Major changes are underway at McGill Engineering that are giving a new look and feel to the 79-year-old Faculty.

A $25-million refit to the Macdonald Engineering Building (see page 2 for story) and the presence of greater numbers of top-calibre graduate students are providing the Faculty with important tools to tackle new research challenges and move in new directions.

The changes are both real and symbolic, says Dean Christophe Pierre. Recently appointed to a second five-year term, Professor Pierre says the changes reflect a University priority expressed in 2005 to revitalize the Faculty of Engineering to ensure that it competes on an equal footing with other elite engineering schools.

One of the benchmarks set at that time was a dramatic increase in graduate enrolment, and the Faculty’s success in this area has been dramatic.

New PhD enrolments, for example, are up 115% over 2006 levels. Annual targets for new doctoral students were set at 100, 125 and 150 during the past three years, and each of these goals was surpassed. Coupled with equally impressive jumps in master’s degree registrations, graduate enrolment eventually topped the 1,000-mark this past fall, and the figure for the academic term just ending was 1,060, split almost evenly between doctoral and master’s students.

“The 1,000-mark was a major milestone,” says Associate Dean, Graduate Education and Research, Andrew Kirk, who emphasizes that the push for more students is not a quantity-over-quality equation. “It’s important
Massive refit breathes new life into Macdonald Engineering

A $25-million government-sponsored renovation is underway at the Macdonald Engineering Building. The massive infrastructure overhaul coincides with work on the building’s fifth floor to build state-of-the-art Integrated Laboratories in Environmental Engineering. That project is a gift from two alumni, husband-and-wife team Andrew Benedek, BEng’66, DSc’05, and Diana Mourato-Benedek, BSc ’81, MSc’83, PhD’90.

The government renovations form part of a $2-billion federal-provincial economic stimulus package to support science and technology initiatives at post-secondary institutions. Called the Knowledge Infrastructure Program (KIP for short), the funds will help to keep Canada’s research and educational facilities at the forefront of scientific advancement.

Improving facilities is a key factor in attracting world-calibre talent, and in the process the KIP program is creating jobs for local engineers, architects, tradespeople and technicians.

Striking improvements

KIP money comes with a major proviso, however; the entire $25-million project at McGill Engineering must be completed by spring 2011. The Benedeks’ laboratories, for their part, will officially open next month, in June 2010. As this issue of the Dean’s Report went to press, finishing touches were being made to the Benedeks’ ultra-modern facilities. A full report about the couple’s generous gift will be published in our next edition, in fall 2010.

The two departments that will benefit most from the government refit are Mechanical Engineering and Civil Engineering and Applied Mechanics, but all students, faculty and staff who use the 104-year-old Macdonald Building will see dramatic improvements.

Electrical and mechanical systems will be upgraded to meet modern research and teaching standards, and ventilation will be extended and centralized to improve air circulation – particularly in laboratories. Most Macdonald Building laboratories will also be reconfigured and relocated to better suit their purpose.

A central atrium

No significant net space will be created by the year-long project, but KIP funds will correct major deficiencies in the building and make better use of existing space. The overhaul will also result in improved energy efficiency and ensure proper heating, cooling, electrical and plumbing services.

The structure collectively known as Macdonald Engineering is actually three separate buildings: a main pavilion and two adjoining wings – the Workman Wing and the Electrical Wing. Several floors of all three buildings will be gutted completely and entirely refitted.

A central atrium will also be installed in what is now an inaccessible inner courtyard between the Workman and Electrical wings. The atrium will include an elevator and provide easier access to the two smaller wings.

(cont’d on page 6)
Collaborating with industry through
A win-win situation for grad students, researchers and society

Stories by Patrick McDonagh

McGill Engineering has made significant progress in graduate education and research during recent years. An impressive list of world-class professors has joined an already talented pool of researchers; larger numbers of highly-talented students have been recruited and exciting new programs have been launched.

The next stage in the Faculty’s development plan involves significantly increased research partnerships with industry, and one of the principal ways of reaching that goal is acquiring greater numbers of Industrial Research Chairs (IRCs).

Sponsored by Canada’s Natural Sciences and Engineering Research Council, in collaboration with industry, NSERC-IRCs provide financial support to help researchers and their teams find innovative solutions to specific questions posed by industry.

Professors and graduate students work with industry representatives to prepare the initial research program proposal, and then, over the five years of NSERC-IRC funding, the company and the researcher regularly exchange ideas and adjust the research focus to ensure its practical relevance. NSERC and the sponsoring company share the cost 50-50.

Andrew Kirk, our Faculty’s Associate Dean, Research and Graduate Education, says the Chairs provide multiple benefits:
• Participating companies use the information obtained through McGill Engineering research to improve their product and develop their business;
• The department in which the IRC Chair is housed receives additional resources to hire more teaching staff;
• Graduate students earn income, gain experience and make valuable contacts that can help them find employment after graduation.

Important student role
“Part of the salary a department would normally pay its professor is covered by the NSERC-IRC. While the Chair-holder focuses on research, the department uses the dollars it saves to recruit fresh talent to teach.”

“As for graduate students, they gain immediate financial benefit because a big chunk of the NSERC-IRC’s resources is usually set aside for them. That’s only reasonable, because the work they do for their supervising professors is key to the success of these projects.”

“Longer-term student advantages flow from the close interaction that occurs between their professor and the firm. Through frequent meetings between our people and the firm’s industrial researchers, partnerships develop that give students a good path into industry after they graduate.”

Four NSERC-IRC projects have been awarded to date at McGill Engineering; three are well underway and one is just getting started. A fifth proposal has been submitted by the Faculty and another partner company, and NSERC is expected to make a decision about that proposal soon.

“All research is designed to be useful,” Professor Kirk says, “but NSERC-IRCs are particularly beneficial for society because they enable our Faculty to use its talent and resources to help companies develop fresh ideas and meet difficult challenges. The net result can often impact positively on both the economy and people’s quality of life.”

In addition to managing the Faculty’s Photonics Systems Laboratory, Research Assistant Josh Schwartz, BEng’03, PhD’08, conducts communications research under the aegis of Professor David Plant. The apparatus above, part of a “burst mode receiver”, receives packets of information travelling through a fibre optic network with unpredictable timing, literally as sudden “bursts” of data.

Second-year Electrical and Computer Engineering master’s student Mathieu Chagnon assists with research on long-haul transmission systems.
“From our perspective, McGill Engineering’s success in obtaining NSERC-IRCs is very gratifying. By partnering with us, companies clearly show that they value our work and have confidence in our professors’ capabilities. That’s quite an endorsement.”

Here are brief summaries of McGill Engineering’s NSERC-IRC projects.

Moving rivers of data in the Internet age

Data runs from our homes and businesses and flows across cities, countries and continents, but these massive rivers of information still hit bottlenecks when transmission channels narrow.

Originally, Bell’s network used twisted pairs of copper cable, which do not require much capacity, to provide voice communications. Today, though, people want video delivered over the Internet, so capacity demands are massive,” says Tho Le-Ngoc, BEng’76, MEng’78, an Electrical and Computer Engineering professor and holder of McGill Engineering’s NSERC/BellCanada IRC in Performance and Resource Management in Broadband xDSL Access Networks.

While most long-distance data transport now relies on fibre optic cable, Bell still uses bundles of copper lines to provide most access links – that is, the connections between network hubs and individual premises. For distances under two kilometres, these copper bundles remain the most economic approach, especially because they are easier to repair than fibre optic cable.

But two-thirds of Internet users have DSL modems that send and receive increasingly hefty data loads along this access network, altering the dynamics of signal interactions in the copper bundles and leading to new problems, including cross-talk and reduced signal strength along certain frequencies.

“The problem is, although we know how to address these issues at lower levels of traffic, we cannot simply use the same formulas to deal with them with increased traffic,” says Professor Le-Ngoc. His laboratory on the eighth floor of the McConnell Engineering Building has more than 200 metres of twisted-pair bundles that circle the room and run down the hallway.

The facility, along with Bell’s one-kilometre loop at its Varennes research site, enable Professor Le-Ngoc’s research team to understand what happens when almost 100 megabits of data flow along bundles of copper wires each second, and to develop the algorithms and perform the calculations that will help Bell optimize copper wire efficiency at these rates.

Working closely with Professor Le-Ngoc is fellow Electrical and Computer Engineering professor and department chair David Plant, who holds another NSERC-Bell IRC – this one in Ultra-High Bit Rate Optical Transport and Access Networks.

While Professor Le-Ngoc’s research covers the copper segment of Bell’s network, Professor Plant is focused on fibre optic cable connections, especially those linking cities.

“As demand for video goes up, so do demands on transport and access networks,” says Professor Plant, noting that Bell recently enhanced connections from 10 to 40 gigabytes/second along the corridors connecting Montreal, Toronto, New York and Chicago.

The challenge: find ways to increase data flow while mitigating problems with signal loss or dispersion along the way. One strategy involves processing signals with a pre-distorted pulse, so that the fibre undoes these distortions during transmission.

However, understanding why distortion occurs in the first place and then distorting the initial pulse properly demands a thorough investigation of the transmission medium.

“The NSERC-Bell IRCs provide a classic example of successful interaction between academia and industry,” says Professor Plant. “We learn a lot about Bell’s needs and those of their customers, and we hear about issues that don’t appear in journals.”

For professors Le-Ngoc and Plant, and their research teams of post-doctoral fellows, graduate students and undergraduates, the NSERC-Bell IRCs enable them to translate these engineering challenges into innovative new research opportunities.

(More IRC stories on page 5)
Supercomputer calculations improve aircraft safety

“Two solitudes” is how Mechanical Engineering professor Wagdi Habashi, BEng’67, MEng’70, characterizes the aerospace industry practices he encountered when first exploring in-flight ice accretion on aircraft a dozen years ago. “One group in a company worked on aerodynamics – designing the airplane, engine, helicopter blades, and so forth – and another worked to protect all of these components from icing. But the two seldom designed together,” he says, “and in-flight icing technology lagged a decade behind aerodynamics technology.”

To aggravate the problem, the sole tools modelling ice build-up during flight came from NASA and the French ONERA (l’Officenationald’études et de recherchesaérospatiales), who allowed only American or French tools modelling ice-build-up during flight. But these tools seldom designed together, says Professor Habashi, “and in-flight icing technology lagged a decade behind aerodynamics technology.”

The research grabbed the attention of Canadian manufacturer Bombardier Aerospace, and in 2003 Professor Habashi became the NSERC-J. Armand Bombardier IRC of Multidisciplinary CFD; the Chair was renewed in 2008, with additional support from Bell Helicopter Textron and CAE.

The CFD Lab, which includes 10 graduate students, post-doctoral fellows and undergraduates, has resolved many of the early modeling challenges, but new problems constantly appear.

“When you design an airplane you use specific atmospheric data, collected by meteorologists, that provide the extremes encountered in clouds in terms of temperature, droplet size, liquid water content in droplets, and so forth,” Professor Habashi explains. “But this information can date back 65 years.”

Recent decades have seen a decline in coal burning, meaning that fewer ash particles are being expelled into the skies. These particles once acted as condensation points for droplets, which would fall as rain.

A mathematical model

A cleaner atmosphere means that droplets now grow bigger, becoming “supercooled large droplets” before they break up and fall as freezing rain or drizzle.

“Once these large drops hit the airplane, they shatter and splatter and are carried by the airstream into places where the pilot cannot remove any ice that forms,” says Professor Habashi.

“We now have a mathematical model of this phenomenon, though,” and the first to benefit will be Bombardier and Bell Helicopter, who have sponsored the research through the IRC.

The CFD Lab is also building models for real-time flight simulation, of special interest to CAE. Professor Habashi’s team is using mathematical models that will enable simulators to respond rapidly to any maneuver the pilot might make.
add distributed generation into the grid, you start having reversed power flows,” Professor Joos says. “Then you also have to manage the voltage profiles, avoiding sags or swells. And the short-circuit and overload protection system has to be sophisticated enough to keep the grid healthy regardless of the power’s source or flow direction.”

Because one needs timely information updates to control this variable, bidirectional energy flow, Professor Joos and his team are exploring ways of integrating communication technologies to make intelligent electrical grids that monitor the energy being generated from all sources while forecasting what more can be expected. Smart meters, for instance, can track both consumption and renewable energy created by independent production.

“The electric distribution grid is a massive infrastructure, and effective management will allow us greater access to renewable energy without needing costly system upgrades,” Professor Joos says. “The decisions made now will affect us for decades.”

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McGill Engineering’s 2010 Alma Mater Fund goal is $1-million. Thank you for your past and future support.