McGill Engineering has an ambitious program to recruit world-class researchers with expertise in areas critical to the education of our students.

One of the tools being used to attract and retain these first-in-class professors is a three-year, $75,000 prize called the Faculty Scholar Award. The award augments funding that professors obtain from external agencies or other sources at McGill. It helps to pay for such items as laboratory expenses and technician support, graduate student support, undergraduate research projects and publication costs.

Five prizes have been awarded to date. If funding is obtained, the Faculty would like to create at least 20 such positions.

The first three recipients, titled Hatch Faculty Fellows, are being supported through a gift from alumnus Gerald G. Hatch, BEng’44, DSc’90 (see Spring 2009 Dean’s Report). In this issue, the two newest Faculty Scholars, Zetian Mi and Mathieu Brochu, explain the objectives of their cutting-edge research. Both are being funded through gifts from Hydro-Québec.

Zetian Mi’s research could lead to major reductions in global energy consumption

by Patrick McDonagh

The U.S. Department of Energy cast down the research gauntlet recently when it announced a goal of replacing light bulbs by 2025 with solid state lighting that draws on electricity converted directly from semiconductors. And professor Zetian Mi has answered the challenge.

Since arriving at the Electrical and Computer Engineering Department in September 2007, Mi has established the only facility at a Canadian university for researching gallium nitride (GaN) nanoscale materials, making him a leading researcher in the field of GaN semiconductors.

Semiconductors such as these could provide an inexpensive, long-lasting light source that is 50% more energy-efficient than current technology. “Since almost 20% of global electricity use is due to lighting, the energy savings would be significant,” Mi says.

Brochu’s team engineers an advanced welding process

Manipulating nanomaterials to manufacture large-scale components

Anomaterials are, by definition, tiny, but professor Mathieu Brochu has taken on the challenge of using nanomaterials to fabricate large objects as well.

The Mining and Materials Engineering Department researcher says that “fabricating laboratory-scale nanomaterials is easy, but to make an actual large-scale component economically — such as a mechanical device or an aircraft part — is no simple task.”

While they boast extremely useful features for large-scale objects, bulk nanomaterials also present daunting problems. For instance, because of their low fracture toughness, an impact could cause something constructed with bulk nanomaterials to break. As a result, such materials are restricted to applications having a static load, which is a significant constraint to their widespread use.
Dean's Message

I recently hosted our Faculty's fall Homecoming Breakfast for alumni, my fifth “welcome back” event in as many years. Looking back over that half-decade, it is clear that our Faculty has witnessed considerable change and remarkable growth. Much of that transformation is due to the support and encouragement of committed alumni.

The latest figures from Campaign McGill show that — with three years to go — McGill Engineering has already reached 80% of its $70-million objective. We are second only to the Faculty of Medicine in terms of dollars raised and percentage of goal reached.

That level of support, including a 52% increase since 2004 in annual gifts to the Alma Mater Fund, enables the Faculty of Engineering to compete as one of the pre-eminent professional engineering schools in the world.

Your donations have helped us to:
• recruit the highest-calibre professors;
• enhance graduate education in order to attract the very best doctoral and masters students;
• restructure undergraduate student support and service programs to meet evolving needs in industry and society;
• considerably increase research funding;
• actively pursue interdisciplinary teaching and research;
• expand partnerships with industry;
• and last, but not least, revamp administrative and operational functions to realize major efficiency gains. This latter initiative has proven crucial in these times of lean budgets.

Balance sheets can never adequately reflect our alumni’s generosity of spirit, but gifts from graduates of our five departments and two schools are a meaningful barometer of your commitment to ensure that McGill Engineering continues to offer its students a first-in-class education.

Thank you for the tremendous contribution you make to helping us fulfill our mission, and please accept my warmest wishes for a happy holiday season and a satisfying 2010.

Christophe Pierre  
Faculty of Engineering

McConnell Challenge Fund doubles donor support for students

A matching gift program established by the J.W. McConnell Family Foundation is helping Faculty of Engineering donors double the size and impact of their gifts.

The $17-million “McConnell Challenge” is open to donors across McGill. Awards are being made on a first-come, first-serve basis, however, and the funding is fast running out, so engineering, architecture and urban planning donors are encouraged to move quickly if they want to take advantage of the offer.

Matches are available for undergraduate scholarships, graduate fellowships, endowed chairs and the multiple support programs administered by the McGill Engineering Student Centre (MESC).

Grateful alumnus Yanping Lin uses matching funds to add to fellowships pool

Mining and Materials Engineering alumnus Yanping Lin, PhD ’92, was one of the first Engineering Faculty donors to avail himself of the McConnell matching gift program. His endowment for graduate fellowships was doubled — meaning that $200,000 is now available in perpetuity for recipients of the Dr. Y. Lin-Alexander Fellowships in Engineering.

A successful entrepreneur — and recently published author — who divides his time between Montreal, Paris and China, Lin is one of a new generation of alumni who are increasingly showing their gratitude to McGill Engineering for the education they received here.

Humanitarian values key to his world view

On a visit to the Faculty not long ago, Lin said that China may be his homeland, “but Canada is now my country.”

“My McGill education taught me about values, fairness, love and generosity as much as it did about metallurgical engineering,” he says. “China is a very different place in that sense, and frankly I might never have become aware of the importance of these values in everyday life had I not accepted McGill Engineering’s offer to study in Montreal.”

Now a father with two young sons and a daughter in her second year at the Desautels Faculty of Management, Lin augmented his income during his doctoral studies by working as a teaching assistant and a research assistant. He says he is eternally grateful to McGill for the support he received when he was a student.

His Chinese-language book, which Lin was unable to publish in China because of its often blunt criticism of contemporary Chinese society, is a study of the differences between Chinese and Western cultures.

“Our values may not be perfect in the West,” he says, “but we are still light years ahead of China in the way Canadian and other educational systems help to develop the whole person.”

Lin, who has been contributing to the Alma Mater Fund since the mid-’90s, says his fascination with Western culture will almost certainly compel him to write more on the subject. He is concerned that many of the Chinese students studying abroad today only focus on the technological aspects of their education. He hopes to kindle in them some of his remarkable passion for Canada and for Canadian — and other Western — values.

Developing the whole person – Yanping Lin
Undergraduate teaching and research

Undergraduate education is experiencing a renaissance at McGill Engineering. Enrolment has increased 20 per cent during the past five years; entering students’ grade point averages are up considerably; several new teaching and research programs have been introduced and 50 additional scholarships have been created as part of a major effort to increase student support.

Renovations have also been made to undergraduate design laboratories in Chemical and Mechanical Engineering, work is underway in Civil Engineering on integrated teaching and research environmental engineering laboratories, and there is improved study space in both the McConnell Engineering and M. H. Wong buildings.

Of the 2,630 undergrads enrolled this fall, 25 per cent are women, 16 per cent are francophone and 26 per cent come from abroad. In fact, there has been a remarkable 45 per cent increase in overseas admissions since 2004.

New programs lie at the heart of the renewal in undergraduate education, including minors in biomedical engineering and mining engineering, a first-year course titled “Introduction to Engineering” and a pilot program with the Faculty of Law and the Desautels Faculty of Management that offers an integrated senior year capstone design project.

Summer Undergraduate Research in Engineering: A ‘SURE’ Thing

One of the most creative new initiatives for undergraduates is a program to expose young minds to research opportunities in academia long before they would normally have the chance.

Launched in May and coordinated by the McGill Engineering Student Centre (MESC), the SURE (Summer Undergraduate Research in Engineering) program is a companion to internships in industry, enabling undergraduate students to learn more about their discipline through summer internships in McGill laboratories and research institutes.

“We are, after all, a research-intensive university, but our undergraduate students don’t always see that,” says Andrew Kirk, Associate Dean, Research and Graduate Education. “Most have little notion of what goes on outside of the classroom.”

“We want SURE to get students excited about their programs and to connect them with the questions their professors are working on. In the same way industry internships show students how companies function and what expectations exist in that world,” Kirk says, “the SURE program shows students how university research works.”

General Engineering program launched in September

In addition, McGill Engineering is now one of a small group of North American engineering schools that offer entering students two options: they can either choose a major at admission, as was the case previously, or follow a new, U0 general engineering program that allows them to wait until the end of their first year before selecting a specialization.

The program gives the 32 students enrolled this year an opportunity to explore different engineering majors and learn more about the academic and professional opportunities associated with each discipline. The program includes career development workshops and information sessions that explain undergraduate research opportunities.
Participants develop insights into research techniques, gaining an overview of the breadth of research taking place across the Faculty and learning about funding opportunities and how to apply for grants. They also get a taste of how exciting masters and doctoral work can be. In that sense, the SURE program is a valuable tool for graduate recruitment at the Faculty.

For 16 weeks during the summer, 70 professors welcomed 116 engineering and architecture undergraduates as members of their research teams.

Each student earned $5,625 for investigating areas as diverse as bioremediation of waste petroleum, aircraft de-icing and the transformation of bedrooms during the 20th century.

Forty-five of the students received funding from a related Natural Sciences and Engineering Research Council of Canada (NSERC) initiative called the Undergraduate Student Research Awards program (USRA). The other students were supported by monies from the Faculty of Engineering, the Office of the McGill Provost and each professor’s individual grant.

The NSERC funding is available to Canadian students only, although the SURE program is open to all, regardless of nationality.

Like scholarships, Kirk says that SURE internships are a major plus on a student’s CV, either when job hunting or applying for graduate school. The supervising professor gets to know the student better through the internship and her/his written assessment or recommendation on a CV can add considerable weight when decisions are made by future employers or graduate school admissions officers.

Dazzling poster display

In fact, SURE provides a number of collateral benefits. Having research experience on a CV improves students’ chances of winning fellowships if they do go on to graduate school – as does being named a co-author on a published paper, which may be the case with several of this year’s SURE participants.

In Professor Zetian Mi’s nanoelectronics laboratory, for instance, students Adrien Pierre and Andy Shih built and tested a memristor, the elusive “fourth circuit” long hypothesized but never fabricated until HP Labs managed the trick last year.

Today, second-year undergrad Shih is co-author on a paper already submitted to a leading journal.

“Acquiring this kind of experience really gives potential grad students a head start,” says Kirk.

SURE also has the happy side effects of increasing McGill Engineering’s research capacity by bringing more people into its laboratories over the summer, and giving graduate students the experience of supervising and training their novice compatriots.

One of the highlights of the SURE program this year was a poster display held August 12th on the mezzanine of the Lorne M. Trottier Building. More than 100 undergraduate researchers documented their summer activities, highlighting the range and depth of research underway at the Faculty.

A panel of graduate students awarded “top poster” recognition to Jonathan Verrett, a chemical engineering undergraduate. He was working on biological hydrogen production research in Professor Viviane Yargeau’s laboratory, under the supervision of graduate student Rujira Jitrwung.

To see his poster, as well as others presented last August, visit the SURE web site at www.mcgill.ca/engineering/sure.

The Faculty of Engineering is currently seeking funding to make the SURE program a permanent fixture in the academic life of our undergraduate students.

With files from Patrick McDonagh
Brochu’s research explores different ways of manipulating and applying nanomaterials to enhance their exceptional qualities — including hardness, strength and oxidation resistance — for use in bulk applications.

Brochu, who is a Canada Research Chair in Manufacturing Nanomaterials as well as a Hydro Québec Nano-Engineering Scholar, says that one way of dealing with low fracture toughness is to develop a type of nanocladding, in which the bulk of a component is made of conventional materials, while the surface uses nanostructures.

“This approach gives us the desired toughness for the component, along with the nano characteristics we want for the surface.”

From aircraft parts to wheels on buses

Practical applications are easy to find. “For example, the de-icing sand used on roads in winter accumulates inside the rims of bus wheels and erodes their surface. I am working on a project to make wheels out of conventional materials, but with a nanomaterial coating that would provide higher resistance to abrasion.”

Applying this nanocladding to conventional material is challenging in its own right, but last summer Brochu and members of his research team — including 13 graduate students and an undergraduate from the Summer Undergraduate Research in Engineering (SURE) program (see page 3) — engineered an advanced welding process capable of depositing nanomaterials on a surface.

An arc weld with a high-frequency pulse having a duration of a few microseconds provides the energy to deposit and fuse materials without causing them to lose their nanostructure — as would be the case with a longer duration or different cooling period.

“This sort of freeforming has never been done before, so I am really proud of it,” Brochu says. “But the concept is very new, so there are still issues to address, such as a low deposition rate that demands a time-consuming layering process.”

Brochu’s welding-edge research is clearly catching the interest of students, but he also has gained a reputation for his pedagogical prowess. After winning last year’s Class of ’44 Teaching Award in recognition of outstanding teaching in the Faculty of Engineering, this fall he received ASM International’s 2009 Bradley Stoughton Award for Young Teachers. The annual prize is presented to the world’s top young materials science teachers. “Some really impressive researchers have won this award before,” Brochu says, “so I’m honoured to be included among them.”

by Patrick McDonagh

Materials Engineering doctoral student Bamidele Akinrinlola is one of 13 graduate students working with professor Mathieu Brochu to develop manufacturing processes that employ nanomaterials. She is seen here working on an electrospark welder. Only one other university in Canada has the device and only Brochu’s group is using the welder to freeform nanostructured materials.
Doctoral students Yi-Lu Chang (left), Feng Li (centre) and professor Zetian Mi (right) use a sophisticated Nitride Molecular Beam Epitaxial Growth System to grow nanostructures in Mi's McConnell Engineering Building laboratory. The million-dollar-plus apparatus enables the team to explore low cost, high quality nanomaterials manufacturing strategies for industry.

Zetian Mi's research (cont'd from front page)

Research on GaN and other nitride-based semiconductors dates only from the 1990s, so they still pose many questions. “But that means that they also offer a lot of potential,” Mi says.

“To use them effectively, however, we must understand GaN more thoroughly and develop the technology that would make it more appropriate for the market.” While some companies are commercializing this technology, concerns about efficiency, cost and yield remain among the major roadblocks.

Mi, who was recently named a Hydro-Québec Nano-Engineering Scholar, is exploring inexpensive fabrication strategies that involve growing highly efficient nanostructures — such as nanowires and quantum dots — on a large-area silicon substrate, an innovative approach that could scale up to levels demanded for industrial manufacturing. Mi’s group (three doctoral students, a post-doctoral fellow and an undergraduate) has already grown green, yellow, amber and red-emitting indium gallium nitride nanowires on a silicon substrate, with these nanowires showing internal quantum efficiencies of more than 45%, as opposed to currently reported values of less than 10% for other approaches.

GaN nanostructures offer a stunning range of potential applications. “The nanowires we grow here are just a little larger than DNA sequences, and when they are combined with DNA, their electrical properties change,” Mi explains.

Harvesting solar energy

“This characteristic can be used to tell us detailed information about the DNA that may not be obtained otherwise. As such, ultra-sensitive DNA sensors are being developed.” Mi’s unique nanowire research was featured with a photo on a recent cover of the prestigious international journal Nanotechnology.

In addition, Mi’s research group is investigating GaN’s potential for harvesting solar energy.

Most solar panels absorb only a portion of the solar spectrum, and even the most advanced solar energy technologies, such as those used on the International Space Station, can take advantage of the entire spectrum only by using a combination of different materials – an approach that is far too expensive for more mundane applications. Systems using nitride-based materials, such as GaN, indium nitride, aluminum nitride and their alloys, can absorb the entire solar spectrum.

“The major problem in tackling this issue is growing sufficiently high-quality nanomaterials, and that is exactly the edge my group has gained in the last two years,” Mi says.