

SUMMARY - INSTITUTIONAL RESEARCH PLAN (2006)

The plan was implemented in January 2001 as part of the institutional planning process of École Polytechnique de Montréal. It applies research consolidation and development guidelines for the years ahead. It is a dynamic tool that is reviewed and adjusted regularly against the major guideposts that define it.

1. INTRODUCTION

École Polytechnique is one of Canada's top research-intensive universities. In line with its vision: "To be a world-class engineering school and an active partner in social, economic and technological development", its research mission is to "perform relevant high-level research that forms the basis of students' training at the master's and doctoral levels with due regard to the needs of industry and society." Aside from contributions in kind from our various partners, École Polytechnique's 2005-2006 annual budget was \$67.7 million, i.e. \$38.8 million in grants and research contracts, \$23.4 million in major infrastructure grants and \$5.5 million in research indirect costs. Its research infrastructure attracted investments of over \$162.8 million for the 1999-2006 period thanks in part to the Canadian Foundation for Innovation (CFI), the government of Québec and to our partners. Polytechnique is renowned for its close ties to the industry and for its important contributions to the development and application of new technologies. It boasts 27 research centres and groups, 15 industrial chairs including 9 funded by the Natural Sciences and Engineering Research Council (NSERC) and 23 Canada Research Chairs of which 19 have been allocated and two renewed for a second term. The chairs are associated with a dozen public or private R&D research centres. Thanks to Polyvalor/Univalor set up to enhance the work of its researchers, so far, 15 spin-off companies have branched out from research conducted in its laboratories, 45 technologies are in process of being commercialized. Up to now, these spin-off companies created 430 direct and indirect jobs and generated \$80 million in private and public capital investment (2001-06 period).

2. INSTITUTIONAL RESEARCH PLANNING PRINCIPLES AND PROCESS

École Polytechnique periodically updates its research programmes and activities according to the following principles: research must contribute to the training of graduate students at the master's and doctoral levels and of highly qualified young researchers, and must enhance the education of undergraduate students. Research must also contribute to the advancement of knowledge in applied sciences and engineering, thus maximizing chances of discoveries, which, in turn, will strengthen the technological capabilities of companies and directly contribute to technological innovation. Research must reflect the current globalization context. It must be open to multidisciplinary problematics and to collaborations with top academic, government and private research teams from Québec, Canada and abroad.

Institutional research is planned using the following process: the Dean of Research and Innovation consults with the *Commission de la recherche* (research commission) and the *Conseil consultatif de la recherche* (advisory council on research) (groups of members external to the École Polytechnique community and with professional responsibilities in their company's research management). The Dean then submits a planning project to the council of directors and summarizes the directions adopted by the departments. The various boards agree on an exchange and discussion process. The school's Director General, upon consulting with the council of directors, makes the final decision as to

the chosen institutional planning course of action and notifies the board of directors, the academic council and École Polytechnique's community.

3. ÉCOLE POLYTECHNIQUE'S RESEARCH DEVELOPMENT PLAN

École Polytechnique has chosen to consolidate and develop its research according to seven major thrusts. These thrusts aimed at being complementary and interactive are part of the technological and scientific pole École Polytechnique has developed with Université de Montréal, whose implementation led to the dedication of the J.-Armand-Bombardier pavilion, a 16,800-square-meter building whose construction cost over \$60 million. The building is totally dedicated to research and incubation of start-up companies and was funded in part by the J.-Armand-Bombardier Foundation, the governments of Canada and Québec. The seven thrusts are:

1. *Multimedia, Information technology and Telecommunications* ("Multimédia, informatique et télécommunications" [MIT])
2. *Life sciences and engineering* ("Sciences et génie du vivant" [VIV])
3. *Advanced materials, Nanoscience and Nanotechnology* ("Matériaux avancés, nanosciences et nanotechnologies" [MAT])
4. *Environment, Energy and Sustainable development* ("Environnement, énergie et développement durable" [ENV])
5. *High-technology manufacturing and Aerospace engineering* ("Hautes technologies de fabrication et aérospatiale" [FAB])
6. *Systems' Science and Engineering* (Sciences et génie des systèmes [SYS])
7. *Training and learning technologies in science and engineering* (Technologies de formation et d'apprentissage des sciences et du génie [FOR])

The latter thrust is a research area new to our institution. It is consistent with the emphasis Polytechnique has always put on the quality of education. The other major thrusts reflect in every way the domains in which our researchers, each in their respective specialty, perform leading-edge research and pave the way to major multidisciplinary projects. This is why École Polytechnique supports as a priority new faculty appointments, the creation of new research teams and centres, the purchase of new state-of-the-art equipment and the allocation of chairs within the seven above-mentioned thrusts. The table below presents our development plan for six of our major thrusts. The seventh, i.e. *Training and learning technologies in science and engineering* ("FOR"), will be developed through other means. We have obtained to this effect jointly with Université de Montréal and École des Hautes Études Commerciales a \$10-million contribution from the J.-A. de Sève Foundation.

	INDUSTRIAL CHAIRS	CENTRES AND GROUPS	CANADA RESEARCH CHAIRS	CFI-QUEBEC-PART. PROJECTS	CFI-QUEBEC-PART. INFRASTRUCTURES
MIT	2	7	6	10	27 030 318 \$
VIV	2	1	6	13	38 978 638 \$
MAT	1	5	4	16	46 437 676 \$
ENV	5	2	2	2	9 393 276 \$
FAB	1	3	1	5	11 229 265 \$
SYS	3	8	4	11	29 747 135 \$
FOR	1	1	---	---	---
TOTAL	15	27	23	57	162 816 308 \$

4. DEVELOPMENT PLAN FOR OUR RESEARCH BASE

Since June 2002, École Polytechnique has hired 60 new faculty and 45 faculty have retired. As of September 1st, 2006, it boasted 233 professors. In order to meet the needs of our students and to be ready for the planned developments in each discipline, we plan to appoint 40 faculty (vs. 20 retirements) over the next years. In the years ahead, we will seek to continue to increase our academic staff and our critical mass of researchers.

4.1 Canada Research Chairs (CRC)

Due to its performance, École Polytechnique was awarded 23 Canada Research Chairs, i.e. 21 NSERC, 1 SSHRC (Social Sciences and Humanities Research Council) and 1 CIHR (Canadian Institutes of Health Research). The table below shows our roll-out plan for the CRCs. The indicators of success arising from the Canada Research Chairs Program are: 1) the number of new faculty positions created through the chairs, 2) the number of new research positions created, 3) the number of supervised graduate students and the percentage thereof enrolled at the doctoral level, 4) the amount of research funding and sponsorships, 5) the resulting research infrastructure, 6) the number and calibre of scientific papers, 7) the number and calibre of training activities, 8) the number of technology transfers (licenses, patents, spin-offs), 9) the number and scope of multidisciplinary projects, 10) the number of invited professors, 11) the national and international scientific outreach (citations, awards, invited lectures, etc.).

Roll-out plan for the Canada Research Chairs

	SPECIFIC TARGETED AREAS	LEVEL 1	LEVEL 2	RESEARCH UNITS, PARTNERS
M I T	Software engineering	G. Antonioli		UofM (Hospitals)
	Photonics	R. Kashyap		GCM, POLY-GRAMES, PolyPhotonique, Nano-Qc
	Microelectronics	Y. Savaria		GRM, RESMIQ, PROMPT-Qc
	Nanorobotics		S. Martel ⁺	GRSTB, NanoQc, MIT (USA)
	Millimetric waves	K. Wu	C. Caloz	POLY-GRAMES, PROMPT-Qc
V I V	Surgical engineering		C.É. Aubin ⁺	UofM (Hospitals)
	Intelligent medical devices	M. Sawan		GRM, RESMIQ, PROMPT-Qc
	Tissue engineering	M. Buschmann		UofM (Hospitals), Nano-Qc
	Biotechnology/Biopharmaceutics		M. Jolicoeur	UdeM, CNRC(IRB)
	Nanomedicine		G. De Crescenzo	GRSTB, Nano-Qc
	Biomechanics		(I. Villemure) *	UofM (Hospitals)
M A T	Nanotechnology	M. Meunier	P. Desjardins ⁺	GCM, UofM, Nano-Qc, CRIAQ
	Composites	F. Trochu		CRÉPEC, McGill, Concordia, CRIAQ, CNRC (IMI et CTFA)
	Advanced photonics materials		M. Skorobogatiy	GCM, UofM, PolyPhotonique
E N V	Water contamination dynamics		(S. Dorner) *	CREDEAU
	Sustainable process engineering		à combler	CIRAIG
F A B	Optimal multicriteria design	D. Pelletier		CRIAQ
S Y S	Operational research	F. Soumis		GÉRAD, UofM, HEC
	Safety/Earthquake engineering	R. Tremblay		GREGS, Sherbrooke
	Technology change management		M. Bourgault	CIRANO
	Ergonomics		D. Imbeau ⁺	IRSST, Sherbrooke
TOTAL (23)		11	12	

* Applications under review at the CRC Secretariat

+ Second term

4.2 Other projects

As part of the fund-raising campaign titled “Un monde de projets” (*A world of projects*) of École Polytechnique, Université de Montréal and École des Hautes Études Commerciales, our professors and their staff have submitted several chair projects since September 1999 (industrial or NSERC/industrial chairs), as well as numerous infrastructure and structuring research projects. A certain number of those projects have been completed or will be completed soon. They were made possible through exceptional contributions collected from our partners. All told, the campaign raised over \$218 million, of which \$42 million went to École Polytechnique.

5. IMPLEMENTATION STRATEGY FOR OUR RESEARCH BASE

In order to get the most out of the current and the future research base, DISCIPLINARY LINKUP must be used as our basic concept. Together with our partners, our initiatives will be accomplished through the following means: inter-institutional clustering and consortiums for research.

5.1 Inter-institutional clustering

We have implemented a strategy for inter-institutional clustering with our university partners. That strategy is based on the *Programme de regroupements stratégiques du Fonds québécois de recherche sur la nature et les technologies (FQRNT)* (strategic clusters programme of the Québec fund for research on nature and technologies), the Networks of Centres of Excellence (NCE) and the NSERC networks. Our research groups and centres act either as leaders or participants in 13 clusters in line with our research thrusts. They are mainly used to fund the human support infrastructure and the networking and give the various teams access to the physical infrastructure provided by the CFI/Québec. These clusters are designed to optimize research activities, to provide access to major equipment, to provide a supervising structure for our student researchers and to foster mobility between university member teams.

5.2 Consortiums for research

We either steer or actively participate in 12 precompetitive research consortiums comprised of research fellows and industrial partners. Mainly under the leadership of *Valorisation-Recherche-Québec* and also as part of the programme entitled “The Initiative on the New Economy” of the SSHRC, Polytechnique researchers, either as individuals or as part of groups or centres, take part in significant or structuring projects involving major Québec universities. With significant funding for support, networking and research infrastructures, some of the consortiums are incorporated as non-profit organizations and their Board of directors is comprised of university and industry members. Their research activities focus on precompetitive projects with due regard to valorization and transfer to industrial partners. Some consortiums are also part of liaison and transfer centres funded by the government of Québec, whereas others, such as the International Institute of Telecommunications (IIT) and the *Institut de génie de l'énergie électrique (IGEE)* focus on teaching with a research component.

6. TRAINING OF RESEARCHERS

The training of researchers (students at the master’s level and doctoral students, postdoctoral fellows, research initiation of undergraduate students) is a fundamental mission for École Polytechnique, and as such, must be seen as a priority as we set out and roll out research projects. The calibre, the variety and the number of research projects combined with the reputation of professors-researchers and their teams have led to a major increase in the number of postgraduate students. Between the winter of 2000 and the fall of 2006, the number of doctoral students rose from 233 to 445, a 91%

increase over 7 years, whereas the number of students at the master-research level was increased by 40% (from 337 to 470 students) for the same period.

7. CONCLUSION

Our strategic plan is based on the high quality and the work of our professors, our research personnel and our students. It is consistent with a realistic appraisal of our current resources and, more specifically, of our growth potential. It is based on our ability to appoint new faculty. On top of replacing retirees, we are taking advantage of the following programs : Canada Research Chair, NSERC industrial research chairs in conjunction with the support of our chair's industrial partners. Moreover, we intend to use NSERC's Faculty Support Programs to hire female faculty. Females now account for 12.9% of the faculty (30 as of the fall of 2006). There are still few female Ph.D graduates, thus limiting the recruitment pool. However, a significant increase in doctoral female students was noted at École Polytechnique, from 5% in 1983, to 12% in 1993 to 20.4% in 2006. We must stress the remarkable work of the Marianne-Mareschal Chair in promoting engineering to women and specifically to young girls. With funding from the NSERC and École Polytechnique, the chair is co-chaired by 3 female faculty and won the *Prix Relève* in 2002 and in 2005 from the *Association de la recherche industrielle du Québec (ADRIQ)* (Québec association for industrial research).

Based on our past successes and despite strong competition, we are confident to meet our appointment objectives of new highly qualified faculty within the domains we chose to focus on. The significant amount of funding and research contracts obtained by our faculty will enable us to maintain our excellence in engineering training and our R&D work capabilities. We are confident that the number of postgraduate fellows, post-doctoral researchers and research professionals and technicians will keep increasing, despite the tremendous pressure being put on our research infrastructures, our space requirements and our research support staff.

Space: Thanks to the new J.-Armand-Bombardier pavilion, we have been able to offer our researchers high-quality laboratories and spaces since May 2004. The pavilion co-owned by Université de Montréal, offers 16,800 square meters of state-of-the-art laboratories to our researchers and their peers from Université de Montréal working in the *VIV*, *MAT*, *FAB* and *FOR* research domains. Moreover, since the fall of 2005, the Claudette-McKay-Lassonde and Pierre-Lassonde pavilions host our researchers working in the *MIT* research thrust. All told, 30% of the 30,000 square meters of the two pavilions are dedicated to research. Lastly, the refit of École Polytechnique's main pavilion, based on the real estate master plan filed with the Québec government in 2001, and the two floors we are occupying in the André-Aisenstadt pavilion will offer a quality research environment to the researchers who will remain in those two existing buildings.

Research infrastructure: With the support of our industrial partners and thanks to our success with the CFI, we will be able to deploy our new research infrastructures, thus enabling us to provide our teams with the equipment they need to develop our priority thrusts.

Research support: While we appreciate the funding of research indirect costs by the federal and the provincial governments and the funding of start-up costs by the CFI, we feel that it should compare more to actual costs, i.e. at least 40% of direct costs. École Polytechnique aims specifically at setting up inter-institutional groups and research consortiums to help fund the technical personnel required to manage the significant equipment pool recently acquired by our researchers.

École Polytechnique de Montréal, as one of the country's major sociotechnological agent of change, is soaring. Despite the major challenges awaiting them, École Polytechnique, its faculty and personnel are committed to meet them successfully with energy and vision, with the help of our numerous public and private partners.