



McGill

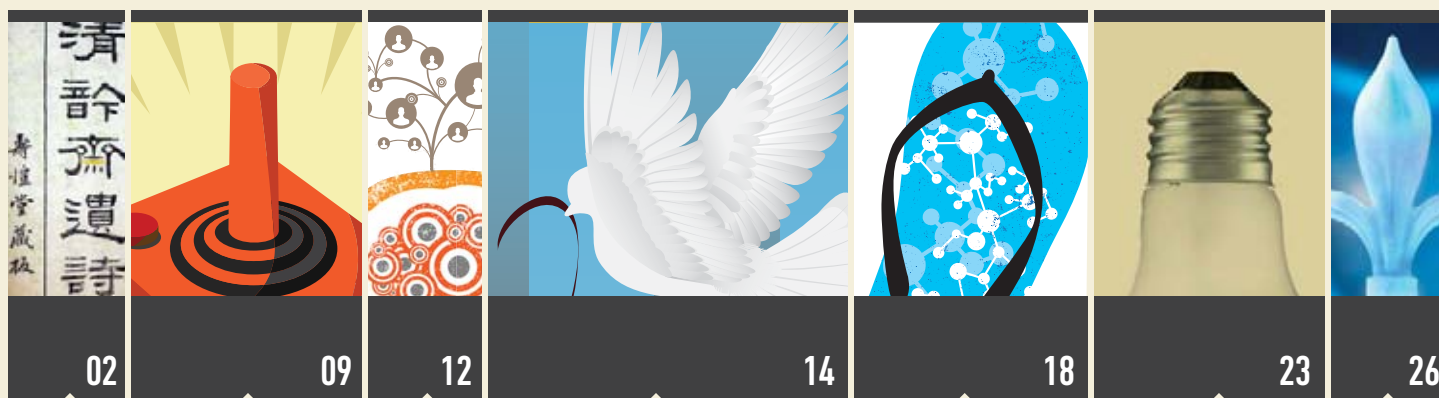
headway //

7.1
SPRING 2013
RESEARCH
INNOVATION
DISCOVERY

DOVE OF HOPE

OVARIAN CANCER HAS MYSTIFIED
ONCOLOGISTS FOR DECADES.
A NEW DISCOVERY COULD
REVOLUTIONIZE TREATMENT
OF THE DISEASE.





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MESSAGE
from
DR. ROSIE GOLDSTEIN
VICE-PRINCIPAL
{RESEARCH + INTERNATIONAL RELATIONS}

What makes McGill's research unique? What common characteristics define our work and bind us together as a community? What fields will demand our attention or produce the greatest breakthroughs in the next decade? //

Over the past two years, I have asked these questions countless times during the extensive consultation process that ultimately formed the basis of the University's renewed Strategic Research Plan (SRP) 2013-17. I met with hundreds of McGill faculty, students, staff and external partners to discuss their research goals, challenges, and priorities for the coming years. The result is a document that we feel, in its content and structure, best encapsulates the overarching themes that emerged through the extensive outreach effort.

So what is a strategic research plan? The simple response is that it is a government requirement needed for many grant applications, for example, for the Canadian Foundation for Innovation, as well as an essential tool that informs strategic resource allocation, such as for Canada Research Chairs. Beyond this, though, we viewed drafting this document as an opportunity to create a reference for reporting, fundraising, and promoting our world-class researchers and students.

With these goals in mind, the SRP articulates some of the characteristics that define how and why certain research is unique in quality and accomplishment at McGill. For me, the key idea that emerged was the power of inquiry. As researchers, interesting questions motivate us. The most challenging questions enliven our minds like a new romance, compelling us to learn, feel, and grow in our pursuit of answers. This passion for research permeates the McGill community; it is palpable and inspiring.

How then can we summarize this desire, this drive? In the end, we chose to include five cross-cutting, interdisciplinary concepts in the SRP, which we identify as McGill's "core commitments." They are:

- IDEAS — supporting excellence in all forms of research, whether basic, applied, or somewhere in between
- INNOVATION — placing a new emphasis on translating research into social, pedagogical, organizational, and technological progress
- SUSTAINABILITY — making this concept a central component of what we study, how we approach our work, and what we are doing to ensure the long-term viability of our infrastructure and core facilities
- COLLABORATION AND PARTNERSHIP — building new connections and expanding existing ones on our campuses and with external partners
- SOCIAL ENGAGEMENT — embracing McGill's role as an active and responsive member of local, regional, and global communities

The SRP is being released at approximately the same time as this issue of *Headway* (you can read it at www.mcgill.ca/research/SRP), and you will see elements of the SRP more and more going forward. In fact, the SRP's influence can be felt throughout the following pages, where you will encounter numerous questions whose answers shape or will shape our world. I hope these stories of excellence-driven research inspire you to ask a few of your own.



The Ming Qing Women's Writings (MQWW) project is an online digital archive of women's writing in China during the Ming and Qing dynasties, from 1368–1911. These collections of writings provide a trove of information about literature, history, politics and gender in pre-modern China.

Their digital versions also provide access to primary source material that is physically available only in rare book libraries such as the Harvard-Yenching Library and the Peking University Library.

For example, as displayed on the iPad above, a young girl's first poem, entitled "On the Round Moon" (咏圓月).

Gan Lirou is seven years old (七歲) and the daughter of a scholar-official in 18th century China. Her poem brims with childish curiosity about the phases of the moon.

*Who sent Wu Gang's axe
誰使吳剛斧
Clearly to chop it exactly round?
分明削正圓
How come not long after it's been full
如何望未久
Again a crescent forms where it has waned?
缺處又成弦*

Gan would go on to write hundreds of poems about the various phases of her life: as a girl, a wife and daughter-in-law, a mother and young widow, and as an elderly woman. The entire opus of her work can be found online in the MQWW archives.

The MQWW project is the most popular digital collection in the McGill libraries, used most frequently by scholars in: China, USA, Taiwan, Canada and Hong Kong.

Grace Fong's research is supported by the Social Sciences and Humanities Research Council of Canada and by the Henry Luce Foundation.

FROM BRUSH TO BIT// DIGITIZING CHINESE LITERARY COLLECTIONS



Chinese literature professor GRACE FONG leads the MQWW project, which recently obtained a grant from the Luce Foundation to collaborate with the National Library of China to digitize 228 additional collections of women's writings from the Qing dynasty. Her recent publications include *Herself an Author: Gender, Agency, and Writing in Late Imperial China*, featuring the writings and biography of Gan Lirou.

ROBOTS TO THE RESCUE



IMAGINE DESCENDING TO THE BOTTOM OF A PITCH-BLACK MINE OR CRASHING THROUGH A WINTRY OCEAN TO AN ICE-BERG TO GATHER INFORMATION ABOUT THAT ENVIRONMENT. Not too pleasant for the most hardy of creatures, not even robots.

But because robots can venture into extreme conditions where humans would struggle, the newly created NSERC Canadian Field Robotics

Network (NCFRN) aims to refine robotic technologies so that these machines will be able to withstand challenging environments and to communicate with one another about the data they collect.

Led by McGill University computer science professor GREGORY DUDEK (see also p.23), the network focuses on robotics in four domains—land, air, water and human settings. In February, the initiative received a \$5-million-dollar Natural Sciences and Engineering Research Council of Canada (NSERC) Strategic Network Grant.

Indeed, the list of potential contributions robotics technologies can make to human endeavours is impressive. On land, robots can navigate surfaces on other planets such as Mars or travel deep into a mine or contaminated site. Unmanned aerial vehicles and amphibious robots can provide crucial information about aeronautic conditions and aquatic dangers such as icebergs. In human environments, assistive robotics holds promise for improving the quality of life of senior citizens.

Announcing the news at a press conference at McGill, the Honourable Gary Goodyear,

Minister of State (Science and Technology), emphasized the far-reaching implications of the network's research. "The innovative solutions developed by Dr. Dudek and other researchers like him will be uniquely Canadian, providing tangible benefits to Canadians," he said, adding, with a smile, "I think you can understand why I love my job so much."

Added Dudek, "My first intelligent machine was made out of matchboxes and beads and my first learning program was written on a manual typewriter in the hopes that I could stick it on the computer one day... It's very gratifying to see this lifelong vision come to fruition."

The NSERC Strategic Network Program is funded by Industry Canada and funds large-scale, multidisciplinary research projects that involve collaboration between academic researchers and Canadian-based organizations.

ORDER, ORDRE!

CIVILIAN HONOURS SUCH AS THE ORDER OF CANADA AND THE ORDRE NATIONAL DU QUÉBEC RECOGNIZE EXCEPTIONAL CONTRIBUTIONS TO SOCIETY and three McGill professors were recently named to these select ranks.



RODERICK A. MACDONALD, a professor in the Faculty of Law, was named to the Order of Canada for "his accomplishments as a legal scholar, notably his contributions to the advancement of law and policy in Canada and abroad." Macdonald has served on a number of provincial, federal and international

commissions and was also the first law professor to act as the President of the Royal Society of Canada, between 2009 and 2011. In recognition of Macdonald's leadership of the RSC, the Society recently announced that its library at its new Ottawa headquarters will be named the Macdonald Reading Room.

WAGDI GEORGE HABASHI, professor of mechanical engineering, and BARTHA MARIA KNOPPERS, director of the Centre of Genomics and Policy, were nominated to the Ordre National du Québec. Habashi, a Knight of the Ordre, was recognized for his pioneering research in computational fluid dynamics and



its contributions to aviation and aerospace safety. Knoppers, an Officer of the Ordre, was lauded for her influential research in a host of subjects in biomedical ethics, from stem cells, cloning and assisted reproduction to public health and pharmacogenomics. She was also recognized for her work with national and international organizations such as UNESCO and the Human Genome Organization.

KILLAM KUDOS

ADMINISTERED BY THE CANADA COUNCIL FOR THE ARTS, the Killam Program's prizes and fellowships are an illustrious recognition of outstanding academic scholarship. Two McGill professors received Killam awards beginning in 2012:

COLIN CHAPMAN, professor of anthropology and environment, received a Killam Research Fellowship to conduct research in Kibale National Park in Uganda, where he is examining how changes in climate affect disease transmission between humans and primates. The research fellowships, awarded to seven recipients across the country considered to have an outstanding reputation in their area of research, provide funding of \$70,000 a year for two years. These funds allow professors to take a break from teaching and administrative duties to pursue independent



research—in Chapman's case, in the field of primate ecology and conservation.

MARK WAINBERG, director of the McGill University AIDS Centre and professor of medicine, microbiology and immunology, was awarded the 2012 Killam Prize in Health Sciences in recognition of exceptional career achievements in HIV/AIDS research. Wainberg, who received the \$100,000 prize in a ceremony at Rideau Hall, is known for first identifying the



compound 3TC, a discovery that was key to the development of one of the most valuable anti-viral HIV drugs. His research is also global in scope and current collaborations include an initiative that seeks to prevent the spread of HIV infection in southern Africa.

The Killam Program offers awards to outstanding Canadian scholars working in the humanities, social sciences, natural sciences, health sciences and engineering.

THE LATEST EXERCISE TREND: BRAIN TRAINING



IN THE SAME WAY THAT SPRING TRAINING IS INTENDED TO WHIP BASEBALL PLAYERS INTO SHAPE FOR THE UPCOMING SEASON, so can you put your brain through the paces and fend off dementia in old age with a new cognitive training project offered by the McGill Centre for Studies in Aging and the Douglas Mental Health University Institute. Called PONDER (Prevention of Neurological Diseases in Everyone at Risk),

the initiative is led by associate professor of psychiatry JENS PRUESSNER, who points out that the more we use our minds, the less likely we are to, well, lose them.

"Studies show that cognitive training has a significant effect on preserving high cognitive function in old age. The idea is that the more intellectual capacity you have to begin with, the more of a buffer you have that will prevent you from being afflicted with neurodegener-

ation or dementia," he says. "Dementia is like descending a mountain—it takes longer to reach the bottom if you start at 1,000 feet than if you start at 100 feet."

To start climbing: the PONDER website (ponder.mcgill.ca) offers a series of online games that progress from encouragingly easy (repeat the sequence of one or two flashing lights as they travel across your screen) to revealingly aggravating (repeat the sequence of seven traveling, flashing lights and realize after three failed attempts that your brain is in some serious need of regular working out).

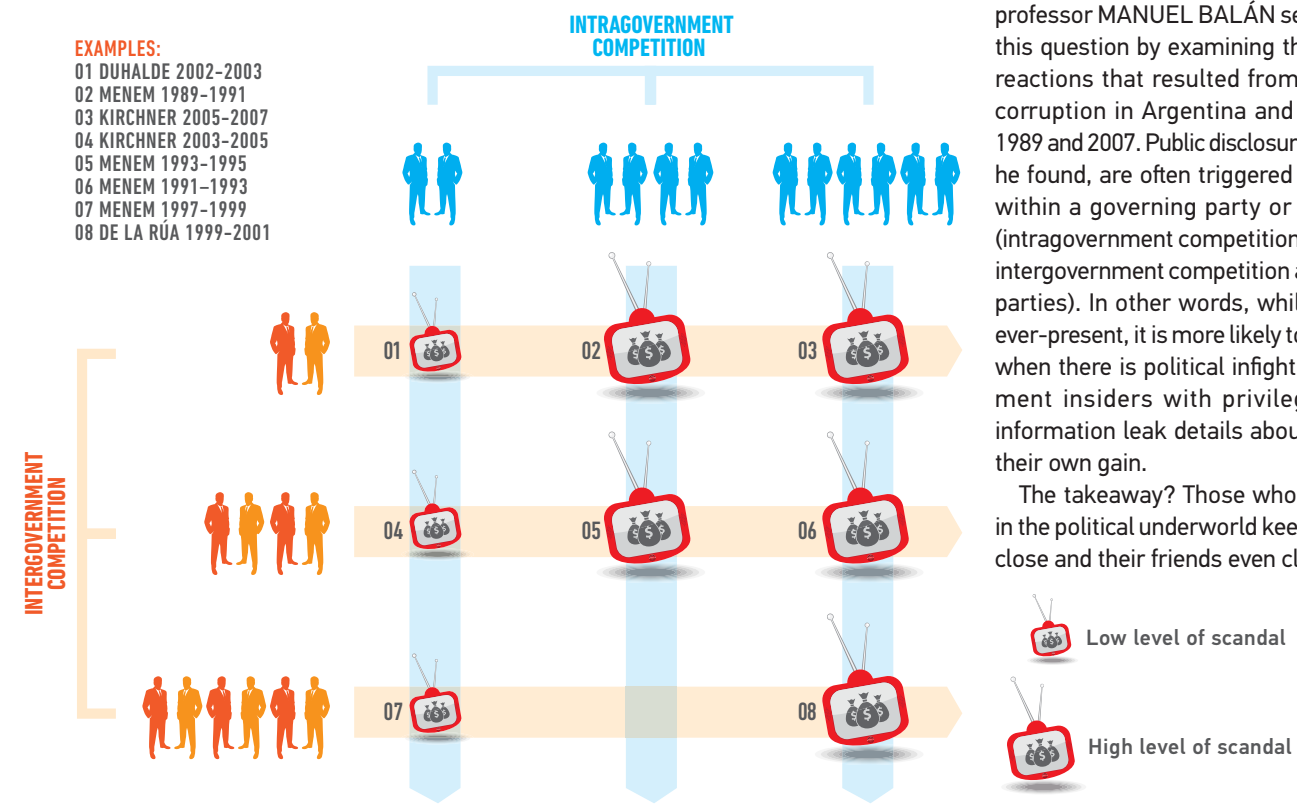
The project encourages participants to register, which gives players access to the full series of games rather than a sample, and which will also allow researchers to create a database of longitudinal cognitive assessments, providing further insight into intervention and treatment of dementia such as Alzheimer's and Parkinson's disease.

So what are you waiting for? Get those neurons firing!

Jens Pruessner's research is funded by the Canadian Institutes of Health Research, the Natural Sciences and Engineering Research Council of Canada, the Alzheimer Society of Canada, Fonds de recherche du Québec — Santé and the donors of the McGill Centre for Studies in Aging.

CORNERING CORRUPTION

LEVELS OF SCANDAL VS LEVELS OF INTRA / INTER GOVERNMENT COMPETITION [ARGENTINA]



WHY DO SOME ACTS OF CORRUPTION BECOME PUBLIC WHILE OTHERS REMAIN SECRET? McGill political science assistant professor MANUEL BALÁN set out to answer this question by examining the publicity and reactions that resulted from revelations of corruption in Argentina and Chile between 1989 and 2007. Public disclosures of corruption, he found, are often triggered by competition within a governing party or coalition itself (intragovernment competition, as opposed to intergovernment competition among multiple parties). In other words, while corruption is ever-present, it is more likely to become public when there is political infighting, as government insiders with privileged access to information leak details about misdeeds for their own gain.

The takeaway? Those who are successful in the political underworld keep their enemies close and their friends even closer...

LEADING THE WAY IN INNOVATION

THREE MCGILL UNIVERSITY RESEARCHERS ARE THE LATEST RECIPIENTS OF CLOSE TO \$11 MILLION IN LEADING EDGE FUND AWARDS from the Canada Foundation for Innovation (CFI). The awards, matched by contributions made by the government of Quebec, will subsidize investment in state-of-the-art equipment that will be available to researchers across the city, province and country, fostering better understanding of nanotechnology, biomolecules and atomic cellular structure.

Physics professor PETER GRÜTTER pursues research in nanoscience — examining and manipulating miniscule “nano objects” such as single electrons, molecules or neuronal synapses. Grütter’s \$4.5-million CFI award allows him to outfit his research facility with cutting edge nanotools and to train new students in research techniques that set the

international standard for nanoscale applications in telecommunications, medicine and computing.

KALLE GEHRING, a professor in the Department of Biochemistry, will receive \$4.8 million for a joint project with Université de Montréal to promote research that looks more closely at biomolecules and their role in various diseases, from neurodegenerative diseases such as Parkinson’s to the growing conundrum of antibiotic-resistant bacteria in infectious diseases. The fund will also support the purchase of microscopes and robotics for examining and making protein crystals.

Another \$1.5-million award will support the purchase of an advanced electron microscope and lab equipment for dentistry professor MARC McKEE’s research into cellular ultrastructures and their role in disease diagnoses, tissue repair and regeneration. These

instruments are unique in Canada and can examine and manipulate molecules at -140 degrees Celsius as well as in various states.

The Canada Foundation for Innovation Leading Edge Fund invests in world-class infrastructure projects and provides support to explore promising new research directions.



One of the atomic-scale microscopes used in Peter Grütter’s research facility

WHAT TO EAT NEXT — A PHOSPHORUS PRIMER

MINED PHOSPHORUS, AN ELEMENT WIDELY USED AS AGRICULTURAL FERTILIZER, IS A NON-RENEWABLE RESOURCE. This finite supply has led some researchers to project a peak phosphorous scenario, akin to that of peak oil, in which the earth's reserves of the mineral will be completely depleted within 50-100 years. Too much phosphorus in an ecosystem as a result of runoff and erosion can also lead to eutrophication, a process of dense plant growth that depletes the system's overall supply of oxygen.

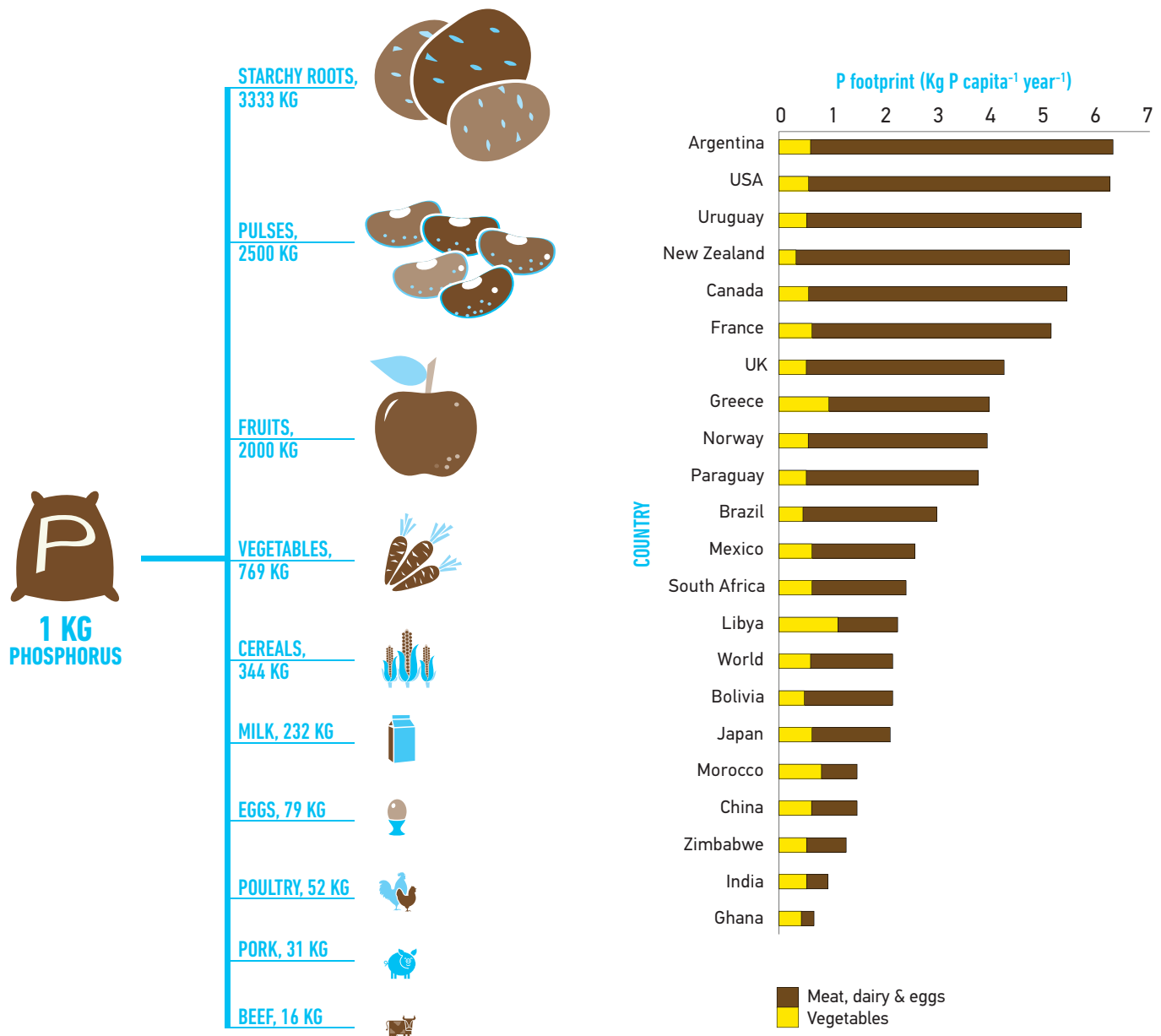
Because the overuse of phosphorus has both agricultural and ecological consequences,

GENEVIÈVE METSON, a PhD student in McGill's Department of Natural Resource Sciences, sought to investigate how changes in diet might contribute to sustainable phosphorus management. To do so, she performed a number of statistical calculations on the amount of phosphorus applied to crops to feed humans, including the feed used by animals ultimately consumed by people.

"Our results demonstrate that changes in diet can be a significant part of the strategy for enhancing sustainability of phosphorus management," Metson says. "In particular, reduced consumption of meat, and especially beef, in

countries with large phosphorus footprints could put a big dent in demand for mined phosphorus — since it takes many kilograms of feed, which is fertilized, to produce a kilogram of meat."

This research was supported by funding from the Natural Sciences and Engineering Research Council of Canada, Arizona State University's Sustainable P Initiative, and the U.S. National Science Foundation.



RENOWNED QUEBEC SCIENTIST GUY ROULEAU HEADS THE MONTREAL NEUROLOGICAL INSTITUTE



AFTER A WORLDWIDE SEARCH, MCGILL'S MONTREAL NEUROLOGICAL INSTITUTE AND HOSPITAL — THE NEURO — HAS A NEW DIRECTOR IN PROMINENT QUEBEC CLINICIAN-SCIENTIST GUY ROULEAU. Previously the director of the Centre of Excellence in Neuroscience of the Université de Montréal, Rouleau's landmark achievements are his contributions to the identification of

over 20 disease-causing genes and his discovery of new mutational mechanisms. Over the last 20 years, Dr. Rouleau and his team have focused on identifying genes causing neurological and psychiatric disease, including autism, amyotrophic lateral sclerosis, epilepsy and schizophrenia.

"The Neuro is a world-renowned hub of innovation known for taking calculated risks

vital for advancing neuroscience and for solving some of the world's most pressing neurological problems," said Jacques Bougie, Chairman of the Neuro's Advisory Board. "It requires a visionary leader and Dr. Rouleau is just the person for the job."

TEN SECONDS TO BLAST-OFF

VOLCANIC ERUPTIONS MAY BE SUDDEN AND VIOLENT, BUT THERE MAY ALSO BE AN ELEMENT OF PREDICTABILITY TO THEIR EXPLOSIVE FORCE.

DON BAKER, a professor in the Department of Earth and Planetary Sciences, worked with a team of international researchers to examine how the formation of bubbles trapped in magma affects the scale of a volcanic eruption. Think of the bubbles that erupt when you shake a can of cola and crack the tab; now convert the cola to molten rock and you get an idea of how Baker's experiments played out in the lab.

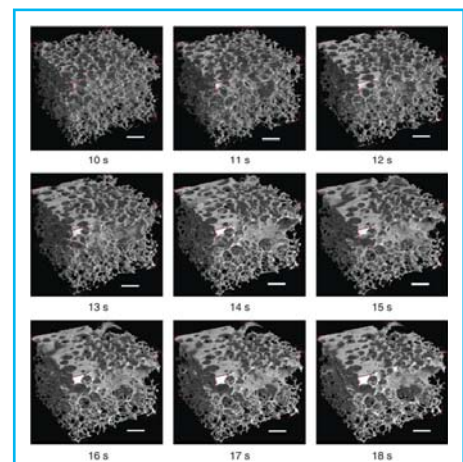
Using a recently developed laser heating system at the Swiss Light Source facility in Switzerland, Baker and his colleagues heated water-bearing molten rock and took three-dimensional tomographic (CAT) scans of the process, measuring the number and size of

bubbles and calculating how the sample lost gas (de-gassed).

They found that the first 10 to 20 seconds of heating results in rapid bubble growth, called vesiculation, creating a porous foam that is highly susceptible to eruption. After this period, if the magma has survived intact, the bubbles coalesce and the magma is already beginning to de-gas, decreasing the likelihood and force of eruption.

These results offer insight into the types of eruptions that will occur in various volcanic regions of the world, and Baker hopes to pursue further research into the effects of the first few seconds of vesiculation, as well as the effect of crystals on the process of growth.

Funding for the study was provided by the Natural Sciences and Engineering Research Council of Canada and the Swiss Light Source.



Bubble growth in a basaltic melt at
1 standard atmosphere (unit of pressure)

POSTDOCTORAL PROGRESS

POSTDOCTORAL SCHOLARS (OR POSTDOCS, AS THEY ARE OFTEN CALLED) ARE A GROWING PRESENCE AT INSTITUTIONS ACROSS NORTH AMERICA and McGill is home to one of the largest communities of postdocs in Canada.

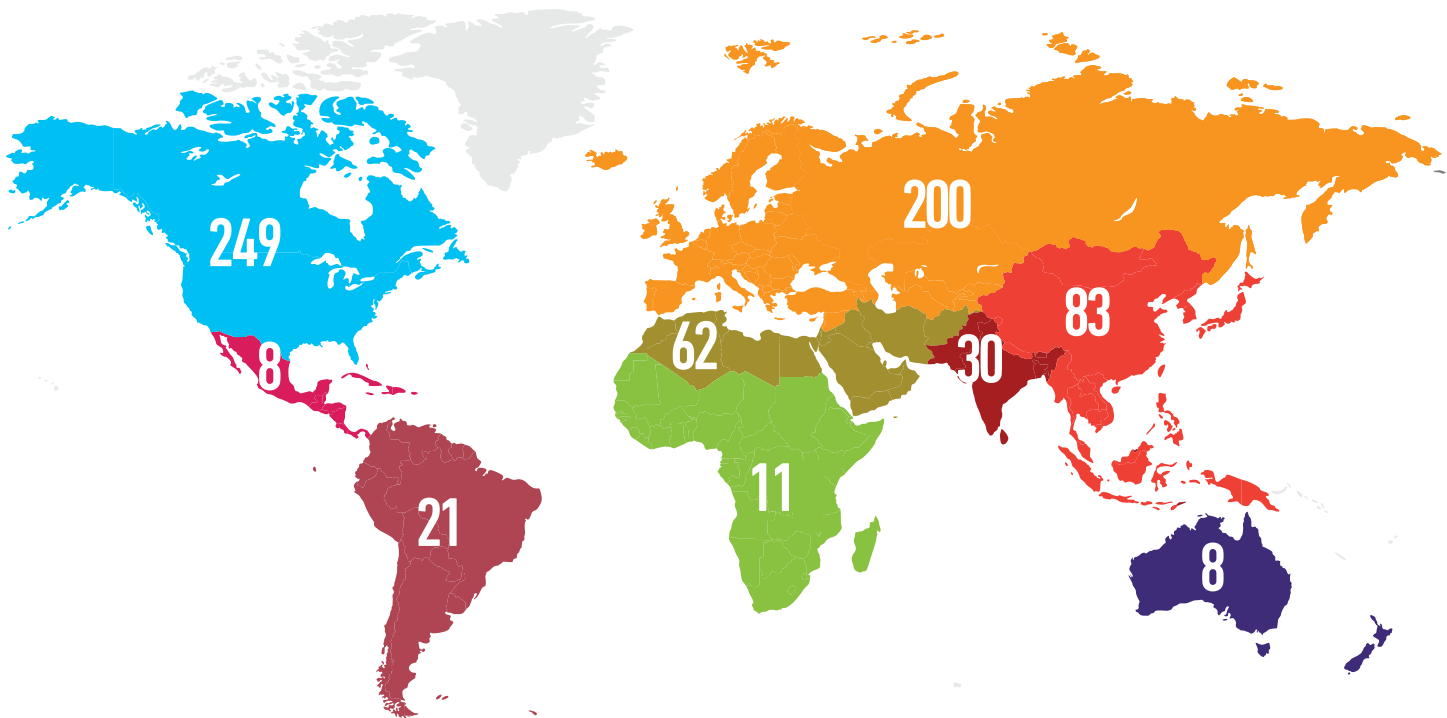
Part researcher and part academic, occasionally a teacher, sometimes an entrepreneur, and, in Quebec, also considered a trainee, a postdoc is an academically affiliated individual who has recently obtained a PhD or an MD and is pursuing specialized research but who does













not hold a permanent post as a professor or lecturer. There are more than 650 postdocs currently registered at McGill and this number rises to include about 1,000 scholars as postdocs arrive over the course of each year.

“Postdocs contribute significantly to the research and academic initiatives of a university, and they often bring important international experience as well,” says LOUISE HARVEY, a postdoctoral fellow from Australia who is pursuing research in neurodevelopmental disorders at the Douglas Mental Health

University Institute and who is an executive member of the Association of Postdoctoral Fellows of McGill University. “It can be a challenging time, but it is also an exciting time to strengthen research skills, to learn new soft skills, such as networking or academic administration, and to meet new people.”

Below, a glimpse of where postdocs at McGill are from and their chosen field of research.



 DESAUTELS FACULTY OF MANAGEMENT	4	 FACULTY OF EDUCATION	9	 FACULTY OF RELIGIOUS STUDIES	2
 FACULTY OF AGRICULTURAL AND ENVIRONMENTAL SCIENCES	18	 FACULTY OF ENGINEERING	61	 FACULTY OF SCIENCE	145
 FACULTY OF ARTS	41	 FACULTY OF LAW	6	 SCHOOL OF CONTINUING STUDIES	10
 FACULTY OF DENTISTRY	7	 FACULTY OF MEDICINE	366	 SCHULICH SCHOOL OF MUSIC	3

SCHOOL 3.0

Based at McGill and drawing together universities from around the globe, the new Learning Environments Across Disciplines project explores how a new generation of technology-rich classrooms can keep students more focused and engaged — and keep would-be drop-outs in school. //

By Laura Pellerine



Do you know that scene in *Ferris Bueller's Day Off*, the one where the high school teacher lectures in a dry monotone voice while his students stare blankly back at him? One student, head on desk, is so bored that drool has pooled near his mouth, while the teacher attempts in vain to engage his charges by repeatedly asking, "Anyone, anyone?"

A new collaborative research project is hoping to prevent such scenes from happening in classrooms in the future — and to inspire at-risk students (Statistics Canada reported 190,800 drop-outs in 2010 alone) to give the classroom another chance.

Susanne Lajoie, a Tier 1 Canadian Research Chair (Advanced Technologies for Learning in Authentic Settings (ATLAS)) and professor in the Department of Educational and Counselling Psychology, is the principal researcher of Learning Environments Across Disciplines. The goal of LEADS is to figure out how students learn, and perhaps even more importantly, how to keep their attention in the classroom. The interdisciplinary research project is using technology-rich learning environments to fully engage students, and to better understand how the act of learning can excite, or bore, students of all ages.

"The big problem in today's world is students have all these beautiful toys — social networking, smartphones, iPads — and then they go to school and teachers tell them to turn off the technology," says Lajoie, who is a Fellow of the American Psychological Association and American Educational Research Association. "Now, that's one way to keep people focused. But another way is to bring the excitement of technology into the classroom — and that's not being done as cleverly as it should be. I'm not saying that just putting a computer into the classroom makes it a good tool. You have to design the technology so it enhances learning and emotional motivation."

Designing that technology is a big part of what LEADS aims to do. Backed by a \$2.5-million "Insights" Partnership Grant from the Social Sciences and Humanities Research Council of Canada, the researchers

will use technology-rich platforms to document how learning occurs, and what educators need to do to get students more engaged.

Joining Lajoie in the seven-year research project are 16 co-applicants and 12 partners representing 19 universities and agencies from Canada, the United States, Germany, Australia, Denmark and China. The project is divided into three themes. Roger Azevedo, a professor in Lajoie's department and the Canada Research Chair in Metacognition and Advanced Learning Technologies, is leading the exploration of cognitive and socially guided learning. Reinhard Pekrun, a psychology professor at Ludwig-Maximilians-Universität in Munich, is leading emotional engagement and disengagement studies. The third theme leader is Jacqueline Leighton, an educational psychology professor at the University of Alberta, who is tackling innovative forms of assessment with methods that go beyond traditional self-reporting data.

The theme leaders are overseeing collaborations between researchers from a wide variety of backgrounds, who gathered for the first time this past June at a two-day conference in Montreal. Psychologists and computer scientists, engineers and ethnographers, educators and physicians — even historians: None are new to the study of education, but they haven't ever shared their ideas with such a diverse pool of thinkers.

"There are people interested in learning theory, there are people interested in emotion theory, there are people designing technologies," says Lajoie. "We've all been working in silos but now we're going to be able to work together to build better tools. One person may be good at designing games but they may never have worked cross-discipline before, so how can they help physicians build games that would be better for medical simulation? By bringing people together we're going to be able to cross methodologies and cross theories."

One cross-discipline that students are sure to enjoy is the welcoming of video games into the classroom. Heading up this end of the project is James Lester, a professor of computer science at North Carolina State University, and co-investigator in LEADS' emotional engagement





01 Jacqueline Leighton
 02 James Lester
 03 Reinhard Pekrun
 04 Susanne Lajoie
 05 Roger Azevedo
 With members of the LEADS Research Group
 at the inaugural annual meeting in Montreal
 in 2012

and disengagement team. For Lester, whose research focuses on creating new learning technologies through the use of artificial intelligence, intelligent tutoring systems, computational linguistics and intelligent user interfaces, deciding to join the team was a no-brainer.

"There's a very strong intelligence computer community in Canada, particularly at McGill, that does work in the application of artificial intelligence to learning environments," Lester says. "Roger Azevedo is one of the key players, he holds a distinguished chair in educational psychology and he's a strong scholar in this area. When I learned that he and Sue would be principals in this effort, it was a really easy decision to join them."

One of Lester's serious games, *Crystal Island*, is a virtual world where students are forced to use their problem-solving skills. In the Grade 8 version, for example, students play the role of detectives stranded on an island when members of their research team start exhibiting symptoms of a disease outbreak. Students then have to use their knowledge of microbiology to diagnose the cause.

So far, Lester says the students are responding positively. "Going into a classroom where students are using game-based learning feels different from traditional classrooms. You sort of expect it could cause students to be louder and more talkative, and be less focused. Actually we find just the opposite — students are very, very focused."

"That's half of the battle," Lajoie says, "keeping people motivated. If they're engaged, they're going to remain and persist in that learning context."

LEADS researchers will largely work with students from Alberta's Rockyview Schools, made up of 40 grade schools in areas just outside of Calgary, and Montreal's Hooked on School network, or Réseau Réussite, that works with young people, parents and other concerned parties to help struggling students achieve success.

"I'm in my early 50s and when I was in school, science was memorizing a bunch of stuff in really thick textbooks," Lester says. "The concepts are interesting if you're a good student, but there are a lot of students out there who are in need of some help, and this technology can be really helpful to those students. One of the great promises of this work is expanding the pipeline at an early age—increasing the

number of students that are interested in science, technology, engineering and mathematics. It's too late to do that once they're in college, and some people believe by even upper elementary school. It looks like these technologies can make a real difference."

LEADS isn't just about designing technology to help students learn—it's also focused on how technology can gauge what students are feeling as they're learning. The researchers have designed affect studies that use various modalities, such as: galvanic skin response that measures, for example, if your palms become sweaty while nervous; posture (whether students are leaning forward in their seat, showing that they're more engaged, or leaning back in boredom); facial expression analysis; and natural language understanding. They'll use computational linguistics techniques to evaluate how a student is feeling based on the language they use. The affect researchers will also study students' problem-solving progress. What does it mean, for example, if a student slows to a halt while working on a science problem? Are they deeply engaged in reflecting on the problem, or are they at an impasse and don't know how to proceed?

"Really strong human tutors, teachers and coaches are very effective at providing engaging experiences for learners and are able to detect when learners are frustrated," says Lajoie. "So what we want to do with learning technology is to be able to detect when students are frustrated and be able to provide support for them so that they'll persist in a learning episode."

"Our goal is that people will become lifelong learners," adds Lajoie. "In today's world, people don't stay in the same jobs for a long time; there's a lot of adaptivity that people need in order to be successful. So we have to teach students how to learn, and to learn in new contexts. By finding ways of keeping people in school they'll have more success in the long run, not just for themselves, but for society." ■

Funding for LEADS is provided by a \$2.5-million grant from the Social Sciences and Humanities Research Council of Canada.

SHARPENING THE BIG PICTURE

If a picture is worth a thousand words, then the value of medical imaging—the ability to capture images of the human body for medical reasons—could be considered the MasterCard equivalent of picture-taking: priceless. Indeed, magnetic resonance imaging (MRI) procedures have become routine in and synonymous with clinical tasks that require an “inside” view of the body and its brain, muscles, connective tissues and, occasionally, tumours. In cognitive neuroscience and neurosurgery, for example, MR images are fuelling new understanding of how our brains work.

Kaleem Siddiqi, a professor at McGill’s School of Computer Science, and Tal Arbel, an associate professor in the Department of Electrical and Computer Engineering, specialize in shape analysis and probabilistic methods in computer vision and medical imaging. Their courses probe the frontiers of medical imaging: how does a computer interpret a medical image? What happens to image information when a three-dimensional scene is projected onto a two-dimensional picture?

Over the years, Siddiqi, Arbel and their colleagues in medical image analysis have watched fellow professors and recent graduates of the Faculties of Science, Engineering and Medicine take up employment in, or sometimes even found, successful medical imaging companies. Many of these companies, which bear inventive industry names such as NeuroRx, Biospective, Intelerad, Rogue Research and Resonant Medical (now part of Elekta), are based in Montreal, and as these companies have grown, they’ve looked to McGill to expand their highly skilled workforce. Students, in turn, have been eager for industry experience.

Seeing an opportunity to formalize this university-industry collaboration, Siddiqi, Arbel and their colleagues developed a proposal for a medical imaging analysis training program and submitted the proposal to the NSERC Collaborative Research and Training Experience (CREATE) grant competition. The CREATE awards seek to harness the talents of motivated science students by training them for the workplace, ideally in a field where their work will contribute to advancing the country’s research priorities. The McGill team’s proposal for a program in Medical Image Analysis—the CREATE-MIA program—was awarded a grant for \$1.65 million over six years.

The project builds on a long history of collaboration, says Siddiqi. “The reason this team exists and the proposal was written was because people were already working together, so it made a lot of sense.”

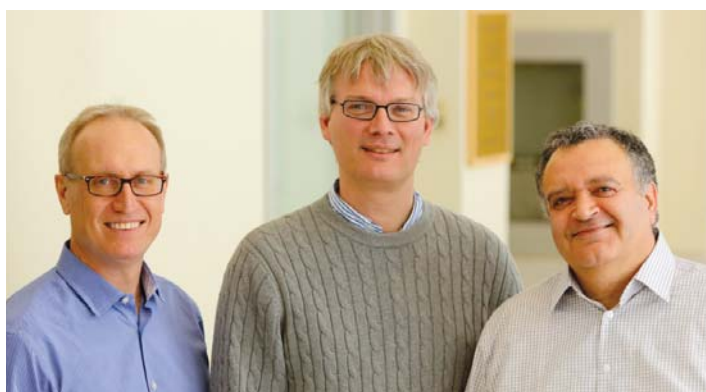
The program highlights Quebec as a hub for innovative medical imaging research, with a decidedly local flavour to the co-applicants named in the proposal: seven researchers from three universities (McGill, Sherbrooke and École de technologie supérieure [ÉTS]), seven industrial partners from the Montreal area, and a handful of clinical and neurosurgical collaborators from universities across the province. Beyond their university affiliations, these researchers are also variously connected to other major local research centres, such as the Montreal Neurological Institute and Quebec’s Biomedical Imaging Network.

Bruce Pike, director of the McConnell Brain Imaging Centre (BIC) and one of three McGill professors of biomedical engineering, neurology and neurosurgery involved in the program, emphasizes the importance of building on these connections, which extend across the province. “We have seen the medical image analysis community in Quebec grow,” he says, “and this program represents an opportunity to keep that network cohesive, to continue the momentum of that large group of expertise, and to strengthen it.”



By Suzanne Bowness

The past decade has seen graduates of McGill's Faculties of Science, Engineering and Medicine parlay their education into several thriving medical imaging start-up companies. Now a \$1.6-million NSERC grant is bringing together today's students with an industry hungry for the next generation of engineers and computer scientists. //



But while the researchers were already collaborating amongst themselves, typical supervisor-student silos meant that students didn't see as much of the crossover. With the CREATE grant, whose very mandate lies in interdisciplinarity and collaboration, students will now be a part of this goal to work across faculties. In practical terms, this will mean taking part in professional development workshops and symposia with students from other departments, as well as taking courses that span an impressive range of fields, from computer science and electrical, computer and biomedical engineering, to neurology, neurosurgery and medical physics.

"The program provides a very rich, cross-collaborative and multi-disciplinary environment where students become aware of and learn about larger parts of the project and different clinical applications of medical imagery," notes Louis Collins, Pike's colleague in biomedical engineering and at the BIC. "We will be collaborating with Maxime Descoteaux, who also does neurosurgery research, at Université de Sherbrooke, and with Catherine Laporte at ÉTS," Collins continues. This means that students at these universities, as well as students at McGill, will have access to and benefit from sharing data in the professors' various areas of expertise, including image-guided surgery software, tracking software, and neurological and ultrasound data.

With generous funding that will allow between 20 and 25 students to go through the program every year for the next six years, the initiative is key to bringing high-quality students to the universities involved, Collins says. Amir Shmuel, assistant professor of biomedical engineering, agrees. "My hope is that this program will allow us to attract the best candidates and graduates in this field and increase the level of cooperation across disciplines," says Shmuel. "I also hope that our graduates will be successful leaders in academia or in the high-tech industry."

Dante De Nigris Moreno, a PhD student who works with Tal Arbel in the Department of Electrical Engineering, welcomes the program's emphasis on industry collaboration. "In academia, we do a lot of research and theory, but at the end, we want to provide a tool and software that is actually used in the operating room," he says, "so it is natural to be on the same page as companies trying to solve the same problem."



"As a PhD student, you often work on your own for four or five years and then get thrown into the workforce," adds Emmanuel Piuze-Phaneuf, who works with Siddiqi and who says he jumped at the chance to participate in the program. "Here, you get to collaborate with companies in the medical sector and find out what they do and what they want. It was an opportunity I didn't want to miss."

Industry partnerships are rewarding for a variety of reasons, notes Arbel. "Students are excited to help provide tools that have health benefits to society, not just to make a lot of money but to have their research... help to develop drugs for particular diseases. Being of service to society is very exciting to them." ■

Funding for the CREATE-MIA program is provided by the Natural Sciences and Engineering Research Council of Canada. To find out more about this program, visit www.cim.mcgill.ca/create-mia.

↖ Left to right: Bruce Pike, Louis Collins and Amir Shmuel of the McConnell Brain Imaging Centre

↑ Left to right: Dante De Nigris Moreno, Tal Arbel, Emmanuel Piuze-Phaneuf and Kaleem Siddiqi



DOVE HOPE

An unusual approach to investigate an unusual disease. On almost every front—symptomatic, diagnostic, treatment, cure—ovarian cancer stubbornly refuses to conform to typical oncological expectations. //

By Victoria Leenders-Cheng

French horns are German in origin, Guinea pigs are not from Guinea... and now it appears that ovarian cancer may not be a cancer of the ovaries after all. Dr. Lucy Gilbert, who directs the Gynecologic Cancer Service at the Royal Victoria Hospital, has been studying ovarian cancer for more than 20 years and says that it is a disease that has confounded oncologists for decades.

Ovarian cancer is a relatively rare cancer—1 in 60 women get it, compared to about 1 in 10 women who get breast cancer—but it is much more deadly: only 54 percent of women who get ovarian cancer survive more than five years after diagnosis, compared to 89 percent for breast cancer.

“Every decade, we make so much progress in how we treat many cancers,” Gilbert continues, citing improved cure and prevention rates for uterine and cervical cancer by way of example. “But for ovarian cancer, the cure rate is flat over the last 30 years.

“This really is a disease that just drives you to your knees.”

The symptoms of ovarian cancer, which include feeling bloated or having heartburn, are non-specific and easy to dismiss as general discomfort or, for older women, chalked up to menopause. Current methods of diagnostic testing for the disease—measuring cancer

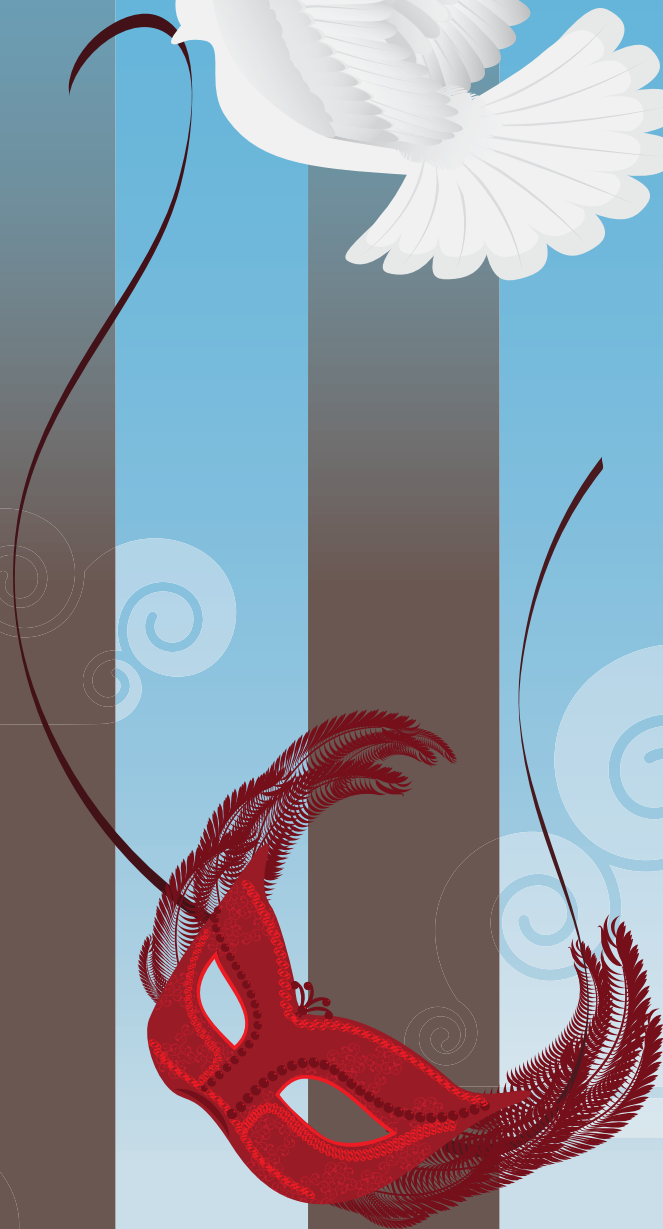
antigen concentrations in the blood or relying on ultrasound images—tend to yield a high number of false-positive results, meaning that many women undergo surgical procedures to remove a cancer that isn't there.

Even when the cancer is accurately diagnosed, Gilbert says, recurrence rates remain high. “These women come, they do exactly what we tell them, they have huge operations and chemo, and then still the disease is back and causes a great deal of suffering.”

In 2007, in the hopes of raising awareness about ovarian cancer and increasing the likelihood of catching the disease in its early stages, three major American cancer organizations recommended that women experiencing symptoms of bloating, frequent urination or abdominal pain for more than two weeks consult a doctor.

Gilbert wanted to find out whether investigating these symptoms would in fact lead to early detection of ovarian cancer and, in 2008, she obtained a grant from the Canadian Institutes of Health Research to do a pilot study.

“Our hypothesis was, if you educate women about these symptoms and you provide easy access to investigation, you may be able to diagnose ovarian cancer early and remove it completely with surgery.”





“WE HAVE UNMASKED THE GREAT PRETENDER”

Gilbert and her colleagues designed a novel study, named Diagnosing Ovarian Cancer Early (DOvE), and invited women 50 years of age or older who had experienced various symptoms of abdominal discomfort or bloating to undergo testing for ovarian cancer. Almost 2,000 women in Montreal responded to the call for participants and two-thirds of them, or 1,455 women, fulfilled the eligibility criteria for further screening.

Once the women were deemed eligible, they underwent a physical examination, a blood test and a transvaginal ultrasound. The blood test checked patients' levels of cancer antigen 125 (CA-125), a protein that is often found in elevated levels in patients with certain types of cancer, including ovarian cancer. The ultrasound examined the shape and size of the ovaries, as well as the shape and size of any cysts present in the organ.

In normal test results, there are fewer than 35 units of CA-125 per milliliter of blood and any cysts found in the ovaries are smaller than 60 cm³. If both test results were normal the first time around, Gilbert and her colleagues repeated the blood test after four months; if either of the results were abnormal, they repeated the blood test at intervals of four to eight weeks.

Of the 1,455 women who participated in the study, 11, or 0.756 percent, were diagnosed with ovarian cancer. Other studies conducted in the UK, Japan and the US with women recruited from the general population had yielded ovarian cancer prevalence rates of between 0.06 and 0.084 percent.

Gilbert's study, in other words, had yielded a prevalence rate that was an astonishing 10 times that of the prevalence rate of studies conducted in the UK, Japan and US. Her results demonstrated not only that women with symptoms of bloating and abdominal pain were 10 times more at risk for ovarian cancer but also that investigating these symptoms can lead to early detection and successful surgery to eradicate the disease.

More surprising, however, was the study's unexpected finding that the deadliest subtype of ovarian cancer is essentially not a cancer of the ovary but of the fallopian tubes.

Much of successful cancer treatment is predicated on the importance of catching the disease early, before it spreads. One subtype of ovarian cancer, called high grade serous cancer (HGSC), alone causes 90 percent of deaths from the disease, in part because it is not caught until it is already at an advanced stage.

The results of Gilbert's pilot study indicated that, in the case of finding and removing this HGSC subtype of ovarian cancer, gynae-oncologists might have been looking in the wrong place all along.

“We kept saying that if we find the cancer early, while it is still on the ovary, we can cure the disease,” Gilbert explains. “But to our surprise, no matter how early [we detected the cancer], in some women there was no cancer in the ovary at all. It had all started in the fallopian tubes.”

The fallopian tubes, responsible for delivering eggs from the ovaries to the uterus, don't in fact touch the ovaries themselves. Instead, they possess finger-like cells called fimbria that drape gently around the ovaries and that sweep the egg into the tube when prompted by hormone indicators released cyclically by the uterus.

“The ovary is a very complex organ,” Gilbert says, “and the fallopian tubes are these delicate organs with these innocuous-looking fimbriae that just float about in the abdomen and drop cancer all over the abdominal cavity, getting it all over the place fairly early.”





This finding has the potential to revolutionize how ovarian cancer is detected and treated, Gilbert says, noting that everything about the disease, from the name, the staging and the diagnostic testing, needs to be reconsidered to improve early detection as well as cure rates.

In thinking about how to present the results of the study, Gilbert, whose two decades in gynae-oncology have given her a poetic appreciation for the organs of the female reproductive system, kept coming back to metaphors of disguise.

"We have unmasked the great pretender," she declares. "This is a very clever disease. It's not really a cancer of the ovary — it's a cancer of the fallopian tubes, which look so innocent and beautiful; to be truthful, the poor ovary is an innocent bystander that gets maligned."

Earlier studies on patients who carry a gene that makes them susceptible to ovarian cancer — the BRCA mutation — had found that a significant percentage of them had cancer in the fallopian tubes. "But we thought this pattern was peculiar to the BRCA mutation and that it was an academic discussion," Gilbert explains. "In clinical practice, we continued to look at the ovary."

The DOvE study is the first to obtain this result in the general population of women, not just those with the BRCA mutation. The finding is so startling that it is being referred to as a paradigm shift for fighting ovarian cancer. "It is rare for us to have been so wrong for so long," Gilbert admits. "For years and years, we've been focusing on the ovaries. To recognize that focusing on the ovary is wrong, to look elsewhere and to think, 'Abdomen, abdomen,' early in the course of the disease, is very different..."

In 2012, the Canadian Institutes of Health Research awarded Gilbert and her colleagues a \$1.4-million grant to expand DOvE to 12 satellite clinics across Montreal. This expanded phase of the study will evaluate 14,000 women at risk for the cancer, which Gilbert estimates will result in the diagnosis of about 100 cases of cancer, most of them early enough that the cancer can be completely removed with surgery.

"From there, we hope to develop good algorithms to advise people all over Canada and the world on how to identify this disease early enough."

Gilbert warns, however, against widespread implementation of her study protocol for the time being, noting that the investigations must be done by doctors and technicians who are knowledgeable about the trickster nature of the disease.

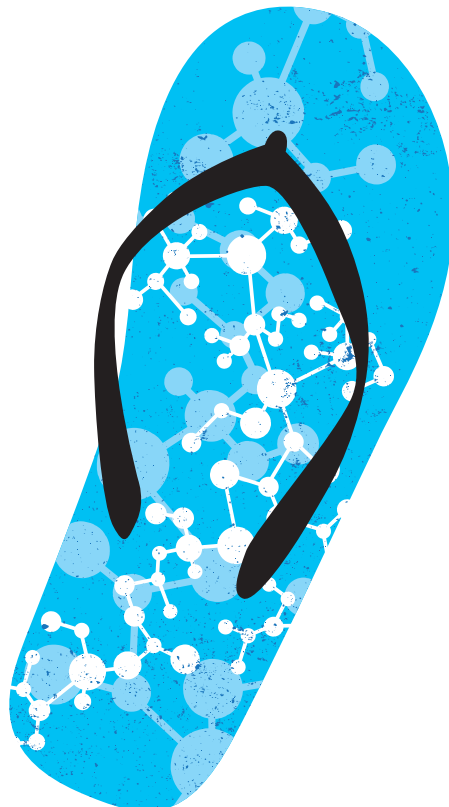
"We are still feeling our way through the fog," she says. "We don't have a magic formula that says, 'Do this and this,' and you will pick up all the ovarian cancer. We don't know yet how we get it or what is an efficient way to catch it, but at least we aren't looking at the wrong thing now." ■

This research was supported by grants from the Canadian Institutes of Health Research, Montreal General Hospital Foundation, Royal Victoria Hospital Foundation, Cedars Cancer Institute, and La Fondation du Cancer Monique Malenfant-Pinizzotto.

what i researched on my summer vacation

Summer research internships aren't just a great way for McGill undergraduates to put their book-learning to work and gain invaluable real-world experience — they're an important part of forging the university-industry collaborations necessary for moving innovations out of academic silos and into the marketplace, where they can change lives. As students gear up for internship season, eight veteran McGill interns share their experiences and lessons learned. //

By Laura Pellerine





claudia macedo

AGE: 22

HOMETOWN: PINCOURT, QUEBEC

MAJOR: MATERIALS ENGINEERING

INTERNEED AT: RIO TINTO, IRON & TITANIUM

FAVOURITE SCIENTIFIC CONCEPT:

"MURPHY'S LAW. NOT VERY SCIENTIFIC, BUT SO TRUE."



martin ahrens

AGE: 21

HOMETOWN: MONTREAL, QUEBEC

MAJOR: MECHANICAL ENGINEERING

INTERNEED AT: FPINNOVATIONS

FAVOURITE SCIENTIFIC CONCEPT:

"I'D HAVE TO GO WITH GRAVITY OR RELATIVITY."

For Claudia Macedo, working as a research and development intern with Rio Tinto, Iron and Titanium (RTIT) Metal Powders was an eye-opening experience and a confidence booster.

Stationed in RTIT's product development department in Montreal, Macedo examined the effects of additives in metal powders. "Many of our customers are in the car industry," she says, "and they expect to receive metal powder that, once it is pressed and sintered [a technical term for moulding and heating powders to create objects], will be the exact size and dimension required."

The client-focused nature of the research was markedly different from the research Macedo was used to doing at McGill. "If there is something the client wants and it requires a new product, you have to test it and make sure it works, with very limited time to do so," she explains. In contrast, the focus of her research at McGill is to explore novel concepts, to "try to find something new."

Still, delving into powder metallurgy was a continuation of the fourth-year materials engineering student's coursework. "For my internship, I needed to understand many basic concepts that are useful for a materials engineer," she explains. "There was a lot of data processing and analysis. I learned about methodologies needed to approach a problem and how to design experiments so that your data is significant."

Macedo's internship experience also opened her eyes to the importance of collaboration — "You have to interact with your department and other departments to get your questions answered," she says. "You have to be able to talk to everyone." She urges interns not to be shy: "Don't be scared to ask questions. If you don't understand something, there is probably someone who can help you, and since you are an intern, they expect and welcome the questions you have for them."

"It's rewarding to see what you're doing being applied to something useful in the real world," says Martin Ahrens. The third-year mechanical engineering student spent his summer interning at FPinnovations, one of the world's largest private, not-for-profit R&D companies. FPinnovations is largely focused on sustainable forestry solutions, but also looks at other areas in need of sustainable, environmentally friendly practices — like the big transport trucks constantly criss-crossing Canada's highways. While interning at the company's Pointe-Claire, Quebec headquarters, Ahrens worked in the PIT (Performance Innovation Transport) division. "I worked a lot with engines, aerodynamics and combustion processes," he says, "all of which is related to my field of study." His job was to examine how to improve fuel consumption in 18-wheelers and other large transportation vehicles. It wasn't a theoretical exercise, either: When it came time to test the mettle of a fuel additive or resistance-reducing trailer skirt, Ahrens was right there as trucks roared through their paces on a test circuit.

"I GOT TO WORK WITH PEOPLE WHO ARE VERY COMMITTED TO — AND REALLY ENJOY — WHAT THEY DO."

"I was surprised to get to go to the tracks," says Ahrens, whose duties included recording meteorological conditions and vehicle data. "It was my first internship and I thought maybe it would be all grunt work, but it was exciting. My internship gave me a broader view of mechanical engineering and I got to work with people who are very committed to — and really enjoy — what they do."





grant macneil

AGE: 21

HOMETOWN: LONG SAULT, ONTARIO

MAJOR: BIOCHEMISTRY

INTERNEED AT: PERKINELMER

FAVOURITE PIECE OF LAB EQUIPMENT:

"AUTOMATIC MULTI-DISPENSE PIPETTE. IT SAVES SO MUCH TIME, IT'S MY BEST FRIEND AT WORK."

For Grant MacNeil, an Honours biochemistry, there's an easy answer to the question "Sports or science?" Both. Growing up, he could be found between the pipes for competitive AA minor hockey and Junior B teams, and he still plays intramural hockey at McGill. He's also currently in his second season as assistant coach for the Hurricanes de Montreal "Pee wee BB" team, an avid runner and a pretty good golfer ("Some days better than others"). On top of all this, there's science.

"IT IS REFRESHING TO SEE HOW TO WORK WITH THESE MOLECULES OUTSIDE THE CLASSROOM"

This past summer the chemistry whiz completed his second 16-week internship with PerkinElmer, a life sciences tools and services provider located in Montreal's Griffintown neighbourhood. MacNeil assisted in developing experimental protocols for AlphaLISA — technology that examines cellular and biochemical functions of biomarkers and analytes including proteins, lipids, and cytokines. The process, he says, "is much faster with far less assay variation" than the current commonplace analytical techniques, such as enzyme-linked immunosorbent assay, western blotting or immunofluorescence — and may help scientists better understand how the behaviour of cell proteins can lead to disease and disorders. "My project could help clients like academic researchers, pharmaceutical companies or biotechnology industries find the best therapeutic drug using an experiment that is quicker and more sensitive than other commonly used methods," MacNeil says.

His summer work doesn't only have real-world relevance — it's also directly related to MacNeil's field of study. "It is refreshing to see how to work with these molecules outside the classroom, where I have heard all about their cellular activities and pathways, but rarely had hands-on experience," he says.

MacNeil also says that the lab experience will be useful in his future career as a dental surgeon. "It has given me invaluable confidence when working with fragile and very expensive material," he explains. "Like your teeth."



clarence leung

AGE: 20

HOMETOWN: LIVINGSTON, NEW JERSEY

MAJORS: COMPUTER SCIENCE AND BIOLOGY

INTERNEED AT: CROWDSOURCING BIOLOGY

PC OR MAC?

LINUX. "BECAUSE IT'S BOTH FREE AS IN 'FREE BEER,' AND FREE AS IN 'FREE SPEECH.'"

Clarence Leung may enjoy indulging in a game or two of Angry Birds, but these days, the game taking up most of his time is a little more serious. Leung spent his summer interning for Crowdsourcing Biology, based at the Scripps Research Institute. The private, non-profit research institution is headquartered in La Jolla, California, but Leung worked from his Montreal home, communicating via webchat and video calls. "Not having to commute is the great thing about being a computer scientist," says Leung, who worked on the development of "Dizeez," a game that engages players to help find missing links between different genes and diseases. "Our goal is that, while players are having fun, they will contribute to science by helping researchers gather more data," Leung says. "So far, we've been able to identify several novel gene-disease links related to conditions such as leukemia and melanoma."

It doesn't hurt that Leung is a joint computer science and biology student. "The work I'm doing uses much of the coursework and research I've performed in machine learning and computational biology," he says. "It's an experience that has me trying to solve what are known as NP-complete problems, which are the toughest problems in the bioinformatics field. They can't be easily solved by brute-forcing all possible solutions with even the most powerful computers. These problems include estimating the genomes of organisms from long ago, based only on the genomes of organisms that exist today, and creating accurate 3-D models for proteins using only information about their electrostatic properties."

Leung isn't a stranger to serious games. He previously helped McGill professor Jérôme Waldispühl to develop another biological game, "Phylo," which uses player brainpower to identify regions of similarity in DNA, RNA and protein sequence alignments.

In the future, Leung is considering going to graduate school to further study how computer science can assist in the biology field. "It's great to be part of a new way of how researchers are approaching the field of biology, with algorithms and statistics, rather than just experiments and test tubes."





debbie wang

AGE: 19

HOMETOWN: CALGARY, ALBERTA

MAJOR: NEUROSCIENCE

INTERNEED AT: SUNCOR

IF I COULD LIVE IN ANY ERA, IT WOULD BE:

"THE 1970s TO 1980s BECAUSE THAT WAS THE ADVENT OF THE DIGITAL AGE."



christopher nickels

AGE: 21

HOMETOWN: KITCHENER, ONTARIO

MAJOR: CHEMISTRY

INTERNEED AT: RESEARCH IN MOTION

FAVOURITE SCIENTIFIC CONCEPT:

"WHAT GOES UP MUST COME DOWN. IT'S NICE AND SIMPLE, AND EASY TO REMEMBER!"

Debbie Wang is happy to call herself a science nerd. But after completing a performance analyst internship with oil company Suncor in Calgary, the neuroscience student is considering swapping her lab coat for a blazer. She spent the summer working with budgets, forecasts and "back office tasks for the trading group" and—even though she's already taking a minor in economics—was surprised to find herself considering a future in the world of finance. Then again, she believes that's what summer is for: exploring new things.

"USING THE SUMMERTIME AS AN OPPORTUNITY TO BE INVOLVED IN DIFFERENT INTERNSHIPS IS VITAL TO DISCOVERING WHAT I WANT TO DO FOR THE REST OF MY LIFE."

That curiosity has already given her some serious research experience. While in high school, Wang volunteered in a lab at the Hotchkiss Brain Institute at the University of Calgary, and competed in several national research competitions on spinal cord health. In 2011, after completing her first year of undergrad studies at McGill, she received a grant from the Fonds de recherche en santé du Québec — Santé to work in professor Nicolas Cermakian's lab at McGill's Douglas Mental Health University Institute, where she did a pilot study looking at a possible connection between circadian rhythms and suicide risk. As for next summer? Who knows.

"I'm hoping to have just as unique an experience as the past two summers," says Wang, who is spending her third year of undergrad studies in Scotland as part of McGill's longstanding student exchange program with the University of Glasgow. "Working at Suncor was an excellent way to learn about Canada's burgeoning energy industry. Part of finding out what path I want to pursue is exploring various fields. Using the summertime as an opportunity to be involved in different internships is vital to discovering what I want to do for the rest of my life."

If Christopher Nickels could be any superhero, he'd want to be Superman. "He really has to know his elemental analysis if he's to avoid Kryptonite," he quips. But, given the second-year chemistry student's province-straddling schedule last summer, the whole flying thing wouldn't hurt either.

Nickels spent his so-called vacation shuttling between Cambridge, Ontario, where he interned at Research In Motion (now BlackBerry) during the week, and McGill, where he devoted his weekends to continuing research he's been doing in professor Tomislav Friščić's green chemistry lab.

As a Materials Lab Associate at RIM, Nickels conducted experiments to better understand the conditions that lead to electrochemical migration on circuitry. The migration is a problem not just for BlackBerrys, but for any device that uses a printed circuit board (and that's pretty much everything, from phones to cameras to MP3 players). If a gizmo is manufactured under less-than-pristine conditions, traces of electrolytic solution can form on the circuit board. Later, when that phone/camera/whatever is used, the electric field produced will cause the migration of ions from that solution, causing dendrites to slowly build up in the gaps between the board's conductors. "We were working on developing standards so we could predict when this is going to happen," says Nickels, "so that we'd be able to set cleanliness standards during manufacturing and to take preventative steps."

Then, on his weekends, Nickels traded electrochemistry for organic chemistry in Friščić's lab, exploring Diels-Alder reactions to create conjugated cyclohexene systems. The process is an important part of a myriad of production processes, from pharmaceuticals to plastics, and Nickels co-authored a paper with Friščić for *CrystEngComm* on the subject.

The Ontario native admits that solvent alternatives and circuit boards are "about as far removed from each other as possible," but loved the range of experience. "Before working at RIM, I was aware of electrochemical research and its application, but had had no previous firsthand experience with it. It helped me gain a greater appreciation for the scope covered in the many different fields of chemistry."





rose-lyne mccall

AGE: 20

HOMETOWN: MONTREAL, QUEBEC

MAJOR: CHEMICAL ENGINEERING

INTERNEED AT: FPINNOVATIONS

PC OR MAC?

PC

Rose-Lyne McCall may be a self-admittedly sensitive person, but she knows how to go after what she wants. Before starting her internship at FPInnovations, a not-for-profit forestry organization, the third-year chemical engineering student was hoping to gain a better grasp of planning and executing lab experiments.

McCall's job was to research new applications for wood fibre, specifically in hygiene products such as diapers (infant and adult) and feminine products. "The goal [for my work] was to reduce the size of baby diapers, which are pretty thick," McCall explains. "We wanted to use a different kind of fibre to help reduce the thickness."

To set up the experiments to test this new fibre, McCall spent the first month of her internship conducting a literature review. "I looked at patents, researched articles and learned about the subject. From that, I came up with some experiments and tests."

McCall would create handsheets (a pulp and paper industry term for the sheets of paper made specifically for testing) containing the fibre, leave them to dry overnight, and then cut them into strips and test the strips for their strength and tensile properties.

This process of experimentation taught her the value of persistence. "I would use different chemicals to make my handsheets and when I would test my paper the next day, I would sometimes get a totally different result from what I expected," McCall says. "It was pretty frustrating but it was also good because it pushed me to figure out what would make it work."

While McCall isn't sure what direction her career will steer her toward, the Montreal native says her experience with FPInnovations was an exciting opportunity to explore. "I learned about different areas where chemical engineering is applied," she says. "And I solidified my laboratory skills!"



alex walsh

AGE: 22

HOMETOWN: MONTREAL, QUEBEC

MAJOR: MECHANICAL ENGINEERING

INTERNEED AT: BOMBARDIER AEROSPACE

FAVOURITE SUPERHERO:

IRON MAN. "I LIKE WATCHING HIS DESIGN PROCESS. AND HE'S GOT LOTS OF COOL TOYS."

Alex Walsh got a taste for high adrenaline while teaching gliding to air cadets — an appetite that came in handy during his internship at Bombardier Aerospace. Working in the company's flight sciences department, located just down the street from Montreal's international airport, Walsh helped adjust the simulated model of an airplane to match the airplane's real-life behaviour. He'd input data relevant to a specific occurrence — such as the pilot input for the take-off of a CRJ1000 — and then study the simulated aircraft response. "If the sim didn't correspond to what a test plane actually did in that same situation, then we modified the computer model to get the same results," Walsh explains. "It's important that the computer model reflects real life as closely as possible for when pilots are training on simulators."

The end of his summer internship didn't mean the end of research for the fourth-year mechanical engineering student. In October, he traveled to Naples, Italy to present a paper at the International Astronautical Congress. (The Canadian Space Agency funded Walsh's trip.) The paper was based on Walsh's in-progress undergraduate thesis, supervised by assistant professor James Forbes, which explores a new control mechanism for flexible telescoping robotic arms. (The problem: the lighter and faster the robotic arm, the more it vibrates.)

Although both his internship and thesis research use the MATLAB programming language, Walsh says he got "completely different things" out of the two experiences. "My thesis research is a lot of analytical thinking and working things out from scratch. For my internship, a lot more numbers were involved, and you had to program quite a bit to be able to handle them. It was really interesting to get experience with that other side — and to actually do the same kind of work as an actual engineer would do in a firm." ■





TURNING RESEARCH INTO INNOV4TION

To celebrate the first four years of the Fessenden Professorships and Prizes in Science Innovation, *Headway* looks at four of the many ways the program has helped McGill researchers translate their ideas into products — because there's more to getting the world to notice your innovative ideas than just building the proverbial better mousetrap. //

By Dana Yates

When it comes to supporting innovation, Canadian researchers need all the help they can get. In the Conference Board of Canada's annual Innovation Report Card, Canada ranked 14th out of the 17 industrialized countries surveyed. As a nation, we're particularly poor at getting research breakthroughs into the marketplace; when it comes to patents (relative to population), we trail all but Ireland, Australia and Italy. Thanks to a unique funding program in McGill University's Faculty of Science, however, it's becoming easier for researchers to turn their discoveries into commercially available technologies.

Launched in 2008, the annual Fessenden Professorships in Science Innovation were created by a \$1.25-million donation from John Blachford, BEng'59, PhD'63, and his wife, Janet. The program is also supported by a \$750,000 contribution from a confidential donor. The Fessenden Prizes in Science Innovation were made possible by a further gift by John and Janet's son, Erik Blachford. The Fessenden program honours Blachford's great-uncle, the late Canadian inventor Reginald Aubrey Fessenden. Among his achievements, Fessenden made the first radio broadcast of the human voice, two days before Christmas 1900. (The voice was his, the message distinctly Canadian: "Is it snowing where you are?")

The Fessenden initiatives consist of two types of awards. Fessenden Prizes, which are awarded to professors and students, recognize McGill

research results that have clear commercialization potential and provide between \$2,500 to \$4000 of funding. Fessenden Professorships promote the development of spin-off companies and are worth between \$25,000 and \$70,000 for one year of funding.

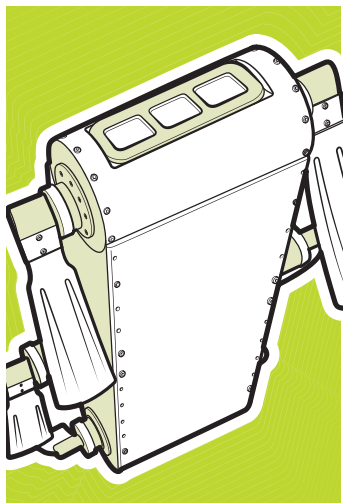
01 The technology transfer process is akin to launching a rocket, says Gregory Dudek, director of McGill's School of Computer Science and the McGill Mobile Robotics Laboratory. "First, one engine fires up and then the next one. Once you have lift-off, everything goes faster and faster."

In 2009, Dudek was awarded a Fessenden Prize, and in the following year, received a professorship. Those awards, he says, were critical. Indeed, they helped him purchase research equipment, hire support staff and finally launch a successful spinoff company.

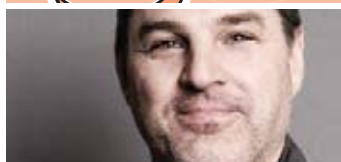
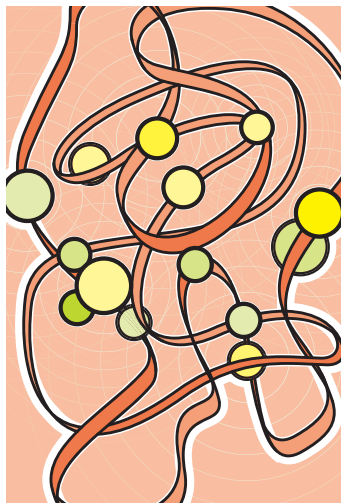
Now, Dudek is president of the Montreal-based firm Independent Robotics Inc. (IRI). Also involving Michael Jenkin of York University, entrepreneur Martin Stanley, McGill mechanical engineering graduate Chris Prahacs and mechanical engineer Bir Bikram Dey, the company develops intelligent, autonomous robots — the kind that explore environments in which people dare not go. Namely, the deepest areas of the ocean.

In the underwater world, humans are limited by the number of oxygen tanks they can carry, the depths to which they can descend and the

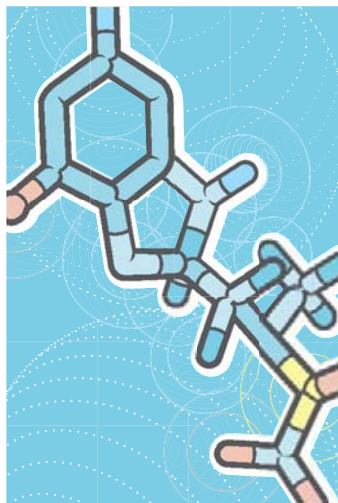
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GREGORY
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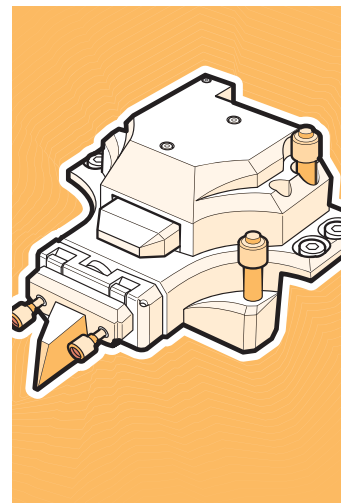
02

NICOLAS
MOITESSIER

03

MASAD
DAMHA

04

ALEKSANDER
LABUDA

delicacy of the aquatic ecosystem. IRI's amphibious robots can, however, create 3-D models of what lies 30 metres beneath the waves, monitor quantities of fish and measure the effects of climate change on coral reefs.

02 That sort of in-depth investigation also characterizes Nicolas Moitessier's research. But instead of studying undersea environments, he is taking a virtual look-see into the human body. An associate professor of chemistry and co-founder of the spinoff company Molecular Forecaster, Moitessier has developed software that predicts how medications will behave in the body.

The software relies upon 3-D drawings of molecules, which are intended to simulate the properties of drugs. Using these molecule models, Moitessier can determine how a drug will perform and how the medication will be cleared from the body. That advance knowledge could one day transform the drug development process.

"Currently, it takes about 15 years and \$1 billion to bring a drug to market. So, instead of running thousands of time-consuming and expensive tests, we could have the results in minutes," says Moitessier. In addition, he notes, the software could protect people from unexpected drug toxicity and the planet from excessive use of pharmaceutical chemicals.

Through his 2008 Fessenden Professorship, Moitessier recruited a research assistant, Université de Montréal PhD grad Éric Therrien, to move the work forward. In fact, Therrien turned out to be so helpful that he eventually became co-founder and president of Molecular Forecaster. And today, Moitessier and Therrien's company has

copyrighted its software and is in negotiations to sell its services to other firms.

03 That kind of success has also been experienced by chemistry professor Masad Damha. The recipient of a 2010 Fessenden Professorship, Damha has applied his funding toward two research projects. The first uses a procedure called RNA interference to slow the spread of brain tumours. The initiative also involves researcher Kevin Petrecca of the Montreal Neurological Institute and Hospital, and Glen Deleavey and Jovanka Bogojeski, two PhD candidates in McGill's Department of Chemistry.

By creating a compound that mimics double-stranded RNA (a key player in the production of proteins), Damha and Petrecca are tricking the body into stopping tumour growth by disrupting the protein-manufacturing process.

"When you target the process that produces proteins, instead of proteins themselves, it's like you're turning off the tap instead of mopping up the floor," says Damha, who used part of his Fessenden funding to hire Swedish postdoctoral fellow Richard Johnsson. Today, Damha's RNA technology is owned by Paladin, a Quebec-based pharmaceutical company.

In Damha's second project, a partnership with Mark Somoza of the University of Vienna, the researchers are improving the way that RNA is grown on delicate glass chips. While producing RNA in this manner helps researchers spot genetic mutations, the chips are easily scratched—and the RNA quality compromised—by the chemical agent involved in synthesis. Damha invented a new method for synthesizing RNA that

prevents etching of the RNA chip. What's more, McGill is now working to license the technology to a company in the United States. (The company cannot be named until the deal is finalized.)

04 Like Damha, Aleksander Labuda has also had some market-shaking ideas — and he has applied them to molecular-sized matter. A PhD student in physics, Labuda is interested in atomic force microscopes (AFM), instruments that generate high-resolution images of surfaces in liquids, air and vacuums.

AFMs, however, have limitations. Labuda's efforts to improve the resolution and reliability of these tools have earned him two Fessenden Prizes. The first, which was awarded in 2010, recognized his development of a new methodology to further improve the resolution of AFMs, bringing the images, he says, "closer to the fundamental limits set by physics."

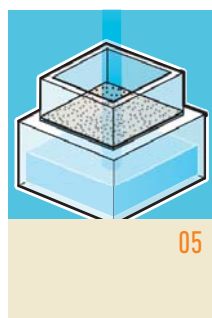
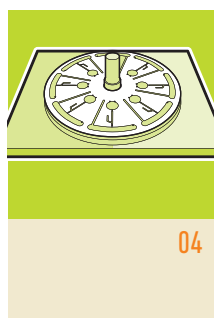
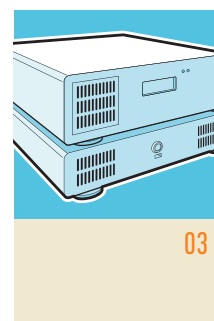
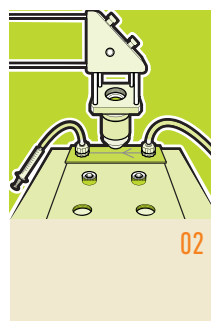
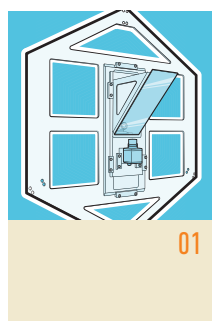
Labuda's second award, which was bestowed in 2011, acknowledged his work to design a unique AFM system in collaboration with Dilson Rassier, a McGill kinesiology professor. Their patented technology measures the force of isolated myofibrils — the smallest parts of muscles that can be separated and still maintain structural integrity — when they are activated. "If we can better understand how myofibrils

work," says Labuda, "we will understand how entire muscles work. Since muscle contraction is responsible for basic functions in life, including locomotion, and heart beating, and is severely affected in diseases such as muscular dystrophy and cardiomyopathy, this technology has far-reaching implications." Discussions are now underway with potential industrial partners to commercialize Labuda and Rassier's system.

To that end, Labuda credits the Fessenden Prize with making him aware of the many steps involved in bringing a product to market. "The prizes force you to think of marketing, competition, potential risks — basically everything that has to do with commercializing an invention." ■

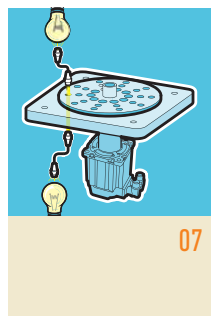
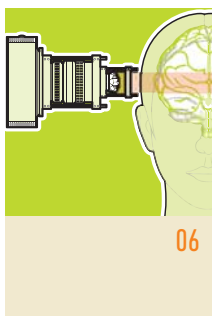
The Fessenden initiatives to promote innovation are possible thanks to gifts by the family of Canadian inventor Reginald Fessenden. McGill University does not receive any financial compensation from these start-up companies or the products they sell.

WEB EXCLUSIVE //
THESE FOUR STORIES ARE JUST
A TIP OF THE INNOVATION ICEBERG



READ ABOUT THE MANY
OTHER RESEARCH PROJECTS THAT
HAVE BEEN FUNDED BY
THE FESSENDEN INITIATIVE AT
PUBLICATIONS.MCGILL.CA/HEADWAY

- 01** ALIGNMENT TOOL FOR DISTRIBUTED MIRROR SYSTEMS
- 02** CLINICAL DEVICE FOR MALARIA DETECTION
- 03** CROWD-SOURCED CO₂ ASSAY
- 04** CENTRIFUGAL MICROFLUIDICS DEVICES
- 05** PAPER FILTERS FOR SUSTAINABLE WATER FILTRATION
- 06** NON-INVASIVE INSTRUMENTS FOR BRAIN ANALYSIS
- 07** CENTRIFUGAL MAGNETIC PULVERIZER



HOW TO BUILD A COMPUTER-ASSISTED ICE SCULPTURE *in* 6 EASY STEPS

Engineering designs, architectural models, you name it: McGill researchers are using robots, and a bit of water, to build 3-D prototypes that are greener, cheaper and more finely detailed than anything made with traditional milling machinery — and it's all made out of ice. //

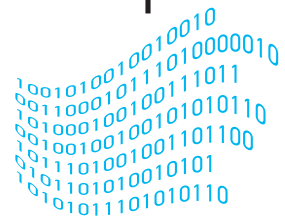
By Julia Solomon

When you think about ice sculpture do you picture winter festivals, watching someone hack away laboriously at a big block of ice? If so, subtract the freezing toes, lukewarm hot chocolate and guy with a chisel from your mental image. Add in some state-of-the-art machinery and an innovative collaboration between McGill's School of Architecture and Department of Mechanical Engineering and you get computer-assisted ice construction. This technique makes it possible to construct complex objects — both large and small — out of ice with a very high degree of accuracy.

"There are lots of applications for this technology," says Eric Barnett, a PhD graduate of McGill's Centre for Intelligent Machines and a key member of the computer-assisted ice construction project. Sure, you could use it to create ice sculptures that would be impossible to carve, but the technology transcends mere novelty: Computer-assisted ice construction can play a valuable role in many engineering, manufacturing and architectural settings where visual prototypes of parts or models are needed. "Prototyping with ice is a very environmentally friendly alternative to plastics or metals," says Barnett, whose supervisors were mechanical engineering professors Jorge Angeles and Damiano Pasini. (Eric also worked closely with now-retired McGill School of Architecture professor Pieter Sijpkens.) "The process uses only water and a biodegradable material for the support scaffolding and the material cost of using our 3-D ice printer is essentially zero."



+



+



01

Create a 3-D virtual model of the ice object to be created. This can be done by 3-D scanning an existing object or by using CAD software.

02

Use an algorithm written in MATLAB code, containing information for controlling robot positioning and deposition of the water and scaffolding material such as shortening methyl ester (SME), to slice the 3-D model into 2-D layers.

03

Start the ice-printing system: boot the robot controller, mount the deposition tool, verify that the liquid dispensing tanks are sufficiently full, and you're ready to print.



04

Micro-solenoid valves and nozzles spray water and SME in alternating layers, each a mere 0.25 millimetres thick. Every five layers, an automated geometric feedback system measures the top surface of the ice and scaffolding and corrects any errors it detects by adjusting deposition control data for subsequent layers.

05

After dispensing is completed, most of the scaffolding material is scraped off, melted, filtered and re-used for building other sculptures.

06

Scaffolding stuck to hard-to-reach or fragile locations can be removed by soaking the sculpture in kerosene.

Enjoy your low-cost, entirely biodegradable, robot-constructed ice sculpture, ready for storage in a very cold place near you. ■

This research is supported by a Strategic Research Grant from the Social Sciences and Humanities Research Council of Canada, as well as the Natural Sciences and Engineering Research Council of Canada and the Fonds de recherche du Québec — nature et technologies. Eric Barnett received doctoral and master's scholarships from the Fondation Universitaire Pierre Arbour.



first_person//

GENOMIC INVESTIGATOR

INTERVIEW WITH TOM BUREAU, ASSOCIATE PROFESSOR OF BIOLOGY

By Victoria Leenders-Cheng

TOM BUREAU SPECIALIZES IN DETECTIVE-STYLE PLANT GENOMICS: he examines the little-understood elements in between genes called non-coding DNA and also meticulously documents plant growth to find defects caused by the suppression of a single gene. The latter task got a big boost last December when a Canada Foundation for Innovation (CFI) award brought a shiny new machine to Bureau's greenhouse lab. The only one of its kind in an academic institution in Canada, the cutting-edge device is called the McGill Plant Phenomics Platform (MP3) and promises to be a powerhouse for plant genomics research.

You compare aspects of your work to that of using facial recognition software to find one individual in a large crowd. How so?

The traditional molecular genetics approach to finding out what a gene might be doing is to perturb the genome—for instance, cause mutations—and then ask what is different about the organism. We're taking a similar approach in the plants we work on, looking at choice targets that we think might be important agriculturally, knocking them out and asking what they do. We are looking for that one defect that tells us something about the gene.

This new machine in your lab, the McGill Plant Phenomics Platform (MP3), looks like a high-tech conveyor belt! It ships plants in and out of the greenhouse and photographs them at various stages of development. What makes this device so important for your work?

We need to capture the plant from a seed all the way to maturity because the defect might reveal itself somewhere along those lines, and to do this in a statistically robust manner, we need to analyze large numbers of plants.

The imaging platform is designed for high throughput image capture and analysis. It has a rotating stage so the camera can

capture metrics like leaf area or branch length in three dimensions and it has infrared, near-infrared and ultraviolet cameras that can look, for example, at the plant's photosynthetic capacity or water movement to try to decipher non-invasively what has been affected by the knocked-out mutation.

To give you an idea of how powerful this device is, our plan B if we didn't have this platform was to do what everybody else does—manual inspection of each plant. Our throughput would have been significantly lower and we would have had to select the targets we were interested in very stringently.

Your research looks specifically at parts of the genome called non-coding DNA. Can you explain what these are?

Genes only make up a small percentage of the genome; the rest is stuff in between the genes that we refer to as non-coding DNA heavily populated by transposable elements. At first, we didn't think these elements had any function for the host and, in fact, we sometimes refer to them as selfish DNA. Recently, though, there has been a lot of interest in these elements because a subset of them does appear to have a function, especially in the regulation of genes.

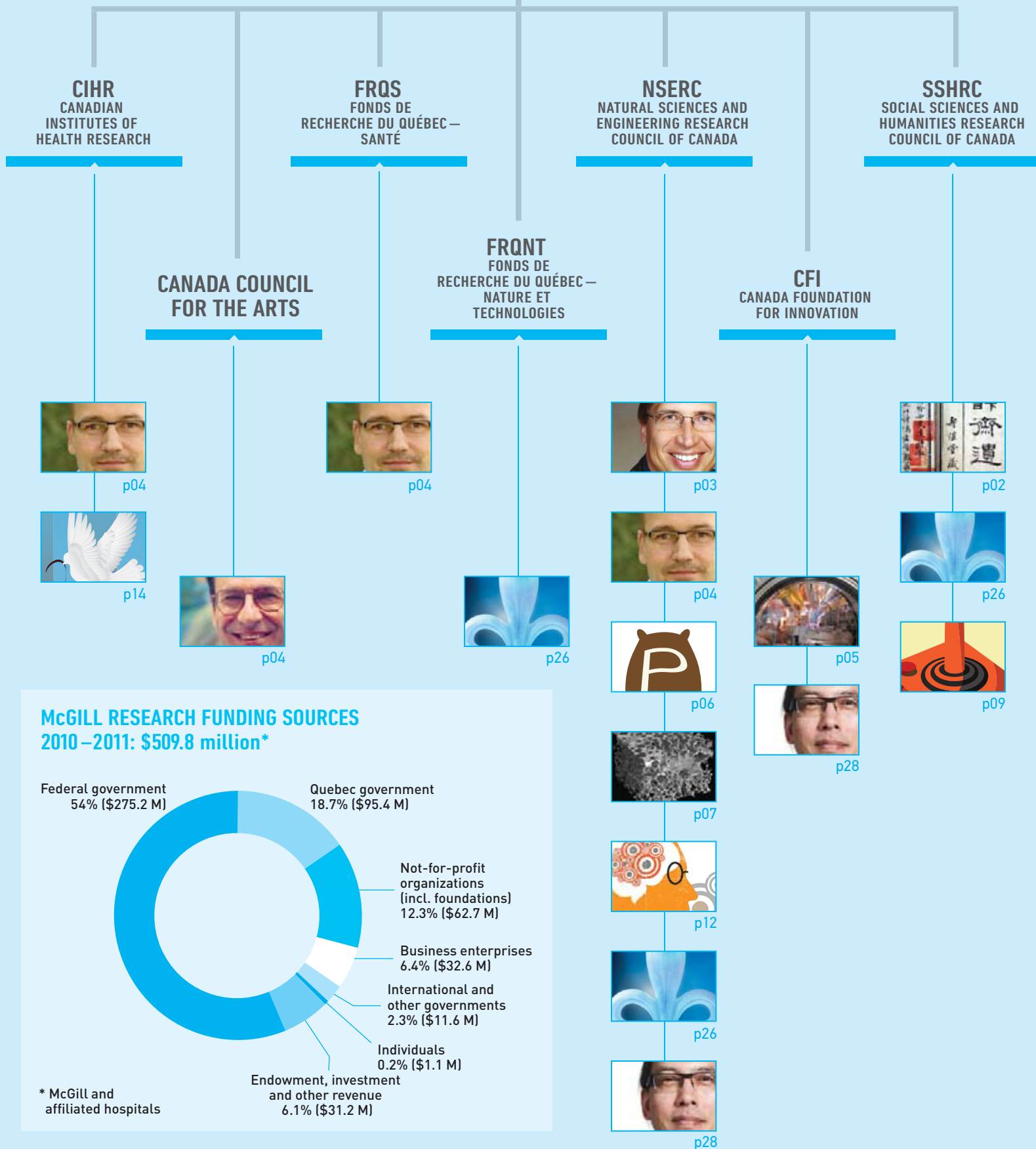
Plant breeders are starting to realize that non-coding DNA could be quite important agriculturally, and our counterparts in the human genomics world are in the same place: there are many known diseases where the genes are not defective but their regulation is being changed. The MP3 allows us to look at these elements closely and to get meaningful, informative data for further investigation. ■

Tom Bureau's research is funded by Genome Canada, Génome Québec, NSERC, a William Dawson Scholar fund, and the Canada Foundation for Innovation (CFI).

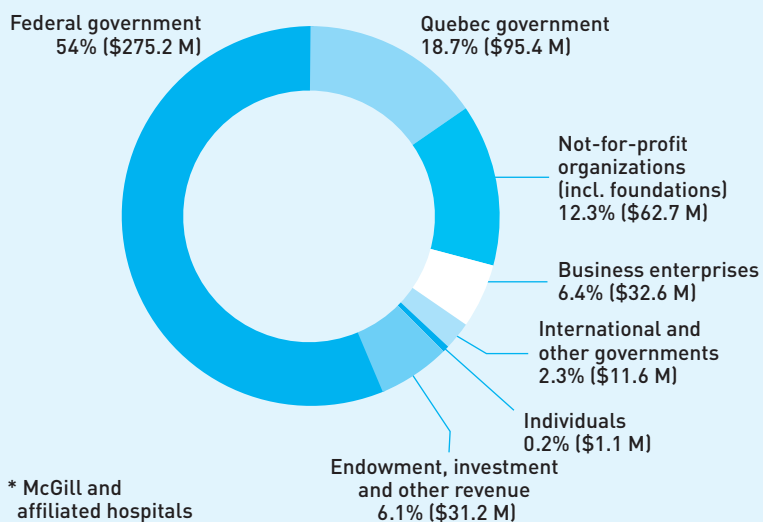


RESEARCH FUNDING

The research featured in *Headway* is supported by various provincial and national funding agencies, including:



McGILL RESEARCH FUNDING SOURCES 2010 – 2011: \$509.8 million*



* McGill and affiliated hospitals



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TECHNOLOGY CAN HELP, BUT IT CAN ALSO HARM.

“You can’t just put a computer into a classroom and expect it to be a useful learning tool.”

Professor SUSANNE LAJOIE, lead researcher of the *Learning Environments Across Disciplines* project, which is developing innovative technology-rich classrooms.

“Today’s children are growing up with digital media. We need to help them draw the line between online comments that are harmless, and those that are hurtful.”

Professor SHAHEEN SHARIFF, recipient of a *Facebook Digital Citizenship* research grant to develop ways to curb cyberbullying.

Putting children on the right technology track: one of the many ways that McGill University research is improving the lives of Quebecers.

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