PERFORMANCE REPORT

# Canadian Space Agency

For the
period ending
March 31, 1997

Improved Reporting to Parliament —
Pilot Document

Canada

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# Foreword

On April 24, 1997, the House of Commons passed a motion dividing what was known as the *Part III of the Estimates* document for each department or agency into two documents, a *Report on Plans and Priorities* and a *Departmental Performance Report.* It also required 78 departments and agencies to table these reports on a pilot basis.

This decision grew out of work by Treasury Board Secretariat and 16 pilot departments to fulfil the government's commitments to improve the expenditure management information provided to Parliament and to modernize the preparation of this information. These undertakings, aimed at sharpening the focus on results and increasing the transparency of information provided to Parliament, are part of a broader initiative known as "Getting Government Right".

This ***Departmental Performance Report*** responds to the government's commitments and reflects the goals set by Parliament to improve accountability for results. It covers the period ending March 31, 1997 and reports performance against the plans presented in the department's *Part III of the Main Estimates* for 1996-97.

Accounting and managing for results will involve sustained work across government. Fulfilling the various requirements of results-based management – specifying expected program outcomes, developing meaningful indicators to demonstrate performance, perfecting the capacity to generate information and report on achievements – is a building block process. Government programs operate in continually changing environments. With the increase in partnering, third party delivery of services and other alliances, challenges of attribution in reporting results will have to be addressed. The performance reports and their preparation must be monitored to make sure that they remain credible and useful.

This report represents one more step in this continuing process. The government intends to refine and develop both managing for results and the reporting of the results. The refinement will come from the experience acquired over the next few years and as users make their information needs more precisely known. For example, the capacity to report results against costs is limited at this time; but doing this remains a goal.

This report is accessible electronically from the Treasury Board Secretariat Internet site: http://www.tbs-sct.gc.ca/tb/key.html

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# THE CANADIAN SPACE AGENCY

## PERFORMANCE REPORT
## FOR THE PERIOD ENDING
## MARCH 31, 1997

John Manley
Minister of Industry

## FOREWORD

This Performance Report is designed to be used as a reference document. It contains several levels of detail, beginning with Spending Authorities as extracted from Part II of the Estimates and Volume II of the Public Accounts. This format provides continuity with other Estimates documents and helps readers to assess the financial performance of the Canadian Space Agency during the past year.

Following the Spending Authorities extracts, the main body of the Report is divided into four sections:

- "Section I — Minister's Message" summarizes the Minister's personal vision for the Industry Portfolio.

- "Section II — Agency Overview" is an overview of the CSA, its seven business lines and the results expected of each.

- "Section III — Agency Performance" describes the results achieved in each business line, and the impact of this performance on plans for the future.

- "Section IV — Supplementary Information" provides further information on costs and resources, as well as special analyses to help the reader understand the CSA's programs more fully.

The 1996–97 Performance Report marks the second step of the CSA's transition to its new performance management framework and the associated performance measurement approach. The framework will be refined during the year and fully applied in the 1998–99 Expenditure Plan.

Human resources are reported in employee full-time equivalents (FTEs). Full-time equivalents factor out the length of time that an employee works during each week by calculating the rate of assigned hours of work over scheduled hours of work.

# TABLE OF CONTENTS


EXECUTIVE SUMMARY . . . . . 1

SECTION I: THE MINISTER'S MESSAGE . . . . . 3

SECTION II: AGENCY OVERVIEW . . . . . 5
- A. The Canadian Space Agency and Canada's Policy Framework . . . . . 5
- B. A New Long-term Space Plan . . . . . 7
- C. Mandate . . . . . 8
- D. Mission . . . . . 8
- E. Strategic Objectives and Priorities . . . . . 8
- F. Business Lines . . . . . 10
  - Earth Observation . . . . . 10
  - Satellite Communications . . . . . 11
  - Canadian Space Station Program . . . . . 12
  - Canadian Astronaut Program . . . . . 13
  - Space Science . . . . . 14
  - Space Technology . . . . . 15
  - Executive and Horizontal Coordination . . . . . 16
- G. Organization . . . . . 19

SECTION III: AGENCY PERFORMANCE . . . . . 21
- A. Performance Expectations . . . . . 23
  - Planned Versus Actual Spending Tables . . . . . 24
  - Summary of Performance Expectations . . . . . 27
- B. Performance Accomplishments . . . . . 29
  - Agency Performance . . . . . 29
  - Performance Accomplishments by Business Lines . . 30
    - Earth Observation . . . . . 30
    - Satellite Communications . . . . . 35
    - Canadian Space Station Program . . . . . 38
    - Canadian Astronaut Program . . . . . 42
    - Space Science . . . . . 45
    - Space Technology . . . . . 50
    - Executive and Horizontal Coordination . . . . 54
- C. Key Reviews . . . . . 58

SECTION IV: SUPPLEMENTARY INFORMATION . . . . . 59
A. Listing of Statutory and Departmental Reports . . . . . 61
B. Contacts for Further Information . . . . . 61
C. Financial Summary Tables . . . . . 62
D. Major Capital Projects . . . . . 65
List of Capital Projects by Business Line . . . . . 65
Description of Major Crown Projects . . . . . 66
Canadian Space Station Program . . . . . 67
RADARSAT I . . . . . 70
E. Addendum on the David Florida Laboratory . . . . . 71
F. Abbreviations and Acronyms . . . . . 75

## EXECUTIVE SUMMARY

The 1996–97 Performance Report for the Canadian Space Agency details the CSA's accomplishments during fiscal year 1996–1997.

The CSA's general objectives are to develop and apply space science and technology to meet Canadian needs and to foster an internationally competitive space industry. In 1994, the Government approved Long-term Space Plan II (LTSP II) which established specific objectives for the Canada's space program for the period 1994 to 2004. Considerable progress was made in 1996-1997 in implementing LTSP II.

One of the priority areas LTSP II identified is satellite observation of the earth. 1996-1997 saw the beginning of the commercial operations of RADARSAT I, Canada's first earth observation satellite. During this first year of commercial operation, sales of data increased from just over $500,000 in the first quarter of 1996 to over $3,000,000 in the first quarter of 1997. More than 8,000 images of the earth were processed and delivered to more than 500 user agencies in over 44 countries. In addition, more than 1200 images were supplied to 160 research projects in many parts of the globe. This increasing commercial success of RADARSAT I is giving the private sector market confidence, which will allow them to invest substantially in RADARSAT II, and the process to select the program's private sector partners began this year.

Satellite communications is another priority identified in LTSP II. 1996-1997 saw the definition of the first phase of the Advanced Satellite Communications Program and the commencement of negotiations with industry for $50 million in R&D projects. This program promotes the development of the technologies needed to design new satellite systems that will bring information highway, multi-media services to all Canadians. In 1996-1997 the Statement of Work was competed for the second phase of the International Mobile Satellite program, which is aimed at positioning Canadian industry in the fast growing market for mobile and personal satellite communications services.

Canada is a participant in the International Space Station Program, and in 1996-1997 the manufacture and assembly of the Space Station Remote Manipulator System (our contribution to the program) was completed. This major milestone in this $1.4 billion program is a critical step in ensuring we can deliver our contribution to NASA on time in 1998. As part of efforts to develop and diffuse space technologies for automation and robotics, nine new Licence Agreements were negotiated with Canadian companies and two Crown-owned

patents issued. One contractor, under contract with Shell Oil, has developed an autonomous automobile refuelling robot, considered to be one of the world's most sophisticated consumer robots.

In 1996-1997 the CSA prepared a proposal to modify LTSP II to allow development, within approved resources, of the Special Purpose Dextrous Manipulator as an additional element of our contribution to the international space station program. The government approved this proposal, which will see, for the first time, the development of a major space component under a firm, fixed-price contract.

In 1996-1997 two Canadian astronauts were launched on NASA shuttle missions. Marc Garneau returned to space in May 1996 and conducted a series of Canadian experiments in microgravity sciences. Bob Thirsk made his first flight in June 1996 and conducted a series of experiments to study the effects of long duration space flight on human physiology. Canadian astronauts continue to be in high demand for public appearances and more than 1200 requests for astronaut appearances were received this year. In 1996-1997 the Young Space Scientist Program was launched and educational kits have been mailed out to schools throughout Canada to involve students in the experiments carried out by our astronauts.

Space Science underpins the whole space program. In 1996-1997 the program supported world class research by Canadian scientists with the launch of the ultra-violet auroral imager aboard a Russian satellite, the participation in Japan's very long baseline interferometry project, the processing of more than 100 materials in the microgravity environment of the Russian *Mir* space station and the design of microgravity experiments for several shuttle missions. Canadian scientists published over 165 papers on the results they obtained from instruments and experiments flown in space.

The CSA continued its ongoing program of technology development in industry and awarded 43 contracts worth $4.3 million, one-third of which went to small and medium-sized companies. In addition, nine projects were awarded to Canadian universities under the CSA-NSERC partnership program.

Finally, and not the least of its activities, the CSA launched extensive consultation to establish the long-term vision for the Canadian Space Program and to prepare proposals for new initiatives that will be submitted for government approval in 1998 as Long-term Space Plan III.

## SECTION I
## THE MINISTER'S MESSAGE

The Industry Portfolio brings together under the Minister of Industry 13 departments and agencies (see box) with responsibilities for science and technology (S&T), regional development, marketplace services and micro-economic policy. With many of the micro-economic levers available to government, as well as 41% of the S&T funding in the federal government, the Industry Portfolio offers a versatile tool kit for meeting the challenges of the knowledge-based economy as Canada moves into the 21st century.

*The Industry Portfolio is ...*

Atlantic Canada Opportunities Agency
Business Development Bank of Canada*
Canadian Space Agency
Competition Tribunal
Copyright Board Canada
Federal Office of Regional Development - Québec
Industry Canada
National Research Council Canada
Natural Sciences and Engineering Research Council of Canada
Social Sciences and Humanities Research Council of Canada
Standards Council of Canada*
Statistics Canada
Western Economic Diversification Canada

** Not required to submit Performance Reports*

The establishment of the Portfolio has also created a new capacity for partnership and innovation, both among its members and with stakeholders in the private and public sectors. This capacity can be exploited in every region of the country, since the Industry Portfolio provides programs and services to businesses and consumers with about 15,000 staff, over 500 points of service in every province and territory, and numerous sites in cyberspace.

As Minister responsible for the Industry Portfolio, I have directed the Portfolio members to actively seek opportunities to exploit the synergies available to them as members of a team of organizations with similar objectives and complementary programs. This continuing emphasis on improving collaboration and partnership has helped to ensure that limited resources are focused more effectively on the priority areas identified for the Portfolio: promoting S&T, encouraging trade and investment, and helping small and medium-sized enterprises (SMEs) to grow. Working in partnership in these areas has enabled the Portfolio to make a significant contribution to meeting government objectives.

Of the 13 members of the Portfolio, all except the two crown corporations (the Business Development Bank of Canada and the Standards Council of Canada) are required to provide annual Performance Reports. Reporting on performance is an important element of program management in the Portfolio. Identifying concrete

objectives for programs and services, and measuring and reporting on progress over time, provides an accountability framework that enables Portfolio members to assess their effectiveness. As the 11 individual Performance Reports demonstrate, the Portfolio members have solid results to report for 1996-97.

Taken together, these reports provide a comprehensive picture of the Industry Portfolio's performance. I would particularly like to highlight the following key Portfolio achievements:

- the 29 very successful SME Conferences and InfoFairs held across the country, attended by almost 51,000 Canadians;
- the publication of *Your Guide to Government of Canada Services and Support for Small Business 1996-1997*, a compendium of all the services and support available to small businesses from the federal government (over 250,000 copies in circulation);
- the strengthening of the Regional Trade Networks and Regional Trade Plans, which bring federal and provincial governments and the private sector together at the regional level to generate new international opportunities for local businesses;
- the coordinated approach to S&T across the Portfolio as reflected in the Portfolio S&T Action Plan—the Portfolio members have taken action on 45 of its 49 initiatives;
- the S&T Forum, which brought together, for the first time, the members of all the boards and councils providing expert advice to the Portfolio departments and agencies; and
- innovative approaches to service delivery building heavily on partnerships, such as the Canada Business Service Centres.

A noteworthy achievement for the Canadian Space Agency over this period is the first year commercial operation of RADARSAT I, Canada's first Earth-observation satellite and a major success story for the Portfolio and the Canadian Space Agency partnership with the provinces and firms in the private sector. Sales of data rose from $500,000 in the first quarter of 1996 to over $3,000,000 for the same period in 1997. Several of the many companies across the country that have sprung up to exploit RADARSAT I data have graduated from being small and medium-sized enterprises to being true international players.

Over the coming year, the Industry Portfolio will continue to build on its synergies and to improve the services and support provided to its wide array of clients.

The Honourable John Manley

**SECTION II**
**AGENCY OVERVIEW**

# A. The Canadian Space Agency and Canada's Space Policy Framework

Canada's unique geographic and demographic character has inspired Canadians to adapt space science and technology to meet our national needs. Canada became involved in space activities with a view to achieving the following concrete goals: to link Canadians from coast to coast, to enhance the management of our environment and natural resources, and to learn how phenomena in space affect life on Earth.

Unlike most federal departments and agencies, the CSA has no significant "A-Base" budget. Most of its financial resources are allocated through periodic long-term space plans, approved by Cabinet. These resources give the CSA the means to implement specific programs that are limited in both scope and time.

The "Space Policy Framework", approved by the government in 1994 as part of Long-term Space Plan II, establishes the strategic importance of space in Canada's transition to a knowledge-based economy and to the government's social, scientific, sovereignty, industrial, security and foreign policy objectives. This framework makes the CSA responsible for coordinating all the Federal Government's policies and programs in civil space-related research, science and technology, industrial development and international cooperation.

The key elements of this Space Policy Framework are as follows:

- Priority is to be given to the development and application of space technologies in the Earth Observation and Satellite Communications programs.

- To ensure commercial success, programming is to be designed to maximize the leverage of federal funding through partnership with industry and the provinces.

- The implementation of programs is to be open to more firms, particularly small- and medium-sized enterprises.

- Sustainable industrial regional development is to be pursued through the use of regional distribution targets.

- Synergy between civil and defence space activities is to be encouraged to optimize the effectiveness of federal space funding.

This policy framework allocates an important role to industry in managing the Earth Observation, Satellite Communications and Space Robotics programs. This increase in private sector participation is expected to produce technology developments closely in tune with the needs of Canadians. It will also encourage companies to further commercialize these technologies.

Significant changes have occurred in the international and Canadian space environment since 1994. These changes gave rise to new opportunities and influenced considerations that affect major components of the Canadian Space Program. In order to ensure the optimum use of the funds, and thereby maximize the socio-economic benefits associated with our investments in space, the following adjustments to the Program were approved:

- To maintain Canada's world leadership in space robotics, the approved funds were to be realigned and the Special Purpose Dextrous Manipulator is to be manufactured in Canada at a total cost of $206.9M.

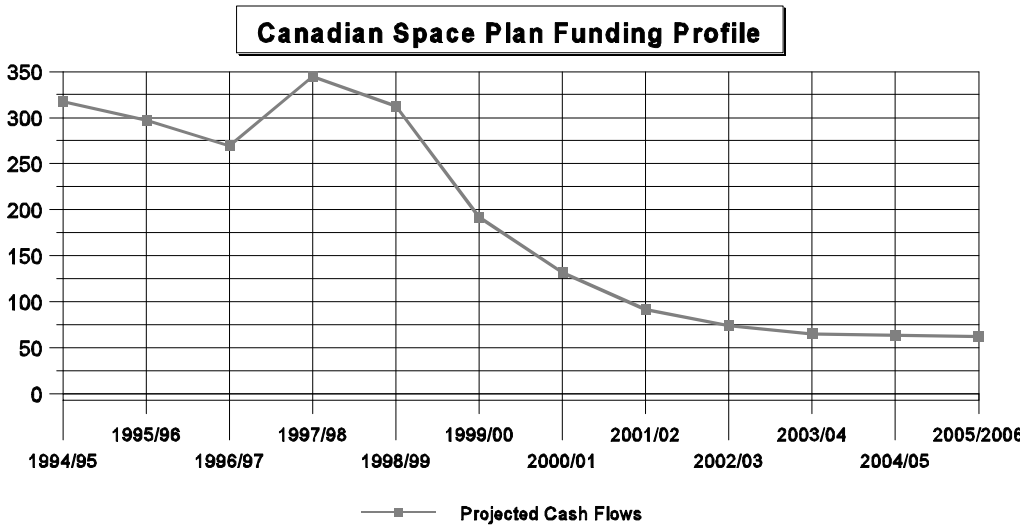
- The Advanced Satellite Communications program is to be implemented using a two-phase approach, a technology phase funded now and a service development phase, to be considered later.

- To provide the needed flexibility, a Contingency Reserve is to be maintained at a level adequate to ensure no requirement for additional funding to implement the adjusted Canadian Space Program.

These adjustments permit the development of RADARSAT II and continue the Earth Observation, Space Science, Space Technology and Astronaut programs approved in 1994.

## B. A New Long-term Space Plan

As the following cash flow chart shows, funding for the Canadian Space Program declines rapidly as the current space initiatives move toward completion by the turn of the century.




The CSA has put in place the organizational structure and processes to develop Long-term Space Plan III proposals for government consideration. More specifically, the CSA has:

- created a Space Plan Task Force within the Agency dedicated to the development of program proposals for consideration in a Long-term Space Plan III,
- developed a long-term space vision for Canada to be made public in the Fall of 1997 to guide the preparation of Long-term Space Plan III proposals, and
- set up working groups composed of stakeholders representing all Canada's space communities to prepare program proposals.

## C. Mandate

*The legislated mandate of the CSA, from the* Canadian Space Agency Act, *SC. 1990, c. 13, is...* to promote the peaceful use and development of space, to advance the knowledge of space through science and to ensure that space science and technology provide social and economic benefits for Canadians.

## D. Mission

The Canadian Space Agency is committed to leading the development and applications of space knowledge for the benefit of Canadians and humanity.

To achieve this, the CSA:

- pursues excellence collectively,
- advocates a client-oriented attitude,
- supports employee-oriented practices and open communications,
- commits itself to both empowerment and accountability, and
- pledges to cooperate and work with partners to our mutual benefit.

## E. Strategic Objectives and Priorities

The priorities that the CSA expects to achieve during the period covered by Long-term Space Plan II appear under the five major categories of activities shown below.

### *1. Effective management of Long-term Space Plan II*

**Objectives**

The overriding objectives of the Canadian Space Program are to develop and apply space science and technology to meet Canadian needs, and to develop an internationally competitive space industry.

- Support for the competitiveness of Canadian space companies, consistent with the government's priority on jobs, growth and international business development
- Completion of the new CSA organizational structure

### *2. Leadership in space R&D for the benefit of Canadians and humanity*

- Greater understanding of space and atmospheric phenomena and the resulting terrestrial effects

- Improvements in health care and medical diagnostics and greater ability to prevent the health hazards of space flight through experiments in space life sciences experiments developed by Canadian scientists and carried out by our astronauts
- Enhanced capabilities in the high-tech industry through strategic technology development and transfer
- Integration and performance testing of the Mobile Servicing System for the International Space Station and delivery of the system to the National Aeronautics and Space Administration (NASA)
- Development of the Special Purpose Dextrous Manipulator for delivery to NASA by Year 2001.

***3. Application of space knowledge to business development and technology transfer***

- The negotiation and implementation of arrangements with a consortium of Canadian companies and other parties aimed at the successful exploitation of the world market in Earth observation (radar satellite imaging through the construction and operation of RADARSAT II)
- Better management of Canada's environment and natural resources through the use of Earth-observation satellite technologies and data
- Arrangements with Canadian satellite communications manufacturers and service providers to develop the advanced technologies required to give all Canadians access to the new satellite-based multimedia services
- The development of strategic industrial alliances with European industry through Canada's participation in European Space Agency programs

***4. Related commercial and scientific activities***

- Continued operation of the David Florida Laboratory as a world-class facility for assembling and testing space-based hardware for domestic and foreign space industries and agencies
- The flight of Canadian astronauts on missions
- Operation of RADARSAT I to generate royalty fees and develop applications

***5. Greater awareness of and education about the importance of space***

- An enhanced S&T culture in Canada through the exploitation of the unique appeal of space

## F. Business Lines

### Earth Observation

*The CSA is organized and managed under the seven business lines shown in Table A at the end of this section.*

**Working with the private sector and other domestic and international partners, the Earth Observation business line focuses on providing Earth Observation data and developing and applying Canadian space and ground technology to meet domestic and international needs, particularly in the areas of environmental monitoring, resource management, surveillance and disaster management**.

***Objectives***

- To ensure continued Canadian leadership in the emerging international Earth Observation market
- To meet Canadian environmental monitoring and resource management requirements as well as other related needs for earth observation data

***Service Lines***

The service lines through which the Earth Observation business line achieves its objectives are:

- RADARSAT I operation,
- RADARSAT II development,
- Generic Earth Observation technological development for future missions,
- Ground infrastructure,
- Applications development and technology transfer,
- The European Space Agency Agreement for Earth Observation, and
- The David Florida Laboratory (See Section E in Supplementary Information).

## Satellite Communications

**In partnership with the private sector, the Satellite Communications business line focuses on the development of the satellite communications technologies and services required to meet Canadian needs while maintaining or expanding Canadian industry's share of the growing international market for satellite communications systems.**

### *Objectives*

- To maintain or expand Canadian industry's share of the growing international market for these new services
- To ensure that Canadians have access to any new multimedia, personal, and mobile communications services made possible by advanced satellite communications technologies

### *Service Lines*

The service lines through which the Satellite Communications business line achieves its objectives are:

- the Advanced Satellite Communications Initiative,
- the International Mobile Initiative,
- European Space Agency Satellite Communications, and
- the David Florida Laboratory (See Section E in Supplementary Information)

## Canadian Space Station Program

**The Canadian Space Station Program business line will ensure that Canadians benefit from their investment in space robotics and from Canada's access to the International Space Station, and that the CSA meets its commitments to its international partners.**

### *Objectives*

- To enhance Canada's ability to operate in space and to exploit the potential of space technologies, particularly automation and robotics
- To meet our commitments to the International Space Station Program

### *Service Lines*

The service lines through which the Canadian Space Station Program business line achieves its objectives are:

- Mobile Servicing System development, including the Space Station Remote Manipulator System, the Mobile Base System and the Special Purpose Dextrous Manipulator;
- Mobile Servicing System operations and utilization, including development of the Mobile Servicing System Operations Complex;
- Strategic Technologies for Automation and Robotics; and
- the David Florida Laboratory (See Section E in Supplementary Information).

## Canadian Astronaut Program

**The Canadian Astronaut Program business line ensures that Canadians, particularly those in the scientific community, benefit from the country's participation in human space flight and that the CSA maintains an astronaut corps that can respond to Canadian needs in human space-based operations.**

### *Objectives*

- To train Canadian astronauts to participate in international human space flights
- To contribute to Canadian S&T experiments in space
- To ensure the health of Canadian astronauts
- To inspire Canadian youth to pursue careers in S&T

### *Service Lines*

The service lines through which the Canadian Astronaut Program business line achieves its objectives are:

- crew training for space missions,
- integration of scientific and technical payloads for flight,
- space awareness, and
- the David Florida Laboratory (See Section E in Supplementary Information).

## Space Science

**On behalf of the Canadian space science community, the Space Science business line procures scientific instruments from Canadian industry and arranges for their deployment, operation and use to obtain scientific data relevant to Canadian needs**.

### *Objectives*

- To ensure that Canada maintains a position of excellence in the worldwide scientific exploration of space
- To procure from Canadian industry the instruments needed to obtain relevant scientific data

### *Service Lines*

The service lines through which the Space Science business line achieves its objectives are:

- Solar-Terrestrial Relations,
- Atmospheric Chemistry and Physics,
- Space-borne Astronomy,
- Space Life Sciences,
- Microgravity Sciences,
- the Scientific Satellite Program, and
- the David Florida Laboratory (See Section E in Supplementary Information).

Advisory Committees have been established to support most of these service lines. The membership represents the scientific communities, other government departments, and industry.

## Space Technology

**The Space Technology business line provides the resources and the technical expertise needed to introduce new technologies to Canadian industrial products and services**.

### *Objectives*

- To ensure that Canada remains at the forefront of space technology development in preparation for Canada's future space programs
- To enhance Canadian industry's international competitiveness through technology transfer and diffusion

### *Service Lines*

The service lines through which the Space Technology business line achieves its objectives are:

- generic technology development,
- strategic space technology development,
- participation in the technology development programs of the European Space Agency,
- diffusion and commercial exploitation of space technologies, and
- the David Florida Laboratory (See Section E in Supplementary Information).

## Executive and Horizontal Coordination

**The Executive and Horizontal Coordination business line supports the Canadian Space Program decision-making process and develops, implements, coordinates and monitors strategies and plans to ensure the efficient implementation of the overall Canadian Space Program (and the Space Policy Framework), in consultation with space stakeholders inside and outside the federal government. It provides the Canadian Space Program with a strategic framework and support in the areas of international cooperation, federal-provincial relations, industrial policy, regional development, communications, and space awareness.**

### *Objectives*

- To provide strategic direction, management and administrative support services to the CSA
- To ensure the necessary cohesion of all Canadian Space Program activities

### *Service Lines*

The service lines through which the Executive and Horizontal Coordination business line achieves its objectives are:

- Executive Offices,
- Policy and Planning,
- Corporate Management,
- External Relations
- Communications,
- Audit, Evaluation and Review,
- Human Resources,
- Administration,
- Legal Services, and
- the David Florida Laboratory (See Section E in Supplementary Information).

# Objectives and Priorities of the Business Lines

## Strategic Objectives

1. To develop and apply space science and technology to meet Canadian needs
2. To develop an internationally competitive space industry

## CATEGORIES OF ACTIVITIES

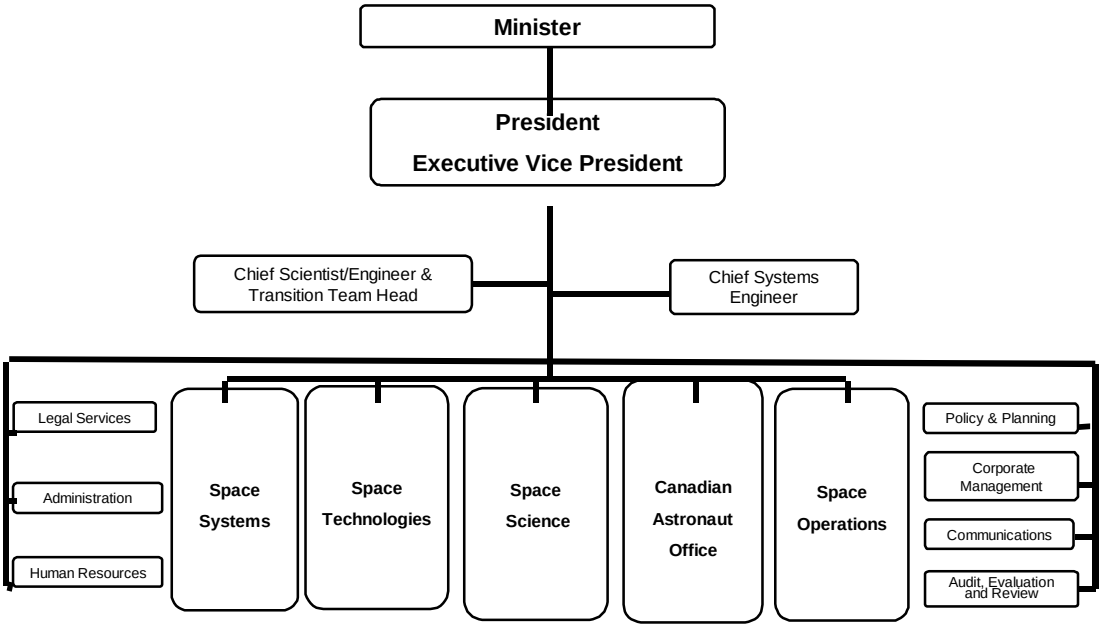
| Effective Management of LTSP II | Leadership in Space R&D for the benefit of Canadians | Application of space knowledge | Related commercial and scientific activities | Increased awareness and education on the importance of space |
|---|---|---|---|---|

| **Business lines** | | | | | | |
|---|---|---|---|---|---|---|
| Earth Observation | Satellite Communications | Canadian Space Station Program | Canadian Astronaut Program | Space Science | Space Technology | Executive and Horizontal Coordination |
| **Objectives** | | | | | | |
| Ensure Canadian leadership in the international Earth-observation market; and meet Canadian environmental-monitoring and resource-management needs. | Ensure that Canadians have access to new multimedia, personal, and mobile communica-tions made possible by advanced satellite com-munications.<br><br>Maintain or expand Canadian industry's share of the international market for these new services. | Enhance Canada's ability to operate in space and exploit the potential of space technologies, particularly automation and robotics.<br><br>Meet the Agency's commitments to the International Space Station Program.<br><br>Enhance Canadian industry's international competitiveness through technology transfer and diffusion | Train Canadian astronauts to participate in international human space flights.<br><br>Contribute to Canadian S&T experiments in space.<br><br>Inspire Canadian youth to pursue careers in S&T. | Ensure that Canada maintains a position of excellence in the worldwide scientific exploration of space.<br><br>Procure from Canadian industry the instruments needed to obtain relevant scientific data. | Ensure that Canada remains at the forefront of space-technology development in preparation for Canada's future space programs.<br><br>Enhance Canadian industry's international competitiveness through technology transfer and diffusion. | Provide strategic direction, management and administrative support services to the CSA.<br><br>Operate DFL as a cost-effective environmental; test facility.<br><br>Ensure the necessary cohesion of all Canadian Space Program activities |

## Objectives and Priorities of the Business Lines (continued)

| **Business lines** | | | | | | |
|---|---|---|---|---|---|---|
| Earth Observation | Satellite Communications | Canadian Space Station Program | Canadian Astronaut Program | Space Science | Space Technology | Executive and Horizontal Coordination |
| **Objectives** | | | | | | |
| The negotiation and implementation of arrangements with a consortium of Canadian companies and other parties aimed at the successful exploitation of the world market in Earth observation (radar satellite imaging through the construction and operation of RADARSAT II).<br><br>Operation of RADARSAT I to generate royalty fees and develop related applications. | Arrangements with Canadian satellite communications manufacturers and service providers to develop the advanced technologies required to give all Canadians access to the new satellite-based multimedia services. | Integration and performance of the Mobile Servicing System (MSS) for the International Space Station and delivery of the MSS to the National Aeronautics and Space Administration (NASA).<br><br>Development of the Special Purpose Dextrous Manipulator , for delivery to NASA by Year 2001. | Testing of the Canadian Microgravity Isolation Mount (MIM) - an instrument designed to minimize the vibrations that affect fluids and material experiments in space — with Canadian astronaut Bjarni Tryggvason's flight aboard the space shuttle in July 1997.<br><br>The flight of Canadian astronauts on missions. | Greater understanding of space and atmospheric phenomena and resulting terrestrial effects. | Enhanced technological capabilities of the high-tech industry through strategic technology development and transfer.<br><br>Continue implementation of the ESA programs within approved resources; and implementation of recommendations arising from the evaluation of the benefits and management of Canada-ESA cooperation.<br><br>Support for the competitiveness of Canadian space companies, consistent with the government's priority on jobs, growth and international business development. | An enhanced S&T culture in Canada through exploitation of the unique appeal of space.<br><br>Completion of the new CSA Organizational Structure.<br><br>Continued operations of David Florida Laboratory (DFL) as a world-class facility for assembling and testing space-based hardware, from domestic and foreign space industries and agencies |

# G. Organization




Reporting to the Minister of Industry, the Chief Executive Officer of the CSA is the President, who may be supported by an Executive Vice-President. The President and Executive Vice-President are also supported by the Chief Scientist/Engineer and the Chair of the Space Plan Task Force. Under the President and Executive Vice-President, there are three areas of responsibility: core, executive and corporate functions.

The core functions are carried out by the following directorates: Space Systems, which provides project management and engineering services; Space Technologies; Space Science; the Canadian Astronaut Office; and Space Operations, which provides an environmental test facility (the David Florida Laboratory) and operates the space and ground segments of the CSA's space-related assets. This includes the RADARSAT I Ground Station and Satellite. The core functions are responsible for meeting the technical mandate of the Agency.

The executive functions are carried out by the following directorates: Policy and Planning, Corporate Management, Communications, and Audit, Evaluation and Review. General corporate functions are delivered by the following directorates: Legal Services, Administration, and Human Resources.

# SECTION III

# AGENCY PERFORMANCE

# A. Performance Expectations

## Authorities for 1996-97 - Part II of the Estimates

***FIGURE 1: Financial Requirements by Authority***

| Vote | ($000) | Main Estimates | 1996-97 Total Authorities[1] | 1996-97 Actuals |
|---|---|---|---|---|
| | **Canadian Space Agency** | | | |
| 40 | Operating Expenditures | 48,772 | 58,652.4 | 56,206.7 |
| 45 | Capital Expenditures | 135,392 | 159,304.6 | 158,747.9 |
| 50 | Grants and Contributions | 39,590 | 38,775.2 | 32,767.7 |
| (S) | Contributions to Employee Benefit Plans[2] | 3,169 | 3,290.0 | 3,290.0[2] |
| (S) | Spending of proceeds from the disposal of Surplus Crown Assets | | 18.1 | |
| | **Total Agency** | **226,923** | **260,040.3** | **251,012.3** |

1. Main Estimates plus supplementary estimates plus other authorities
2. $ 121,000.00 authorized by the Receiver General in period 15.

## Planned Versus Actual Spending Tables

***FIGURE 2: Comparison of Total Planned Spending [(1)] to Actual Expenditures, 1996-97 by Organization and Business Line ($000)***

| | Business Lines / Activities | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | EO | SC | CSSP | CAP | SS | ST | EHC | **Total** |
| **Organization/Program Structure** | | | | | | | | |
| Executive | | | | | | | 1,030 | 1,030 |
| | | | | | | | 2,261 | 2,261 |
| Executive Functions | | | | | | | 8,772 | 8,772 |
| | | | | | | | 5,269 | 5,269 |
| Corporate Functions | | | | | | | 7,836 | 7,836 |
| | | | | | | | 12,610 | 12,610 |
| Space Systems | | | 85,858 | | | | | 85,858 |
| | | | 94,685 | | | | | 94,685 |
| Space Technologies | 51,325 | 14,889 | | | | 23,566 | | 89,780 |
| | 37,981 | 18,413 | | | | 21,122 | | 77,516 |
| Space Science | | | | | 33,464 | | | 33,464 |
| | | | | | 37,979 | | 161 | 38,140 |
| Canadian Astronaut Office | | | | 8,783 | | | | 8,783 |
| | | | | 9,591 | | | 276 | 9,867 |
| Space Operations | | | | | | | | |
| | 14,084 | | | | | | 2,646 | 16,730 |
| Subtotal | 51,325 | 14,889 | 85,858 | 8,783 | 33,464 | 23,566 | 17,638 | 235,523 |
| | 52,065 | 18,413 | 94,685 | 9,591 | 37,979 | 21,122 | 23,223 | 257,078 |
| Revenues credited to the Vote | 8,600 | | | | | | | 8,600 |
| | 6,066 | | | | | | | 6,066 |
| **Total** | **42,725** | **14,889** | **85,858** | **8,783** | **33,464** | **23,566** | **17,638** | **226,923** |
| | **45,999** | **18,413** | **94,685** | **9,591** | **37,979** | **21,122** | **23,223** | **251,012** |
| **% of Total** | **18.3** | **7.3** | **37.8** | **3.8** | **15.1** | **8.4** | **9.3** | **100.0** |

**Abbreviations:**

EO Earth Observation
SC Satellite Communications
CSSP Canadian Space Station Program
CAP Canadian Astronaut Program
SS Space Science
ST Space Technology
EHC Executive and Horizontal Coordination

**Note:** Shaded numbers denote actual expenditures/revenues in 1996-97.

(1) Does not reflect Supplementary Estimates and other Spending Authorities. Includes Main Estimates only.

*FIGURE 3: Comparison of Total Planned Spending to Actual Expenditures, 1996-97 by Business Line ($000)*

| | FTEs | Operating [2] | Capital [2] | Grants and Contributions | Gross Expenditures | Less: Revenues credited to the Vote | Total |
|---|---|---|---|---|---|---|---|
| **Business Lines** | | | | | | | |
| Earth Observation | 33 | 667 | 32,183 | 18,475 | 51,325 | 8,600 | 42,725 |
| | 33 | 1,811 | 33,130 | 17,124 | 52,065 | 6,066 | 45,999 |
| Satellite Communications | 4 | 4,126 | 365 | 10,398 | 14,889 | | 14,889 |
| | 7 | 11,308 | 892 | 6,213 | 18,413 | | 18,413 |
| Canadian Space Station Program | 89 | 4,257 | 81,601 | | 85,858 | | 85,858 |
| | 89 | 1,201 | 93,484 | | 94,685 | | 94,685 |
| Canadian Astronaut Program | 22 | 8,691 | 92 | | 8,783 | | 8,783 |
| | 43 | 9,591 | | | 9,591 | | 9,591 |
| Space Science | 36 | 3,452 | 29,862 | 150 | 33,464 | | 33,464 |
| | 34 | 2,144 | 35,685 | 150 | 37,979 | | 37,979 |
| Space Technology | 62 | 12,969 | 665 | 9,932 | 23,566 | | 23,566 |
| | 61 | 11,718 | 516 | 8,888 | 21,122 | | 21,122 |
| Executive and Horizontal Coordination | 103 | 16,831 | 172 | 635 | 17,638 | | 17,638 |
| | 125 | 21,724 | 1,106 | 393 | 23,223 | | 23,223 |
| **Total Agency Estimates[1]** | **349** | **50,993** | **144,940** | **39,590** | **235,523** | **8,600** | **226,923** |
| **Total Agency Actuals** | **392** | **59,497** | **164,813** | **32,768** | **257,078** | **6,066** | **251,012** |
| **Other Expenditures** | | | | | | | |
| Cost of services provided by other government departments[3] | | | | | | | 1,569 |
| | | | | | | | 1,336 |
| **Total Cost of the Program** | | | | | | | 228,492 |
| | | | | | | | 252,348 |

(1) Does not reflect Supplementary Estimates and other Spending Authorities. Includes Main Estimates only.
(2) Includes contributions to employee benefit plans.
(3) Contributions covering employees' share of insurance premiums and costs paid by the Treasury Board Secretariat; accommodation received without charge from Public Works Government Services Canada (PWGSC) $ 121,000.

**Note:** Shaded numbers denote actual expenditures/revenues in 1996-97.

***Figure 4 : Agency Planned versus Actual Spending by Business Line ($000)***

| | Actuals 1993–94 | Actuals 1994–95 | Actuals 1995–96 | Total Planned 1996–97 | Actuals 1996-97 |
|---|---|---|---|---|---|
| **Business Lines / Activities** | | | | | |
| Earth Observation | 103,583 | 82,580 | 67,317 | 51,325 | 52,065 |
| Satellite Communications | 9,877 | 12,434 | 18,022 | 14,889 | 18,413 |
| Canadian Space Station Program | 173,100 | 141,521 | 136,300 | 85,858 | 94,685 |
| Canadian Astronaut Program | 5,997 | 7,252 | 8,768 | 8,783 | 9,591 |
| Space Science | 23,733 | 32,706 | 35,058 | 33,464 | 37,979 |
| Space Technology | 19,564 | 22,497 | 23,134 | 23,566 | 21,122 |
| Executive and Horizontal Coordination | 48,076 | 19,713 | 22,559 | 17,638 | 23,223 |
| **Subtotal** | **383,930** | **318,703** | **311,158** | **235,523** | **257,078** |
| Less: Revenue credited to the Vote | (6,000) | (1,116) | (9,300) | (8,600) | (6,066) |
| **Total** | **377,930** | **317,587** | **301,858** | **226,923** | **251,012** |

## Summary of Performance Expectations

In delivering its program and in achieving its objectives, the CSA performs in five major categories of activities. The medium-term results expected from these activities are shown in the following Table.

**Performance Framework**

| **Categories of Activities** | | | | |
|---|---|---|---|---|
| Effective management of Long Term Space Plan II | Leadership in space R&D for the benefit of Canadians and humanity | Application of space knowledge to business development and technology transfer | Related commercial and scientific activities | Increased awareness of and education on the importance of space |
| **Results Expectations** | | | | |
| Development and application of space S&T to meet Canadian needs<br>**(All business lines)** | Increased understanding of space phenomena; avoidance of resulting terrestrial effects; improvement in atmospheric circulation models; increased understanding of pollution **(Space Science)** | Improved technical capabilities and revenues throughout the Canadian high-tech industry<br>**(Space Technology)** | Operation of DFL as a world-class facility for assembly and testing of space-based hardware<br>**(All business lines)** | Increased Canadian awareness of space S&T and applications for industry and society<br>**(Executive & Horizontal Coordination)** |
| Development of an internationally competitive space industry<br>**(All business lines)** | Prevention of health hazards of space flight; development of medical improvements (e.g., diagnostics, health care) **(Space Science)** | Development of Canadian remote-sensing industry (exploiting data from RADARSAT I) and partnerships with the private sector for Earth observations **(Earth Observation)** | Participation of several Canadian astronauts in space flights, with increased opportunities for research in space **(Canadian Astronaut Program)** | Research opportunities for students in space S&T<br>**(All business lines)** |
| | Economic benefits (employment, regionally distributed industrial activity) of investments in space technologies **(Canadian Space Station Program and Space Technology)** | | | |
| | Enhanced Canadian R&D capability by developing application-oriented technologies **(Space Technology)** | | | |

## B. Performance Accomplishments

## Agency Performance

Canada ranks eighth among the world's space-faring nations. As a country we recognized very early that space would bring enormous benefits to its small population, spread over the second largest country on Earth. Canada was the third nation to launch a satellite, in 1962; this heralded the very successful series of*Anik* communications satellites and paved the way for the development of the Canadian space industry. The space program moved into remote sensing for the management, surveillance and protection of Canadian territory, oceans and environment. A unique expertise in robotics also developed, thanks to the Canadian robotic arm (Canadarm), which equips the US space shuttles and has been effectively used on missions such as the flight to repair the Hubble space telescope. This strategic and world-renowned expertise has led to Canadians being invited to participate as a full partner in the largest cooperative R&D program in history, the International Space Station. Canada's contribution to that program will be the Mobile Servicing System, which will be used for the assembly, maintenance and operation of the station.

In Canada, the space industry is an important building block of the knowledge-based economy, providing the type of activities and high-quality jobs required in technologically advanced nations. This sector employs approximately 3000 people in all regions of the country; it generates about $700 million in sales of goods and services; and 45% of its manufacturing sales are exports. More than 85 per cent of the CSA's budget is contracted out to Canadian industry and scientific organizations.

During 1996-97, the CSA revised its organizational and decision-making structures to heighten their ability to contribute to government objectives and strategies and to enhance coordination with central agencies and other departments. The reorganization of the CSA strengthened its executive and horizontal functions and improved the decision-making process.

# Performance Accomplishments by Business Lines

## Earth Observation

### *Objectives*

- To ensure continued Canadian leadership in the emerging international Earth Observation market
- To meet Canadian environmental monitoring and resource management requirements as well as other related application needs

### *Strategies*

Working with the private sector and other domestic and international partners, the Earth Observation business line focuses on producing Earth observation data and developing and applying Canadian space and ground technology to domestic and international needs, particularly in the areas of environmental monitoring, resource management, surveillance and disaster management.

The overall strategy is to maintain the present leadership in civilian Earth Observation radar technology, to transfer this expertise gradually to the private sector and to ensure its commercial success by encouraging the development of worldwide applications and sales of data products and related technologies. Strategies related to specific elements include the following:

- ensuring that RADARSAT I continues to supply timely and high-quality data to program partners, including federal user departments and agencies such as the Ice Services Branch of Environment Canada, provincial governments, RADARSAT International Inc., the private company that sells RADARSAT data worldwide, NASA, the National Oceanic and Atmospheric Administration and other interested partners;
- implementing, with Canadian industry and international partners, the RADARSAT II mission, and developing advanced space technology to ensure the long-term success of the Canadian Earth Observation program;
- implementing the Earth Observation Support Program (ground infrastructure, and application development and technology transfer components) in cooperation with the Canada Centre for Remote Sensing to improve access to Earth Observation data and develop new applications, especially for radar satellite data, in areas with greatest market potential; to develop a strong Canadian value-added industry; and to maximize returns on public investment through partnership;
- implementing, with industry and international partners, the RADARSAT II mission to ensure the commercial viability of the RADARSAT family of satellites, and the continued availability of radar data; and
- identifying new opportunities where the CSA could cooperate with its national and international partners on remote sensing technology and infrastructure development.

***Results Expectations and Performance Measures***

- Operational use of Earth Observation and development of the Canadian remote-sensing industry exploiting data from RADARSAT I, including integration with other data sources; and partnerships with the private sector for RADARSAT II
- Greater Canadian awareness of the benefits of Earth Observation and its exploitation by the private and public sector
- Identification of new research and development opportunities
- Space hardware qualified by the David Florida Laboratory, a world-class facility for assembly and environmental testing
- Revenue from Radarsat International Inc.

The intended effects of the Earth Observation business line are new international opportunities and market niches for Canadian companies; increased employment; operational solutions to resource management problems, disaster management and surveillance; and improved knowledge of Canada's land mass.

The main outputs of the Earth Observation business line are contracts to industry, satellite-based Earth-observation Synthetic Aperture Radar data, and enhancements planned for the RADARSAT system.

### *Performance*

The Earth Observation business line is developing a successful Canadian remote-sensing industry, exploiting data from RADARSAT I, in partnership with the private sector in Earth observation.

*According to its design, RADARSAT I was intended to deliver images electronically on a four-hour turnaround. In operation, its delivery time averages 1½ hours.*

Commercial operations of RADARSAT I commenced in April 1996, following a commissioning period. During its first year of operations RADARSAT I has supplied timely and high quality data to program partners, including federal user departments and agencies such as the Canadian Ice Service of Environment Canada, the provincial governments, RADARSAT International Inc., the private sector company that sells RADARSAT data world-wide, NASA and the National Oceanic and Atmospheric Agency. In 1996-97, RADARSAT fulfilled more than 11,000 user requests. Of these, 8,000 images were processed and delivered to user agencies. The international client base included more than 500 commercial and government users from over 44 countries.

According to the original design, RADARSAT was intended to provide four-hour turnaround in the electronic delivery of images to the Canadian Ice Service for producing ice maps for the Canadian Coast Guard. In operation, delivery time is averaging 1½ hours from the time the image is taken. RADARSAT has archived substantial volumes of images for future commercial use. It has mapped all of North

America for the first time and 53 per cent of the rest of the Earth (ScanSAR Wide coverage). A six-week outage during the 1996 summer eclipse season provided valuable information for the future management of the spacecraft. Since August more than 92 per cent of the planned data requests have been delivered to the users.

Sales of RADARSAT data in 1996 were affected by the outage. However, the pace picked up rapidly and constantly from August 1996, and in the First Quarter 1997, sales were 15 per cent beyond projections.

**RADARSAT Sales ($000)**

| | **1996** | | | **1997** |
|---|---|---|---|---|
| Q1 | Q2 | Q3 | Q4 | Q1 |
| $524 | $1,340 | $963 | $2,122 | $3,176 |

The ground stations network initially included two stations in Canada (Prince Albert, Saskatchewan, and Gatineau, Quebec) and one in Alaska (Fairbanks). Three more stations were signed in 1996-97: West Freugh (UK), Tromso (Norway) and Singapore. These additional stations allow more data to be received directly. Agreements have also been signed with China and Japan for direct reception. This will open new global markets for RADARSAT International Inc.

Long-term Space Plan II announced plans for a second RADARSAT satellite, which is to provide data for the seven years following the 1995-2001 projected life span of RADARSAT I. RADARSAT II will be a key milestone in transferring the business to the private sector. In particular, the private sector will be responsible for the construction and launch of RADARSAT II, operation of the system and development of the Canadian Earth observation business. Under Long-term Space Plan II, a total of $241.4 million has been allocated for RADARSAT II.

In 1996-97 the RADARSAT II Program passed several important milestones. The feasibility study started the previous year by a private sector consortium was completed with the delivery of a business plan for privatizing the RADARSAT II Program. To avoid delays, a contract was awarded to provide high power microwave circuits and approval was obtained from Treasury Board to initiate a pre-start contract to procure long-lead items and initial engineering work.

Synthetic Aperture Radar Technology Development is an advanced program focusing beyond RADARSAT I and II, aimed at developing the enabling technologies required for radar missions. In 1996-97, studies were conducted for the development of dual polarization, dual-frequency antennae, on-board radar data processing and low-mass, low-cost Synthetic Aperture Radar antennae concepts.

The Earth Observation Support Program is intended to help the private sector to commercialize Earth-observation data, and will ensure that Canadian industry is in a

position to respond to the demand it has created. It includes the Ground Infrastructure and Applications and the Technology Transfer programs, which will enable Canada to receive data from new Earth-observation satellites and support emerging Canadian value-added industries in developing applications to meet Canadian and international market needs. The Earth Observation Support Program is managed by the CSA, in cooperation with the Canada Centre for Remote Sensing, under the terms of a memorandum of understanding between the two organizations. The total amount set aside for this initiative, through Long-term Space Plan II is $91.1 million ($13.5 million in 1996-97).

Under the Ground Infrastructure Program, contracts were signed with Canadian industry to construct and deliver the next generation archive and management facilities for Earth Observation data. A total of over 1,300 images received from the European Remote Sensing-1 and European Remote Sensing-2 satellites was processed and distributed to Canadian users. Canadian industry completed the design phase of the Canadian Earth Observation Net core system for on-line access to Earth Observation data, and delivered related application tools.

*The private sector will be responsible for the construction and launch of RADARSAT II, the operation of the system and the development of Canadian Earth observation business.*

Under the Application Development and Research Opportunity (ADRO) Program, over 1,200 RADARSAT images were supplied to more than 160 research projects in many areas of the globe. The RADARSAT User Development Program supported 18 industrial project proposals to develop new applications using Synthetic Aperture Radar data. Contracts were awarded to small and medium-sized enterprises to support the development of market-ready value-added products and services that will boost RADARSAT data sales and help Canadian companies carve a niche in the international markets.

The User Education and Training Initiative contributed to industrial competitiveness by funding 18 projects to develop and market educational and training Earth Observation materials. The Earth Observation Pilot Projects Program supported 19 projects to transfer Earth Observation technology to a broader base of user agencies. The Earth Observation Data Set Program, which supplies RADARSAT and other Earth Observation data to Canadian students and researchers approved 10 research proposals to develop new algorithms and techniques. In order to develop further the market for RADARSAT data these programs are reaching a broad range of users to familiarize them with the RADARSAT capabilities and are encouraging the development of new applications.

## *FIGURE 5: Financial Performance, Earth Observation*

### 1996–97 Comparison of Main Estimates to Actuals

| | Operating [1] | Capital [1] | Transfer Payments Grants and Contributions | Gross Expenditures | Less: Revenues Credited to the Vote | Total |
|---|---|---|---|---|---|---|
| **Service Lines** | | | | | | |
| RADARSAT I | | 12,054 | | 12,054 | (8,600) | 3,454 |
| | 299 | 13,785 | | 14,084 | (6,066) | 8,018 |
| RADARSAT II | | 5,100 | | 5,100 | | 5,100 |
| | | 5,849 | | 5,849 | | 5,849 |
| Generic EO Technological Development | | 300 | | 300 | | 300 |
| | | 299 | | 299 | | 299 |
| Ground Infrastructures | 132 | 3,968 | | 4,100 | | 4,100 |
| | | 2,971 | | 2,971 | | 2,971 |
| Applications Development and Technology Transfer | 353 | 10,670 | | 11,023 | | 11,023 |
| | 358 | 9,640 | | 9,998 | | 9,998 |
| ESA Earth Observation | | | 18,475 | 18,475 | | 18,475 |
| | | | 17,124 | 17,124 | | 17,124 |
| **David Florida Laboratory** | 182 | 91 | | 273 | | 273 |
| | 1,154 | 586 | | 1,740 | | 1,740 |
| **Total Estimates** | **667** | **32,183** | **18,475** | **51,325** | **(8,600)** | **42,725** |
| **Total Actuals** | **1,811** | **33,130** | **17,124** | **52,065** | **(6,066)** | **45,999** |

(1) Includes contributions to employee benefit plans.

(2) Actual net expenditures in 1996–97 were $ 3.3 million more than originally planned in the Main Estimates. The most significant factors in this difference are :

- additional funding to the RADARSAT I project for launch insurance purposes;
- the transfer of the testing of the Mobile Servicing System (MSS ) from a private sector contractor to the David Florida Laboratory as well as the redistribution of Space Station revenue to other agency business lines.

## Satellite Communications

***Objectives***

- To maintain or expand Canadian industry's share of the growing international market for these new services
- To ensure that Canadians have access to any new multimedia, personal, and mobile communications services made possible by advanced satellite communications technologies

***Strategies***

In partnership with the private sector, the Satellite Communications business line focuses on the development of satellite communications technologies and services required to meet Canadian needs while maintaining or expanding Canadian industry's share of the growing international market for satellite communications systems.

The overall strategy is to negotiate arrangements with the Canadian telecommunications industry to foster the development of the technologies and systems required to give Canadians equal access to advanced communications services, as well as to help our industry maintain or develop export niches in international markets. Strategies related to program elements include:

- negotiating with the private sector co-funded arrangements to design user-driven and industry-led Advanced Satellite Communications and International Mobile initiatives,
- establishing implementation arrangements that will optimize synergies between the CSA, the Communications Research Centre and industry capabilities and, thereby, the effectiveness of private/public funds, and
- identifying potential areas for cooperation with the Department of National Defence on communications technology and infrastructure development.

***Results Expectations and Performance Measures***

- Development of satellite communications technologies and services to meet Canadian needs (e.g., equitable access to bandwidth-on-demand services in all parts of Canada)
- Greater Canadian awareness of space S&T and applications for industry and society
- Research opportunities for students in space S&T
- Space hardware qualified by the David Florida Laboratory, a world-class facility for assembly and environmental testing.

Satellite communications is Canada's most mature space technology application and has the greatest potential for immediate economic return. This business line will ensure that Canadians continue to benefit from services provided by advanced space technologies and that Canadian industry maintains or expands its share of the growing international market for these new services and products.

The main outputs of the Satellite Communications business line will be next-generation commercial satellite components and services. They will enhance the position of the Canadian satellite communications industry as a world-class supplier of space subsystems and offer Canadians new multimedia and personal-communications services.

The main performance indicators will be the sales of products developed by industry and the availability of new multimedia and personal communications services in all regions of Canada.

### *Performance*

The Advanced Satellite Communications Initiative has focused on the development of the new technologies needed to design new satellite systems that will provide bandwidth-on-demand Information-Highway-style services to all Canadians. These new multimedia service offerings may deliver to individuals a combination of entertainment, video, telephony, image transfer, and broadband communications.

*Satellite communications is Canada's most mature space technology application and has the greatest potential for immediate economic return. The CSA ensures that Canadian industry maintains or expands its share of the growing international market for these new services and products.*

The International Mobile Initiative helps to position Canadian industry in the fast-growing market for mobile and personal satellite communications services, both as suppliers of subsystems to international consortia operating constellations of satellites and as providers of services to Canadians. At least six major international systems are currently being proposed, with a projected investment in facilities, over the next 10 years, of $10–$20 billion. A total budget of $24.5 million is allocated to this program.

In 1996-97, the Satellite Communications business line has:

- awarded several European Space Agency contracts to develop technology related to multi-media and personal communications services,
- within the Advanced Satellite Communications Initiative, defined the first phase of the program (government contributions totalled $50 M over 2½ years) and begun negotiations for five R&D projects with 25 per cent industry contributions, and
- completed a Statement of Work for the Phase II Request for Proposal to award Canadian companies funding on a 50-50 basis to develop technologies for personal mobile communications under the International Mobile Initiative.

## *Figure 6 : Financial Performance, Satellite Communications*

**1996-1997 Comparison of Main Estimates to Actuals**

| ($000)<br>(shaded lines show Actuals) | **Operating [1]** | **Capital [1]** | **Grants and Contributions** | **Gross Expenditures** | **Less: Revenues Credited to the Vote** | **Total** |
|---|---|---|---|---|---|---|
| **Service Lines** | | | | | | |
| Advanced Satellite Communications | | | | | | |
| | 6,532 | | | 6,532 | | 6,532 |
| International Mobile | 3,396 | | | 3,396 | | 3,396 |
| | 3,019 | | | 3,019 | | 3,019 |
| ESA Satellite Communications | | | 10,398 | 10,398 | | 10,398 |
| | | | 6,213 | 6,213 | | 6,213 |
| David Florida Laboratory | 730 | 365 | | 1,095 | | 1,095 |
| | 1,757 | 892 | | 2,649 | | 2,649 |
| **Total Estimates** | **4,126** | **365** | **10,398** | **14,889** | | **14,889** |
| **Total Actuals** | **11,308** | **892** | **6,213** | **18,413** | | **18,413** |

(1) Includes contributions to employee benefit plans.

(2) Actual expenditures in 1996–97 were $ 3.5 million more than originally planned in the Main Estimates. The most significant factors in this difference are:
- a provision of $ 6.7 million for the Advanced Satellite Communications Initiative to continue technology development activities in order to be a viable supplier of advanced satcom components and terminals;
- changes in the levels and mix of market demand for client services at the David Florida Laboratory.

# Canadian Space Station Program

### *Objectives*

- To enhance Canada's ability to operate in space and to exploit the potential of space technologies, particularly automation and robotics
- To meet our commitments to the International Space Station Program

### *Strategies*

The Canadian Space Station Program business line will ensure that Canadians benefit from their investment in space robotics and from Canada's access to the International Space Station, and that the CSA meets its commitments to its international partners.

The overall strategy is to maximize Canadian industry's participation in a large international cooperative S&T program and in the development and operation of advanced space robotics, to plan for the use of the Space Station by Canadian scientists, and to meet our commitments to our International Space Station partners.

Strategies related to specific elements include the following:

- managing the Canadian industrial team so that it completes the development of the Mobile Servicing System on time and within budget and managing the changing interfaces agreed to by NASA and the CSA in June 1994,
- with the upcoming launch of space-based systems, shifting the primary focus in the CSA and in Canadian industry from space system development to the ground segment and operations,
- ensuring that the division of responsibilities between the CSA and NASA allows Canada to maximize the benefits of its participation in this international program,
- working with the private sector to manufacture the Special Purpose Dextrous Manipulator in Canada, and
- negotiating in-kind arrangements with international partners to keep down the cost of using Canada's share of Space Station resources.

### *Results Expectations and Performance Measures*

- Completion of the Mobile Servicing System and fulfilment of other obligations to the International Space Station Program
- Economic benefits (e.g., employment, regionally distributed industrial activity) of investments in space technologies
- Greater Canadian awareness of space S&T and applications for industry and society
- Research opportunities for students in space S&T
- Space hardware qualified by the David Florida Laboratory, a world-class centre for assembly and environmental testing.

The CSA is committed to delivering the elements of the Mobile Servicing System to NASA before the stated need date. Successful on-orbit checkout of the system's elements, with the support and monitoring of the Mobile Servicing System Operations

Complex in Saint-Hubert, is expected to boost the visibility of Canadian space robotics technology and demonstrate Canada's ability to deliver and operate turnkey robotic systems. The long-term benefits of this item in the business line include substantial employment as a result of export sales, and sustainable development in all regions of Canada.

Gaining experience in operating such a sophisticated space system and successfully demonstrating the capability of the space and ground systems of the Mobile Servicing System are central to Canada's realizing longer-term economic benefits. Succinctly stated, the goal is to achieve a $6.4 billion return on a $1.4 billion investment, mostly through spin-off and diffusion, in all economic regions of the country.

The main outputs of the Canadian Space Station Program business line are the following:

- development and delivery of the Mobile Servicing System, including the Special Purpose Dextrous Manipulator, to the International Space Station on time, within budget, and as specified;
- development of the ground elements to support the in-orbit testing and commissioning of the Mobile Servicing System;
- successful in-orbit commissioning of the Mobile Servicing System with the support of the Mobile Servicing System operations complex in Saint-Hubert, Québec;
- development and implementation of the training program to support Mobile Servicing System operations; and
- planning the use of the International Space Station by Canadian scientists.

To meet the schedule of the International Space Station Program, the CSA is committed to delivering the elements of the Mobile Servicing System to NASA to meet its launch deadlines and to support the assembly seqence.

The following table shows the international milestones for the business line:

| **Canadian Space Station Program** | **Date** |
|---|---|
| Initiation of the CSA's development and design phase | July 1987 |
| First MSS elements delivery to NASA | Aug 1998 |
| First Space Station elements launch | Jun 1998 |
| First MSS element launch (SSRMS) | Jun 1999 |
| Second MSS element launch (MBS) | Mar 2000 |
| Third MSS element launch (SPDM) | Jan 2002 |
| Permanently manned capability | Mar 2003 |

### *Performance*

The CSA remains on schedule to meet Canada's obligation to deliver the first of the components of the Mobile Servicing System (the Space Station Remote Manipulator System) to NASA in 1998. By the end of March 1997, the manufacture and assembly of the Space Station Remote Manipulator System was complete, with the Mobile Base System close behind. Acceptance reviews for both the Space Station Remote Manipulator System and the Mobile Base System will be conducted during 1997. Integration and test activities have been under way since the fall of 1996, when all flight units were integrated. The critical design of the Canadian Space Vision System was completed in early 1997.

The Mobile Servicing System Operations and Training Simulator component of the Mobile Servicing System Operations Complex at Saint-Hubert, Quebec overcame technical difficulties and has been completed by July 1997. The Multimedia Learning Centre, courseware development and the Virtual Operations Training Environment will have completed their first phase by mid-1997.

Changes in the scheduled delivery and launches reflect major slippage in the whole assembly sequence of the International Space Station Program, owing mainly to Russia's delay of the Service Module. These changes were endorsed in May 1997 by the Space Station Control Board.

1996-97 was the most challenging year to date of the Space Technologies for Automation and Robotics Program because it had to plan and implement the remaining activities to fulfil its mandate by the scheduled program sunset of 1999-2000. Over this period, apart from managing close to 20 ongoing National and Regional Joint Business Venture contracts, the Space Technologies for Automation and Robotics Program initiated two National sub-Programs through competitive Requests for Proposals in the field of "Human-Machine Interface and Telepresence" and "Imaging Systems". The Program also launched Regional Joint-venture Initiatives in seven provinces in Atlantic Canada, Quebec and the Prairies, resulting in 28 new industry-led Space Automation and Robotics R&D contracts. Two Sub-programs in the field of "Tactile and Proximity Sensors" and "Operating Systems and System Architectures for Ground Control" ended with final Forum presentations held at the CSA.

In terms of intellectual property management, nine (9) new Licence Agreements were negotiated with Space Technologies for Automation and Robotics contractors, four (4) Crown-owned patent applications were submitted and two (2) Crown-owned patents were granted. Significant commercial success was achieved by one contractor, International Submarine Engineering of Vancouver BC. Under contract with Shell, the firm developed the first Autonomous Robotic Automobile Refuelling robot. The Shell Smart Pump, considered one of the world's first and most sophisticated consumer robots, is a triumph of Canadian technological innovation. International Submarine Engineering was awarded the Shell Smart Pump Project in large part owing to the expertise it developed under a CSA contract to design and build robotic control systems for use on

the future International Space Station.

Activities to promote the diffusion of the technologies fostered by the Space Technologies for Automation and Robotics Program reached a peak in Fora held at the CSA, nation-wide bidders' conferences to promote Regional Joint Venture Initiatives, press conferences, technical presentations and participation at major Canadian conferences. A public Space Technologies for Automation and Robotics Web Site has been set up on the Internet (**www.space.gc.ca**), and an Automation & Robotics Testbed established at the CSA in cooperation with other Agency groups to test the technologies fostered by Space Technologies for Automation and Robotics, to develop new operational scenarios, and to showcase the achievements of the Program's contractors to industry and other Canadian and international government agencies. Finally, a Space Technologies for Automation and Robotics Program Status Report was released, summarizing all the Program's achievements to date.

The Space Technologies for Automation and Robotics service line has been moved to the Space Technology Business Line and will be reported there in future reports.

### *FIGURE 7: Financial Performance, Canadian Space Station Program*

**1996–97 Comparison of Main Estimates to Actuals**

| ($000)<br>(shaded lines show Actuals) | Operating [1] | Capital [1] | Grants and Contributions | Gross Expenditures | Less: Revenues Credited to the Vote | Total |
|---|---|---|---|---|---|---|
| **Service Lines** | | | | | | |
| MSS Development | | 53,046 | | 53,046 | | 53,046 |
| | 216 | 78,648 | | 78,864 | | 78,864 |
| MSS Operations | | 21,156 | | 21,156 | | 21,156 |
| | 216 | 9,105 | | 9,321 | | 9,321 |
| STEAR | | 5,266 | | 5,266 | | 5,266 |
| | 217 | 5,451 | | 5,668 | | 5,668 |
| David Florida Laboratory | 4,257 | 2,133 | | 6,390 | | 6,390 |
| | 552 | 280 | | 832 | | 832 |
| **Total Estimates** | **4,257** | **81,601** | | **85,858** | | **85,858** |
| **Total Actuals** | **1,201** | **93,484** | | **94,685** | | **94,685** |

(1) Includes contributions to employee benefit plans.

## Canadian Astronaut Program

### *Objectives*

- To train Canadian astronauts to participate in international human space flights
- To contribute to Canadian S&T experiments in space
- To ensure the health of Canadian astronauts
- To inspire Canadian youth to pursue careers in S&T

### *Strategies*

The Canadian Astronaut Program business line ensures that Canadians, particularly those in the scientific community, benefit from Canada's participation in human flights in space and that the CSA maintains an astronaut corps that can respond to Canadian needs in human space-based operations.

The overall strategy aims at ensuring that Canadian astronauts support shuttle operations and Space Station assembly and operations, while giving Canadian industry and researchers access to space.

Strategies related to specific elements include the following:

- ensuring that Canada retains a prominent role in space robotic system operations and training by negotiating the division of responsibilities between NASA and the CSA;
- developing applications through medical R&D related to preventing, diagnosing and treating crew medical problems, and maintaining the health, well-being and productivity of crews;
- inspiring youth to pursue careers in S&T; and
- informing the public of the benefits of space activities by capitalizing on the intense public interest in human space flight.

### *Results Expectations and Performance Measures*

- The participation of several Canadian astronauts in space flights, with more opportunities for research in space
- Greater Canadian awareness of space S&T and applications for industry and society
- Research opportunities for students in space S&T
- Space hardware qualified by the David Florida Laboratory, a world-class facility for assembly and environmental testing. The intended effects of the program are contributions to the development of high-technology-systems for space and Earth applications, microgravity research in life, medical and material sciences, a better-informed public, and enhanced international prestige for the Canadian Space Program.

The main outputs of the Canadian Astronaut Program business line are highly qualified and fully trained payload and mission specialists, and participation in space missions, communication activities, research, and technological development.

The performance indicators are the international and national prestige of Canadian astronauts, assessments of the astronauts' research contributions, delivery of project products on budget and on time, and changes in public awareness and perception of space S&T over time.

### *Performance*

The Canadian Astronaut Program is securing several flights of Canadian astronauts, with more opportunities for research in space.

***The Flights***

In 1996, two NASA space missions included Canadian astronauts. Marc Garneau flew as a mission specialist on STS-77 in May 1996, and Robert Thirsk flew as a payload specialist on STS-78 in June 1996. Bjarni Tryggvason was a payload specialist on STS-85, launched in July 1997, and Daffyd Williams was assigned as a mission specialist on STS-90, scheduled for April 1998.

Marc Garneau's mission, STS-77, included the Canadian-led Commercial Float Zone Furnace experiment sponsored by the Space Science Program, in which 12 sample materials contributed by scientists from Canada, the United States and Germany were melted down using a specialized process called float zoning, to produce high-quality crystalline materials. Also aboard was the Canadian-designed and -built Aquatic Research Facility, which allowed Canadian and American researchers to conduct studies on the life cycle and feeding patterns of small aquatic animals. Canadarm once again played a critical role in this important space mission, assisting in the assembly of the International Space Station, which will function as a permanently staffed orbiting laboratory. Two Canadian Get Away Specials (GAS), NANO-GAS and ACTORS, were aboard space shuttle *Endeavor*. The results of these experiments, sponsored by the Space Science Program, are expected to lead to high-performance laser and electronic equipment and devices.

*Canada donated the first Canadarm to NASA for the Space Shuttle* Columbia. *Since then, NASA has ordered four additional units.*

Robert Thirsk's mission, STS-78, with the International Life and Microgravity Spacelab, helped set the stage for the International Space Station by studying the effects of long-duration space flight on human physiology, and he helped conduct the types of experiments that would be done on the orbital platform. Among these was the Torso Rotation Experiment, an experiment designed by a McGill University team to investigate the neurological and visual changes that astronauts might experience in adapting to their space environment. The results of these experiments will have medical applications on Earth.

### *Flight Opportunities*

While outside the reporting period covered by this report, Bjarni Tryggvason's mission, STS-85 in August 1997, had the Microgravity Isolation Mount as the main Canadian payload. Designed in Canada, the Microgravity Isolation Mount applies the principle of magnetic levitation to isolate experiments from the vibrations of the spacecraft the microgravity environment, a distinct improvement for experimenters who use spacecraft such as the Russian space station *Mir,* the space shuttle, or the International Space Station. On 23 April 1996, a Microgravity Isolation Mount was launched into space aboard the Russian *Priroda* module, which subsequently docked with *Mir*. The mount was activated for the first time by US Astronaut Shannon Lucid during her six-month stay aboard *Mir*. It was a new version of the mount, with greatly enhanced performance characteristics, that was tested during Mission STS-85 this past August.

STS-90 will be a 16-day Neurolab mission to study the effects of microgravity on neurophysiology and human performance. The Spacelab, a fully equipped international space laboratory carried in the shuttle's cargo bay, offers a unique environment in which international investigators will conduct a series of 26 experiments. The Canadian experiment, called the Visuo-Motor Coordination During Space Flight experiment, is designed to help researchers understand the change in motor function, such as pointing and grasping objects, under conditions of weightlessness. This project is significant to our understanding of the limits of muscular performance on Earth, and has implications for rehabilitation after injuries. Canadians are also participating in a second experiment, the Role of Visual Cues in Spatial Orientation, which will reveal how people use visual signals to determine up and down in a zero-gravity environment. Orientation and depth perception are critically important to pilots of aircraft and space vehicles.

Astronaut Chris Hadfield has also been chosen by NASA to be the first Canadian to participate in an extravehicular activity, or space walk, during the installation of the Canadian manipulator system for assembling the International Space Station. This flight is scheduled for 1999.

### *Awareness*

Canadian astronauts make public relations appearances at media events and at professional associations and educational institutions, where they speak about the research they are carrying out in space for Canadian scientists and its benefits for the Canadian public and the Canadian economy. From April to December 1996, a total of 1,119 requests for astronaut appearances were received by the Canadian Astronaut Program. The Young Space Scientists Program was launched in 1996, and educational kits have been mailed out to schools all over Canada to involve students in the experiments being carried out by the astronauts on space flights. One experiment that was very popular, CANOLAB, distributed canola seed from space to classes across the

country. They grew them in their classrooms to compare the results with regular seed grown at the same time. The enthusiastic response from the students and from teachers, coupled with the fascination of the public and the media with the astronauts, gives the whole space program high visibility.

***FIGURE 8: Financial Performance, Canadian Astronaut Program***

**1996–97 Comparison of Main Estimates to Actuals**

| ($000)<br>(shaded lines show Actuals) | Operating [1] | Capital [1] | Grants and Contributions | Gross Expenditures | Less: Revenues Credited to the Vote | Total |
|---|---|---|---|---|---|---|
| **Total Estimates** | **8,691** | **92** | | **8,783** | | **8,783** |
| **Total Actuals** | **9,591** | | | **9,591** | | **9,591** |

(1) Includes contributions to employee benefit plans.

(2) Actual expenditures in 1996–97 were $ 0.8 million more than originally planned in the Main Estimates. The most significant factors in this difference are:
- an adjustment for the salaries of the astronauts;
- the hiring of additional staff for the Space Vision System (SVS) and Microgravity Isolation Mount (MIM) projects.

## Space Science

### *Objectives*

- To ensure that Canada maintains a position of excellence in the worldwide scientific exploration of space
- To procure from Canadian industry the instruments needed to obtain relevant scientific data

### *Strategies*

On behalf of the Canadian space science community, the Space Science Program procures scientific instruments from Canadian industry and arranges for their deployment, operation and use to obtain scientific data relevant to Canadian needs.

To achieve benefits for the scientific community, Canada's space industry, and the public at large, the CSA will implement the following strategies during the period covered by the business plan:

- continuing international science cooperation with Canada's traditional partners and other space-faring nations, to improve funding leverage and to gain access to a wider range of scientific data. Specific undertakings during the period involve NASA, Russia, Japan, Sweden, Finland, France and Australia;

- the issue of and response to a Canadian and international system of Announcements of Opportunity to ensure the widest possible participation in scientific ventures of interest to Canada, and the use of peer review within the Scientific Community to ensure that the best proposals are chosen to meet Canadian needs in Space Science; and
- for all of the above activities, the exploitation of special technical capabilities in advanced research and development in Canadian industry, especially in small and medium-sized enterprises. This R&D will involve technology transfer from the universities, and will help Canadian companies become commercially competitive.

***Results Expectations and Performance Measures***

- Greater understanding of space phenomena, avoidance of resulting terrestrial effects, improvement in atmospheric circulation models, and a better understanding of pollution
- Prevention of the health hazards of space flight, development of medical and material processing improvements (e.g., diagnostics, health care)
- Better capability of small and medium-sized enterprises to develop and use space technologies
- Greater Canadian awareness of space S&T and applications for industry and society
- Space hardware qualified by the David Florida Laboratory, a world-class facility for assembly and environmental testing.

The intended effects of the Space Science business line are the advancement of knowledge, the development of highly qualified personnel, the application of research results, and the development of technologies, products and spin-offs for private sector industry.

The main outputs of the Space Science business line are the maintenance of a world-class capability in astronomy and solar-terrestrial relations, more research activity in atmospheric sciences, expanded research capacity in the Space Life Sciences and Microgravity Science programs, and financial support for research using data collected by space missions by making maximum use of international missions and the opportunity for flights on the NASA shuttle, the Russian space station*Mir*, and international satellites.

The performance indicators for the Space Science business line are:

- the number, size and diversity of the experiments flown,
- the effectiveness of management in relation to the number of launches and the achievement of major milestones within available funding,
- the program's scientific output in terms of the number of scientific papers published in prestigious national and international journals,
- the program's prestige and recognition in terms of the acceptance of Canadian proposals in international missions, and

- the extent of the technological and other benefits obtained, including the wide distribution of work across Canada.

### *Performance*

The work of the Space Science business line is helping us to understand space phenomena, avoid unwanted terrestrial effects, improve atmospheric circulation models, and understand pollution. The Space Science business line is involved in the prevention of the health hazards of space flight, medical improvements such as diagnostics and health care, and improvements in the capabilities of small and medium-sized enterprises in using new technologies such as optical document readers.

In 1996-97 we witnessed the continued operation of the Microgravity Isolation Mount on the *Mir* Space Station and added the Queen's University Experiment on Liquid Diffusion furnace facility to this activity. Over 1000 hours of Microgravity Isolation Mount operation and close to 100 materials samples were obtained from the Queen's University Experiment. The Aquatic Research Facility, the Torso Rotation Experiment, and the Commercial Float Zone Furnace flew on the Space Shuttle as internal payloads, while two shuttle bay experiments, the Atlantic Canada Thin-film Organic Semiconductors (ACTORS) and NANO-GAS were also flown. The year also saw the launch of the Ultra Violet Auroral Imager aboard the Russian *Interball* satellite. Canadian participation in the Japanese space radio telescope project, the Very Long Baseline Interferometry Space Observatory Project, was realized with the February 1997 launch. Several missions have been supported, more than 10 major projects and more than 35 smaller projects are under development, and several new projects have been started.

In 1996-97, more than 100 papers were published based on the results obtained in such projects as the Canadian Wind Imaging Interferometer, the Cold Plasma Analyser, the *Viking* and *Freja* Auroral Imagers, the Canopus network of ground-based observations, and the Suprathermal Ion Mass Spectrometer. In the life sciences, more than 15 papers were published using data from the International Microgravity Laboratories (IML-1 and 2) and Life Microgravity Spacelab flights, and more than 50 papers were published in the Microgravity Sciences. Postgraduate degrees, at the doctoral and master's levels, were granted for work based on the data from the above projects.

The business line's prestige and recognition are demonstrated by the fact that Canadian proposals have been accepted for several international missions: NASA's Neurolab and Far Ultraviolet Spectroscopic Explorer programs, Sweden's *Odin* satellite, Japan's Planet B satellite mission for the Thermal Plasma Analyser project and the Very Long Baseline Interferometry Space Observation Project satellite program, the Space Drums furnace in the International Space Station furnace facility and Microgravity Isolation Mount, and the Queen's University Experiment in Liquid Diffusion on the Russian *Priroda* module.

During this period, the program played a key role in supporting new and ongoing initiatives in Atlantic Canada. For example, agreements with the Atlantic Canada Opportunities Agency and the Maritime Provinces for cooperative activities in microgravity continue to accomplish established goals.

Technologies developed in recent Space Science project contracts have enabled small and medium-sized enterprises to develop products and potential products. For example, Millennium Biologix has developed techniques for bone cell growth, CAL Corp has developed a wide-field star sensor, Bubble Technology Industries Inc. and Thomson & Nielsen Electronics Ltd. have developed dosimeters and radiation detectors, Ceramics Kingston produces cutting and nonabrasive materials for the manufacturing industries, AMISTAR exports semiconductor materials, Legacy Systems produces mass storage systems, AASTRA Aerospace Inc. exports communications equipment for both the United States and Canada (more than $6 million worth), and Bristol Aerospace Ltd. exports rocket and telemetry systems and attitude- and guidance-control systems to the United States. All these products are intended for the international market. In addition, Bomem, Com Dev, and Bristol Aerospace have won contracts from the United States as a result of their participation in Space Science activities.

*Technologies developed in the space program have made many small and medium-sized companies international winners.*

In 1996/97, the Space Science Program has accomplished the following:

- launched the Ultraviolet Auroral Imager on the Russian *Interball* satellite;
- developed the optical spectrograph for Sweden's *Odin* satellite;
- discussed a memorandum of understanding with NASA for the first Canadian-led science satellite since the *Alouette*-ISIS program in the late 1960s;
- launched the Aquatic Research Facility, the Commercial Float Zone Furnace, the Torso Rotation Experiment, the Atlantic Canada Thin-film Organic Semiconductors and NANO-GAS on the NASA shuttle;
- participated in the Japanese Very Long Baseline Interferometry Space Observatory mission, providing recording, playback and correlation equipment; and
- supported the Microgravity Isolation Mount on the Russian *Priroda* module and launched the Queen's University crystallization/liquid diffusion furnace.

## *FIGURE 9 : Financial Performance, Space Science*

## 1996–97 Comparison of Main Estimates to Actuals

| ($000)<br>(shaded lines show Actuals) | Operating [1] | Capital [1] | Grants and Contributions | Gross Expenditures | Less: Revenues Credited to the Vote | Total |
|---|---|---|---|---|---|---|
| **Service Lines** | | | | | | |
| Solar Terrestrial Relations | 659 | 7,181 | | 7,840 | | 7,840 |
| | 3 | 6,796 | 25 | 6,824 | | 6,824 |
| Atmospheric Chemistry and Physics | 566 | 6,077 | | 6,643 | | 6,643 |
| | | 11,093 | 25 | 11,118 | | 11,118 |
| Astronomy | 252 | 7,100 | | 7,352 | | 7,352 |
| | | 8,407 | 25 | 8,432 | | 8,432 |
| Space Life Sciences | 395 | 2,250 | 150 | 2,795 | | 2,795 |
| | | 2,969 | 25 | 2,994 | | 2,994 |
| Microgravity Science | 907 | 5,300 | | 6,207 | | 6,207 |
| | 2,141 | 6,261 | 25 | 8,427 | | 8,427 |
| Scientific Satellite Program | 247 | 1,741 | | 1,988 | | 1,988 |
| | | 159 | 25 | 184 | | 184 |
| David Florida Laboratory | 426 | 213 | | 639 | | 639 |
| | | | | | | |
| **Total Estimates** | **3,452** | **29,862** | **150** | **33,464** | | **33,464** |
| **Total Actuals** | **2,144** | **35,685** | **150** | **37,979** | | **37,979** |

(1) Includes contributions to employee benefit plans.

(2) Actual expenditures in 1996-97 were $ 4.5 million more than originally planned in the Main Estimates. The most significant factors in this difference are:

- PWGSC negotiated a new price/rate structure with a contractor of the Agency, which resulted in a significant cost increase to two contracts held with CSA/Space Science. This resulted in a significant price increase in 1996-97;
- the payment issued for the ESA joint project with Sweden (ODIN) increased the Agency's contribution on launch costs. This project will enable Canada to participate in the development, manufacturing and launch of a scientific satellite for studies of astronomical objects and of chemical processes in the atmosphere of the Earth including the distribution and transport of ozone and ozone depleting chemicals.

## Space Technology

### *Objectives*

- To ensure that Canada remains at the forefront of space technology development in preparation for Canada's future space programs
- To enhance Canadian industry's international competitiveness through technology transfer and diffusion

### *Strategies*

The Space Technology business line provides the resources and the technical expertise needed to introduce new technologies to Canadian industrial products and services.

The following strategies are designed to ensure continued success in the Space Technology business line:

- continuing to focus technology development on long-term needs and selected market niches,
- developing partnership arrangements to leverage funding,
- developing a systematic approach for transferring space technologies to non-space applications,
- increasing the participation of small and medium-sized enterprises in the Space Technology program,
- closely coordinating the R&D activities sponsored through European Space Agency participation with those performed in house and contracted out, and
- managing Canada's participation in the European Space Agency's contracting programs and those of others so as to maximize the long-term export of Canadian products and services.

### *Results Expectations and Performance Measures*

- Economic benefits (e.g., employment, regionally distributed industrial activity) of investments in space technologies
- Enhanced Canadian R&D and industrial capability through the development of application-oriented technologies
- Improved technical capabilities and revenues throughout the Canadian high-tech industry
- The adoption, adaptation, development, diffusion and direction of technology in Canadian industry
- Greater Canadian awareness of space S&T and applications for industry and society
- Research opportunities for students in space S&T
- Improved skill sets for industry
- Operation of the David Florida Laboratory as a world-class facility for assembling and testing space-based hardware.

The intended effects of the Space Technology business line are applied research results, a competitive space industry, non-space spin-offs, and highly qualified personnel in the space industry.

The main outputs of the Space Technologies business line are the technologies required for Canada's space program.

The performance indicators of the Space Technologies business line are:

- scientific productivity measured by the number of inventions, technical papers, and workshops,
- the performance of the space industry measured by exports,
- the satisfaction of the Space Technology Program's clientele,
- the degree of co-funding and partnership with other industrial and departmental stakeholders,
- the number and funding level of projects for small and medium-sized enterprises, and
- the industrial return from the European Space Agency program.

The main benefits that flow from investments in space technology development fall into the following categories:

*Interested individuals and businesses can find out more about the CSA on our web site:* ***www.space.gc.ca.***

- direct support to application-oriented missions, with resulting benefits to the scientific, technical or industrial users;
- industrial benefits to the participating Canadian space companies that are given the opportunity to supply components, systems and services to meet Canadian space needs and capture export sales;
- improved technical capabilities and revenues throughout the Canadian high-technology industry;
- industrial benefits through diffusion of space S&T to non-space applications;
- international alliances established as a result of Canada's participation in the European Space Agency's programs and the International Cooperation Program, resulting in greater export opportunities; and
- research opportunities for students interested in space S&T.

### *Performance*

In 1996-97, the Space Technology business line awarded 43 contracts worth $4.5 million covering all priority sectors of the Canadian Space Program, which included $2.0 million in contributions from industry and research institutions. One-third of the funding was obtained by small and medium-sized enterprises. In addition, nine projects were awarded to Canadian universities under the CSA-National Sciences and Engineering Research Council's Research Partnership Program in which 33 per cent of cash contributions are furnished by industry and of which 50 per cent is for student stipends.

ESA awarded 29 contracts totalling $13 million to companies across Canada. These were for the priority areas of the Long-term Space Plan II: Satellite communications and Earth observation.

The Commercialization Office, created to promote and track commercial exploitation of space technologies and operational space systems and to protect and manage the CSA's intellectual property, is now staffed and fully operational. To date, six new patent disclosures have been processed. Twelve exploitation licenses have successfully been negotiated.

In disseminating space technologies for terrestrial market opportunities, four business cases have been completed and three new projects initiated. A collaborative agreement was signed with the Alberta Research Council to merge the CSA's activities and regional programs with complementary objectives. Negotiations with other regional organizations and funding institutions have been initiated.

The number and diversity of industries reached and the significant level of project co-funding indicate that the Space Technology programs meet the Canadian high technology industry's needs. They also demonstrate that industry is confident of the merits of these projects and that its technical capabilities and ability to generate revenue will benefit accordingly. Space Technologies success stories have been written that document specific achievements.

*One-third of the funding awarded by Space Technology under the Canadian Space Station program was obtained by small and medium-sized enterprises.*

In addition, in 1996-97 the Space Technology program oversaw a variety of programmatic and technical achievements from its in-house and contracting-out activities exemplified by:

- establishing an Attitude Control System testing facility in St-Hubert to implement international collaboration (Sweden, *Odin*) and support Canadian industry collaborative activity in this area (Bristol, Dynacon),
- developing the Uncooled Bolometric Array to the commercialization stage, which will be undertaken by a company created solely for this purpose, INFRA,
- demonstrating space servicing free flyer technologies and haptic devices with a view to the CSA/NASA and the CSA/NASDA collaboration, and
- furthering the development of advanced technologies and concepts for future synthetic aperture radar missions by collaboration with the private sector.

## *FIGURE 10 : Financial Performance, Space Technology*

## 1996–97 Comparison of Main Estimates to Actuals

| ($000)<br>(shaded lines show Actuals) | Operating [1] | Capital [1] | Grants and Contributions | Gross Expenditures | Less: Revenues Credited to the Vote | Total |
|---|---|---|---|---|---|---|
| **Service Lines** | | | | | | |
| Generic Technology Development | 11,646 | 605 | 275 | 12,526 | | 12,526 |
| | 10,555 | 516 | 393 | 11,464 | | 11,464 |
| Strategic Technology Development | 1,200 | | 600 | 1,800 | | 1,800 |
| | 1,163 | | | 1,163 | | 1,163 |
| ESA Technology Development | | | 8,407 | 8,407 | | 8,407 |
| | | | 8,495 | 8,495 | | 8,495 |
| Diffusion and Commercial Operations of Space Technologies | | | 650 | 650 | | 650 |
| | | | | | | |
| David Florida Laboratory | 123 | 60 | | 183 | | 183 |
| | | | | | | |
| **Total Estimates** | **12,969** | **665** | **9,932** | **23,566** | | **23,566** |
| **Total Actuals** | **11,718** | **516** | **8,888** | **21,122** | | **21,122** |

(1) Includes contributions to employee benefit plans.
(2) Actual expenditures in 1996-97 were $ 2.4 million less than originally planned in the Main Estimates. A principal factor in this difference is the slippage in contract expenditures to 1997-98 owing to operational delays.

## Executive and Horizontal Coordination

### *Objectives*

- To provide strategic direction, management and administrative support services to the CSA
- To ensure the necessary cohesion of all Canadian Space Program activities

### *Strategies*

The Executive and Horizontal Coordination business line supports the Canadian Space Program decision-making process and — in consultation with space stakeholders both inside and outside the Federal Government — develops, implements, coordinates and monitors strategies and plans to ensure the efficient implementation of the overall Canadian Space Program (and the Space Policy Framework). This business line provides the Canadian Space Program with its strategic framework, assistance and support in the areas of international cooperation, federal-provincial relations, industrial policy, regional development, communications activities, and space awareness.

Specific strategies include:

- developing a vision for Canada's existing and future Space Program and setting up the organizational structure and processes to develop Long-term Space Plan III;
- developing proposals permitting Canada to manufacture the Special Purpose Dextrous Manipulator within approved funding;
- conducting an independent evaluation of Canada's participation in the programs of the European Space Agency;
- creating a business line management unit to coordinate the strategic direction of the CSA programs within the business lines, and to assess the performance of the business lines;
- maintaining the CSA's relationships with international organizations to enhance its position, as well as that of its stakeholders, and support the marketing activities of the Canadian space industry;
- developing recommendations on priorities, strategies and plans governing all aspects of international relations, including partnerships;
- gathering intelligence and undertaking assessments of the operating environment;
- forming partnerships with provincial governments for the exchange of industrial information, support of space-related research activities, promotion of Canadian space-industry products and services, implementation of jointly funded programs, and regional distribution;
- developing industry-related strategies and policies for R&D, including interdepartmental coordination, industrial partnerships, technology transfer and commercialization, sector road mapping, and priorization; and
- developing and implementing a strategic communications framework for the CSA.

| *Results Expectations and Performance Measures* |
|---|
| # Effective management of Long-term Space Plan II |
| # Greater awareness of and education on the importance of space |
| # Development of Long-term Space Plan III and vision |

The intended effects of the Executive and Horizontal Coordination business line are the development and application of space S&T to meet Canadian needs, an internationally competitive space industry, greater awareness of space S&T and applications for industry and society, research opportunities for students in space S&T, and the optimal delivery of the Canadian Space Program.

The main outputs of the Executive and Horizontal Coordination business line include the following:

- development of a long-term space vision for Canada,
- the establishment of the CSA's Space Plan Task Force, the formation of working groups staffed with experts representing all Canada's space communities and the formulation of a process to develop program proposals for the next Long-term Space Plan,
- government approval to manufacture the Special Purpose Dextrous Manipulator by Canada and adjustments to existing space programs,
- evaluation of the Canada/European Space Agency programs by an independent consulting firm,
- objectives and orientation for the management of the CSA's business,
- liaison with portfolio departments and central agencies, reports on federal government departments, the Ottawa environment and portfolio activities,
- objectives, policies, programmatic priorities and strategies for participating in and contributing to federal activities,
- a strategic program-level interface with stakeholders,
- reports on factors affecting space and business line and program areas,
- the analysis of national and international policies and activities and their interrelationship with space, the Canadian Space Program and the CSA,
- the building and management of foreign partnerships to support the implementation of the Canadian Space Program,
- support for the export development activities of the Canadian space industry,
- management of the CSA's political relationships with foreign agencies and partners,
- policies and strategies to build partnerships with industry and provinces in support of space R&D and technology development, applications, commercialization and transfer, and
- communications and awareness strategies to maximize the impact on the public's perception of space.

### *Performance*

In 1996–97, the major accomplishments of this component have been the following:

- submitted a proposal to realign the Canadian Space Program funding related to the International Space Station and the Satellite Communications and Earth Observation initiatives,
- worked with Industry Portfolio partners to develop a common evaluation performance/framework,
- consolidated industrial-cooperation activities with federal regional departments and signed memoranda of understanding with several partners,
- implemented a Corporate Communications Strategy and conducted a major awareness program across Canada, and
- carried out a major reorganization to reflect the CSA's new incarnation as an agency and give managers greater flexibility in managing the CSA's business.

## *FIGURE 11 : Financial Performance, Executive and Horizontal Coordination*

### 1996–97 Comparison of Main Estimates to Actuals

| ($000)<br>(shaded lines show Actuals) | Operating [1] | Capital [1] | Grants and Contributions | Gross Expenditures | Less: Revenues Credited to the Vote | Total |
|---|---|---|---|---|---|---|
| **Service Lines** | | | | | | |
| Executive Offices | 3,076 | 81 | | 3,157 | | 3,157 |
| | 3,618 | 316 | | 3,934 | | 3,934 |
| Policy and Planning | 1,706 | | 175 | 1,881 | | 1,881 |
| | 1,306 | | 378 | 1,684 | | 1,684 |
| Corporate Management | 1,953 | | | 1,953 | | 1,953 |
| | 4,413 | | | 4,413 | | 4,413 |
| Communications | 1,763 | | 460 | 2,223 | | 2,223 |
| | 2,762 | | 15 | 2,777 | | 2,777 |
| Audit, Evaluation and Review | 315 | | | 315 | | 315 |
| | 201 | | | 201 | | 201 |
| Human Resources | 1,588 | | | 1,588 | | 1,588 |
| | 1,261 | | | 1,261 | | 1,261 |
| Administration | 5,987 | | | 5,987 | | 5,987 |
| | 6,373 | | | 6,373 | | 6,373 |
| Legal Services | 261 | | | 261 | | 261 |
| | 234 | | | 234 | | 234 |
| David Florida Laboratory | 182 | 91 | | 273 | | 273 |
| | 1,556 | 790 | | 2,346 | | 2,346 |
| **Total Estimates** | **16,831** | **172** | **635** | **17,638** | | **17,638** |
| **Total Actuals** | **21,724** | **1,106** | **393** | **23,223** | | **23,223** |

(1) Includes contributions to employee benefit plans.

(2) Actual expenditures in 1996-97 were $ 5.6 million more than originally planned in the Main Estimates. The most significant factors in this difference are :

- the role of the Corporate Management Directorate was enlarged to include Secretariat services and systems, Business Management, Logistics, Coordination and Production functions;
- the transfer of the testing of the Mobile Servicing System (MSS) from a private sector contractor to the David Florida Laboratory.

# C. Key Reviews

### Evaluation of Canada's Participation in the Programs of the European Space Agency

The Government of Canada instructed the Canadian Space Agency in 1994 to conduct a study on the advantages and impacts of Canada/ESA programs prior to the expiry of the current Cooperation Agreement in December 1998. The final report presents the results of an in-depth evaluation of the benefits of the Canada/ESA Cooperation with respect to past and present performance against its economic, technological and political objectives. This evaluation is one of the important aspects to be considered by the government in the renewal of the Canada-ESA Cooperation Agreement in the context of the Long-term Space Plan III.

### Management Process Audit of the David Florida Laboratory

This study was a review of the management processes in the laboratory with a focus on mandate, organizational structure, planning and control processes, and client services. The study concluded that the David Florida Laboratory is well managed, with the necessary management processes in place. Opportunities were identified for the CSA to improve the accountability framework, and for the David Florida Laboratory to improve the documentation of its administrative practices and to clarify the reporting structure.

### Management Process Audit of the Space Science Program

This study was a review of the management processes in Space Science with a focus on mandate, organizational structure, planning and control processes, and client services. The study provided a favourable review of the management processes, in place and planned, with minor exceptions. An opportunity was identified to improve the exploitation of data produced by the Space Science Program and delivered to the Canadian scientific community.

# SECTION IV

# SUPPLEMENTARY INFORMATION

-

## A. Listing of Statutory and Agency Reports

1997-98 Estimates
Supplementary Estimates (B), 1996-97
1997-98 to 1999-00 Business Plan
Report on Youth

## B. Contacts for Further Information

**# Earth Observation**
Florian Guertin
Business Line Coordinator
514-926-4879

**# Canadian Astronaut Program**
Berthier Desjardins
Director General
Canadian Astronaut Office
514-926-4703

**# Space Technology**
Virendra K. Jha
Director General, Space Technology
514-926-4600

**# Satellite Communications**
Garry Lindberg
Chief Scientist/Engineer
514-926-4372

**# Canadian Space Station Program**
Alain Poirier
Director General, Space Systems
514-926-4461

**# Space Science**
Barry Wetter
Director General, Space Science
613-990-0799

**# Executive & Horizontal Coordination**
Jacques Bruneau
Director, Corporate Management
514-926-4407

***David Florida Laboratory***
Rolf Mamen
Director General
Space Operations
613-998-2873/514-926-6530

# C. Financial Summary Tables

## FIGURE 12 : Authorities for 1996-97

### *Financial Requirements by Authority*

| Vote | (thousands of dollars) | 1996-97 Main Estimates (1) | 1996-97 Actuals |
|---|---|---|---|
| | **Canadian Space Agency** | | |
| **40** | **Operating Expenditures** | **58,652.4** | **56,206.7** |
| **45** | **Capital Expenditures** | **159,304.6** | **158,747.9** |
| **50** | **Grants and Contributions** | **38,775.2** | **32,767.7** |
| **(S)** | **Contributions to Employee Benefit Plans** (2) | **3,290.0** | **3,290.0**(2) |
| **(S)** | **Spending of proceeds from the disposal of Surplus Crown Assets** | **18.1** | |
| | **Total Agency** | **260,040.3** | **251,012.3** |

**(1) Main Estimates plus Supplementary Estimates plus other authorities**
**(2) $ 121,000.00 authorized by the Receiver General of Canada in period 15.**

## FIGURE 13 : Revenues by Business Line ($000)

| | Actuals 1994–95 | Actuals 1995–96 | Planned 1996–97 | Actuals 1996–97 |
|---|---|---|---|---|
| **Revenue Credited to the Vote by Business Lines** | | | | |
| ***Earth Observation*** | | | | |
| Contributions from the provinces for RADARSAT I development | 1,116 | | | |
| Recovery from RADARSAT International for data processor* | | | 2,500 | 5,500 |
| Royalties | | | 6,100 | 566 |
| **Total Credited to the Vote** | **1,116** | | **8,600** | 6,066 |
| **Revenue Credited to the Consolidated Revenue Fund by Business Lines** | | | | |
| ***Earth Observation*** | | | | |
| DFL testing service fees | 393 | 452 | 87 | 311 |
| ***Satellite Communications*** | | | | |
| DFL testing service fees | 595 | 1,630 | 133 | 472 |
| ***Canadian Space Station Program*** | | | | |
| DFL testing service fees | 11 | 215 | 42 | 149 |
| ***Canadian Astronaut Program*** | | | | |
| DFL testing service fees | | 32 | | |
| ***Space Science*** | | | | |
| DFL testing service fees | | 32 | | |
| ***Space Technology*** | | | | |
| DFL testing service fees | 21 | 130 | | |
| ***Executive and Horizontal Coordination*** | | | | |
| DFL testing service fees | 43 | 338 | 117 | 418 |
| Rental fees | 6 | 18 | 12 | |
| Miscellaneous | 1 | 2 | | |
| **Total credited to CRF** | **1,070** | **2,849** | **391** | **1,350** |
| **Total Program Revenues** | **2,186** | **2,849** | **8,991** | **7,416** |

* The 1996–97 actual recovery from RSI for the data processor are $7.5 M.

## FIGURE 14 : Transfer Payments by Business Line ($000)

| | Actual 1993–94 | Actual 1994–95 | Actual 1995–96 | Total Planned 1996-97 | Actual 1996–97 |
|---|---|---|---|---|---|
| **Grants** | | | | | |
| Space Science | 0 | 300 | 150 | 150 | 150 |
| Space Technology | 0 | 178 | 317 | 875 | 393 |
| Executive and Horizontal Coordination | 145 | 152 | 271 | 365 | 219 |
| **Total Grants** | **145** | **630** | **738** | **1,390** | **762** |
| **Contributions** | | | | | |
| Earth Observation | 11,837 | 15,442 | 16,199 | 18,495 | 17,124 |
| Satellite Communications | 6,391 | 8,213 | 5,549 | 10,398 | 6,213 |
| Space Technology | 8,688 | 8,873 | 9,782 | 9,057 | 8,495 |
| Executive and Horizontal Coordination | 35 | 344 | 375 | 270 | 174 |
| **Total Contributions** | **26,951** | **32,872** | **31,905** | **38,200** | **32,006** |
| **Total Transfer Payments** | **27,096** | **33,502** | **32,643** | **39,590** | **32,768** |

### Revolving Fund Use of Financial Authorities

The Canadian Space Agency does not have revolving funds.

### List of Contingent Liabilities

As of March 31, 1996, Canadian Space Agency does not have Contingent liabilities.

### Legislation Administered

*Canadian Space Agency Act*(S.C. 1990, c. 13)

# D. Major Capital Projects

## FIGURE 15 : List of Capital Projects by Business Line ($ 000)

| | Previously Estimated Total Cost | Currently Estimated Total Cost | Forecast Expenditures to March 31, 1997 | Actuals 1996–97 | Future Years Requirements |
|---|---|---|---|---|---|
| **Business Lines** | | | | | |
| **A. Earth Observation** | | | | | |
| 1. RADARSAT I | 615,163 | 615,293 | 574,004 | 7,720 | 41,289 |
| 2. RADARSAT II | 16,163 | 16,070 | 12,956 | 5,849 | 3,114 |
| 3. EO Support Program | 87,064 | 83,304 | 17,482 | 299 | 65,822 |
| 4. Misc. capital projects | | | | 13,197 | |
| | | | | **27,065** | |
| **B. Satellite Communications** | | | | | |
| 1. Building refit / DFL | 7,111 | 7,111 | 3,111 | 892 | 4,000 |
| **C. Canadian Space Station Program** | 1,187,234 | 1,167,227 | 1,070,974 | 93,484 | 96,253 |
| **D. Space Science** | | | | | |
| 1. Space Science projects | | | | 35,685 | |
| **E. Space Technology** | | | | | |
| 1. Misc. capital projects | | | | | |
| 2. STEAR Program | | | | 516 | |
| **F. Executive and Horizontal Coordination** | | | | | |
| 1. Misc. capital projects | | | | 1,106 | |
| **Total Capital Expenditures** | | | | **158,748** | |

**FIGURE 16 : Explanation of Major Changes**
**Between Previously and Currently Estimate Total Costs ($ thousands)**

| | Previously Estimated Total Cost | Currently Estimated Total Cost | **Increase (Decrease)** | Explanation |
|---|---|---|---|---|
| **Business Lines** | | | | |
| A. Earth Observation | | | | |
| 3. Earth Observation Support Program | 87,064 | 83,304 | (3,760) | The Earth Observation Support Program has been de-scoped |
| C. Canadian Space Station Program | 1,187,234 | 1,167,227 | (20,007) | The STEAR program was transferred out of the major Crown project and is now in a different business line (Space Technology) |

## Description of Major Crown Projects

A project is considered a major Crown project when its estimated cost will exceed $100 million and Treasury Board would assess the project as being one with a high risk. In addition, Treasury Board may direct that projects with total projected costs of less than $100 million but with a current risk assessment of "high" be managed as Major Crown Projects. Finally, Treasury Board reserves the right to require any project exceeding the Minister's delegated project

Two of the projects in the CSA's capital program are Major Crown Projects: the Canadian Space Station and RADARSAT I. Reports on each are provided in the pages that follow.

## *The Canadian Space Station Program*

### *Overview*

On January 25, 1984, the President of the United States directed NASA to develop and place into orbit a permanently staffed space station. Friends and allies of the United States were invited to participate in its development and use, to share the benefits, and to promote peace, prosperity and freedom through this cooperative venture. In September 1988, Canada signed a formal agreement with the governments of the United States, member states of the European Space Agency, and Japan to participate in the International Space Station Program. Canada's contribution includes the design, construction, and operation of the Mobile Servicing System, plus responsibilities for the operations and use of the Space Station.

The Canadian Space Station Program received Effective Project Approval from Treasury Board in February, 1990. The program defines all the activities necessary to discharge Canada's obligations, up to and including completion of the on-orbit testing and commissioning of Mobile Servicing System.

***Socio-economic Objectives***

To improve the regional distribution of space-related government expenditures

To foster an environment conducive to the commercialization of technologies resulting from the program

### *Performance Objectives*

- To develop and provide the space and ground elements that constitute the Mobile Servicing System
- To develop the capability to assume operational responsibility for the elements supplied by Canada
- To facilitate the use of the Space Station by Canadian industry, government and universities
- To develop and apply strategic technologies of significance to the Mobile Servicing System, particularly in the field of automation and robotics
- To participate in the international management process established for the Space Station

***Lead and Participating Departments***

*Lead Authority*:
The Canadian Space Agency

*Service Department*:
Public Works and Government Services Canada

### *Cost Objective*

The total cost of the Canadian Space Station Program from 1990–91 to 1999–2000 is as follows:

| (millions of dollars) | Currently Estimated Total Cost | Forecast Expenditures to March 31, 1997 | Actual 1996–97 | Future Years' Requirements |
|---|---|---|---|---|
| | 1,369,113 | 1,058,974 | **94,685** | 310,139 |

### *Schedule Objective*

The schedule of the Canadian Space Station Program is designed to meet the agreed requirements for implementing the International Space Station Program. A summary of the Canadian phases follows:

| | ***Schedule*** | |
|---|---|---|
| | **Start** | **End** |
| Phase A — Preliminary studies | Oct 1984 | Aug 1985 |
| Phase B — Project definition | Jul 1985 | Jul 1987 |
| Phase C — Design and development | Jul 1987 | Apr 1993 |
| Phase D1 — Manufacturing and testing | Dec 1992 | March 2002 |
| Project evaluation | Jan 2000 | Jun 2000 |

| ***Equipment Element*** | ***Delivery*** | ***Launch*** |
|---|---|---|
| Space Station Remote Manipulator System | Oct 1997 | Jun 1999 |
| Mobile Base System | Mar 1998 | Mar 2000 |
| Special Purpose Dexterous Manipulator | Feb 2001 | Jan 2002 |

### *Major Milestones*

The following table outlines the international milestones driving the Canadian Space Station Program:

| ***Canadian Space Station*** | ***Date*** |
|---|---|
| Initiation of CSA's development and design phase | Jul 1987 |
| First MSS elements delivery to NASA | Aug 1998 |
| First Space Station elements launch | Jun 1998 |
| First MSS element launch (SSRMS) | Jun 1999 |
| Second MSS element launch (MBS) | Mar 2000 |
| Third MSS element launch (SPDM) | Jan 2002 |
| Permanently manned capability | Mar 2003 |

### *Achievements*

By the end of March 1998, the integration and tests of the Space Station Remote Manipulator System (flight model) will be complete, and the assembly, integration and ground-based tests of the Mobile Base System (MBS) will follow soon after. Acceptance reviews for both Remote Manipulator and Base System are planned activities for 1997. Integration and test activities are under way (fall of 1997), with all flight units integrated and undergoing testing. Activities to be carried out after the acceptance review on the Space Station Remote Manipulator System and the Mobile Base System, such as the system level end-to-end tests, have begun.

The preliminary design for the Canadian Space Vision System is complete, and in August 1997 the system flew on mission STS-85. The Mobile Operations Training Simulator is delivered and operational. The Multimedia Learning Centre and the Virtual Operations Training Environment are well under way.

Since 1984 the program has issued about 750 contracts ($919 million), with expenditures benefitting all regions of the country, accruing social economic benefits of $2.6 billion and creating 31,000 jobs.

In April 1997, the Prime Minister announced the decision to manufacture the Special Purpose Dextrous Manipulator under a firm fixed price contract. This project began in August 1997. The Intergovernmental Agreement\Memorandum of Understanding negotiations are being pursued to incorporate Russia as one of the international partners.

# RADARSAT I

### *Overview*

RADARSAT I is a Canadian-led project involving the United States, several of the provinces, and the private sector. This sophisticated remote-sensing satellite, carrying Synthetic Aperture Radar, was launched in November 1995 and will operate for about six years. It covers most of Canada every 72 hours, the Arctic every 24 hours. It can monitor and map renewable resources for the agricultural and forestry sectors. RADARSAT I can gather the data needed for more efficient resource management; ice, ocean and environmental monitoring, disaster management and Arctic and offshore surveillance.

***Lead and Participating Departments***

*Lead Authority*:
The Canadian Space Agency

*Service Department*:
Public Works & Government Services

*Third Party*:
Environment Canada

RADARSAT I also supports fishing, shipping, oil exploration, offshore drilling, and ocean research. The development and operation of this system are expected to provide more than $1 billion in benefits to the Canadian private and public sectors. In addition (and excluding a direct contribution of $27.0 million by the Province of Quebec to the primary contractor), a total of $93.4 million is expected in revenues to support the development and operations of RADARSAT I. This includes $53.0 million in royalties on worldwide sales of RADARSAT I data, $10.0 million from RADARSAT International Inc. for equipment, and $30.4 million from provincial governments for work related to satellite construction.

### *Major Milestones*

| Phase | Description | Date |
|---|---|---|
| A | Preliminary studies | Completed |
| B | Feasibility and concept definition | Completed |
| C1 | Systems requirement and preliminary design | Completed |
| C2 | Development and testing up to Qualification Test Review | Completed |
| D1 | Manufacture of the protoflight subsystems up to acceptance testing of the subsystems | Completed |
| D2 | Assembly and integration of the subsystems up to Flight Readiness Review, plus post-launch and commissioning activities up to System Acceptance | Completed |
| E | Operations | April 1996 to March 2001 |

### *Summary of Costs*

| ($000) | Currently Estimated Total Cost [1] | Forecast Expenditures to March 31 1997 | Actual [2] 1996–97 | Future Years' Requirements |
|---|---|---|---|---|
| RADARSAT I (1) | 615,293 | 574,004 | **14,084** | 41,289 |

(1) Estimated total cost does not include a direct contribution of $ 27.0 million by the Province of Quebec to the prime contractor.
(2) Actual expenditures in 1996-97 do not include $ 6 million in revenues credited to the vote

### *Achievements*

Effective Program Approval was obtained for RADARSAT I in March 1991. The Preliminary Design Review was held in July 1991, marking the end of the C1 phase. A contract for phase C2 to D1 was awarded to the primary contractor in July 1991, with an amendment to cover all the contractors' activities until completion of phase D2. In 1994–95, the manufacturing, assembly, integration and testing were done on all the major subsystems, and contracts were awarded for all the significant subsystems of the ground segment. During 1995–96, the spacecraft was assembled and tested and the full Space-Ground System was qualified. RADARSAT I was launched in November 1995 and began operations in April 1996. The system includes receiving stations for Synthetic Aperture Radar data located at Prince Albert, Saskatchewan, Gatineau, Quebec, and Fairbanks, Alaska. CSA and RADARSAT International Inc. signed agreements with network stations in Norway, the United Kingdom, Singapore, China and Japan for the direct reception of the RADARSAT data.

## E. Addendum on the David Florida Laboratory

The David Florida Laboratory is Canada's national facility for testing, assembling and integrating satellites and other space hardware. It is a critical component of the CSA infrastructure that supports the Agency's priorities in all business lines. Its cost is therefore spread among them. The laboratory also serves private sector firms in the development and qualification of their space products.

### *Objective*

**#** To provide an environmental test facility capable of meeting the current and emerging needs of Canada's space community and space-related objectives

### *Results Expectations and Performance Measures*

# An environmental test facility capable of meeting the current and emerging needs of Canada's space community

The intended effects of the maintenance and operation of the David Florida Laboratory include:

# contributions to industrial growth, development and competitiveness,
# high-technology employment,
# technological autonomy in the domain of space (communications and remote sensing),
# contributions to the Consolidated Revenue Fund, and
# national and international recognition of Canadian capabilities in space.

The main outputs of the David Florida Laboratory are:

# the maintenance and operation of a national facility for spacecraft assembly, integration and testing in support of the Canadian Space Program,
# timely and accurate testing of satellites and other space-based and ground-segment hardware,
# international marketing of its services for spacecraft assembly, integration and testing,
# the ongoing provision of world-class test facilities, and
# the acquisition and development of test technologies.

***Program Elements***

*The program elements through which the David Florida Laboratory achieves its objectives are:*

Environmental/Functional Testing

Infrastructure Support

Program Technical Support

Program Management

### *Performance*

During fiscal year 1996-97, the environmental test facilities of the David Florida Laboratory were fully occupied by several programs and projects. Highlights include:

# MSAT M1, the mobile communications satellite environmentally tested by the laboratory (thermal vacuum, vibration and radio frequency) was successfully launched on April 20, 1996 aboard an Ariane *IV* rocket from Kourou, French Guiana and subsequently placed into commercial service;

# significant progress was made on the environmental test program for the Mobile Servicing System (joints, motor modules, latching end effectors, flight support equipment and the Mobile Base System) part of Canada's contribution to the International Space Station Program;

# following the award of a contract by CTA Space Systems of McLean, Virginia to Spar Aerospace, the laboratory received and began environmental testing, at the subsystem level, of the INDOSTAR communications satellite. The INDOSTAR

Satellite Program calls for the delivery of a geosynchronous direct broadcast communications satellite to Indonesia;

- thermal vacuum, vibration, thermal, electromagnetic compatibility testing and mass properties measurements of the Earth Observation Satellite High Gain Antenna for Spar Aerospace;

- completion of a full environmental test campaign consisting of radio frequency, thermal and thermal/passive intermodulation measurement, thermal vacuum and vibration testing on a series of Skynet UHF helical antennas being built by the Atomic Energy Authority, UK for Marconi Space and Defence Systems. The contract for the test program was awarded to Spar Aerospace and all testing was completed at the David Florida Laboratory. The units have since been returned to the UK for integration onto the Skynet spacecraft;

- Radio frequency testing, Phase II, of the modified developmental synthetic aperture radar antenna (DDSAR - dual polarized/dual frequency) for RADARSAT II;

- as a Designated INMARSAT Representative and Authorized Antenna Test House, the laboratory performed radio frequency and thermal/passive intermodulation measurement testing on a number of INMARSAT aeronautical antennas for a variety of antenna manufacturers, both domestic and foreign. This reporting period also included upgrades to the data acquisition/measurement system to allow for INMARSAT Aero I antenna testing;

- supported the environmental testing of the Queen's University Experiment in Liquid Diffusion, the Measurement of Pollution in the Troposphere project, the Thermal Plasma Analyzer, the Neurolab Visual coordination facility, OSIRIS and BIOS II experiments for Space Science;

- performed thermal balance testing on a series of high conductivity panels for Space Technology;

- assisted in the environmental testing of the Space Debris Shield flown on the STS-80 space shuttle mission, for the Canadian Astronaut Office;

- made good progress on the construction activity related to the laboratory's midlife refit project, including completion of the Phase I mechanical and electrical modifications and implementation of energy conservation measures in the building;

- ongoing measurements related to the practical test phase of the European Space Agency's electrostatic discharge characterization R&D program (electrostatic discharge aspects of satellite design) with Matra Marconi Space, France. The long-term goal of this initiative is the development at the laboratory of an electrostatic discharge measurement capability for spacecraft;

- installed and commissioned a new extremely high frequency (EHF) anechoic chamber operating in the near field mode at the K (18-25 GHz) and Ka (26.5-40 GHz) frequency bands. The system was heavily used to support the testing of a series of Global Positioning System antennas for the Geodetic Survey of Natural Resources Canada;

- hosted approximately 625 registered visitors, representing both national and international delegations, thereby augmenting the international recognition of Canadian capabilities in space-based technology.

### *Distribution of David Florida Laboratory Costs*

| **Business Lines** | **1996–1997** |
|---|---|
| Earth Observation | 1,740 |
| Satellite Communications | 2,649 |
| Canadian Space Station Program [1] | 832 |
| Canadian Astronaut Program | 0 |
| Space Science | 0 |
| Space Technology | 0 |
| Executive and Horizontal Coordination | 2,346 |
| **Total DFL costs** | **7,567** |

(1) Canadian Space Station Program, or 1Space Robotics Development and Operations.1

### *FIGURE 18 : Financial Performance, David Florida Laboratory*

**1996-97 Comparison of Main Estimates to Actuals**

| ($ 000)<br>(shaded lines show Actuals) | **Operating** | **Capital [1]** | **Grants and Contributions** | **Gross Expenditures** | **Less: Revenues Credited to the Vote** | **Total** |
|---|---|---|---|---|---|---|
| **Program Elements** | | | | | 0.00 | |
| **Total Estimates** | **6,092** | **3,045** | | **9,137** | | **9,137** |
| **Total Actuals** | **5,019** | **2,548** | | **7,567** | | **7,567** |

(1) Includes contributions to employee benefit plans.

## E. Abbreviations and Acronyms

| | | |
|---|---|---|
| **A** | ACOA | Atlantic Canada Opportunities Agency |
| | ACTORS | Atlantic Canada Thin-film Organic Semiconductors |
| | AI&T | Assembly, integration and testing |
| | ARF | Aquatic Research Facility |
| | ARTES | Advance Research in the Telecommunications Systems Program |
| | ASTP | Advance Systems and Technology Program |
| | ASVS | Advanced Space Vision System |
| **C** | CCRS | Canada Centre for Remote Sensing |
| | CEONet | Canadian Earth Observation Net |
| | CFZF | Commercial Float Zone Furnace |
| | CNES | Centre national d'études spatiales (France) |
| | CPA | Cold Plasma Analyser |
| | CRC | Communications Research Centre |
| | CSA | Canadian Space Agency |
| | CSP | Canadian Space Program |
| | CSVS | Canadian Space Vision System |
| **D** | DA | Departmental approval |
| | DFL | David Florida Laboratory |
| | DND | Department of National Defence |
| | DUP | Data User Program |
| **E** | EMC | Elecromagnetic compatibility |
| | EOPP | Earth Observation Preparatory Program |
| | EPA | Effective program approval |
| | ERS-01/02 | European Remote Sensing |
| | ESA | European Space Agency |
| | ESD | Electrostatic discharge |
| **F** | **F**FORD-Q | Federal Office of Regional Development–Quebec |
| | BI | Federal Building Initiative |
| | FTE | Full-time equivalent |
| | FUSE | Far Ultraviolet Spectropscopic Explorer |
| **G** | GSTP | General Support Technology Program |
| **I** | IGA | Intergovernmental agreement |
| | IML-1 & 2 | International Microgravity Laboratories |
| **J** | JPL | Jet Propulsion Laboratory |
| **L** | LMS | Life and Microgravity Spacelab |
| | LTSP | Long-term Space Plan |

| | | |
|---|---|---|
| | MBS | Mobile Base System |
| | MCP | Major Crown project |
| | MIM | Microgravity Isolation Mount |
| | MMLC | Multimedia Learning Centre |
| | MOPITT | Measurement of pollution in the troposphere |
| **M** | MOTS | Mobile Operations Training Simulator |
| | MOU | Memorandum of understanding |
| | MRC | Medical Research Council of Canada |
| | MSAT | Mobile Satellite |
| | MSS | Mobile Servicing System |
| | MSTP | European Manned Space Program |
| | NASA | National Aeronautics and Space Administration (United States) |
| | NASDA | National Space Development Agency (Japan) |
| **N** | NRC | National Research Council of Canada |
| | NSERC | Natural Sciences and Engineering Research Council of Canada |
| | NOAA | National Oceanic & Atmospheric Administration (United States) |
| **O** | OPF | Operation Plan Framework |
| | OSIRIS | Optical Spectrograph and Infrared Imaging System |
| | PAS | Program Activity Structure |
| | PIM | Passive intermodulation measurement |
| | POEM/ENVISAT | Polar Orbit Earth Observation Mission |
| **P** | PPA | Preliminary project approval |
| | PRAB | Program Review Approval Board |
| | PSDE | Payload and Spacecraft Development and Experimentation |
| | PWGSC | Public Works and Government Services Canada |
| **Q** | QUELD | Queen's University Experiment on Liquid Diffusion |
| **R** | RF | radio frequency |
| | RSI | RADARSAT International Inc. |
| | SAR | Synthetic aperture radar |
| | SIFAC-95 | Space Industry Forum in Atlantic Canada |
| | SME | small- and medium-sized enterprise |
| | SMS | Suprathermal Ion Mass Spectrometer |
| | SOSC | Space Operations Support Centre |
| | SPDM | Special Purpose Dextrous Manipulator |
| **S** | SRMS | Space Remote Manipulator Simulator |
| | SSRMS | Space Station Remote Manipulator System |
| | STACI | Space Technology Atlantic Canada Initiative |
| | STEAR | Strategic Technologies for Automation and Robotics |
| | STS-77 & 78 | Space Transportation System |
| | SVS | Space Vision System |
| **T** | TMI | Telesat Mobile International |
| | TPA | Thermal Plasma Analyzer |
| | TRE | torso rotation experiment |

| | | |
|---|---|---|
| **U** | UARS | Upper-Atmospheric Research Satellite |
| **V** | VCF | Visual coordination facility |
| | VOTE | Virtual Operations Training Environment |
| | VSOP | Very Long Baseline Interferometry Space Observatory Project |
| **W** | WED | Western Economic Diversification |
| | WINDII | Wind Imaging Interferometer |