Evaluation of the Space Capacity Development Program of the Canadian Space Agency

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Prepared by the Audit and Evaluation Directorate
Canadian Space Agency

Acknowledgments

The contribution and collaboration of many individuals have made this evaluation possible. We wish to thank all of those who participated in interviews, provided information, and responded to inquiries.

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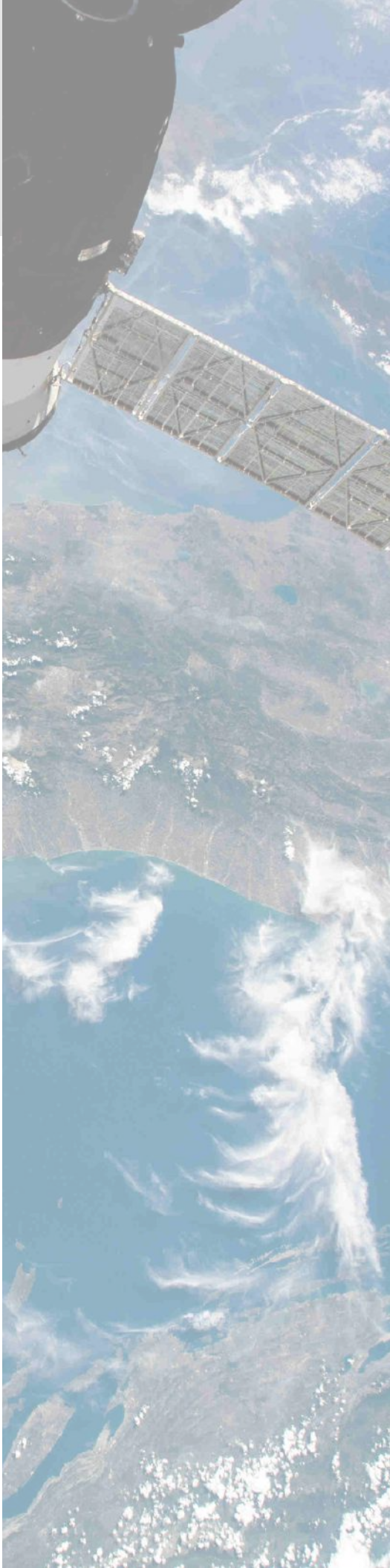
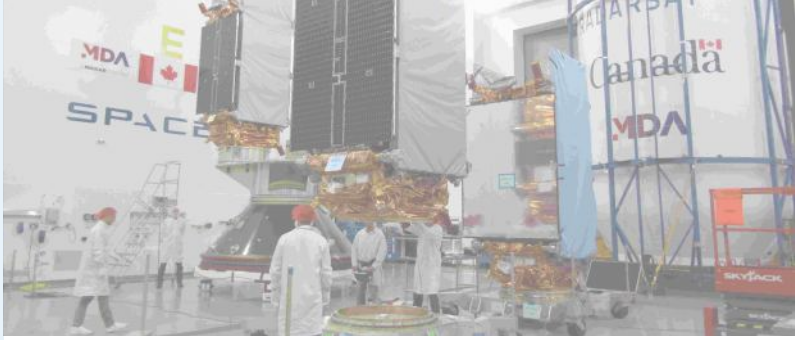


EXECUTIVE SUMMARY



This report presents the findings of the evaluation of the Space Capacity Development Program (hereafter referred to as the "SCDP") implemented by the Canadian Space Agency (CSA). This is the first evaluation of this program, and it was carried out by the CSA's Audit and Evaluation Directorate between September 2018 and March 2020, with the support of PRA Inc. This evaluation is included in the CSA's five-year Evaluation Plan and was conducted in accordance with the Treasury Board of Canada's *Policy on Results* (2016).

The SCDP came into effect on April 1, 2018. It supports activities ranging from pre-mission research and development to timely flight demonstrations, while developing the space workforce of tomorrow, in order to position the Canadian space sector to take advantage of global opportunities. The SCDP is intended to provide recipients with a comprehensive approach – from idea to space – by intervening along the innovation continuum. The program combines seven CSA initiatives (attached to three branches), each with their respective mandates and objectives, but which, taken collectively, allow for an integrated approach. These initiatives are as follows: Youth Learning; Science, Technology and Expertise Development in Academia (STEDiA); Space Technology Development (STD); Application Development; Canada-European Space Agency (ESA) Cooperation; Provision of Expertise and Facilities; and Capability Demonstration. SCDP expenditures total close to $80 million annually, which includes expenditures for all seven initiatives as well as program management costs.

The evaluation looked at the implementation of the SCDP since it came into effect in 2018–19, and more specifically at the implementation of the integrated approach proposed by the program. This evaluation is part of a constructive approach aimed at supporting SCDP officials in implementing the program, which continued throughout the evaluation process. This objective, as well as the scope of this evaluation, was made possible by the fact that the relevance, effectiveness and efficiency of each of the initiatives that make up the SCDP had already been evaluated, in whole or in part, over the past five years (CSA, 2014, 2016, 2017b, 2017c, 2018h). This evaluation is based on a variety of data-gathering methods: a comparative study, a literature and document review, 46 individual or group interviews, and 10 case studies.

Relevance

The SCDP components meet well-documented needs, particularly with respect to STEDiA, STD, ESA and Provision of Expertise and Facilities initiatives. However, at the time of the evaluation, the role the SCDP intends to play in capability demonstration (other than through its STRATOS initiative) and application development was still being defined. Also, the extent to which youth learning is an integral part of the process of developing space capabilities (from idea to space) was still to be clarified.

The interdependence between the various components of the SCDP justifies, in principle, greater integration within the program. This approach is also being adopted by other space agencies. However, the literature confirms that program or policy integration is inherently difficult and requires significant planning and implementation efforts. This is the challenge currently facing the SCDP.

Finally, the relevance of the SCDP must be considered with the role that other organizations (institutional, private and public) in the space capacity development ecosystem are called upon to play, whose contribution is essential to the achievement of the SCDP's expected results. **The CSA is called upon to play a coordinating role at the national level**, guided by a vision of what Canada wants to achieve in this area.

Implementation

Based on a constructive approach, this evaluation is intended to contribute to the decision-making process surrounding the definition of the integrated approach proposed by the SCDP and its implementation processes. The analysis of the **conditions for success in implementing the program** has made it possible to highlight the challenges related to the integration of the complementary initiatives that make up the SCDP and to identify avenues for improvement. The purpose of the evaluation was not to dictate to program managers the actions related to the implementation of the SCDP's integrated approach, but rather to provide a time for reflection on the approach undertaken and to propose courses of action that could serve as inspiration for program managers during the next stages of SCDP implementation. It will then be up to the program team to determine the desired level of integration and identify the actions to be taken to achieve it.

The grouping of the seven initiatives constitutes the very foundation of the program's conceptualization, which will be called upon at various stages of space capacity development. Collaboration between these initiatives, on the one hand, and with external partners, on the other, must become a reflex in order to create synergies and realize the added value of the SCDP. The initiatives' participation in the activities and projects supported by the program must be guided by the targeted results and anticipated benefits for the program's clients. As such, the case studies selected for this evaluation demonstrated the program's ability to promote collaboration among the various SCDP initiatives and contribute to the achievement of common outcomes for the development of space capabilities.

The changes brought about by the creation of the SCDP and its integrated approach to date are often imperceptible to recipients and external partners, since the program has not yet been widely publicized within the Canadian space sector. The latter remain accustomed to dealing with the program's flagship initiatives, such as STEDiA or STD. For their part, program representatives recognize the need for a concerted approach within the program. However, the evaluation revealed ambiguities surrounding the value proposition of the program. Clarification of the integration approach would help program officials and recipients to develop a common understanding of the nature and extent of the integrated approach proposed by the program, and the anticipated trajectory for achieving this approach.

The evaluation recommends that the CSA clarify the operational implementation of the Space Capacity Development Program's strategic vision and develop a Change Management Plan and a Communications Plan that take the program's directions into account.

PROGRAM DESCRIPTION

General Overview

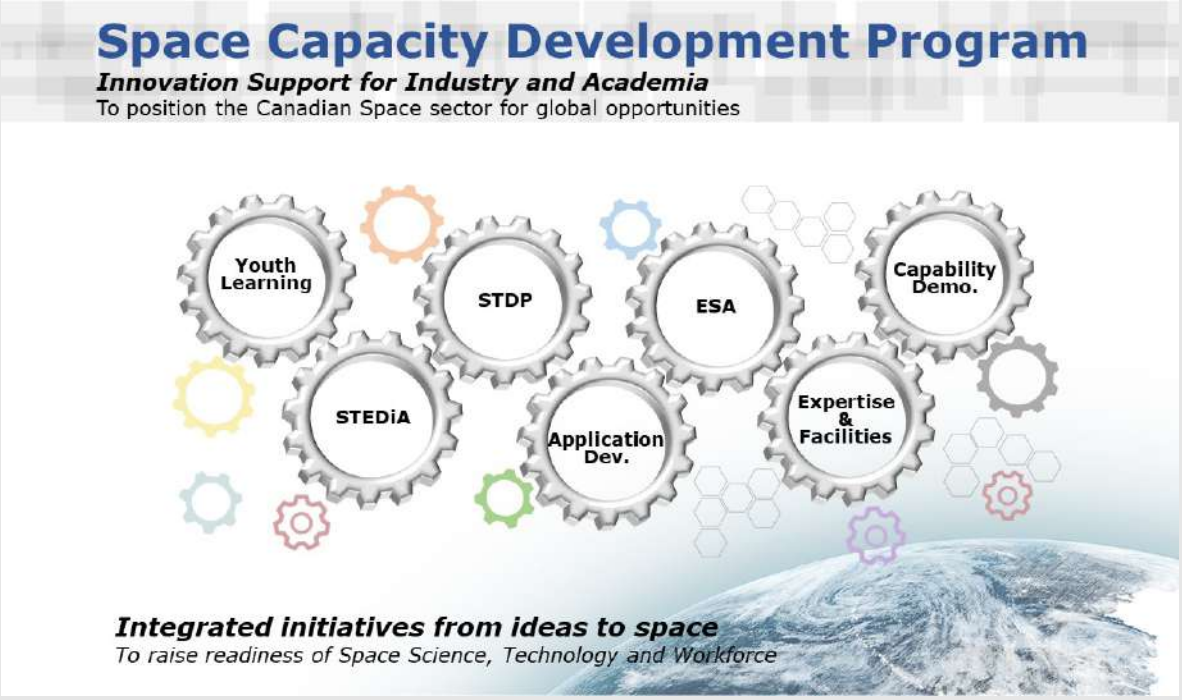
The Canadian Space Agency (CSA) consists of three programs (excluding internal services): Space Exploration, Space Utilization, and Space Capacity Development (CSA, 2019a). The Space Capacity Development Program (SCDP) came into effect on April 1, 2018.

The SCDP supports activities ranging from pre-mission research and development to timely flight demonstration, while developing the space workforce of tomorrow, with the aim of positioning the Canadian space sector to seize global opportunities. **The SCDP offers a comprehensive approach – from idea to space –** with activities aimed at increasing space and market readiness so that science and technology are ready for use on commercial and government space missions. It is also developing the space workforce of tomorrow by supporting the hands-on experience of post-secondary students and young professionals – that is, post-doctoral fellows or other professionals with less than five years of experience since graduation – while encouraging young people from kindergarten to high school to pursue careers in science, technology, engineering and mathematics (STEM) related fields.

The SCDP collaborates with industry and academia in three areas – science, technology and labour – and is implemented through a coordinated set of seven initiatives, affiliated with the Space Science and Technology and Space Utilization Branches, as well as the Communications and Public Affairs Directorate (CSA, 2018a). Each of these initiatives, or their respective activities, was already part of the CSA's service offering prior to the creation of the SCDP in 2018–19, while the majority of SCDP initiatives were sub-programs of the 1.3 Future Canadian Space Capacity Program (CSA, 2016a). Nevertheless, the program now offers a more integrated approach to the implementation of these initiatives and their activities, since each initiative is designed to work in a complementary manner at different stages of the innovation continuum. Thus, the SCDP combines seven initiatives, each of which has its own mandate and objectives, but which, taken collectively, allows for an integrated approach, from idea to space. The SCDP's preferred approach reflects the commitment of the federal government and the CSA to foster innovation and to report on results achieved for the benefit of Canadians.

It should be noted that throughout this report, the term "SCDP recipient" refers, unless otherwise indicated, to all groups targeted by the program, i.e., universities and colleges, space companies, and students (CSA, 2018a). SCDP recipients include both recipients of transfer payments (grants and contributions) and entities selected under contractual agreements.

SCDP Initiatives



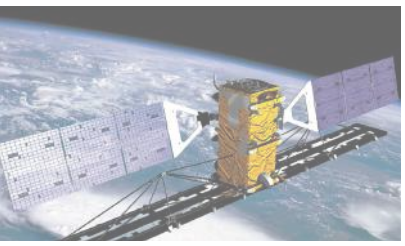
Youth Learning

This initiative aims to inspire and **encourage young Canadians** – from Kindergarten to High School – to pursue learning and careers in STEM-related fields, which are critical areas for an innovative economy. The initiative also aims to position the CSA as a partner for stakeholders (in industry, academia and not-for-profit organizations) working to promote youth engagement in STEM-related studies and careers. This initiative is the responsibility of the Communications and Public Affairs Directorate.

STEDiA

The Science, Technology and Expertise Development in **Academia** (STEDiA) initiative helps colleges and universities develop the space science, technology and expertise that will be needed for future commercial and government space missions. This initiative supports, mainly through grants, Canadian university and college research projects that provide hands-on experience in space-related missions to post-secondary students and young professionals. The program also supports student participation in conferences or training opportunities offered by other space agencies or international organizations. This initiative falls under the responsibility of the Space Science and Technology Branch.

Space Technology Development (STD)



The objectives pursued by this initiative are to **support innovation in order to foster the growth of the Canadian space sector** and reduce technological unknown for future space missions, while developing the expertise required for the future. The initiative provides support in the form of contracts and contribution agreements to entities (primarily the space industry) that are selected based on their ability to advance the development of specific space technologies. Contracts are issues to Canadian organizations for the development of technologies to meet the future needs of the Canadian Space Program, while contributions are issued to Canadian organizations to support the commercial potential of innovative technologies through the development of new products and services, processes and know-how. This initiative falls under the responsibility of the Space Science and Technology Branch.

Application Development

This initiative has the objective of **Canadian industry develop new applications and innovative services** using space data and information. The contribution agreements under this initiative provide financial support to help Canadian downstream industry have access to and take full advantage of space data and information to develop new applications or enhance existing applications and, as such, position themselves in the Canadian and global marketplace. This initiative falls under the responsibility of the Space Utilization Branch.

Canada-European Space Agency Cooperation

The main objective of this initiative is to facilitate access of the Canadian space industry to the **European and global market**. Under the Cooperation Agreement between Canada and the European Space Agency (ESA), Canadian organizations can bid on ESA contracts related to programs and activities in which Canada participates, thereby creating alliances with European industry and gaining access to space qualification or flight opportunities for their technologies and products. This initiative falls under the responsibility of the Space Science and Technology Branch.

Expertise and Facilities

Through the Provision of Expertise and Facilities initiative, the CSA provides specialized support to the space sector (industry, academia, and other government departments) through a **team of experts and state-of-the-art facilities and laboratories**, including the David Florida Laboratory. This initiative is the responsibility of the Space Science and Technology Branch.

Capability Demonstration

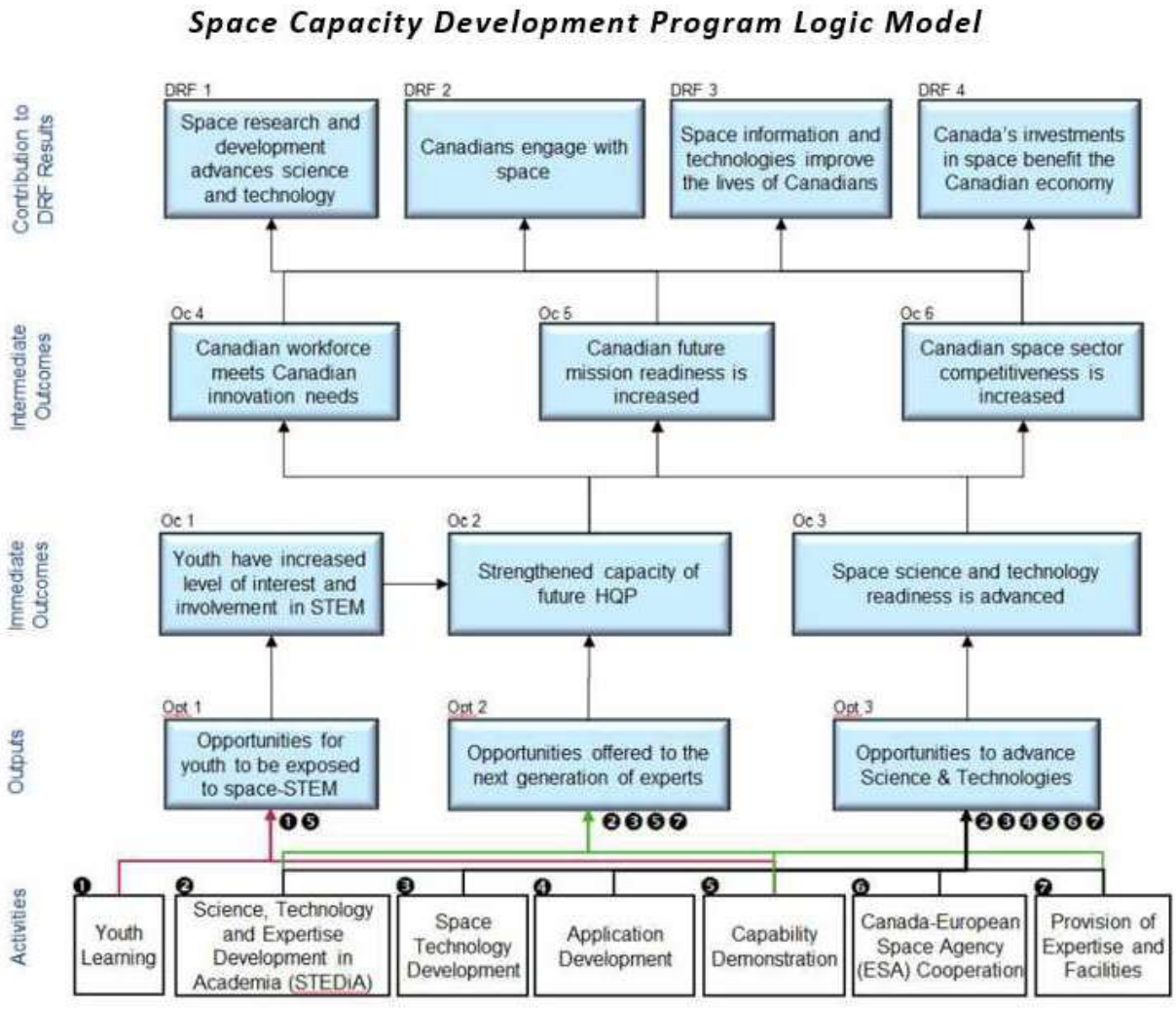
This initiative provides industry and academia with frequent and tailored opportunities to **test and fly new technologies**, scientific experiments and operational approaches on a variety of pre-space and space platforms in order to gain flight experience and develop the expertise needed to position the Canadian space sector on the international scene. The ability and opportunities to test or demonstrate these technologies, experiments and operational approaches in a timely manner are critical to the development of Canada's future space capacity, including innovative space-related science, technology and services. This initiative is the responsibility of the Space Science and Technology Branch.

Program Logic

As stated in its *Performance Information Profile* (CSA, 2018a), the design of the SCDP is based on the assumption that the development of space science and technology, the provision of space expertise and facilities, and the enhancement of STEM skills by the program's target populations will ultimately result in contributions to the three priority areas identified in the Government of Canada's Plan for Innovation and Skills (ISED, 2017): people, technologies and firms.

Ultimately, the SCDP aims to create the conditions necessary to contribute to long-term, sustainable economic growth, the generation of new ideas and innovation. The Canadian space sector is expected to generate significant revenues and growth for Canada's national economy through the development of a wide range of technologies, equipment and products. This involves transferring technology with industries as well as developing people with a focus on innovation and skills to stimulate successful industries and remain competitive in the global economy. In doing so, the SCDP contributes to the four outcomes of the CSA's *Departmental Results Framework* (DRF) (CSA, 2019a).

Logic Model

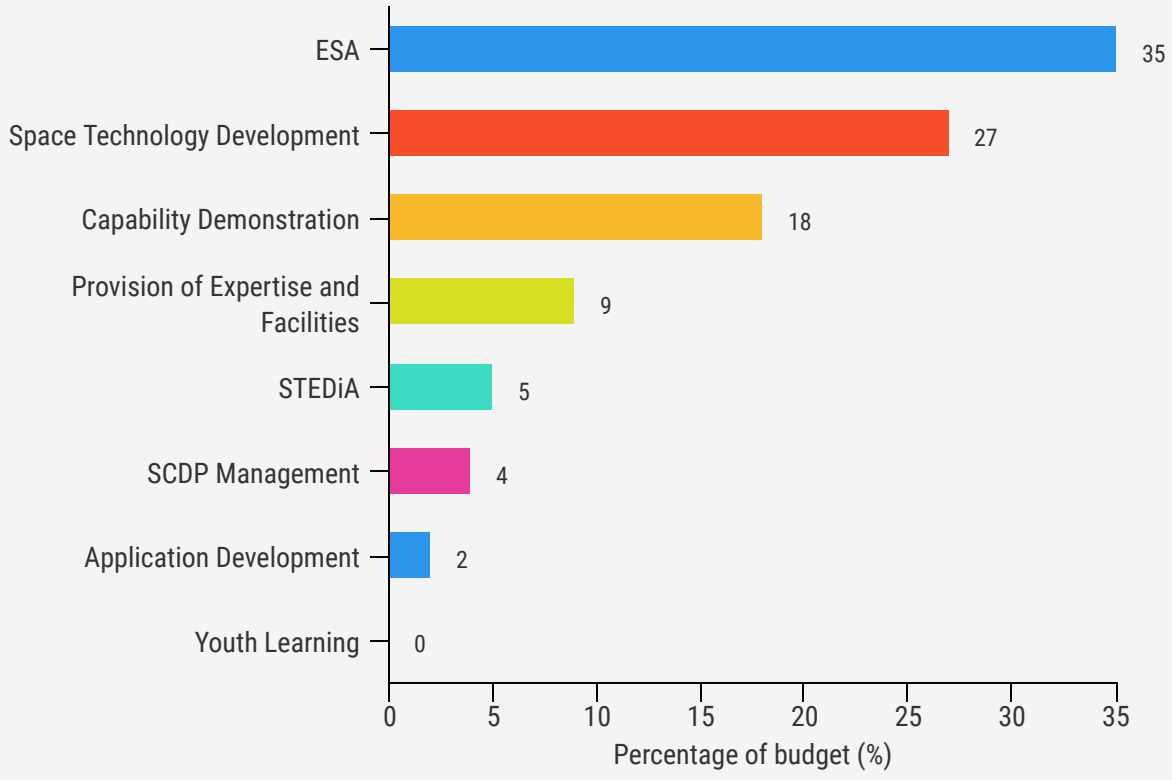


Program Resources

In 2019–20, expenditures for the SCDP are expected to total close to **$80 million**, which includes expenditures for the seven initiatives as well as program management costs. These expenditures also include funds paid out through contracts, grants and contributions to the main recipients, mainly in the Canadian space industry and the academic sector, in addition to funds from the *Canadian Space Agency's Contribution Program to the European Space Agency* (CSA, 2018h).

An increase in expenditures is expected in 2020–21 when the SCDP budget will reach nearly $97 million, mainly due to expenditures associated with the Quantum Encryption and Science Satellite (QEYSSat) demonstration mission and the *Lunar Exploration Acceleration Program* (CSA, 2020). More details on the SCDP financial information are presented in Appendix A of this report.

Percentage distribution of SCDP resources (2020–21)



EVALUATION APPROACH AND METHODS

This evaluation report fulfills the commitment to evaluate the SCDP, as set out in the *CSA Departmental Evaluation Plan 2018–19 to 2022–23* (CSA, 2019b). This evaluation was conducted in accordance with the Treasury Board of Canada Policy on Results (2016). The evaluation focused on the implementation of the SCDP since its inception in 2018–19, and more specifically on the implementation of the integrated approach proposed by the program. The implementation evaluation (also called a "formative" or "delivery" evaluation) focuses on the implementation of the program, its conceptual logic, its output generation and ways to improve its efficiency. Thus, unlike traditional evaluations conducted by the CSA, this evaluation does not focus on the results of recent years, but specifically on the implementation of the integrated approach proposed by the SCDP.

This purpose, as well as the scope of this evaluation, was made possible by the fact that the relevance, effectiveness and efficiency of each of the initiatives that make up the SCDP had already been evaluated, in whole or in part, over the past five years (CSA, 2014, 2016, 2017b, 2017c, 2018h).

The main limitation encountered in this evaluation concerns the recent implementation of the program, which began shortly before the time this evaluation was initiated. This evaluation is part of a constructive approach aimed at supporting SCDP officials in implementing the program, which continued throughout the evaluation process. The purpose of this evaluation is to inform decision-making by program representatives and CSA senior management with respect to program implementation and promotion of the program to its recipients and partners.

A description of the methods used in this evaluation is presented in Appendix B of the report.

RELEVANCE OF THE SCDP

The evaluation of the relevance of the SCDP covers both the activities within the SCDP and the more conceptual framework that some form of integration of these activities can lead to an enhanced level of effectiveness. The analysis also looks at the positioning of the SCDP within the broader framework of federal priorities.

Relevance of SCDP Initiatives

During the last program evaluation cycle, the CSA had the opportunity to explore and document the relevance, effectiveness and efficiency of the various initiatives that now make up the SCDP (CSA, 2014, 2016, 2017a, 2017b, 2018h). All the recommendations resulting from these evaluations have been considered in the framework of action plans.

Excerpts from Evaluation Reports on SCDP Initiatives

Youth Learning. Over the years, the need to promote STEM to young Canadians has been well documented and is a challenge that continues to face Canada and many other countries. The CSA has a unique focus to attract young Canadians to study in STEM-related fields. There are good reasons to continue these activities in order to reverse the declining interest and low level of commitment to STEM among young women (CSA, 2017b).

STEDiA. This initiative responds to the need for Canadian research institutions to engage in space research projects of a practical nature. The activities carried out under this initiative are a concrete means by which the CSA supports the acquisition of knowledge in space science and technology, including the development of highly qualified personnel in Canada (CSA, 2017b).

DTS. The development of new technologies is central to the CSA's ability to actively engage in space activities. The STD initiative remains the main tool to develop technologies for future space missions. It is also through this initiative that the Canadian space sector can access the type of support it needs to develop technologies that enhance its industrial capacity (CSA, 2016b).

Application Development. The Earth Observation Application Development Program (EOADP) – which provides financial support and access to images to Canadian private sector organizations – has demonstrated a good return on investment through the commercialization of several of the projects supported by EOADP. Nevertheless, the revision of the funding model for the entire CSA's Earth Observation Business Line could strengthen the commercial benefits of this sector (CSA, 2017c).

ESA. It is in Canada's best interest to maintain its long-standing participation in ESA programs and activities since the participation of the Canadian space sector in competitions for ESA contracts provides the opportunity to strengthen its capabilities in a variety of space technologies, which can also support the missions and activities undertaken by the CSA. This initiative also facilitates the participation of Canadian scientists in ESA missions and provides the CSA with privileged access to detailed information and insights on the evolution of European participation in space activities (CSA, 2018h).

Provision of Expertise and Facilities. Overall, this group provides valuable expertise to internal and external stakeholders and is a key asset for the CSA in developing highly qualified personnel and acquiring knowledge in space science and technology (CSA, 2017b). This group has also provided expertise on a range of issues related to intellectual property management, technology transfer and technology commercialization (CSA, 2016b). The David Florida Laboratory, which provides specialized activities and services focused on the assembly, integration and testing of space systems and equipment for the CSA and external clients in Canada and around the world, has also demonstrated its relevance in supporting the growth and self-sufficiency of the Canadian space program and the aerospace industry (CSA, 2014).

Capability Demonstration. Access to stratospheric balloons in Canada through the CSA's STRATOS program is a well-suited tool to support the acquisition of knowledge in space science and technology and the training of highly qualified personnel. The relevance of stratospheric balloon activities is also demonstrated by the fact that it is a rather flexible, accessible and effective means of demonstration (CSA, 2017b).

This evaluation has confirmed that while each of these components remains relevant, there are also emerging needs that are also of concern to the SCDP.

Thus, the **STEDiA, STD, ESA and Provision of Expertise and Facilities** initiatives considered pillars of the SCDP that have a well-established history and continue to meet well-documented needs.

As for the SCDP activities related to the **demonstration of capabilities**, they were, prior to the SCDP, largely focused on the STRATOS program, offering the possibility of using stratospheric balloons for research and development purposes (CSA, 2018g). The CSA rover fleet is also used for demonstration activities, such as in the LEAD project, which is the subject of a case study in this evaluation. Other platforms are also made available to SCDP recipients in partnership with other federal departments or space agencies, such as aircraft or sounding rockets. That being said, this evaluation indicates that a number of needs persist in the area of space capability demonstration, particularly in terms of access to laboratories or institutions suitable for research, various suborbital and orbital platforms, and opportunities for demonstration and validation on the International Space Station. In the past, the CSA has supported demonstration missions, the most recent being the QEYSSat mission. However, the case studies in this evaluation showed that other technologies could also benefit from orbital testing.

These demonstration needs involve both academia and the space industry, including the emergence of small companies – marked by the New Space movement – that wish to position themselves in the market related to space activities and their terrestrial applications.

Moreover, according to several key informants, it is expected that the Capability Demonstration initiative will expand opportunities for technology demonstration and maturation to increase, among other things, access to rovers, research aircraft, high-altitude aircraft, sounding rockets and access to the International Space Station and to Canadian and foreign demonstration satellites.

The **Application Development** initiative is a relatively new component of the SCDP, although this type of activity has been present in other CSA programs, especially in Space Utilization. Through its *SmartEarth* initiative, the CSA intends to expand opportunities for government, industry and academic sectors to develop applications that will maximize the use of space data (CSA, 2019f).

Support for commercialization is also a need that was raised during the evaluation and whose application is largely cross-cutting, since it ties in with several of the initiatives included in the SCDP. Moreover, this need is in line with the Government of Canada's intentions set out in its *Innovation and Skills Plan*, which aims to "bridge the gaps between science and commercialization, investment and business development" (ISDE, 2019, p. vi).

> **New Space**
>
> In the narrowest sense possible, New Space refers to the phenomenon of entrepreneurs taking initiatives aiming to disrupt and revolutionize the traditional space sector through the introduction of innovative technologies and solutions, in order to make space activities more affordable and profitable. A broader, more fitting understanding of New Space views these disruptive actions as taking place within an active, living ecosystem which is reacting to—and often, accommodating and even making possible—these disruptive activities. Governments, investors, start-ups, traditional space primes and others are all adapting their behaviours to thrive in the new environment and stay atop of the latest developments and innovations. (Euroconsult, 2017, p. 5)

With respect to activities aimed at increasing **youth awareness of space** and STEM-related disciplines, there is a broad consensus from the evaluation on their importance. In fact, this is an area of activity found in virtually all space agencies around the world. In addition, the Government of Canada has repeatedly reiterated its commitment to supporting the development of science and technology skills among youth, particularly in the space sector (ISDE, 2014, 2019a, 2019b). Instead, the question that was raised during the evaluation is whether this component should necessarily fall under the SCDP. This question is motivated in part by the fact that the CSA's Communications and Public Affairs Directorate undertakes a wide range of activities aimed at raising public awareness of the realities and opportunities associated with space, including many activities that specifically target youth, without these being specifically associated with the SCDP.

The Logic behind Integration

If individual SCDP initiatives are responding to documented needs, what about the need for further integration?

First, it should be noted that the concepts of program or policy coordination and integration remain, to date, difficult to define precisely. Some authors who have examined this issue note that integration requires both interdependence and coordination among the programs or policies that are being integrated (Tosun and Lang, 2017: 554). Moreover, the benefits that can be derived from integration should not be assumed, as they will require significant planning and implementation efforts (Peters, 2018, pp. 9-10). This is precisely what we have seen to date with the SCDP.

The evaluation confirms that there is a logic of interdependence between the various components of the SCDP, particularly in the context of an "idea-to-space" approach, with possible applications on Earth. However, and as noted earlier, the extent to which youth learning is reflected in this approach remains ambiguous. It should be noted, for example, that some space agencies, such as JAXA (Japan Aerospace Exploration Agency) or NASA (National Aeronautics and Space Administration), have undertaken efforts to integrate and adapt their technology development programs, but they do not include the awareness component for youth or the general public, which are under separate directorates. Various factors, including the level of human and financial resources, can influence these organizational decisions.

Finally, it should be noted that Canada has been participating in ESA programs since 1979 under the agreement signed to that effect and the related contribution program, whose activities are administered by the Space Science and Technology Branch. While none questioned the inclusion of the ESA initiative within the SCDP, some external stakeholders consulted as part of this evaluation pointed out that collaborations with other agencies, including NASA, are just as important for the development of new missions or technologies or for demonstration missions and should therefore be reflected, conceptually at least, within the SCDP.

Contribution to Federal Government Priorities

The SCDP is a CSA's pillar that supports the development of some of the **technologies required** for the CSA's various missions, contributes to the **positioning of Canadian industry** in the space sector, and supports research in the development of advanced technologies and **space-related science**. As such, space exploration or space-use missions undertaken by the CSA or in which it collaborates or participates require support from the SCDP. In this sense, SCDP activities are a priority for the CSA and contribute to supporting federal government priorities as several departments use data and products from these missions to achieve their own departmental outcomes (CSA, 2016b; 2017c).

The program also reflects the federal government's priorities in the development of **highly qualified personnel** and the expansion of **economic opportunities** related to advanced technologies. The latter have been among the federal government's priorities, particularly since the announcement of the *Innovation and Skills Plan* (Budget 2017) and subsequent investments.

In fact, the SCDP's desire to bring together components of the CSA's service offering focused on the development of science and technology and the development of a skilled space workforce is in line with the logic proposed by the Government of Canada's ***Innovation and Skills Plan***. Like the SCDP, this Plan "proposes an integrated, government-wide approach to support companies at all stages of their growth. Through the work of all levels of government...it supports Canadian businesses along the innovation continuum" (SEI, 2019, pp. 18, 48). Several respondents – both internal and external – interviewed for this evaluation called for strengthened interdepartmental collaborations.

In addition, the **new *Space Strategy for Canada*** unveiled in March 2019 confirms the importance that the federal government places on space, including the promotion of STEM-related fields among Canadian youth, economic growth related to advanced technologies and their terrestrial applications.

In particular, this strategy reinforces the Canadian government's commitment to invest in the space sector and confirms Canada's participation in the U.S.-led Lunar Gateway project with an investment of $2.05 billion over 24 years – including a contribution of $150 million over five years for the development of space technologies and science under the Lunar Exploration Acceleration Program (CSA, 2020). Following this announcement, the Prime Minister of Canada also announced the "launch of a Junior Astronaut Recruitment Initiative to inspire the next generation of astronauts and encourage young Canadians to pursue careers in science, technology, engineering and mathematics" (Government of Canada, 2019a).

Roles and Responsibilities

The CSA's **legislative mandate** includes the development of space capabilities, both technological and scientific. The activities undertaken through the SCDP reflect this mandate.

However, the **space capacity development ecosystem** in Canada includes many players, including academic institutions, industry, other federal departments, granting agencies (notably the Natural Sciences and Engineering Research Council of Canada and the Canada Foundation for Innovation) and other government agencies (for example, the Communications Research Centre Canada and the National Research Council Canada). In this context, the achievement of objectives related to the SCDP is largely dependent on the contribution of these other players.

The extent to which greater integration of the SCDP components will facilitate collaboration between the CSA and the other players in this ecosystem remains uncertain. Shared opinions were expressed in this regard during the consultations conducted as part of this evaluation. In general, however, **it is expected – in the opinion of both internal and external respondents consulted – that the CSA:**

- Implement the *Space Strategy* to guide space capacity development efforts in Canada;
- Assume a coordinating role in this area, including the responsibility to facilitate exchanges and collaborations between these various partners;
- Provide stable and long-term support to academia and industry whose activities are largely focused on space.

IMPLEMENTATION OF THE SCDP

This evaluation focuses on the implementation of the integrated approach proposed by the SCDP. As previously stated, this program brings together seven CSA initiatives involved in the development and demonstration of space science and technology and the development of tomorrow's space workforce. Each of these initiatives, or their respective activities, were already part of the CSA's service offering prior to the creation of the SCDP in 2018–19, while the majority of SCDP initiatives were sub-programs of the 1.3 Future Canadian Space Capacity Program (CSA, 2016a). The current program is based on the premise that by offering a range of collaborative services along the innovation continuum, the SCDP should maximize its contribution to the development of space capabilities – in short, that the whole is greater than the sum of its parts.

Previous evaluations of each of the initiatives that make up the SCDP have confirmed their relevance and ability to contribute to the development of space capabilities. This evaluation is part of a more constructive approach aimed at supporting SCDP officials in implementing the program. The purpose of this evaluation is thus to inform decision-making with respect to the continuation of the program's integration process and its promotion among recipients and partners. With this in mind, the evaluation highlighted seven conditions for the successful implementation of the program and its integrated approach. "According to Jaramillo and Marshall (2004), critical success factors are tasks or attributes that should receive priority attention by management because they drive performance" (Shehu and Akintoye, 2009).

The purpose of the next section of this evaluation is therefore to take stock of program implementation and, above all, to provide avenues for improvement with respect to each of the conditions for success identified in the figure to the left. The evaluation acknowledges the integration efforts already undertaken by program staff since the creation of the SCDP – even under the former *Program Alignment Architecture*, as shown in some case studies – and their commitment to a continuous improvement approach. **The application of a conceptual framework based on the conditions for success allows the evaluation to propose courses of action that program managers can use as inspiration for the next steps in implementing the SCDP.** It will then be up to the program team to determine the desired level of integration and identify the actions to be taken to achieve it.

Vision and Leadership

The *SCDP Management Framework* (CSA, 2018b) briefly describes the value proposition of the program and the benefits expected from the integration of the various initiatives that make up the program. This framework, which had not yet been formally approved at the time of the evaluation, provides an initial outline of the SCDP's vision. That said, **the evaluation highlighted the importance of further clarifying the program's ambitions.**

Based on the interviews, most CSA representatives understand the rationale behind the new approach proposed by the program and recognize a certain need for better coordination of SCDP initiatives. However, several representatives of the various program initiatives questioned the very meaning of the concept of integration, the expected scope of this integration in the context of the SCDP, and the program's strategic directions, i.e., the path to be followed to decompartmentalize the program and its initiatives. The operational vision of the SCDP and its integrated approach would thus benefit from being clarified. This fundamental and unifying element for the teams would make it possible to articulate in greater depth the program's value proposition (i.e., the added value of the integrated approach for the CSA and the program's recipients and partners) and its planned trajectory.

Senior Management Commitment

In addition, the transition to the SCDP's integrated approach represents a **major change in organizational culture.** Several internal and external respondents interviewed as part of the evaluation, including experts in organizational management and program managers with an approach similar to that of the SCDP, emphasized the importance of senior management commitment and support as a condition for success in defining and implementing the program's vision, as well as the optimal mobilization of the teams involved. While all employees undeniably have a role to play in integrating the various program initiatives and operationalizing the changes, it is up to senior management to take the lead in conceptualizing and promoting the program. The leadership provided by senior management of the program, and of the whole of CSA, is seen by these interviewees as essential to ensure the transition to the SCDP and the establishment of program priorities, as well as to facilitate teamwork.

Published annually for CSA employees, the Space Science and Technology Branch's Business Plan is a good opportunity to promote the SCDP vision and team spirit among Branch employees. The various case studies developed as part of this evaluation also illustrated past and present opportunities where senior management demonstrated its commitment to promoting collaboration among the various initiatives of the SCDP, even before the program was formally created. Projects such as LEAD or the CubeSats Project benefited from the outset from the program's senior management's desire to see several initiatives contribute to the achievement of common results for the development of space capabilities. That said, these projects are specific examples of collaboration. In order to promote an integrated approach, it is essential that senior management's commitment be reflected in all program activities and that it increase opportunities to demonstrate effective leadership to the various stakeholders (program representatives and CSA staff, partners and external recipients).

> “Fundamentally, leadership is about transforming people in an organization and leading them to higher performance as a result. […] Leadership is more then just meeting targets; it’s about articulating where you want to go and how you might have to change to get there. (M. Roberto. 2011. p. 7)

Communication and Visibility

The *Program Directory* (CSA, 2019a), establishing the current SCDP structure to replace the former *Program Alignment Architecture*, was formalized on April 1, 2018. The implementation of the program must therefore be accompanied by a considerable communication effort inherent in this new integrated approach proposed by the program.

Communication Strategy

Based on their experience in public administration or managing programs with a similar approach to the SCDP, all respondents to the Comparative Study emphasized the importance of developing and implementing a clear communication strategy to ensure that all stakeholders – internal and external – understand the rationale, nature and extent of the program integration process. Several program representatives questioned future changes and how their job responsibilities and the initiative to which they are attached will be affected by the transition to an integrated approach and the renewal of the program. These questions are a reminder of the **importance of communicating, on an ongoing basis, a clear vision of the program** and its objectives, structures and processes. The experts consulted also reminded us that it is preferable to communicate changes sufficiently in advance so as not to take work teams and program recipients by surprise.

Moreover, the public administration experts consulted are of the opinion that the communication strategy should include **consultation mechanisms** – both internal and external – whereas in the context of organizational change, stakeholder buy-in is often the result of a participatory approach. It is also recommended that the pool of stakeholders consulted be broadened to ensure a diversity of discourse and proposals for change.

> “How to foster links between different initiatives without overloading people with information; how to share the right information with the right people?
> (Senior Management Representative)

As such, the management framework setting out the foundations of the SCDP (CSA, 2018b) proposed the **creation of an advisory committee** made up of representatives of all program stakeholders, namely representatives of associations, academia, the space industry and other government departments. Established as part of the program's continuous improvement process, the purpose of this committee would be to provide strategic advice, guidance and recommendations on SCDP-related activities, as well as to discuss and assess opportunities for collaboration among organizations responsible for innovation support programs (CSA, 2018b; 2018c). The creation of this committee had not yet been approved at the time of writing this evaluation report. That said, the vast majority of SCDP initiatives have their own external consultation mechanisms to improve their activities or review their investments. The functioning of the existing committees and consultation mechanisms should be clarified as to how they would juxtapose or merge with the new SCDP Advisory Committee, without risking multiplying the channels of communication with external representatives.

The communication and information transfer strategies and practices deployed by each of the SCDP initiatives are also potentially to be strengthened in the context of an integrated program. At the time of the interviews, several representatives of the program's initiatives said they would like to have **more information on the other initiatives making up the program**, their mandates and priorities, and the schedule of upcoming activities, with a view to identifying possible collaborations. In addition, two of the SCDP initiatives come under the Space Utilization Branch and the Communications and Public Affairs Directorate.

Opportunities for dialogue between these two initiatives and those under the Space Science and Technology Branch should be maximized. The Space Science and Technology Branch also recently commissioned a report on innovation ecosystems in the context of SCDP implementation (Arche Innovation, 2019). This report reiterates the importance of communication among program teams and proposes several strategies, including the publication of a newsletter for program employees, the use of virtual collaboration tools, and the organization of working sessions between teams or lunch and learns sessions, as examples. That said, some communication mechanisms are currently being implemented, including the publication of the Space Science and Technology Branch Business Plan and biannual meetings with Branch employees. The evaluation therefore suggests that program managers confirm whether the information needs identified during the interviews have been met or, if so, the nature, scope and depth of the desired information and the preferred communication mechanisms.

Also, given the current context of the space industry – marked by a revival and the emergence of many small and medium-sized enterprises (SMEs) driven by the *New Space* movement – it is important to ensure that simple and popularized language is used to capture the attention of these new players in the space sector who are unfamiliar with government jargon.

Finally, with regard specifically to efforts to raise **awareness among young people and students**, it is interesting to note that several external respondents wanted the CSA to increase the visibility of a wide variety of professions in the space sector (including engineers, technicians, scientists, computer scientists and artificial intelligence specialists) to complement the promotion of astronauts. They also suggest addressing various themes of interest to young people, such as climate change, or maximizing the use of rovers as promotional tools for young people.

Visibility and Promotion

The visibility of the program was also the subject of much discussion during the interviews conducted for this evaluation. The SCDP was first presented to Canadian space sector stakeholders in May 2018 and again in June 2019 at conferences organized by the Canadian Aeronautics and Space Institute. According to some of its representatives, the CSA should maximize the visibility of the SCDP's flagship initiatives while its partners and recipients are used to dealing with STD, ESA, and STEDiA initiatives – particularly with its Space Science and Technology Flight and Ground Investigation component. Other respondents, on the other hand, questioned whether the program should promote an integrated platform by developing its own brand image. In all cases, several suggested **multiplying the platforms for promoting the program** and/or its initiatives in order to reach a broad audience (e.g., through the CSA Web site, social media, webinars, or the Innovation Canada portal).

Planning

Program activity planning was repeatedly emphasized as a condition for the successful SCDP implementation. The evaluation highlighted the need to intensify efforts to prioritize and plan program activities with a view to greater integration of SCDP initiatives. The purpose of this exercise is twofold: on the one hand, to plan the integration of initiatives under the same program, and on the other, to plan program activities and investments to ensure operational consistency among the initiatives concerned.

Implementation Plan for the Integrated Approach

As previously mentioned, each of the SCDP initiatives, or their respective activities, were already part of the CSA's service offering prior to the creation of the program, with several constituting sub-programs of the 1.3 Canada's Future Space Capabilities Program (CSA, 2016a). Nevertheless, **the promotion of a more integrated approach is initiating a paradigm shift in the management of these activities.** At the time of the interviews, several CSA interviewees highlighted uncertainties regarding the operationalization of the integrated approach and the changes to be expected for each of the initiatives. These uncertainties highlighted **the need for a detailed "game plan" to guide the implementation of this new integrated program and its timeline.** A *SCDP Management Framework* (CSA, 2018b) is currently being developed; however, there is little documentation of the interrelationships between the various initiatives, as well as the strategies and preferred actions for implementing the integrated SCDP approach and ensuring greater coordination and collaboration among the initiatives. Program officials should continue their efforts to clarify the program's new directions and plan the changes needed to achieve the program's vision and harmonize the practices and activities of the various initiatives that make up the program. For some program representatives, this downtime is crucial to properly plan for integration and a successful transition to the new program.

Program Activity and Investment Planning

The planning of program activities and investments was central to the interviews, both internally and externally. The *Space Strategy for Canada*, released in March 2019, was very well received by the stakeholders interviewed (ISDE, 2019b). Nevertheless, some respondents stressed the need for the CSA to establish a detailed, long-term implementation plan for the *Space Strategy* in order to be able to better guide the selection and implementation of SCDP activities and help program partners and recipients plan their own activities and investments.

For many respondents, the process of prioritizing and planning activities in the context of implementing the new SCDP will have to lead to decision-making; **in short, choices will have to be made.** One of the public administration experts interviewed for this evaluation warned program officials of the risk of dispersion inherent in adopting an integrated approach in the context of a program that will have to intervene in a wide range of activities, as is the case with the SCDP. It is important to clearly define needs and areas of intervention – based on past investments and their impact, as well as program and CSA objectives and expected results – in a limited budget context. Many recognized the sensitive nature of this type of exercise, but also the need to ensure greater predictability of interventions and operational consistency within the SCDP and with the CSA's other program sectors.

In addition, the evaluation identified opportunities for improvement with respect to program activity planning. Program governance is responsible for setting priorities and approving expenditures for the various SCDP initiatives. That said, some respondents called for the strengthening of investment planning and coordination mechanisms among initiatives in order to maximize the harmonization of collective interventions within the program and the program's potential impact on its target clienteles. **The transitional phase toward an integrated approach thus provides an opportunity to review and clarify the roles and responsibilities** assigned to the various initiatives under the program, and even those of the CSA's other program sectors. The SCDP aims to offer recipients a comprehensive approach – from idea to space – by intervening along the innovation continuum. Each initiative must therefore ensure that it enters the scene and mobilizes its resources at the most opportune time for its recipients.

The case studies also highlighted the challenges associated with planning the program's activities. Projects have received funding from the SCDP (or the sub-programs of the former *Program Alignment Architecture* that now make up the SCDP) on various occasions in past years, in addition to using program support during demonstration or simulation exercises. That said, some of these projects are awaiting a CSA decision on their ability to integrate a demonstration orbital mission, after having been tested in a quasi-space environment under the STRATOS program. Some CSA officials have called for a tightening of the CSA's project and mission prioritization, planning and selection exercises in order to increase value for money. To that end, they propose, among other things, that a roadmap covering all SCDP activities be developed to better orchestrate the program's activities according to departmental priorities and complement the roadmaps of the CSA's other program sectors.

> "How far do we want to go with integration?" asked one respondent. "How should we work together? People are used to working in a certain way and until they see benefits to change, that's the status quo," said another program representative.

Structures and Resources

The analysis of the conditions for success in implementing the SCDP's integrated approach focused on the program's structure and the allocation of its resources. The evaluation highlighted the need, expressed by certain respondents, to rethink the program's structure and the allocation of its resources in order to achieve efficiency gains and maximize the program's interventions on the space innovation and capability development continuum.

Organizational Model

The coming into force of the *Policy on Results* (TBS, 2016) led the CSA to review its programmatic structure. With the exception of Space Science and Technology employees assigned in a matrix format to projects conducted by the Space Utilization and Space Exploration Branches, the former *Program Alignment Architecture* (CSA, 2016a) mirrored the organizational structure, while the administration of each program was the responsibility of a single Branch. The current – results-based – model provides an innovative conceptual lens. That said, **the discrepancy between the SCDP's organizational structure and its programmatic structure** raised questions with several CSA representatives. The grouping of seven initiatives – attached to two branches and one directorate – is the very foundation of the program's conceptualization, which is called upon to intervene at various stages of space capacity development. Nevertheless, employees, who are used to working on one initiative, find it difficult to see how they can maximize collaboration with their colleagues in their own directorate, but also with teams from two other branches, in a coordinated and concerted manner, without risking compromising value-for-money efforts.

> "The reflex of distinguishing who is responsible for an activity at the organizational level and to which program that activity contributes is sometimes difficult to have. This is new and we still don't have all the structures or mechanisms to look at programs through this lens. (Senior Management Representative)

Furthermore, this dissonance between the organizational and programmatic structure could have an impact on the sense of ownership of the program, anticipates a senior management representative.This complexity of the SCDP's organizational model leads some program representatives to suggest that it might be desirable to consider a different grouping of SCDP initiatives. In the course of this evaluation, some questioned the possibility of redesigning the program's organizational structure while retaining the seven initiatives. Others, however, raised the possibility of taking the logic of integration even further by implementing a model in which certain initiatives would be consolidated or merged. No consensus was reached on this issue following the key informant interviews.

SCDP Governance

The **complexity of the program's governance structure** was also questioned during the interviews. While some initiatives already have their own steering committee, the program is considering doing the same for all initiatives. This multiplication of steering committees would make it difficult to share information among the work teams, thus replicating the old program structure in isolation. Conversely, several noted the absence of a steering committee for the SCDP itself. The *SCDP Management Framework* (CSA, 2018b) currently being developed proposes the establishment of a committee to oversee the steering committees for the various initiatives, but this had not yet been implemented at the time of the evaluation. In addition, the identification of expected results common to all initiatives, through the *Performance Information Profile*, has certainly represented a significant step forward in results-based decision-making.

That said, the transition that has begun towards greater integration of the initiatives is expected to materialize even more strongly in the program's governance structure. The establishment of an integrated structure could have the effect of optimizing operational coherence, generating more synergies between initiatives, increasing information sharing, and strengthening the sense of ownership of the program.

Resource Allocation

In addition, the organization and allocation of human, material and financial resources present many challenges for the SCDP implementation. The current structure for allocating resources among the various initiatives that make up the SCDP is considered too rigid by some CSA representatives. They would like to see the ratio of program investments devoted to the various components of the innovation continuum – that is, activities that promote youth learning, science and technology and application development, demonstration activities, consulting services and access to laboratories, and commercialization support – be more flexible in terms of the program's priorities and strategic directions, as well as the status of ongoing projects and activities. **This change in practice, and this increased flexibility in the way the program's budget envelope is administered, would better reflect the integrated approach proposed by the program** while encouraging collaboration among the various initiatives and their concerted effort to develop space capabilities. In addition, a few respondents, including funding recipients, questioned the splitting of support, financial or in-kind, provided to certain technology development projects or activities. This project splitting – and the uncertainty it creates – increases the risk for companies and researchers of losing highly qualified personnel and a loss of efficiency in their technology development activities. As well, it becomes more difficult to track funding for technology development when it is fragmented over time and across program initiatives.

In addition, **collaboration takes time**, as several respondents noted. The workload of team members currently leaves them with little flexibility to develop collaborations across initiatives and, if necessary, with external partners, or at least to ensure that they bridge the different stages of a comprehensive "idea-to-space" approach to space capacity development. Yet, employee involvement is at the very heart of the transitional phase initiated by the program and must help to ensure the sustainability of organizational changes.

Concerns were also raised about the ability of some teams to complete their activities due to a lack of human resources. **The risk lies in the low number of staff available by area of expertise in a timely manner to complete projects.** This non-redundancy in human resources planning could weaken their ability to support projects. To date, the teams have managed to keep pace, but the risk remains. In addition, the case studies revealed certain issues with respect to the availability of equipment – particularly the rover fleet – thus highlighting the importance of clarifying the priority level of recipients using this equipment, in the context of close involvement of the initiatives in joint projects. Complementarity between SCDP initiatives, promoted as part of an integrated approach, could be limited because of the risks posed by potential equipment breakdowns, in addition to the workload of the teams responsible for this equipment, which are often called upon by several projects simultaneously.

Some challenges were also raised during the interviews – both internal and external – as to the practices, processes and terms and conditions for funding program activities. The delicate issue of the **role of experts** in monitoring and supporting funded projects proved to be at the heart of the program representatives' concerns. Assuming that by offering a concerted range of services along the innovation continuum, the SCDP should maximize its contribution to the development of space capabilities.

This integrated approach calls for the participation of the various initiatives in carrying out projects funded by the SCDP. However, this collaborative model – which is expected to grow in the context of an integrated program – raises complex issues, particularly with regard to the **distribution of the roles and responsibilities of the various internal and external teams** involved in carrying out projects in order to guarantee the independence of the various stakeholders. The recent *Guide to Departmental Collaboration with Grant and Contribution Recipients* (TBS, 2019) states that "if only one department funds and collaborates on a project, a clear separation is required between the unit that administers the funding agreement and the unit that collaborates on the project.

The Canadian CubeSat Project, which is the result of close collaboration between the STEDiA, Capability Demonstration and Provision of Expertise and Facilities initiatives (see box), has faced challenges of this nature. How, for example, can the involvement of CSA experts be maximized without them interfering in the development of technologies – that is, CubeSats – whose design is the responsibility of funding recipients? One of the strategies identified by respondents was to ensure that the information provided by CSA experts, at the request of a team, was shared with all 15 participating university teams. Also, this technical or scientific information is likely to guide the teams in the design of their CubeSat but cannot dictate the use of a method or process, in order to preserve the independence of funding recipients. This example illustrates how those responsible for SCDP initiatives have succeeded in adapting their practices while maximizing the support offered to funding recipients.

A similar issue was raised regarding the loan of equipment and the use of some of the CSA-owned laboratories and workshops by external clients. A few respondents called for clarification of the guidelines and selection criteria for equipment loans and the use of these laboratories and workshops, which would result in operational efficiency gains for employees responsible for analyzing applications.

Finally, **multi-year approval of projects or recurring activities** was also proposed by a few respondents, which would lead to efficiency gains. Also, external respondents reiterated, as a good practice, the importance of simplifying funding applications and increasing the predictability of funding offer notices. This last point was raised during consultations recently conducted by the Application Development Initiative, as well as in the evaluations of the Space Expertise and Proficiency Program (which included the STEDiA Initiative; CSA, 2017b) and the Class Grant and Contribution Program (CSA, 2017a).

The Canadian **CubeSat** Project is a competition organized by the CSA that offers professors and students from Canadian post-secondary institutions the opportunity to design and build their own miniature satellite, known as CubeSat. This initiative supports 15 Canadian teams in each of the 13 provinces and territories. This initiative, launched in 2017, is the result of close collaboration between three SCDP initiatives:

- The STEDiA initiative is responsible for the administration of funding agreements with Canadian universities;
- The Capability Demonstration initiative oversees projects, ensures that teams have the technical information they need to design their satellite, and arranges access to the International Space Station from where the satellites will be put into orbit;
- The Provision of Expertise and Facilities initiative provides training and advice to teams throughout the execution of their project, in addition to providing qualification and testing services.

Collaborations and Synergies

The evaluation provided an opportunity to further explore opportunities for collaboration among the various initiatives in the context of the integrated approach proposed by the SCDP. Many suggestions were made by respondents, both internal and external. That said, many felt that strengthening a culture of collaboration, both between SCDP initiatives and between the program and its partners, is a condition for successful SCDP implementation and could help the program maximize its contribution to the development of space capabilities in Canada.

Strategic Collaborations

Collaboration must become a reflex in order to decompartmentalize initiatives. The effort is twofold: at the outset of any project, those in charge should ask themselves, on the one hand, about the potential contribution of other initiatives (or partners) to the realization of the project and, on the other hand, about the extent to which the project can contribute to the achievement of the greatest number of expected results. The objective is to strategically identify possible synergies between the initiatives according to the nature of the activities or projects and their objectives. The integrated approach proposed by the program does not require the participation of each initiative in all of the program's activities; rather, it is a matter of identifying the initiatives concerned based on the targeted results and the anticipated benefits for the program's clients.

Therefore, collaborations should be planned and structured from the earliest stages of activities or projects in order to secure the resources needed to carry them out. In addition, the case studies have shown that, on some occasions, the leverage effect generated by collaboration can be realized through the injection of limited additional resources. The organization of the Youth Open House at the Stratospheric Balloon Launch Base in Timmins and the presence of participants of the CAN-SBX Challenge are convincing examples of how this project was enhanced to maximize the program's contribution to the development of space capabilities in Canada.

This leverage effect can also materialize through intangible practices at zero cost to the program, such as modifying the requirements of funding agreements (for example, the STD initiative encourages the space industry to collaborate with the academic sector when implementing Announcement of Opportunities by favouring projects that will include the participation of students and academics). The added value of the program's integration is likely to be embodied in the multiplication of this type of practice.

Some respondents also suggested **continuing to experiment with the integrated approach through cross-cutting pilot projects.** This suggestion is consistent with the proposal made by the authors of the Innovation Ecosystem Report commissioned by the CSA (Arche Innovation, 2019). In addition, several respondents cited the Canadian CubeSat Project as a model for the future of the program. As illustrated in the case study, this initiative combined the strengths of the STEDiA, Provision of Expertise and Facilities, and Capability Demonstration initiatives to enable post-secondary students to design and build their own miniature satellite and participate in a real space mission, while once tested and certified, CubeSats will be launched to the International Space Station, from where they will be launched into orbit in 2021-22 (CSA, 2018d).

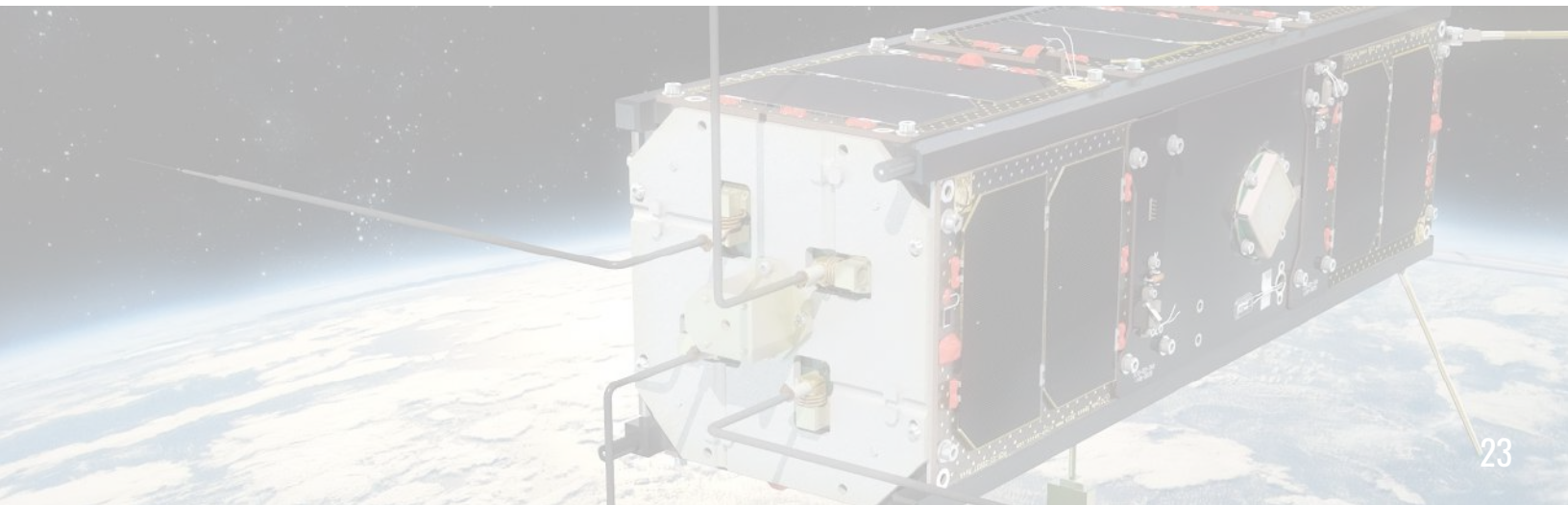
> “ The persons responsible for the initiatives look at them in such detail that they do not see the links between them. More exploration of common ground would be desirable. (CSA Representative)

Strengthening Partnerships

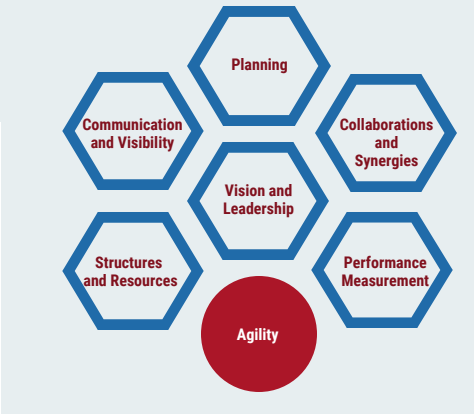
In addition, several respondents – both internal and external – stressed the need for the SCDP to work more closely with other government departments in order to maximize complementarity of services and, once again, to benefit from a leverage effect. Collaborations already exist with several departments, including the National Research Centre of Canada (NRC). That said, there is a need to optimize business practices by increasing opportunities for interdepartmental collaboration. This area for improvement had already been highlighted in previous evaluations, including the evaluation of the Space Expertise and Proficiency Program (CSA, 2017b). **In particular, the Innovation for Defence Excellence and Security (IDEaS) program was mentioned several times during the interviews as a potential partner.**

The importance of strengthening collaboration between the academic research community and the industrial sector was also emphasized a few times by internal and external respondents. Some funding recipients would like the CSA to further facilitate the development of partnerships between these two key sectors. Program officials also mentioned the possibility of better coordinating SCDP investment efforts in these two sectors, which are often called upon to participate jointly or subsequently in the various stages of preparation for a space mission.

> “ We need to think about what unites the initiatives. Where are the intersections? (Senior Management Representative)



Agility



Agility is one of the three principles of the Government of Canada's *Beyond 2020 Initiative for Public Service Renewal*. "Being agile forces us to experiment and try new things," the Clerk of the Privy Council and Secretary to the Cabinet recently stated in his Annual Report to the Prime Minister on the Public Service of Canada (Government of Canada, 2019b).

Several respondents – both internal and external – identified the SCDP's ability to be nimble and flexible in responding to the needs of users and partners as a condition for the successful implementation of the integrated approach. Moreover, one of the public administration experts interviewed warned program officials about the risk of developing a program whose integration relies on complex mechanisms and procedures that limit its ability to respond to user needs. **The program must be designed from the perspective and needs of recipients and users**, on whom the achievement of expected results depends.

Some respondents expressed the wish that the program should allow for **more room for error** and greater risk-taking, both in the program implementation itself – for example, by streamlining administrative procedures or setting up pilot projects –and in the implementation of activities and projects by funding recipients.

> "I have been shocked and incredibly happily surprised at how willing the CSA is to step outside its comfort zone as a space agency and try new things. They have recognized that [the Canadian CubeSat Project] is not a commercial, operational space mission at all. (Funding Recipient)

Alternatives to the SCDP Delivery Model

The exploration of new service delivery and project life-cycle management models was also proposed by some CSA representatives, with a view to improving accessibility to services by recipients and the SCDP's response to their needs. The challenge for the program lies, as mentioned by several respondents, in its ability to seize opportunities as they arise while maintaining the predictability of its service offering.

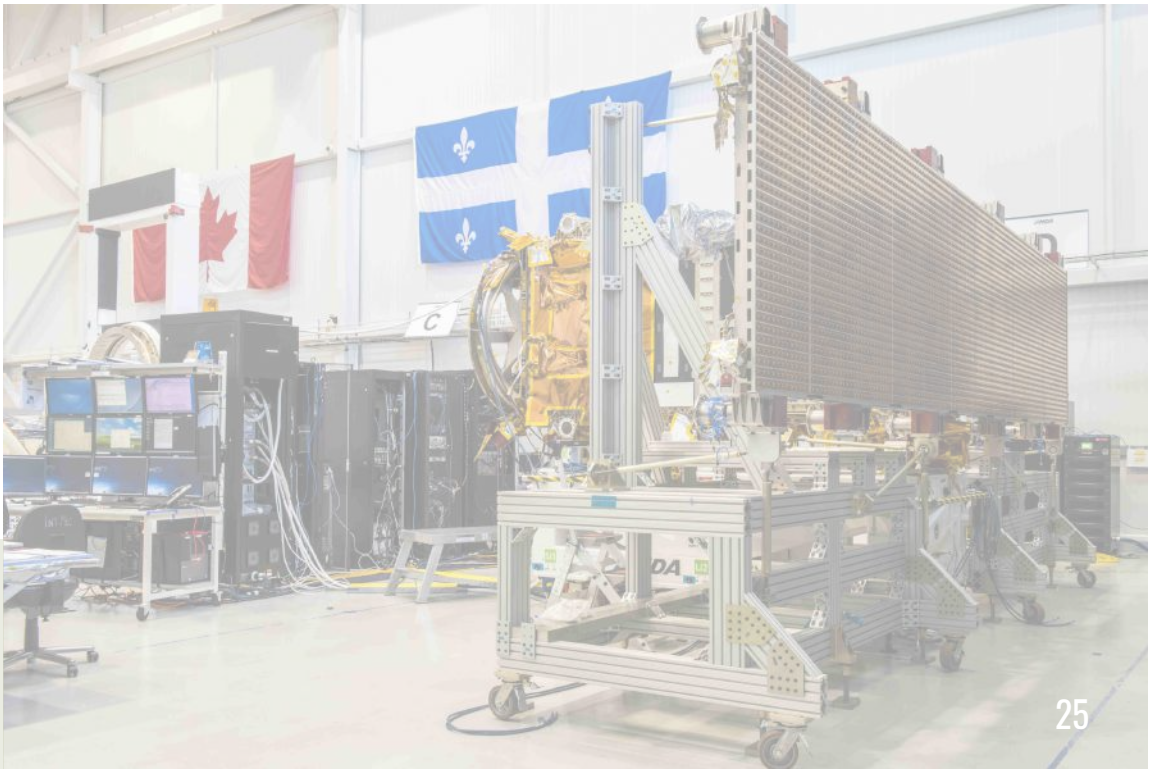
Two models were proposed by CSA representatives interviewed for this evaluation. Some raised the idea of consolidating access to services and funding offered by the SCDP for recipients through a **"single window" approach**. This would not involve consolidating or merging the initiatives, but rather putting in place a mechanism that would act solely as a conduit to channel applications to the initiatives concerned. This "single-window" approach would make it possible to have an overall view of the activities and projects seeking support from the program and to avoid potential duplication. That said, several respondents raised doubts about the feasibility of implementing this approach because of the risk of not redirecting the application to the appropriate interlocutors. Moreover, this approach would represent a major change for recipients, who are used to responding separately to notices of funding offers issued by the various initiatives.

The use of a **project gating process in the orientation and management of the project life cycle** was also suggested by a few respondents. Under this approach, calls for proposals would be administered separately by the various SCDP initiatives, as is currently the case for the STEDiA, STD and Application Development initiatives, for example.

The use of a project gating process in the orientation and management of the project life cycle was also suggested by a few respondents. Under this approach, calls for proposals would be administered separately by the various SCDP initiatives, as is currently the case for the STEDiA, STD and Application Development initiatives, for example. However, recipients could, in a single application, already identify all the services offered by the SCDP to which they would like to have access during the life of the project (such as financing, demonstration, expertise, qualification and testing services, or equipment loans, in particular). Respondents who suggested adopting this approach saw a two-fold benefit. On the one hand, this approach would avoid the need for recipients to resubmit a request to access the various services offered by the SCDP in a timely manner. As a result, recipients would have access to a wide range of services throughout the duration of the project, thus facilitating their navigation on the innovation continuum.

In addition, the adoption of a project gating process would allow program officials to periodically assess the status of projects and grant authorization to proceed to the next gating point. This approach would have the advantage of limiting the fragmentation of support for high-potential projects, but would require careful planning, a concerted approach, and flexibility in implementation.

Furthermore, these alternatives to the program delivery model should consider the current environment of the spatial ecosystem, as some stakeholders tend to move away from the traditional model of government program support based primarily on the provision of funding and/or long-term support. Some of these new players are more interested in one-time support (such as expertise, testing, or qualification services) that will serve as a stepping-stone on the innovation continuum.



Performance Measurement

In recent years, there has been a confirmed desire to tighten the performance measurement practices of the initiatives that now make up the SCDP. The program's implementation is part of this continuity, as the *SCDP Management Framework* (CSA, 2018b), currently being developed, reiterates the program's intention to put in place continuous improvement mechanisms. Furthermore, the use of performance measurement as a management tool represents a significant cultural change, as noted by a senior management representative interviewed for this evaluation.

Results, Indicators and Targets

Under the former *Program Alignment Architecture* (CSA, 2016a), each sub-program or sub-sub-program had its own *Performance Measurement Strategy* that included a logic model and performance indicators. As a result, performance measurement for the initiatives making up the SCDP was broken down into seven Performance Measurement Strategies totalling more than 100 indicators. The consolidation of these strategies into a single *Performance Information Profile* (PIP; CSA, 2018a) and logic model, as well as the rationalization of performance indicators, is undeniably a significant step toward the implementation of an integrated approach within the SCDP.

Thus, in general, the exercise that led to the drafting of the program's PIP was welcomed by most program representatives. A majority expressed satisfaction with the logic model developed and felt that it adequately reflects the program's expected outcomes. However, some respondents questioned the choice of certain indicators and associated targets. An initial report on the program's performance, covering the period from April 1, 2018 to March 31, 2019, was produced by program officials (CSA, 2019c). **Of the SCDP's 14 output and outcome indicators, a large majority (12/14) had a target that had already been met or was in a good position to be met.** This report, which identified methodological issues, confirms the program's willingness to refine certain indicators and to review the PIP soon.

According to the PIP, the indicators measuring the increased competitiveness of the space sector are all related to the ESA initiative. However, some respondents – both internal and external – regretted the **lack of information on the medium-term benefits** of projects funded by the STD initiative (including commercial benefits, development of partnerships, and integration of technologies into CSA or foreign missions). The same comment could apply to the Application Development initiative, as the evaluation of the Earth Observation Business Line (CSA, 2017c) showed that of the 41 application development projects surveyed, 21 had been commercialized and 15 others were expected to be commercialized. Moreover, one senior management member wanted to see a **better linkage between the performance measurement tools** of the Application Development and STD initiatives.

In addition, the STEDiA, STD and Application Development initiatives use the CSA's *Class Grant and Contribution Program to Support Research, Awareness and Learning in Space Science and Technology* for the delivery of G&Cs. A better linkage with the Performance Measurement Strategy (CSA, 2013) for this program was suggested by several respondents, as well as with the indicators and data-gathering tools used by the other CSA program areas. Some changes have already been made by those responsible for performance measurement at the CSA, but greater coordination of performance measurement practices is still desirable.

One of the public administration experts consulted for the evaluation pointed out the challenge of attributing results in the context of a program with an integrated approach. It then becomes more difficult to identify the initiatives or factors that have led to change. The issue of double counting was raised by a program representative when concerted action between initiatives could make it more complex for the various work teams to compile results.

Measuring the Added Value of the Integrated Approach

The evaluation highlighted the performance measurement challenges associated with the integration of initiatives under one program. The current SCDP logic model and its indicators focus on workforce and space technology development and the competitiveness of the Canadian space sector. These key components of the program's performance measurement have been built primarily by amalgamating the expected results of each of the initiatives that make up the SCDP. However, little effort has been made to measure the added value of the integrated approach. Previous evaluations have demonstrated the relevance and ability of each of the initiatives to achieve its expected results and thus contribute to the development of space capabilities. **However, how can the added value resulting from their consolidation be qualified and measured?** This fundamental question is not currently represented in program performance measurement documentation. Depending on the nature and extent of the desired integration of the program's various initiatives, efforts should be made to measure the status of implementation of the integrated approach and its benefits for program recipients and partners. Access to this data would also make it possible to adequately support a future evaluation of the implementation, relevance, effectiveness and efficiency of the program.

> “ The development of the Performance Information Profile (PIP) and Logic Model provided an opportunity to reflect on what is being sought to be accomplished and which initiatives contribute to the expected outcomes. (Program Representative)

Scope of Youth Activities

With regard specifically to the Youth Learning initiative, the interviews revealed a disparity in the discourse regarding the activities under this SCDP initiative versus the other promotional and awareness-raising activities for young people that are part of the corporate function of the Communications and Public Affairs Directorate. The case studies also highlighted STEM promotional activities organized by other SCDP initiatives, such as the open house at the stratospheric balloon launch base in Timmins and the demonstration activities organized by MCSS at CSA facilities. The SCDP should determine whether all concerted and coordinated youth communications efforts should be identified and measured under the SCDP and adjust the level of resources allocated to this initiative accordingly.

> “ The challenge of the program's integrated approach is to clarify the links between its various components. How does one feed into the other? How is each component part of a greater synergy? To really bring the model to life, the CSA must demonstrate the added value of an integrated approach. (Space Sector Association Representative)

GBA+

Gender-Based Analysis Plus

Reflecting the requirements contained in the Federal Government *Policy on Results* (Government of Canada, 2016), the **CSA adopted in 2017 its Gender-Based Analysis Plus (GBA+) policy**, which is based on the concept of GBA+, as defined by Women and Gender Equality Canada. This framework therefore governs the GBA+ analysis undertaken as part of this evaluation.

The evaluation indicates that the SCDP has begun to integrate GBA+ into the administration of its activities. While this is an evolving process, **tangible progress has already been made**, particularly with respect to the Announcements of Opportunity that are issued under the SCDP. The interviews conducted, however, confirmed the importance of continuing the process of informing and raising awareness among the SCDP team so that all its members share a common vision of the objectives related to GBA+.

The consultations conducted as part of the evaluation also indicate that there is a general understanding among the SCDP team members that GBA+ is not limited to sex (biological differences) or gender (the social construction of sex), but includes other identity factors such as ethnicity, living with a disability or living in an isolated environment.

GBA+ is an analytical approach used to assess the potential impact of policies, programs, services and other types of initiatives on diverse groups of men and women, taking into account gender and other identity factors. The "plus" in the name serves to emphasize that GBA+ goes beyond gender and includes the examination of a range of other intersecting identity factors (such as age, education, language, geographic origin, culture and income). GBA+ is a key element in the development of policies and programs that contribute to the advancement of gender equality. (CSA, 2017d)

As an illustration, the evaluation documented some examples of GBA+ integration related to the SCDP:

- The **Canadian Stratospheric Balloon Launch Site Open House** which, among other things, involved young students from Aboriginal communities;
- The planning efforts surrounding the new **Junior Astronauts program** to ensure reaching certain groups that are generally under-represented in STEM-related fields;
- Female student recruitment efforts through the Canadian **CubeSat** Project (21 female students participated in this initiative).

In light of these findings, the evaluation concludes that, in general, the SCDP does not have an impact that differs for different groups of women or men and will not create barriers to equal participation for any particular identity group in the Canadian population. Nevertheless, additional opportunities for improvement were suggested by key informants; the evaluation encourages the program to continue the dialogue on practices for integrating GBA+ into program activities.

CONCLUSION AND RECOMMENDATION

Relevance

The SCDP components meet well-documented needs, particularly with respect to STEDiA, STD, ESA and Provision of Expertise and Facilities initiatives. However, at the time of the evaluation, the role that the SCDP intends to play in Capability Demonstration (other than STRATOS) and Application Development was still being defined. Also, the extent to which Youth Learning is an integral part of the process of developing space capabilities (from idea-to-space) was still to be clarified.

The interdependence between the various SCDP components justifies, in principle, greater integration within the program. This approach is also adopted by other space agencies. However, the literature confirms that program or policy integration is inherently difficult and requires significant planning and implementation efforts. This is the challenge currently facing the SCDP.

> “Culture eats strategy for breakfast. The best strategy will not survive in a culture that is not ready for it. I see the advantages of an integrated approach, but I think they are predicated on the very clear spelling out of roles and responsibilities, ongoing communication, and on the building of a culture of collaboration. These are not easy things to do in any organization, but I think they are key for the success of this kind of enterprise.
> (Comparative Study Participant)

Finally, the relevance of the SCDP must consider the role that other organizations (institutional, private and public) in the space capacity development ecosystem are called upon to play, whose contribution is essential to the achievement of the SCDP's expected results. The CSA is called upon to play a coordinating role at the national level, guided by a vision of what the whole of Canada wants to achieve in this area.

> “The CSA is not a big enough player to afford silos. There needs to be a change in culture. We need to trust each other, share the same objectives and a common vision, have a clear and unified message, and be a team. (Senior Management Representative)

Implementation

Based on a constructive approach, this evaluation is intended to contribute to the decision-making process surrounding the definition of the integrated approach proposed by the SCDP and its implementation processes. The analysis of the conditions for success in implementing the program has made it possible to highlight the challenges related to the integration of the complementary initiatives that make up the SCDP and to identify avenues for improvement. The purpose of the evaluation was not to dictate to program managers the actions related to the implementation of the SCDP's integrated approach, but rather to provide a time for reflection on the approach undertaken and to propose courses of action that could serve as inspiration for program managers during the next stages of SCDP implementation. It will then be up to the program team to determine the desired level of integration and identify the actions to be taken to achieve it.

The grouping of the seven initiatives is the basis for the conceptualization of the program, which is expected to be involved at different stages of space capacity development. Collaboration between these initiatives, on the one hand, and with external partners, on the other, must become a reflex in order to create synergies and realize the added value of the SCDP. The initiatives' participation in the activities and projects supported by the program must be guided by the targeted results and the anticipated benefits for the program's recipients. As such, the case studies selected for this evaluation demonstrated the program's ability to promote collaboration among the various SCDP initiatives and contribute to the achievement of common results for the development of space capabilities.

The changes brought about by the creation of the SCDP and its integrated approach to date are often imperceptible to recipients and external partners, since the program has not yet been widely publicized within the Canadian space sector. The latter remain accustomed to dealing with the program's flagship initiatives, such as STEDiA or STD. For their part, program representatives recognize the need for a concerted approach within the program. However, the evaluation revealed ambiguities surrounding the value proposition of the program. Clarification of the integration approach would help program officials and recipients to develop a common understanding of the nature and extent of the integrated approach proposed by the program, and the anticipated trajectory for achieving this approach.

The evaluation recommends that the CSA clarify the operational implementation of the Space Capacity Development Program's strategic vision and develop a Change Management Plan and a Communications Plan that take the program's directions into account.

Management Response and Action Plan

Recommendation	Responsibilities Organization or Function	Management Response	Action Plan Details	Timeline
The evaluation recommends that the CSA: 1) Clarify the operational implementation of the strategic vision of the Space Capacity Development Program, and 2) Develop a Change Management Plan and a Communications Plan that take the program's directions into account.	Under the responsibility of the Director General of Space Science and Technology (STS) With the support of the Director General of Space Utilization and the Director of Communications and Public Affairs	Clarifying the operational implementation of the SCDP and developing a Change Management Plan and a Communications Strategy will maximize the anticipated benefits of the program's strategic vision for its integrated approach – from idea to space. The STD Branch will continue the implementation of the program by ensuring that it carries on with its continuous improvement and retooling process as prescribed in its Management Framework. By remaining flexible and agile, this continuous improvement process will allow the SCDP to align with the various terms and conditions of the CSA's new Strategic Investment Planning Framework and will facilitate the implementation of the solutions put forward in this report that could improve the integrated implementation of the program.	1) An overall SCDP Steering Committee will be set up to optimize complementarity and harmonization in the planning and delivery of the various initiatives. 2) In collaboration with the CSA's Communications and Public Affairs Directorate, the STS Branch will develop a Change Management Plan and a Communications Strategy, the elements of which will be shared with internal and external stakeholders, depending on the relevance of the information for a given group and the communication medium that will be deemed most effective. 3) The actions in this Action Plan will be incorporated into the updated SCDP Management Framework to be delivered by the end of the second quarter of 2021–22.	September 30, 2020 March 31, 2021 September 30, 2021

Appendix A
Financial Data

Space Capacity Development Program (SCDP)			
Initiatives	Expenditures ($'000)	2019-2020	2020-2021
		Forecasts	
SCDP Management	Salaries	2,354	2,436
	Operations and Maintenance	804	1,084
	Capital	0	0
	Grants and Contributions	0	0
	Total	**3,158**	**3,520**
	Employees - Full Time Equivalent	22	19
Youth Learning	Salaries	0	0
	Operations and Maintenance	0	0
	Capital	0	0
	Grants and Contributions	0	0
	Total	**0**	**0**
	Employees - Full Time Equivalent	0	0
Science, Technology and Expertise Development in Academia	Salaries	353	523
	Operations and Maintenance	128	115
	Capital	0	0
	Grants and Contributions	5,018	4,369
	Total	**5,499**	**5,007**
	Employees - Full Time Equivalent	7	5
Application Development	Salaries	0	419
	Operations and Maintenance	0	0
	Capital	0	0
	Grants and Contributions	1,000	1,520
	Total	1,000	1,939
	Employees - Full Time Equivalent	0	4
Space Technology Development	Salaries	1,223	1,423
	Operations and Maintenance	10,209	11,269
	Capital	0	0
	Grants and Contributions	10,000	13,551
	Total	21,432	26,243
	Employees - Full Time Equivalent	10	10
Capability Demonstration	Salaries	1,655	2,333
	Operations and Maintenance	1,709	1,849
	Capital	1,323	13,238
	Grants and Contributions	0	0
	Total	4,687	17,420
	Employees - Full Time Equivalent	18	16
ESA	Salaries	470	684
	Operations and Maintenance	194	194
	Capital	0	0
	Grants and Contributions	31,659	32,886
	Total	32,323	33,764
	Employees - Full Time Equivalent	4	5
Provision of Expertise and Facilities	Salaries	5,922	5,554
	Operations and Maintenance	2,227	2,272
	Capital	3,303	1,265
	Grants and Contributions	0	0
	Total	11,452	9,091
	Employees - Full Time Equivalent	61	61
Total (SCDP)		**79,551**	**96,984**

Appendix B
Methods

A matrix containing several evaluation questions related to the program's relevance, performance and efficiency was developed in co-operation with various CSA representatives. Evaluation data were collected using several research methods, briefly described below.

Literature and document review: The evaluation of the SCDP was based on a thorough analysis of several sources of information, such as public reports, national and international academic publications, government publications and CSA internal documents. The objective of this documentation review was to document the relevance of the SCDP, i.e., the extent to which the program meets a demonstrable need and is aligned with government roles and responsibilities, the implementation of the program's integrated approach, and the degree to which the SCDP is efficient and provides value for money and processes. The literature review also proved useful in documenting, in the scientific literature, the terminology used by the program.

Comparative study: The comparative study consisted in comparing the SCDP delivery model with programs with a similar integrated approach within the Canadian federal government and other space agencies. More specifically, it aimed to identify and document the conditions for success in implementing an integrated approach in a science-based program, as well as obstacles, best practices and lessons learned. Experts in public administration were also consulted as part of this comparative study.

Key informant interviews: Interviews were conducted to document the relevance of the program, its implementation and the challenges faced by key stakeholders, as well as the degree of efficiency of the program. They also helped to gain a thorough understanding of the SCDP's activities and to corroborate and clarify information obtained through other lines of evidence. A total of 60 individuals from different stakeholder groups were consulted through 46 individual and group interviews. They were mainly CSA representatives (36), recipients and partners from academia, the space industry and other federal departments (16), as well as representatives of space sector associations (2). In addition, six key informants were interviewed as part of the comparative study.

Case Studies: Ten case studies were conducted as part of this evaluation. These case studies targeted projects of different nature and scope, either ongoing or completed, that involved more than one SCDP initiative in their delivery. The projects that were the subject of a case study were identified in collaboration with program officials. Although all of the projects targeted by a case study began before the SCDP was officially created in April 2018, these case studies were intended to demonstrate the complementarity of the SCDP's service offering and to document the conditions for success in implementing the program's integrated approach, as well as best practices and lessons learned. Several of the SCDP initiatives had already had the opportunity in the past to work together on joint projects under the former Program Alignment Architecture (CSA, 2016a). These case studies thus sought to highlight the ability of SCDP initiatives to collaborate and to illustrate the SCDP's desire to maximize the synergy between these initiatives along an innovation continuum. The following table lists the case studies, a brief description of which can be found in Appendix C of this report.

10 Case Studies							
Projects	Specific Initiatives						
	Youth Learning	STEDiA	STD	Application Development	Expertise and Facilities	Capability Demonstration	ESA
Canadian CubeSat Project		✓			✓	✓	
Lunar Exploration Analogue Deployment "LEAD"		✓	✓		✓	✓	
Aerosol Limb Imager Version 2 "ALI V2"		✓	✓		✓	✓	
Canadian Atmospheric Tomography System "CATS"		✓	✓			✓	
"HiCIBas" High-Contrast Imaging Balloon System		✓			✓	✓	
Quantum Encryption and Science Satellite "QEYSSat"		✓	✓		✓	✓	
Dusty & Dirty Thermal Vacuum Chamber "DTVAC"			✓		✓		
Canadian Reduced Gravity Experiment Design Challenge « CAN-RGX » Canadian Stratospheric Balloon Experiment Design Challenge «CAN-SBX »					✓	✓	
Demonstration activities organized by Mission Control Space Services	✓				✓	✓	
Open house at the stratospheric balloon launch	✓				✓	✓	

Appendix C
Case Studies

Canadian CubeSat Project

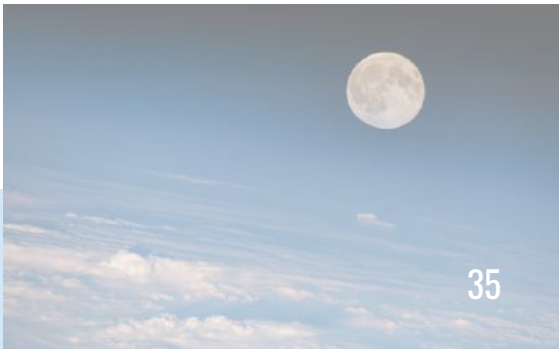
The Canadian CubeSat Project is a competition organized by the CSA that offers professors and students from Canadian post-secondary institutions the opportunity to design and build their own miniature satellite, known as CubeSat. This initiative supports 15 Canadian teams in each of the 13 provinces and territories. A total of 37 institutions are participating in this initiative (including participation from universities in Europe, Australia and the United States). Each team is guided or supervised by space experts. CubeSats will be launched from the International Space Station in 2021–22, allowing students in each team to operate their satellite and conduct their science experiments for up to 12 months.

The objectives of this initiative include: to stimulate students' interest in science, technology, engineering and mathematics; to develop their space know-how; and to provide them with hands-on experience to prepare them for the job market (CSA, 2018d). To carry out this project, three SCDP initiatives are working closely together: STEDiA, Capability Demonstration, and Provision of Expertise and Facilities.

Lunar Exploration Analogue Deployment "LEAD"

The LEAD project provides an opportunity for scientists and engineers to conduct a series of field tests to simulate a lunar sample return mission (CSA, 2019d). This project aims to position Canada for future contributions to Lunar rover missions by demonstrating human and robotic exploration capabilities beyond low Earth orbit. In doing so, the LEAD project supports the development of space science and technology and fosters the continued development of a critical mass of researchers and highly qualified personnel in Canada (CSA, 2018e).

Thanks to the participation of the SCDP, three teams of scientists and engineers from academia and the space industry were able to take part in LEAD. Four SCDP initiatives are working closely together to ensure the success of this project: STEDiA, STD, Provision of Expertise and Facilities, and Capability Demonstration.



Aerosol Limb Imager Version 2 "ALI V2"

ALI is an atmospheric observation tool capable of measuring the concentration of aerosols – that is, fine dispersed particles – in the upper atmosphere using a unique optical device. The upgraded version of ALI V2 can detect a wider range of optical waves, allowing it to measure aerosol size with greater accuracy (CSA, 2018f). Data collected from ALI V2 could lead to a better understanding of the impact of aerosols on climate change and health effects.

The development of this tool is being led primarily by Honeywell Aerospace and the University of Saskatchewan. It has been supported by the STEDiA, STD, and Provision of Expertise and Facilities initiatives, and has been successfully deployed three times (2014, 2017 and 2018) in the gondola of a stratospheric balloon with the support of the Capability Demonstration initiative.

Canadian Atmospheric Tomography System "CATS"

CATS is an imaging tool capable of representing vertical profiles of trace gases in the atmosphere, such as ozone and nitrogen dioxide. A vertical profile shows the variation in the concentration of a gas at different altitudes. This system can sample several atmospheric zones simultaneously, allowing for better spatial resolution. This tool could thus provide relevant data for climate studies to better understand the causes of climate change (CSA, 2018f).

This project, led primarily by Honeywell Aerospace and the University of Saskatchewan, was supported by the STD, STEDiA, and Capability Demonstration initiatives.

High-Contrast Imaging Balloon System "HiCIBas"

Led mainly by Université Laval, the HiCIBaS project aims to develop a new type of Low-Order Wave Front Sensor (LOWFS) as a generic precision pointing telescope system that could be used in future missions requiring sub-milli-arcsecond level pointing (e.g., high contrast imaging missions) (CSA, 2018f).

The development of this sensor, which measures the causes of image distortion and blurring in high-contrast imagery, was supported by the STEDiA initiative. The project was also supported by the Provision of Expertise and Facilities initiative and was deployed in a stratospheric balloon gondola with support from the Capability Demonstration initiative.

Dusty & Dirty Thermal Vacuum Chamber "DTVAC"

The development of the Dusty & Dirty Thermal Chamber (DTVAC) was made possible with the support of the STD initiative. This chamber, developed by MPB Communications Inc. is designed to reproduce the environment of Mars and the Moon and simulate their particular conditions, which can have a significant impact on the operation and performance of space materials such as rovers, landers, scientific instruments and auxiliary robotics. This chamber will be used primarily for rover testing, but also for rotational, optical and surface devices for international lunar and Mars missions (R. V. Kruzelecky, 2018a, 2018b). In addition to the support of the STD initiative, this project benefited from the services of the Provision of Expertise and Facilities initiative during its development.

Quantum Encryption and Science Satellite "QEYSSat"

The Quantum Encryption and Science Satellite (QEYSSat) mission aims to spatially demonstrate quantum key distribution, a technology that creates encryption codes that are virtually impossible to crack. This technology will enable Canada to secure its communications as we enter the age of quantum computing. The emergence of fast and powerful quantum computers may pose a threat to the privacy of Canadians because the technology used today to protect data will soon be inadequate. Although quantum key distribution devices currently exist on Earth, their capacity remains limited because they transmit quantum particles via fibre optics. For its part, QEYSSat involves using satellites rather than just cables, as is currently the case (CSA, 2019e). The microsatellite used for the QEYSSat mission is expected to be launched into orbit by 2022–23.

The development, design and implementation of the QEYSSat mission is mainly led by the Institute for Quantum Computing at the University of Waterloo and Honeywell Aerospace. This demonstration mission has been supported over the years by the STD, STEDiA, and Capability Demonstration initiatives.

Canadian Reduced Gravity Experiment Design Challenge "CAN-RGX" & Canadian Stratospheric Balloon Experiment Design Challenge "CAN-SBX"

The Canadian Reduced Gravity Experiment Design Challenge (CAN-RGX) is a competition organized by the agency Students for the Exploration and Development of Space Canada (SEDS-Canada). This competition offers Canadian post-secondary students the opportunity to design and test a scientific experiment on the National Research Council of Canada (NRC) Falcon 20 aircraft (SEDS-Canada, 2019). The parabolic flights performed by this aircraft recreate conditions similar to those of weightlessness.

The Canadian Stratospheric Balloon Experiment Design Challenge (CAN-SBX) is a similar competition to test scientific experiments conducted by Canadian students at high altitudes using a stratospheric balloon at the CSA base in Timmins, Ontario. Both competitions benefit from the close collaboration of the Capability Demonstration initiative, in addition to the support provided by the Provision of Expertise and Facilities initiative.

Demonstration activities organized by Mission Control Space Services

Mission Control Space Services (MCSS) is a Canadian company specializing in the development of technologies needed to operate robots in space. With the support of the CSA, MCSS organizes annual educational simulation activities of robotic missions and workshops for Canadian and international students at various academic levels (MCSS, 2019).

The conduct of these demonstration activities benefits each year from the close collaboration between the Capability Demonstration and the Provision of Expertise and Facilities initiatives. The Youth Learning initiative may also be called upon to contribute since some of the Canadian students participating in these activities are at the primary and secondary levels.

Stratospheric Balloon Launch Site Open House

STRATOS, the CSA's stratospheric balloon program – part of the Capability Demonstration initiative – provides Canadian universities and companies with the opportunity to test and validate new technologies and conduct scientific experiments in a near-space environment. STRATOS thus helps to inspire and train the next generation of experts (CSA, 2018g).

The Timmins Stratospheric Balloon Launch Site was inaugurated in June 2013 under an agreement between the CSA and its French counterpart, the Centre National d'Études Spatiales (CNES). The STRATOS program, in collaboration with Science Timmins, organized a first open house in August 2018 to allow students from the Science Timmins Summer STEM Camp and the media to attend workshops and visit the stratospheric balloon launch and control sites. This open house was an opportunity for the CSA to inspire young Canadians and increase their knowledge of space, as well as an opportunity for a young Canadian student to launch a weather balloon designed as part of a school project (CSA, 2018i).

In addition to the Capability Demonstration initiative, this activity was supported by the Provision of Expertise and Facilities initiative. The Youth Learning initiative may also be called upon to contribute to a future edition of this open house.

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