Submission to the Aerospace Review

by

The Canadian Satellite Design Challenge Management Society Inc.

The thesis of this submission to the Aerospace Review is to recommend the institution of a series of Canadian design competitions in order to promote investment into, expertise in, and development of, innovative new technologies, processes, products and applications for the aerospace and space sectors.

Contact Information

Author: Lawrence (Larry) Reeves,
President,
Canadian Satellite Design Challenge Management Society Inc.
5050 Elgin St., Vancouver, B.C. V5W 3J6
Phone: 778-988-6343
e-mail: LReeves@Geocentrix.ca

Introduction: The Canadian Satellite Design Challenge

The Canadian Satellite Design Challenge (CSDC) is a Canada-wide competition for teams of university students to design and build a small science research satellite known as a "cubesat" or "nanosatellite". These satellites have dimensions of 34x10x10 cm, and a mass of up to 4 kg.

Once constructed, the satellites will undergo full space environmental and launch qualification testing. The winning satellite will then be selected to be launched into orbit, in order to conduct its research mission.

The CSDC is managed by the Canadian Satellite Design Challenge Management Society Inc. (CSDCMS), a federally-incorporated not-for-profit organisation (co-registered and headquartered in British Columbia).

The CSDC was initiated in January, 2011. Twelve Canadian universities from Victoria to Halifax, representing seven provinces are participating in the competition. The teams have proposed a variety of science and technology development payloads for their satellites (listed in Appendix A), in many instances providing a novel element to previous experiments on other satellites and contributing to research at their universities, and in some cases attracting the interest of industry.

Design Competitions as a Vehicle for Advancement

The CSDC has been modelled after several existing undergraduate engineering design competitions, such as the Society for Automotive Engineers' (SAE) Solar Car and Super Mileage competitions, NASA's Space Elevator and Lunar Regolith competitions and the U.S.

National Science Foundation's CubeSat programme.

One noteworthy aspect of these existing university competitions is that the prizes are often negligible compared to the financial and labour resources that are invested into them. Additionally, in these competitions, team members dedicate an enormous amount of time to the competition, most of it extra-curricular time, often without receiving academic credit for their efforts. For most participants, it is the challenge to develop something new, innovative, or better - and the desire to win - which motivates and drives them.

On a larger scale, an example of the investment, innovation, and development which competitions can generate can be found in the X-Prize competitions for commercial space-tourism, low-mileage vehicles, Genomics mapping, and lunar landers. For example, in the original X-Prize for non-governmental space flight, Scaled Composites raised approximately $25 million (U.S.) for their entry, in order to win a $10 million prize [3]. Following their success, further investment followed to develop a new business of space tourism.

Competitions for the advancement of technology are not a recent phenomenon [1]. In 1714 the British government offered prizes for higher-accuracy clocks which would improve navigation. In the 1780's the French Academy offered a prize for the development of a process to extract soda from sea salt. The automotive industry has had numerous competitions since the late 1800's to develop and improve the utility, cost, speed, economy of operation, and aesthetics of cars. And, throughout the 20th century, competitions helped to develop, grow, and push the boundaries of aircraft capabilities.

Funding Research and Development for Canadian Competitions

Success and innovation need not be restricted to those with large financial and technical resources. Although the original X-Prize was won by Scaled Composites Ltd., a company with huge financial backing (Paul Allen, Sir Richard Branson) and an extensive history of successes, amateurs, hobbyists, and entrepreneurial experts can also achieve remarkable results with comparatively tiny financial resources. Copenhagen Suborbitals, in Denmark, is a not-for-profit organisation which has built and launched a 31-foot-tall suborbital rocket, entirely from volunteer labour and a budget of approximately $60,000 per year [4].

In design competitions, teams often secure sponsorship or in-kind donations from companies in the competition domain, and "product promotion sponsorships" from unrelated companies. At many universities, faculty funding is available for design competitions.

Mitacs is a national funding network which co-funds university graduate student research projects conducted in collaboration with an industry partner, and is an excellent funding mechanism. University competitions, often restricted to undergraduate students, can benefit from greater involvement of the experience and research focus of graduate students; advanced design competitions can create research opportunities which are eligible for Mitacs funding, and which are germane to the competition, graduate-level theses, and the industry partners.

Finally, under Industry Canada's Industrial-Regional Benefits (IRB) programme, foreign companies which receive large Canadian Government contracts can be required to return economic benefits to Canada. The foreign companies can offset these IRB commitments by investing in qualified Canadian Research and Development programmes, receiving a credit of up to 10 times their contribution. The CSDCMS is in the process of establishing relationships to secure IRB-eligible funding, and this avenue could be used for other design competitions.

Summary

Design competitions challenge participants to develop something new, different, or innovative which bests the others. The resources which participants invest into a competition often far outweigh the return. “Bragging rights” may in fact be the most valued element of winning, but in the process technological advancements are realised.

Prior to instituting the Canadian Satellite Design Challenge, there was only one university in Canada which had built and launched a nanosatellite, and possibly only two or three others which had designed one. With 12 universities participating, the CSDC has quickly expanded the space mission knowledge base across the country.

For the Canadian aerospace and space sectors, prize-based design competitions can foster the development of new technologies, or create new applications for existing technologies. They could be employed to achieve specific results, such as reduce the costs of development or manufacturing, or increase capability, reliability or accuracy of components.

The report from the 1st Canadian Nanosatellite Workshop, held in Quebec City in April, 2012, endorsed constructive competitions as an innovation driver, and specifically cited the CSDC as a model to follow [5].

Design competitions help to build a culture of capably addressing challenges, and they help to build the leaders who can address them. By sharing and promoting this culture through public outreach initiatives, it will motivate and inspire youth to pursue science and engineering educations and careers, and become the next generation of leaders to further Canada’s position in the aerospace and space sectors.

As seen on CBC television’s *Dragon’s Den*, there is no shortage of Canadian inventors and entrepreneurs with ideas or products which they believe can be commercially successful. Although many of the ideas presented on the show lack significant merit, a few abound in it and receive offers of hundreds of thousands of dollars in investment to develop them. Without a forum to encourage and solicit ideas, they might not have ever been born.

The CSDCMS believes that university or public design competitions which are focussed on developing innovative new products and technologies are an excellent vehicle for enhancing the competitiveness and ensuring the growth of Canada’s aerospace and space sectors.

In conclusion: if you want to be more competitive, you have to compete.

References:

[1] Brennan, Timothy J., Molly Macauley, and Kate Whitefoot, *“Prizes, Patents, and Technology Procurement: A Proposed Analytical Framework”*, Discussion paper 11-11, Washington, DC: Resources for the Future.

[2] X-Prize organisation, web site.

[3] Scaled Composites Ltd., web site.

[4] Copenhagen Suborbitals, web site.

[5] Lee, Regina, Sunil Bisnath, Patrick Gavigan and Alfred Ng, “*Small is Beautiful: Report from the 1st Canadian Nanosatellite Workshop*” (CNW 2012), 13 June 2012. The report is available at: http://spaceref.ca/news/Canadian-Nanosat-Workshop-Report-Final.pdf

Appendix A:

Participating Teams and Mission Concepts

The following list gives the participating teams and a description of the payload(s) that each team is preparing for their mission.

- **Carleton University** (Ottawa, ON)
  - Measure the Total Electron Content in the ionosphere.
- **Concordia University** (Montreal, QC)
  - Space weather payload suite: Geiger-Müller proportional counter, flat Langmuir probe, and MEMS gas analyser.
- **Dalhousie University** (Halifax, NS)
  - GPS occultation experiment, and atmospheric density measurement.
- **Queen's University** (Kingston, ON)
  - Observe atomic vapour flux distribution in micro-gravity.
- **Royal Military College of Canada** (Kingston, ON)
  - Receiving ADS-B transmissions to monitor aircraft traffic in remote areas
- **The University of Alberta** (Edmonton, AB)
  - Near-infrared spectrometer to measure atmospheric concentrations of greenhouse gasses.
- **The University of British Columbia** (Vancouver, BC)
  - Radio Telescope calibration payload.
- **The University of Manitoba** (Winnipeg, MB)
  - Test the resilience of tardigrades (extremophile bacteria) to survive orbital environment
  - Spectroscopy experiment to measure solar intensity over the UV to NIR spectrum.
- **The University of Saskatchewan** (Saskatoon, SK)
  - Detector to monitor the intensity and anisotropic modulation of galactic primary cosmic rays.
- **The University of Victoria** (Victoria, BC)
  - Diamagnetic materials experiment, and amateur "Software-Defined Radio" payload.
- **The University of Waterloo** (Waterloo, ON)
  - Measure arctic sea ice extent by reflection of GPS signals.
- **York University** (Toronto, ON)
  - Measure airglow emissions resulting from tropospheric convection, and investigate their correlation with earthquakes.