LIST OF ACRONYMS USED

CRIAQ: Consortium for Research and Innovation in Aerospace in Québec
NSERC: Natural Sciences and Engineering Research Council of Canada
CED: Canada Economic Development
CFI: Canada Foundation for Innovation
FRQNT: Fonds de recherche du Québec – Nature et technologies
FRQS: Fonds de recherche du Québec – Santé
FRQSC: Fonds de recherche du Québec – Société et culture
GARDN: Green Aviation Research & Development Network
IRSST: Institut de recherche en santé et en sécurité du travail
SAQ: Société des alcools du Québec
UDMN: Ultra Deep Mining Network
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MAJOR PROJECTS

Over the course of the past year, a number of external research funds have contributed to the launch of new projects, the hiring of research students or the acquisition of strategic equipment for the various laboratories at ÉTS. The following is a list of some of the promising projects that were launched in 2013-2014.
<table>
<thead>
<tr>
<th>External Fund</th>
<th>Professors</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMORCHEM</td>
<td>Yvan Petit</td>
<td>Development of a Medical Device to be Used to Repair Greater Trochanter Fractures (in partnership with AmorChem and Hôpital Sacré-Cœur de Montréal in collaboration with Univalor)</td>
</tr>
<tr>
<td>CRIAQ / NSERC</td>
<td>René Landry Jr.</td>
<td>Interference Mitigation in Satellite Communication</td>
</tr>
<tr>
<td>CRIAQ / NSERC</td>
<td>Ilian Bonev</td>
<td>Improvement of the Precision of Industrial Robots Using Close-Range Photogrammetry</td>
</tr>
<tr>
<td>NSERC</td>
<td>Mohammad Jahazi</td>
<td>Forming Technologies of High-Strength Alloys (CRD – in collaboration with Sorel Forges)</td>
</tr>
<tr>
<td>NSERC</td>
<td>Rita Noumeir and Georges Kadoum</td>
<td>Real-Time Telemedicine for Medical Evacuations by Air (CRD – in collaboration with MEDTEQ)</td>
</tr>
<tr>
<td>NSERC</td>
<td>Sophie Lerouge</td>
<td>Innovative Vascular Implants Based on Electrostatic Spinning and Bioactive Coating (PRCS-IRSC)</td>
</tr>
<tr>
<td>NSERC</td>
<td>François Gagnon</td>
<td>Renewal of the NSERC-Ultra Electronics Chair in Wireless Emergency and Tactical Communication</td>
</tr>
<tr>
<td>CED</td>
<td>Ilian Bonev, Claude Thibeault and Mohamed Cheriet</td>
<td>Semi-Industrial Research Equipment for the Development of Advanced Technologies Intended to Improve Manufacturing Processes Related to Production and Assembly</td>
</tr>
<tr>
<td>CFI</td>
<td>Mohamed Cheriet</td>
<td>Smart and Sustainable ÉTS Student Residence Testbed</td>
</tr>
<tr>
<td>CFI</td>
<td>Yvan Petit</td>
<td>High-speed Multimodal Monitoring of Experimental Traumatic Vertebral Fractures and Spinal Cord Injuries</td>
</tr>
<tr>
<td>CFI</td>
<td>Mohamed Cheriet</td>
<td>Global Current: Culture and Literacy Networks 1050-1900 Testbed</td>
</tr>
<tr>
<td>FRQNT</td>
<td>Daniel Rousse</td>
<td>Potential of Wind-Diesel-Compressed Air Hybrid Energy Systems for Mining Sites</td>
</tr>
<tr>
<td>FRQS</td>
<td>Nicola Hagemeister</td>
<td>Improved Diagnosis and Treatment of Osteoarthritis of the Knee: A Clinical and Economic Imperative for Our Health System (in collaboration with the Ministère des Finances et de l’Économie – MFEQ)</td>
</tr>
<tr>
<td>GARDN</td>
<td>Ruxandra Botez</td>
<td>Flight management performance optimization II (in collaboration with CMC Electronics)</td>
</tr>
<tr>
<td>IRSST</td>
<td>Jérémie Voix</td>
<td>Development of a Method for Measuring Actual Exposure to Noise While Wearing Hearing Protection and Application in the Development of Dosimetric Hearing Protectors</td>
</tr>
<tr>
<td>SAQ</td>
<td>Michel Vaillancourt, Alan Carter and Daniel Perraton</td>
<td>Research Project on the Integration and Repurposing of Post-Consumer Glass in Roadway Structures and Coated Material</td>
</tr>
<tr>
<td>UDMN</td>
<td>Sylvie Nadeau and 15 other professors</td>
<td>“Miners – Mining Vehicles – Personal Protective Equipment” Component</td>
</tr>
</tbody>
</table>
OVERVIEW: KEY FIGURES...

RESEARCH INTENSITY ($/PROF)

The average funding per professor is higher than the Canadian university average.

EXTERNAL CONTRACTS AND GRANTS

- 2009-2010: $8,308,889
- 2010-2011: $8,375,825
- 2011-2012: $9,509,131
- 2012-2013: $11,950,315
- 2013-2014: $10,747,960

- 2009-2010: $4,843,685
- 2010-2011: $5,951,389
- 2011-2012: $5,447,911
- 2012-2013: $5,447,911
- 2013-2014: $6,261,919
### Main Research Funding Categories

Scholarships for graduate and post-graduate studies are included in total funding.

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Funding</th>
<th>Total Recurrent Funding</th>
<th>Total External Funding</th>
<th>NSERC</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009-2010</td>
<td>$14,315,771</td>
<td>$13,152,574</td>
<td>$1,163,207</td>
<td>$1,076,776</td>
</tr>
<tr>
<td>2010-2011</td>
<td>$16,370,230</td>
<td>$15,327,214</td>
<td>$1,043,016</td>
<td>$1,072,146</td>
</tr>
<tr>
<td>2011-2012</td>
<td>$19,838,907</td>
<td>$18,798,978</td>
<td>$1,040,929</td>
<td>$1,040,929</td>
</tr>
<tr>
<td>2012-2013</td>
<td>$19,080,762</td>
<td>$18,120,742</td>
<td>$860,020</td>
<td>$860,020</td>
</tr>
<tr>
<td>2013-2014</td>
<td>$21,786,494</td>
<td>$20,837,484</td>
<td>$949,006</td>
<td>$949,006</td>
</tr>
</tbody>
</table>

**Total** | $92,563,662 | $87,601,601 | $5,062,061 | $5,062,061 |
Dear readers and friends,

If we take a moment to look back over the last year, we will find many reasons to celebrate. Indeed, 2013-2014 stands out as a banner year for ÉTS.

Firstly, our admission numbers were up again this year, at every level. The implications of this fact go far beyond simple statistics. It affirms what we hear during discussions with students and what we glean from their conversations among themselves: young people are confident in the ability of ÉTS to help build their future. For us, this represents the fruit of our ongoing efforts, and also a great responsibility. I am convinced that their faith in us is well founded.

As we welcome these enthusiastic young minds, we continue to hire several promising young professors in order to maintain our level of excellence in terms of research and the transmission of knowledge.

We are well aware of the importance of organizational structure when it comes to research, which is why we launched our internal consultation on research, which led to the strategic reorganization of these structures. Of course, the primary objective of this reflective exercise was to provide researchers and post-graduate students with the best possible conditions for carrying out innovative, exciting and well-run projects with a view to producing scientific advances. The reorganization affected the majority of departments at ÉTS, and we are extremely proud of the results.

The Dean of Research Office has also been very active, launching a number of projects that we are convinced will have a positive impact on ÉTS for many years to come.

We know that our professors are well respected in their fields, both here and abroad, and they have received many honours celebrating their excellence, which also serves to enhance our international reputation. In fact, over the past year alone, ÉTS has funded no less than seven research chairs with a view to reinforcing the position of the chairholders as leaders in their respective fields.

1 Please note that this introduction refers to the period from April 1, 2013 to March 31, 2014.
In the highly competitive world of cutting-edge research, funding and talent are the two cornerstones. There was positive activity on this front last year as well, to the tune of $19M in recurring funding. Projects carried out in partnership with industry continue to account for more than two-thirds of our research funding, which is perfectly in keeping with our mission of providing engineering for industry.

According to the list of Canada’s Top 50 Research Universities, which is published annually by Research Infosource, ÉTS is currently ranked 31st in terms of overall funding and 15th in terms of research intensity. When it comes to the relative growth of our research activities compared to the previous year, ÉTS ranks 4th in Canada, which is a very enviable position.

We are extremely proud of this overwhelmingly positive summary, and it inspires us to do even more. ÉTS has enormous potential, and we will pursue our hard work with a view to continually expanding our horizons.

I would like to close by acknowledging the incredible support that we have received from everyone. The success of ÉTS is only possible thanks to the sustained and concerted efforts of our professors, research professionals, post-graduate students and the entire support staff.

Thank you, and congratulations to everyone!

Sylvain G. Cloutier,
Dean of Research
To provide an accurate representation of the scope and specificity of the research initiatives undertaken at ÉTS, we have created a matrix featuring our eight major domains of R&D. The first five domains (columns) correspond to business sectors recognized as key by the economic milieu, industrial clusters, and various levels of government. Active fields of research at ÉTS that belong to one or another of these major domains are listed within each column.

The three enabling technologies (rows) correspond to leading approaches in engineering R&D, ranging from the most theoretical (ideation and design) to the most tangible and/or practical (materials characterization, nanotechnologies). In turn, these three domains, which are of competitive interest to all business sectors, encompass various categories of activity.

The table clearly reveals the interdependence among sectors and technologies, enabling the positioning of each professor and each research project at a point where a business sector and an enabling technology meet.
### AEROSPACE AND LAND TRANSPORTATION:

- NSERC/P&WC Industrial Research Chair on Propulsion System Integration and Optimization
- Canada Research Chair for Aircraft Modelling and Simulation Technologies
- Industrial Research Chair in Forming Technologies of High-Strength Alloys (CM2P)
- ÉTS Research Chair on Rehabilitation and Strengthening of Civil Infrastructures
- ÉTS Research Chair on Engineering of Processing, Materials and Structures for Additive Manufacturing
- Aeronautical Research Laboratory in Active Control, Avionics and Aeroservoelasticity – LARCASE
- Composite Materials Manufacturing and Characterization Laboratory – LFCMC
- Laboratory of specialized embedded system, navigation and avionics – LASSENA
- Machine Dynamics, Structures and Processes Team – DYNAMO
- Optimization of Aerospace Manufacturing Processes Laboratory – LOPFA
- Products, Processes, and Systems Engineering Laboratory – LIPPS
- Shape Memory Alloys and Intelligent Systems Laboratory – LAMSI
- Stress Analysis by Finite Element and Testing Laboratory – ACEFE
- Thermo-Fluids for Transport Laboratory – TFT

### ENERGY:

- Canada Research Chair in Electrical Energy Conversion and in Power Electronics
- Hydro-Québec/TransEnergy Chair on Simulation and Control of Electric Power Systems
- Industrial Research Chair in Technologies of Energy and Energy Efficiency – T3E
- ÉTS Chair on Power Systems Security
- Power Electronics and Industrial Control Research Group – GREPCI
- Research Laboratory on the Nordic Environment Aerodynamics of Wind Turbines – NEAT
- Thermal Technology Centre – CTT

### ENVIRONMENT AND CONSTRUCTION:

- Canada Research Chair in Characterization of Contaminated Sites
- Pomerleau Industrial Research Chair in the Integration of Construction Practices and Technologies
- ÉTS Research Chair on Blends and Nanocomposites Based on Thermoplastics
- Design, Development and Implementation of an Integrated Chronographic Model for Project Planning Laboratory – MGPlan
- Engineering for Sustainable Development Laboratory – LIDD
- Experimental Station of Pilot Processes in Environment – STEPPE
- Geotechnical and Geoenvironmental Engineering Laboratory – LG2
- Integration and Sustainable Development in Built Environment – GRIDD
- Pavement and Bituminous Materials Laboratory – LCMB
- Research Group on Digital Applications in Engineering and Technology – GRANIT
- Research team specialized in Development and Research on Structures and Rehabilitation – DRSR
# Research Chairs and Units by Sector of Activity

## Health Technologies:

<table>
<thead>
<tr>
<th>Chair/Unit</th>
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<tbody>
<tr>
<td>Canada Research Chair in Biomaterials and Endovascular Implants</td>
</tr>
<tr>
<td>Canada Research Chair in Engineering Innovations in Spinal Trauma</td>
</tr>
<tr>
<td>Canada Research Chair in Precision Robotics</td>
</tr>
<tr>
<td>Canada Research Chair on 3D Imaging and Biomedical Engineering</td>
</tr>
<tr>
<td>Chaire de recherche en orthopédie Marie-Lou et Yves Cotrel de l’Université de Montréal et de l’ÉTS</td>
</tr>
<tr>
<td>Sonomax-ÉTS Industrial Research Chair in In-Ear Technologies – CRITIAS</td>
</tr>
<tr>
<td>ÉTS Research Chair on Interactive Robotics</td>
</tr>
<tr>
<td>Research Chair on Materials used in Protective Clothing and Equipment in Occupational Health and Safety</td>
</tr>
<tr>
<td>Biomedical Information Processing Laboratory – LATIS</td>
</tr>
<tr>
<td>Control and Robotics Laboratory – CoRo</td>
</tr>
<tr>
<td>Interventional Imaging Laboratory – LIVE</td>
</tr>
<tr>
<td>Imaging and Orthopaedics Research Laboratory – LIO</td>
</tr>
<tr>
<td>Research Team in Work Safety – ÉREST</td>
</tr>
</tbody>
</table>

## Information and Communications Technologies (ICT):

<table>
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<tr>
<th>Chair/Unit</th>
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<tbody>
<tr>
<td>NSERC-Ultra Electronics Chair on Wireless Emergency and Tactical Communications</td>
</tr>
<tr>
<td>Canada Research Chair in Hybrid Optoelectronic Materials and Devices</td>
</tr>
<tr>
<td>Canada Research Chair in Smart Sustainable Eco-Cloud</td>
</tr>
<tr>
<td>Vantrix Industrial Research Chair in Video Optimization</td>
</tr>
<tr>
<td>ÉTS Research Chair on Adaptive and Evolutive Surveillance Systems in Dynamic Environments</td>
</tr>
<tr>
<td>ÉTS Research Chair on Physical Layer Security in Wireless Networks</td>
</tr>
<tr>
<td>Advanced Research in Telecommunications – COMunity</td>
</tr>
<tr>
<td>Communications and Microelectronic Integration Laboratory – LACIME</td>
</tr>
<tr>
<td>Computer System Architecture Research Laboratory – LASI</td>
</tr>
<tr>
<td>Design and Control of Production Systems Laboratory – C2SP</td>
</tr>
<tr>
<td>Imaging, Vision and Artificial Intelligence Laboratory – LIVIA</td>
</tr>
<tr>
<td>Multimedia Communication in Telepresence – Synchronmedia</td>
</tr>
<tr>
<td>Multimedia Research Laboratory – LABMULTIMEDIA</td>
</tr>
<tr>
<td>Organizational Engineering Research Laboratory for the Digital Enterprise – NUMERIX</td>
</tr>
<tr>
<td>Production Technologies Integration Laboratory – LITP</td>
</tr>
<tr>
<td>Software Engineering Research Laboratory – GÉLOG</td>
</tr>
<tr>
<td>Telecommunications and Computer Networks Management Laboratory – LAGRIT</td>
</tr>
</tbody>
</table>
MECHANICAL ENGINEERING IN SERVICE OF HEALTH

Professor Petit is interested in the biomechanics of bones and joints; the assessment, prevention and treatment of spinal and spinal cord injuries; and the development of new protective and medical devices. In other words, he improves the quality of life of many people.

Yvan Petit is a professor in the Department of Mechanical Engineering associated with The Research Team in Work Safety (ÉREST), a member of the Imaging and Orthopaedics Research Laboratory (LIO) and holder of the Canada Research Chair in Engineering Innovations in Spinal Trauma. His areas of expertise include Computer-Aided Design (CAD), biomechanics, medical and protective devices, bones and joints and additive manufacturing technologies.

In summarizing the work of Yvan Petit, one could say that he uses engineering resources to understand the underlying causes of injuries. Some of the main projects that he is currently working on involve hip fractures and the spinal column.
Improving repairs of hip fractures
Working in collaboration with a specialist in repairing fractures of the greater trochanter, Yvan Petit is developing a new, more effective prosthesis that will improve the way fractured bones heal, be less susceptible to breakage and last longer.

Improving understanding of spinal and spinal cord injuries
Yvan Petit is seeking to enhance understanding of how injuries occur, improve how they are assessed and increase the ability to prevent them. Developing tools used for assessment and simulation will help the researcher to determine how injuries occur, identify fracture patterns and understand the relationship between the quality of the bones and the type of fracture.

Partners
Professor Petit’s work is carried out in cooperation with a number of partners, including Hôpital du Sacré-Cœur de Montréal, École Polytechnique de Montréal, Aix-Marseille Université, the Institut français des sciences et technologies des transportations, de l’aménagement et des réseaux (IFSTTAR), AmorChem and Pega Medical.

“This highly intelligent individual is, first and foremost, a manual worker and a pragmatist. He loves to build with his own hands, test empirically and “see if it works”. In his free time, you will find him perched on a ladder, hammer in hand – except on Monday evenings, when hockey reigns supreme.”
CREATING COMPUTERS WITH EMBEDDED OPTICS

“EVERYTHING DEPENDS ON THREE PARAMETERS: DISTANCE, SPEED AND DENSITY.”

Professor Véronique François
Information and Communications Technologies (ICT)
Advances in the field of fibre optics, photonic devices and optoelectronic circuits have revolutionized the telecommunications universe. Another major shift is developing, in which fibre optics featuring enhanced spatial density will play a preponderant role. Véronique François is among those leading the way.

In 2003, after spending 11 years as a researcher in the burgeoning optical telecommunications industry, Véronique François joined the Department of Electrical Engineering at ÉTS as a professor. Her areas of expertise include photonics, optical instrumentation, fibre optics, optical interconnects and configurable optical switches.

**Enhancing spatial density**

Some tasks that require enormous calculation capacities, such as weather forecasting, climate study and molecular modelling, are performed by supercomputers. These high-performance machines contain a large number of cores that must be connected together using “interconnects”. Traditionally made of copper, they are now being replaced by optical interconnects. While these interconnects are ideal for communication among mainframes, they are too large for electronic circuits.

**Multi-core microstructured fibres**

In order to solve the size problem, Véronique François is seeking to enhance the spatial density of interconnects by working with multi-core microstructured fibres instead of conventional fibre optics. These fibres are filled with numerous waveguides that can transmit data in parallel.

**Singlemode fibre**

Another avenue that Véronique François is exploring is the integration of singlemode fibre optics into optical interconnects, which currently function with multimode fibres that do not allow for the transmission of data over lengths exceeding 500 metres. With the incredible growth in the quantity of data, certain industry leaders, including Facebook and Google, are seeking connections that can cover up 2,000 metres to link their gigantic computer parks.

At present, we are still at the research stage, but according to Véronique François, a true pioneer in the sector, multi-core microstructured fibres will be reality within five years, signalling the beginning of another technological revolution.

How can we cover great distances in less time? With fibre optics, Véronique François has certainly found the quickest path. However, she has already considered a more traditional and romantic method for covering great distances: piloting long-haul aircraft.
Using the New to Preserve the Old

“Composite materials are discreet, and they don’t disfigure the structure.”
Almost half of Québec’s built heritage requires intervention. Armed with the knowledge that we can only replace the old with the new in exceptional cases, we understand the importance of rehabilitation and strengthening work. Omar Chaallal is a world-renowned specialist in this field.

Professor Chaallal teaches in the Department of Construction Engineering. His main areas of expertise include structures, reinforced concrete, strengthening, composite materials, seismic analysis and soil-structure interaction. He heads the Research team specialized in Development and Research on Structures and Rehabilitation (DRSR), and has authored numerous books and more than a hundred scientific articles.

Rehabilitation and composite materials
The deterioration of infrastructures is a reality throughout the Western world, and this problem is especially prevalent in Québec. In the majority of cases, we choose to extend the life of the infrastructure through targeted rehabilitation interventions.

The intervention process comprises three steps: assessment, diagnosis and methodology. This involves: 1) identifying the damage; 2) determining the cause and the solution; and 3) developing a rehabilitation plan that takes into account the various technical and socio-economic constraints.

Until recently, concrete has been the preferred material among engineers, but more and more, we are turning toward composite materials in order to carry out rehabilitation works.

However, using these materials is not simple, especially because we don’t know as much about them, such as how they will react in specific situations. Omar Chaallal and his team conduct extensive laboratory tests aimed at measuring the properties of rehabilitated materials and structures, and predicting how they will react under actual operating conditions.

Shearing
The research unit led by Omar Chaallal is among the world leaders in using composite materials for the rehabilitation of deficient structures in terms of shearing force, which are often characterized by diagonal cracking. He has developed a method that is recognized around the globe, which has been dubbed the Embedded through-section (ETS) method.

Other projects
Among the many other projects that this prolific researcher has worked on in recent years, the seismic retrofitting of towering structures and bridges, taking into account the interaction between the soil and the structure, is worthy of note.

Omar Chaallal loves to relax in arid, desert-like conditions, such as those found in Arizona, where he can walk, often by himself, meditating and perhaps thinking about some new material.
ADVANCED KNOWLEDGE FOR AN AGE-OLD ACTIVITY

High-strength metallic alloys are the material of choice for the fabrication of critical parts in the transportation and energy industries. The growing expectations and the highly competitive nature of the market require the development of new, better-performing alloys, which in turn requires an in-depth knowledge of materials, processes and in-use properties.

Mohammad Jahazi is a professor in the Department of Mechanical Engineering who has been working in the area of forming and joining of high-strength alloys for more than 25 years. He is the holder of an Industrial Research Chair, and has published more than 180 works. He is recognized around the world as an expert in his field.

Highly sought-after alloys
In order to improve understanding of the interactions between the materials, the forming process and the in-use properties, Professor Jahazi studies the microstructures that control these interactions and affect the properties of the alloys, which must exhibit total reliability when subjected to enormous mechanical forces. The art of the researcher comes to the fore in this quest for perfection.

Improving processes
Mohammad Jahazi’s work focuses on optimizing fabrication processes against a backdrop of international competition and environmental concerns.

For example, the transportation industry requires more and more extremely large ingots, which take a long time to solidify, and their microstructures must be free of all heterogeneity. Enhanced understanding of the mechanisms that govern these two factors will allow for reduced solidification time while producing the desired microstructures. As a result, quality and productivity will be enhanced and significant savings will be generated while reducing the ecological footprint.
A win-win relationship

There is obviously a great deal of know-how in industry, but it lacks the scientific expertise of researchers like Mohammad Jahazi. In exchange for this expertise, partner companies welcome students in a win-win relationship.

“There is a huge difference between the weight of a piece of steel and the grace of a poem, but Mohammad Jahazi moves from one to the other with the utmost ease. When he is not hard at work in his laboratory, he can be found in his garden, in the mountains or with his nose buried in a book of Persian poetry. You can bet that there is a solid beam connecting these two worlds.”

“THERE IS A CERTAIN POETRY IN THE FABRICATION OF A PIECE OF STEEL.”

PROFESSOR MOHAMMAD JAHAZI
Energy conversion

Over the last decades, we have seen a multiplication in the forms of energy used in our daily lives. It is no longer rare to see an engine or a building powered by a variety of sources. In order for everything to function effectively and remain stable, these sources of energy often have to be converted. Handy Fortin Blanchette is an expert in the field of energy conversion.

A professor in the Department of Electrical Engineering, Handy Fortin Blanchette has acquired more than 10 years of experience in industry. His areas of expertise include modeling and fabrication of high-density power converters and the simulation of electric traction units in deferred- and real-time using a Field Programmable Gate Array (FPGA).

In other words, he is an expert in energy conversion.

Mastering electromagnetic fields
An improvement of a few percentage points in terms of the conversion process has a significant impact over the long term. In order to achieve this, we use new material, reduce weight, adjust the volume, enhance sustainability, and optimize the layout of the parts according to the electromagnetic fields, which cause considerable interference that hinders performance.
“AT A TIME WHEN THE WORLD’S ENERGY NEEDS CONTINUE TO GROW, THERE IS NO SUCH THING AS AN INSIGNIFICANT ADVANCEMENT IN THE FIELD OF ENERGY CONVERSION.”

Expertise on the move
His expertise in energy conversion leads Professor Fortin Blanchette into countries where advanced technology is less common, including India, where close to 30,000 villages are powered by a variety of extremely unstable energy sources. An ÉTS joint project with a Québec company is attempting to connect all of these energy sources to multiport converters that will convert the energy and stabilize the voltage. The converters were designed by Professor Fortin Blanchette.

Optimizing through simulation
Today, multinationals make extensive use of simulations. Using real-time simulators, Handy Fortin Blanchette and his colleagues are able to reproduce physical phenomena at the same speed at which they actually occur, which allows them to optimize the systems and improve the performance of energy converters.

Converting energy is one thing, but Handy Fortin Blanchette is also passionate about transforming matter. A born carpenter, he can build a house as easily as some can cook up a meal. He loves the tangible aspect of manual labour, on which he is not shy to spend a great deal of... energy.
HELPING ROBOTS AND HUMANS TO LIVE SIDE BY SIDE

“ROBOTS CAN ENHANCE OUR LIVES. AND SAVE THEM.”

PROFESSOR VINCENT DUCHAINE
They detect the presence of humans and are learning to share space with them. Their fingertips are covered with a “sensory” skin. Even the way they look sometimes has us believing that we are dealing with living beings. Welcome to the world of humanoid robots, and the world of Vincent Duchaine.

Vincent Duchaine is the embodiment of the exceptional researcher whose work is financed by numerous research funds. A professor in the Department of Automated Manufacturing Engineering since 2010 and holder of the ÉTS Research Chair on Interactive Robotics, this young researcher and successful entrepreneur has been garnering international recognition since completing his Ph.D.

A visionary
Robotics is a passion for Vincent Duchaine. He is a visionary whose goal is to create a synergy between robots and humans sharing a workspace, and ultimately, a living space. The positive repercussions of his research are manifold, especially in the fields of rehabilitation, assistance for disabled individuals and assisted surgery.

Environment-sensing robots
However, the development of cooperative robots raises the important question of safety: how can we be sure that these powerful creations do not represent a danger to the people who work beside them? The answer: by making them sensitive to their environment.

Vincent Duchaine equips his robots with sensors that enable them to perceive their environment. He also gives them a sense of touch, thanks to a type of artificial skin that can detect and localize contact, giving the robot the ability to react, adjust and cohabitate with humans.

An intelligent and sensitive hand
Professor Duchaine’s work has led to human applications. Individuals who have an artificial arm are deprived of the sense of touch and the ability to feel the objects that they pick up. Vincent Duchaine has adapted his work with artificial skin to create tactile sensors that reproduce the sensitivity of fingertips on a healthy hand. These sensors are affixed to a prosthesis that is attached to a haptic device mounted on the arm that is able to transmit the perceived sensations.

There are two careers that would have been a perfect reflection of Vincent Duchaine’s creative and meticulous personality: astronaut or history professor. He is passionate about dragon boats, and is trying to convince his teammates that a robot would make an excellent coxswain.
Adaptive Videosurveillance

"Pretty soon, cameras may be everywhere."
SURVEILLANCE CAMERAS ARE PART OF OUR DAILY LIVES. WE MAY THINK THAT THESE MACHINES USE A SOMEWHAT UNSOPHISTICATED TECHNOLOGY: AFTER ALL, THE CHEAPEST MOBILE PHONE CAN PRODUCE A VIDEO WITH STUNNING PRECISION. NOTHING COULD BE FARTHER FROM THE TRUTH.

Éric Granger has been a professor in the Department of Automated Manufacturing Engineering since 2004, working in the emerging field of adaptive recognition systems, with specific expertise in the following areas: multi-classifier systems, adaptive and intelligent systems, pattern recognition and computer vision for applications related to biometrics, videosurveillance and computer security. He is a member of the Imaging, Vision and Artificial Intelligence Laboratory (LIVIA) at ÉTS and the strategic center studying distributed intelligent shared environments (REPARTI).

**What is facial recognition?**

Facial recognition relies on biometrics. It targets the automatic recognition of an individual from images of his or her face. This is most frequently achieved through the comparison of two images of a face – one captured by the recognition system cameras and one that is already saved in the database.

In videosurveillance, the systems capture images of faces in video sequences, which brings us to Éric Granger’s area of expertise: designing algorithms that allow for an automatic link to be established between the recorded images of faces and the previously saved images of faces.

**Adaptive algorithms**

However, there is a whole world between theory and practice. In reality, the conditions under which images are captured are often mediocre (insufficient light, moving subjects, variations in the resolution, clothing that obscures faces, glasses, etc.), and it is very difficult to develop reliable systems.

In light of these challenges, Professor Granger and his colleagues develop adaptive and intelligent systems that rely on algorithms that use new operational data and contextual information to enhance recognition.

There is no doubt that facial recognition through videosurveillance will continue to progress at a sustained pace thanks to its extreme usefulness in matters related to security, and also because of its potential in terms of marketing.

*His work may be ushering in the future, but Éric Granger turns his thoughts to the past in his free time. A history buff, this fall he dove into the American Civil War and the habits and customs of the Middle Ages, and he hasn’t ruled out returning to school when he retires. Once an intellectual...*
Inventing New Materials

Given the technological possibilities, our consumption habits and economic and environmental demands, the need for new high-quality materials has never been greater. Nicole Demarquette’s job is to invent them.

Nicole Demarquette is a professor in the Department of Mechanical Engineering. She joined ÉTS in 2012, after many years at São Paulo University in Brazil. She heads the ÉTS Research Chair on Blends and Nanocomposites Based on Thermoplastics.

Why create new materials?
The creation of new materials meets a variety of needs in industry (lower production costs, specific mechanical or electrical properties, lightweight) and among consumers and society (fashion trends, environmental concerns). The demand will continue to grow.

Two techniques
The easiest way to create new plastic materials is to blend two polymers in an extruder or an internal mixer in order to create a third material that combines the properties of the two original materials, as long as the morphology of the blend is optimized.

There is another technique, which involves introducing a nanometric reinforcement into a thermoplastic matrix in order to create a nanocomposite. For example, if we want to add conductive properties to a material, we add carbon nanoparticles. This creation technique produces results that are often very beneficial. These reinforcements are introduced in such minuscule quantities that they have the effect of enhancing the properties of the original material without altering its density. This is a crucial aspect in the transportation industry, among others.

Controlling the microstructure
Whether we are blending thermoplastics or adding nanoparticles to an existing material to produce a nanocomposite, the greatest challenge remains obtaining the optimal microstructure that imbues the new material with the specific targeted qualities. Without adequate morphology, the polymer will not possess the desired properties.
Professor Demarquette also works on designing products created through electrospinning, a manufacturing technique that uses electrical energy to transform a polymer-based solution into nanometric fibres with very specific properties.

Nicole Demarquette is a music lover who could easily see herself as a conductor. Instead of creating musical works, she creates materials, and derives great joy from playing piano and classical guitar, and from listening to Ravel, Debussy, Stravinsky or Villa-Lobos.
ÉTS: Giving the sense of touch back to those who have lost it
June 11, 2013 (Martin Primeau)

“As humans, we tend to believe that touch is essentially associated with pressure, but in reality, the most abundant receptors in our fingers are those that are sensitive to variations.” – Vincent Duchaine, Professor and holder of the ÉTS Research Chair on Interactive Robotics

Discriminating among sounds (Découverte)
April 14, 2013
(André Bernard and Éric Lemyre)

“The current trend is toward smart auditory protection and the ability to discriminate what is useful, such as alarms or voices, from what is useless, including background noise.” – Jérémie Voix, professor and holder of the Sonomax-ÉTS Industrial Research Chair in In-Ear Technologies (CRITIAS)

Reinventing public transit
March 15, 2014 (Nathalie Vallerand)

“We can’t continue to increase the number of vehicles in cities *ad infinitum*. And unless we choose to adopt the serpentine, we will have to get there through the gradual transformation of the automobile.” – Mathias Glaus and Robert Hausler, Professors and members of the Experimental Station of Pilot Processes in Environment (STEPPE)

Interview with Hany Moustapha (Live from the Bourget Air Show)
June 29, 2013 (Maryse Jobin)

“We are very lucky in the Montreal area. With all of the major players, four universities that have very strong aerospace programs, the Québec government’s support for research programs, the aerospace cluster and the institutes, we have a great network and a powerful hub.” – Hany Moustapha, Professor and Director of AÉROÉTS.

Prevention and cure (Risk management Feature)
February-March 2014 (Valérie Levée)

“Zero accidents is the ideal to be targeted, but since this is a probabilistic phenomenon, accidents can happen, despite the best intentions in the world.” – Sylvie Nadeau, Professor and Director of the Research Team in Work Safety (ÉREST)

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ÉTS AND ITS PROFESSORS IN QUEBEC MEDIA

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DRAME — INFRASTRUCTURES IN THE AGE OF CLIMATE CHANGE
April 20, 2013 (Caroline Rodgers)

The infrastructures that Quebec develops today must take into account the climate change that will occur over the coming decades. At the ÉTS Research group specialized in Development and Applied Research in Environmental Modeling (DRAME), they are working on predicting how these changes will affect the hydrology of Québec.

LE DEVOIR

ENGINEERS AND HOSPITALS
March 2014 (Dominique Forget)

“The time had come,” exclaims Industrial Engineer Claude Olivier, professor in the Department of Automated Manufacturing Engineering at École de technologie supérieure, who has analyzed the operations of several hospitals, both in Montréal and in remote areas. He believes that, “from a medical perspective, Quebec provides superior-quality care. However, we lag far behind from a logistical perspective. There are pickle factories that are being managed better than our hospitals.”
École de technologie supérieure (ÉTS), part of the Université du Québec network, educates professional engineers and researchers who are recognized for their practical and innovative approach. Ranked 24th among all engineering schools and faculties in Canada, ÉTS is home to approximately 60 research chairs, centres and laboratories, with which numerous post-doctoral fellows and graduate students are associated. This synergy of expertise and excellence contributes to scientific progress and increased industrial productivity and quality, as well as the training of a highly qualified workforce.

For more information concerning the research chairs, laboratories and groups at ÉTS, please consult the Research and Innovation section of the ÉTS website, at www.etsmtl.ca.

Genius is one percent inspiration and ninety-nine percent perspiration.

Thomas A. Edison.