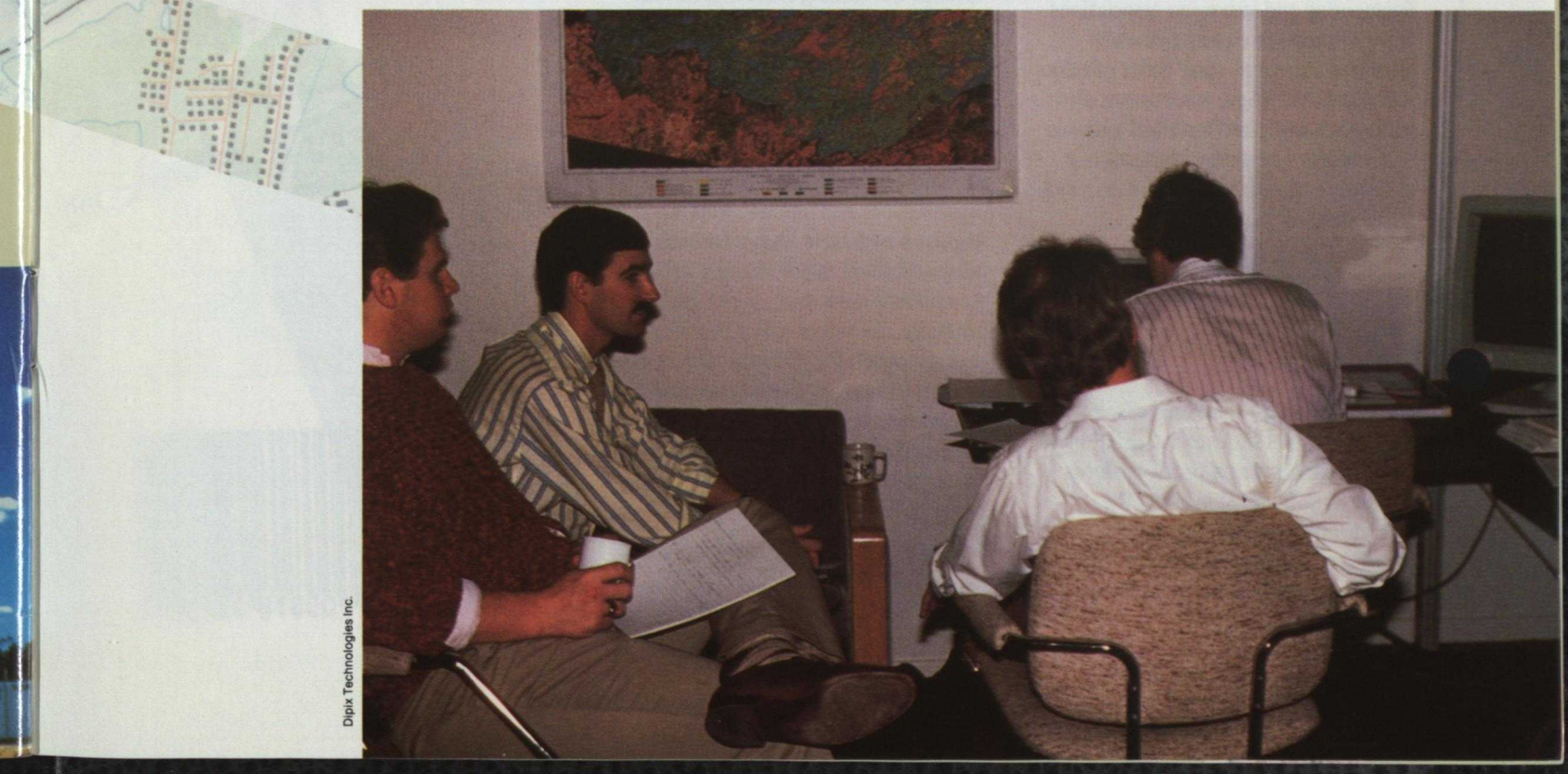
For example, technical institutions such as the College of Geographic Sciences in Nova Scotia, Sir Sandford Fleming College in Ontario, the Southern Alberta Institute of Technology and the British Columbia Institute of Technology provide one- and two-year programs to teach digital mapping skills, GIS programming, specialized applications and the broader science of geomatics.

Canada's universities and colleges include more than 80 institutions of higher education: 61 are English-language, 16 are French-language and 5 are bilingual. Four universities offer degree programs in surveying engineering or the equivalent: Université Laval, University of New Brunswick, University of Toronto at Erindale College and the University of Calgary. These surveying engineering programs have helped drive the development and acceptance of new technologies through research in global positioning systems, geomatics and land information management.

The quality of Canadian consulting engineers in every specialty is known around the world through 40 years of work in more than 100 countries. Professional engineers trained in Canada meet and often exceed the highest international standards.

In addition to formal educational programs, many private-sector groups and educational institutions offer specialized and, in some cases, tailor-made short courses. Particular expertise has been developed in meeting the needs of overseas users. In any given year, hundreds of people from outside Canada take advantage of Canadian educational opportunities in surveys, mapping, remote sensing and GIS.

Dipix offers training in Canada and abroad.



Dipix Technologies Inc.

INSTITUTIONS

Professional Societies

Much of Canada's reputation for excellence is a result of the stringent qualifications required of its geomatics professionals. For example, cadastral surveyors must meet strict Canadian educational and professional requirements before being allowed to offer their services to the public.

National and provincial professional surveying associations issue licences to practise, a responsibility delegated by legislation. "CLS," for instance, indicates a qualified "Canada Land Surveyor," and "ALS" indicates an "Alberta Land Surveyor."

Nearly all geomatics professionals belong to one or more of the numerous professional societies in their fields. Among them are:

- the Canadian Institute of Surveying and Mapping;
- the Canadian Council of Land Surveyors; and
- the Canadian Remote Sensing Society.

Engineering and surveying associations in every province ensure that their members adhere to strict codes of ethics and standards. These associations also publish scientific and technical journals that advance knowledge and maintain vital international links for the exchange of information.

Industry Associations

The private sector's national association is the Geomatics Industry Association of Canada (GIAC), a non-profit business organization founded in 1961. The Association's mission is to support the growth and development of the Canadian geomatics industry. From an initial membership of 8 firms, the association has grown to over 80 member firms representing all the disciplines within geomatics, including aerial photography, cartography, control surveying, engineering surveying, geodesy, geophysical surveying, land/geographical information processing, land surveying, mining surveying, photogrammetric mapping and remote sensing.

One of the most important of GIAC's services is a government relations program aimed at assisting legislators and senior officials to implement a legislation and policy framework that will enhance the business climate for the industry. Particular emphasis is placed on promoting increased contracting-out of work and improved procurement practices.

The Association represents the industry in formal negotiations with government, and is widely regarded as the industry's official spokesperson. This role was recognized when a Memorandum of Understanding (MOU) was signed in 1987 with Energy, Mines and Resources Canada, the leading federal geomatics agency. Within the context of this MOU, co-operative activities are being pursued in export market development, technology transfer and research.

GIAC acts as an information conduit to its member firms and to other organizations and interest groups. Regular newsletters keep members informed about major changes in government legislation, policy and programs, as well as major events and changes within the industry. The Association contributes to relevant government and professional publications, and the views and concerns of the membership are communicated through papers, briefs and reports.

Promotion of the Canadian geomatics industry, both within Canada and abroad, is an important focus for GIAC. A directory of member firms is widely distributed to potential users of geomatics technology and services. The Association collaborates with government agencies and sister associations in the co-production and distribution of special promotional materials.

GIAC is also involved in the development and delivery of educational programs with a business focus, and regularly co-sponsors technical and professional development programs in concert with national professional associations in the geomatics sector.

Béliveau-Couture

Computer-assisted mapping, GIS services and consulting are among the range of geomatics services offered by the Béliveau-Couture Group.

External Affairs and International Trade Canada
Affaires extérieures et Commerce extérieur Canada