

STRATEGIC RESEARCH PLAN

A- CONTEXT

ÉTS mission is to focus on research and education in applied engineering and technology, with a view to advance the economic and technological development of Québec. The research and development (R&D) activities at ÉTS are carried out in a way that is coherent with ÉTS motto, "**Engineering for Industry**". Thus a sustained partnership between ÉTS and its many external partners in a variety of sectors is central to the fulfillment of its mission, and serves as the backdrop for this *Strategic Research Plan*. The collaborations between ÉTS and large enterprises, SMEs, especially VSEs, contribute to the rapid technological expansion of both industry and ÉTS. For this reason, applied research projects must be tailored as much as possible to the needs of those partners: private enterprises or public institutions, non-profit organizations, municipalities and the health sector. At the same time, our partners become valuable allies in technology transfer and commercialization, which is why it is important for us to establish close collaborative relationships with enterprises interested in integrating our research results into their products and/or operations.

University research in engineering has grown significantly in recent years. The themes of this research, which are described more fully below, cover topics of increasing interest to engineers, like biology, health and sustainable development, thus imposing more demands on engineers for advanced multidisciplinary and networking skills. In addition, the competitive economic climate that currently prevails in Quebec and Canada, in all sectors, requires that the results of applied research be commercialized and serve as a foundation for innovation through technology transfer. It is within this larger framework of engineering research that ÉTS intends to contribute to addressing the social, economic and environmental challenges we face as a society.

B- OBJECTIVES

ÉTS has succeeded in positioning itself with advantage in technological R&D and maintaining a vigorous rate of growth in this field. Both grants and contracts are on the rise, but remain in balance, and, relatively speaking, the level of involvement of ÉTS in **R&D partnerships** far exceeds that of most Canadian universities. ÉTS plans to maintain this momentum by concentrating on growth areas where its researchers have distinguished themselves by their expertise and their achievements, using state-of-the-art research infrastructure.

This *Strategic Research Plan* proposes two main objectives. The first is **to affirm and extend the excellence of ÉTS in applied engineering research**. In order to achieve this objective, ÉTS intends to vigorously support its researchers in the R&D domains in which it is renowned. The second is **to encourage collaborative R&D and the strengthening of the synergy between ÉTS and external sectors (industrial, social and health, among others)**. Considering the social, economic and environmental issues that society must resolve in the future, ÉTS has the potential to be a key partner in these sectors, capable of pushing technology transfer further, to the point of bringing innovations to market, adoption, even certification.

With regard to the first objective, the *Strategic Research Plan* aims to:

- Create a body of knowledge, disseminate it and train highly qualified personnel, both in terms of scientific expertise and the skills required to conduct R&D throughout the value chain, from research to technology transfer to commercialization;
- Ensure the presence of ÉTS as a major player in strategic and emerging R&D domains, as identified and prioritized by our partners in the social, industrial and governmental sectors;
- Support the development and increase the value of researchers' expertise in the specific sectors where they excel;
- Promote the appreciation of applied engineering research among the general public locally, nationally and internationally.

With regard to the second objective, the *Strategic Research Plan* supports:

- The development of sustainable, efficient and effective collaboration of ÉTS with these sectors;
- University/sector synergy via the partnership programs of funding agencies;
- The identification of new opportunities for collaboration as well as their development;
- The value-added treatment of inventions and their transfer to industry, such as protecting intellectual property, securing patents and licenses, and creating spin-offs, even by means of more appropriate mechanisms for bringing a product to market, similar to knowledge pooling (e.g. free software) and standardization in software engineering, or the certification of new products in the health technologies;
- The establishment of alliances/networks with researchers at other institutions, both public and private, at the local, national and international levels.

C- RESEARCH DOMAINS AND FUTURE PERSPECTIVES

Based on the repute and the diversity of expertise of its professors, R&D at ÉTS covers multiple themes that are at the leading edge of scientific and technological advances. These themes represent, in general, concrete challenges for our partners in the social, industrial and governmental sectors. A convenient representation to appreciate the full extent and the specificity of such research is to outline the **8 major R&D domains** in two orthogonal directions as follows:

- Table A – **Business Sectors** – five (5) of them, spread side by side;
- Table B – **Enabling Technologies** – three (3) levels stacked vertically.

Tables A and B give details, in the next two pages, of the expertise, specialized infrastructures and/or the critical mass of researchers who have achieved pre-eminence in each of the 8 major domains. These domains are important to our partners and constitute the distinctive R&D signature of ÉTS.

It is also important to remember that such domains are not fixed or static, but interrelated and likely to evolve over time, particularly with the arrival of new teaching staff and the development of partnerships with the social, industrial and governmental sectors. Moreover, there may be many interrelationships between domains; for example, one research topic may become linked to another topic, or to a number of topics. In order to simplify the presentation, the topics are mentioned only once in the Tables.

It is worth noting that some of the research themes are just emerging, and these increasingly involve researchers from more than one, or even the majority of the domains. Examples are **life-cycle analysis** and **nanotechnologies**, which will be discussed in the next section, **innovation**

management, in which ÉTS intends to position itself as a reference standard, and **university pedagogy**, which aims to include quality and innovation in all the course offerings at ÉTS. In general, these new research themes embrace a variety of topics that are outside the traditional frame of reference of engineering, and hence the need for the researchers to adopt multi-, or even inter- or trans-disciplinary approaches. ÉTS plans to promote and support the development of such approaches in R&D.

Expertise and future perspectives

ÉTS is following with interest the emergence of new research topics. Globally, we see future developments in R&D on a continuum, from ever smaller devices at the nanoscale to large systems at planetary scale, encompassing the perspective of sustainable development and integrating the various domains presented in the Tables below. This comprehensive view of research unites the areas of expertise, the critical masses, the specialized infrastructures and the groups of researchers that continuously evolve at ÉTS, and for which Research Chairs are either currently in operation or at the planning stage. Moreover, ÉTS intends to develop and maintain a heightened awareness of the major environmental issues that arise, integrating them into a **life-cycle** perspective in such a way as to contribute to the design of concrete approaches and products that are both effective and sustainable. ÉTS also wishes to develop and strengthen its expertise in **nanotechnologies**. This very promising sector intersects with most of the research domains at ÉTS.

Table A: Business Sectors



1. HEALTH TECHNOLOGIES

- biomechanics and biomaterials
- health and safety in the workplace (ergonomics, vibration, acoustics, industrial hygiene, security design, protective equipment, risk management)
- imaging and medical devices
- telehealth, electronic patient records

2. ICT (Information and Communications Technologies)

- electrooptical and radio frequency devices, microsystems, sensors, MEMS, RFID
- micro-electronics, LTCC micro-fabrication
- telecommunications: wireless, optical, photonic, networking, GNSS/navigation

3. ENVIRONMENT AND CONSTRUCTION

- climate change
- construction, maintenance and rehabilitation of urban structures and infrastructures
- roads, bituminous materials
- soil decontamination, water treatment, residual materials recycling

4. AEROSPACE AND LAND TRANSPORTATION

- aerodynamics, aeroservoelasticity, wake dynamics, ice buildup on wings
- aerospace fabrication processes and in-service performance, avionics
- mass transit, cyber transportation, safety
- propulsion, gas turbine engines

5. ENERGY

- heat transfert, energy conservation, internal combustion engines and biofuels
- power electronics, energy efficiency
- production, transportation and distribution of electricity
- renewable energy : wind, hydraulic, geothermal, solar, etc.

Table B: Enabling Technologies

1. ENGINEERING SCIENCES

- ideation and design
- modeling, simulation, analysis, optimization
- operations, production and supply chain management
- project management, life-cycle analysis, certification
- innovation management

2. SOFTWARE AND COMPUTER APPLICATIONS

- software engineering, security, biometrics, surveillance
- multimedia: AI, computer graphics, interfaces, video, vision, voice, digital documents
- maintenance, quality, embedded systems

3. MATERIALS AND FABRICATION

- product development and prototyping, fabrication process optimization
- manufacturing systems, robotics, automation
- machine dynamics and vibrations
- machine elements (pressure tanks, seals, tribology, gears)
- forming; clean, high-speed, high-performance machining
- materials characterization and in situ testing, development of advanced materials (shape memory alloys, composites, plastics, polymers)
- nanotechnologies



The following is a list of emerging R&D themes that correspond to ÉTS research domains that are prioritized for development :

- Generation and distribution of electricity, renewable energies;
- Consideration of the life-cycle perspective in the rehabilitation of urban infrastructures and in workplace health and safety;
- Fabrication process optimization, advanced materials and composites, non-invasive and non-destructive testing, micro-fabrication;
- Digital enterprises and e-businesses, data mining and data fusion;
- Integration of bio-, micro- and nano-systems, digital imaging, touch screens, piezoelectric circuits;
- Biosignals, medical robotics, microfluidics, plasma technologies;
- Systems integration, green vehicles : aircrafts and ground-based transportation.

D- DEPLOYMENT OF RESEARCH CHAIRS

Over the past few years, ÉTS has achieved the establishment of Research Chairs in each of its major domains of expertise, thus resulting in a significant increase in the total number of Chairs. These include Industrial Chairs and NSERC Chairs. However, additional Chairs have also been secured from the Canada Research Chair (CRC) program, in recognition of the sustained and substantial¹ increase of ÉTS R&D activities during this period. At the present time (January 2012), fourteen externally funded Research Chairs at ÉTS (seven CRCs, five Industrial Chairs, and two NSERC Industrial Chairs) represent all the R&D domains, with a strong presence in energy and health technologies on the one hand, and in engineering sciences, materials and fabrication on the other.

¹ According to the annual ranking of Canadian universities published by *Research Money*, ÉTS placed first in this category in November 2005, and second in November 2007.

Two CRCs recently awarded to ÉTS (one Tier 1 and one Tier 2) have not yet been assigned. Moreover, ÉTS created last year a new program for the establishment of internal Chairs - CRI (Chaires de recherche institutionnelles) - in order to accelerate the process of securing externally funded Chairs for highly productive and/or promising researchers. Seven (7) new CRIs were announced last summer, which brings the total number of Research Chairs at 24, including also the first inter-university Chair with the Faculty of medicine of Université de Montréal.

E- MONITORING RESEARCH PROGRESS

At ÉTS, assessing the progress and performance of research activities is based first on the annual reports produced by accredited research groups, as well as on the annual institutional report of research activities prepared by the Office of the Dean, Research. In the latter are recorded the funding awarded to researchers in various peer-reviewed competitions, and contracts made with industry. Once grants have been obtained, other factors are taken into account in the assessment, including publications, the supervision of graduate students and activities associated with technology transfer. The institutional report also details the activities and recent achievements in R&D of the Research Chairs and departments.

F- PLANNING AND APPROVAL PROCESS

The Director General of ÉTS is responsible for the *Strategic Research Plan*. Under his authority, the *Plan* is prepared by the Director of Research and Industrial Relations, with the assistance of the Dean of Research and Technology Transfer, who consult researchers, collect information, perform analyses and conduct appropriate consultations with partners as necessary in order to prepare the *Plan* and update it periodically. The completed *Strategic Research Plan*, and any modifications made to it subsequently, must be approved by the Board of Governors of ÉTS on the recommendation of Senate (Commission des études).

G- CONCLUSIONS

The *Strategic Research Plan* embodies the mission of ÉTS, which is to offer university education and to conduct research in applied engineering and technology. The *Plan* is aimed at strengthening the domains in which the university excels, but also targets new ones that will create the technological advances that will have a significant impact on society. It is a dynamic tool which is designed to evolve, but also to reflect faithfully ÉTS' commitment to pursue its R&D priorities as well as its desire to anticipate the great challenges to society, in order to respond to them effectively and with originality.

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