Geomatics Industries

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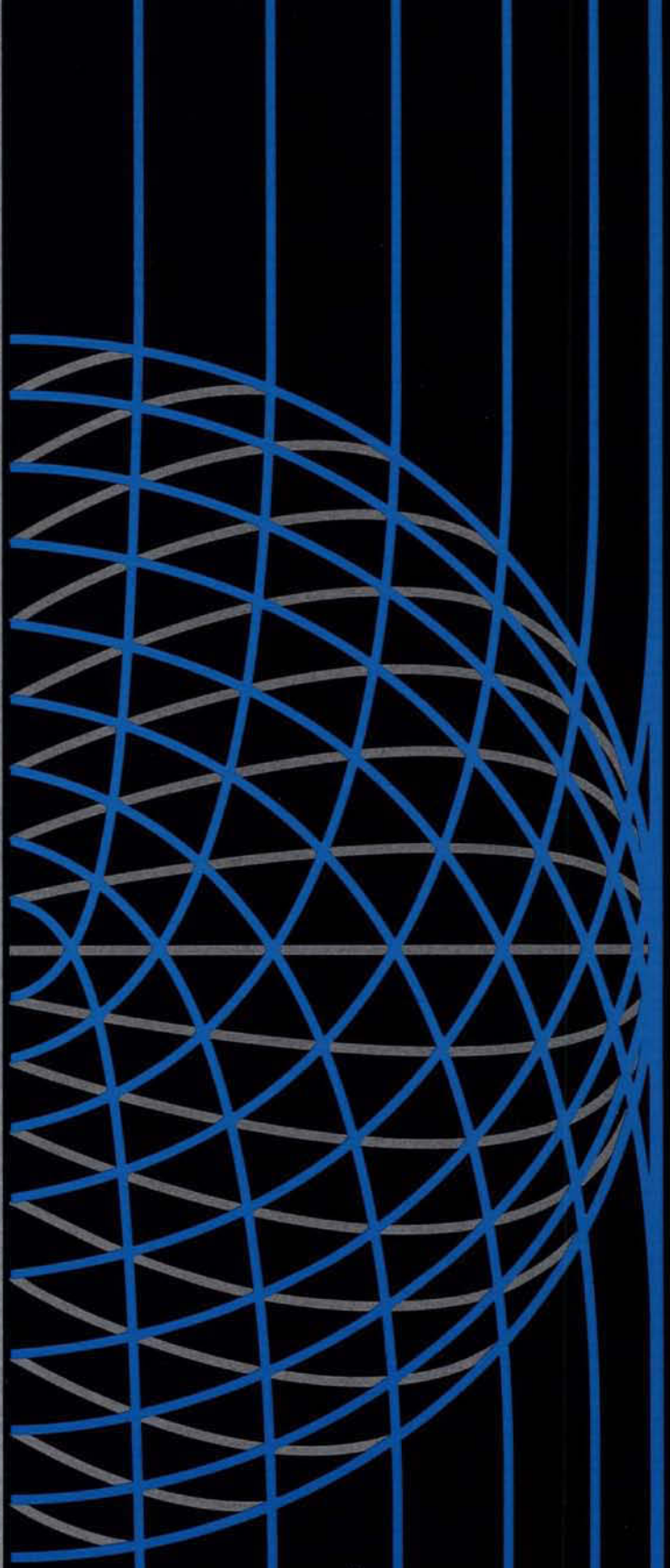
INDUSTRY PROFILE



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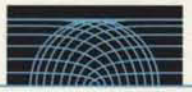


I N D U S T R Y P R O F I L E

1990–1991

GEOMATICS INDUSTRIES

FOREWORD

In a rapidly changing global trade environment, the international competitiveness of Canadian industry is the key to growth and prosperity. Promoting improved performance by Canadian firms in the global marketplace is a central element of the mandates of Industry, Science and Technology Canada and International Trade Canada. This Industry Profile is one of a series of papers in which Industry, Science and Technology Canada assesses, in a summary form, the current competitiveness of Canada's industrial sectors, taking into account technological, human resource and other critical factors. Industry, Science and Technology Canada and International Trade Canada assess the most recent changes in access to markets, including the implications of the Canada-U.S. Free Trade Agreement. Industry participants were consulted in the preparation of the profiles.

Ensuring that Canada remains prosperous over the next decade and into the next century is a challenge that affects us all. These profiles are intended to be informative and to serve as a basis for discussion of industrial prospects, strategic directions and the need for new approaches. This 1990–1991 series represents an updating and revision of the series published in 1988–1989. The Government will continue to update the series on a regular basis.

Michael H. Wilson
Minister of Industry, Science and Technology
and Minister for International Trade

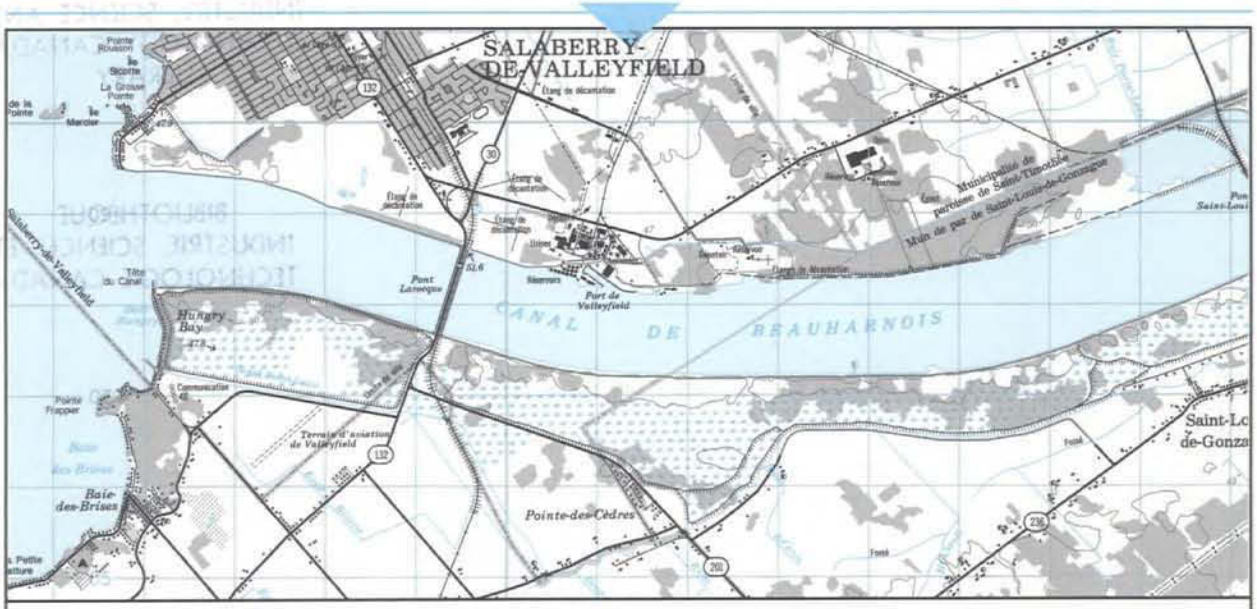
Structure and Performance

Structure

The word "geomatics"[1] was first introduced in 1975 by Dr. Bernard Dubuisson. The term refers to disciplines that acquire, manage and distribute space or geographically referenced data for everything from mapping a rugged seabed to establishing property boundaries for new neighbourhoods. In Canada, geomatics includes such disciplines as aerial photography (see Maps 1 and 2 on page 2 for examples); surveying such as cadastral surveying (i.e., land and boundaries), engineering surveying, geodetic surveying, geophysical surveying, hydrographic surveying (hydrography) and mining surveying; mapping including cartography and photogrammetry; Geographical Information Systems (GIS); and remote sensing (see Glossary on page 13 for definitions).

Over the last several years, technological advances have had a significant impact on these disciplines and the way they interrelate. The introduction of computers with their ability to record, store, manipulate and retrieve computerized or digitized data has expanded the geomatics industry's ability to respond to increasing demands from clients for geographical information. In fact, the geomatics industry is increasingly devoting its energies to the development and use of remote sensing equipment and software as well as computer-based GIS. As well, the technology is breaking down the barriers between the geomatics subdisciplines, while at the same time

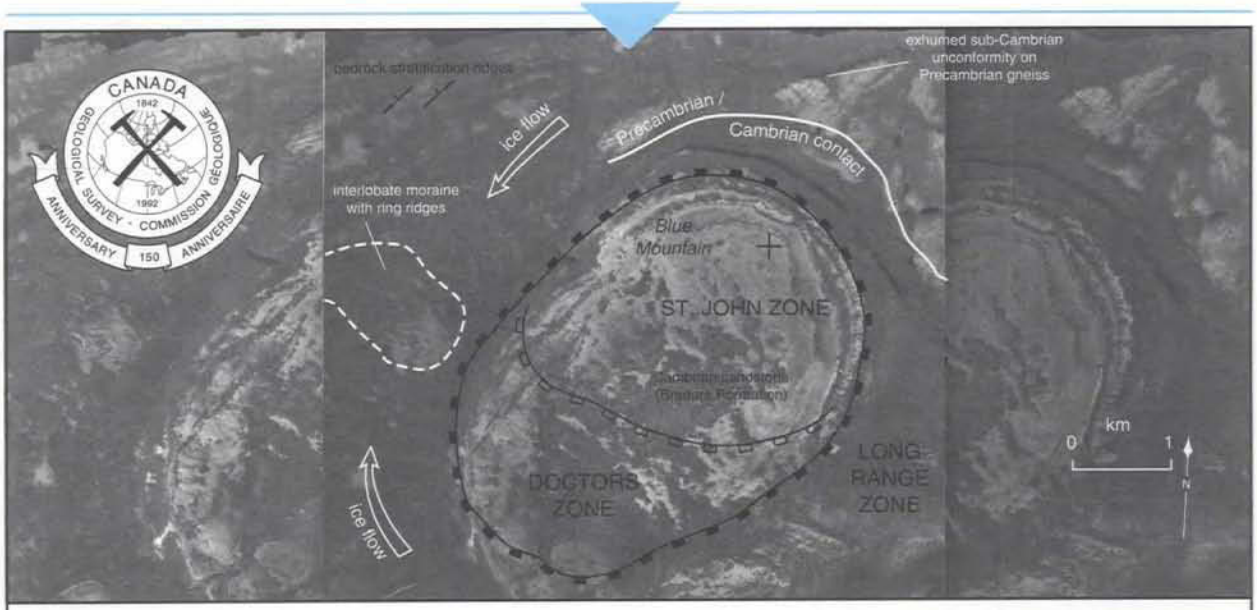
[1]The previous profile for this industry was entitled *Surveying and Mapping Services*.



This is part of a National Topographic Series 1:50 000 scale digital map of the Salaberry-de-Valleyfield/Huntingdon area located in southern Quebec close to the border with the United States. It is compiled from aerial photographs using computerized photogrammetric and cartographic techniques. This series of maps is part of the National Topographical Data Base, which is the national data bank of information describing the physical features (contours, drainage, roads, etc.) of the Canadian land mass. Responsibility for creating and maintaining this database lies with Energy, Mines and Resources Canada.

Courtesy of the Surveys, Mapping and Remote Sensing Sector, Energy, Mines and Resources Canada.

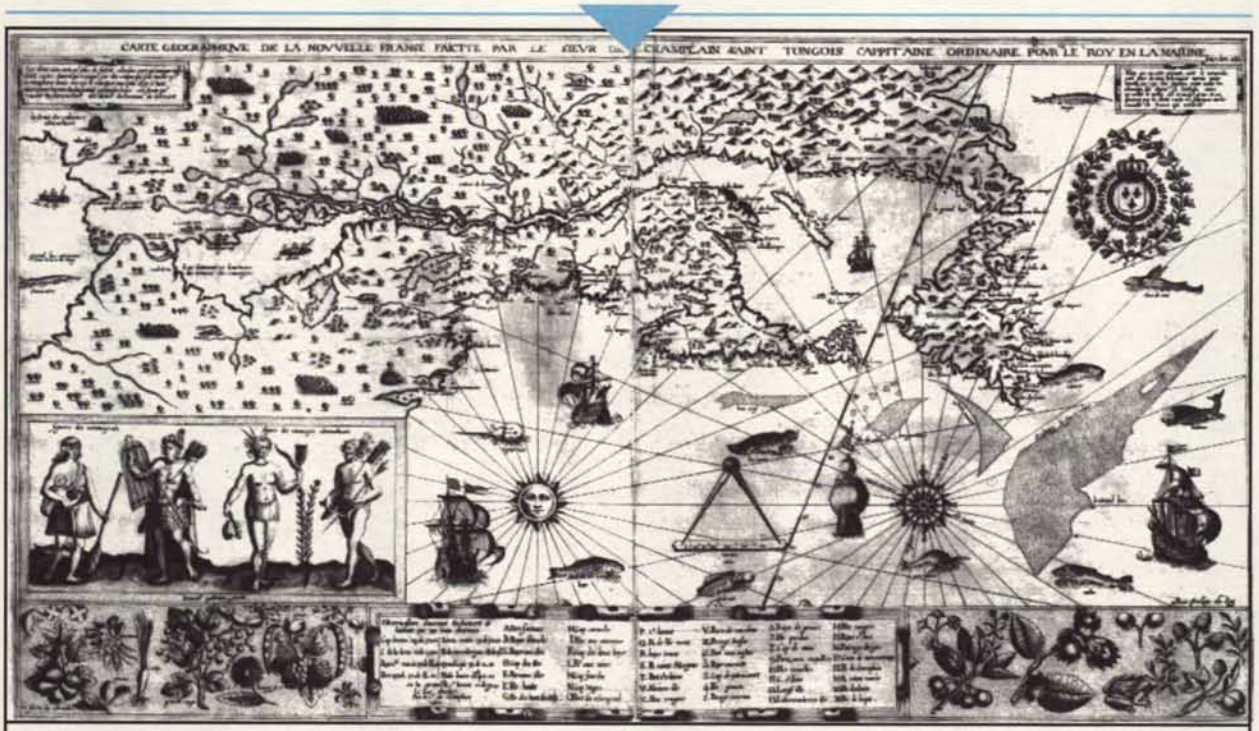
Map 1 — Salaberry-de-Valleyfield/Huntingdon Map (A Product of Aerial Photography and Remote Sensing)



This illustration depicts the limits of three successive glaciations around Blue Mountain, Newfoundland, and was created by combining scanned airphoto images with computer linework and text. It is part of the Geoscience Surveys program that provides a geoscience knowledge base contributing to economic development, public safety, environmental protection and national sovereignty. At the time of its founding, 150 years ago, the Geological Survey conducted surveys and produced maps that served prospectors searching for mineral deposits as well as those seeking to open up and settle the Canadian land mass.

Courtesy of the Geological Survey of Canada Sector, Energy, Mines and Resources Canada.

Map 2 — Blue Mountain, Newfoundland



This Nouvelle France map drawn by Champlain begins with Newfoundland and Labrador in the northeast, passes through the Maritimes and New England and then follows the St. Lawrence River through to the Great Lakes. It indicates both native and French settlements, including Quebec. In the lower left-hand side, Champlain depicts two native couples — one "Montagnais" and the other "Almouchicois." Below the couples are drawings of North American flowers and an index table of the names of places identified by letters and numbers in the map itself. This chart was included in the 1613 publication entitled *Les Voyages du Sieur de Champlain Xaintongeois, Capitaine ordinaire pour le Roy, en la Marine.*

Courtesy of the National Library of Canada.

Map 3 — Samuel de Champlain's 1612 Map of Nouvelle France

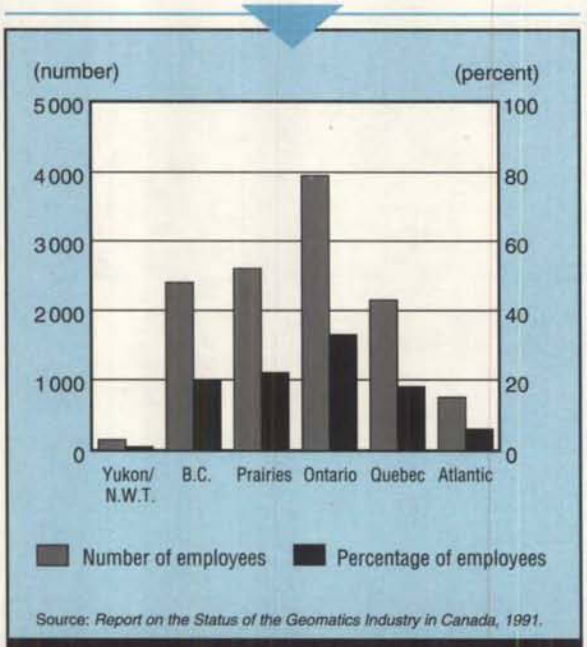
encouraging other professions to become more directly involved in geomatics issues.

Establishing legal boundaries for land ownership is the historical foundation of surveying and it continues to play a major role. This tradition began in the early 17th century with the arrival of the first European colonists. In fact, Samuel de Champlain, who established the French settlement at Quebec, was a surveyor and mapmaker by trade (see Map 3). Because of the legal ramifications associated with property ownership, it is a legal requirement that surveying be carried out by licensed practitioners. Over time, self-governing professional organizations have been established under provincial and federal legislation and regulations to maintain educational surveying standards and to license land surveyors. At present, there are approximately 3 200 licensed surveyors across Canada. This number has remained relatively constant over the last several years.

Since the Second World War, other geomatics industry disciplines such as hydrography, cartography and remote sensing have emerged and established professional associations that, because their members are not involved in establishing legal property boundaries, do not license their practitioners. Survey technicians and technologists who receive their training from various community colleges and institutes of technology are organized through provincial associations. Businesses working within the geomatics field have established non-profit industry associations to represent their interests.

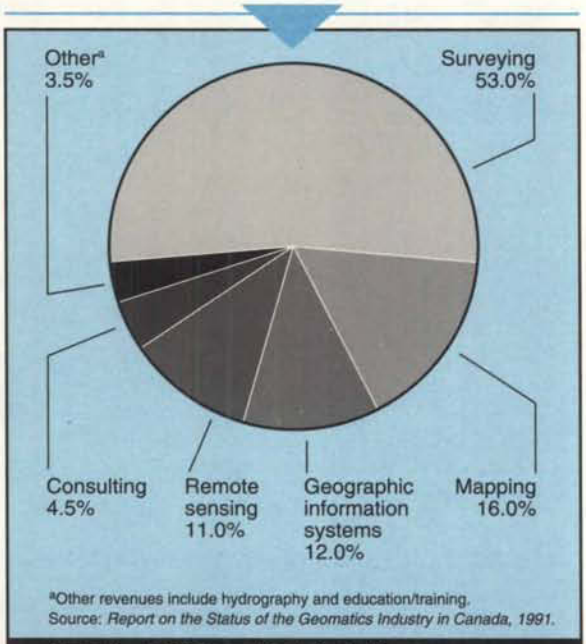
In 1991, the geomatics industry in Canada consisted of approximately 1 355 firms employing about 12 000 people. The distribution of these firms and employees (Figure 1) corresponds to the overall distribution of Canada's population except for British Columbia where the share of the national geomatics industry work force is almost twice the portion of the country's population resident in that province.

In 1991, 60 percent of the industry's firms were corporations, 22 percent were sole proprietorships, while the remaining 18 percent were partnerships. Many of the sole proprietorships and partnerships are owned and operated



Source: *Report on the Status of the Geomatics Industry in Canada, 1991.*

Figure 1 — Employment by Region, 1991



[a]Other revenues include hydrography and education/training.
Source: *Report on the Status of the Geomatics Industry in Canada, 1991.*

Figure 2 — 1990 Geomatics Industry Revenue (Total revenues = $750 million)

by licensed surveyors who are often prohibited by legislation from incorporating. Total revenues for the industry amounted to an estimated $750 million during the fiscal year ending in 1990. Foreign billings accounted for $120 million, or 16 percent of total revenues.

In terms of revenue, about 86 percent of the total number of firms within the geomatics industry were small enterprises with annual revenues of less than $2 million in 1990–1991 (Table 1). The larger geomatics firms, which were responsible for 68 percent of the total industry's revenues, tended to be more diversified in their operations. In terms of employment, while smaller businesses with 50 employees or less represented 92 percent of the total number of industry firms, they accounted for just under half of the industry's overall employees. The remaining 8 percent of the geomatics companies were responsible for about 51 percent of the overall industry employment.

Table 1 — Geomatics Industry Composition, 1990–1991

Revenues	% of industry firms	% of industry revenues
Annual revenues less than $2 million	86	32
Annual revenues of $2 million or greater	14	68
Total	100	100

Source: ISTC estimates.

In 1990, 63 percent of the geomatics industry's gross billings in the domestic market came from the private sector, while the remaining 37 percent was drawn from federal, provincial and municipal governments. The housing, real estate, engineering and construction, as well as the mining and petroleum industries accounted for the bulk of the private sector clientele. As well, private individuals accounted for about 18 percent of private sector gross billings in the domestic market. Economic trends affecting these clients have an important ripple effect on the geomatics industry.

Over 90 percent of the industry's revenues are earned by providing a wide array of services while sales of equipment and software account for the remaining revenues. In 1990, most of the industry's revenues were derived from traditional geomatics sectors such as land surveying, accounting for 53 percent, followed by mapping, consulting, hydrography and education/training, which in total accounted for a further 24 percent share of the market (Figure 2). GIS and remote sensing, which are intimately linked to ongoing technological and computer-driven developments, represented the remaining 23 percent of geomatics sales.

Beginning in the 1950s, the geomatics industry expanded its operations to foreign markets. Canadian firms provided

various land surveying and mapping services to developing countries through contracts under foreign aid programs funded by various Canadian and international agencies. To date, members of the geomatics industry have established commercial links in over 100 countries throughout Africa, Asia, the Middle East, South America, Central America and, to a lesser degree, the United States and Europe.

The bulk of overall exports consists of computerized systems and software while the remainder consists of services. In fact, Canadian exporters have developed an international reputation in a number of fields. As well, Canada supplies the global community with as much as 75 percent of all remote sensing satellite data ground-receiving stations and a significant portion of all image analysis systems (see industry profile entitled *Space*). Ninety percent of the world's most advanced radar services are provided by Canada. Canadian geomatic companies have also established a solid reputation in the fields of digital mapping, geodetic, cadastral and geophysical surveying where they supply 70 percent of the world's market for geophysical airborne survey services and equipment.

Performance

Recently, the geomatics industry has witnessed a number of significant developments. The industry has been affected by national economic trends. At the same time, technological developments have impacted on the composition of the industry's work force as well as levels of capital investment and productivity. Finally, changes in foreign markets have presented the industry with a number of new challenges.

Between 1983 and 1990, total industry revenues increased from $340 million to an estimated $750 million. Domestic sales were largely responsible for this growth although foreign billings also expanded. Recently, however, with the onset of the recession and fiscal restraint, the industry has experienced certain weaknesses in client demand from the government, real estate, construction and natural resource sectors. Members of the industry reported average profits levels from 1986 to 1988, followed by a slight increase for 1989 and 1990 and a recession-related drop in 1991 and 1992.

During 1991, the recession had a significant impact on the surveying element of the industry, particularly on cadastral surveyors who depend heavily on the construction and real estate industries. Housing starts, which provide an indicator of cadastral surveying demand, are estimated by the Canada Mortgage and Housing Corporation to have declined by 14 percent, dropping from 181 630 units in 1990 to 156 197 units in 1991. Similarly, a significant portion of the geomatics industry relies on the mining sector and the petroleum industry. In 1991, total capital spending by the mining sector was flat at $7.7 billion. Completed oil well drillings, which tend to reflect the demand for geophysical surveying services, declined by 6.3 percent to 5 388 well completions in 1991. In contrast, for other industry segments such as mapping and remote sensing, the effects of the economic downturn have apparently been less severe.

The percentage of industry firms with annual revenues of over $1 million between 1983 and 1990 increased from 11 percent to 24 percent while those with revenues of less than $250 000 dropped by one-third, from 58 percent to 40 percent. Over the same period, the total number of firms increased by 13 percent (from 1 200 firms to 1 355) while the overall number of employees rose by 33 percent (from 9 000 people to 12 000). This resulted in the average number of employees per firm increasing by over 15 percent to nine employees. The average number of employees per firm would have risen still further except for factors such as an increase in the number of sole proprietorships. When looked at together, these figures point to a movement within the industry toward the emergence of larger, more sophisticated firms. While it is too early to foresee the effects of this development, a similar trend is unfolding in the United States, where large, multi-disciplinary companies are targeting the market for highly technical geomatics services and products.

The growing emergence of computer-driven technology is probably the most significant recent development in the industry. This is reflected in the rising level of revenues and employment being generated by the industry's GIS and remote sensing sectors (Table 2). Industry clients are demanding products that are relatively easy to operate, generate and integrate multi-sourced data and offer substantial cost savings and efficiency improvements. By meeting these criteria, the industry passes on productivity gains through more sophisticated products.

Table 2 — GIS and Remote Sensing Revenues and Employment

(Percentage of total industry)

	1983	1990–1991
GIS		
• revenues	1	12
• employment	1	13
Remote sensing		
• revenues	5	11
• employment	5	7

Source: *Report on the Status of the Geomatics Industry in Canada, 1991*, pages 27 and 32.

GIS is a relatively new tool that allows users to compile, update, analyze, display and produce large amounts of computerized geographical data. The potential for data manipulation and cost savings offered by GIS is encouraging clients to convert their non-computerized or analogue geographical data into digital data and then build GIS data bases with the converted data. To be able to deliver services using this new technology, the industry will need to alter the way it does business. In fact, some of these changes are already well under way.

During the last several years, the academic qualifications of geomatics industry employees have risen dramatically. From 1983 to 1991, the percentage of employees having a bachelors degree doubled from 15 percent to 29 percent, while at the same time, the percentage of employees without post-secondary studies dropped by one-third, from 45 percent to 30 percent. Furthermore, the percentage of the geomatics industry's work force consisting of professionals increased from 25 percent in 1983 to 29 percent in 1991. One of the factors that explains these developments is the greater reliance of the industry on highly technical geomatics activities. Firms working with new technological developments draw on professionals who may not have traditional geomatics backgrounds. For example, those firms working in the field of software development would employ computer science professionals.

General technological developments are also pushing industry players to make more substantial investments in capital equipment, computer software and research. From 1986 to 1990, the industry spent an estimated average of 6.5 percent of its gross billings on research and development (R&D). Between 1979 and 1983, geomatics firms increased their investments in equipment and software from an estimated 10 percent of overall sales to about 27 percent, and remained constantly in the mid-twenties throughout the 1980s. Although the cost associated with equipment purchases has declined since then, expenditures on software and software maintenance are on the rise.

In the future, productivity improvements are expected to counterbalance increasing capital and labour costs. Currently, labour costs represent about one-half of the geomatics industry's expenditures. To a certain degree, productivity savings are already being realized. For example, cadastral surveying offices have experienced output increases ranging from 30 to 50 percent while not increasing their staff.

The nature of foreign trade has changed over the past few years. The market in developing countries for conventional surveying services has declined considerably in importance. This decline is due to a combination of circumstances including: changing program and budgetary priorities of various Canadian and international aid and financial institutions; the fact that aid agencies tend to increasingly treat geomatics services as subcontracted components of large, multi-disciplinary contracts; and decisions by developing countries to support local geomatics industries. This means that the emphasis for exports has now shifted to sales of more sophisticated equipment, software and services where Canada has developed certain specialized niches such as remote sensing and aerial surveying.

Strengths and Weaknesses

Structural Factors

There are many factors that impact on the geomatics industry's general level of competitiveness. Elements that affect competitiveness include the vast geography of Canada, the interrelationships with other private and public parties, the public educational infrastructure that supports the industry and the fragmented nature of the national market.

The enormous breadth and diversity of the Canadian land mass and the demands of a resource-based economy have provided the geomatics industry with numerous challenges. In meeting these challenges, the geomatics industry has developed world-class expertise in a number of fields. For example, the need to survey Canada's huge land mass efficiently and cost-effectively contributed to the development of labour-saving techniques such as aerial photographic surveying, airborne sensors and extensive satellite technology. At the same time, the industry has also responded to the geographical information requirements of various natural resource industries. Remote sensing and image analysis techniques were developed and modified to assist in a wide range of activities including maintaining crop and forest inventories, monitoring forest fire hazards and ice floe movements as well as searching for minerals and fossil fuels.

Although there are signs that the industry is evolving toward larger, more diversified corporate structures, it still consists primarily of smaller, independent firms. This structure tends to have an impact on the types of activities that are conducted within the industry. Small firms often find it difficult to undertake R&D or to invest in expensive capital equipment. Their size also restricts their ability to seek less expensive share equity capital and bond financing. To overcome these limitations, firms will sometimes form informal alliances for specific targeted projects. To date, there does not appear to be an extensive move within the industry toward either company acquisitions or industry mergers.

Over the years, one of the industry's key advantages has been a well-trained labour force. Provincial and federal land surveyor associations have established strong accreditation

programs to license professional surveyors. Increasingly, a bachelors degree in survey science or engineering is becoming a prerequisite for entry into the profession. Well-established, public sector education programs are also in place at the university, community college and technical institute levels. Recently, however, there has been some concern within the industry as well as the academic community that these educational programs may not be keeping pace with the technological changes in the geomatics industry. At the same time, community college and technical institute geomatics programs are experiencing difficulties in attracting students and maintaining their program funding. To respond to these challenges, some educational institutions are modifying their curriculums to reflect the increasingly important information management component of geomatics services. The speed with which the technology is changing has also created a growing demand for continuing education and career update courses from those people already working in the industry.

Barriers to interprovincial trade are usually felt through government and private sector procurement policies that favour the awarding of conventional surveying and mapping contracts to firms located in the province where the work is to be conducted. Such "buy local" preferences lead to inefficient duplication and overcapacity of skills as well as hinder the natural development of strong, competitive firms within the industry. However, as clients come under increasing pressure to be competitive and reduce costs, these procurement policies are changing to reflect a greater emphasis on bottom-line considerations. Although cadastral surveying is primarily governed by provincial legislation, a reasonably high degree of educational reciprocity between the provincial professional associations means that there are only minimum restrictions on land surveyors seeking to practise outside their home provinces.

Trade-Related Factors

Over time, Canada has developed numerous areas of specialized expertise, such as airborne radar systems, digital mapping, GIS, satellite data ground-receiving stations, and image analysis systems, which are well received in the international market.

The industry is less successful, however, in offering its less specialized or general services. Selling general services requires an effective and ongoing marketing effort that is often beyond the resource capabilities of many small and mid-sized Canadian geomatics firms. As well, given the highly competitive nature of the general services sector, it is vital to be able to offer attractive pricing for cost-conscious customers. Canadian firms have found it difficult to compete with firms based in developing countries that benefit from lower labour costs. This is especially true for services that are labour-intensive such as "on the ground" surveying and the conversion of paper-based mapping information to computerized data files. These countries are increasingly able to draw on local, highly skilled professionals for relatively sophisticated work assignments. As well, international geomatics contracts can provide a source of much needed "hard" currency, which in part may explain increasing competition from Eastern European countries such as Poland.

Developing and maintaining strong partnerships between private and public sector players is an essential element to successful sales abroad. Over time, the industry has benefited from federal government support in a number of areas such as the Program for Export Market Development (PEMD), joint government/private sector research and personnel exchanges, industry development funding provided through programs such as the Atlantic Geomatics Alliance, which is co-ordinated by the Atlantic Canada Opportunities Agency (ACOA), as well as assistance from the Export Development Corporation (EDC) and the Canadian International Development Agency (CIDA) in financing projects abroad. Supply and Services Canada (SSC) provides government-to-government export contracting and contract management services while External Affairs and International Trade Canada (EAITC) and Energy, Mines and Resources Canada (EMR) promote Canadian geomatics products and services on the international market. Canada's international competitors are often linked with their national governments, which provide generous support programs ranging from significant and costly concessional financing to assistance in identifying and pursuing marketing opportunities.

The level of access to the U.S. market, which currently represents about 20 percent of the Canadian geomatics industry's sales abroad, is a key issue for the future. Under the terms of the Canada-U.S. Free Trade Agreement (FTA) implemented on 1 January 1989, industries of both countries are able to establish a business presence and make investments in each other's market. The FTA has heightened both the importance of the U.S. market as well as the need to be competitive. Nevertheless, entry to the U.S. market still presents a number of challenges. "Buy local" policies of potential customers, U.S. federal legislation that prohibits the forming of consortia for the purposes of competing for bids, and restrictive governmental procedures that hinder the entry of geomatics professionals all serve to restrict access to the U.S. market. Canadian firms seeking to increase their penetration into this market are looking to strategies such as establishing business alliances with U.S. counterparts, subcontracting to or from U.S. firms, and opening branch offices.

On 12 August 1992, Canada, Mexico and the United States completed the negotiation of a North American Free Trade Agreement (NAFTA). The Agreement, when ratified by each country, will come into force on 1 January 1994. The NAFTA will phase out tariffs on virtually all Canadian exports to Mexico over 10 years, with a small number being eliminated over 15 years. The NAFTA will also eliminate most Mexican import licensing requirements and open up major government procurement opportunities in Mexico. It will also streamline customs procedures, and make them more certain and less subject to unilateral interpretation. Further, it will liberalize Mexico's investment policies, thus providing opportunities for Canadian investors.

Additional clauses in the NAFTA will liberalize trade in a number of areas including land transportation and other service sectors. The NAFTA is the first trade agreement to contain provisions for the protection of intellectual property rights. The NAFTA also clarifies North American content rules and obliges U.S. and Canadian energy regulators to avoid disruption of contractual arrangements. It improves the dispute settlement mechanisms contained in the FTA and reduces the scope for using standards as barriers to trade. The NAFTA extends Canada's duty drawback provisions for two years, beyond the elimination provided for in the FTA, to 1996 and then replaces duty drawback with a permanent duty refund system.

In a number of key geomatics sectors, including specialty air services, the NAFTA is expected to result in an even more liberalized continental market in North America. Increased access to Mexico's market by Canada should enhance the export possibilities of this sector, particularly in the area of computerized systems and software.

Technological Factors

The growth sectors of the industry are now being driven by rapidly changing technological developments. Sales of new equipment and sophisticated software are largely generated by activities such as GIS data base development, GIS applications and ongoing efforts related to aerial and satellite remote sensing. For example, Canadian firms manufacture airborne lasers used to monitor oil pollution, satellite-aided search and rescue ground stations, airborne and spaceborne radar systems and a number of remote sensing image analysis systems. Currently, the industry is also involved in development work that will lead to the 1994–1995 launching of the *RADARSAT* (radar satellite system) observation satellite. That satellite will be able to generate resource management information and perform ice and ocean surveillance by using radar technology capable of penetrating both cloud cover and darkness.

For the most part, however, the geomatics industry devotes its technological energies to the development of new software and systems. This work has been assisted by the combination of a skilled geomatics work force and sophisticated, demanding customers who encourage the industry to be innovative in developing systems. For instance, the presence of a dynamic agricultural industry that was seeking new means for better managing its resources pushed the development of Canadian geomatics software and systems that provide crop inventories, acreage estimates, crop stress evaluations and irrigation mapping. The geomatics industry has also developed GIS applications that draw data from satellite and remote sensing sources and then generate forest-type mapping, monitor forestry inventories and fire hazards, and estimate timber and harvest volumes. Close interrelationships between the mining and fossil fuel exploration sectors and the geomatics industry have resulted in a similar meeting of minds and systems development. Nevertheless, as the marketplace becomes increasingly competitive, both the industry and its clients will need still greater co-operation and collaboration.

Recently, the building of GIS has become the most important area for new technological developments. Digitized GIS data bases provide clients with a number of advantages; the most important is the ability to easily integrate and analyze multi-level, multi-sourced geographically referenced information. For example, EMR has initiated the production and dissemination of its topographical map series directly in digital form and has developed GIS applications that make direct use of digital spatial data, thereby rendering the task of creating digital data bases for all users more efficient and cost-effective. Currently, there are a number of extensive provincial projects under way to develop automated land registry and parcel systems. This experience allows the industry to build on its technical GIS expertise while at the same time developing a better knowledge of the "general contractor" management skills needed in the construction and integration of large, complex GIS applications. With the growth of GIS, these relatively scarce management skills are being eagerly sought by industry clients.

Other Factors

In 1990, 37 percent of the industry's overall revenues were earned from federal, provincial and municipal governments. These sales represented about one-third of the total value of the geomatics budgets for all levels of government. Therefore, government procurement and budget restraint policies have a significant impact on the industry. Despite current restraints on government expenditures, EMR is carrying out the most extensive contracting-out program ever known in Canada. Through this program, EMR is encouraging an increased private sector involvement in the direct production of spatial data.

Although funds are scarce, the need for geographic information and geomatics services continues to grow. To meet these demands, governments often work in partnership with the private sector toward certain common goals. An example of this co-operation is the *RADARSAT* satellite project. This project is being jointly funded by the federal and several provincial governments together with a consortium of private sector firms. Several of the provincial land registry GIS initiatives also involve partnerships with the private sector. In the case of the Province of Ontario Land Registration Information System (POLARIS), a company owned jointly by the province and its private sector partner has been established to build the new system. POLARIS consists of two data bases — a title/land registry index and computerized property maps. By combining public and private efforts, it will be possible to significantly reduce the time required to complete POLARIS.

Evolving Environment

For the geomatics industry to remain healthy and competitive, it will need to maintain and strengthen its links with existing customers as well as seek out new clients. Prosperous, demanding buyers will keep the industry innovative and healthy. After governments, the real estate, construction and natural resource sectors are the largest private sector users of geomatics goods and services. If the present long-term trend, noted recently in the Michael Porter study[2] of the Canadian economy, toward less competitive Canadian resource-based industries continues, the geomatics industry may be faced with the task of restructuring a number of its activities. An example of this restructuring can be seen in the geophysical survey sector, which works closely with the mining industry. The mining industry's expenditures on capital and exploration have been flat in recent years, and this lack of growth has had a number of effects on the geomatics industry. Sales to the mining industry, which once sponsored geophysical surveying research, have declined and this has led to reduced geomatics industry research as well as dwindling student enrolments. In response, the sector has turned to other areas such as environmental surveying.

Upcoming technological trends are poised to affect the industry in a number of fields. Equipment and GIS software are increasing in both sophistication and accessibility for use by non-geomatics specialists. More and more economists, accountants, lawyers, engineers and others who work with geographically based information are asking for practical, hands-on training so that they may work directly with GIS. The trend toward GIS has also created a number of new markets. For example, there is a growing demand for conversion of existing paper data bases to digitized data formats. Once the data have been converted, customers can then have the data restructured to allow for a multitude of innovative technologies for information integration and analysis. Over the next few years, worldwide demand for GIS products and services is expected to exceed $10 billion.

Increased demand for computerized data and information will also result in a number of general technical developments. Modern remote scanning and digital data-capture technologies will replace traditional aerial photography and photogrammetry for updating digital data files. There will be a movement toward digital colour printers that will produce maps on demand, thereby reducing the need for inventories of paper maps. Market pressure will continue to grow for more complex workstation systems capable of processing spaceborne radar images. Along with hardware improvements, there will be numerous software developments. Increasingly, there will be requirements for universal software applications that are able to run on multiple operating systems. Applications will be developed to allow for the integration of images, video and audio data.

Clearly, to remain competitive, geomatics firms will need to invest in and develop new equipment and software applications. This need for investment may encourage the present trend toward larger firms that have better access to capital funding. As the industry becomes more technologically sophisticated, it will also require a more technically knowledgeable work force. The demand for university and community college graduates will rise. Educational institutions, therefore, will be under increasing pressure to be more flexible in providing relevant instruction for a rapidly evolving environment. Certain institutions have revised or are revising their curriculums to reflect the importance of GIS data management functions. For example, EMR has established a training centre oriented toward updating and upgrading geomatics technical and professional skills. For these efforts to be fully successful, more effective co-ordination will be required between the educational institutions and the private sector.

The FTA, and more competitive conditions in developing countries, have heightened the industry's general awareness of the U.S. market. GIS industry revenues for the U.S. market were approximately US$3 billion out of a total world market of US$4.5 billion in 1991. This market offers a number of

[2]Michael E. Porter, *Canada at the Crossroads, the Reality of a New Competitive Environment*, a study prepared for the Business Council on National Issues and the Government of Canada (Ottawa: Supply and Services Canada, October 1991).

opportunities to Canadian firms, particularly in the fields of land registry GIS, aerial surveying and remote sensing. For example, U.S. local governments, which are seeking to achieve cost savings and efficiency improvements through the use of modern GIS land registry systems, would be one potential client group for the industry.

As noted earlier, NAFTA offers a potential entry to a larger integrated continental marketplace. Although it is too early to predict the effects of such a trade deal, the Mexican marketplace offers possibilities for the export of Canadian geomatics expertise. As well, direct competition from the well-trained Mexican geomatics industry would heighten pressures on the industry to be more competitive.

For the foreseeable future, managing with constrained financial resources will continue to be a priority for governments throughout North America. Public sector geomatics initiatives, therefore, will be oriented toward maintaining and upgrading existing data bases in a cost-effective manner. This creates a favourable climate for GIS applications, which can enhance data maintenance and manipulation while offering certain efficiency improvements and cost savings. Though limited, governments will also undertake a certain number of new initiatives. For example, aboriginal peoples' land claims negotiations will require extensive survey work. One such claim in the Yukon is expected to require about $50 million of geomatics services over the next 10 years. In addition, there will be a growing demand from both governments and the private sector for surveys linked to environmental concerns.

Competitiveness Assessment

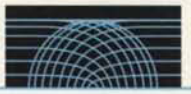
The Canadian industry supplies most of the geomatics services required by the Canadian market. The need for an extensive knowledge of local land registry systems and legal practices tends to preclude foreign practitioners from entering the important field of land surveying. Similar factors restrict Canadian surveyors from exporting their services abroad. However, other geomatics services are beginning to experience considerable foreign competition. This competition will increase for labour-intensive projects such as converting paper-based data to digital format for use with GIS systems. In fact, two significant Canadian data-conversion contracts were awarded recently to U.S.-based firms. A number of developing countries also offer this type of service to Canadian customers.

In contrast to services, much of the equipment, hardware and software sold and used domestically is drawn from foreign sources. For example, most computer workstations and personal computers (PCs) used by the industry are supplied by U.S. manufacturers. The same is true for satellite-based Global Positioning System (GPS) receivers that are now employed in activities such as land surveying, navigation and mapmaking. Similarly, although there is significant Canadian industry involvement in the GIS software market, the market is dominated largely by U.S. firms such as Environmental Systems Research Institute (ESRI) and Intergraph. European companies produce most of the photogrammetry compilation equipment used to produce maps as well as the sophisticated cameras used in aerial photography. Canadian firms tend to establish niches of expertise in the development and production of some specialized geomatics equipment such as certain geophysical/geological instrumentation.

In foreign sales, two discernible trends have developed over the past several years. First, sales of traditional surveying and mapping services to developing countries have declined due to a number of factors including changing foreign aid priorities, the tendency to increasingly treat geomatics services as subcontracted components of larger contracts, and decisions by developing countries to support local geomatics industries. Second, Canadian firms with well-established, world-class competencies are continuing to sell their services and products abroad. Examples of Canadian world-class capabilities include areas such as aerial surveying; remote sensing/ground receiving stations, data assimilation and information extraction software, high-speed image processing and high capacity data storage equipment; processing and analyzing remote sensing images; data acquisition and plotting; topographic and thematic mapping; consulting; and training.

Canada has been particularly active in Southeast Asia where, over the past several years, Canadian firms specializing in remote sensing and GIS have obtained contracts totalling between $70 million and $80 million. Generally, in terms of sophisticated technology services and products, Canada's principal competitor countries are France, Germany, the Netherlands, Switzerland, Great Britain, the United States, Japan and Australia. For example, France competes with Canadian firms in the field of processing and analyzing remote sensing data. The Netherlands, through its International Training Centre, has developed an internationally recognized expertise in providing training related to remote sensing and other related disciplines. In addition, a number of Asian and Eastern European nations are becoming increasingly more active in competing for international contracts.

Many factors, including the FTA, the NAFTA and the very size and breadth of the opportunities presented by the North American market are opening up markets to the Canadian geomatics industry. The future level of success that the industry experiences in responding to these challenges will be its true measure of competitiveness.



For further information concerning the subject matter contained in this profile or in the ISTC sectoral study (see page 12), contact

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PRINCIPAL STATISTICS

	1983[a]	1984[b]	1985[b]	1986[b]	1987[b]	1988[b]	1989	1990[c]	1991[c]
Firms	1 200	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1 355
Employment	9 000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	12 000
Total revenues ($ millions)	340	392	452	521	470	759	N/A	750	N/A
Foreign billings ($ millions)	60	69	80	92	N/A	N/A	N/A	120	N/A

[a] *Report of the Task Force on the Surveying and Mapping Industry in Canada, 1985*, prepared for the Department of Regional Industrial Expansion (DRIE) by the Canadian Institute of Surveying and Mapping (CISM), February 1985.

[b] ISTC estimates.

[c] *Report on the Status of the Geomatics Industry in Canada, 1991*, prepared for Industry, Science and Technology Canada by the Task Force on the Status of the Geomatics Industry in Canada, November 1991.

N/A: not available

REGIONAL DISTRIBUTION[a] (1991)

	Atlantic	Quebec	Ontario	Prairies	British Columbia/Yukon/NWT[b]
Firms (% of total)	10.0	23.6	28.3	19.7	18.4
Employment (% of total)	6.3	17.9	32.9	21.6	21.3

[a] *Report on the Status of the Geomatics Industry in Canada, 1991*, pages 24 and 31.

[b] The Yukon and Northwest Territories (NWT) made up 0.4 percent of total firms and about 1 percent of total employment.

INDUSTRY ASSOCIATION

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SECTORAL STUDIES AND INITIATIVES

The following report is available from Industry, Science and Technology Canada (see page 11).

Report on the Status of the Geomatics Industry in Canada, 1991

In 1991, a Task Force of industry, academic and government representatives conducted a study of the geomatics industry in Canada. As part of its mandate to foster and encourage Canadian industry, Industry, Science and Technology Canada provided a major portion of the funding for this initiative.

The report covers topics such as the status of the geomatics industry, government initiatives, research and development, markets and human resources. The study's principal findings concerning the industry have been included in this profile.

GLOSSARY OF GEOMATICS TERMS[a]

SURVEYING

Cadastral Surveying
Advises on, reports on, supervises or conducts surveys to establish, locate, define, or describe lines, boundaries or corners of parcels of land or land covered with water.

Engineering Surveying
Provides control for the design and development of man-made structures. It is the foundation of all construction and development projects.

Geodetic Surveying
Measures and represents the shape and size of the earth, its gravity, and an accurate three-dimensional co-ordinate system on which all measurements depend. Geodetic surveying provides the basic survey framework for the nation.

Geophysical Surveying
Positions, in three dimensions, the location and extent of subsurface resources like oil, gas, minerals, etc. The end products are maps, digital terrain models and reports.

Hydrographic Surveying
Measures the topography of the seabed and the characteristics and dynamics of the sea (tides, etc.).

Mining Surveying
Establishes control for the design and development of underground and surface mines, and also for the monitoring of earth movements in the excavations as work progresses.

MAPPING

Cartography
The art, science and technology of making maps and charts.

Photogrammetry
The science and technology of producing maps of the terrain from aerial and space imagery. The products are maps in paper or digital form and digital terrain models.

GEOGRAPHICAL INFORMATION SYSTEMS

Geographical Information Systems (GIS)
Consist of data bases comprising data that have spatial location as a main attribute. These systems depend on digital data produced usually by photogrammetry or remote sensing.

REMOTE SENSING

Remote Sensing
Captures, identifies, classifies and evaluates objects, areas, or phenomena using data recorded by sensing devices in aircraft or in earth-orbiting satellites. The usual output is digital data in the form of minute cells or pixels of information that can be enhanced and manipulated to form images in computer-aided interpretation systems.

[a] *Report on the Status of the Geomatics Industry in Canada, 1991*, pages 17–19.

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