REALLY BIG SKY COUNTRY

Alberta scientists in the U.S. space program.

By Harry Vandervlist

Scholars and scientists were the first genuine global citizens. From medieval scholars walking across a fragmented Europe in search of a copy of Aristotle's writings to Charles Darwin filling the Beagle with samples and sketches, curiosity and inquiry have always drawn researchers from one place to another.

Today a scientist's "place" may be decided not by geography at all, but by her most important loyalties. Scientists may be loyal to a group of colleagues connected by e-mail or to a data-collection instrument—a specific satellite, a telescope in Chile or a particle accelerator in Switzerland. (Or to a specific funding body like NASA or the Alberta Heritage Foundation for Medical Research, of course.)

In this context, does it make any sense to talk about "Alberta scientists"? And what would the term mean: Albertans who became scientists, researchers trained in Alberta, or people actually doing science within the province's borders?

If an "Alberta scientist" is one to whom Alberta has made a significant difference—as a birthplace, certainly, but also as a provider of education and research facilities—then it does make sense to say that Alberta has made crucial contributions to current space research. In fact, an Alberta scientist was there at the beginning of the post-Second World War space research boom: the first commercial satellite company was founded in 1963 by Joseph Charyk, an Alberta-born engineer and professor of aeronautics. Charyk pioneered satellite reconnaissance and served as undersecretary of the air force in the United States.

Today Anthony Lui, an Alberta-educated space physicist, is doing important work on the energy disturbances that cause auroras—electrical storms in space that affect crucial communications satellites and even air travel. And as recently as last February, former Calgarian Douglas Hamilton was scrambling to prepare medical research and monitoring equipment to be sent aloft with the U.S. space shuttle.

Like most busy professionals, Doug Hamilton has an e-mail backlog more than 50 messages deep, and he's working overtime to meet a deadline. His schedule is not organized around the next board meeting or the end of the first quarter, however. Hamilton's work as a flight surgeon for NASA revolves around people who revolve around the earth: astronauts in the space shuttle and the international space station. We spoke in February, after a delay in the space shuttle mission to repair the Hubble telescope opened up a small space in Hamilton's schedule.

What qualifies Hamilton to work as an astronaut doctor and space medicine researcher? To start with, the Calgary-born engineer and physician has more letters after his name than in it (30, to be exact: MD, PhD, MSc, Elec Eng, FRCPC, ABIM, PEng, PE). The lengthy chain of abbreviations reflects a long road that started from Elboya School in Calgary. After bachelor's and master's level studies in elec-

trical engineering at the University of Alberta, Hamilton found his way back to Calgary as a computer expert working for the university's medical school. While working with Dr. John Tyberg, a cardiac researcher, he says, "I began to get familiar with the patients and doing rounds and realized I really enjoyed doing medicine. The next thing I knew I was in a master's program with John, which turned into a PhD, which eventually turned into an MD/PhD."

Having turned himself into an engineer/physician, Hamilton soon discovered a shortage of opportunities to exercise this combination of skills. Though he was perfectly suited to fields like telemedicine or medical informatics, Calgary couldn't offer work in those areas. After responding to an ad in a medical journal, the father of two found himself relocating to the Johnson Space Center in Houston, Texas. There, the would-be astronaut (he made the top 20 out of 5,300 applicants to the Canadian Space Agency's program in 1992) works directly with those about to be launched into space.

Hamilton's work involves assuring the health of the astronauts while he collects data for space medicine research. The astronauts are monitored with a special harness that forms part of their spacesuits. Hamilton makes sure these harnesses

ARION PREDIKA

COURTESY DOUG HAMILTON

Dr. Doug Hamilton and a technician at the space shuttle Endeavour's hatch in the Kennedy Space Center in Florida.

will work correctly with the computers on the ground. Here, his engineering training comes in handy. This year, he says, "I had to go out and find the parts to build my own harness simulators. I've got transistors that were last manufactured in the seventies, but I got my grubby hands on 'em. It's amazing what you can get on the Web." Hamilton and his colleagues then test the equipment by sending astronauts into a vacuum chamber wearing their suits. "We make sure they're instrumented and we have to make sure our computer displays are properly working for the flight surgeons here."

This year's mission sees the first use of upgraded equipment Hamilton describes as bringing NASA's medical monitoring "into the 21st century." After an exhaustive search, Hamilton selected and modified new technology to meet much more stringent demands than similar devices used in hospitals. For one thing, it's imperative that medical communications never interfere with the space shuttle's navigation and guidance. "We don't want to send bad signals and have the shuttle turning upside down," Hamilton says. And while hospitals strive to protect the security of medical records, NASA transmissions must be ultrasecure, since, as Hamilton points out, "every hacker in the world is trying to get into Mission Control."

All this preliminary work gives Hamilton the chance to closely monitor the astronauts—for example, while they are doing spacewalks. "This is a Hubble repair mission and we're doing five spacewalks, which is a very aggressive schedule. My intention is to be able to analyze all the data and hand in a report within a half hour of the hatch closing," he says. Some

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of the data collected on the current flight may also have a non-scientific purpose, Hamilton admits. "A couple of astronauts have never done a spacewalk before, and they want me to capture their heartbeats as they open the hatch and look out for the first time. They want me to make a really good job of it because they want to frame it and put it up in their house."

When not working with shuttle astronauts, Hamilton also monitors and consults with those working in the international space station. In both situations his blend of medical and technological expertise serves him well. "I have been blessed by getting my clinical background, but with the engineering education I received I can understand a lot of the technology and what's behind it," he says.

"When my patients are whirling around the earth at 17,000 miles per hour and I'm on the ground, you have to know a little bit about the kind of devices and communication structure you're using. Otherwise you don't know how good that data is." Working at the Space Center is not like working in a hospital, he explains. "A hospital is a medical-centred environment, and the engineer is the outsider sitting in the bowels of the basement making the computers run. It's a role reversal here—I'm a doctor and this is an engineer-centred environment." With a foot in both worlds, Hamilton often finds himself filling in the communications gaps between other engineers and medical doctors.

It's pointless to inquire whether Hamilton might have been happier to exercise his skills closer to home: there is no space flight centre in Alberta. However, he does tell the story of a fellow flight surgeon who returned to Houston after attending a medical conference in Banff. "When he came back he drove to my office, walked in my door and said, 'You are insane! What are you doing here? Why don't you live up there? It's the most beautiful place in the

world.' I said, 'If you can get the space program to move up to the Rockies…'"

Despite the impossibility of practising his skills in Canada, Hamilton feels strongly about using his Canadian education to encourage students to follow in his footsteps: "I don't think there's ever been a trip to Canada I've done where I haven't done something in a school, to get the kids going." He feels Canadians have something unique to offer. "We're a little more open-minded, I think; we're more creative and we think a little bit differently." As a Canadian working in a U.S. facility full of international visitors, he finds he feels comfortable with everyone. "Alberta, and Calgary in particular, is known for hospitality, and that rubs off. It's easier to meet people—and there are some very serious people in this building."

With research missions to Mars and more satellites around the earth, forecasting "space weather" is increasingly important

What Alberta-trained space physicist Anthony Lui remembers most about Calgary is the wind whistling down Crowchild Trail. "When I was a graduate student I shared an apartment very close to the Brentwood Mall," he recalls. "At that time I was working very hard and I would just go back to my apartment for dinner, then after dinner I would go back to the lab. The one thing that sticks in my mind even now is how windy it was and how cold it was even in the summer time." He tries to remember the song he associates with his years in Calgary. "'Four Strong Winds,' that's what it was called."

That Lui should recall the Calgary wind (and an Ian Tyson song) is very apt, since his current research at the Applied Physics Lab at Maryland's Johns Hopkins University has to do with solar winds and "space weather." Solar wind consists of all the material—a million tons each second—continuously thrown into space by the violent activity on the surface of the sun. This material carries with it part of the sun's magnetic field. As this wind blows through the solar system it collides with the earth's own magnetic field to create violent disturbances—like the aurora borealis, or "northern lights."

When Lui first came to Calgary from Hong Kong at the end of the sixties, he did not yet know his graduate research would focus on the various types of auroras, and the events that initiate magnetic storms. Once he arrived, he discovered that Dr. D.C. Anger had access to the first satellite-based imagery of auroras through the Canadian satellite ISIS 2. At the time, the U of C was "one of the strongest schools in Canada, or internationally, in space physics," says Lui. He completed his MS in physics with research based on the satellite data.

"We have a basic understanding that auroras are due to electrons coming down from space, from a region we call the magnetosphere," he explains. "After looking at aurora pictures for some time, I was interested in studying what causes the aurora, what causes the electrons to come down." This led Lui to research the onset of substorms in the magnetosphere.

His curiosity about space led him on an increasingly international trajectory as a student. In the summers of 1972 and '73, he travelled to the famous Los Alamos lab in New Mexico, where U.S. scientists were using satellites to monitor compliance with the ban on nuclear tests in the upper atmosphere. Their satellites allowed Lui to measure charged particles in space.


Dr. Anthony Lui

"The scientists there wanted me to stay in Los Alamos, but at that time I was rooted in Calgary so I said no," Lui recalls. While he continued doctoral research at U of C, he also visited the Geophysical Institute at the University of Alaska to work with S. I. Akasofu, the world authority on auroras. In 1977, he moved on to a research associate position at the Herzberg Institute of Astrophysics of the National Research Council of Canada. "After that I got calls from the Applied Physics Lab at Johns Hopkins University," he recalls. The lure of more and better satellite data led Lui to move. "The NRC wanted me to stay as a science officer, but the APL has a lot more laboratories and programs. At that time, Canada wasn't too active in sending out satellite missions: I was part of a committee to propose two Canadian satellites to study space, but it was moving very slowly and they never got funded. Looking back, I guess I made the right choice because of the number of satellite projects based here."

Lui's research is a perfect example of the way highly theoretical science often turns out to have unsuspected practical applications. At first his interest in substorms was motivated purely by a desire to understand nature. Now, with research missions to Mars and greater satellite activity around the earth, forecasting "space weather" is increasingly important. Lui likens it to the need to forecast earth weather. "In the old days, all people cared about was the local weather. Then we had globetrotters who wanted to know about global weather. And now we are trying to predict the space environment. We now have people willing to pay millions of dollars to go into space—they'll want to know what's going to happen." Even if "space tourism" remains a novelty, such predictions already help prevent damage to satellites. They are even used by airlines flying polar routes at high altitude, because of the danger

of high radiation or communication disruptions during extreme magnetic disturbances.

Since moving his research to Johns Hopkins, Lui has maintained contacts with Calgary researchers such as Professor LeRoy Cogger. His own globetrotting career demonstrates the challenge faced by any jurisdiction that would like to claim researchers as its own. From Hong Kong to Calgary to Alaska to Maryland, Lui has had to go wherever the best satellite data and the most active research teams could be found.

Hamilton and Lui are among hundreds of scientists born or trained in Alberta who are now developing space science around the world. Yet much of their work was made possible by an Alberta-born scientist who was there in the very earliest days of the field. At a time when space science was closely associated with Cold War military applications, Joseph Charyk became a leader in the development of satellite technology. The son of Ukrainian immigrants, Charyk graduated from the University of Alberta's engineering program in 1942. Just over 30 years later, in 1973, he was elected to the U.S. National Academy of Engineering in recognition of his pioneering contributions to space flight. Last year, his work was recognized by the CEO of Lockheed Martin Global Telecommunications, John V. Sponyoe, at a Princeton University symposium on the future of global telecommunications: "Today, there are some 750 active satellites hovering above our planet, allowing us to watch television from exotic locales, place a phone call to virtually any place on earth or withdraw cash from our account in Washington via a bank in New Zealand. And it's because of pioneers like Joe Charyk that such activities have become commonplace."

COURTESY ANTHONY LUI

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Dr. Joseph Charyk

Charyk's involvement in space science began with a post as professor of aeronautics at Princeton. He went on to direct Lockheed Aircraft's astrophysics and chemistry laboratory. Just as the Cold War was approaching its crucial years, Charyk took up the position of undersecretary to the U.S. Air Force. When John F. Kennedy became president in 1961, he created a national reconnaissance office to oversee early satellite surveillance activity. According to Air Force historian Cargill Hall, this agency was "made a classified organization whose existence was known only to those directly involved. (For many years even the name of the office was classified Secret)." As Air Force undersecretary, Charyk became one of the joint directors (along with CIA deputy director Richard M. Bissell Jr.). Among his activities during this period was the approval of the secret SR-71 spy-plane program in December 1962.

In the hyperalert era of the early 1960s, nothing could be more consequential than the kind of intelligence gathered by high-altitude aircraft like the SR-71 and by reconnaissance satellites. The existence of a "missile gap," by which the U.S.S.R. supposedly had outstripped the U.S. in the deployment of strategic missiles, was refuted as a result of satellite intelligence. Later, such surveillance enabled the verification of missile treaties.

In 1963, Charyk moved to the private sector and founded Communications Satellite Corporation or COMSAT, later INTELSAT, responsible for launching Early Bird, the first commercial telecommunications satellite. Global satellite communication became possible four years later. This, in turn, made it possible for viewers to watch Neil Armstrong set foot on the moon in 1969, in the first live global television broadcast. (On that day in 1969, a young Doug Hamilton, who had dismantled his family's TV set out of curiosity, was hastily re-assembling it in time to see the lunar landing.)

The development of orbiting satellites continued in tandem with the Cold War. Satellite link technology enabled the famous "hot line" between Washington and Moscow. Through the 1970s, satellites became more essential to the worlds of commerce and entertainment as well. The first international tests of the Internet, with its reliance on satellite links, were performed in 1977. Worldwide broadcasting of soccer matches began in 1978. It's no exaggeration to say that instant access to broadcasts and databases anywhere in the world—something taken for granted today—became possible as a result of technology originally developed under Dr. Charyk's direction. In 1989, with the Berlin Wall reduced to rubble and the Cold War over, Charyk was awarded the U.S. National Medal of Technology for his role in growth of the INTELSAT system, now used by 160 countries.

Despite the ever-increasing internationalization of all aspects of science, it remains clear that Albertans and Alberta institutions have played an important role in the field of space science. Will these contributions continue in the future? Doug Hamilton thinks it's imperative to encourage young students to ensure those contributions. In fact, he's so convinced, he's willing to correspond with students interested in his own field: "If answering an e-mail helps get the kids engaged, whether it's in space or in technology, I'll try to answer them.

"I am truly a blessed person to have been raised in Alberta and to have received the education I did," he says. Ideally, dozens of Alberta scientists will be making similar statements in 2022. Perhaps just last March one such future discoverer was hastily re-assembling a computer, eager to follow World Wide Web updates for the same Hubble repair mission on which Hamilton worked.

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