Lift Off

by **Dario Schor**

Canada is overdue for a national space strategy. In August 2017, the renewed Space Advisory Board (SAB) submitted its recommendations to the Minister of Innovation, Science, and Economic Development. The report incorporates the views from not only the experienced board members, but also from in-person and virtual roundtable discussions engaging industry stakeholders, thus providing a more comprehensive outlook on the future of Canada in space. This article summarizes the main discussion points from the stakeholder meetings and reviews the key recommendations from the SAB as they relate to Canada's future in space.

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THE STAKEHOLDER MEETINGS

From April to May 2017, the SAB hosted seven in-person meetings in different cities and two virtual events engaging northern communities and young professionals to collect input from different space industry stakeholders. The meetings were well attended by students, industry professionals, academia, teachers, space enthusiasts, journalists, and others. The "Consultation Paper for the Space Advisory Board: Driving Canada's Future in Space" laid out the two main topics for discussion: using space to drive broader economic growth and leveraging space for the benefit of Canadians. Over 150 participants attended the in-person and online meetings. The three most prominent discussion points during those meetings were (i) balanced space program, (ii) modernizing laws and regulations, and (iii) education and outreach.

A balanced space program would include a combination of stable funding for flagship missions and smaller scientific and technology demonstration "contributions" missions. Large programs like the International Space Station provide high visibility for Canada while contributing to international research collaborations, strengthening humanitarian activities such as disaster management and ecosystem monitoring, as well as supporting national needs; e.g., security. Smaller initiatives enhance Canada's ability to respond to new developments in the field that enable industry and academia to obtain flight heritage on emerging technologies and contribute instrumentation or technologies to international partner missions while developing skills and talent in a competitive market. A balanced program would improve the current model where many preliminary studies are conducted, but missions are scattered over long periods, thus making it difficult for both industry and academia to find opportunities to test new developments in flight and to maintain viable teams.

Space Legislation

A strong case was made to update Canada's space legislation to keep up with international trends in areas like remote sensing, space mining, and impacts on on-orbit servicing. For instance, while Article 2 of the Outer Space Treaty from 1967 states that outer space and other celestial bodies are not subject to national appropriation, there is no consensus on whether this extends to materials extracted from the celestial bodies. The United States has already passed the so-called Commercial Space Launch Competitiveness Act in 2015 explicitly allowing US citizens to "engage in the commercial exploration and exploitation of space resources" and other nations are expected to follow. Similarly, there is a need to revisit the Canadian Remote Sensing Space Systems Act that attempts to balance the dual use of space activities as it relates to space assets, ground stations, and data collected. An independent review published in February 2017 by Ram Jakhu and Aram Daniel Kerkonian from the McGill University Institute of Air and Space Law further anticipates that the act may not be able to keep up with emerging technologies and possibly hinder national and international business opportunities with its strenuous licensing processes; e.g., the current delay in approving the use of Inuvik's satellite ground station to communicate with the fleet of satellites from the American remote sensing firm Planet. The act also places stringent regulations on the dissemination of "raw data" that has potential to be used for many applications versus the oversight applied to "remote sensing products" that have been transformed for specific uses. Combined with existing favoured public-private partnership models where the Canadian government does not own the satellites collecting remote sensing data, results in data access for Canadians are being limited. Alternative models, where the government subsidizes data access, can thus be considered more advantageous in order to support researchers and startups who are trying to leverage advances in the availability and processing of big data for addressing global challenges and looking for new market opportunities, respectively.

ROCKET ENGINEERING COMPETITION

The Intercollegiate Rocket Engineering Competition (IREC) *challenges university teams to design, build, and launch rockets to 10,000 feet or 30,000 feet while carrying a 10 pound payload. The competition takes place at Spaceport America in New Mexico, United States over the course of a week. Canadian teams have been participating in the competition since 2011 and have been recognized with many awards.*

rockÉTS from École de technologie supérieure in Montreal is one of the many university teams in Canada participating in IREC since 2012. The group of over 30 passionate engineering students designed the EMERILLON-IV consisting of a carbon fibre body that is 139.54 inches high, has a 5.16 inch diameter, and houses a payload, avionics, and parachute. The scientific experiment is designed to execute autonomously during the 2-3 minute long trajectory that reaches speeds of over 550 mph.

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Preparing the next generation

The education and outreach discussions stressed the important role space plays in developing STEM activities to inspire the next generation. However, besides the traditional methods involving astronauts and flagship missions, the discussions focused on the important roles played by some of the non-traditional initiatives. There are student competitions that develop leaders who become ambassadors for the sector visiting schools, using their enthusiasm to connect with pre-university students, and challenge this cohort to think big. These activities are driven by a push to train highly qualified personnel for the space industry. However, there is strong evidence that graduates from Canadian space programs lack opportunities for employment in Canada; e.g., the CSA's recent astronaut search revealed that 26 of the 72 Canadian applicants shortlisted at that stage of the competition were living abroad at the time of application. Comments made by participants at the Space Advisory Board's young professionals meeting reflected this concern: a frequent theme being that many bright individuals are looking to develop their career elsewhere, with a sizeable number of participants calling in from the United States and Europe.

THE SAB RECOMMENDATIONS

The SAB report entitled "Consultations on Canada's Future in Space: What we Heard" was released in August 2017. It describes the roundtable discussions as being filled with "bold, aggressive, and inspirational" ideas for a national space strategy and provides two main recommendations to (i) designate space as a national strategic asset, and (ii) expand the role of the SAB.

The first recommendation links all of the aforementioned topics from this article. It further emphasizes the need for the government department and agencies to work together to synchronize policies to form a whole-of-government approach needed as the basis for a national space program. As an example, this would include implementing interdepartmental standards for space data organization, collection, analysis, storage, and distribution. Some attempts for an integrated approach are already underway as described in a CASI ASTRO 2016 conference paper entitled "RCM Data Utilization & Application Plan" by Daniel de Lisle from the Canadian Space Agency. Other important steps would be updating procurement policies to favour domestic products and acquiring space services from the private sector as opposed to government owned and operated space systems. These two policies combined would create a more

Custom avionics control the experiment, measure the performance of the rocket, and log data for post-processing. After a few top five finishes, in 2016, the team received first place in the Basic Category (10,000 feet) and the Jim Furfaro Award for Technical Excellence. Team lead Robert Houde highlighted one of the new features added for the 2017 competition: an ejection system relying on noble gases only instead of the traditional black powder. This novel technology earned the team the 2017 Dr. Gil Moore Award for Innovation. Looking forward, the team is working towards getting access to the test facilities needed to push their designs to the Advanced Category.

Rocketry team from École de technologie supérieure, Montreal

University of Victoria's **ROCKETRY TEAM** is another Canadian success story. Their first entry into the competition in 2016 received third place in the Basic Category. Raising the stakes for 2017, Annaliese Meyer, the Payload Science Lead, and her team developed a novel ultraviolet sterilization unit for interplanetary sample retrieval. In this experimental setup, bacteria was placed on aluminum squares where it was exposed to three specific wavelengths of ultraviolet light during the flight. The preliminary results showed a significant reduction of the survival rate of flight tests versus their control experiments - furthering the understanding of effects of the flight for future sample return missions. The advanced payload design earned the first place in the Space Dynamics Laboratory Payload Challenge in 2017. The team collaborated with members of the IEEE Student Branch in the design of the guidance, navigation, and control unit under the direction of Martin Kellinghusen. They designed custom boards, firmware, and software to run the experiment autonomously. Rather than using the traditional "remove-before-flight" pin, a hall effect sensor was used to detect a magnet placed to arm the rocket on the launch pad. The novel design removed many structural constraints placed on the electrical design. Although not required, a 70cm amateur radio band transmitter was used to send live telemetry to a nearby portable ground station, thus enabling them to monitor the state of the rocket while on the launch pad and in flight. Live telemetry feeds help to mitigate risks to ensure the system is operational before launch (e.g., not overheating) and also serves as a forensic measure in the event of a catastrophic failure.

These activities are not easy and require lots of sponsors; a special acknowledgement goes out to the IEEE Canadian Foundation (ICF) for supporting the University of Victoria rocketry team.

"UVic Rocketry would like to extend our profuse thanks to ICF for their generous donations and support of our team," says Annaliese Meyer, Payload Science Lead. "The foundation makes it possible for our wide range of members to reach new heights in their professional and academic goals."

The success of these teams builds on the rich history of Canadian sounding rockets that dates to the first Black Brant launch on September 5, 1959. For more information on the IREC competition and the teams participating, please visit http://www.soundingrocket.org/. And who knows, perhaps these students will get a minor in "rocket science" with their engineering degrees. ■

welcoming environment for New Space entrepreneurs that focus not only on the space assets, but also on the downstream applications related to the big data movement. Finally, there is a strong recommendation to dedicate 10% of the Canadian Space Agency budget to research at Canadian universities that includes both developing new technologies and providing flight opportunities to establish flight heritage.

The second recommendation focuses on the role of the SAB. At first glance, this can appear to be self-promoting, however, if one reads the details, this point speaks on behalf of the citizens the board is representing. The first part of this recommendation aims to continue engaging with the community of stakeholders to continue discussing the "bold, aggressive, and inspirational" ideas throughout the development of a national space policy. The second portion of this recommendation focuses on what many roundtable attendees pondered: how are they going to measure progress? The board is volunteering to help develop metrics to evaluate the implementation of the plan, monitoring the progress against the metrics, and advising the minister on the various findings. It is holding the government accountable to the input from the many stakeholders.

CONCLUDING REMARKS

Ultimately, an updated space strategy with a long-term vision must balance many factors, including national security and commercial interests. The items highlighted in this review all point to needed policy changes. More support is necessary in order to build a more balanced space program including the encouragement of novel commercial ventures; these will not only inspire the next generation, but also provide employment opportunities within Canada. Hence, the Space Advisory Board and the Canadian government have a lofty challenge ahead of them: drafting a national Space Strategy to position Canada at the forefront of the New Space movement. For more information, please refer to the consultation papers and the summaries for each of the meetings at https://www.ic.gc.ca/eic/site/ad-ad.nsf/eng/h_ad03983.html. ■

About the Author

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