Space

IC

INDUSTRY PROFILE

Industry, Science and Technology Canada
Industrie, Sciences et Technologie Canada

Business Service Centres / International Trade Centres

Industry, Science and Technology Canada (ISTC) and External Affairs and International Trade Canada (EAITC) have established information centres in regional offices across the country to provide clients with a gateway into the complete range of ISTC and EAITC services, information products, programs and expertise in industry and trade matters. For additional information, contact one of the offices listed below:

Newfoundland

Atlantic Place
Suite 504, 215 Water Street
P.O. Box 8950
ST. JOHN'S, Newfoundland
A1B 3R9
Tel.: (709) 772-ISTC
Fax: (709) 772-5093

Prince Edward Island

Confederation Court Mall
National Bank Tower
Suite 400, 134 Kent Street
P.O. Box 1115
CHARLOTTETOWN
Prince Edward Island
C1A 7M8
Tel.: (902) 566-7400
Fax: (902) 566-7450

Nova Scotia

Central Guaranty Trust Tower
5th Floor, 1801 Hollis Street
P.O. Box 940, Station M
HALIFAX, Nova Scotia
B3J 2V9
Tel.: (902) 426-ISTC
Fax: (902) 426-2624

New Brunswick

Assumption Place
12th Floor, 770 Main Street
P.O. Box 1210
MONCTON, New Brunswick
E1C 8P9
Tel.: (506) 857-ISTC
Fax: (506) 851-2384

Quebec

Suite 3800
800 Tour de la Place Victoria
P.O. Box 247
MONTREAL, Quebec
H4Z 1E8
Tel.: (514) 283-8185
1-800-361-5367
Fax: (514) 283-3302

Ontario

Dominion Public Building
4th Floor, 1 Front Street West
TORONTO, Ontario
M5J 1A4
Tel.: (416) 973-ISTC
Fax: (416) 973-8714

Manitoba

Newport Centre
8th Floor, 330 Portage Avenue
P.O. Box 981
WINNIPEG, Manitoba
R3C 2V2
Tel.: (204) 983-ISTC
Fax: (204) 983-2187

Saskatchewan

S.J. Cohen Building
Suite 401, 119 - 4th Avenue South
SASKATOON, Saskatchewan
S7K 5X2
Tel.: (306) 975-4400
Fax: (306) 975-5334

Alberta

Canada Place
Suite 540, 9700 Jasper Avenue
EDMONTON, Alberta
T5J 4C3
Tel.: (403) 495-ISTC
Fax: (403) 495-4507

Suite 1100, 510 - 5th Street S.W.
CALGARY, Alberta
T2P 3S2
Tel.: (403) 292-4575
Fax: (403) 292-4578

British Columbia

Scotia Tower
Suite 900, 650 West Georgia Street
P.O. Box 11610
VANCOUVER, British Columbia
V6B 5H8
Tel.: (604) 666-0266
Fax: (604) 666-0277

Yukon

Suite 210, 300 Main Street
WHITEHORSE, Yukon
Y1A 2B5
Tel.: (403) 667-3921
Fax: (403) 668-5003

Northwest Territories

Precambrian Building
10th Floor
P.O. Bag 6100
YELLOWKNIFE
Northwest Territories
X1A 2R3
Tel.: (403) 920-8568
Fax: (403) 873-6228

ISTC Headquarters

C.D. Howe Building
1st Floor, East Tower
235 Queen Street
OTTAWA, Ontario
K1A 0H5
Tel.: (613) 952-ISTC
Fax: (613) 957-7942

EAITC Headquarters

InfoExport
Lester B. Pearson Building
125 Sussex Drive
OTTAWA, Ontario
K1A 0G2
Tel.: (613) 993-6435
1-800-267-8376
Fax: (613) 996-9709

Publication Inquiries

For individual copies of ISTC or EAITC publications, contact your nearest Business Service Centre or International Trade Centre. For more than one copy, please contact:

For Industry Profiles:
Communications Branch
Industry, Science and Technology Canada
Room 704D, 235 Queen Street
OTTAWA, Ontario
K1A 0H5
Tel.: (613) 954-4500
Fax: (613) 954-4499

For other ISTC publications:
Communications Branch
Industry, Science and Technology Canada
Room 216E, 235 Queen Street
OTTAWA, Ontario
K1A 0H5
Tel.: (613) 954-5716
Fax: (613) 952-9620

For EAITC publications:
InfoExport
Lester B. Pearson Building
125 Sussex Drive
OTTAWA, Ontario
K1A 0G2
Tel.: (613) 993-6435
1-800-267-8376
Fax: (613) 996-9709

Canada

(V.8.93.03)

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

1990–1991

SPACE

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

Introduction

Canada's space activities go back as far as the 1930s. Then, Canadian scientists studied the upper atmosphere using ground-based instrumentation. Following World War II, Canada expanded its atmospheric observations by building and using rockets and balloons. The opening of the Churchill Research Range in Manitoba and the development by Bristol Aerospace in Winnipeg of the *Black Brant* series of rockets allowed Canada to make major scientific contributions to the International Geophysical Year in 1957–1958.

With the launch of the *Alouette I* research satellite in 1962, Canada became the third country in the world to design and build its own satellite. *Alouette I* was followed in 1965 by *Alouette II*. That spacecraft not only was a scientific success, but also achieved a goal of equal significance — the successful transfer to Canadian industry of space technology developed by the federal government. With the launch of *Anik A1* in 1972, Canada became the first country in the world to operate a commercial domestic communications satellite system.

Canada's decisions to orient itself toward communications and, later, remote sensing were not unique. Most industrialized nations regard the use of space for communications and surveillance as being of national strategic importance. However, the associated high costs, high risks and long waiting period for economic returns have deterred some private sector investment. As a result, governments are important and active participants in the development of a domestic space industry through policy and financial support — either directly, with research and development (R&D) contracts, or indirectly, by providing a national market.

Today, Canada routinely uses space technologies for telecommunications, weather forecasting, air navigation, upper atmosphere research, resource management, search and rescue, and mapping, to name but a few applications.

Structure and Performance

Structure

The space industry in Canada comprises producers of rockets and satellites, as well as related goods and services needed to create space equipment and systems, used for communications and surveillance from space. (It does not include service providers that use the equipment and systems, which are described in related industry profiles on *Aerospace, Geomatics Industries* and *Telecommunications Equipment.*)

Industry, Science and Technology Canada (ISTC) estimates that the Canadian space industry in 1990 provided employment for about 3 000 people. It generated sales of approximately $400 million, about 45 percent of which were exports. These figures include only the space-related activities of firms active in the industry, not total company activities.

Sales of space products and services represented approximately 5 percent of the value of the total sales of the Canadian aerospace sector. On a per capita basis, the Canadian space industry's sales and employment are comparable with those of most industrialized countries. As a result of the high quality of Canadian products and Canada's relatively small domestic market, the Canadian space industry exports a larger proportion of its total production than do other countries.

In 1990, approximately four-fifths of the industry's revenue and employment were in Ontario (43 percent) and Quebec (39 percent), with significant concentrations of activity in the Toronto and Montreal areas. The remaining revenue and employment were distributed among British Columbia (10 percent), Manitoba (4 percent), Saskatchewan (3 percent), and other provinces collectively had about 1 percent (Figure 1).

Although as many as 50 Canadian firms are involved in the space industry, only seven firms recorded individual space-related sales in excess of $8 million in 1990. Together, these seven firms accounted for over 90 percent of industry sales. Spar Aerospace Limited (located in Canada, the United Kingdom and the United States) is by far the largest firm, representing over half of total industry sales and employment. Spar Aerospace reported total sales of $467 million in 1991, a 39 percent increase over the level attained in 1990. About 70 percent of Spar's sales are space-related.

The majority of the companies in the Canadian space industry, including five of the seven leading firms, are

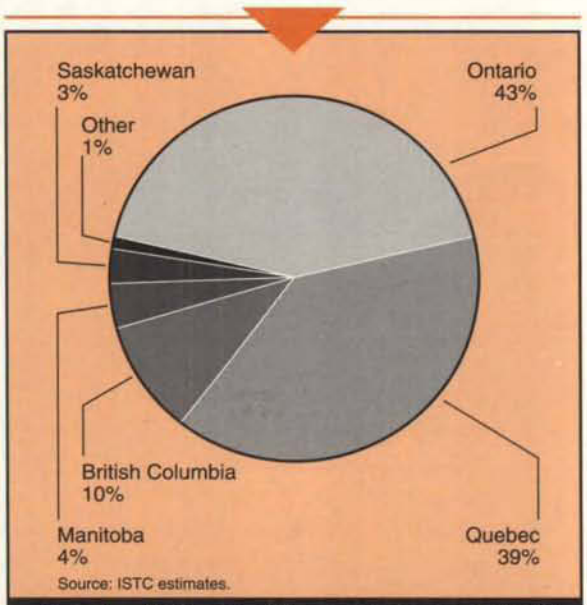

Figure 1 — Distribution of Revenue and Employment, 1990

Canadian-owned and Canadian-controlled. With the exception of Spar Aerospace, they are generally closely held, with the principal shareholders occupying key executive positions.

Most foreign-owned firms participating in the Canadian space industry manufacture specialized space-related products (mainly components), along with other products that are not space-related. These subsidiaries do not have world mandates for their space products. Their space-related revenues are usually small relative to their total revenues.

Beyond the Canadian-based activities of these firms, the imported content of total Canadian space industry shipments is estimated to be 30 percent. Subassemblies and components used in domestic production constitute the bulk of imported items.

International

In 1990, world space industry activity was valued at about US$80 billion. This activity was concentrated in the former Soviet Union (45 percent), the United States (43 percent), Europe (6 percent) and Japan (2 percent). Other countries made up the remaining 4 percent (Figure 2). Canada accounted for less than half of one percent of the total.

Worldwide, the space industry, like the aircraft industry, is characterized by its strategic significance, cyclical activity, rapid innovation, substantial indirect government assistance for R&D, long pay back periods and a large proportion of highly skilled staff.

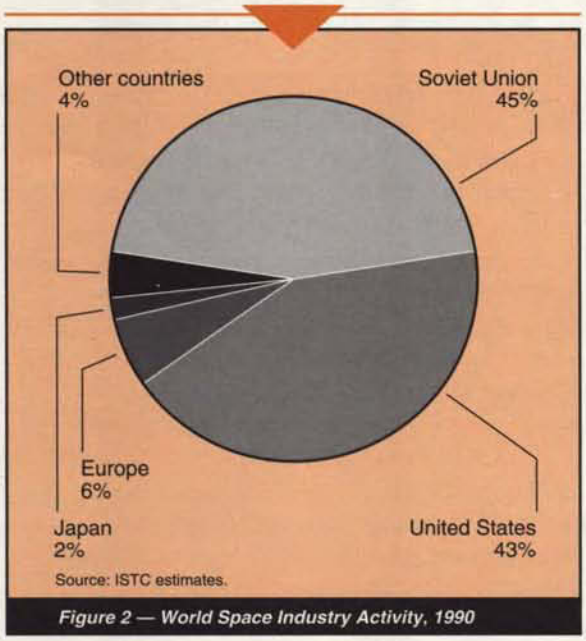

Figure 2 — World Space Industry Activity, 1990

Government programs account for 92 percent of the space market worldwide. More than half of these government programs are military space programs; the remainder of the programs are for civilian use. The commercial market, which consists entirely of communications satellites, accounts for about 8 percent of the total space market. As a rule, governments try to procure equipment from domestic firms. Where national security or R&D are involved (as is the case in most non-commercial activities), such preference can be practised without contravening the General Agreement on Tariffs and Trade (GATT) or the Canada-U.S. Free Trade Agreement (FTA), which was implemented on 1 January 1989.

Domestic

The federal government in Canada participates in space activities through the programs of a number of departments and agencies.

The Canadian Space Agency (CSA), formed in 1990, co-ordinates the federal government's Canadian Space Program. The CSA chairs the Interdepartmental Committee on Space (ICS), which is composed of those federal departments and agencies with an interest in space. As part of this task, the CSA has initiated the preparation of the new Long-Term Space Plan (LTSP) to provide the government with options for continuing the Canadian Space Program into the next century. The CSA's present major activities include the development and operation of the Mobile Servicing System (MSS) for space stations and the development of a radar satellite system (*RADARSAT*), a sophisticated remote-sensing satellite scheduled for launch in 1995. In addition to responsibility for the Canadian Astronaut Program, the CSA co-ordinates Canada's continuing participation in the European Space Agency (ESA), which was created in 1975 by 13 European nations. The CSA also has responsibility for ongoing international space science and technology projects, including the International Space Station *Freedom* Program. The CSA operates the David Florida Laboratory in Nepean, Ontario, a world-class facility for testing satellites and components prior to launch. The laboratory is available to Canadian companies on a cost-recovery basis. It also funds some space-related R&D programs in Canadian universities.

ISTC has the responsibility to promote the international competitiveness and industrial excellence of the space industry. Specific responsibilities include market intelligence and analysis and promoting industrial development using the Defence Industry Productivity Program (DIPP).

The Department of Communications (DOC) has played a pivotal role in the development of the Canadian space industry. It developed the International Satellites for Ionospheric Studies (Alouette-ISIS) programs and the *Communications Technology Satellite* (*CTS*), also known as *Hermes*. It was instrumental in the formation of Telesat Canada, which has subsequently been acquired by Alouette Telecommunications Inc., a company formed by Spar Aerospace and Canadian telephone companies. At present, DOC's largest space activity is related to the *Mobile Satellite Communications System* (*MSAT*), a satellite slated for launch in 1994. Although Canada's space communications system resides in the private sector, DOC retains important expertise in space communications systems, electronics and applications in the department's Communications Research Centre (CRC) at Shirley's Bay in Nepean, Ontario.

The Canada Centre for Remote Sensing, established by Energy, Mines and Resources Canada in 1972, is the lead agency in remote sensing in Canada. It is an acknowledged international centre of expertise in this field.

The Department of National Defence (DND) is conducting R&D related to space-based surveillance and communications systems. Although DND does not operate space systems at present, it plans to make greater use of space for surveillance and communications.

Other departments with a role in space activities are Environment Canada (Atmospheric Environment Service) and Fisheries and Oceans Canada. As well, most provincial

governments actively support the development of space companies located in their province.

Space Products and Services

Internationally, space industry products and services cover a wide spectrum and can be categorized into five subsectors:

- communications satellite systems and subsystems — satellite buses[1] (spacecraft platforms[2]), payloads[3] and ground stations;[4]
- remote-sensing satellite systems and subsystems — satellite buses and sensors for use in space, and antennas and data and image-processing equipment for use on the ground;
- robotics, including automation and space teleoperators — Canadarm-type remote manipulators (man-in-the-loop) and automatic "intelligent" dexterous manipulators;
- launch systems; and
- space science systems — apparatus for many different scientific studies undertaken in space, including astronomical observations and upper atmospheric experiments on the physical, chemical and biological effects of low gravity.

In the communications satellite systems subsector, the Canadian space industry primarily designs, develops and manufactures systems and subsystems. This work includes systems engineering and consulting services, manufacturing payload components and the production of ground stations. Canada is the world's leading independent supplier of antennas, compressed data systems and power suppliers. About 65 percent of all radio frequency compressed data subsystems (signal-processing devices) used on communications satellites in the Western world are built by COM DEV Ltd. While Canadian firms have not yet developed a capability to manufacture complete satellite buses (the spacecraft structures on which the payloads are mounted), they do manufacture bus components, such as power systems, solar arrays and spacecraft structures. When a complete satellite is supplied by a Canadian company, the bus, which typically constitutes 30 to 50 percent of the value of the satellite, is invariably obtained abroad.

In the remote-sensing satellite systems subsector, which designs and builds ground observation stations, Canadian companies are highly regarded around the world as developers and manufacturers of systems used for receiving, processing and analyzing data. They also have good reputations as developers and manufacturers of the spaceborne sensors used on satellites.

Sales of new equipment and sophisticated software are generated by Geographical Information Systems (GIS) data base development, GIS applications and ongoing efforts related to aerial and satellite remote sensing. For example, Canadian firms manufacture laser equipment that is used to monitor oil pollution. They also make satellite-aided search and rescue stations, airborne and spaceborne radar systems and a number of remote-sensing, image-analysis systems.

In the space robotics subsector, Spar Aerospace designed and developed teleoperators (robotic arms such as the Canadarm that have all the motor functions of a human arm) and the next generation of automatic dexterous manipulators required for the International Space Station *Freedom* Program. These robotic technologies, first developed for use in space, are beginning to be used in a variety of applications on earth, such as mining and handling radio-active material.

In the launch systems subsector, Canada does not currently have the capability to launch satellites into orbit. However, Bristol Aerospace of Winnipeg is a world leader in designing and constructing sounding rockets that can carry scientific experiments into space for a short time. These delivery systems facilitate work by other Canadian firms that design and build payloads for space R&D. The situation may change because some Canadian companies have expressed interest in developing launchers to send small satellites into low earth orbit.

In the space science systems subsector, a number of companies (CAL Corporation, SED/Calian, COM DEV, MPB Technologies Inc.) and, under CSA guidance, leading Canadian universities are involved in space science activities, such as space physics, upper atmospheric research,

[1]A satellite is generally considered to consist of two main parts: the infrastructure (called the bus) that mechanically and electrically supports the satellite's activities (examples of bus components are the satellite frame and power-generating equipment); and the element (called the payload) that satisfies the purpose of the satellite mission (examples of payload components are communications transponders and earth-monitoring sensors).

[2]Platforms — metal skeletons and panels, solar panels, apogee- and attitude-control motors, station-keeping sensors, batteries, power generation equipment, air conditioning equipment and storage compartments.

[3]Payloads — onboard electronics for signal amplification, modulation/demodulation and multiplexing; receivers; transponders; antennas; sensors; transmitters and aerials.

[4]Ground stations — house primary sending and receiving equipment including voice and data-capturing functions.

microgravity research (concerning both materials and biological systems) and space astronomy.

Canadian companies are most active in communications satellite systems, remote-sensing satellite systems and space robotics. Revenue is also derived from consulting and other services. Examples of some of the activities carried out by Canada's larger space firms are highlighted in the Appendix on page 12.

Spar Aerospace represents one of the largest technological groups in Canada's private sector. It is engaged in the areas of communications, remote sensing, space robotics and electro-optics. It is also active in aviation markets. With the exception of Spar Aerospace, all Canadian firms specialize in particular technological areas. Canadian firms have established international reputations for high quality.

Performance

International

The space programs of the United States and the former Soviet Union were comparable in size and by far the world's largest in 1990. These programs were followed in size by those of the ESA, France, Japan, Germany, Italy, India, the United Kingdom, Canada, Brazil, Belgium and Spain. Competition among these nations is intense and increasing.

There has been reduced emphasis on some military applications since the end of the cold war, but governments throughout the world have sustained procurement of space technology for military communications and surveillance as well as for research and space products for non-military uses. Companies that receive large defence space contracts often use the resultant technologies in commercial projects.

Domestic

Faced with a large land mass, a barren north and widely dispersed communities in remote areas, the Canadian government decided in the 1960s to use space technology to serve the country's distinctive and strategic requirements. The first activity involved studying communications phenomena, and shortly thereafter, Canada began developing communications satellites, which have remained the focus of Canada's space industry.

The resulting Canadian communications satellite subsector, although small, has grown over the years. The subsector grew consistently in sales and employment until the end of the 1980s. Even during the recent recession, sales and employment have remained constant or have grown slightly.

The Canadian government has developed and maintained a good rapport with the Canadian space industry. Since the mid-1970s, strategically timed government spending on R&D and the procurement of systems have contributed greatly to strengthening the industry. For example, encouragement and support were given to Spar Aerospace to develop its in-house prime-contractor capability for communications satellite systems. Spar's involvement in satellite production programs began with *Alouette I* in 1962 and has continued in more than 50 private and government satellite programs.

Telesat Canada, formed by an Act of Parliament in 1969, owns and operates Canada's domestic communications satellite network. As a result of procurements by Telesat, not only has Spar Aerospace become a world-class satellite manufacturer, but also many other Canadian companies have established well-deserved reputations as suppliers of satellite components and subsystems.

MSAT, a satellite-based mobile communications system sponsored by DOC, will provide two-way voice and data transmission services to users in vehicles, ships, transportable stations and ultimately to users with appropriate portable equipment. The system will employ two satellites: one owned and operated by Telesat Mobile Inc. (TMI)[5] in Canada and the other by the American Mobile Satellite Corporation (AMSC) in the United States. The two satellites will provide complementary and backup services within the United States and Canada. Spar Aerospace and Hughes Aircraft are co-prime contractors for the satellites, which are due to be launched in 1994.

In addition to communications satellites, Canada's geography also led to an early interest in earth observation technologies. In the early 1970s, the Canadian government decided to promote the use of earth observation from space for resource management. This decision led to the development of highly specialized and internationally renowned Canadian capabilities in receiving, processing and analyzing remote-sensing data. This capability was shown by MacDonald, Dettwiler and Associates when it designed and installed the majority of *Landsat* (a series of earth-observation satellites launched by the United States since 1972) and meteorological satellite ground stations, as well as processing systems for nearly every *Landsat* ground station in the world.

RADARSAT will be the first Canadian remote-sensing satellite. It will generate resource management information and perform ice and ocean surveillance. This sophisticated satellite will use synthetic aperture radar (SAR), a powerful

[5]TMI is owned by Telesat Canada (50 percent), Unitel Communications Holdings (30 percent) and Japan's C. Itoh Group (20 percent).

microwave instrument that transmits and receives signals to "see" the surface of the earth through clouds and darkness. *RADARSAT* involves the Canadian federal and provincial governments, the private sector and the U.S. government. Canada is responsible for designing and integrating the overall system, for controlling and operating the satellite in orbit, and for operating two data reception stations. The United States will launch the satellite and will operate a data reception station in Alaska in exchange for radar data for U.S. research programs.

The earth environment space initiative is a proposal for another Canadian earth observation satellite, in which optical sensors would provide environmental data that could be used to protect Canada's environment. The proposal is being reviewed by the CSA as a candidate for inclusion in the next Long-Term Space Plan.

The Canadian market is limited in size and is dominated by major projects. The procurement of Canadian space equipment by both the government and the private sector is sporadic. Annual domestic sales have fluctuated, and the industry has looked to exports to maintain growth. Canadian companies have been successful in the United States, Japan, the European Community (EC), China, India, Indonesia and Brazil. Other important markets include owners and operators of international and regional communications satellite systems, such as the International Telecommunications Satellite Organization (INTELSAT), the International Maritime Satellite System (INMARSAT) and the Arab Space Communications Corp. (Arabsat).

Despite participation by the CSA in international space programs, access to the markets of developed countries is difficult. Canadian exports have been largely directed to the United States (where even a small percentage of the market is significant), international satellite organizations, and the market for communications and remote-sensing satellite systems in developing countries.

The industry has been successful in its export drive. Total exports have grown from about $10 million in 1977 (17 percent of sales) to an estimated $180 million in 1990 (45 percent of sales). In some specific subsystems, Canadian companies enjoy a major share of the world market.

Strengths and Weaknesses

Structural Factors

At present, Canada does not have an operational military space program. However, there are a number of major civilian space programs in place, including the creation of the MSS, *RADARSAT* and *MSAT*. These domestic projects will maintain a high level of activity until the mid-1990s, but export markets will remain crucial to the survival and growth of the industry.

Key factors that determine the ability of Canadian space firms to compete internationally depend on the market being targeted. General requirements for success in different markets are as follows:

- Price, quality and performance are all-important in the space segment of the communications satellite subsector. In the ground station segment, where Canadian companies occupy a sufficient share of world markets to take advantage of economies of scale and design experience, price is the key determinant, because technology is rapidly becoming standardized.
- Developing-country markets for communications and remote-sensing systems are sensitive to political and economic pressures. These clients demand a competitive price and a package of other factors, including low-interest financing for the buyer, export lines of credit (such as those made available to certain countries by Canada's Export Development Corporation), technology transfer and countertrade (trade that is conditional upon a reciprocal purchase, offset or barter).
- Government procurement activities in developed countries are based on the usual requirements of price, quality and performance. In addition, they often require domestic subcontracting or offsets.

Space companies in the United States, Europe and Japan have large domestic markets that provide a secure base and permit the companies to develop economies of scale. Canadian space companies are often at a disadvantage when competing in markets requiring high-volume products, where efficiencies related to economies of scale largely determine success. In addition, they are also more sensitive to fluctuating exchange rates than their counterparts, because they depend to a greater extent on export sales. Canadian space companies, therefore, are compelled to look to those markets where they can compete on the basis of better technology. Proximity to the U.S. market is an advantage that allows Canadian space companies to meet U.S. requirements quickly. Contacts with the U.S. space industry allow them to keep abreast of technological developments.

Although Canadian space companies are known to produce high-quality and technically advanced products, the lack of large-scale production and resulting economies of scale puts them at a price disadvantage for certain products. As a result, many Canadian space companies focus on markets in which they can compete most effectively, such as those that stress quality and performance. In these markets, governments are essential in helping companies compete,

particularly in developing-country markets where aid and concessional financing, training and countertrade may be the most important considerations.

In the United States, Europe and Japan, the major companies involved in the space industry are mostly powerful, diversified corporations with large and capable divisions dedicated to space-related products. For example, British Aerospace and Matra Marconi Espace employ a total of 93 000 and 25 000 people, respectively, 2 000 and 1 400 of whom are engaged in space-related activities. Hughes Aircraft is part of General Motors, the largest corporation in the world, and Rockwell Space Division is part of Rockwell International, which has over 100 000 employees. Canada's largest space corporation, Spar Aerospace, on the other hand, employed about 2 900 people in 1991, half of whom were in space-related jobs. Canadian space companies that are diversified (e.g., Bristol Aerospace and CAE Electronics) have relatively modest resources committed to space-related activities.

In general, the advantage of foreign corporations lies not only in the size of their respective space divisions, but also in the synergy that can result from associations within a very large organization. The benefits include opportunities for technology transfers within the company and an ability to withstand the cyclical nature of the space market. In short, the strengths of foreign competitors are derived both from the size and breadth of their operations and from the level of direct and indirect assistance available from their respective governments.

The signs of consolidation and rationalization in the industry are of international significance. Examples of this trend include the acquisition of Marconi (United Kingdom), Fairchild (United States) and ANT (Germany) by Matra of France, as well as the acquisition in 1990 of Ford Aerospace by Loral in the United States.

Trade-Related Factors

The Canadian space industry is experiencing increasing competition in international markets. Even though tariff barriers do not have any real impact on trade in either commercial or defence aerospace products, Canadian exporters face a variety of non-tariff barriers (NTBs) and other restrictive practices that, in many cases, effectively exclude them from foreign markets. Industrialized nations attempt to protect domestic producers in their markets with a variety of NTBs that can override the criteria of price, quality and delivery in the evaluation of bids.

Some countries have policies that severely limit access by non-domestic companies. The economic union of the EC after 1992 may broaden the application of NTBs and make the market that much more difficult for non-European firms to address. Canadian space firms are already developing links with European space firms and customers through Canadian participation in programs such as those of the ESA.

Canada is the only non-European country that has a close co-operation agreement with the ESA. Originally signed in 1978, the agreement was renewed in 1990 for another 10 years. Canada contributes to the operations of the ESA and is able to participate in many ESA programs as if it were a member of the agency. As a result, Canadian firms have been awarded ESA contracts, which enhance their international experience to exploit markets in Europe and elsewhere. Some examples of such successes are MacDonald, Dettwiler and Associates in the *ERS-1* satellite (earth remote-sensing satellite), Spar Aerospace in *Olympus* (an experimental communication satellite) and COM DEV in *ARTEMIS* (an experimental communication satellite).

In some cases, the NTBs have been successfully removed. For example, Japanese satellite procurement has been supplied almost entirely by domestic suppliers. Both government and industry were regarded as being protectionist. Under pressure from the United States, however, the Japanese communications satellite market is opening up to foreign competition. As a result, Canadian companies, such as COM DEV and Spar Aerospace, are slowly penetrating the Japanese market by providing high-quality products and applying sustained marketing strategies.

The recent recession has been particularly hard on developing nations. Their problems have led to a shrinking of the world market and fiercer competition in the remaining market. To counter NTBs and shrinking markets, the Canadian industry has effectively developed products for market niches, especially those markets requiring low-volume, high-value-added, research-dependent products. Canadian space companies have been highly successful in supplying the world with satellite systems and subsystems. They have, as a strategy, developed reputations for product performance and reliability that would be costly for competitors to replicate. In the ground segment, the Canadian industry is a respected and significant supplier of communications ground stations, satellite-control and ground-based testing systems, and technologies for earth-observation data reception and analysis.

Some Canadian space companies have succeeded in exploiting their specialized skills through partnerships with large foreign multinational companies. To facilitate entry into foreign markets, Spar Aerospace co-operated with Alcatel on *Telecom II*, and COM DEV has developed arrangements with TRW to develop several communication satellite components. Other companies are establishing such alliances.

With the openness of markets following the collapse of the former Soviet Union, SOVCAN STAR Satellite

Communications Inc., a joint Russian-Canadian venture, has been established to produce and operate communications satellites, capitalizing on the availability of Russian expertise. It is the first satellite company to be granted rights to establish a commercial communications system for Russia. Five geostationary satellites — three positioned over Russia — are expected to be launched, beginning in 1996. SOVCAN STAR utilizes the strength of several Canadian companies: COM DEV for satellite multiplexing and switching equipment, Canadian Satellite Communications Inc. (CANCOM) for marketing of space communications services, Spar Aerospace for its experience as a prime satellite contractor, and General Discovery Ltd. for its promotional capabilities. Through SOVCAN STAR, these Canadian skills will complement those of Russia's Nauchno-Proizvodstvennoe Obiedinenie Prikladnoi mekhaniki (NPO-PM), which designs, manufactures, tests, launches and operates communications, geodetic and navigation satellites.

Intergovernmental links, joint ventures or consortia are also being used to improve market access and to share costs, risks and technology. An example of this co-operation is the *RADARSAT* satellite project. Co-operation agreements and arrangements have been signed by Canadian government departments with counterparts in several countries, including Japan, Russia and the United States, and with international organizations such as the ESA and several of its members.

Technological Factors

The strength of the Canadian space industry lies in its sophisticated high-technology capability as a supplier of systems and subsystems for communications satellites and its specialized leading-edge capabilities in remote sensing and space tele-robotics. Canada is a leader in the development of very high frequency communications, on-board processing and switching of data.

Canada is recognized as a world leader in space tele-operator technology. The outstanding performance of the Canadarm in the U.S. space shuttle program and Canadian activity in providing the MSS, a critical part of the space station *Freedom*, are examples of Canadian excellence in this field of technology.

Canadian companies are now developing Miniaturized Hybrid Microwave Integrated Circuit (MHMIC) and surface mount technologies that will substantially reduce the mass, volume and power requirements of solid-state power amplifiers, thereby reducing launch costs, improving performance and allowing satellites to remain operational for longer periods.

The growth of the industry depends on rapidly changing technology. For example, Canada is developing applications of space technologies for military communications and surveillance. In military communications, MPR Teltech in conjunction with COM DEV is developing an advanced, extremely high frequency Satellite Communications *(SATCOM)* system for DND. DND has also awarded several development contracts for space-based radar to be used for military surveillance.

The space industry is a key strategic industry for Canada, and the government is committed to its development. Government expenditures on non-military space projects, which averaged $150 million annually over the period 1984 to 1989, grew to about $300 million in 1990 and are projected to have exceeded $330 million in 1992.[6] Government expenditures focus on space robotics (the MSS), remote-sensing technology development (*RADARSAT*), communications (*MSAT*), space research and participation in ESA programs.

In addition to the specific policies and measures described earlier, Canadian space industry R&D benefits from funding under several federal assistance programs, such as the ISTC's DIPP, the Space Industry Development Program of DOC, the Industrial Research Assistance Program (IRAP) of the National Research Council of Canada, and the Strategic Technologies in Automation and Robotics (STEAR) Program and User Development Program (UDP) of the CSA. These programs will assist the industry in developing spinoffs from space expenditures.

Because of the strategic importance of space technology and its use, a growing number of countries have space programs and are fostering comprehensive domestic capabilities. The use of space technology and products by governments and private users is increasing, and markets for some products and services are reaching levels sufficient to support commercial ventures.

Evolving Environment

As the industry matures and as the cold war abates, there is a shift away from military to civilian use of space technology. This shift is allowing the private sector to offer new commercial space products and services. Satellites are getting larger (multi-use platforms) as well as smaller (dedicated missions in low earth orbit), more powerful and longer-lasting, allowing the use of smaller and cheaper ground stations. The market for ground stations for private business communications

[6]Not all government expenditures on space are included in the total space sales of $400 million for 1990 reported by the industry. Government expenditures include R&D, infrastructure, etc., as well as direct funding in support of the industry.

networks is strengthening. As well, the processing and sale of remote-sensing data available from existing and planned satellites from many countries for meteorological, geological, agricultural and geodetic uses are now under way in France (*SPOT*), the United States (*Landsat*), India (*IRS*), Canada (*RADARSAT*), Japan (*J-ERS*) and the ESA (*ERS-1*).

Because of Canadian industry's dependence on export markets, the international trend toward commercialization is a welcome development. The Canadian government recognizes the importance of the Canadian space industry and is supporting its quest for commercial opportunities and export markets. Government initiatives in the form of international co-operation, investment in science, technology transfer and sharing R&D costs with Canadian space companies help develop the Canadian subcontractor and supplier base and encourage companies to undertake activities in robotics, artificial intelligence and electro-optics. The Canadian government, both as a purchaser at home and as an export promoter abroad, has helped Canadian space companies sell into export markets in the space industry in the past and is committed to doing so in the future.

Prospects for the Canadian space industry are sound, particularly in communications satellite systems and in sensors and processing equipment for remote-sensing satellites. Canadian companies are also exploring new market opportunities for terrestrial applications of technologies originally developed for use in space. For example, the Canadarm technology is being applied to develop robots for use in hazardous terrestrial environments and for defence applications; expertise in sophisticated space hardware is being used to develop airborne electronic communications and defence equipment.

In the future, material processing in space (such as manufacturing high-quality drugs, alloys and crystals) may become commercially attractive. The Canadian government is attempting to position industry to take advantage of these opportunities through the UDP.

Despite the concerns of all governments with protecting their domestic industry, the high cost of space programs has led them to co-operate on major programs. The ESA is a prime example of such co-operation, with common space objectives among sponsors and an impressive record of international collaboration. The International Organization for Standardization's ISO 9000 standards are being adopted in the EC and are under consideration by the American Federal Aviation and the National Aeronautics and Space Administration (NASA).

The trend toward co-operation is seen also in the undertaking by ESA members, Japan and Canada, under the leadership of the United States, to build space station *Freedom*, due to be launched in the late 1990s. Canada's contribution is the MSS, which consists of technically advanced robotic equipment that will be used for assembling and maintaining the space station, for servicing its instruments and for visiting low-orbit satellites. Participation in the space station program provides Canadian industry, government and universities with an opportunity to use the space station to advance their scientific, technological and commercial interests.

The U.S. market remains vital to Canadian space companies, some of which are actively seeking collaborative arrangements with U.S. companies to facilitate access. Within Canada, companies have formed consortia to bid on major procurement contracts that are too big for any one company to handle alone. The trend toward co-operation also provides manufacturers with additional resources and the possibility of cost-sharing, which helps them win export contracts. On 4 December 1992, Spar Aerospace and COM DEV signed a Memorandum of Understanding to obtain a degree of co-operation between the two companies when approaching international markets.

Entry into markets in developing countries is complex and a number of factors, such as technology transfer, local content, credit, *credit-mixte* and countertrade, in addition to price and superior technology, are involved in winning contracts. The role of government becomes crucial to Canada's success in these markets by providing marketing support and export financing through the Export Development Corporation. Where technology and infrastructure development assistance are important to the client country, organizations such as the Canadian International Development Agency can be pivotal in the negotiations. The willingness and ability of Canadian companies to enter into countertrade and technology-transfer arrangements make it easier for them to gain access to these markets.

Many countries are projecting an increase in space budgets over the coming years, implying that there will be an ongoing demand for space professionals. There is currently a shortage of qualified engineers and technicians in Canada and many of the industry's professionals are being drawn from other countries. To remain competitive in the global market, the Canadian space industry must continue to attract new scientists, engineers, production technicians and other workers. For this reason, government and industry must continue involving universities in the development of Canadian space capabilities. At present, Canadian companies are currently involved in joint projects with McGill University, l'École Polytechnique, Concordia University, the University of Waterloo and Queens University, to name a few.

In addition, the Government of Canada established the Canadian Network for Space Research (CNSR) in 1990 as one of the centres funded under the government's networks of Centres of Excellence program. The network concept involves bringing together in one distributed organization

similar activities located in university, industry and government laboratories across Canada. At present, there are six universities, two federal departments, an Ontario Centre of Excellence and six industries involved in five major projects. The administrative centre for the CNSR is the University of Calgary.

Competitiveness Assessment

The Canadian industry competes internationally in space subsystems, state-of-the-art instrumentation and most types of ground-based equipment. However, U.S. space firms, with a domestic market many times larger than that of the rest of the world, are the largest and most experienced space companies, and they are the only firms that have been able to develop real economies of scale in complete satellite systems.

The United States continues to be the world's largest commercial and military market for space products. It offers Canadian companies opportunities through co-operating with U.S. firms, subcontracting on specific projects, formal joint-venture arrangements with U.S. firms, or the establishment of independent manufacturing facilities in the United States.

Canadian space companies continue to be strong in high-technology, high-quality products. They rarely choose to compete in high-volume, low-cost products, because these markets are technologically easy to enter for high-volume producers, who can quickly establish large-scale production and eliminate competition on the basis of cost. Therefore, Canadian companies are most likely to continue to compete successfully in markets requiring high-technology systems and subsystems in which quality and performance are of prime importance. For example, Canada has a competitive industrial capability in key remote-sensing technologies, such as radar systems, ground-receiving stations, image analysis and GIS. *RADARSAT* services will be available to customers in all countries. *RADARSAT* International (RSI)[7] is involved in space and remote-sensing technologies and has been licensed by the Canadian government to market *RADARSAT* data worldwide.

Given the small size of Canada's domestic market, the industry is aware that it needs to develop products with broader market appeal — items that will lower costs and improve competitiveness. COM DEV and Spar Aerospace have been able to establish success in subsystems, and Bristol Aerospace's *Black Brant* sounding rocket now enjoys similar acceptance. As well, recent events in the international marketplace, in particular, the present rationalization of the space industry worldwide, including both the amalgamation of companies within industrialized countries and the formation of transnational alliances of space firms, suggest that Canadian companies should consider entering into alliances or partnerships with other Canadian companies and international players to ensure market access and to create economies of scale. This strategy is especially relevant to companies that participate in designing and manufacturing communications satellites and ground equipment.

The FTA will reinforce the position of Canadian companies. Firms that have carved a niche for themselves on the basis of technology and/or performance should benefit from easier and expanded access to the U.S. civilian market, particularly in the communications satellite market.

Governments will continue to play an important role in regulating space activities and in funding the development and production of space products, particularly in the non-commercial segments of the space market, with the possible exception of communications satellites. The technological risks involved, the long payback period on investment and the high costs of R&D are likely to maintain the need for government involvement.

The competitive picture is evolving rapidly with the possible entry of Russia into global markets for space products and systems. Pricing and technology issues, as well as those issues relating to some aspects of security, will be key factors in the ability of Canadian niche players to identify optimum alliances for complementary goods and services.

The space industry is cyclical in nature, with each program entailing large investments, complex technology, long lead times and often extended intervals between contract awards. In such an industry, careful management is needed to maintain the knowledge and capability required to remain internationally competitive in terms of quality and price and to remain at the forefront of technological advances.

For further information concerning the subject matter contained in this profile or in the publications listed on page 11, contact

Space, Marine and Defence Branch
Industry, Science and Technology Canada
Attention: Space
235 Queen Street
OTTAWA, Ontario
K1A 0H5
Tel.: (613) 954-3776
Fax: (613) 954-4246

[7]RSI is a consortium of three Canadian companies: COM DEV, Spar Aerospace and MacDonald, Dettwiler and Associates.

MAJOR FIRMS

Name	Country of ownership	Location of major firms
Bristol Aerospace Limited	United Kingdom	Winnipeg, Manitoba
CAL Corporation	Canada	Ottawa, Ontario
COM DEV Ltd.	Canada	Cambridge, Ontario Moncton, New Brunswick
MacDonald, Dettwiler and Associates Ltd.	Canada	Richmond, British Columbia
MPR Teltech Ltd.	United States	Burnaby, British Columbia
SED/Calian (Subsidiary of Calian Communications Systems Ltd.)	Canada	Saskatoon, Saskatchewan
Spar Aerospace Limited	Canada	Sainte-Anne-de-Bellevue, Quebec Toronto, Ontario Ottawa, Ontario

INDUSTRY ASSOCIATION

Aerospace Industries Association of Canada (AIAC)
Suite 1200, 60 Queen Street
OTTAWA, Ontario
K1P 5Y7
Tel.: (613) 232-4297
Fax: (613) 232-1142

SECTORAL STUDIES AND INITIATIVES

The following publication is available from ISTC (see address on page 8).

Aerospace and Defence-Related Industries Statistical Survey Report – 1991
This survey provides statistical data and aggregate five-year projections of industry sales, investment intentions, employment, cost of sales and other indicators. It was prepared by the Aeronautics Branch of ISTC in March 1992.

The following publication is available from InfoExport (see inside front cover).

Canadian Space-Related Products and Services for World Markets
This document gives company information on Canadian space-related products and services for world markets. The document was prepared by the Aerospace and Defence Programs Division of External Affairs and International Trade Canada in May 1992.

APPENDIX — CANADIAN SPACE-RELATED PRODUCTS AND SERVICES[a]

Bristol Aerospace Limited
Bristol has designed, integrated, tested and launched over 200 rockets (including the *Black Brant*) and shuttle payloads. It has also studied and designed small satellites and was one of the first organizations to advocate their use for space science research.

CAL Corporation
CAL designs and manufactures state-of-the-art scientific instruments for space, spacecraft power subsystems and components, spacecraft antennas, materials processing equipment for use in microgravity, data management systems for space applications, and ground equipment for search and rescue satellite systems and mobile satellite communications. It also does systems studies and mechanical, structural and thermal designs. The majority of search-and-rescue satellite receiving stations used around the world are supplied by CAL.

COM DEV Ltd.
COM DEV is Canada's largest exporter of equipment for communications and remote-sensing satellites. It has supplied payload subsystems for 130 spacecraft for over 40 international programs. COM DEV has supplied 65 percent of the Western world's requirement for multiplexing and switching equipment. It has built on this success and has developed products for commercial and defence-related spaceborne, airborne, shipborne and ground-based electronics markets.

MacDonald, Dettwiler and Associates Ltd. (MDA)
MDA is an international leader in advanced systems development for the aerospace, defence and electronics manufacturing industries. It is the world's largest supplier of turnkey remote-sensing satellite ground stations, as well as air traffic control and flight data management systems, weather information processing and distribution systems, surveillance systems, and systems for receiving and processing optical, radar and sonar images from spaceborne, airborne and shipborne sensors.

MPR Teltech Ltd.
MPR offers the aerospace industry a wide range of design and fabrication services. MPR works on components such as application-specific integrated circuits (ASIC), thick-film hybrids and hybrid and monolithic microwave integrated circuits. The company also creates complex subsystems, such as transmitters and receivers, and complete systems, including large software systems for communications network management.

SED/Calian
SED/Calian possesses specialized expertise in satellite-ground communications systems, including carrier monitoring and uplink control systems, spectrum monitoring and management systems, and fading channel simulation. It also specializes in the operation and maintenance of testing laboratories and satellite-ground facilities and in the provision of technical, administrative, engineering and project-management support in aerospace and space communications projects.

Spar Aerospace Limited
Spar Aerospace is engaged in the design, development, manufacture and servicing of systems for the space, robotics, communications, remote sensing, electro-optics and aviation markets. It was selected as the prime contractor for Canada's contribution to NASA's International Space Station Freedom Program providing the Mobile Servicing System (an advanced Canadarm). It is also the prime contractor for the remote-sensing *RADARSAT* and the mobile communications satellite *MSAT*, to be acquired by Telesat Mobile Inc. and the American Mobile Satellite Corporation (AMSC). It built all the remote manipulators for the U.S. space shuttle and was the prime contractor for the *Anik-D*, *Anik-E* and *Brazilsat I* communications satellites. It is internationally recognized as a premier supplier of antennas, transponders and complex high-power amplifiers.

Printed on paper containing recycled fibres.

[a]The list includes major Canadian companies who reported space sales in excess of $8 million in 1990. Information on other Canadian space companies may be available upon request from ISTC (see page 10).