



Twenty years of Earth system science at UVic

SEOS celebrates 20th anniversary

SEOS students on a field school in the Rockies.

The School of Earth and Ocean Sciences (SEOS) has plenty to celebrate in 2011: a record number of student enrollments, leading roles in innovative science projects on an international level, and a solid future. This year marks 20 years of teaching and research on some of the most compelling questions facing our planet.

Established in 1991, the school was the first in Canada to develop curriculum where the earth is studied as a system by combining earth sciences, atmospheric physics and oceanography in one program. "We took a novel approach from the outset, integrating specialties in geology, geophysics, oceanography and atmospheric sciences into a single school," says Chris Barnes, professor emeritus and SEOS' founding director.

This approach has paid off. The school has a very strong undergraduate program in earth system science where students are trained, not only in geology, but also in oceanography and atmospheric science and obtain an understanding of how all three are inter-related.

SEOS faculty are engaged in research covering the full geoscience spectrum from acoustical oceanography to climate modelling, attracting graduate students from across Canada. With the assistance of post-doctoral fellows and the use of specialized research facilities, these groups are on the forefront of geoscience technology.

The school spent the first decade building the academic unit, ultimately growing to 22 faculty today from the initial complement of six. "We've built a range of interdisciplinary undergraduate and graduate programs," says Faculty of Science Associate Dean Kathy Gillis,

and director of SEOS from 2003 to 2010. "Because we were the only ones in Canada with an earth system approach, we attracted outstanding researchers."

During its second decade, SEOS influenced the university to establish earth, ocean and climate science as one of its research and teaching priorities. The genesis of the "big science" projects of NEPTUNE Canada and VENUS began during this period within the school, although today these projects operate separately from SEOS under Ocean Networks Canada.

In 2008, a new state-of-the-art building—the Bob Wright Centre for Ocean, Earth and Atmospheric Sciences—united under one roof all members of the school, who were previously spread out among seven buildings on campus.

To strengthen its research and educational programs, from its earliest days, SEOS built solid collaborations with industry and the government labs in the region, such as Natural Resources Canada, Fisheries and Oceans Canada, Environment Canada and the BC Geological Survey. Today SEOS has 56 adjunct professors. SEOS undergraduate and graduate-level students benefit from access to all that intellectual power.

"We've achieved, within 20 years, a level of excellence of which we can be proud," says the school's current director, Stephen Johnson. "This school has positioned UVic and its students to be able to contribute on a local, national and international level to the most pressing issues facing the earth today."

SEOS by the numbers:

Alumni: 357

Undergraduate Students:

1991–1992 – **42**

2010–2011 – **176**

Graduate students:

1991–1992 – **16**

2010–2011 – **81**

Research Funding

1991–1992 – **\$565,000**

2010–2011 – **\$4.8 million**

DEAN'S MESSAGE



Welcome to this edition of *Science Matters*. I wish to take this opportunity to congratulate the School of Earth and Ocean Sciences (SEOS) on the occasion of its 20th anniversary. SEOS, like all Faculty of Science departments, is conducting world-class research that is making an impact, not just on the discipline, but on society as

well. The stories in this newsletter clearly show this. At the same time these stories represent just a small fraction of the exciting science research taking place on campus and beyond.

We are immensely proud that professors Dante Canil and Julio Navarro have been named Fellows of the Royal Society of Canada, and that professor Andrew Weaver has been awarded the Miroslaw Romanowski Medal. These distinctions illustrate that UVic Science is having an impact and making a difference. It is also significant that professor Gary McGillivray, department of mathematics & statistics, has won the Harry Hickman Award for Excellence in Teaching. Not only is that a most deserved personal achievement for Gary, but it serves as a reminder that in addition to research, UVic Science is committed to teaching excellence.

In the spring 2011 edition of *Science Matters*, we featured a story on a new graduate program in neuroscience. I'm pleased to report that it received approval from the Ministry of Education and the first students registered in September.

I hope you enjoy this newsletter, and that you will be able to sense the excitement I feel everyday about the activities and the future of the UVic's Faculty of Science.

Rob Lipson

New chair focuses on the health of people and forests

Imagine the day when we can use a simple screening test to detect diabetes, cardiovascular disease or cancers in their early stages—or have new and improved drugs for the treatment of AIDS and Creutzfeld-Jakob disease. How about the day when we can breed trees that naturally ward off attacks by pests like the mountain pine beetle or are super-efficient at storing carbon and reducing global warming?

Those days might not be far off, thanks to a new research chair recently awarded to the University of Victoria. The Don and Eleanor Rix BC Leadership Chair in Biomedical and Environmental Proteomics will investigate the use of cutting-edge proteomics technologies and techniques to improve human and forest health.

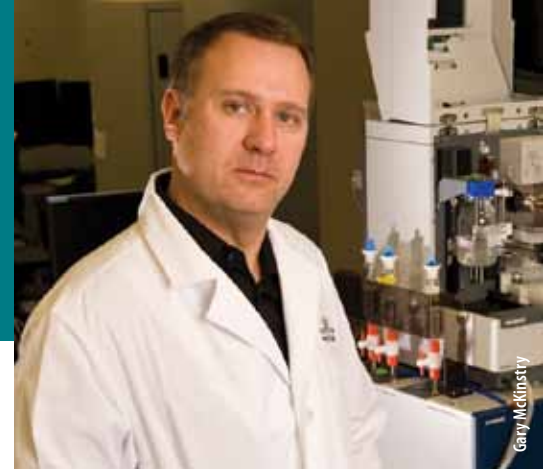
The chair comes with an endowment of \$4.5 million—with equal contributions from the Rix Family Foundation and the BC government's Leading Edge Endowment Fund (LEEF). The chairholder is Dr. Christoph Borchers, a proteomics pioneer who has headed the UVic-Genome BC Proteomics Centre since 2005.

Donald Rix was a leading physician and philanthropist and an active member of the biotechnology industry. He was chairman of LifeLabs Diagnostics Inc., with over 80 labs across BC, and chairman of Cantest Ltd., one of Canada's leading analytical laboratories. He died in 2009, and his wife, Eleanor, died in 2007. Their daughter, Laurie, chairs the Rix Family Foundation.

"This new chair builds on UVic's strengths as a national leader in the development, use and application of proteomics technologies for improving human and environmental health," says Dr. Howard Brunt, UVic's vice-president research. "We're deeply grateful to the Rix family and to the province for supporting this prestigious chair."

Proteomics is the study of all the proteins—antibodies, enzymes and structural molecules—that are directed by genes to keep cells functioning and healthy. It is applicable to just about every area of biomedical investigation, including health, agriculture, fisheries and forestry.

The chair program will support a research and training program in proteomics at UVic, primarily through the UVic-Genome BC Proteomics Centre. It will combine technology development, applications to biomedical and environmental sciences, and commercialization through spinoff companies and industry partnerships.



Borchers

Probability in chaos

Mathematician Anthony Quas is an expert in dynamical systems, an important area of mathematics that has blossomed in the computer era. Quas applies the techniques of probability to the study of ergodic theory, which makes predictions about the average long-term behavior of chaotic dynamic systems. A dynamical system is any system that changes over time according to some predetermined rule, such as planetary motion being governed by the laws of gravity, or systems that model weather behavior.

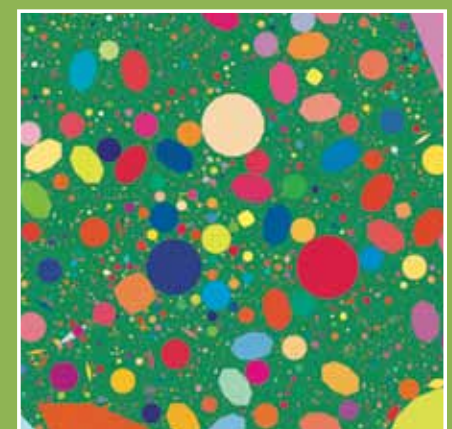
"Dynamical systems is the elaborate term for chaos theory," explains Quas. Chaos in mathematics involves the study of these systems, where small disturbances in initial conditions can have a dramatic long-term effect. This sensitivity is known in popular culture as the "butterfly effect," from a paper by Edward Lorenz—a pioneer of chaos theory—titled: *Predictability: Does the Flap of a Butterfly's Wings in Brazil set off a Tornado in Texas?* "It's fascinating, because despite things having a random, unpredictable element, you can make

strong predictions about the cumulative effects of random things," says Quas.

Research mathematics is about constructing a theory that describes the relationship between phenomena, he explains.

A particular focus for his work recently has been the use of dynamical systems methods in the study of mixing in ocean systems. The principal goal is to describe obstructions to mixing in the ocean. Many things get pumped into the ocean and one would assume it's all gradually incorporated and becomes equally dispersed. In practice that does not always happen. There are great regions of the ocean that mix very poorly, such as in gyres—large systems of rotating ocean currents. Quas' theory is geared towards locating these gyres and the mechanisms behind them.

In addition, Quas, a Canada Research Chair, is interested in the dynamics of expanding maps, information theory, statistical mechanics and percolation theory.



These vivid images might appear to be random sets of colourful circles, but they are in fact precisely calculated periodic domains in a piecewise isometric dynamical system—part of a family of dynamical systems whose properties Quas' work is elucidating.

Alumni profile

Medical physics alumnus heads to Stanford

Karl Bush is fast tracking his radiation oncology physics residency with the BC Cancer Agency's Vancouver Island Centre so he can begin the next chapter of his career, one which has a steeply rising trajectory.

The gifted young scientist has accepted a faculty position with Stanford University's School of Medicine, starting January 2012. As a clinical assistant professor with the Department of Radiation Oncology, he'll primarily be conducting research in medical physics, an area in which he is already earning an international reputation.

Bush obtained all of his degrees at UVic—a bachelor of physics in 2003, his masters and PhD in medical physics in 2006 and 2009 respectively. It was in a third-year medical physics class that Bush began to appreciate the hands-on application of physics and to realize the potential of how to use his degree.

Bush did graduate-level and post-doctoral research on methods to more accurately determine radiation doses that

cancer patients receive during radiotherapy. His work has helped to improve the calculation speed for determining this critical piece of information, resulting in methodologies that now take a tenth of the time. It's credited with providing anyone in the medical physics profession a way of running calculations for radiation doses on desktop computers, resulting in very precise treatment plans, better-focused radiotherapy, and improved patient safety and treatment outcomes.

"The potential impact of Karl's work has been repeatedly noted by prominent members of the medical physics community whose research is similar," says Dr. Andrew Jirasek, one of Bush's PhD supervisors. "His work is significant not only for its novelty, but because it can be incorporated by other research groups, having a positive impact in a wide range of applications. This is a rare accomplishment."



Katherine Blake

Karl Bush in front of a radiotherapy accelerator at the BC Cancer Agency. Completing his undergraduate and graduate studies at UVic stood him in good stead for securing a faculty position at Stanford University. He'll move with his wife, Laura Benard (BSc Biology 2004), and two young children, to California in January.

Wasp seeks surrogate conifer mother

Researchers working in a joint Canada-France project can attest that surrogate motherhood enslaves conifer ovules. Along with collaborators in Avignon and Orléans, four UVic biologists are investigating how a group of insects are able to invade ecosystems. The three-year project, funded by a \$900,000 grant, will directly contribute to improving policy on international seed transfer.

Principal UVic investigator, Patrick von Aderkas, along with colleagues Steve Perlman, Jürgen Ehling and Jean-Noël Candau, aim to understand the details of parasitism and link these to the consequences of invasion.

Female chalcid wasps lay their eggs inside the developing conifer seed, in "a brazen deception worthy of the slickest con artist," fooling the tree into housing and feeding its larvae until they metamorphose and emerge. In some years this parasitism can destroy entire seed crops in cedar and Douglas-fir forests.

Human trade in seed unwittingly results in international distribution of the insects, which travel in the seed. In southern France, for example, as few as 20 female wasps have been responsible for an outbreak that has parasitized all the cedars near Avignon.

The project, aptly named *The Biology of Invasion*, spans many levels of investigation – from molecular mechanisms to mathematics.



JN Candau

Chalcid wasps

Infested conifer seed: some seeds are empty, some have plant embryos and others have insect larvae.

JN Candau

RESEARCH PROFILE

Alexandre Brolo, Chemistry

Imagine a gold cube so small that its cross-width is about 10,000 times smaller than the diameter of a human hair. The colour is not the usual yellow we associate with gold because metals at those dimensions change colour when molecules stick to their surface. Chemist Alexandre Brolo looks for new ways to fabricate very small metallic structures and explores their properties in a variety of applications, such as sensors for cancer diagnostics and the fabrication of more efficient solar cells.

Brolo is one of Canada's most accomplished young physical-analytical chemists. He is an expert in plasmonics—the phenomenon that arises when light interacts with the electrons in metals at the nanoscale. His research focuses on the use of these metallic nanostructures for use in biosensors—analytical devices which convert biological responses into electrical signals. These biosensors are used expressly for detecting specific biological markers for diagnosing cancers, with Brolo's current projects investigating lung and ovarian cancer.

Brolo's research program has attracted more than 50 coworkers, including undergraduates, graduates, postdoctoral fellows and visiting international graduate students. Also very skilled at fostering collaborations with researchers whose expertise complements his own, Brolo has initiated multidisciplinary collaborations with oncologists, immunologists, physicists and engineers.

He was the recipient of a visiting professor fellowship from the Brazilian government in 2007 and in 2010 the Faculty of Science awarded him its Research Excellence Award. In May 2011, the university recognized him with the Craigdarroch Silver Medal for Excellence in Research.

Since joining UVic in 2001, Brolo has become a high-impact contributor to the field of applied photonics (detecting and manipulating light for technical applications) and has established an international reputation in spectroscopy and nanochemistry.



Brolo

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DISTINGUISHED LECTURE SERIES

All is not lost: Successful brain aging

Nearly 400 people attended a free public lecture Sept. 21st to hear Stanford neuroscientist Robert Sapolsky present a fascinating and funny look at human beings' favourite organ—the brain. Through his incredible story telling ability, Sapolsky shared his research on the aging brain, answering questions on how a lifetime of wear and tear translates into the nuts and bolts of brain-function decline. His presentation considered some of the most common and terrifying neurological diseases of aging—Alzheimer's, Parkinson's and Lou Gehrig's. The humor and humanity he brought to what is sometimes-sobering subject matter made Dr. Sapolsky a fascinating speaker.

The Faculty of Science brought Sapolsky to campus as its fall 2011 Vifor Pharma Distinguished Speaker. Over the past five years, Vifor Pharma has generously sponsored this highly successful distinguished lecture series. It has enhanced and inspired the academic pursuits of students and faculty at UVic and has been a tremendous intellectual resource for the local community.

Making a mark Faculty milestones & achievements

Three UVic scientists earn national honours

Two University of Victoria scientists have joined the ranks of Canada's academic elite. Geologist Dante Canil and astrophysicist Julio Navarro have been elected fellows of the Royal Society of Canada for their outstanding scholarly and scientific achievements. The distinction is considered Canada's highest academic honour.

Canil is an international leader in the study of the Earth's mantle, the super-heated layer of rock below the crust that makes up about 85 per cent of the planet's mass. His pioneering work has greatly expanded our understanding of the volcanic rocks that host diamonds, the ancient deep regions of the continents, and the evolution of oxygen in the Earth and atmosphere.

Navarro is one of the world's leading astrophysicists whose research on galaxy formation and evolution—primarily using sophisticated computer simulations—has shaped our current understanding of how such structures in the universe are formed. He is especially well known for his work on dark matter, a mysterious substance that astronomers speculate holds galaxies together and influences the expansion of the universe.

The society has also awarded its 2011 Miroslaw Romanowski Medal to UVic climatologist Andrew Weaver (BSc 1983) for "his exceptional research achievements, scholarly writings and resolute efforts to share his knowledge on climate change [which have been] critically influential the world over."

Weaver is one of the world's leading authorities on climate change. He is recognized nationally and internationally as a leader in climate modelling and analysis and, in particular, as an expert on the role of the ocean in climate variability and change. His recent research on ancient climates has contributed significantly to our understanding of climate change and variability over the last 130,000 years of Earth history.



MacGillivray

Harry Hickman Alumni Award for Excellence in Teaching

Mathematics and statistics professor Gary MacGillivray (BSc 1985, MSc 1986) has won the Harry Hickman Award for Excellence in Teaching. MacGillivray is recognized for "investing a great deal of effort both in class as well as out of class to support the success of his students."

His all-encompassing philosophy of teaching as something much more than simply lecturing to a class is lauded by colleagues and students alike. He is known for his down-to-earth approach and sincere interest in the welfare of his students. He has been teaching at UVic for 19 years and will receive the award at UVic's Legacy Awards gala in November.



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