



# New Chair on Process Technology and Engineering

Philippe Tanguy, professor in the Department of Chemical Engineering, specialist in flow modelling in process engineering and Director of École Polytechnique's *Unité de recherche sur les procédés d'écoulements industriels (URPEI)*, has been named holder of the new Chair on Process Technology and Engineering. The chair was created at École Polytechnique in partnership with TOTAL, the world's fourth-largest oil and gas company.

This chair is responsible for the activities of URPEI, created in 1993, and consists of the same team — in addition to Professor Tanguy, another professor, two research associates and about a dozen students. The chair represents a new chapter in the long partnership between URPEI and the TOTAL group.



Philippe Tanguy, professor in the Department of Chemical Engineering, has been named holder of a new chair in partnership with Total, the world's fourth-largest oil and gas company.

Its objective is to develop new mixing processes that are more energy efficient and environmentally friendly, with a view to sustainable development and clean chemical engineering. "Our initiatives are fundamental in nature, but are aimed at specific industry applications, such as petrochemistry, multiphase transportation in oil production, and the upgrading of petroleum refining byproducts," explains Professor Tanguy. "Naturally, we take TOTAL's needs into consideration, but more broadly we are hoping to meet the general needs of the oil and chemical industries." Professor Tanguy adds that the results of the chair's work will be for public use.

Research program activities:

- Physical modelling of process flows
- Numerical simulation in process engineering
- Technological innovations in the flow processes of complex fluids
- Technology monitoring

The Chair on Process Technology and Engineering has an annual budget of \$200,000 and receives another \$100,000 worth of equipment each year. It will support URPEI, which has also received a grant of more than \$500,000 from the Natural Sciences and Engineering Research Council of Canada (NSERC) to finance research into chaotic mixing with the backing of TOTAL and two

other prestigious partners: Procter & Gamble (USA), Dow Chemicals (USA), as well as Mixel (France), Paprican of Pointe-Claire and COESI of Montréal.

"Our work concerns all industries that use mixers," Professor Tanguy notes, adding: "The new chair strengthens Polytechnique's expertise in process engineering and our research will lead to the development of new applications in the process industries." ■

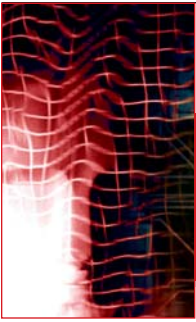
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## To the Point



# APPLIED AND BASIC RESEARCH AT POLYTECHNIQUE

École Polytechnique is renowned for the research it conducts in conjunction with users and companies. This is reflected in the numerous partnership contracts and subsidies granted to its professors, as witnessed by their results in recent competitions in strategic projects, cooperative R&D and innovation launched by the Natural Sciences and Engineering Research Council (NSERC) and *Valorisation-Recherche Québec* (VRQ), as well as by our involvement in large-scale research groups such as Prompt-Québec. These achievements have also earned Polytechnique a large number of industrial chairs: we currently have 16, including Professor Philippe Tanguy's new chair in conjunction with the TOTAL petroleum group. Given our focus on engineering and expertise in the area of design, it was only natural that the holders of the NSERC Chair in Environmental Design Engineering agree to meet at Polytechnique in January at the invitation of Professor Paul Stuart.

École Polytechnique is a university that conducts high-calibre applied and basic scientific research. The successes of professors working in the health field have earned the institution a 24<sup>th</sup> Canada Research Chair (CRC), the first under the Canadian Institutes of Health Research. The chair should be filled in the next year with the recruitment of an external professor. Prior to the award, Polytechnique held 22 CRCs in natural sciences and engineering and one in humanities and social sciences. The latter Chair was recently awarded to Professor Mario Bourgault. Seventeen CRCs have already been attributed and one is currently under evaluation.

Applied, design and basic research activities may appear to be in conflict with one another; however, they all play a role in the vision of École Polytechnique, which is "to be an internationally renowned school of engineering and an active partner in technological, economic and social

development" as well as its research mission: "to conduct pertinent and high-level research that constitutes the basis for training at the master's and doctorate levels and that takes into account the requirements of industry and society."

In this issue, we will continue our focus on the new generation of professors with Isabelle Villemure; we will conduct an interview with Suzie Poulin to highlight the significant contribution that research associates make, and take advantage of the arrival of two new department heads to further demonstrate that administrative responsibilities are not incompatible with a career as a professor-researcher. ■  
Enjoy!

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



## Appointments

# Research-based teaching in the Department of Chemical Engineering

*Professor Robert Legros, Ph.D., recently appointed Head of the Department of Chemical Engineering, has a vision of higher education that is right in step with this department's established tradition of research-based teaching.*

Professor Legros's main focus is to train the highly qualified personnel sought by industry, while at the same time contributing to the advancement of

knowledge in the Department's strategic fields of basic and applied research.

This specialist in fluidized bed systems, who is now conducting research into different recovery and purification systems processes for the biopharmaceutical industry, does not believe that his role as a university researcher will be called upon to change radically in the near future. ▶▶



As Head of the Department of Chemical Engineering, Robert Legros plans to continue active collaboration with industry in order to keep up with the fast pace of change in the biopharmaceutical industry and provide Polytechnique researchers with access to a dynamic research environment.

"I will always be required to teach researcher-students and to publish research results. Don't forget that practically all graduate students in chemical engineering are there to do research projects," Professor Legros says.

"What is likely to change, however, is the research environment available to researcher-students. The biopharmaceutical field is changing rapidly with the use of biotechnologies to produce complex molecules or new drugs.

Research infrastructures are becoming more sophisticated and expensive. As a result, research networks will be called upon increasingly to meet these needs." Which explains the fact that Professor Legros's priorities include continued active collaboration with industry and the acquisition of adequate funding.

"As Head of the Chemical Engineering Department, I will have to support the researchers in their work by providing them with access to a dynamic research

environment (adequate laboratory space, technical and support staff, etc.). My other challenge will be to ensure continuous harmony between teaching and research, and specifically research-based teaching." ■

## Ludvik Martinu: new Head of the Department of Engineering Physics

*Ludvik Martinu, Ph.D. in Applied Physics and Associate Director of the Groupe de recherche en physique et technologie des couches minces (Thin-Film Physics and Technology Research Centre), was appointed to a three-year term as Head of the Department of Engineering Physics in January.*

With the arrival of five new professors since 2002 and the imminent acquisition of new research space in the future J.-A.-Bombardier Building, the Department of Engineering Physics is expanding rapidly. "We are currently working on updating the graduate studies program by emphasizing nanoscience, nanotechnology, photonics, nuclear physics and energetics," Professor Martinu says. "We are impatiently awaiting the benefits of our recent initiatives, including new requests for funding to the Canada Foundation for Innovation."

All these are challenges for Professor Martinu, who likens his new role to that of an orchestra conductor. "Directing the department will give me the opportunity to foster collaboration and exchange between different research groups, in particular activities in the fields of solid-state physics - more specifically thin films and advanced materials, optics and photonics, as well as nuclear physics and energetics. Coordinating activities in these fields of research and education

will demonstrate the department's strengths and contribute to its national and international recognition."

This new mandate will not prevent Professor Martinu from intensifying his own work on developing new fabrication methods for thin films and coatings for their applications in optics, photonics, aerospace, energy control and other cutting-edge technologies. Together with Dr. Jolanta Sapiuha, he leads a team of about 15 researchers working on advances in the field of functional coatings and surface engineering.

"This is a constantly evolving field, especially with the appearance of new materials whose microstructure and properties are controlled on the nanometer scale," he says. "At Polytechnique, we have access to the latest process and material-control techniques, a fact which opens the way for new applications in diverse sectors, including optics, photonics, aerospace and biomedicine, but also in the automobile, pharmaceutical, cosmetics and other industries."

This prolific researcher, who has contributed to more than 200 publications, several patents, and who actively participates in a number of international societies, believes that research makes a major contribution to increasing the visibility of the Department of Engineering Physics, and of Polytechnique in general. Among other things, the fact that many researchers are members of



"Directing the Department of Engineering Physics will give me the opportunity to foster collaboration and exchange between different research groups, in particular activities in the fields of solid-state physics and thin films," explains Ludvik Martinu.

such organizations as the *Regroupement québécois sur les matériaux de pointe*, the *Réseau photonique* de Montréal and the *Centre d'optique, photonique et laser* further expands the influence of École Polytechnique.

"What's more," Professor Martinu adds, "our students often have the opportunity to take part in industrial projects, and present their results at international symposia; all of that also increases our visibility." ■



## Profile

# Building the bridge between engineering and biology

Isabelle Villemure, recently appointed assistant professor in the Department of Mechanical Engineering, teaches applied mechanics concepts to undergraduate students and conducts research on the mechanical modulation of bone growth and development. She enthusiastically combines her professorial duties with her research work, which aims at understanding the involvement of the mechanical modulation of bone growth in the progression of certain musculoskeletal pathologies, such as idiopathic scoliosis, and eventually improve methods for treating these progressive pathologies. "I have always hoped to explore the different facets of engineering, and not restrict myself to its purely technical aspect," she says. "The beneficial impact of engineering research on humans and on society is very important to me."

It is this motivation towards accomplishments with a social impact that led this civil engineer, who specializes in structural dynamics, to complete a doctorate in biomedical engineering (biomechanics orientation) at Université de Montréal, after having gained two years of work experience. Her doctoral research project was a "Biomechanical Study of Growth and Deformation Processes of the Scoliotic Spine," completed using finite-element modelling

techniques and geometric modelling of spinal structures. She followed up with a post-doctorate in the mechanobiology of growth plates at the University of Calgary.

Combining her knowledge of biomechanics, mechanical modelling, experimental mechanics of living tissues, and biology, Professor Villemure is attempting to determine the mechanisms that control the response of growing bone tissue to its mechanical environment. To do this, she is exploring three complementary research fields: experimental tissue mechanics, mechanotransduction and biomechanical modelling. Among other things, her work has earned her a grant from the 2003-2004 Strategic Program for Professor-Researchers, part of the *Fonds québécois de la recherche sur la nature et les technologies (NATEQ)*.

Professor Villemure remains enthused by the challenge of her multidisciplinary research work in a field that is still relatively little studied in Canada. "I am certain that the connections between engineering and biology will continue to strengthen. There are many avenues to explore, and new and increasingly powerful research tools continue to emerge. Mechanobiology is a relatively new, but fast-growing, discipline. Our work is helping us develop new and very promising experimentation

methods, and their potential applications are eliciting strong interest from the medical field." ■



Isabelle Villemure, a new recruit in the Department of Mechanical Engineering



## Interview

# Profile of a research associate: Suzie Poulin delves beneath the surface of solid materials

The Department of Engineering Physics is home to the *Laboratoire d'analyse de surfaces des matériaux (LASM)*, which studies and characterizes the surfaces and interfaces of solid materials, identifying and resolving problems, if any.

Suzie Poulin, M.Sc. in Chemistry, research associate in the Department of Engineering Physics and member of École Polytechnique's Research Commission, served as *LASM's* coordinator from the time of its creation in 1984 until its expansion in 2002. She now shares this duty with another research associate.

The studies conducted under the leadership of this surface-analysis specialist deal with practically every high-tech, industrial and medical field, and focus on all types of materials: organic, magnetic, electric, as well as polymers, composites, semi-conductors, biomaterials, thin films, etc.

"Our team of three research associates and a technician works to meet the needs of two types of client: internal, meaning the researchers and students of the (*GCM*) *Groupe de recherche en physique et technologie des couches minces* (Thin-Film Physics and Technology Research Centre) and other Polytechnique departments; and external, because businesses or other universities often consult us for all sorts of problems with materials," Ms. Poulin says. "Personally, I like this diverse project range, which ensures that we acquire expertise in a very wide range of fields."

Ms. Poulin devotes a large part of her time to supervising students. "For some projects, my role is limited to doing the analyses and providing the results, but very often I have to teach the students how to assimilate techniques, use the laboratory equipment correctly for their experiments, and learn to derive usable results."

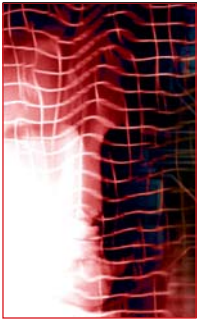
Ms. Poulin, who will soon be celebrating a quarter-century at Polytechnique, has witnessed major technological changes in her field of expertise. Over the years, the laboratory has been equipped with cutting-edge surface-analysis tools, including an R-X photoelectron spectrometer (XPS), an atomic-force microscope (AFM), two Fourier transform infrared spectrometers (FT-IRs) that measure by photoacoustics and imaging, and even a time-of-flight secondary ion mass spectrometer (TOF-SIMS), the only one currently available in Québec.

"The arrival of this equipment, which involved sizeable investments (\$1 to \$2 million per apparatus), completely changed our way of working, which became a lot more operational," says Ms. Poulin. "*LASM* is a very high-performance laboratory and we want to raise awareness of its work both inside and outside École Polytechnique because we can provide many services — for example imaging, chemical surface analysis, profiling, etc. — to researchers and businesses, and even to the hospital community."

With the development of the future technopolis, other major changes are imminent for *LASM*. "We are awaiting the arrival of new professors and the start-up of new projects, including in nanotechnology," Ms. Poulin enthuses. ■



Suzie Poulin, who will soon be celebrating a quarter-century at Polytechnique, has witnessed major technological changes in her field of expertise, surface analysis.



# Partnerships

## Prompt-Québec: universities take a client-oriented approach toward companies

The management team of the *Partenariat de recherche orientée en micro-électronique, photonique et télécommunications* (Partnerships for Research on Microelectronics, Photonics and Telecommunications), better known as Prompt-Québec, consists of only four people. Nevertheless, Prompt-Québec's approximately 200 university and industrial researchers make it one of the most remarkable research initiatives launched in its area of expertise in the past few years.

Incorporated in February 2003, Prompt-Québec is still in its infancy. The organization initiated its first project only in July of the same year. The 12 projects launched thus far, at a few months' interval, are divided almost equally into two major areas – photonics of telecommunications and wireless communications.

The impetus behind Prompt-Québec comes from five universities, including École Polytechnique, which joined together and presented companies with a client-oriented approach to research.

"Prompt's objective is very different from traditional research projects,"



As part of the Prompt-Québec program, Ke Wu, professor in the Department of Electrical Engineering, is working on developing a universal radio receiver.

explains Ke Wu, professor of Electrical Engineering and holder of a Canada Research Chair at École Polytechnique. His current research activities are part of the Prompt framework. "It is aimed at large-scale projects that focus on the specific requirements of Québec industry," Professor Wu notes. Currently, 25 companies are involved in Prompt's activities. The partnership now comprises 10 universities.

As highlighted by Charles Despins, President of Prompt, the organization had no intention of investing its \$5-million budget in bricks and mortar. "We have hundreds of millions of dollars worth of assets in universities across Québec, as well as nearly 100 professor-researchers with their research teams and budgets. Prompt's funds act as leverage to link people working on these ongoing projects together and with other researchers in the industry."

Mr. Despins points out that "Polytechnique is in a leadership position" in the chain because six of its professors and their groups, including that of Professor Wu, are involved in Prompt's activities. Professor Wu is currently working on a multidisciplinary project with a group of researchers, each focusing on a different aspect of the task, aimed at developing a software-defined universal radio receiver.

Today, users need different devices to receive waves encoded in TDMA, CDMA, OFDM, or even FM and AM modes. Professor Wu is working in close collaboration with Professor Chaker of INRS-EMT, who specializes in materials



Charles Despins, President of Prompt-Québec

and physical plasma, to develop a key component called an "adaptive filter". The filter is designed using a new ferro-composite based (ferroelectric) material and will be used to develop the universal radio. The three key features are as follows:

- Changes in the receptivity of the material (thus, the response of a circuit or device made of such a material) will be carried out by software controlling the electrical virtue (or properties) of the material;
- The material will allow for miniaturization so that its universal capabilities are provided by a circuit no larger than the nail on the small finger; and
- Production will be highly cost-effective.

The work is funded by a three-year strategic grant of \$417,000 from the NSERC and a further \$200,000 over two years from Prompt-Québec.

Users will not have to wait another 50 years to see this latest development in the radio become reality. "We expect to have a real prototype in the next year and a half," the researcher says. ■

# 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
<b>NSERC – Collaborative R &amp; D</b>			
BUSCHMANN, Michael	Novel Sensing Technologies, Structure-Function Database and Electromechanical Modeling for Cartilage Diagnostics	\$267,375 over 3 years	\$402,375
GUIBAULT, François	Hydraulic Turbine Blade Optimization	\$145,000 over 2 years	\$265,000

## NSERC – Strategic Project Grants (SPG)

BALAZINSKI, Marek	Système d'aide à la décision fondé sur la logique floue et les algorithmes génétiques	\$186,000 over 3 years	\$244,500
MARTEL, Sylvain	Propulsion et contrôle de micro-dispositifs par gradients magnétiques pour applications endovasculaires	\$401,500 over 3 years	\$401,500
SAVADOGO, Oumarou	Development of Direct Ethanol PEM Fuel Cells	\$293,550 over 3 years	\$293,550
SAWAN, Mohamad	RFIC Techniques for Efficient Power Transfer with Full-Duplex High Data Rate Communication Dedicated to Electronic Implants	\$402,000 over 3 years	\$462,000
STUART, Paul	Innovative Approach to the Optimization of Integrated Newsprint Mill Dynamic Operations	\$300,500 over 3 years	\$330,500
TANGUY, Philippe	Innovative Non-Newtonian Mixing Technologies	\$530,000 over 3 years	\$605,000
YAHIA, L'Hocine	Développement de substituts osseux personnalisés à base de biocéramique et de bioverres à gradient fonctionnel	\$306,000 over 3 ans	\$306,000

## NSERC – Novel Next Generation Technology Initiative in Energy Research and Technology Related to Greenhouse Gas Mitigation (GHGM)

MEUNIER, Michel	The Single-Chamber Solid Oxide Fuel Cell as an Efficient Energy Converter and Greenhouse Gases Reducer	\$348,000 over 3 years	\$348,000
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## NSERC- Idea to Innovation (I2I) Program

TRÉPANIÉ, Jean-Yves	Validation de principe du logiciel VADOR	\$123,495 for 1 year	\$123,495
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## VRQ – Prompt-Québec

Martini, Ludvik	New Optical Thin Films for Active and Passive Photonic Devices	\$100,000 per year over 2 years	\$200,000
Sawan, Mohamad	Convertisseurs analogiques-numériques dédiés aux récepteurs sans fil : conception, implantation et caractérisation	\$100,000 per year over 2 years	\$200,000
Wu, Ke	Low-Cost Electronically Tunable RF and Microwave Circuits and devices Based on Ferroelectric Materials	\$100,000 per year over 2 years	\$200,000

## CIPI – Canadian Institute for Photonic Innovations

Godbout, Nicolas	Scalable Absolutely Secure Optical Fibre Networks Using Quantum Cryptography	\$1,071,250 over 5 years	\$1,071,250
Maciejko, Romain	Biophotonic Systems Using High Resolution and Diversity Imaging	\$806,275 over 5 years	\$806,275
Wu, Ke	Broadband Radio-Over-Fiber System for Full Duplex Hybrid Optical/Wireless Access	\$792,500 over 5 years	\$792,500

## Industrial Chair

Tanguy, Philippe	Chair on Process Technology and Engineering TOTAL S.A.	-----	\$1,000,000
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## Canada Research Chairs

Bourgault, Mario	Technological Project Management	\$100,000 per year	\$100,000 per year
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Some of the projects led by École Polytechnique researchers are conducted in collaboration with other universities.



## Events

# Overview of the 4<sup>th</sup> Symposium of the NSERC Chairs in Design Engineering

On January 19 and 20, École Polytechnique played host to the 4<sup>th</sup> symposium of the Natural Sciences and Engineering Research Council of Canada (NSERC) Chairs in Design Engineering. The event was organized by Professor Paul Stuart, holder of Polytechnique's NSERC Chair in Environmental Design Engineering, titled *Process Integration for the Pulp and Paper Industry*.

The 11 holders of these chairs, which were created with the objective of improving the level and quality of design engineering activities at universities across Canada, meet twice a year to work together on various projects including currently preparing a white

paper on design competencies. The result of their group effort will be delivered to the Canadian Academy of Engineers and the Canadian Engineering Accreditation Board.

During this latest symposium, two instructors from the University of Western Ontario led a workshop in change management in order to help the chair holders with their goal of leading institutional change to raise the standard of design education in engineering faculties. The objective of these activities is to train engineers to master tools that will enhance Canada's capacity for technological innovation. The audience also heard interesting speeches on the importance of design in engineering and the fundamental role it plays at École Polytechnique.

Robert L. Papineau, École Polytechnique's Director General, demonstrated this essential role and the need to support design courses at the École de Design. He also emphasized the importance of multidisciplinary in design and spoke of the challenge of teaching undergraduate students how to solve open-ended problems. Christophe Guy, Director of Research and Innovation, focused on the main thrusts of Polytechnique's Institutional Research Plan and underlined the achievements of our professors in enhancing research. Robert Legros, Director of the Department of Chemical Engineering, presented the results of a North



At the invitation of Paul Stuart, the 11 holders of the NSERC Chairs in Design Engineering met at École Polytechnique in January.

American study on changes in the chemical engineering design course sequence.

Michel Perrier, Professor in École Polytechnique's Department of Chemical Engineering, talked about the new web-based course that will be available to third-year students starting in 2005. This very innovative course will emphasize project-based teaching and design skills.

The next meeting of the NSERC Design Chairs will be held this summer at Dalhousie University, Halifax. ■

The presentations of Messrs. Papineau, Guy and Legros may be downloaded from:

[www.polymtl.ca/carrefour/cms/apercu.php?NoDocument=1601](http://www.polymtl.ca/carrefour/cms/apercu.php?NoDocument=1601)

**Thursday, June 3, 2004**  
Amphithéâtre, C-631  
Free admission

**3<sup>rd</sup> Polytechnique Research Day**

**ON THE AGENDA**  
**Morning**  
Fascinating lectures on cutting-edge topics and introduction of the research teams that will be moving into the brand-new J.-A.-Bombardier building.

**Afternoon**  
Visualization in Engineering.

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