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University Training and Research in Canada

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Overview

- **Training needs**
 - Canadian industry studies – stakeholders
 - Employment opportunities – industry workforce
- **University education and training**
 - University and faculty statistics - hiring
 - Student enrollments – interests
 - University programs – constraints and options
- **Government-supported R&D programs**
 - Government programs and research funding mechanisms
 - University R&D initiatives
- **Summary and final comments**



Training needs

Reports on labour needs – an industry perspective

- **Canadian Electricity Association – comprehensive study**
 - “Keeping the future bright – 2004 Canadian Electricity Sector human resource sector study” - R.A. Malatest & Associates
 - Identified shortfall, average scenario, engineers: 660 per year, cumulative over 5 years: 3300; trades: 2700 per year, cumulative over 5 years: 13500
- **Other study – CanWEA**
 - “Detailed Canadian Large Wind Turbine Industry Labour Forecast – 2015” – Delphi Group
 - Identified needs, engineers, mechanical: 860 man-years, electrical: 110, civil: 80
- **Statistics on university education – limited data collection**



Employment opportunities

Statistics – new graduates – Province of Quebec

Companies	2003-06	%	Yearly	2003-04	2004-05	2005-06
Utility (HQ)	42	34%	14	16	13	13
Manufacturers	27	22%	9	11	8	8
Consulting	26	21%	9	10	8	8
Other	27	22%	9	9	9	9
Total	122	100%	41	46	38	38

Note: Province of Quebec - Based on the statistics compiled by the Institute of Electrical Power Engineering (funded by Hydro-Quebec)



Identified new training needs

Canadian electrical power industry stakeholders

- **Utilities**

- Transmission system operators – new transmission planning, operation of electricity markets (ISO)
- Generation and distribution – integrating renewables and distributed generation

- **Manufacturers**

- Transmission and distribution equipment – substation automation
- Generation – power electronic interfaces (renewables, wind)

- **Consultants**

- System designers – merchant power plants
- Project managers – generation, transmission and distribution

- **Others**

- Software development and general power engineering services



Industry workforce

Meeting industry needs – industry solutions

- **Workforce characteristics – CEA report**
 - Retirements – the aging workforce – is there a crisis today?
 - Future manpower needs, associated with new technologies – are they increasing, diversifying?
- **Industry solutions to shortages of experienced engineers**
 - Employ retired engineers (particularly from utility, Hydro-Quebec)
 - Hire immigrants – requires some in-house training
 - Hire engineers from other specializations (telecommunications) – requires in-house training
 - Workforce renewal efforts – succession planning (rare, except Hydro-Quebec, an attempt to integrate new graduates)
- **University challenge – attracting the best brains**



Power Engineering education in Canada

University and faculty statistics – major universities

Resources		Numbers	%
Universities	Programs	21	NA
	Courses	100	NA
	Faculty*	90	NA
	Students	190	NA
Faculty	Avg/Univ	4.3	NA
	Professor	44	58**
	Associate	21	28**
	Assistant	11	14**
	Retired	14	15
	Tenured**	65	86

Notes: * including Retired faculty
 ** not including Retired faculty

Fall 2007



University education and training

University and faculty statistics - comments

- **Power Engineering programs in universities**
 - Reinstated to a varying extent in most universities - maintaining core power engineering programs when financially feasible
 - University support stemming from the reduced interest in Information Technologies and growing interest in energy
- **Faculty members in universities**
 - Number of faculty on the rise - large number of new hires in 2000-2004 (see Associate nos) – positions still open (> 5)
 - Number of faculty attributed as a function of the total enrollment - a small percentage (5-10 %) attributed to Power Engineering
 - Regular faculty positions are tenure-track positions
 - Associate professors are (usually) tenured
 - Positions vacated by retirements remain with the Power Group



University education and training

Faculty hiring – notes on the Canadian context

- **Allocating faculty resources in universities**
 - Numbers depend upon student and industry interest (employment opportunities)
 - Availability of research funding is secondary in the allocation of faculty positions
 - Research mostly funded by governments (Federal, NSERC, Provincial) – not necessarily targeted to critical industrial areas
- **Faculty members in universities**
 - Research is one of the components of the responsibilities of professors (typically 40 %)
 - Criterion for excellence is NSERC individual grant
 - Individual (Discovery) grants average 30 K\$ per faculty (40 % of NSERC budget of 960 M\$) – 90 % of faculty hold such a grant



University education and training

Program and student statistics - comments

- **Student enrollments in power engineering programs**
 - Student interest and enrollment in specialization courses remain low (typically 5 %, maximum 10 % of total student population)
- **Power engineering specialization courses**
 - Offerings are usually few (typically 2-3 courses, mostly Power Electronics and Power Systems, Electric machines, occasionally Renewable Energy)
 - Not all courses offered every year
 - Universities tend to abandon concentrations (including Power) – difficult to manage in a shifting labor market (example of move away from telecommunications)



Recruitment challenges

Student interest – situation similar to that of the USA

- **Student enrollments – stable or decreasing**
 - Electrical Engineering: decreasing in most universities in Quebec
 - Power Engineering: decreasing interest in a specialization, interest in keeping many options open
 - Power Engineering – graduate: reduction in the number of applicants – more competition for fewer applicants
- **Student perception – an image problem**
 - Mature/standard technologies: offer limited challenges
 - New technologies – materials: more applied than fundamental
 - Environment – economics: perceived as external to power engineering
- **Student interest – the attractiveness of the competition**
 - Multidisciplinary areas – electronic implants – bioengineering



University education and training

Constraints in training power engineers

- **Existing programs – limited scope for change**
 - Traditional disciplines – mechanical, electrical, civil, others
 - Initiatives to reconfigure programs to be multidisciplinary (more attractive?) – electromechanical, energy, environment – limited success
- **Constraints – few opportunities for specialization**
 - Large number of core subjects (software, computers, signal processing) – limited number of slots for specialization (3-5)
 - Program accreditation – standardized contents
 - Focus on modern fields – telecom, control, electronics, software
- **Possible solutions for specialized training**
 - Training at the Masters level



University education and training

Meeting the industry needs – tools

- **General engineering training – meeting requirements**
 - Standard Bachelor of Engineering program – electrical
 - Possible specialization concentrations – industry support
- **Higher education – graduate programs**
 - Professional MEng – combined BEng-MEng
 - Traditional Masters degrees – project or research theses
- **Additional training**
 - Internships – BEng (expanding interest), possibly MEng (industry collaborative programs)
 - Training by employer



Specialized training - R&D initiatives

University research

- **Main source of funding: NSERC – focus on**
 - Support of fundamental and applied research
 - Training of highly qualified personnel
- **Impact of R&D activities on Power Engineering education**
 - Visibility of the profession, the university and industrial sponsors
 - Participation of undergraduate students in research projects
 - Technology transfer – university-industry dialogue
- **Benefits for industry – limited interest**
 - Advance access to and knowledge of research results
 - Direct access to highly qualified personnel
- **Others**
 - Direct participation of industry in collaborative R&D projects



Government supported R&D programs

Funding opportunities

- **Natural Sciences and Engineering Research Council (NSERC) partnership programs (budget: 350 M\$, 07-08)**
 - Strategic projects – industry in-kind participation in the project
 - Collaborative R&D projects – industry cash contribution (50 %)
 - Idea to innovation – industry commitment to exploit idea
 - Industrial Research Chair – industry commitment (50 %, 5 yrs)
 - Research Networks – targeted areas
 - Centres of Excellence – major impact for Canada required
 - Canada Research Chair – incentive to hire from outside (5-7 yrs)
- **Canadian Foundation for Innovation (CFI)**
 - Partnership – Federal (40 %) / Provincial (40 %) / Private (20 %)
 - Large infrastructure funding and support – (0.3 – 5 M\$)



University R&D initiatives

Examples of research funding in the Canadian system

- **University research groups**
 - Research projects related to newer fields (wind energy) - present in most Canadian universities – mostly government funded (usually NSERC and provincial granting agencies) – strategic projects (usually 3 years)
 - Industry direct funding of research laboratories – contracts
 - Industry partnership funding – collaborative research projects
- **Research chairs**
 - Canada research chairs (power electronics, among others)
 - NSERC Industrial Research Chairs (power systems) – funding from utilities (Manitoba Hydro, Hydro-Quebec, among others)



University R&D initiatives

Funding opportunities - NSERC Strategic Network

- **Program aims to develop university research networks**
 - A means to enhance the interest in a specific area, to increase the number of highly qualified personnel (one of the objectives of NSERC)
- **NSERC target areas identified – 7 areas among which:**
 - Sustainable Energy Systems (Production, Distribution and Utilization)
- **An first example: NSERC Canadian Wind Energy Strategic Network (proposal under review)**
- **Participants**
 - Researchers (39) from universities (16) across Canada
 - Partners (15) from utilities, industry, government laboratories, association (interest group)



Summary – the Canadian situation

Strength and weaknesses

- **Strength of the Power Engineering education system**
 - University support – maintaining an adequate number of faculty
 - University support – maintaining a set of core power courses
 - Government support – core and targeted research funding
 - Utility support for undergraduate training – funding of special initiatives in some jurisdictions (for ex. Quebec, Ontario)
 - Utility support of research – through research chairs in targeted areas (for ex. Quebec, Manitoba, Ontario)
- **Weaknesses**
 - Limited industry (manufacturers and consultants) support for university training and research
 - Limited number of research networks regrouping faculty across the country, compared to other disciplines (microelectronics, telecommunications) – a major national project needed?



Final comments – helping recruit the best

Industry collaboration with and support to universities

- **Enhancing training attractiveness – industry input**
 - Expert contributions to university courses – practical content
 - Internships – motivate students to enter the field
 - Scholarships to enhance interest in the discipline
 - Industry on-campus recruiting
 - Greater industry support for graduate training
- **Involvement of Canadian associations**
 - CEA (Canadian Electricity Association) – establishing needs
 - Human Resources Canada (Elect. Sector) – support programs
 - Canadian Wind Energy Association (CanWEA)
 - AIEQ (Association de l'industrie électrique du Québec) – partner in the Institute of Electrical Power Engineering



Final comments

Model of industry-university partnership

- **Institute of Electrical Power Engineering**
 - A not for profit organization (incorporated in 2001)
 - A utility (Hydro-Quebec) response to the projected shortage of power engineers
 - Funded by Hydro-Quebec, supported by major stakeholders (ABB, BBA, AREVA, Cegertec, Siemens, SNC-Lavalin, AIEQ)
 - University participation – all universities in Quebec (9) offering a Power Engineering program, including McGill University, Concordia University, Ecole Polytechnique, Ecole de technologie supérieure, Université Laval, and 2 others
 - Graduates 45 engineers (BEng) with a strong training in electrical power engineering (4 compulsory specialization courses min)

