AGENCY SPOTLIGHT

UNIVERSITY OF TORONTO'S SPACE FLIGHT LABORATORY

Trailblazing Small Satellite Technology

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Tucked inside an unassuming office building on the outskirts of Toronto is one of Canada's most innovative space laboratories.

It is not part of industry, nor is it run by the Canadian Space Agency.

But the University of Toronto's Space Flight Laboratory (SFL) has been behind some of the country's most successful small satellite programs, has two spacecraft in orbit and is working on new systems for a variety of international and Canadian customers.

SFL is also the mission control center for the Microvariability and Oscillations of Stars (MOST) astronomy mission under the Canadian Space Agency's Small Payloads Program. Launched in 2003 aboard a Russian-built Rockot vehicle, the suitcase-size MOST is Canada's first space telescope as well as its first space science microsatellite.

"It's not a big operation," Kevin Shortt, president of the Canadian Space Society, said of SFL. "But that's the whole point of microspace operations; you set up a couple of PCs and you have yourself an operations center.

"But as far as the project work they're doing, [SFL] is leading edge in nanosat and small satellite technology in Canada," he added.

SFL, part of the university's Institute for Aerospace Studies, was founded in 1998 with five people involved in working on MOST. As it continued space research work focused on microsatellites the laboratory grew. It now has 15 personnel as well as 14 graduate students with an annual budget of 2 million Canadian dollars ($1.6 million).

"Our focus has been on microsatellites from the very beginning, so we were able to construct a program that wasn't tied down by any existing or traditional approaches," explained Robert Zee, director of the Space Flight Laboratory.

"Internationally, we're offering some of the highest performance missions within our cost regime," he said. "Our goal is to offer high-performance three-axis stabilized microsatellite missions at a significantly cheaper price point than you'd normally be able to find out there right now."

Zee said SFL is not just a university satellite program but a combination of professional staff and students who work on specific missions. Its clients range from industry, such as Com Dev Ltd. of Cambridge, Ontario, to the Canadian Space Agency, the Canadian military and the Norwegian government.

Zee said the lab's tightly integrated team approach is important to building small satellites on a short schedule and tight budget. But working quickly and on a low budget means that SFL rarely is able to use specific space mission components or radiation-hardened systems.

"So we tend to use commercially available components, what you would find in your cell phone, laptop, palm pilot — products being marketed widely in terrestrial applications," he explained. "There's a natural performance advantage but we also have to be very careful how we use these components in space because the environment is different."

SFL developed the Canadian Advanced Nanospace eXperiment 2 (CanX-2) nanosatellite, which has been in orbit about a year. The 3.5-kilogram satellite was launched from India in April 2008 on board Polar Satellite Launch Vehicle C9, Zee said. The milk carton-sized spacecraft is Canada's smallest operational satellite, built, launched and operated for around 1 million Canadian dollars.

The spacecraft will be used to support a formation-flying demonstration mission involving two satellites, CanX-4 and CanX-5, planned for the near future.

In addition to providing precise updates on the satellite's position in orbit, a GPS receiver on board CanX-2 is being used by Professor Susan Skone at the University of Calgary, Alberta, to perform radio occultation experiments — measurements of delays in GPS signals through the atmosphere to infer atmospheric properties such as water vapor and total electron content.

CanX-2 also carries a compact spectrometer developed by Professor Brendan Quine at York University, Toronto, that measures concentrations of greenhouse gases in the atmosphere, Zee said. At present, the satellite is alternating between the two science experiments.

SFL also designed and built the Canadian Advanced Nanospace eXperiment 6 (CanX-6), a 6.5-kilogram, 20-centimeter cubesat. It was conceived in October 2007, built in six months, and launched in April 2008, along with CanX-2.

Zee said the lab built the spacecraft after being approached by Com Dev Ltd., which had developed technology for receiving automatic identification signals (AIS) from ships.

Ships of a certain class are required to carry AIS transponders that broadcast their identity, location and heading as part of a terrestrial-based collision-avoidance system. Com Dev is one of several companies interested in detecting AIS signals from space for global ship tracking and monitoring.

"That technology had not yet flown in space so they were anxious to get some space qualification to verify if their approach and their algorithms actually worked," Zee explained. "They needed to get something up very quickly."

Zee said the lab used some of the same systems developed for CanX-2, along with new technology, to quickly build the CanX-6 spacecraft. It is also equipped with a VHF antenna to receive signals from ships.

He said the lab's team was able to develop and build the spacecraft and arrange a launch in the time it normally takes to do a concept study. "It's not a process of cutting corners," Zee said. "It's a process of being very judicious in doing what we do and what we don't do in terms of relating to quality."

The budget for the project was under 1 million Canadian dollars.

The satellite is seen as a technology demonstrator that precedes the development of an operational space-based AIS platform to provide data on maritime vessels.

SFL is now working with Com Dev on the Maritime Monitoring and Messaging Satellite (M3MSat), which is classified as a microsatellite. Defence R&D Canada and the Canadian Space Agency also are involved and the spacecraft is expected to become the Canadian government's first operational AIS satellite.

The CanX-6 work also has set the stage for another Space Flight Laboratory AIS mission, this one for the Norwegian government. It launches later this year from India, Zee said.

The laboratory also is currently involved in the development of nanosatellites for a joint Austrian-Canadian program. The satellites will each carry a 3-centimeter aperture telescope, with the first nanosatellite set for launch in late 2009 or early 2010, although the schedule is dependent on the Austrian government.

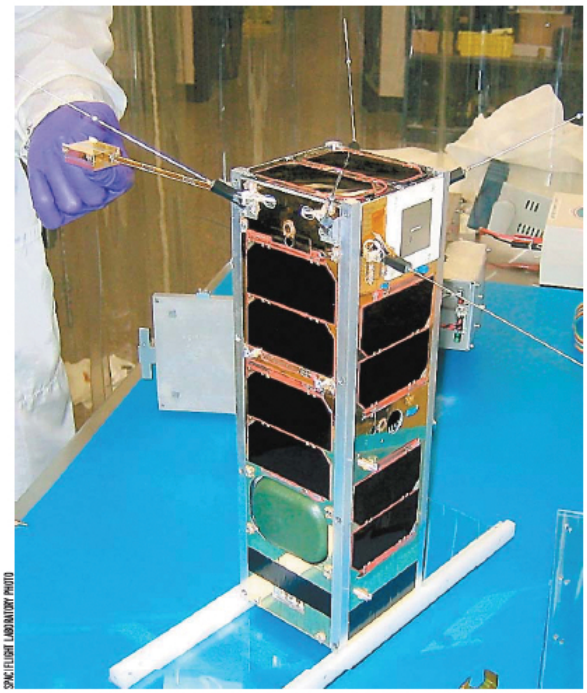
"Right now we're completing the two satellites for Austria, and the Canadian Space Agency is looking to fund two more satellites to complete the constellation," Zee said.

He points out that SFL will continue in the future to focus on microsats and nanosats, with a goal of making that class of spacecraft more capable and cheap enough to be attractive to a wider range of organizations.

The main challenge in that area, however, is coming up with systems to deorbit such satellites after they have expired. As concern over the increasing amount of space debris continues, that deorbit capability will be essential, he added. "If we don't have such technology it might limit our ability to actually implement these missions," Zee said.

Shortt, the Canadian Space Society's president, said SFL's work is causing a ripple effect in the country's academic community as other universities are now exploring the creation of similar laboratories. He said that Zee has successfully created an organization that has retained its academic roots while at the same time developed partnerships with industry and governments.

"It's seen as an opportunity to give students real world R&D [research and development] experience and to actually conduct missions." Shortt said. "So they're getting the best of both worlds."



SPACE FLIGHT LABORATORY PHOTO

The Space Flight Laboratory developed the Canadian Advanced Nanospace eXperiment 2 (CanX-2) nanosatellite, which has been in orbit about a year.

Space Flight Laboratory at a Glance

Mission: Promoting the use of novel technologies in space, such as microsatellites, to bring about lower costs while training graduate students to strengthen the Canadian skill base in space systems engineering.

Director: Robert Zee

Year Established: 1998

Location: Toronto

Budget: $2 million Canadian dollars ($1.6 million)

Employees: 15, plus 14 graduate students

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