Eurêka

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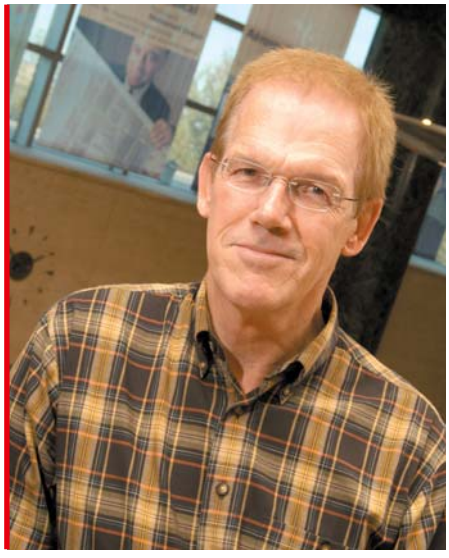
André Turgeon

to optimize optimization at the Poly

André Turgeon joined the Department of Mathematics and Industrial Engineering last September after approximately 30 years at the Institut de recherche en électricité du Québec (IREQ). He took over the Hydro-Québec/NSERC Industrial Chair on the management of water-resource systems, bringing his extensive experience in stochastic optimization to the École.

The new professor's contribution is based on very practical concerns: how much water should be discharged from Québec's numerous water reservoirs, most of which fall under the responsibility of Hydro-Québec?

The question is significantly more complex than it sounds. A reservoir such as Baskatong on the Gatineau River is used for many purposes. It provides water to villages and summer houses, prevents flooding in spring, is used for recreational boating in the summer and, naturally, supplies hydroelectric power plants. The amount of water that flows into the reservoirs and the quantity to be discharged are very random variables. Here's a concrete example: the weather forecast calls for 100 millimetres of water accumulation. Technicians lower the small reservoir to prevent flooding. Unfortunately, the weather forecast is wrong and there is no precipitation. The small reservoir is low and holidaymakers complain.



Another example: technicians delay lowering the reservoir in order to avoid wasting water. However, it rains heavily and the reservoir fills up so fast that when the spillways are opened, the lowering creates floods. In this case, it is local residents who complain.

"Simulation tools driven by optimization models that take randomness into account must be developed to help the decision-making process," Professor Turgeon says. "One of the reasons for my joining the Polytechnique is to create expertise in this area of optimization within the department."

Naturally, the Polytechnique is not devoid of optimization skills, however, the discipline is generally applied to deterministic problems — in other words, problems that do not, or are considered not to have, randomness. Deterministic optimization models have limited potential in a context such as that of Hydro-Québec, where both input and output are random.

As can be expected, the professor's work will benefit Hydro-Québec, which contributed $750,000 to the new chair; however, its impact will also help the research being conducted at the Polytechnique. ■

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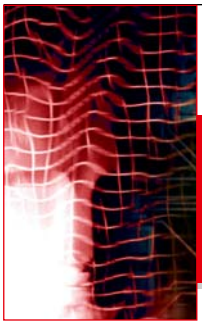


To the Point

SHOWING THE POLYTECHNIQUE'S ACHIEVEMENTS TO THE WORLD

You are reading the first edition of the third year of publication of École Polytechnique's research newsletter, ***Eurêka***. This is also the first bilingual edition. The newsletter, printed in 2,500 copies and also disseminated on the Polytechnique's Web site, is written mainly for the École community, but it is also given to our outside partners in the university, industry and government sectors in Québec and eslewhere, as well as to the many visitors we welcome to the Polytechnique. We felt a bilingual version was necessary to inform the research world of the achievements of Polytechnique professors, students and staff.

This edition of ***Eurêka*** introduces readers to some new faces at the École! An experienced researcher who comes to us from the Institut de recherche en électricité du Québec (IREQ), Professor André Turgeon is the holder of the Mathematics and Industrial Engineering Department's new Hydro-Québec/NSERC Industrial Chair on the management of water-resource systems. A younger professor, Christian Cardinal of the Department of Electrical Engineering, is one of four professors recruited following the latest Programme stratégique de professeurs-chercheurs contest, under the auspices of the Fonds québécois de la recherche sur la nature et les technologies. The other three, who will be profiled in coming editions of Eurêka, are: David Ménard (Physics Engineering), Louis-Martin Rousseau (Mathematics and Industrial Engineering), and Isabelle Villemure (Mechanical Engineering and Biomedical Institute).

It has been nearly two years since the Valorisation-Recherche Québec program created, in collaboration with Québec's universities, large research consortiums in Québec. One of the first, NanoQuébec, is introduced in this edition by its Administrative Director, Robert Sing. Our representative on its Scientific Board, Professor Patrick Desjardins, also explains to readers its importance for École Polytechnique. The École is also very intimately involved in two other groups: the Consortium de recherche et d'innovation en aérospatiale du Québec (Consortium for Research and Innovation in Aerospace in Québec - CRIAQ) and PROMPT-Qc (microelectronics, photonics and telecommunications): several Polytechnique professors are directing major projects with them (see list on P. 7) and I am honoured to sit on their Board of Directors.

The École's research is also its groups and centres — including our newest, the Groupe de recherche en informatique mobile (P. 5) — and leading-edge facilities such as the Laboratoire de recherche en fabrication virtuelle (P. 6).

Finally, the École's research is also its students. And to motivate the undergraduate students and create vocations, the Research Involvement and Initiation Program (UPIR) is rising from its ashes (P. 8). Twenty-eight students are participating in the Research Involvement and Initiation Program (UPIR) this year. ■

Enjoy!

Christophe Guy, Eng., Ph.D.
Full Professor
Director, Research
and Innovation

Profile

Vocations discovered later in life are often the strongest!

As an electronics technician for a small repair company, Christian Cardinal felt he often gave his bosses a bit of a hard time.

"I always had my nose in a book; I was more interested in finding the cause of a problem than in repairing it," he says.

After working in this profession for seven years, the lure of studies and research proved too strong to resist. At the age of 27, this amateur jazz guitarist registered for engineering courses at the Université du Québec-affiliated École de technologie supérieure (ETS) and worked his way up to receiving his doctorate at the Polytechnique three years ago. After his studies, he worked at the École for two years as a researcher and lecturer.

Then, late in 2002, Richard Hurteau, Director of the École's Department of Electrical Engineering, suggested that Mr. Cardinal submit an application for the Strategic Program offered by the Fonds québécois de la recherche sur la nature et les technologies (FQRNT), which would also earn him a professorship. In September 2003, the Fonds granted him a $203,000 subsidy over three years (including salary contributions, a research fund as well as an amount earmarked for the acquisition of infrastructures). He was also appointed a professor in the Polytechnique's Department of Electrical Engineering.

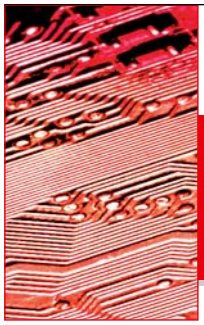
In his doctoral thesis under the direction of David Haccoun, a full professor in the Department of Electrical Engineering, and in conjunction with two ETS professors – Naïm Batani and François Gagnon – he contributed to the creation of an innovative technique for correcting errors in data transmission: convolutional self doubly orthogonal codes and iterative threshold decoding. The researchers now hold a patent protecting their work.

"There are already several error-correction techniques, however, they are relatively complicated to implement on telecommunications equipment," the new professor admits. "Our technique is midway between the high-performance, yet complicated and expensive, technology and other less-effective but simpler solutions."

Having outlined the key principles of a field under development, Professor Cardinal now plans to use his subsidy to deploy the practical aspects of his original research.

"I now want to go further," said the researcher. "My work doesn't stop at optimizing this error-correction technology; I also have to implement it on a communication system, taking into account, for example, the modulation technique and the characteristics of the transmission channel." ■

Christian Cardinal, a new professor recruited by École Polytechnique's Department of Electrical Engineering.



Partnerships

NanoQuébec seeks to rally a world-class community

Compared to the United States — which invests hundreds of millions of dollars in various nanotechnology-related research projects — Québec cannot be described as a major player in this field. But it is not entirely without means either.

"Until recently, Québec's resources were scattered," says Robert Sing, Administrative Director of NanoQuébec. "We have a very wide range of skills. However, they don't always work together. Many of our researchers have acquired international reputations but they have not yet developed a collective reputation. This is what we're trying to do at NanoQuébec; we are striving to rally researchers together to work on certain projects."

There are approximately 100 researchers in Québec who are closely or remotely linked to nanotechnologies, and the École Polytechnique alone employs 15 of them.

Created officially in the spring of 2001 by six Québec universities, NanoQuébec was granted start-up funding of $10 million over three years from Valorisation-Recherche Québec. The NanoQuébec network plans to focus on three objectives during its initial years of existence.

First, it aims to ensure the proper functioning of a major pool of high-tech equipment, purchased at a cost of over $150 million, installed throughout the universities.

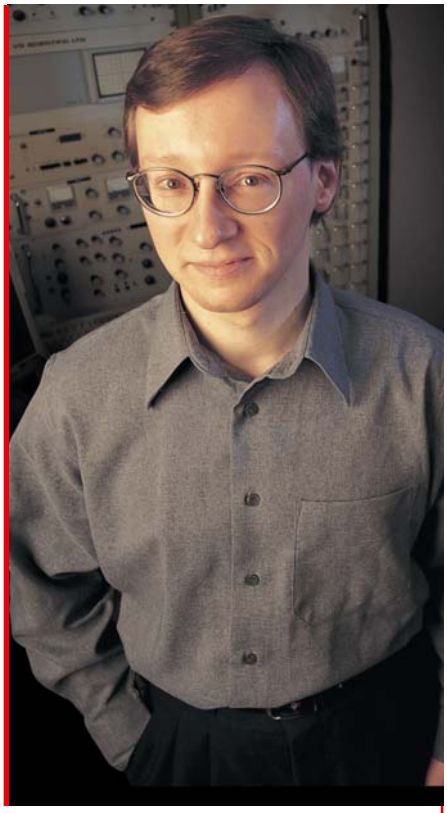
The second objective is to fund multidisciplinary research projects in four areas: nanomaterials; nanoelectronics and nanophotonics; nanosystems; nanobiology and nanopharmaceuticals.

NanoQuébec's third objective is to promote the nanotechnologies community in Québec, to raise its visibility and to support regional and international collaborative projects.

Approximately two years ago, there was talk of an institute that would physically group the nanotechnology community in Québec. However, Mr. Sing is weary of such construction projects. "An announcement of physical premises attracts a lot of attention, but I think we can work better if we strive to pool our resources in a network."

Patrick Desjardins, a researcher at the Polytechnique's Department of Engineering Physics and a member of NanoQuébec's scientific council, feels that even with its limited resources, Québec is not far behind the leading countries.

"It wouldn't take that many more millions of dollars for us to create an outstanding community; " Mr. Desjardins said. "We could probably use $10 million a year for 10 years instead of the $3.5 million that NanoQuébec is currently receiving. That alone would significantly improve the situation." ■



Patrick Desjardins, professor in École Polytechnique's Department of Engineering Physics and member of the NanoQuébec scientific council.

Advanced Research

Samuel Pierre: getting a fix on total mobility

We are all aware to what extent we are increasingly living in a universe without fixed anchor points. For example, corporate hierarchies are disappearing, making way for more flexible groupings. The same logic is beginning to apply to mobile telecommunications networks, and Professor Samuel Pierre and his research group are at the leading edge of these developments.

Past computing logic followed the client/server architectural principle: a constellation of clients revolved around a fixed centre — the server — and each client was supplied by this centre.

"Today, we are moving into a new universe of total or global mobility," says the professor in the Department of Computer Engineering and holder of the NSERC/Ericsson Industrial Research Chair in Next-Generation Mobile Networking Systems. "Within such networks, there will no longer be fixed infrastructures: all elements can move and all mobile components (telephones, palmtop and laptop computers, etc.) can act as mobile routers for each other."

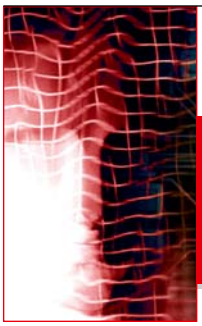
That said, how are the elements of a network — applications, services, security, inter-unit transfers — to be looked at now? That is exactly what is being examined by the approximately 60 researchers, research associates and students who form the new Groupe de recherche en réseautique et informatique mobile (GRIM), which was created last June on the basis of the Laboratoire de recherche en réseautique et informatique mobile (Mobile Computing and Networking Research Laboratory – LARIM), founded by Professor Pierre in 1999.

The Groupe de recherche en réseautique et informatique mobile (GRIM). Front, left to right: Samuel Pierre and Steven Chamberland. Centre: Hanifa Bouchenab and Alejandro Quintero. Rear: Philippe Galinierand Jean Conan. Absent: Gilles Pesant.

This global mobility raises a lot of challenges that GRIM is exploring. For example, a "client" that is simultaneously a server can no longer hold an entire resource-consuming application. It must manage it on a piece-by-piece basis and distribute it in the same fashion to all other participants who need it. How do we look at this mosaic, bearing in mind that the units have very different individual configurations, have a limited amount of energy and reduced processing and display capacity, and must contend with relatively restricted bandwidth?

There are other challenges: in a nomadic world, how do we ensure that a call made from one side of the planet reaches the party on the other side, while directing it through several heterogeneous networks? And how do we ensure consistent service quality between source and destination for the entire duration of the connection?

The bottom line is that in the global village, we also need to think about the village centre — but a nomadic centre that is constantly on the move. ■



Spotlight on Infrastructure

René Mayer: virtually reconstructing reality

Developed about 15 years ago, digital simulation of industrial machining processes could be said to be in its teenage years and, like any teenager, it is beginning to reflect reality relatively faithfully, but still has some way to go. René Mayer, Director of the Laboratoire de recherche en fabrication virtuelle, is working to help the process grow into adulthood.

"Simulators of numerical control machines are based on a perfect machine, which is a good start, but they don't take into account a lot of factors, such as the geometric imperfections of guides, dynamic effects or changes in temperature, either in the machine or the surrounding environment," says Professor Mayer. "You also have to consider the fact that digitally controlled equipment now achieves 1-g acceleration which brings new source of errors."

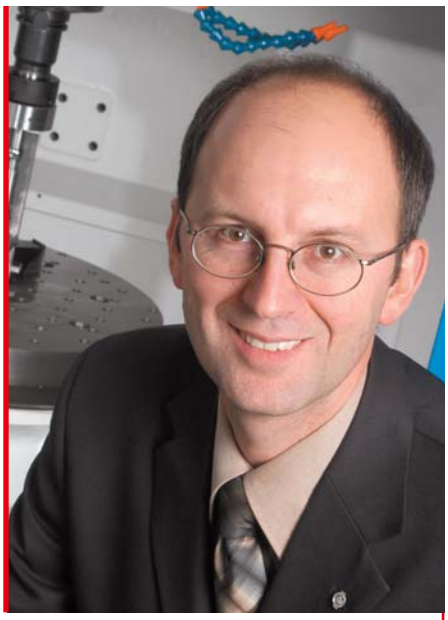
Professor Mayer is therefore striving to develop digital simulation to a point where it can produce a representation that is a considerably more complex, refined and accurate depiction of the reality in the industry. In order to achieve this goal, he has been allocated a budget of $6.7 million, which, with the help of colleagues Guy Cloutier, Marek Balazinski and Luc Baron, made it possible to set up one of the most advanced laboratories in the world.

Based on the Polytechnique's former central machining workshop, the École has invested $1.225 million to equip the machine tooling and metrology rooms. The first, which measures 2,000 ft^2 has state-of-the-art machinery acquired at competitive prices from partner manufacturers and that has the various characteristics that Mr. Mayer and his students are using in their machining studies to produce "real" reference pieces.

The second room, which covers 1,000 ft^2, is used for metrology of machined parts and, by extension, the "imprints" left by machines. These instruments are on a three-foot-thick concrete slab anchored to the rock of Mount Royal. Inopportune vibrations are therefore eliminated, while systems maintain the temperature and humidity at constant levels. As can be expected, half the budget is allocated to the wide range of instruments required for this work.

Pratt & Whitney, which has contributed $250,000 to the budget, is the leading industrial sponsor and hopes to be the primary beneficiary of the work being conducted by Professor Mayer. The results should not be too long coming, as a first partial simulator should be transferred to the Consortium de recherche et d'innovation en aéro-spatiale du Québec (Consortium for Research and Innovation in Aerospace in Québec - CRIAQ) within a year.

Mr. Mayer predicts it will take another five years to complete a simulator that closely reflects reality . . . exactly the amount of time it takes for a teenager to become an adult! ■



René Mayer, professor in École Polytechnique's Department of Mechanical Engineering and Director of the new Laboratoire de recherche en fabrication virtuelle.

New projects

The École'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			
Massicotte, Bruno	New Partially Encased Composite Columns Made in High Performance Materials for Lateral Load Resisting Systems in Medium and High-Rise Buildings.	$252,600 over 3 years	$378,900
Turenne, Sylvain	Extrusion de profilés de tellurures thermoélectriques.	$395,000 over 3 years	$544,000
Lefebvre, Louis-A. et Lefebvre, Élisabeth	The LIPE Project: Methods and Tools for Knowledge-Based Adaptative SMEs.	$135,000 over 3 years	$270,000
Soumis, François	Optimisation d'horaires d'employés travaillant sur des quarts.	$234,750 over 3 years	$469,500
Yelon, Arthur	Magnetic Nanocomposites for High Frequency Applications.	$185,000 over 3 years	$365,000
Canada Research Chairs			
Jolicoeur, Mario	Chaire de recherche du Canada en génie métabolique	$100,000 per year $250,000 FCI-Infrastructure	$100,000 per year $314,654 FCI
Tremblay, Robert	Chaire de recherche du Canada en génie parasismique	$200,000 per year $250,000 FCI-Infrastructure	$200,000 per year $510 ,156 FCI
CRIAQ (Consortium for Research and Innovation in Aerospace in Québec)			
Mayer, René	Usinage haute performance des composantes en alliages légers pour l'industrie aéronautique	$220,000 over 3 years	$391,000
Trépanier, Jean-Yves	MOSAIC – systèmes d'Optimisation basés sur des Standards et des Analyses et permettant une Intégration Configurable	$350,000 over 4 years	$920,000
Canadian Foundation for Innovation – New Opportunities Fund			
Rochefort, Alain	Virtual Laboratory for Numerical Nanoscience Experiments : From Atomic STM Imaging to Nanostructure Growth and Reactivity	$386,028 FCI-Infrastructure	$483,275

Awards for best theses and dissertations

In an effort to acknowledge the excellence of its graduate students, École Polytechnique is presenting four awards this year for best student work: two for doctoral dissertations and two for master's theses.

Frédéric Sirois of the Department of Electrical Engineering receives a $2,000 award for his dissertation titled *Modélisation de la caractéristique E-J des supraconducteurs à haute température critique*. Mr. Sirois's work was supervised by Professor Guy Olivier and by Julian Cave, a researcher with the Institut de recherche en électricité du Québec (IREQ). It is also noteworthy that Mr. Sirois completed his studies in three years, eight months, with a perfect 4.0/4.0 mark.

Gilles Dennler of the Department of Engineering Physics receives a $2,000 award for this dissertation titled *PECVD de composés de silicium sur polymères : étude de la première phase du dépôt*. His work was directed by Professor Michael J. Wertheimer and by Yvan Ségui, Director of Research at the Centre National de la Recherche Scientifique (CNRS), Université Paul Sabatier in France. Mr. Dennler completed his studies in three years as part of a Québec-France co-guardianship.

Sébastien Roch of the Department of Mathematics and Industrial Engineering receives a $1,000 award for his thesis titled *Tarification optimale: complexité et approximation*. Mr. Roch worked under the guidance of Professor Gilles Savard and Patrice Marcotte, of the Université de Montréal's Department of Computer Science and Operational Research.

Justin Novosad, a student in the Biomedical Engineering program, receives a $1,000 award for his thesis titled *Techniques explicites pour la reconstruction 3D de la colonne vertébrale à partir d'images radiographiques*. His work was directed by Professor Farida Chériet and by Hubert Labelle, of the Biomedical Institute.

The jury members also gave a special mention to **Circé Malo-Lalande**, a student in the Mineral Engineering program, for an excellent master's thesis titled *Application de la méthode électromagnétique transitoire en boucle simple pour l'exploration de gisement de type plaque*.

The evaluation committee comprised Professors Diane Riopel, Brunilde Sansò and Mario Jolicoeur, along with Professor Jean Dansereau, Director of Graduate Studies and Mentoring. ■

What's new ?

Research Involvement and Initiation Program is back

Scrapped following budget cutbacks in the 1990s, the Research Involvement and Initiation Program (known by its French acronym UPIR – Unité de participation et d'initiation à la recherche) returns to the École this year. Its resurrection will provide 28 undergraduate students with an opportunity to get acquainted with scientific research by working on projects under the guidance of experienced researchers.

Catherine Beaudry, a professor in the Department of Mathematics and Industrial Engineering, is quite familiar with the program, having participated in two projects herself while studying for her Bachelor's Degree in Electrical Engineering. The research project to which she contributed under the direction of Professor David Haccoun dealt with the characteristics of telecommunications satellites, an area of interest that turned out to be extremely useful when she moved on to Oxford University for her graduate studies. There, she focused on supply and demand in the field of communications satellites.

Ten years later, the roles are reversed. As part of the UPIR program, Ms. Beaudry is currently supervising the work of Bogdan Adrian Radu, who is studying for his own Bachelor's Degree in Electrical Engineering and who this year is designing simulation algorithms to analyse R&D investment decisions made by high-tech companies. Will this be the beginning of a new scientific vocation? ■

After having participated as a student in the École's Research Involvement and Initiation Program (UPIR), Catherine Beaudry, now a professor in the Department of Mathematics and Industrial Engineering, is supervising the research project of Bogdan Adrian Radu, one of 28 students enrolled in the UPIR program this year.

Three new graduate programs launched

In an indication of the growth of its research and teaching activities, École Polytechnique launched three new graduate programs this fall.

The Department of Mathematics and Industrial Engineering is offering Québec's only doctoral program focusing on the main directions of industrial engineering: production, organization and technological innovation, as well as systems analysis and optimization. For its part, the Department of Computer Engineering is offering M.A.Sc. (thesis option) and M.Eng. (non-thesis option) programs in computer engineering, as well as a new master's program leading to a Graduate Diploma. The department's professors and their students are conducting research into the following six main directions: computer hardware, software engineering, computer networks, computer systems, audiovisual information processing, artificial intelligence and algorithmics.

These new specializations join the approximately 50 master's and doctoral programs already available at the École, and in which nearly 1,700 students are enrolled. ■

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