Eurêka

JUNE 2004 THE RESEARCH NEWSLETTER OF ÉCOLE POLYTECHNIQUE DE MONTRÉAL VOLUME 3 • NO. 3

J.-Armand-Bombardier Building: an new multi-disciplinary interface

The J.-Armand-Bombardier Building, which was inaugurated on May 17, is now functional after a little over 24 months of work. With a gross surface area of 16,800 m² and an investment of approximately $60 million, the building houses research activities in high-tech areas including aeronautics and aerospace, nanosciences and nanotechnologies, biopharmaceutics, synthetic chemistry, biotechnologies and pharmaceutical technologies and pre-incubation. It also houses a centre for technologies used to teach and train students in the sciences and engineering.

Optimized building

The new building is designed to bring researchers and graduate students together. "This is not a simple building where research is conducted; rather, it is a place that stimulates research," says Michel Rose, Director of the Major Construction Projects Office. "In addition to the high-tech facilities, the researchers and students will also have access to areas, such as the gardens, that are conducive to thought and discussion." With the separation of heavy laboratories and offices as well as the development of eight indoor gardens, this building is an ideal environment for work, thought and discussion. The innovative physical layout of the building won the *Canadian Architect's Award of Excellence.*

The J.-Armand-Bombardier Building also has spaces devoted to the pre-incubation of five spin-off companies. Each will have 140 m² of offices and premises adjacent to the laboratories. Currently, this potential is of interest to three groups. "The work involved in isolating and separating the various companies under development to protect them and prevent any leaking of information is challenging," says Jean Choquette, Consultant with Polytechnique's Department of Research and Innovation. "The companies have access to high-tech equipment and carry on their activities within the same research sector."

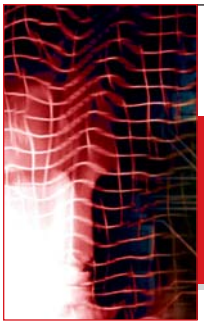
A few facilities

The new building consists of seven Class 10,000 clean rooms and 12 other Class 100,000 rooms; approximately 170 laboratory hoods connected to a centralized variable-flow control system; a 4,000-ton anti-vibration block that isolates devices such as nuclear magnetic resonance and nanotechnology equipment; networks providing over 20 types of gas, some of which are hazardous; and an incredible cooling capacity equivalent to four times that of the future Lassonde buildings (or 750 bungalows).

Professors moving to the J.-Armand-Bombardier building:
Back, left to right: Arthur Yelon; Michael Buschmann; Alain Rochefort.
Centre, left to right: Joseph Pegna; Yves-Alain Peter; David Ménard; Michel Meunier; Robert Legros.
Front, left to right: Mario Jolicoeur; Jean-Yves Trépanier; Patrick Desjardins; Ion Paraschivoiu.

INDEX

ÉCOLE POLYTECHNIQUE MONTRÉAL
Affiliated with Université de Montréal



To the Point

Montréal Technopôle

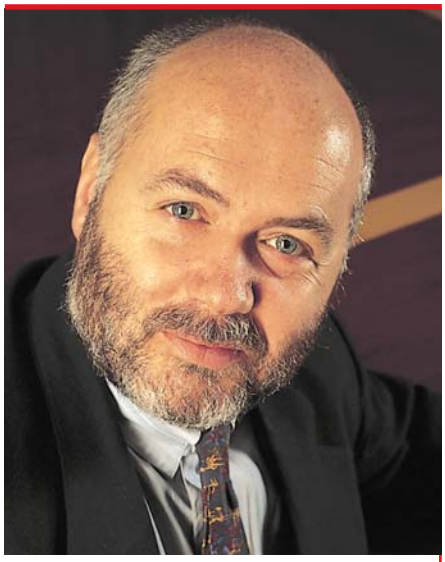
The new J.-Armand.-Bombardier building inaugurated on May 17 is the physical embodiment of the Montréal Technopôle concept, a close collaboration between École Polytechnique's engineering researchers and scientists at Université de Montréal.

The building will soon house a multi-disciplinary facility working on electronic materials and nanosystems. Professors Patrick Desjardins (Polytechnique) and Richard Martel (Université de Montréal) recently obtained more than $20 million in financing required for the project from the Canada Foundation for Innovation and Recherche-Québec. The two researchers are members of the Thin Films Group and participate actively in the Regroupement québécois sur les matériaux de pointe (Québec Centre for Advanced Materials) and Nano-Québec; they are the very example of fruitful and structuring cooperation. The Maison des technologies d'enseignement et de formation en sciences et en génie (Centre for Teaching and Training Technologies in Sciences and Engineering), which is located on the sixth floor of the building, will house three chairs funded by the Succession J.-A. DeSève, one for each of the three institutions on the campus.

The building will be home to teams from Polytechnique and Université de Montréal working in the field of advanced materials and nanotechnologies, life sciences and engineering, as well as teaching and training technologies; these, however, are only three of the six areas in which the two institutions will be cooperating in the framework of Montréal Technopôle. Projects in the other three areas (multimedia-IT-telecommunications, the environment and sustainable development, systems engineering) will have to be conducted in a different location. In the field of operational research, the André-Aisenstadt building has been housing the Group for Research in Decision Analysis (GERAD) and the Centre for Research on Transportation (CRT) for several years. Both inter-institutional research centres bring together under one roof researchers from Polytechnique, Université de Montréal and HEC Montréal.

Our centre on sustainable development, the CIRAIG (Interuniversity Reference Centre for the Life-Cycle Assessment, Interpretation and Management of Products, Processes and Services), which recently received funding from two Québec funding agencies (FQRNT and FQRSC), is still looking for premises where researchers from the three institutions can work together as a group. We are optimistic that the opening of the Lassonde Buildings will free up some space for them, and why not in the Aisenstadt building, which could then become the second Montréal Technopôle building.

Montréal Technopôle is ideal for multidisciplinary and inter-institutional research; it believes in close cooperation to ensure productive research and training at the graduate level that is open to and at the cutting edge of technology. Let's join forces to ensure its success!



Christophe Guy, P.Eng., Ph.D. Professor
Dean, Research and Innovation

Profile

Frédéric Sirois
stops over in the private sector on his way to academia

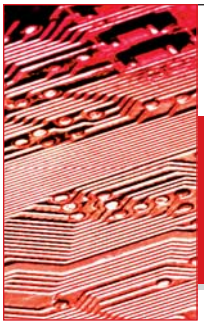
There is often a world of difference between the research subjects that we find interesting at university and those that are carried out in the private sector, as Frédéric Sirois is discovering. Mr. Sirois, whose doctoral thesis focused on the modeling of superconductors, is currently working as a researcher at the Institut de recherche d'Hydro-Québec (IREQ) in the area of distribution networks and power distribution. He plans to ensure that this foray into the private world will benefit him in the long run.

In his doctoral thesis, Mr. Sirois proposed new models based on the physical behaviour of superconductors to optimize design. "I started off with physical models that were slightly simplified but retained the characteristics of materials in high-current applications," he says. "They are obviously simpler models but they can be used in current CAD applications."

After a four-month trip across Central America, he joined the IREQ and has been working alongside some 250 researchers for the past year. Superconductors do not feature at all in his work; rather, he is focusing on the architecture of distribution networks and how to optimize them. This involves juggling several variables, for example, the availability of equipment, the location of change-off points and many more. Naturally, financial considerations are also important. "For a single investment, an optimized network is more reliable, provides better performance and the life cycle of the equipment is longer," explains the researcher.

Mr. Sirois is not planning to spend the rest of his days in the private sector. His medium-term plans are to find a position as a university professor and he hopes that his time in the private sector will help him achieve this objective. "I think it will give me an edge," he says. "The private sector puts us in touch with real constraints that we are not fully aware of in the academic world. For instance, an entire project can grind to a halt if the splicers' union tells its members not to work. You have to be flexible enough to adapt ..." ■

Frédéric Sirois who won an École Polytechnique award for best thesis in 2003 is currently working as a researcher at the Institut de recherche d'Hydro-Québec (IREQ).



Profile

When microelectronics go plastic

Gilles Dennler can boast about working at the very cutting edge of one of the newest areas of engineering – organic electronics – at the Linz Institute for Organic Solar-Cells (LIOS). In spite of this, he plans to return to Montréal one day in hopes of participating in the work currently under development in the same field at Polytechnique.

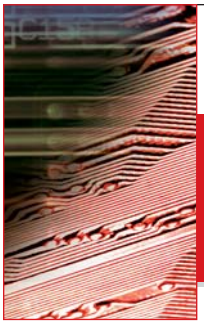
Organic electronics, a relatively new area, won the Nobel Prize for Chemistry in 2000. The field focuses primarily on using the semi-conducting properties of certain organic materials, such as so-called conjugated polymers.

Gilles Dennler who won an École Polytechnique award for best thesis in 2003 is currently working as a researcher at the Linz Institute for Organic Solar-Cells in Austria.

There are three advantages to this type of technology: mechanical flexibility, the processes require low temperatures, and production costs could be significantly lower than those of traditional microelectronics. "It could be described as rolls of plastic on which electronics would be drawn by the kilometre," Mr. Dennler explains.

The researcher's work at the Institute is in a field related to organic microelectronics: plastic solar cells. "Manufacturing current cells in polycrystalline silicon consumes a significant amount of energy," he explains. "Silicon cells have to produce several years' worth of energy to make up for that used to manufacture them." Plastic cells are more cost-effective and feature the great advantage of having an extremely malleable design. They have one disadvantage: the current energy conversion rate stands at only 5% compared with 12% for the current cells. This drawback can be offset by increasing the solar absorption area.

Surprisingly, Mr. Dennler's doctoral thesis, which was directed by Professor Michael Wertheimer and completed at Polytechnique, on growth modes of plasma deposited silicon oxide (SiOx) onto polymeric substrates led him to his current position in Linz. The interior of the packaging of several food items, such as chips, is coated in a thin layer of SiOx to prevent oxygen and water vapour from affecting the freshness of the product. "Semi-conducting polymers are also quite unstable when exposed to air and need to be properly encapsulated," he points out. "This link pushed me to make the leap from one area of research to the other." ■



Partnerships

CRIAQ
Adding a long-term perspective to aerospace research

"Like many other sectors, the aerospace industry has a somewhat short-term vision when it comes to research and development," says André Bazergui. Luckily, working in close cooperation with universities, key stakeholders in Québec's aerospace industry have promoted and created the Consortium de recherche et d'innovation en aérospatiale au Québec (Consortium for Research and Innovation in Aerospace in Quebec-CRIAQ), "which brings a more long-term perspective to research," adds the former Director General of École Polytechnique, who is currently a partner at Innovitech and CEO of CRIAQ.

CRIAQ stands for more than a long-term vision of research. The consortium is a one-of-a-kind partnership between universities and industry in this high-tech area and, as such, propels Québec into the ranks of the important players on the international scene. The research projects – the final selection was made by an international jury – meet the needs expressed by the industry and most of them are conducted by universities. The 13 projects earmarked for the first round of financing have already started or will do so shortly. They focus on six major themes: low-cost manufacturing and composites, acoustics and icing, modeling and simulation, multi-disciplinary design and systems integration, avionics, and micro-electro mechanical systems.

CRIAQ's virtual structure is also an interesting aspect. "We don't spend funds on bricks and mortar," Mr. Bazergui points out carefully. The Consortium will receive $5.2 million over the next three years from Valorisation-Recherche Québec, $400,000 a year for four years from the FQRNT (Fund for research on nature and technology) and more than $3 million over three years from the industry. The funds will be used to support the work of the researchers.

CRIAQ supports many of Polytechnique's masterminds, such as the modeling team headed by Jean-Yves Trépanier in the Deparment of mechanical engineering and René Mayer's team working on high-performance machining (see the November 2003 issue of *Eurêka*).

The industry is especially interested in the modeling work carried out in the framework of the MOSAIC project (Multidisciplinary Optimization Standard Approach Integration Configurability – Systèmes d'optimisation sur des standards et des analyses et permettant une intégration configurable) under the direction of Professor Trépanier. The project will help bring together various modeling tools from the MOSAIC project as well as enterprise systems into one comprehensive package that can be used to fully optimize an aerospace product.

"Naturally, we do have some form of optimization, but it isn't very systematic," Professor Trépanier says. "Decisions regarding optimization are made primarily orally between departments and on a more or less systemic basis. With our approach, decisions can be made in a more rigorous and methodical manner." ■

André Bazergui, CEO of CRIAQ

Advanced Research

Maksim Skorobogatiy
Toying with light

"I was born in Russia," says Maksim Skorobogatiy, "but Canada is my second home." The 29-year-old researcher arrived at Polytechnique in 2003 after completing his doctorate degree at MIT and a two-year period working for a company active in the area of photonic crystals. "I plan to stay here now," he says with conviction. And that is great news because the holder of a Canada Research Chair in photonic band gap materials and devices is involved in a highly advanced area that will strengthen Québec's position in the area of photonics.

Maksim Skorobogatiy, professor in the Department of Engineering Physics and holder of a Canada Research Chair in Photonic Band Gap Materials and Devices.

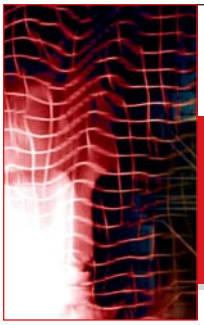
Like computer chips, which are very compact devices used to control electrical current, photonic crystals enable ultra-compact optical components to control light waves. Moreover, photonic crystal being carefully assembled of sub-wavelength dielectric elements is really an artificial material whose properties can be engineered to exhibit very different light transmission characteristics from that of its constituent materials.

Traditionally, fibre-optic information transmission is carried out using 1,550-nanometre light waves. This is the optimal frequency for fibre optics, where optical loss of the light conducting silica material is minimal.

However, "the 3- and 10-micrometre wave is extremely interesting for medical applications," points out the new Canadian. "Unfortunately, at such wavelengths it is extremely hard to find optically transparent materials to make a high quality fibre for guiding a laser beam it through the cavities and curves of the human body." The only option would be to transmit a light through the hollow low loss fibre core and use photonic crystals to confine the light. To inject the photonic crystals into the fibre one would place minute holes or deposit very thin multilayers into a fibre structure. This will make it possible for the fibre to transmit at the new required wavelength.

The researcher has two areas of interest. He would like to develop new applications for photonic crystals, especially biocompatible fibre optics and, most importantly, he would like to make industrial manufacturing processes more accessible.

He plans to achieve his objectives in an unusual manner. "Usually," he explains, "we focus directly on improving processes. However, the tolerance requirements for photonic crystals are such that this approach would be very costly." Mr. Skorobogatiy feels it would be better to focus on the designing of the products themselves to ensure that they can handle less precise crystals and are considerably less expensive to manufacture. ■



Telecommunications

Steven Chamberland Telecommunications industry shoemaker!

In the past few years, the telecommunications sector has experienced technological advances unmatched by any other industry. Unfortunately, although carriers have been improving their service offering at a frenetic pace, they have overlooked the internal network management systems. They are also doing nothing to develop architectures that can help resolve these problems and handle the astronomical increase in Internet traffic. The latter doubles virtually every two years. Carriers are certainly living up to the proverb of the shoemaker always being the worst shod!

This is the type of shortcoming being targeted by Steven Chamberland, Associate Professor of Computer Engineering and holder of the new Bell Chair in Telecommunications Network Architecture. The Chair will receive a $75,000-a-year subsidy for five years and the expert hopes an application for funds submitted to the Natural Sciences and Engineering Research Council of Canada (NSERC) will be approved, thereby doubling the current subsidy.

The first aspect that the researcher will tackle is that of architectures. "The new architectures being implemented have created many technical problems that need to be resolved," he said. "The Chair's proposal consists of developing architectures, protocols and software that will optimize the network infrastructure's performance and simplify its management."

For instance, he says, "We will have to develop ways to ensure that any breakdowns at the optical level, for example, can communicate with the Internet level to propagate the problem to the entire network." ■

Front, left to right: André H. Caron, holder of the Bell Chair in Interdisciplinary Research on Emerging Technologies, Université de Montréal; Marcel Boyer, holder of the Bell Chair in Industrial Economy, Université de Montréal; Steven Chamberland, holder of the Bell Chair in Telecommunications Network Architecture, École Polytechnique de Montréal; Rear, left to right : Joseph Hubert, Dean, Faculty of Arts and Sciences; Isabelle Courville, President, Bell Canada Enterprise Market; Robert Lacroix, Rector, Université de Montréal; Robert L. Papineau, Director, École Polytechnique de Montréal

Other projects Polytechnique's funded by Bell Canada

The JVR Cyr - BELL Canada Chair in Technological Entrepreneurship
The Chair, which is held by Jozée Lapierre, has a two-fold mission: to promote technological entrepreneurship and to support technology management research projects.

NSERC Industrial Chair in Site Remediation and Management
The objective of this Chair is to develop biological site restoration technologies by focusing on aspects associated with microbiology and engineering, risk analysis and the future of pollutants in the environment. The Chair is held by Réjean Samson and Louise Deschênes.

HEC Montréal – Polytechnique – Université de Montréal Entrepreneurship Centre
The mission of this non-profit organization is to generate interest in entrepreneurship and innovation in universities and to provide concrete support for the start-up of businesses. The centre is an incubator for innovative projects.

Interuniversity Reference Centre for the Life-Cycle Assessment, Interpretation and Management of Products, Processes and Services-CIRAIG
The Centre groups together and provides access to the leading Québec and Canadian universities involved in the life-cycle assessment and management of products, processes and services in an effort to support industry and government efforts in sustainable development.

Major Projects Launched Recently

Polytechnique's research activities are constantly developing. *Eurêka* plans to provide a summary of new projects in each edition of the newsletter.

OFFICIAL(S)	PROJECT TITLE	GOVERNMENT GRANTS	OVERALL BUDGET
NSERC – Collaborative R&D			
WERTHEIMER, Michael R.	Development of ultra-high performance permeation barrier processes and materials	$248,000 over 2 years	$424,000
NSERC – Idea to Innovation (I2I) program			
CIUREANU, Petru	Product authentication system based on the giant magneto impedance effect	$175,000 over 2 years	$245,000
KASHYAP, Raman	Waveguide fabrication with lasers	$125,000 over 1 year	$125,000
TREMBLAY, Robert	PT-SCED braces for the protection of structures subjected to extreme loadings	$125,000 over 1 year	$125,000
Industrial chair			
CHAMBERLAND, Steven	Bell Chair in Telecommunications Network Architecture	----------	$350,000 over 5 years
CRC – Canada research chairs			
SKOROBOGATIY, Maksim	Theory, manufacturing and applications involving photonic crystals	$500,000 over 5 years	$500,000
FQRNT – Regroupement stratégique			
CARREAU, Pierre	Centre for Research into Plastics Processes and Composites	$2,670,000 over 6 years	$2,670,000
FQRNT/FQRSC – Regroupement stratégique			
SAMSON, Réjean	Interuniversity Reference Centre for the Life-Cycle Assessment, Interpretation and Management of Products, Processes and Services	$1,460,000 over 6 years	$1,460,000
FRSQ – Regroupement stratégique			
SAVARD, Pierre	Institute of Biomedical Engineering / Biomedical Modeling Research Group	$300,000 over 1 year	$300,000
Canada Foundation for Innovation / Recherche Québec - Innovation fund			
DESJARDINS, Raymond	(CRÉDEAU) Centre for Research, Development and Validation of Water Treatment Technologies and Processes	$9,988,546	$12,485,683
MARTEL, Sylvain	Advanced Nanorobotics Research Infrastructure	$3,459,030	$4,428,859
TROCHU, François	Laboratory for the Intelligent Manufacturing of Composites	$2,363,981	$3,838,450
* MARTEL, Richard (DESJARDINS, Patrick)	Infrastructure for multidisciplinary research on electronic materials, nanoscale systems and innovative device technologies	$16,327,764	$20,430,558
Canada Foundation for Innovation / Recherche Québec - CRC			
BOURGAULT, Mario	Multi-system infrastructure of collaborative and distributed technology project engineering	$245,154	$326,116
SKOROBOGATIY, Maksim	Draw tower for experiments in drawing low-melting temperature material preforms and optimization of microstructured fibre drawing process. Fabrication of all-polymer hollow photonic band gap fibres.	$250,000	$337,478
Canada Foundation for Innovation / Recherche Québec – New Opportunities Fund			
DUBOIS, Charles	Laboratory for the Polymerization and Modification of Solid Substrates	$406,850	$520,935

** Project piloted by Université de Montréal. Polytechnique's share in the project: 45.76%*

Eurêka is published regularly by the École Polytechnique Communications Office for the Research and Innovation Directorate. Coordination: Catherine Flores Writing: Yan Barcelo, Mathieu Faucher, Catherine Flores Translation: Mark Daly Revision: Constance Forest Photos: Denis Bernier, Normand Cadorette, Normand Rajotte Contributors to this edition: Christophe Guy, Jean Choquette Graphic design: Tact Publicité

Information and free subscription: Communications Office (514) 340-4915 Web site: www.polymtl.ca/carrefour/eureka/