Professional Engineers
Ontario

PROCEEDINGS

2020 ENGINEERING FORUM

Collaborators:

Council of Ontario Deans of Engineering

Engineering Institute of Canada

Ontario Society of Professional Engineers

Professional Engineers Ontario (Host)

March 31, 2001

Published by
Association of Professional Engineers of Ontario

Contents

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Ontario

2020 ENGINEERING FORUM

March 31, 2001, 8:45 a.m. – 4:00 p.m.
Professional Engineers Ontario, 25 Sheppard Ave. W., Toronto

8:00 a.m.	Continental Breakfast	
8:45 a.m.	Welcome	Peter DeVita, P.Eng.
8:50 a.m.	Introduction	Dr. Walter Bilanski, P.Eng.

CODE Session

9:00 – 9:45 a.m.

◆ Trends in Science & Technology	Dr. Derek Northwood, P.Eng.
◆ Critical Skills Required by Engineers for the Years leading to 2020	Dr. Samy Mahmoud, P.Eng. Dr. Tyseer Aboulnasar, P.Eng. Dr. Franco Berruti, P.Eng.

9:45 – 10:00 a.m.	Discussion
10:00 – 10:15 a.m.	Break

Engineering Institute of Canada Session

10:15 – 11:00 a.m.

◆ Role of EIC	Dr. John Plant, P.Eng.
◆ Means of Acquiring Skills	Dr. André Rollin, ing
◆ Roles of the Technical Societies	Bruno Di Stefano, P.Eng.

11:00 – 11:15 a.m.	Discussion
11:15 – 11:30 a.m.	Break

Ontario Society of Professional Engineers Session

11:30 a.m. – 12:15 p.m.

◆ Comments from OSPE's Members' Forum	Paul Martin, P.Eng.
◆ The Renaissance Engineer: The ideal engineer of the future	Márta Ecsedi, P.Eng.
◆ Shifts in the Culture of the Workplace	Jeremy Cook, P.Eng.

12:15 – 12:30 p.m.	Discussion
12:30 – 1:30 p.m.	Lunch

Professional Engineers Ontario Session

1:30 – 2:15 p.m.

◆ Relevance and Need for Licensure in Global Manufacturing	John Mann, P.Eng.
◆ Human or Machine? Future Ethical Questions in Biomedical Engineering	Dr. Monique Frize, P.Eng., OC
◆ Engineering Licensing: Defining the boundaries of engineering and emerging frontiers	Peter DeVita, P.Eng.

2:15 – 2:30 p.m.	Discussion
2:30 – 2:45 p.m.	Break

Roundtable Discussion

2:45 – 3:45 p.m.		Dr. John Runciman, P.Eng.
3:45 – 4:00 p.m.	Closing	Peter DeVita, P.Eng.

Council of Ontario Deans of Engineering Session

TRENDS IN SCIENCE & TECHNOLOGY

Derek O. Northwood, P.Eng., Ryerson Polytechnic University

ABSTRACT

SWITZERLAND The marriage of biology and microelectronics that may cure diseases and create designer babies will create trillions of dollars of new wealth, leaders attending a business summit have been told.

Scientists at the World Economic Forum at Davos, Switzerland, had little doubt that nanotechnology, genomics and robotics are going to be the hot technology growth areas in the years to come, but many are also unnerved about their impact on society.

The reason is last year's mapping of the human genome, the genetic recipe book which scientists have broken down into digital code.

Bill Joy, scientist at Sun Microsystems, said the genome project has far-reaching economic implications.

"Over the course of the next century, it can create $1,000 trillion of new wealth," Joy said. *(Reuters, January 29, 2001)*

So many genes, so little time. The stampede is on, as whole new companies and even whole new fields are arising day by day to mine the treasures found deep in the core of each one of our cells.

THIS IS THE 21st CENTURY GOLD RUSH

Where do we go in the future and what trends in science and technology will be impacting engineering in the year 2020? The editors of *Science* have chosen six hot topics to watch in 2001. These are:

- infectious diseases;
- ocean studies with satellites;
- quality control in RNA synthesis;
- science funding around the world;
- the post-Big Bang "quark soup"; and
- a symmetry in cell development.

The Natural Sciences and Engineering Research Council (NSERC), in its Strategic Projects Grants competition, has introduced significant changes to stimulate research in the following areas:

- Biosciences;
- Environment and Sustainable Development;
- Information and Communication Technologies;
- Value Added Products and Processes.

Discussions with colleagues have brought forward a number of suggestions as to areas that will see an ever-increasing activity in the next 20 years:

- New Materials and Biomaterials;
- Biomimicry;
- Surface Science;
- Nanotechnology;
- Informatics (Bio);
- Imaging;
- Biotechnology;
- Proteomics and Genomics (Protein Engineering/Genetic Engineering);
- Microarrays or Gene Chips;
- Metabolic Engineering;
- Catalysis;
- Advanced Microscopy;
- Sensors;
- Financial Engineering.

This list is not meant to be all-inclusive and, as can be readily seen, contains components that have already been highlighted. The "lesson" I see in all this is the increasing need for all engineers to have more exposure to biology and the life sciences.

When this forum was originally being planned by representatives of PEO, CODE, EIC and OSPE, seven questions were posed:

1. What will the engineer in 2020 look like?
2. Where will science & technology have taken us?
3. What critical skills are required by engineers?
4. How are those skills imparted? By whom? When in career development?

5. What are future engineering scopes of practice?
6. What are key issues that will affect the public interest?
7. What is the role of our four groups (and others if necessary) in responding to these future needs as we see them?

Each "group" has chosen to address only some of these questions. Abstracts of presentations frequently mention increasing ethical and moral expectations. Are the required "standards" increasing at a rate that exceeds that in the past? Are we being faced with a different set of moral and ethical dilemmas that have been brought on by developments in science and technology? Is there increasing public (or "media") concern?

"Science is the study of what is………. Engineering is the creation of what never was………."
Theodore von Karman
Co-founder, Jet Propulsion Laboratory

"The most productive technologies are those that disappear. They wear themselves into the fabric of everyday life until they are indistinguishable from it."
Mark Weiser
Chief Technologist, Xerox PARC (in memoriam)

"We, as engineers, can 'engineer' our future and, if we are really successful in introducing these technologies, no one will really know we have done it."
Metro – Toronto – Monday, January 29, 2001

"Computer/Biology Boom Promises to Dwarf Net"

"SWITZERLAND The marriage of biology and microelectronics that may cure diseases and create designer babies will create trillions of dollars of new wealth, leaders attending a business summit have been told.

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"The reason is last year's mapping of the human genome, the genetic recipe book which scientists have broken down into digital code.

"Bill Joy, scientist at Sun Microsystems, said the genome project has far-reaching economic implications. 'Over the course of the next century it can create $1,000 trillion of new wealth', Joy said."
(Reuters)

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This is the 21st century Gold Rush.

Top 10 Scientific Developments in 2000
(*Science*, 22 December, 2000)

First Place – Genome Sequencing

Genome sequencing steamed full speed ahead in 2000, as researchers used a synthesis of biology, chemistry, physics, mathematics, computer science, and engineering to decode the script of life in a variety of organisms, from people to fruit flies.

First Runner-up – Molecular Mapping of Ribosome

Ribosome is the cell's essential protein factory. Higher-resolution maps of the ribosome revealed startling details about its structure that boost support for an "RNA World" as a model for the origin of life on Earth.

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- Quality control in RNA synthesis;
- Science funding around the world;
- The post-big bang "quark soup";
- Asymmetry in cell development.

NSERC, in its strategic projects grants competition, has introduced significant changes to stimulate research in the following areas:

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- Environment and sustainable development;
- Information and communication technologies;
- Value added products and processes.

Areas of ever-increasing activity over next 20 years:

- New materials and biomaterials;
- Biomimicry;
- Informatics (bio);
- Biotechnology;
- Proteomics and genomics (protein engineering/ Genetic engineering);
- Microarrays or gene chips;
- Metabolic engineering;
- Catalysis;
- Imaging;
- Advanced microscopy;
- Surface science;
- Nanotechnology;
- Sensors;
- Financial engineering.

What does this mean for accredited engineering programs in 2020?

First, take a look at what happened from 1981-2000.

New CEAB Accredited Programs: 1981-2000 (apart from traditional disciplines)

Program	Number Created
Computer engineering	17
Materials engineering	6
Environmental engineering	4
Geomatics engineering	2
Aerospace engineering	2
Biological engineering	1
Biosystems engineering	1
Agricultural & bio-resource engineering	1
Food engineering	1
Manufacturing engineering	2
Genie des systems electromecaniques	1
Building engineering	1
Ocean and naval architectural engineering	1

New CEAB accredited programs 2001 – 2020?

- Software engineering
- ?
- ?

Inertia of "systems" is such that few of the advances in science and technology will see their way to accredited programs by 2020. If software engineering is an example, there are going to be "interesting times" as we work with our non-engineering partners on genetic engineering, protein engineering, metabolic engineering, or financial engineering.

Bioscience Holds a Key to Toronto's Future

"This is much more important to Toronto's, and Ontario's, future than the Olympics 2008 bid. It is the goal of making Toronto, and related research capacities across Ontario, a world centre in bio-science research and development, with all kinds of commercial spin-offs.

"Bio-science, the field of genomics and proteomics, or study of proteins, holds the promise of enormous economic and social benefits of great long-term significance".

David Crane, The Toronto Star,
Tuesday, March 6, 2001

CRITICAL SKILLS REQUIRED BY ENGINEERS FOR THE YEARS LEADING TO 2020

Dr. Samy Mahmoud, P.Eng., Dean, Faculty of Engineering and Design, Carleton University

Dr. Tyseer Aboulnasr, P.Eng., Dean, Faculty of Engineering, University of Ottawa

Dr. Franco Berruti, P.Eng., Dean, Faculty of Engineering and Applied Science, University of Western Ontario

ABSTRACT

The presentation will identify and discuss the key skills deemed to be critical for engineers to be successful in the future, and the practical ways of acquiring such skills. The presentation will focus on incremental skills, which are considered complementary to a solid technical traditional background, and will elaborate on the following:

1. Analytical ability to solve complex problems in a constrained environment;
2. Entrepreneurial skills and business knowledge;
3. Leadership attributes and abilities;
4. Social, global and political awareness;
5. Management of a project/enterprise in an environment characterized by change;
6. Communications skills.

It is expected that the discussion will challenge the balance between "hard" and "soft" skills, and the ability to provide opportunities to develop such a comprehensive level of expertise within the postsecondary educational environment and in the workplace. In addition, it will be important to debate the respective responsibilities of universities and employers in contributing to the acquisition of these critical skills.

Some of the skills deemed to be critical for engineers to be successful in the future, and the practical ways of acquiring such skills include:

1. Analytical ability to solve complex problems in a constrained environment

Students are educated throughout their engineering curriculum to conceptualize and develop solutions to many problems under a set of assumptions, input data and predefined conditions. In the practical world, many of such assumptions are not valid, and the data available may be incomplete, probabilistic or fuzzy. In developing approaches to problem solving, engineering students should be aware and conscious of the difference between an academic setting and a real-world situation. Engineering students need to develop critical thinking skills and the ability to operate in a global international environment. Teamwork skills are essential, together with lifelong learning skills. Imparting this knowledge to them can be done through some examples in the curriculum, by engaging in practical real-world design problems and case studies, and by work experiences such as co-op and internships. All these skills are developed further with on-the-job experiences.

2. Entrepreneurial skills and business knowledge

It is essential for engineers who have the energy, creativity and desire to take an innovative idea from a conceptual stage to an implementation stage in the form of a viable enterprise, commercial or otherwise. This process has created many successful organizations and has been the main driver for economic growth and wealth creation in recent years. It is thus essential for practising engineers to acquire the skills necessary to form an enterprise, to secure the necessary financial and human resources to launch the enterprise and to ensure its success in the first few critical years of its life. This knowledge can be attained through special courses, or modules taught within courses, in the engineering curriculum. Engineering programs should also be encouraged to launch a series of seminars and meetings on a regular basis that feature speakers and participants with a strong track record of achievements as entrepreneurs in various engineering disciplines.

3. Leadership attributes and abilities

In recent years, engineers have shown considerable enthusiasm for assuming leadership roles in their organizations. In the process, they accepted the responsibilities associated with such roles. This trend is bound to continue and to expand as engineers enhance their awareness of the vital role they play in wealth creation in the new socio-economic order. It is thus essential to equip young engineers with the knowledge, skill and education that will enable them to assume leadership positions at some point in their professional careers. These skills include being able to organize, inspire and empower their subordinates and co-workers, being good listeners and keeping an open mind in order to promote the generation and flow of creative and innovative ideas. Learning such skills can begin with their undergraduate education through participation in many of the activities of the engineering students' societies. Later, on-the-job training and special advanced seminars and workshops can be utilized to enhance such leadership skills.

4. Social, global and political awareness

Engineers must be constantly aware that their profession exists and functions in a wider social, global and political context. To be effective and most productive, engineers must possess full knowledge of this wider context and the impact it has on their profession. In practice, all engineering disciplines are affected by legislative, regulatory and standardization activities, both national and international. It is important for engineers to understand how such organizations function, and to have the necessary skills to participate in their activities and influence their direction. This knowledge can be imparted to engineering students as material within various engineering courses, as well as in the humanities and social science component of the curriculum. Practising engineers should be encouraged to participate at some point in their careers in the activities of one or more of such organizations and expand their horizons.

5. Management of a project/enterprise in an environment characterized by change

Management skills include the essential aspects of project/product planning, resource allocations, management of personnel, project lifecycle phases, implementation and testing, validation and verification, configuration management and product deployment. It is essential for engineers to learn the methodologies associated with management practices and the tools available for project/product management. Furthermore, it is crucial for engineers to learn how to adapt and apply management methods and practices in environments that are increasingly characterized by rapid changes in technology, markets, and other social and economic factors. Basic engineering management knowledge is taught in most undergraduate engineering curricula. Advanced training courses, seminars and workshops are provided to engineers as part of on-the-job training. Senior engineers have the opportunity to gain knowledge on strategic and corporate management aspects later in their careers.

6. Communications skills

It is essential for engineers to acquire the necessary skills for communicating their ideas, views and proposed plans effectively in many forums and to different constituencies, including for example, other engineers, corporate executives or the public at large. Communicating ideas, views and specific proposals may be done in many forms, such as formal oral and written presentations, informal discussions, publication of position papers, public speeches, media interviews, etc. Evidence has constantly demonstrated that advanced communication skills enable engineers to be more effective and influential. They are also widely regarded as major success factors in an engineering career. Imparting communication skills is a requirement in accredited engineering programs in Canada. Engineers should be advised to work on enhancing and honing such skills throughout their careers through practice and attending advanced training sessions.

Engineering Institute of Canada Session

THE ROLE OF THE ENGINEERING INSTITUTE OF CANADA

John Plant, P.Eng., EIC Executive Director

The EIC is a federation of national Canadian technical societies whose combined membership is approximately 35,000 engineers, geoscientists and engineering technologists. The member societies are: The Canadian Society for Chemical Engineering; The Canadian Society for Civil Engineering, The Institute of Electrical and Electronics Engineers Canada; The Canadian Society for Engineering Management; The Canadian Geotechnical Society; the Canadian Society for Mechanical Engineering; and The Canadian Medical and Biological Engineering Society. The Canadian Nuclear Society and the Canadian Chapter of the International Association for Ocean Engineering appear to be close to joining. The EIC Life Members Organization provides support for student activities and engineering research. The Institute enjoys the support of 56 industrial sustaining members and partnerships with 32 educational institutions–both public and private.

Through the EIC, the member societies collaborate in areas of mutual interest:

- continuing education and professional development;
- communication with educational institutions and industry;
- the good image of the profession;
- recognition of individual merit (honours, awards and fellows); and
- awareness of the history of the profession.

The EIC represents its member societies at:

- joint meetings of the Canadian Council of Professional Engineers (CCPE), Association of Consulting Engineers of Canada (ACEC), Canadian Academy of Engineering (CAE) and EIC;
- PAGSE: The Parliamentary Advisory Group on Science and Engineering;
- IACEE: The International Association of Continuing Engineering Education;
- IACET: The International Association of Continuing Education and Training; and
- ad hoc events such as, for example, the PEO 2020 Engineering Forum.

The EIC maintains:

- a website with links to its member societies, its education institutional partners, its industrial sustaining members and practically all engineering associations;
- an administrative office providing communication, insurance and workshop organization services to the members;
- a standards compliance service in continuing education;
- electronic registry for continuing education and professional development activities; and
- Engineering History and Archives, and Honours, Awards and Fellows committees.

Sustaining Members of the EIC (2001)

Sustaining members provide approximately 40 per cent of the Institute's cash flow through donations that depend on the number of engineers employed in the company. They are featured on the EIC website, where they may indicate they are looking for new engineering employees. Their employees may use the professional development registry free of charge.

ABB Asea Brown Boveri Inc.
Ainley Group
Bechtel Canada Co.
Bell Canada
Bombardier Aéronautique
Bombardier Inc.
Cameco Corporation
Campbell Woodall and Associates
CANAC Inc.
Canam Manac Group
CITO
Cogeco Inc.
CRS Robotics Corporation
Cruickshank Construction Kingston
Delcan Corporation
Dessau-Soprin Inc.
Dillon Consulting
DY4 Systems Inc.
Enbridge Pipelines Inc.
Geo-Canada Ltd.
Golder Associates Ltd.
Graeme Murray Consultants Ltd.
Great Lakes Power Limited
Hatch Associates Ltd.
Honeywell Limited
IMC Global Inc.
IMC Kalium Canada Ltd.
Imperial Tobacco Canada Limited
Ingersoll-Rand Canada Inc.
Inland Cement Limited
IPSCO Inc.
J. D. Mollard And Associates Ltd.
John Deere Limited Welland Works
Klohn Crippen Consultants Ltd.
Kruger Inc.
Maritime Electric
NSERC
Pratt & Whitney Canada
QIT-Fer et Titane Inc.
Reid Crowther & Partners
Ron Eng. & Const. (Eastern) Ltd.
SC Infrastructure Inc.
Société canadienne de Métaux Reynolds

Spriet Associates
St. Lawrence Seaway Management Corporation
Syncrude Canada
TAI Reinforced Earth Company Ltd.
Telesat Canada
Tembec Inc.
Thurber Management Ltd.
Toyota Canada Inc.
Trans Mountain Pipe Line Company Ltd.
Yoneda & Associates

Participating Partners with the EIC

(Providers of continuing education that award the EIC Continuing Education Unit [CEU])

Acadia University
Advanced Technology Education Consortium
Canadian Wood Council
Concordia University
CSA International
Daltech Dalhousie University
École Polytechnique
EPIC Educational Programs Innovations Center
George Brown College
Global Educational & Consulting Services
Golder Associates Ltd.
HEC École des Hautes Études Commerciales
JOT Inc.
Kadon Electro Mechanical Services
McMaster University
Okanagan University College
Royal Military College
Ryerson Polytechnic University
St. Clair College
Simon Fraser University
Skills For You
Southern Alberta Institute of Technology
Technical University of British Columbia
Université de Sherbrooke
University of British Columbia
University of Calgary
University of Manitoba
University of New Brunswick
University of Ottawa
University of Saskatchewan
University of Toronto
University of Victoria

Participating partners are providers of continuing education and professional development that commit to the standards promoted by the EIC. They pay a membership fee and may use the EIC logo as a standard of their commitment. They award EIC CEUs for their continuing education courses.

Activities Relating to the Member Societies

Through the EIC, the member societies collaborate in areas of mutual interest:

- continuing education and professional development;
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Representation Roles

The EIC represents its member societies at:

- Joint meetings of the CCPE, ACEC, CAE and EIC;
- PAGSE; The Parliamentary Advisory Group on Science and Engineering;
- IACEE: The International Association of Continuing Engineering Education;
- IACET: The International Association of Continuing Education and Training;
- Ad hoc events such as, for example, the PEO 2020 Engineering Forum and the World Congress on Continuing Engineering Education.

Activities Maintained by the EIC

- a website with links to its member societies, its education institutional partners, its industrial sustaining members and practically all engineering associations;
- an administrative office providing communication, director's insurance and workshop and meeting organization services to the members;
- standards compliance in continuing education;
- an electronic registry for continuing education and professional development activities (15,000 course registrations);
- Engineering History and Archives Committee; and
- Honours, Awards and Fellows Program.

Trends

- Technical societies in Canada face increasing competition with American equivalents.
- Education is increasingly seen as the principal factor in international competition.
- It is increasingly understood that engineers need soft skills as well as technical (hard) skills (conflicts with needs for increased specialization).
- Global competition is creating demand for:
    - evidence of competence (education, professional development and experience),
    - accreditation,
    - evidence of standards.

Personal Recommendations

1. The various organizations that comprise the engineering profession should recognize clearly defined niches for each and strongly support each other.
2. The philosophy that an engineering career is one of lifelong learning should be reinforced.
3. Engineering schools should be encouraged to differentiate more, some following the Canadian Academy of Engineering model of a less specialized, broader based B.Eng. that includes soft skills development and others that provide a high degree of technical specialization.

MEANS OF ACQUIRING SKILLS

Prof. Andre Rollin, ing., EIC Past President

ABSTRACT

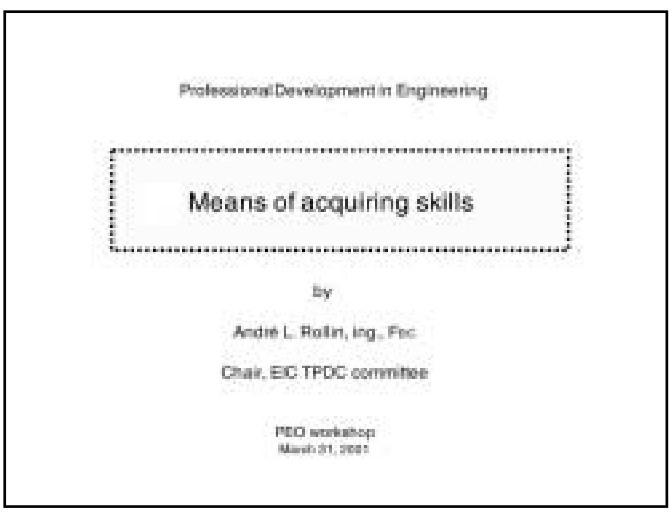
Today, corporations are relying more and more on employees with technical and management skills. Organizations that must respond quickly and effectively to global markets are modifying their approach to professional development – as are the engineers they employ. A few of the new trends are learning on demand, onsite training and distance education, and a tendency to shift away from conventional university credit programs. The present wave in industrial needs is related to project management, communications, teamwork, knowledge transfer, certification and others. The next wave is related to fuzzy thinking, value thinking, process thinking and lean thinking. Another factor shaping the lifelong learning activities of engineers is increased public interest in the accountability and skills of licensed professionals. Although learning does not equal competence, it is a necessary condition for it. Thus, professional development with participation in learning activities has become the norm of responsible professional behaviour. In a growing number of jurisdictions in Canada and in the United States, it is a legal requirement and members are required to record and even to report their involvement.

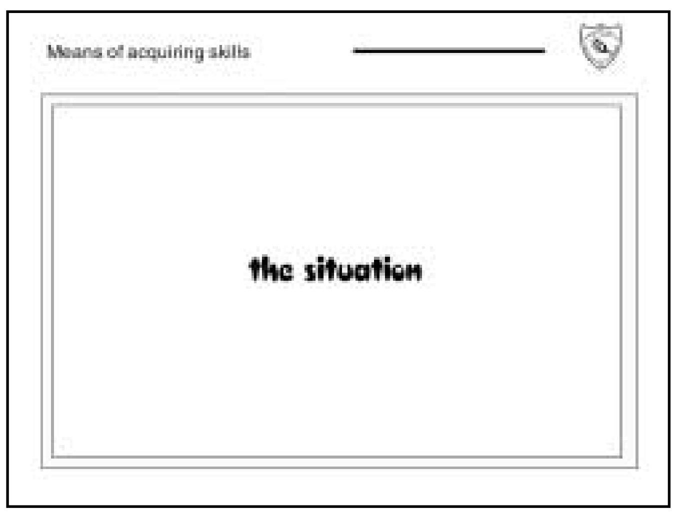
Lifelong learning activities are diverse and are generally categorized in "Continuing Education Activities (CEA)" and "Professional Development Activities". Continuing Education means learning activities meeting the standards introduced by the International Association of Continuing Education and Training (IACET). In Canada, EIC Continuing Education Unit (CEUEIC) has been adopted in some constituencies as a measure of participation. The CEUEIC is defined as "10 hours of participation in a continuing education program organized in compliance with the EIC standards under responsible sponsorship, capable direction and qualified instruction".

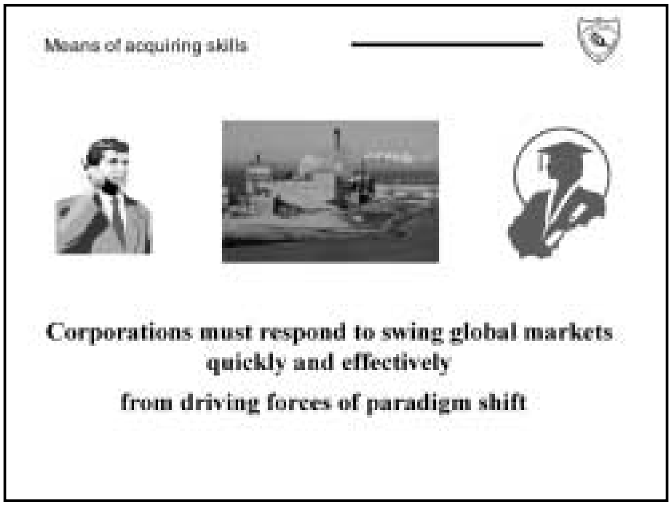
Professional Development Activities (PDA) include a relatively wide spectrum of activity recognized by most of the licensing bodies. A Professional Development Hour (PDH) is equivalent to the time spent participating to a non-certified development activity. The scale of recognition of PDHs varies from one province or state to another. Professional development activities can include such formal and informal learning activities as:

- attending corporate internal workshops and courses offered by equipment providers;
- attending external workshops, conferences, congresses and symposia;
- making presentations for seminars, courses and conferences;
- authoring technical articles, books, research reports and papers;
- attending meetings of technical or professional associations;
- mentoring junior engineers; and
- participation in audits, task groups, committees and review teams for codes and standards.

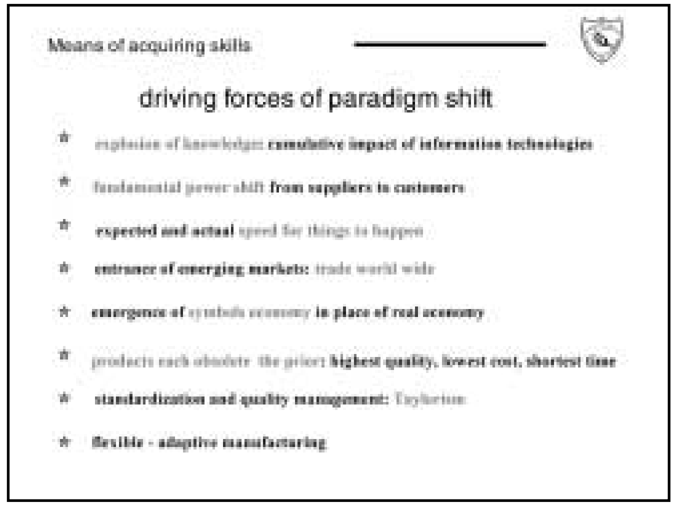
In 2020, engineers will advance in their careers by improving their skills and will contribute to the prosperity of their organization by being prepared to face the future reengineering of their corporation. Collectively, engineers can increase the public's esteem for the engineering profession by keeping their knowledge and skills current.



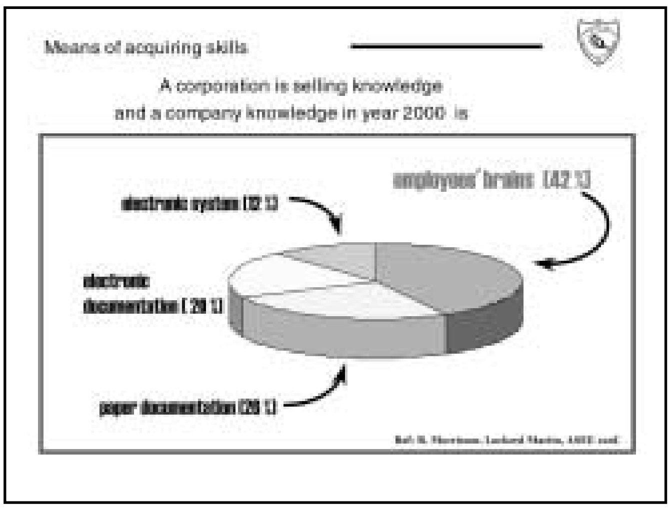




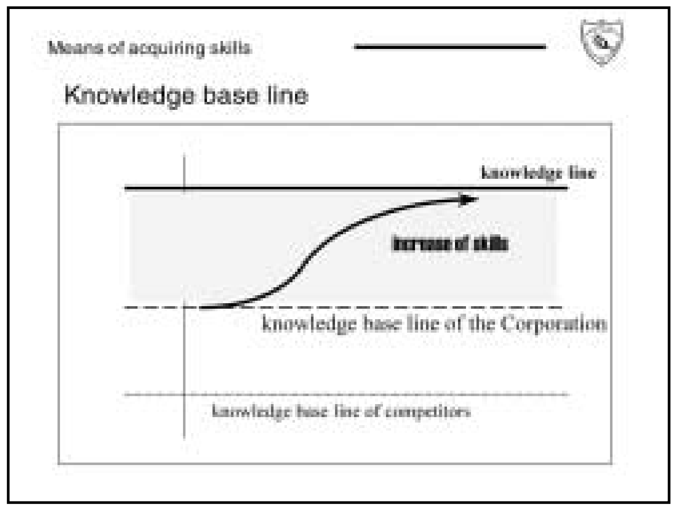
Means of acquiring skills
Corporations must respond to swing global markets quickly and effectively
from driving forces of paradigm shift



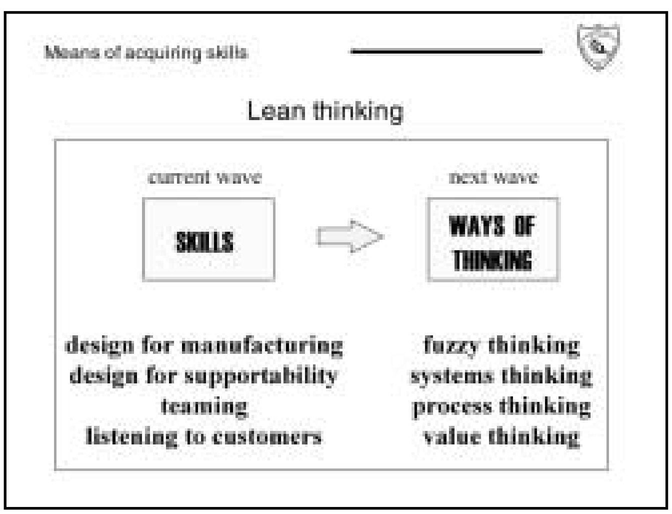
Means of acquiring skills
driving forces of paradigm shift
explosion of knowledge: cumulative impact of information technologies
fundamental power shift from suppliers to customers
expected and actual speed for things to happen
entrance of emerging markets: trade world wide
emergence of symbols economy in place of real economy
products each obsolete the prior: highest quality, lowest cost, shortest time
standardization and quality management: Taylorism
flexible - adaptive manufacturing



Means of acquiring skills
A corporation is selling knowledge
and a company knowledge in year 2000 is
employees' brains (42 %)
electronic system (12 %)
electronic documentation (20 %)
paper documentation (26 %)



Means of acquiring skills
Knowledge base line
knowledge line
increase of skills
knowledge base line of the Corporation
knowledge base line of competitors



Means of acquiring skills
Lean thinking
current wave
next wave
SKILLS
WAYS OF THINKING
design for manufacturing
design for supportability
teaming
listening to customers
fuzzy thinking
systems thinking
process thinking
value thinking

Means of acquiring skills
current areas of opportunity
computer-aided engineering: analysis, modeling, graphics
manufacturing automation: robots, numerically-controlled machine, integrated systems
management information systems: process control, manufacturing data bases
multifunctional global teams
skill development
communications

Means of acquiring skills

Top ten topics

1-	communication skills	43 %
2-	management (including ISO 9000)	42 %
3-	computer	42 %
4-	environment (including ISO 14000)	27 %
5-	communication technologies	21 %
6-	instrumentation	20 %
7-	law and regulations	19 %
8-	financial accounting	17 %
9-	construction and building	16 %
10-	hydraulic	12 %
	processes	12 %

Ref. surveys of Canadian Prof. Ass., year 1990

1- communication skills
2- leader skills
3- team work
4- legal & financial
5- motivation to self-educate

Ref. survey in USA, year 2000 (22 employers, 150 engineers) ASEE conf.

Means of acquiring skills

the future need - fuzzy thinking

THINK IN TERMS OF

- multiple scenarios
- uncertain outcomes
- weight risks and rewards
- range of possibilities
- value of an information

A commercial entreprise is a mechanism for converting risks (capital, time and reputation) to rewards (harvest a return on investment)

Means of acquiring skills

as a result - shifts in professional development

* learning on demand right now
* training on site with performance base evaluation
* decisions of C.E. taken at the project manager level
* continuing education is the responsibility of individual engineers
* learning at distance is available
* corporates are going away from conventional universities: two solitudes

Means of acquiring skills

responsibility of individual engineer

by obligations **by initiatives**

Means of acquiring skills

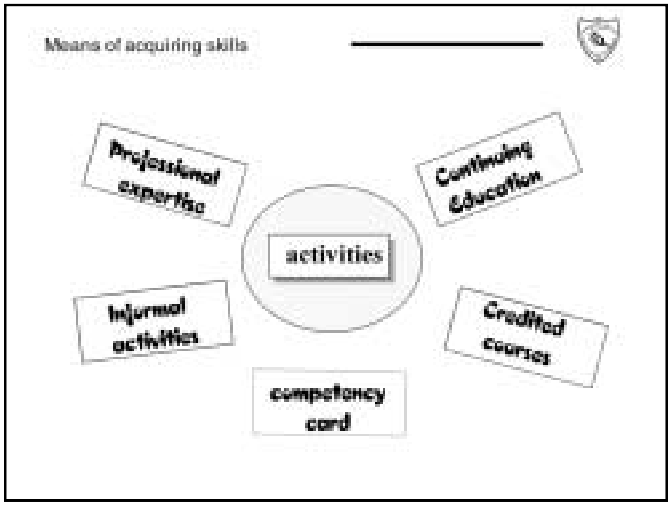
purpose of professional development

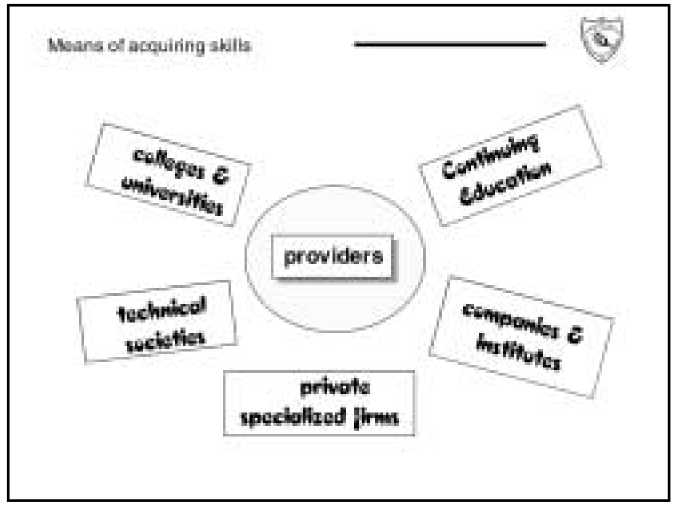
upgrading	62 %
interest	20 %
review	18 %

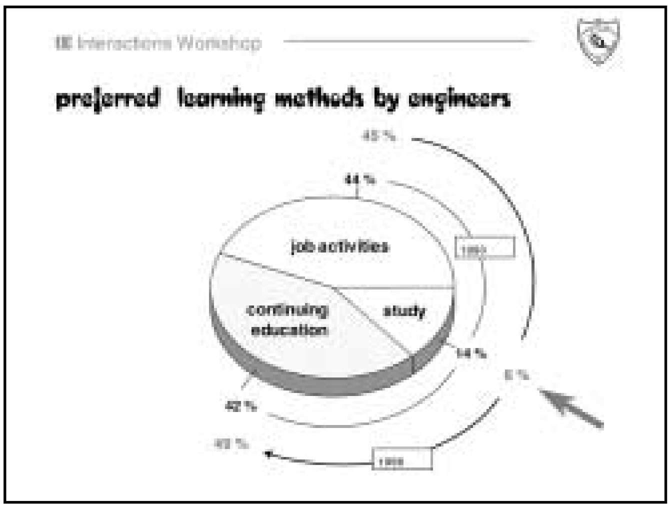
Means of acquiring skills

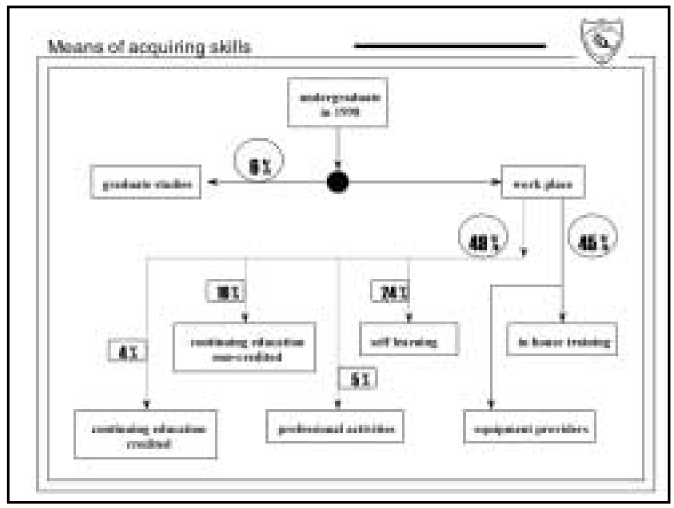
Preferred format

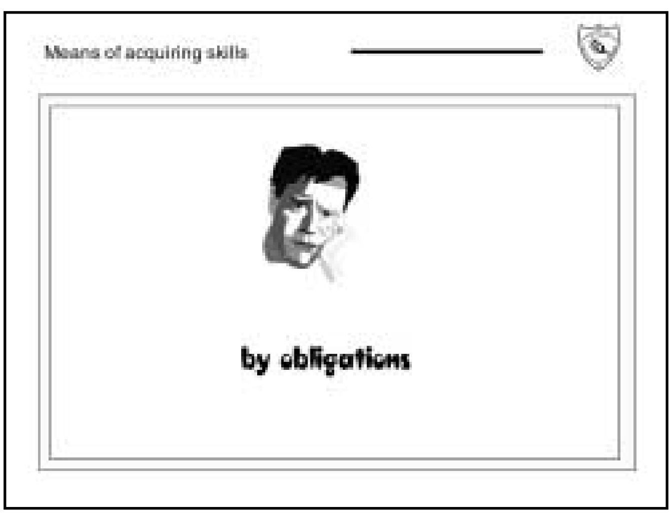
1-	weekday workshop	39 %
2-	evening course	21 %
3-	intensive retreat	20 %
4-	weekend activities	10 %
5-	others	10 %

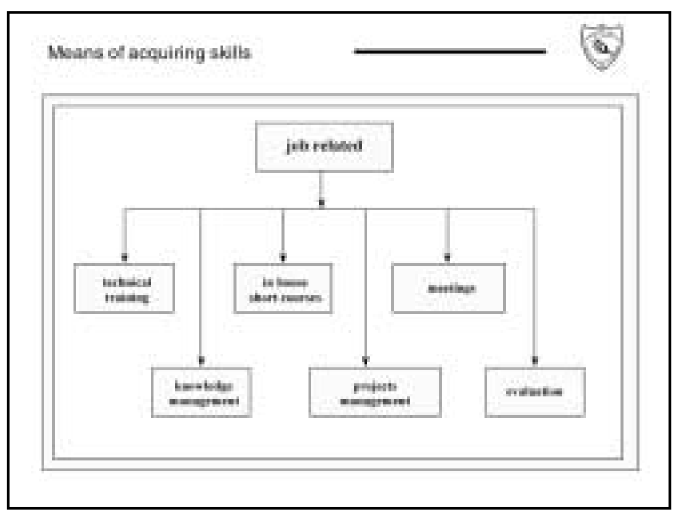

Means of acquiring skills
activities
Professional expertise
Continuing Education
Informal activities
Credited courses
competency card

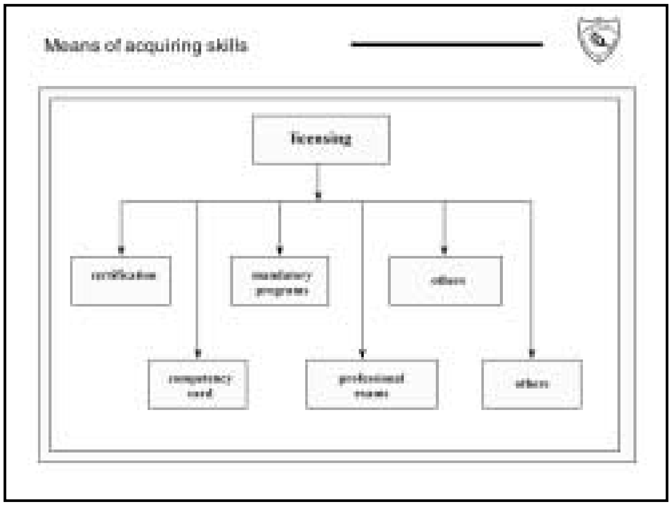

Means of acquiring skills
providers
colleges & universities
Continuing Education
technical societies
companies & institutes
private specialized firms

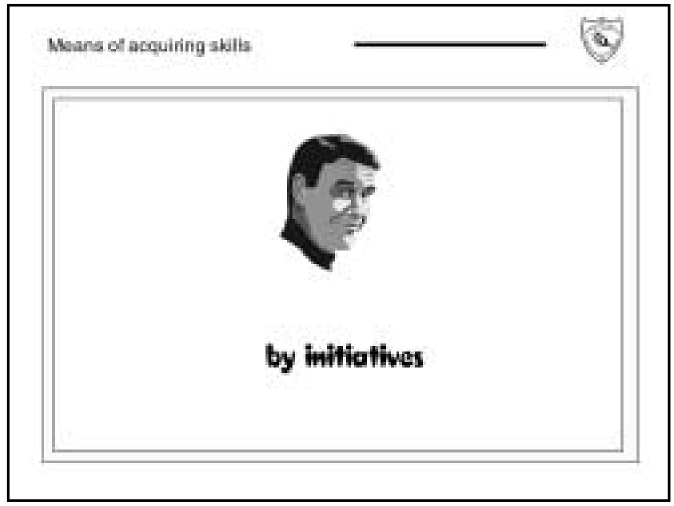

Interactions Workshop
preferred learning methods by engineers
45 %
44 %
job activities
continuing education
study
14 %
6 %
42 %

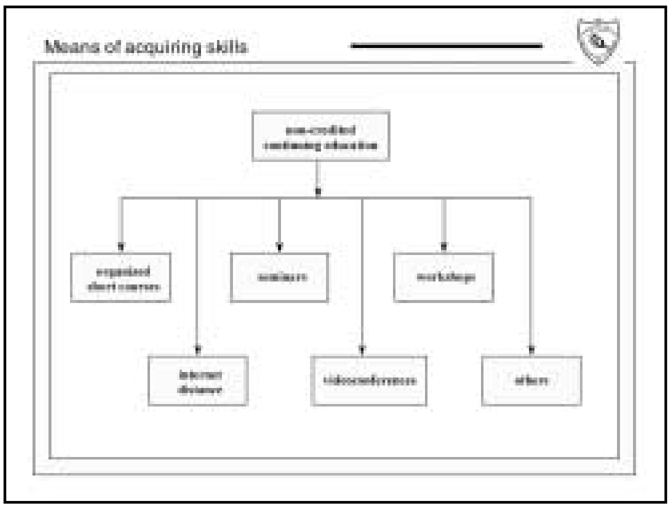

Means of acquiring skills
graduate studies
work place
6 %
48 %
46 %
18 %
24 %
4 %
5 %
continuing education non-credited
self learning
in house training
continuing education credited
professional activities
equipment providers

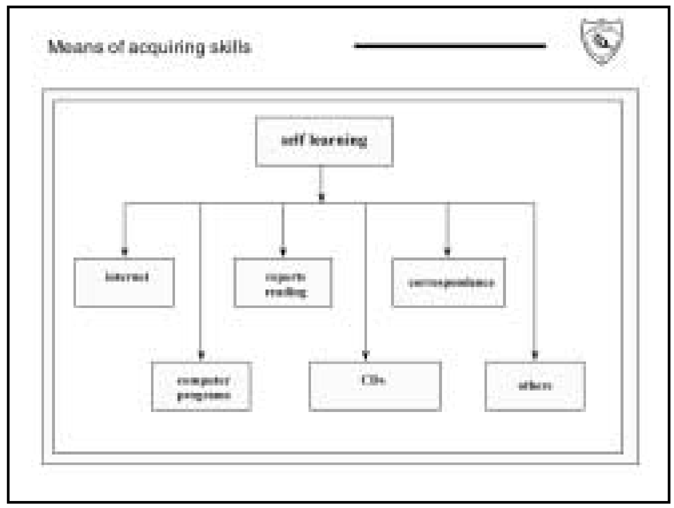

Means of acquiring skills
by obligations

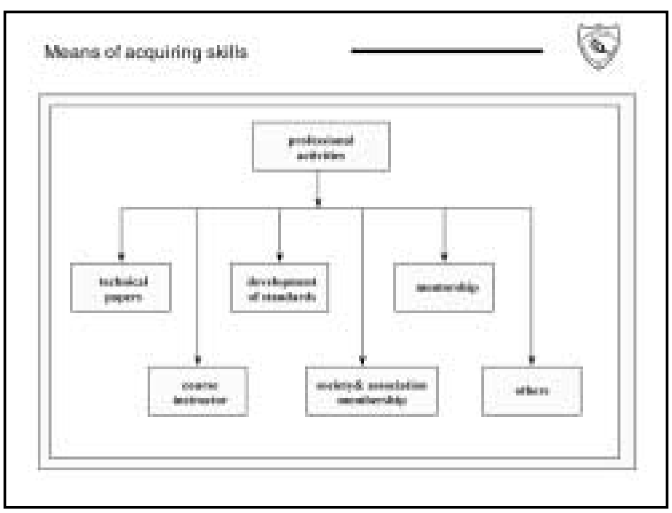

Means of acquiring skills
job related
technical training
in house short courses
meetings
knowledge management
projects management
evaluation

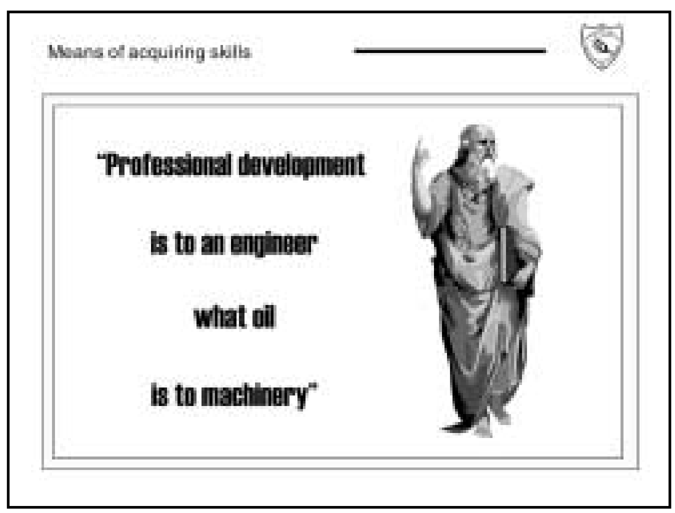

Means of acquiring skills
licensing
certification
mandatory programs
others
competency card
professional exams
others


Means of acquiring skills
by initiatives


Means of acquiring skills
non-credited continuing education
organized short courses
seminars
workshops
Internet distance
videoconferences
others


Means of acquiring skills
self learning
Internet
correspondence
computer programs
CDs
others


Means of acquiring skills
professional activities
technical papers
development of standards
mentorship
course instructor
society& association membership
others


Means of acquiring skills
"Professional development
is to an engineer
what oil
is to machinery"

ROLES OF THE TECHNICAL SOCIETIES

Bruno Di Stefano, P.Eng., member of the Executive of the Institute of Electrical and Electronics Engineers Canada

ABSTRACT

"The Roles of the Technical Societies are discussed through a presentation of the IEEE."[1]

"The IEEE (The Institute of Electrical and Electronics Engineers, Inc.) is a non-profit, technical professional association of more than 350,000 individual members in 150 countries."[2]

The IEEE and its predecessors, the AIEE (American Institute of Electrical Engineers) and the IRE (Institute of Radio Engineers), date to 1884. "The technological problems encountered in the design and operation of long submarine cables were much more sophisticated than those associated with land-line telegraphs that a new class of technical personnel gradually developed, consisting of men with substantial knowledge of electrical principles and techniques."[3] These professionals felt the need to create a body that would act as a forum to share technical information. They created the AIEE (American Institute of Electrical Engineers) in 1884.[4]

The IEEE mission is to "promote the engineering process of creating, developing, integrating, sharing, and applying knowledge about electro- and information-technologies and sciences for the benefit of humanity and the profession." Consistent with its mission, the IEEE focus has always been split into two main areas:[5]

1. advancement of science and technology[6]; and
2. support of members careers.

The IEEE encourages professional vitality through lifelong learning for its members by means of:

- international and local conferences, seminars and professional meetings for career development and networking;
- opportunities to develop leadership and other personal skills through volunteer activities;
- more than 300 continuing education and training programs;[7]
- career management tools resource materials; and
- financial services and portable benefit programs.

The IEEE creates a sense of family and a community of members, worldwide, by:

- an extensive network of IEEE Technical Societies, Sections, Chapters and Student Branches;
- serving as a vehicle to promote the industry and the profession;
- recognizing engineers' accomplishments through peer awards; and
- establishing cooperative agreements with other technical societies around the world.

The IEEE governance is organized around two orthogonal directions:

- Technical (TAB, Technical Activities Board);
- Regional (RAB, Regional Activities Board).

Elected, unpaid volunteers who are part of the profession and understand the needs of the members run both TAB and RAB and their sub-units.

The IEEE has evolved with technology and with the changing make-up of its members in relation to their professional profile, national and ethnic make-up, gender, etc. This continuing evolution has resulted in a society that responds to the changing needs of its members. However, the IEEE is not a self-serving organization focused only on the needs of its members. All of its activities are also targeted to the benefit of humankind, to the protection of the public, and to promoting scientific and technological literacy of the public at large.

Consistent with its past, the IEEE will continue evolving with the times, and with the needs and expectations of society at large and of its members.

1 Official information about The IEEE, its Constitution, its Bylaws, its Code of Ethics, and more can be found at the following web pages and their sub-pages:
http://www.ieee.org/
http://www.ieee.org/about/
http://www.ieee.org/about/whatis/
http://www.ieee.org/about/whatis/constitution.html
http://www.ieee.org/about/whatis/bylaws/index.html
http://www.ieee.org/about/whatis/code.html

2 http://www.ieee.org/about/whatis/

3 Robert A. Chipman, "Theory and problems of Transmission Lines", " 1968 McGraw Hill Book Company

4 "The world's first professional association of electrical engineers was the Society of Telegraph Engineers, founded in England in 1871, and most of its charter members were submarine telegraph engineers." ... "The Society ... became the present-day Institution of Electrical Engineers (IEE) in 1889". (See footnote 3)

5 "From its earliest origins, the IEEE has advanced the theory and application of electro-technology and allied sciences, served as a catalyst for technological innovation and supported the needs of its members through a wide variety of programs and services."[2]

6 "Through its members, the IEEE is a leading authority in technical areas ranging from computer engineering, biomedical technology and telecommunications, to electric power, aerospace and consumer electronics, among others."[2] "Through its technical publishing, conferences and consensus-based standards activities, the IEEE produces 30 per cent of the world's published literature in electrical engineering, computers and control technology, holds annually more than 300 major conferences and has more than 800 active standards, with 700 under development."[2]

7 These 300 courses are available to all members world-wide. At the local level, the IEEE Sections organize a very large number of courses, seminars, workshops, and other forms of continuing education.

The Role Of Technical Societies

Bruno Di Stefano, P.Eng.
b.distefano@ieee.org

IEEE

Networking the World™

The Institute of Electrical and Electronics Engineers, Inc.

IEEE: Networking the World

- Foster technological innovation
- Enable members' careers
- Promote community worldwide
- World's largest technical professional society
- More than 350,000 members in 183 countries.

IEEE members have advanced the profession, and develop technologies that benefit humanity.

Fostering Technological Innovation

IEEE produces nearly 30% of the world's literature on electrical engineering, electronics & computing.

- A publishing program of periodicals, books, standards, conference proceedings, electronic products & mixed media
- Over 300 annual IEEE conferences
- Over 700 standards development groups
- 36 Technical Societies & 2 Technical Councils

Enabling Members' Careers

IEEE encourages professional vitality through life-long learning for its members.

- International & local conferences, seminars & professional meetings for career development & networking
- Opportunities to develop leadership & other personal skills through volunteer activities
- More than 300 continuing education & training programs
- Career management tools & resource materials
- Financial services & portable benefit programs

Promote Community Worldwide

IEEE creates a sense of family & a community of members worldwide by:

- Extensive network of IEEE Societies, Sections, Chapters & Student Branches
- Serving as a vehicle to promote the industry & the profession
- Recognizing engineers' accomplishments through peer awards
- Establishing cooperative agreements with other technical societies around the world

IEEE Vision

To advance global prosperity by fostering technological innovation, enabling members' careers & promoting community world-wide.

February 2000

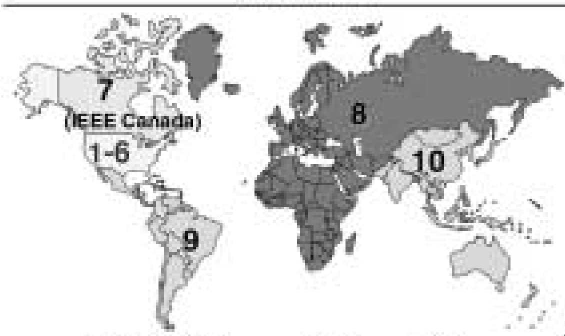
IEEE Mission

The IEEE promotes the engineering process of creating, developing, integrating, sharing, & applying knowledge about electro- and information-technologies & sciences for the benefit of humanity & the profession.

February 2000

IEEE Membership By Regions

31 December 1999

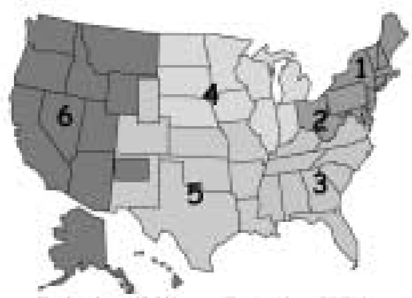


Regions 1-6	228,332	Region 9	13,532
Region 7	14,897	Region 10	50,766
Region 8	44,732		
WORLD TOTAL		352,259	

February 2000

IEEE Membership By U.S. Regions

31 December 1999



Region 1	43,546	Region 4	25,714
Region 2	35,200	Region 5	31,213
Region 3	31,149	Region 6	61,490

TOTAL 228,332

February 2000

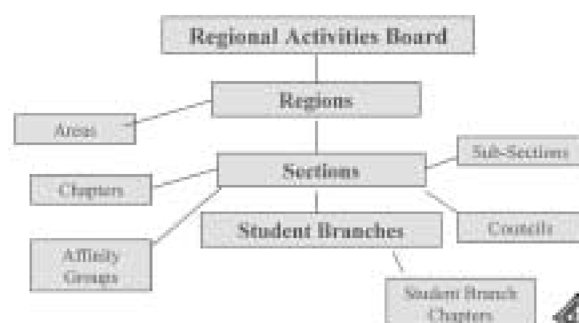
Geographic Units

31 December 1999

Regions	10
Areas (in some Regions)	28
Councils (in some Regions)	21
Sections	297
Subsections (in some Sections)	51
Society Chapters (in some Sections/Councils)	1,183
Student Branches	1,033
Student Branch Chapters	258
Total Geographical Units	2,881

February 2000

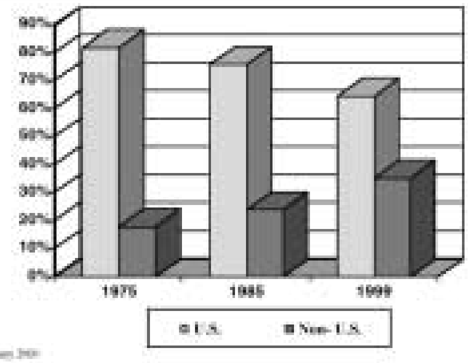
Regional Structure



February 2000

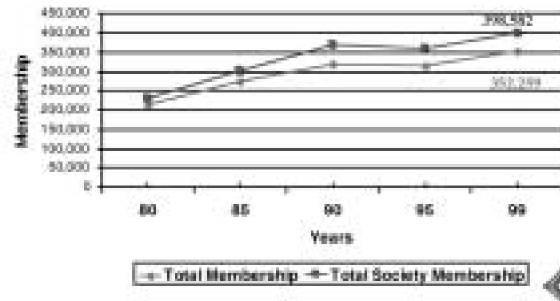
Worldwide IEEE Membership

31 December 1999



IEEE Membership Growth

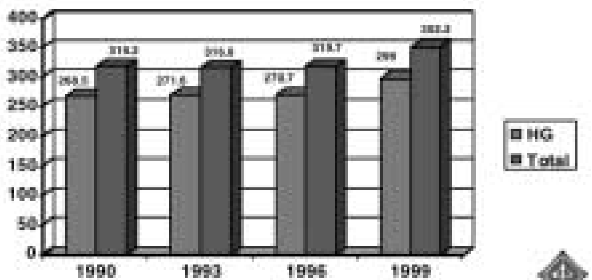
1980-1999



Membership Trends

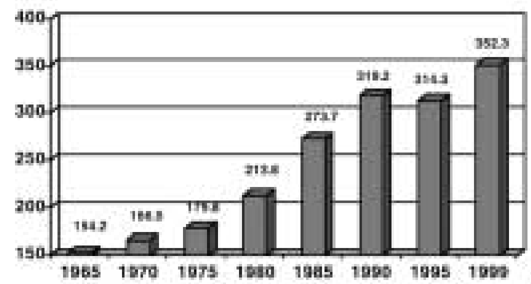
Higher Grade and Total from 1990 - 1999

(in thousands)



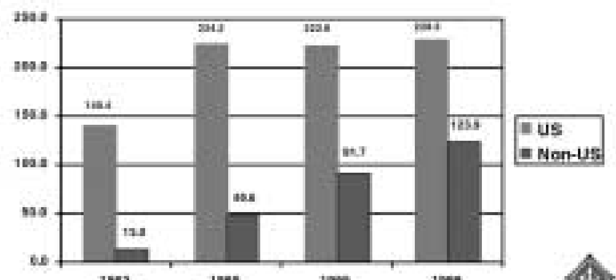
Long-Term Membership Trends

1965 - 1999 (in thousands)



Long-Term Membership Trends

US versus Non-US (1963 - 1999)



IEEE Membership in Regions 1-6 (U.S.)

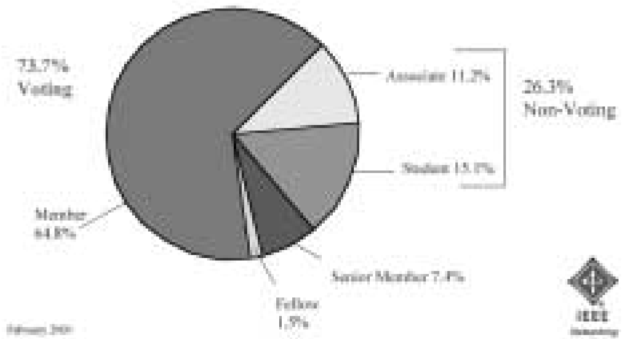
Region	1999 Total	1998 Total	Growth %
1	43,546	43,070	1.1
2	35,200	34,575	1.8
3	31,169	30,748	1.34
4	25,714	25,358	1.4
5	31,213	31,128	.027
6	61,490	59,719	2.96
1-6 Total	228,332	224,598	1.66

IEEE Membership in Regions 7-10

Region	1999 Total	1998 Total	Growth %
7	14,897	14,699	1.34
8	44,732	40,361	10.82
9	13,532	12,049	12.3
10	50,766	43,104	17.78
7-10 Total	**123,927**	**110,213**	**12.44**

IEEE Membership by Grade

31 December 1999



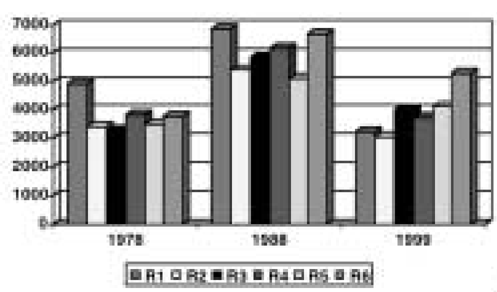
IEEE Voting Member Comparison

	1999 Total	1998 Total	Growth %
Honorary	21	22	-4.5
Fellow	5,318	5,183	2.6
Sr Member	26,017	25,439	2.3
Member	228,150	222,252	2.7
Total	**259,506**	**252,896**	**2.6%**

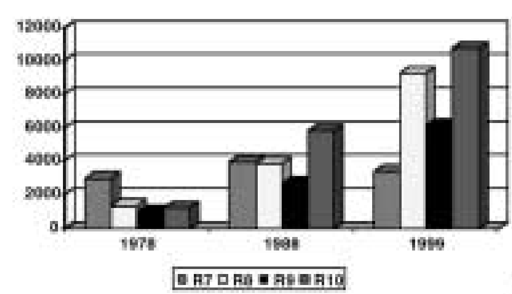
IEEE Student Membership

Region	1999 Total	1998 Total	Growth %
1	3,251	2,249	44%
2	3,069	3,023	1.5
3	4,036	4,174	-3.3
4	3,759	3,811	-1.4
5	4,153	4,534	-8.4
6	5,316	4,073	30.5
7	3,416	3,169	7.8
8	9,293	8,068	15.2
9	6,194	5,369	15.4
10	10,783	8,925	20.8
Total	**53,270**	**49,395**	**7.8%**

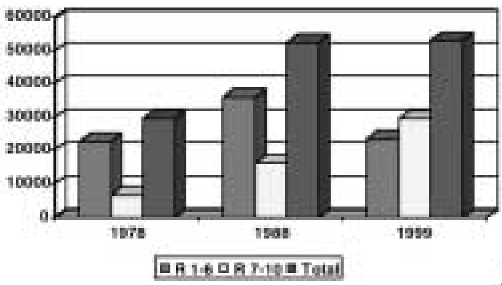
IEEE Student Membership (R1-6)



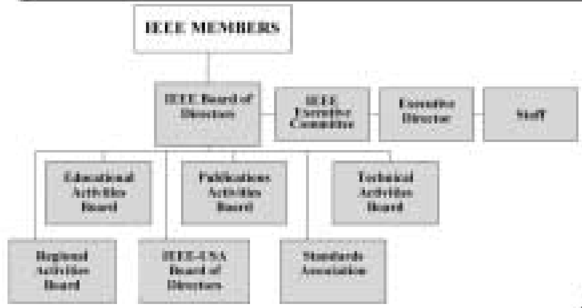
IEEE Student Membership (R7-10)



Total IEEE Student Membership



IEEE Organization



Career & Educational Activities

Enabling Careers through Life-long Learning

- Continuing education programs organized by Sections can be tailored for local membership needs.
- These activities are most important, since they are planned by members & cater directly to member needs.
- *Section Education Chair's Guide to Planning Successful Educational Programs* provides guidelines for organizing continuing education activities.

http://www.ieee.org/organizations/eab/

IEEE Publications

- World's leading publisher in Electrical and Computer Science
- *Spectrum* Magazine - award winning monthly publication
- The INSTITUTE - news supplement to Spectrum
- IEEE *Potentials* Magazine - quarterly magazine for student and recent graduate members
- OPeRA (Online Periodicals Research Area) - search, browse selected IEEE Transactions & Journal to members of participating technical societies
- IEEE/IEE Electronic Library (IEL) - 32% of world's current literature in electrical engineering and computer science.

http://www.ieee.org/organizations/pubs/pubs.html

IEEE Conferences

350,000 Participants at 300 meetings & conferences worldwide:

- Region Conferences
- International Conferences
- Symposiums
- Workshops
- Tutorials

http://www.ieee.org/organizations/tab/conflink.html

IEEE Standards Association

- IEEE-SA formed in 1996
- World leader in the development and dissemination of voluntary, consensus-based industry standards involving today's leading-edge electrotechnologies
  - ✓ More than 800 active standards
  - ✓ 30,000 volunteers in standards working groups
- Supports international standardization and encourages the development of globally accepted standards
- Individual and corporate membership available

http://standards.ieee.org/


IEEE Awards & Recognition
Peer recognition to individuals whose contributions to the art and science of electro- and information technologies world-wide have improved the quality of daily life
Medal of Honor/IEEE Medals
IEEE Fellows
Technical Field Awards
Honorary Membership
Service Awards
Corporate Recognition
Prize Paper Awards
Society & Conference Awards
Public Service & Professional Recognition
Geographic Unit Awards
http://www.ieee.org/about/awards/
IEEE


IEEE Technical Societies
Aerospace & Electronic Systems
Antennas & Propagation
Broadcast Technology
Circuits & Systems
Communications
Components, Packaging, & Manufacturing Technology
Computer
Consumer Electronics
Control Systems
Dielectrics & Electrical Insulation
Education
Electromagnetic Compatibility
Electron Devices
Engineering in Medicine & Biology
Engineering Management
Geoscience & Remote Sensing
Industrial Electronics
Industry Applications
Information Theory
Instrumentation & Measurement
Lasers & Electro-Optics
Magnetics
Microwave Theory & Techniques
Nuclear & Plasma Sciences
Oceanic Engineering
Power Electronics
Power Engineering
Professional Communication
Reliability
Robotics & Automation
Signal Processing
Social Implications of Technology
Solid-State Circuits
Systems, Man, & Cybernetics
Ultrasonics, Ferroelectrics, & Frequency Control
Vehicular Technology
IEEE

Ontario Society of Professional Engineers Session

COMMENTS FROM THE ONTARIO SOCIETY OF PROFESSIONAL ENGINEERS' (OSPE'S) MEMBERS' FORUM

Paul Martin, P.Eng.

ABSTRACT

Selected comments from OSPE's and PEO's web-based Members' Forums related to the 2020 Vision exercise will be presented.

The members' views range widely over various issues related to the future of the profession; these topics include: visions of engineering work altered by technological advancement, changes to the nature of firms and the work environment, developing trends in education, recruitment, labour standards, fees, advocacy and other factors affecting engineering work, emerging areas of practice, and many other topics.

The actual postings reviewed will be selected from the most interesting and topical present on these forums at the latest date possible prior to the presentation. The members' comments will be presented as a window into what we as a profession-at-large predict about our future, and what we hope can be accomplished by our regulatory and advocacy organizations on our behalf.

OSPE is Ontario's new advocacy and member services association for engineers. As part of PEO's 2020 Engineering Forum, OSPE created a moderated Member's Forum on this topic. My presentation is merely a re-statement of the comments of OSPE's membership, with some of my own views added. You can read the members' comments yourself by visiting the OSPE website at www.ospe.on.ca .

Futurist Views

Some members leapt forward and made projections of what our tools, our work environments and our work relationships might look like in 2020. One such comment is given below:

Posted by: William (Bill) D. Conning on 8/3/2001 6:46:53 PM

"Computer on! ... and your day begins in your home office.
"Panel 1 on! ... and you sit down before a 3'x 5' digital video panel. Beside you is an array of two more video panels.
"Check mail! ... and your mail list comes up as you put the heads-up optical headset on.
"Connect me with Roger, Paul, Maria, and Suzanne! ... and they appear on screen.
You begin your conference and discuss design parameters, budget, potential consulting partners, next steps and priorities and arrange to block time to meet again in two days at an appointed time.
"You optically upload the meeting notes (that were voice typed as the meeting progressed) to your Palm XX Digital Communicator/Portable Virtual Office, and leave for the client meeting. No brief case ... no roll of drawings ... only your 5000GB Palm XX.

"When you return to your office, you give the computer the command to 'view activity' and all those at work stations without their privacy or out-of-office feature activated appear as an array on screen. You decide to visit with Darlene in HR.

"Then you 'Resume Project ##' and panels 1, 2, and 3 show the current stages of work. You decide to reconfirm land contours by submitting a satellite survey request, and giving the GPS coordinates of the construction area. You select 'filter out all structures' and send the request that will be completed within the next 30 minutes.

"The interpersonal challenges you face are those associated with social isolation. Virtual meetings account for most of the interaction time. Design work is done alone or via virtual collaboration. You have a feeling that society is becoming less and less personal and it bothers you.

"Computer off! And your workday ends".

Extrapolated Visions

Unlike the post given above, most engineers were unwilling to make the leap to the future. Rather, they identified present trends and attempted to extrapolate them to the future. In the futurist post above, and in the extrapolated visions the majority gave, a number of themes were evident:

1. Problems Resulting With the Use of New Tools

Technological advance often outstrips our human abilities to cope. No doubt, it takes a while for any profession to adapt to new tools—even the profession responsible for designing and building the tools. We're not afraid of our tools; we embrace them, as they can reduce the tediousness of our work, allowing us to focus our attention on the larger issues. That being said, many engineers fear that the increases in productivity expected from the use of these tools raises productivity expectations rather than giving more time to look after the "big picture", effectively giving them less time to complete their tasks, forcing them to trust their new tools before they're ready to do so.

There is also some fear that we may automate ourselves out of a job by means of creating engineering "expert systems". Rather than these being used as tools for engineering productivity improvement, engineers fear that they will be used to allow non-engineers to carry out engineering tasks in an increasingly unregulated environment.

2. The Rise of Abstraction

The tools of abstraction (computers, telecommunications equipment, etc.) are taking us farther from one another and farther from the physical reality of our work. Some members caution us to remember that we are applied scientists, and our grounding in physical reality, ability to use well-calibrated commonsense, and the need for practical rather than theoretical solutions is our strong point. We lose this at our peril.

3. Collaboration Across Geography and Company Borders

The advances in telecommunications make it conceivable for us to leave behind our conventional notions of company, country and the like. We can reach out to the world from our own homes, collaborating with colleagues from other nations and other disciplines in a seamless way. Perhaps groups of independent engineers will coalesce around projects, rather than working strictly as employees. This may bring benefits, but may also bring social isolation.

4. Changes in Trade, Economic and Regulatory/Legal Relationships

Members expressed concerns related to globalization, sustainable development, changes in recruitment patterns, changes in how clients expect design/construction projects carried out, changes to labour laws, the loss of loyalty in relationships between engineers and employers and vice versa, and numerous other topics.

Some engineers view the disparity between compensation levels and responsibility level between engineers working in traditional fields and unregulated practitioners working in the information technology field to be a striking trend. Engineers are leaping across this divide in increasing numbers, and unless the lot of the average engineer improves in the near future, this trend can be expected to continue.

Some posts touching on these themes are given below:

Posted by: Ahmed Bashir on 3/25/2001 4:49:38 AM

"There will be more accidents caused by software because more and more requirements in products, systems and networks will be allocated to software. More systems will be commissioned with large software component and critical interfaces. A greater reliance will be put on such automation systems to perform critical tasks.

"Not enough engineers will be trained in the application of software hazard analysis. Regulatory agencies like OSPE ought to look into standards like MIL-STD-882-B, Notice 1, and ensure this vital engineering discipline moves from a specialty to common practice.

"There must be (free) training provided to practising engineers. It is believed that Dr. Dave Parnas of McMaster University would be an excellent resource."

Posted by: Andrew Bobkowicz on 8/3/2001 8:45:37 PM

"Good ENGINEERING is practised when you walk about, visit the shop or manufacturing floor where all the action is, where you should see your input (by computer or ordering others) in action. Use ALL your God-given senses! Observe and let that input guide you, and all the new tools at your disposal, on what you want to see happen next to improve things even more. Now and in the future, that is engineering in action."

Posted by: John W Baxter on 8/3/2001 6:26:42 PM

"Engineering problem solving will be almost totally computer-based. It is important that we start now to ensure that our future engineers are not totally reliant on computers for problem solving. I believe that the engineering undergraduate degree must include at least one full course of logical problem solving. We must never lose the importance of the human input."

Posted by: Bob Goodings on 3/22/2001 11:24:45 AM

"The consulting engineering business is being driven by the client. Only big firms can afford to put in proposals on many of the projects on the market today. Many are DESIGN/BUILD with partners that include contractors, suppliers, financial planners, venture capital, banks and other lending institutions. They all are important—but remember they cannot even start until the professional engineer puts the scheme together so they can then do their specialty.

"Unfortunately the engineer is rarely the chief earner or team leader, but is a key risk taker. The money finders are the best paid.

"All this needs clever professional engineers and big pockets. The little firm of the past is not able to participate in these big projects as a leader. There is lots of room for niche engineering. That's why this change is not all so gloomy."

Posted by Rene Caskanette on 9/3/2001 3:52:06 PM

"In the consulting environment the trends get bigger and go global. Consolidation can only go so far, and there will be no more small firms left, only the big guys. If you are a partner, you get rich. But who wants to do the work at the bottom for low pay with no job security? When the work drops off, the engineers are laid off. Consulting firms are having recruiting and retension problems and it should not be surprising. New graduates can get a more secure and higher paid position with an IT company, and learn the skills necessary to spin off and start a new company if and when that time comes.

"The larger companies have to commit to employees so they have a stable work environment, if there is to be any long term improvement. Without this, the quality of work will suffer as the best engineers go into other jobs. Can this happen when shareholders need their return on investment?

"It would be nice to see small companies network and form teams which could compete with the big guys, in the virtual corporation model. Small companies are more employee-friendly, and more flexible in terms of client service.

"I'm not sure how consulting firms will evolve, but technology will play a key role. Virtual offices can network and exchange information quickly and efficiently, opening the door for more collaboration. "Someone still has to make the client contact and secure the job, but this may become a specialty, with the sales firm managing the project and parceling out the work to smaller firms to perform the various tasks necessary to deliver the finished product to the client.

In the extreme, this allows engineers to work from a home office, with a workstation networked to a central server, communicating in privacy with other engineers in the same position. Each engineer contributes to the project and the manager puts it all together for the client and secures the next jobs. New jobs are distributed to the appropriate engineers or posted for the engineers to prepare bid proposals for a portion of the job suited to them. This low overhead operation would allow for good profit margins for the people doing the work and managing the project, as compared to operations with high fixed costs for office rental and associated costs.

"This could attract good engineers back to consulting, with the freedom to work independently, while earning a good income, and removing the sales and management tasks, which some engineers like to avoid.

"Only time will tell the tale".

Personal Views and Summation

Technological change is happening at an exponentially increasing rate. The implications to the profession are wide-reaching, but their exact nature is unknown. Furthermore, our regulatory processes have proven to be slow and ponderous, unable to keep up with technological change. The technological jobs will come, and they will be filled. If they must be filled by unlicensed practitioners, industry will soldier on regardless and new certification bodies will rush in to fill the vacuum. We ignore this fact at our peril, as our slide into irrelevance as a profession has already begun.

Areas of tremendous growth potential, such as life sciences and biotechnology, were absent from the membership's posts. I speculate that the reason for such an absence is a symptom of the above problem. Like chemical engineering before them, practitioners in the life sciences and biotechnology have not been required by regulatory action and demand-side legislation to be licensed for the protection of the public. Licensed engineers are therefore missing out on the economic opportunity these areas represent, and are not fulfilling their necessary public protection role to the extent that they should be. We need to reform our regulatory processes and associations such that they respond more quickly to technological change and are more proactive in responding to the resulting public protection needs.

THE RENAISSANCE ENGINEER: THE IDEAL ENGINEER OF THE FUTURE

Márta Ecsedi, P.Eng.

ABSTRACT

1. Engineers need to learn how to listen and deal sensitively with "the public".

Managers and engineers need to learn to deal sensitively with sensitive people, the very people included in the PEO's definition of public interest. These are the people who are vulnerable because they lack the information, the technical knowledge, or the time for deliberation, which it is the professional duty of the engineer to provide.

2. Engineers need to become "renaissance" people with balanced technical and artistic skills.

Engineers need to take the opportunity presented by our changing times "to adopt a new ideal, a new vision of our preferred future".

Engineers need "to go back to the past to models like Leonardo da Vinci, who was a renaissance hero with technical skills who also had the ability to think with his heart".

Recently, I had the privilege of presenting the first Claudette MacKay-Lassonde Memorial Lecture at Lakehead University. The subject was one that was near and dear to Claudette's heart—"The Renaissance Engineer". With the assistance of PEO staff, we created a lecture that I think would make Claudette proud. I have taken excerpts of that lecture, quotes from Claudette and thoughts of my own to develop what I am presenting today.

I want to start with a simple question: If we started from scratch with a blank piece of paper in front of us, how would we design the ideal engineer?

Claudette MacKay-Lassonde thought that we should go "back to the future". She said we should take as our model a person such as Leonardo da Vinci who combined technical skill with the creativity and sensitivity of the artist to become the symbol of the Renaissance man.

I don't think it's too ambitious to set our sights on creating the Renaissance Engineer.

Along with strong technical skills, engineers would need to be able to:

- understand product design without being designers;
- develop strategic plans and advise management on a course of action for their realization without being strategic planners;
- amass extensive computer knowledge and capability without being systems analysts;
- understand value-added concepts and collect, manipulate and furnish financial evidence without being accountants;
- understand marketing and sales without being marketers;
- understand domestic and global business economics without being economists;
- be concerned about potential environmental impact without being environmentalists; and
- work closely with people at different levels of the organization and deal with a variety of clients without being psychologists.

The long and short of it is that engineers will have to apply their technical skills with more heart than they have exhibited before.

Engineers will have to learn to listen with their hearts, to acknowledge their feelings, to trust their instincts, to balance all of those against the cold hard mathematical facts.

Engineers need to learn to deal sensitively with sensitive people, the very people included in the PEO's definition of public interest. These are the people who are vulnerable because they lack the information, the technical knowledge or the time for deliberation, which it is the professional duty of the engineer to provide.

Engineers need to learn how to judge feelings, to listen to people "who talk with their heart leaving behind any logic whatsoever".

Because engineers are able to understand technology better than any other single public group, we must measure both the positive and negative effects on the public of any new technology. We are bound by obligation to protect the public from any harmful effects of technological change.

Parents and educators have an obligation to help young people develop new sets of skills and attitudes to enable them not just to cope in this new environment, but more importantly, to drive Canadian companies to their competitive limits.

A balanced education is necessary to be able to identify problems and come up with solutions.

Two of the skills that are required to be this renaissance engineer are self-confidence and listening.

"In a knowledge-driven economy," Claudette stated, "self-confidence means a willingness to champion new ideas and the resilience to roll with the punches when ideas turn out to be better in the abstract than in reality."

Self-confidence provides the persistence to try again from another angle. Self-confidence enables an individual to withstand the criticism of colleagues, to live with the fact that not everyone will like everyone else.

Young people's education needs to provide technical expertise and a sense of self-confidence so that they can become the resources Canada needs to build successful enterprises.

If engineers cannot feel or see by themselves, they must learn to listen to those who can, listen not only with their brains but also with their hearts, listen and try to understand why some people feel so strongly about things engineers wouldn't give a second look to.

Listening is a crucial element of communications, a skill many eminent engineers have argued for very strongly as essential in the training of young engineers.

I would disappoint you if I didn't bring up this next thought.

In building the design for the renaissance engineer, we must involve women, not only for their hearts, but also as yet untapped resources of technical brilliance. We have managed to increase the undergraduate enrolment of women from 2 per cent in my day to 25 per cent today at the undergraduate level. But what about the graduate and professorial level, where it is not close to 25 per cent? If we are to teach our young engineers about sensitivity, self-confidence and listening, we need to have role models who emulate these attributes. I'm not suggesting that all of our male professors do not have these skills, but we all know that a woman brings out the best in the male species when it comes to the soft skills we all agree must be displayed.

Welcoming women into the profession at all levels is a step toward becoming the Renaissance Engineers of tomorrow; welcoming women as true partners makes good sense, not only because of their honed technical skills but also because of what we can learn from their sensitive, intuitive side.

In conclusion, engineers need to take the opportunity presented by our changing times to adopt a new ideal, a new vision of our preferred future.

The engineering profession should bring human wisdom to the high-tech bells and whistles of the 21st century.

Claudette said: "What made Leonardo who he was, was not his ability to be mathematical and logical, but his ability to sense the beauty and powerful enigma of a fleeting smile, and capture it on canvas as the painting known as the Mona Lisa."

I think it's appropriate that today we are talking about Engineers in the Year 2020 because in hindsight our vision can be 20/20. Claudette had it right when she suggested that we go "back to the future".

I hope that I have provided some food for thought and that we as practitioners and educators can apply some of the thoughts that I have presented to crafting the Renaissance Engineer, the ideal engineer of the future.

SHIFTS IN THE CULTURE OF THE WORKPLACE

Jeremy Cook, P.Eng., Chair, Board of Directors, Ontario Society of Professional Engineers

ABSTRACT

1. Measurement and accuracy

Capability to measure things more accurately will increase, as will the ability to display the results quickly and in detail. This will affect the workplace's perception of what is an acceptable answer in any given situation.

2. "Brand name" solutions

The workplace will become more complex and it will be increasingly difficult for decision makers to understand the solutions being offered to them. This will result in a preference for brand name solutions and qualifications.

3. Changes in accountability

The focus will shift from accountability for solutions to accountability for problems. This will be reflected by an increasing demand for liability insurance.

Why be concerned about culture at all? After all, engineering is the profession dedicated to the application of science and *engineering principles*[8]. And these principles are based on the immutable laws of the universe that are notoriously indifferent to human emotions. This may be true but the relationship between society and engineers is undoubtedly influenced by perception as well as reality.

In a study on the causes of inflation, the French government cut thousands of cheeses in half and put them on sale. One half were marked 37 centimes, and the other 56 centimes. The higher-priced cheese sold faster[9]. Consumers were equating higher price with higher quality.

Clearly, in the above example people's perceptions were erroneous; however, this did not stop them from purchasing the cheese. What perceptions will people have in the Year 2020 and how will this affect the engineering profession?

Measurement and Accuracy

We used to measure the passage of time with devices such as sundials and candlesticks. Then came mechanical clocks followed by watches, and now we have digital read outs on watches, cell phones and pagers. We marked time first by the hour, then by the quarter hour, then the minute. Now we ask: "Does your phone plan bill by the second"?

We used to fish with a rod and reel and rely on our knowledge of the fish and the waters. Now we use the Global Positioning System and fish finders. This is not in itself either right or wrong, nor is it undesirable, but as we change how we do things this alters our appreciation of them and, by degrees, our understanding of them as well.

There are examples of lost science, e.g. the papyrus paper of ancient Egypt. We know what it is and what it is made of but we cannot reproduce it to match the quality of some of the samples that still survive. We have lost our understanding of the original manufacturing process. We have lost the logic behind it.

The sophisticated technology in our workplace is rapidly improving our capability to measure and calculate both quickly and accurately. Our culture is coming to depend on this speed and accuracy but at the same time it seems to be less interested in the logic that explains what was involved. For example, it is no longer necessary to know the mathematics for calculating a trigonometric function; we just need to know which buttons to push on the calculator. And the answer we get is so believable that there is no need to question it.

If we extrapolate this attitude, by the Year 2020 our culture may have shifted to the point where we judge technical answers by response time and number of decimal places involved. And these answers will be perceived to be right. The implication for professional engineers may be the need to preserve *understanding* along with speed and accuracy as being part of the criteria for acceptable answers.

"Brand Name" Solutions

There is another aspect to the introduction of increasingly accurate and sophisticated technology into the workplace. It makes the workplace more complicated.

How many people today can program the clock in their neighbour's car without consulting the vehicle's manual? Although the cleverness of our technology is increasing, it is not necessarily becoming easier to use. In fact, in certain areas it is already becoming difficult to master. Consider today's advertisements for mechanical designers that ask for two to three years experience with design aids such as Pro/ENGINEER[10] and SolidWorks[11]. Why? Because it takes about this length of time to become proficient with such systems and the employer has already invested too much money to delay making a return on that investment.

It is not just software and mechanical systems that this trend applies to. Look at the evolution of Quality Assurance in the workplace. Over the last 20 years in North America, we have experienced Total Quality Management, ISO 9000, QS 9000 and now Sigma Six. Again, looking at industry journals and recent job advertisements, the attitude appears to be developing that if a person does not have specific credentials in these areas nothing else matters.

As both the introduction and rate of change of technology in the workplace increases, it will become more and more difficult for decision makers to assess the consequences of the choices they are being asked to make. Presumably, this will create fear and anxiety over the possibility of making mistakes. The workplace reaction to date has been to find ways to simplify and then justify the decision-making process through adopting de facto standards based on widely used products and services.

If this trend continues, the implication for professional engineers is that an engineering licence by itself may be insufficient for them to remain competitive in the workplace and additional credentials, whether formal or de facto, will be required.

Changes in Accountability

A few years ago, an engineering company designed and installed some state-of-the-art clean rooms for a pharmaceutical company in the United States. A couple of years later, the pharmaceutical company chose to redecorate the corridor outside the clean room area. The pharmaceutical company wanted to manage the redecoration itself but asked the engineering company to write a specification for the type of paint to be used. The contractor hired by the pharmaceutical company used a high-pressure paint system and aimed the nozzles directly at the joints between walls and ceilings of the clean rooms, thus forcing paint through the seals and into the clean rooms. The resulting lawsuit found the engineering company liable for over $1 million in damages, even though it was not responsible for either hiring or instructing the contractor.

Ontario's new *Condominium Act*, which is to be proclaimed in force on May 5, 2001, requires owners to conduct periodic reserve fund studies to ensure that adequate funds are set aside for expected repairs and replacements. The regulations will permit these reserve fund studies, which used to be performed by professional engineers and architects, to now be performed by those without professional qualifications. The regulations also

8 Professional Engineers Act, R.S.O. 1990, c. P.28, s. 1.
9 *Ogilvy on Advertising* by David Ogilvy, published by John Wiley & Sons Canada Limited, 1983.
10 Pro/ENGINEER is "the industry's de facto standard 3D mechanical design suite" says its provider ParametricTechnologyCorporation.
11 The "Certified SolidWorks Professional Program (CSWP) establishes an industry standard by which all SolidWorks professionals can be evaluated" says its provider SolidWorks Corporation.

introduce a requirement that all parties performing reserve fund studies must be covered by a 10-year, $2-million liability insurance policy[12].

There will always be more accountability, legal or otherwise, for professionals than for non-professionals. However, both these examples indicate a trend towards less interest in responsibility for actions and more interest in compensation in the event that something should go wrong. In the later case, there is an implication that increasing the amount of compensation available after the fact reduces the need for professional involvement beforehand.

The implication for professional engineers in the future is that this appears to be a shift away from professional accountability towards financial accountability.

Conclusions

The engineering profession in Ontario may be faced with the following situations by the Year 2020:

1. Workplace culture may demand fast answers and a high degree of accuracy but be less interested in the logic behind the answers.

2. Workplace culture may deal with its own complexity by setting up de facto standards based on widely used products and services rather than relying on traditional professional qualifications.

3. Workplace culture may place a greater value on compensation after the fact than on efforts to avoid the problem in the first place.

If this seems like a dark picture, remember, it is not the future that will be, it is the future that may be. I think the future holds many wonderful opportunities and I want professional engineers to share in these opportunities. I conclude that our success in this regard will depend, at least in part, on our awareness of the workplace.

[12] Current minimum liability insurance coverage requirements for a Certificate of Authorization holder are $500,000 for one year or $250,000 with automatic reinstatement. (There is also the declaration of non-insurance option.)

Professional Engineers Ontario Session

HUMAN OR MACHINE? FUTURE ETHICAL QUESTIONS IN BIOMEDICAL ENGINEERING

Dr. Monique Frize, P.Eng., Professor, Systems & Computer Engineering, Carlton University, The School of Information Technology and Engineering, University of Ottawa; Chair, NSERC/Nortel Ontario Women in Engineering

ABSTRACT

The next major wave, after high tech, will likely be the field of biomedical engineering. However, with new developments, such as nanotechnology, biological computers, robotic engineering, genetic engineering, and their many links to health and biomedical advances, will come serious hazards, such as the potential loss of what is human and human control over the future. To minimize negative impacts and optimize positive ones on our society and people, we need to place ethics, ethical decision-making training, and the study of social impacts front and centre in all of our engineering works and for all the future engineers we train. It will also be important to integrate diversity into the design of the future.

The paper and discussion address three main questions:

1. What could be the impact of women on technology if more women become involved in its design?
2. The new developments, particularly in robotics, genetic engineering, and nanotechnology, raise very serious concerns about the future of humanity.
3. What ethical guidelines and social factors can be put into place in order to prevent technological determinism (technology development out of control), thus mitigating the potential harm of these developments?

The Potential Impact of Women on Technology Development

“On September 13, 2000, just prior to the third Grace Hopper Celebration, 50 senior and successful technical women from the computing field in industry, academe, and government from the U.S., Canada, and Ireland met to explore their perspectives on the future of computing. … These women were professors, department chairs, deans … directors and fellows, executives and company founders.” *(Anita Borg, 2001).*

The questions discussed during the day were: “What are the most important technical issues for the next 10 years? What are the most important issues to be addressed? How must computing and IT (Information Technology) education change to meet the needs of the future? What can senior women in the field do to address the issues”? *(Borg, 2001).*

Borg continues:

“The results challenge the entire computing field to rethink and expand the way that we approach the future, prioritize our projects, teach our students and inspire the creation of fabulous technologies. … Computing has been driven by technical or scientific goals … to create the fastest, the smallest, the hottest, biggest, or coolest (technologies).” *(Borg, 2001)*

“The participants considered a variety of challenges that had the potential of improving human life and condition, driving extraordinary technical innovation”. *(Borg, 2001)*

“By the end of the day, there was consensus on the first priority for our attention: ‘to achieve universal literacy’. Literacy could enhance progress in every aspect of education, health, the environment, and economic growth.” *(Borg, 2001)*

Another result of the day’s work was the recognition that these goals can only be achieved if more women join IT fields in greater numbers.

Anita Borg, through the Institute for Women and Technology, is “after a broader, richer technology, one that reflects a more humanistic perspective in the way it’s used. That kind of technology opens the door for women to bring their whole selves to the job. And it will do the same thing for men: It will open up areas of richness and avenues of creativity and collaboration. But first, we need more female engineers shaping and designing the technology that’s shaping our lives.”

One way to achieve a greater participation of women is to attract more girls and young women to use computers and to enroll in high school technology courses. However, when studying girls and boys and computing, Maria Klawe (2000) found the following: Regarding computer games, girls cared more about the story line and the main characters; they wanted games with positive social interactions, worthwhile goals, and opportunities for creative activities. Boys liked fun, fast action, competition, and violence. Both boys and girls liked adventure, challenge, humour, graphics, sound effects, and music. Boys were much more aggressive in getting their fair share (or more) of time on the computers and video games. Girls were often reluctant to assert their right to take their turn when it came around (unless a researcher helped them).

If we do succeed to increase the participation of women in computing and in the design of technology, here are some of the qualities successful women are said to bring to the wired world: courage and determination (brave, persistent and take risks); creativity (new ways to do things); customer understanding; tendency to use a collaborative approach; and passion (for change) and a profound caring about the future *(Napier et al., 2000).*

Potential Impact of Technology on Society

A paper by Bill Joy, Chief Scientist, Sun Microsystems, published in *Wired* magazine (April, 2000), expressed his concerns regarding future technological developments. Among his main concerns were: unintended consequences of discovery and innovation, and unrestricted and undirected growth and self-replication. Bill Joy concentrated on three areas of major concern: robotics, genetic engineering (includes biotechnology) and nanotechnology. The combination of nanotechnology and robotics and nanoscale molecular electronics, he says, can bring massive power to individuals and small groups and can lead to building technological concepts that replace humans. He also listed his concerns in the areas of: genetically modified foods, and biotechnology (new viruses, plants, animals, cloning). The mix of human and machine parts (such as bionic arms, legs, artificial hearts, pacemakers, mood enhancing drugs), the replacement of reproduction, new cures, and xenotransplantation could lead to humans being part human and part machine, and thus blur the consciousness of what is truly human.

The question we can pose is: What is the limit that defines our humanity when we have animal and machine parts? The Centre for the Study of Technology and Society summarizes well the issue: "The same technologies that will let us cure diseases, expand the economy and overcome everyday inconveniences can theoretically bring about catastrophes. Is the risk of apocalypse serious enough for us to relinquish the current pace of technological innovation?"

There are already many signs that some of Bill Joy's fears are already happening. For example, the Pentagon has just invested $50 million US to create bionic men who will have suits made of frog muscles so that they can leap off buildings. Dozens of families have asked two researchers to clone humans (previous dead child, etc.). It seems that technology is often ahead of societal guidelines and laws.

Role of ethics and social factors to minimize harm

Are we living in an era where technological determinism prevails? Can society provide sufficient controls and moral and ethical guidance to prevent irreparable harm to our world and the people in it? More work is needed to address all the aspects of new technologies. Even more urgently, we should be providing education and training to our engineering students on how to make ethical decisions and on how to think of societal impact of their future technological developments. They must be able to understand how to verify the models that assess the impacts (positive and negative) of technological development on society; they need a heightened awareness of universal responsibility and interdependability of engineers and society.

This can be accomplished through courses such as Professional Practice, and Technology and Society, especially if these courses are mandatory and core to the requirements for graduating.

John Seely Brown (2000) responds to Bill Joy that "there is a role for Society, institutions and corporations, communities, governments to develop laws, moral positions, ethical analysis that respond to the new needs created by the new technologies. Public awareness of issues and consequences of dealing or not dealing with these issues may bring some control over the outcomes."

Licensure Issues for the Engineer of 2020

Engineers graduating in the next two decades, in all fields but particularly in bioengineering, will need to be knowledgeable on the various codes of ethics (PEO's, IEEE's, etc.); they will be expected to know the principles and process of ethical decision making and be socially responsible engineers. The latter means that the new graduates will be expected to understand how to assess the positive and negative impacts of engineering works on society and on people. They should commit, in an oath delivered at Iron Ring ceremonies of the future, to respecting the world we live in and our humanity. The new engineers will have studied how to be professionals and how to safeguard the environment and principles of sustainable development and safety of people in all senses of the word.

Conclusion

Recent research has shown that women will bring diversity and richness to design, new ways to do things, and, more importantly, make different choices about what to design. Such direction would, I am sure, not only improve the human condition, but also bring major profits to the investors of this approach.

Technological development brings major benefits and hazards in its wake. Each of us can do our part to ensure a positive impact for society and that our efforts help to solve some of the world's largest problems and challenges. Society must institute laws and ethical codes of conduct to guide the direction and impacts of the developments.

To ensure that engineering students become socially responsible in this new century, it is essential to instruct them on how to assess the impact of their work on people and society and teach them the process of ethical decision making. There should be a guideline on how to include these important concepts in our engineering curriculum. In closing, I hope that each of us will take up the challenge. Each of us can be part of the solution.

Recommendations for Deans of Engineering and Applied Science and for PEO

1. Improve the culture and climate for under-represented groups, and particularly women. (See Appendix I for details.)
2. Include social responsibility, how to assess the impact of technology on people and society, ethical decision making, and gender issues in the engineering programs. Students should ideally be in their last year for this course when enrolled in it. (See Appendix II for a suggested list of content for a course that would meet the needs expressed in the paper.)
3. Develop a dual degree: Arts and Engineering. This could be an opportunity for students who do well to continue their education in an arts topic that they enjoy and develop necessary communication, interpersonal, and critical thinking skills, while also completing an engineering degree in a discipline of their choice.
4. Ensure students not enrolled in a dual degree choose their complementary electives in a way to obtain the desirable people, social, and critical thinking skills.

Appendix I. Improving the Environment and Retention of Women in Engineering Programs

Several studies in the literature have found that the engineering culture is highly masculine. For example, Hacker (7) describes the culture of engineering as an environment that stresses the importance of technology over personal relationships; formal abstract knowledge over inexact humanistic knowledge; and male attributes over female ones. Robinson and McIlree (8) and Sorenson et al (9) agree and describe in more recent studies the culture in the world of high technology workplace. Suggestions to improve the environment for women are to make the curriculum more relevant to them, more gender sensitive and more reflective of society's needs. Increasing the number of women in the field would help to accelerate the integration of feminine perspectives into the engineering culture and curriculum. Courses that emphasize the beneficial applications of technology and engineering will increase the appeal of engineering programs to women and to men. Examples include solving environmental problems, inventing tools and equipment for the disabled, designing and constructing safe highways and developing user-friendly technologies for use in health care institutions and for home-care programs. All engineering students need to understand the complex nature of technological decision making and to realize that the best solutions are based on a blend of technological, political and societal values.

The average attrition rate in engineering is 36 per cent, according to a study by Pomfret and Gilbert (10). Efforts to attract women are wasted if women cannot progress academically and in the workplace, with success and confidence. A study by Drolet and Turgeon (11) concluded that young women have particular characteristics that make it more difficult for them to persist in their studies when difficulties are encountered. The study found that the women were perfectionists, were harder on themselves than the men and attributed results to effort rather than talent. They also tended to prefer collaboration to competition and to place more importance on a supportive environment. As long as women remain a minority, they will need moral support that can be provided through peer counselling, networking and mentoring programs, such as the WISE chapters (Women in Science and Engineering). Contact with women who work as engineers in the community would help the students to understand the workplace, its difficulties and challenges. It is also time for male professors to become role models for male students, by their fair and respectful treatment of everyone in their classes, regardless of gender, race, or sexual orientation. Finally, women students and professors should not blatantly deny that there are gender issues in engineering. This attitude makes them part of the problem instead of the solution and can only contribute negatively to the discussion and delay progress toward achieving true equity: the equal respect and valuing of feminine and masculine perspectives and traits.

Changes to the engineering curriculum and the faculty environment will only be possible if all stakeholders, engineering students, professors, deans, employers of engineers and the professional associations, make some effort to redress inequities and find original and innovative ways to include more women in all facets of engineering professional life. Feminine values must be included in engineering education, and women engineers valued for their contribution to the humanization of the field. In this rapidly changing society, success will be linked to the integration of diversity. Increasing the number of women will ensure the development of a gender-balanced view on which to develop the technological solutions of the future. For too long, engineering has utilized and benefited from only half of its potential human resources.

The economic well being of Canada and the development of its technological base depends to a great extent on the effective employment of engineers. In this period of global competition, employers cannot be satisfied with anything less than the very best engineers available, regardless of their gender. Increasing the pool will create the level of excellence that will bring Canada successfully into the new century. The purchasing power of women is expected to increase as women join the workforce in greater numbers every year. The successful companies of the future should undoubtedly hire a more gender-balanced team to design their new products. Huband (12) says: "With more women in engineering, the programming of some consumer appliances could be made less mystifying and actually accessible to the average user." New products should be more relevant and attractive to the purchasers who, increasingly, are women.

Appendix II. Proposed Guide for a Professional Practice Course

A survey carried out by the author of this paper in the summer of 2000 has shown that the content and manner in which this course is taught varies greatly from one place to the other. The course focuses primarily on the engineer's responsibility to clients and the public. The manner of evaluating the students in this course varies from one university to another, from a simple PASS/FAIL through the assessment of a logbook in which the lecture notes are compiled, to a full assessment with log books, two essays, and a final exam worth 50 per cent of the final mark. For the former model, it is not surprising that students frequently do not take the course seriously. For the other end of the spectrum, students cannot graduate unless they pass each requirement of the course successfully.

We can provide many of the needed skills within the existing curriculum, provided we change some of the approaches to our teaching. One of the most obvious courses to start with is the professional practice course. One of the factors that really distressed me when I started the course was the fact that some of the women in my class used male language exclusively, even when referring to their own experiences. This showed me how engineering students (even women) have been conditioned to see engineering and engineers in male terms. This is a systemic problem and it will only disappear by providing a positive example in the classroom.

Although the content may vary slightly between various instructors across the country, there may be some advantage to developing a "guideline" to ensure that a number of issues more in tune with today's workplace are covered. By changing a small portion of the content, the guests invited to do a class, some of the assignments, and by increasing the participation of the students in the classroom, the results can develop the communication skills of the students, their interpersonal skills, the importance of understanding other cultures, and inform them on how to develop their entrepreneurship skills.

The Proposed Course Content

Note: An important step is to balance the gender of the speakers and request that inclusive language be used in all presentations.

Societal Impact

A history professor whose expertise is in the social impact of technology was invited to discuss these issues with the students; this was followed by the writing of an essay, where the students were asked to invent an engineering job that they have enjoyed for about five years and to discuss how their work impacts society both in a positive and a negative manner. Most students get the point and do a very interesting paper, although it is obvious that they struggle more with finding the negative aspects than the positive ones, and they often conclude in this way: "Although there are some negative impacts of my work on society, the positive impacts far outweigh the negative ones". That is a normal reaction, since they chose to be engineers, and thus to be creators of new technologies. But they do admit, frequently, that the essay has forced them to think about these things and that they would not have given this any thought without this exercise.

Occupational Health and Safety (OHS)

The Canadian Engineering Accreditation Board (CEAB) added this requirement several years ago and it seemed appropriate to fit this into the "Profession Course". A lawyer was invited to describe the OHS Law in New Brunswick; she discussed the concept of "Due Diligence", and provided real-world examples of accidents and of the court decisions on these. She recommended ways to prevent accidents and how to deal with them when they occur. The topic of "Product Safety" has also been added to meet the CEAB request; the invited specialist does an excellent task at explaining how the WHMIS system works; he also provides lively examples of accidents and discusses prevention measures.

Environmental Concerns

The specialist is a geological engineer who discussed how the environment comes into the equation of any major (and even smaller) engineering project. She encouraged the students to respect the public, to treat people who are not engineers with respect and to learn how to address them in terms that they will understand, instead of the usual professional jargon that we engineers are so prone to use in conversations with each other, but also when we speak to non-engineers.

Entrepreneurship

The guest described the characteristics of successful entrepreneurs, and the various business opportunities existing in this global market environment. The guest is the holder of the Technology Management and Entrepreneurship Chair at the University of New Brunswick.

Engineering Workplace and Gender Issues

This includes the current skills desired by employers; a description of current obstacles for women in the profession; and solutions to achieving gender balance. The concept of employment equity was discussed, as well as what sexual harassment (and other forms) is and how to eradicate its presence both at the university and in the workplace. Future engineers should also know that many employers now expect men to be able to work successfully with and for women, and have adopted workplace policies that prohibit homophobia, racism and sexism.

Ethical Theories and Ethical Decision Making

Four ethical theories are described as well as the process of ethical decision making when faced with moral dilemmas in our professional work. Several case studies are assigned to the students as one of the two main assignments of the course. The new role models in this class showed my students that women and men were competent engineers and they each shared interesting experiences with the class. This alone (I am sure) has had a major impact on the attitude of the students. The students are also asked to use gender-inclusive language in the classroom, in their essay, and in their case study analyses; the majority of them did, even on the exam.

Issue of Privacy

With our privacy being invaded more and more today, even by governments who purport to be democratic, by such means as the cameras that have been installed in many public places in the UK, the ECHELON system that detects emails and telephone conversations of private citizens (UK and USA with participation from several other western countries), the global file that was being compiled by HRDC (Human Resources and Development Canada) on Canadians, it is essential to present the issue of privacy, particularly to students who are in the fields of electrical, computer, software, and communications engineering, as well as those in computer science. Hopefully this will build some consciousness about future information technology designs that keep in mind the privacy needs of our citizens.

Other Topics That Are Normally Included in this Course

The role of the provincial and territorial professional engineering associations, of the Canadian Council of Professional Engineers, and of the scientific associations, such as IEEE (Institute of Electrical and Electronics Engineers) and others relating directly to the various disciplines of engineering; the issue of liability and how to minimize this risk; how to plan a career; the importance of continuing education; and the legal aspects of engineering, such as contract law and intellectual property laws, are also covered.

Results

After several years of observation, I can report that results are quite positive. Most of the older students (those in fourth year) understood and appreciated the points made in all the new content and their logbooks reflect this. Some of the younger students (in third year) respond differently and state that it is a waste of their time to present them with the ethics and the gender material. In spite of their resistance, it is likely that they will understand the workplace better and face moral dilemmas with more assurance when they are working. The writing skills of most students improve during the term. Their greater understanding of the new workplace environment seems to be decreasing the fears and anxieties they may have had about it. Being more prepared, they may be able to handle the stresses and unexpected more wisely, more calmly. This is true for both the women and the men. Many of the myths the students hold at the beginning of the course are destroyed and are replaced by facts and real-life examples. The role models who visit the class provide again a real-life reinforcement through their own messages of the facts and concepts discussed in the classroom.

References

Borg, A. *Notes from the Discussion Day in Cape Cod.* www.iwt.org, 2001.

Brown, J.S. and Duguid, P. *A response to Bill Joy and the doom-and-gloom Technofuturists.* www.thestandard.com/article/display/0,1151,14013,00.htm

Centre for the Study of Technology and Society: www.tecsoc.org/innovate/focusbilljoy.htm, 2001

Drolet, D. and Turgeon, L. *Les filles engenie: Des differences connaitre et respecter*. University de Laval, Quebec. Presented at the Montreal Forum CCWE, 1991.

Hacker, S. *Pleasure, Power & Technology*. UNWIN HYMAN, Boston: 1989.

Huband, F.L. (1991) "Why Women?" *ASEE Prism*, September, 4, 1991.

Klawe, M. *www. taz.cs.ubc.ca*, 2000.

Joy, B. "Why the Future doesn't need us". *Wired*. April 2000; 13 pages (also found on www.wired.com/wired/archive/8.04/joy.html)

Napier, J., Shortt, D., Smith, E. *Technology with Curves*, Harper Collins Publishing Ltd., 2000.

Pomfret, A. and Gilbert, S.N. *Did they jump or were they pushed: Gendered Perceptions and Preferences Affecting Attrition Among Science and Engineering Students*, (CCWE Conference), Dept. of Sociology and Anthropology, U. of Guelph, Guelph, Ontario, 1991.

Robinson and McIlree "Men, Women, and the Culture of Engineering" *The Sociological Quarterly*, 32 (3):403-421, 1991.

ENGINEERING LICENSING: DEFINING THE BOUNDARIES OF ENGINEERING AND EMERGING FRONTIERS

Peter M. DeVita, P.Eng., President, Professional Engineers Ontario

ABSTRACT

The Vision 2020 presentation by Peter DeVita, President of Professional Engineers Ontario, will address key issues in serving and protecting the public interest as mandated by the principal object in the *Professional Engineers Act*.

The mechanics of licensing include the functions of admissions, complaints and discipline, enforcement and professional affairs. Accreditation is part of the admissions process. These will be briefly described for context.

Like the two sides of a coin, the profession is called upon to bring benefits while avoiding harm to human welfare. The challenges to the profession are immense, as will be illustrated by a short look at artificial intelligence, bioengineering and electromagnetic transmissions.

The face of engineering practice is changing. Over 50 years ago, infrastructure design dominated engineering. The projection of current enrolment statistics and trends show that this portion of engineering will fall to below 15 per cent of the total practice (from the Canadian Council of Professional Engineers' Canadian Engineering Resources Board's recent enrolment report). The mature practices have evolved into consulting design services offered by engineering firms. These newer areas tend to have engineers working as employees in the design of products and processes. Could the non-traditional areas also develop using the independent practitioner model? This has not been the trend, but it is a possibility. Elliot Kraus in *Death of the Guilds* would argue that the independent model versus the employee model would give the public better protection. It is also a characteristic of the newer non-traditional areas that demand-side legislation is very small to non-existent. These two factors underlie the profession's concerns for relevance – with the trends going in the wrong direction.

Our crystal ball look will expose tough questions that require more than technical know-how. Like never before, engineers must take more responsibility in human affairs. With the accelerating pace of change and the increasing pervasiveness of technology, the common person has a declining ability to assess the impact of technology.

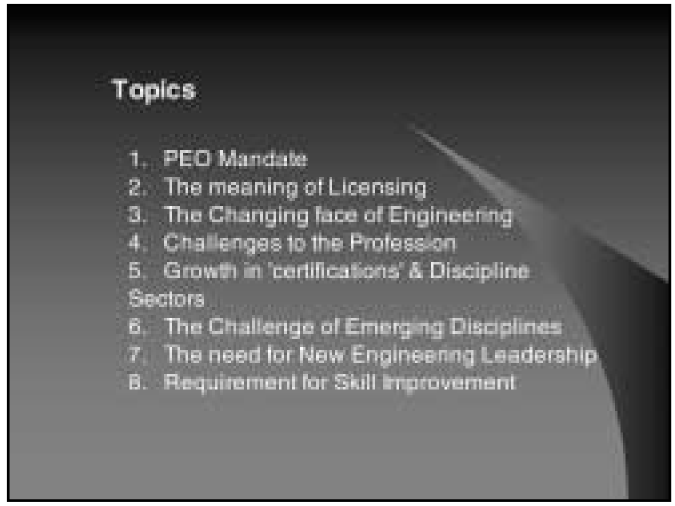
The growth in "certifications", e.g. the Building Regulatory Reform Advisory Group proposals, Canadian Council for Human Resources in the Environment Industry's CCEP, and IEEE's Software Engineer, can be interpreted as an expression of the public's desire to identify qualified people so that it can achieve a measure of protection. Licensing can be viewed as certification with legal enforcement added. The important point to note is that these certifications are highly specific to distinct areas of practice. Hence, to increase the relevance of the P.Eng licence, the profession must learn how to implement "Discipline Sector Segmentation". In future, a generic P.Eng. will not be good enough.

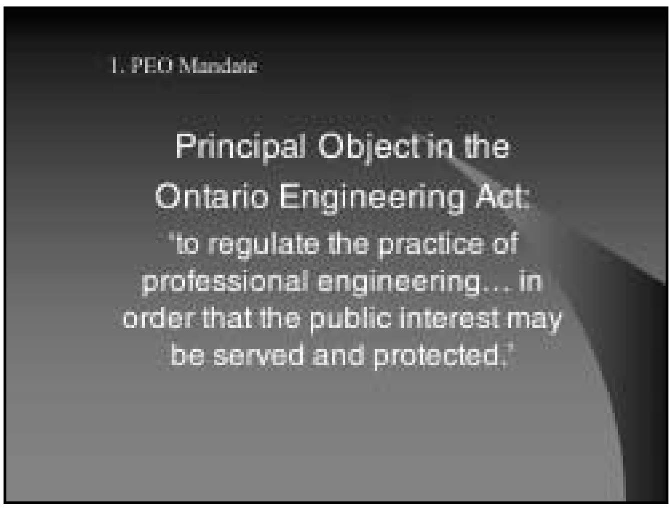
As new areas of practice emerge, the profession must become more proactive in identifying them. This requires two key parts: defining the core body of knowledge, and defining the new areas of practice and putting into place new demand-side legislation. The process must involve the universities, industry and government, with PEO at the coordinating centre.

The need for more leadership places far more demands on the future engineer. As well as all the technical skills, business and communication skills are also required. (The O'Grady Reports and the Canadian Academy of Engineering's December 1999 Report echo these ideas.) These skills will need to be exercised within a deeper understanding of the ethics and moral expectations of all peoples in our diverse culture.

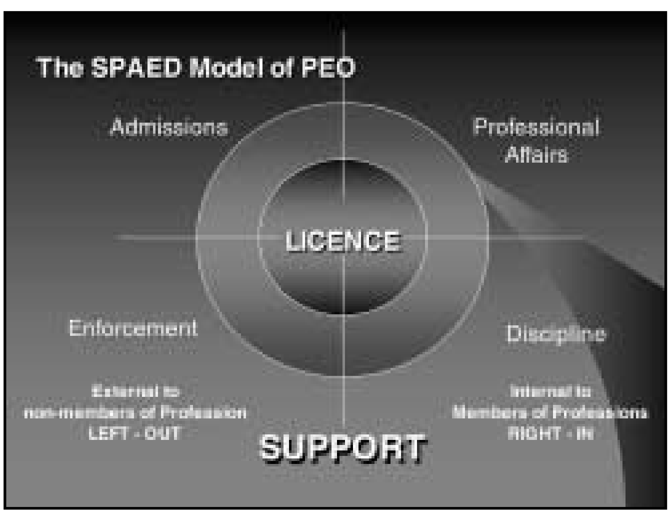
The making of such an engineer will require more that our current four years of undergraduate education. All three steps in the making of an engineer—academics, experience and ethics—need to be enhanced. In order to equip future engineers with an understanding of the broader context of their practices, it is time to consider a postgraduate degree as the minimum educational requirement for entrance to the profession. Added to this, we must also significantly enhance our internship programs by working with industry. Finally, we need a fresh look at what to include in a broader meaning of ethics.

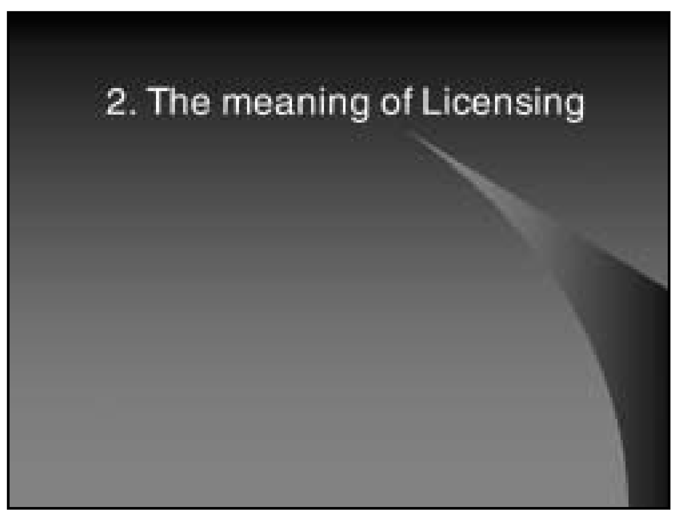

Vision 2020
Peter DeVita, P.Eng.
President,
Professional Engineers
Ontario


Topics
1. PEO Mandate
2. The meaning of Licensing
3. The Changing face of Engineering
4. Challenges to the Profession
5. Growth in 'certifications' & Discipline Sectors
6. The Challenge of Emerging Disciplines
7. The need for New Engineering Leadership
8. Requirement for Skill Improvement


1. PEO Mandate
Principal Object in the
Ontario Engineering Act:
'to regulate the practice of
professional engineering… in
order that the public interest may
be served and protected.'


Mechanics of Licensing
Admissions
Enforcement
Professional Affairs
Discipline


The SPAED Model of PEO
Admissions
Professional Affairs
LICENCE
Enforcement
Discipline
External to non-members of Profession LEFT - OUT
Internal to Members of Professions RIGHT - IN
SUPPORT


2. The meaning of Licensing

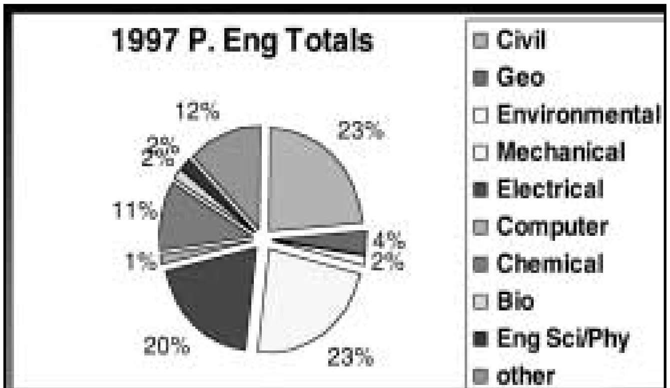
Background

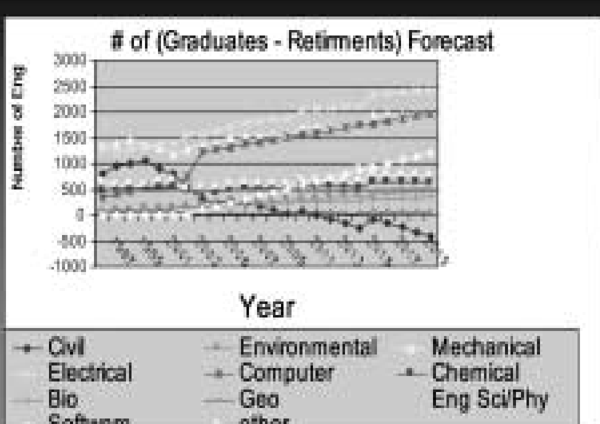
1983 Excerpts from Attorney General's speech on the occasion of the First Reading of Bill 123, The Professional Engineers Act, November 17, 1983:

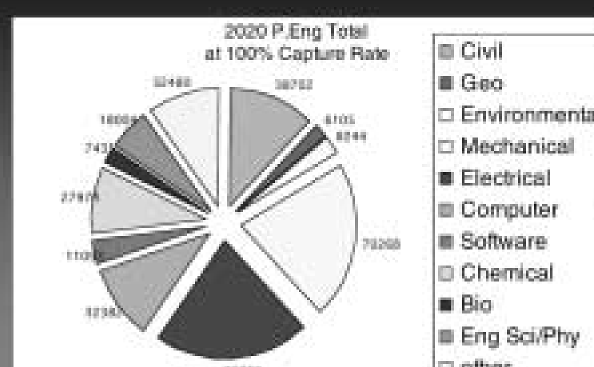
"A license is an exclusive right to practise an occupation. As a general principle, every person should be free to utilize his or her abilities, education, training, and experience in earning a livelihood. Therefore, it is wrong to create a restriction on this general principle by establishing licenses, unless this legislature is satisfied that licensing is necessary to protect the public."

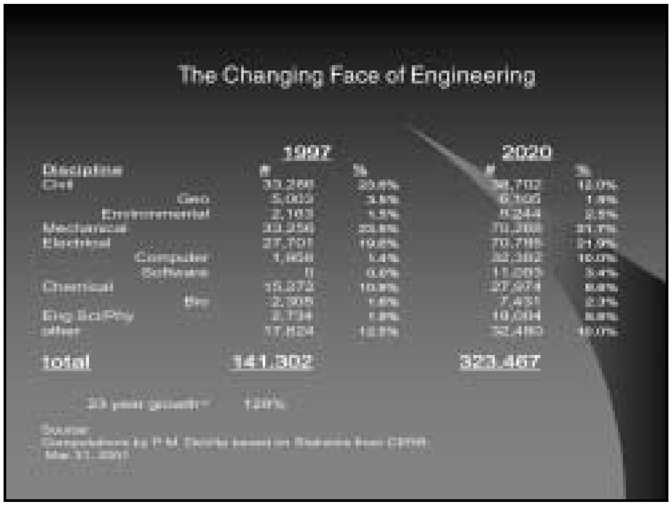
"It is by now axiomatic that self-governing licensing bodies exists only to **serve** that public interest. The financial or other interests of their members should not be a concern. *The economic benefits that may inure to the possessors of a license are a possible by-product of licensing, but it is not a reason for the legislature conferring the licensing power on a self-governing organization.*"

3. The Changing face of Engineering

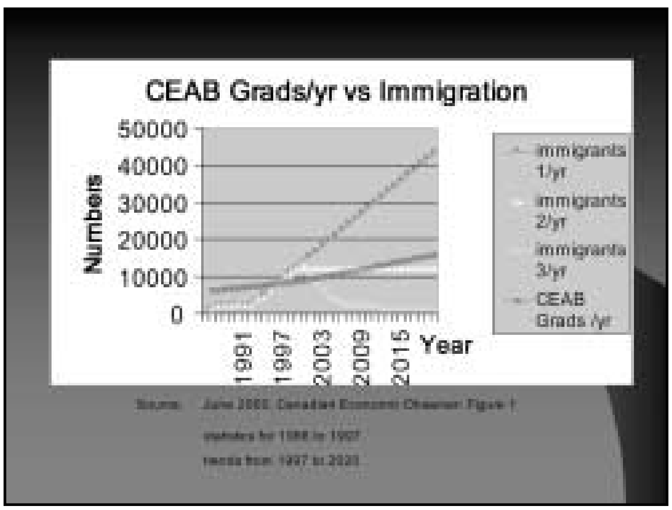


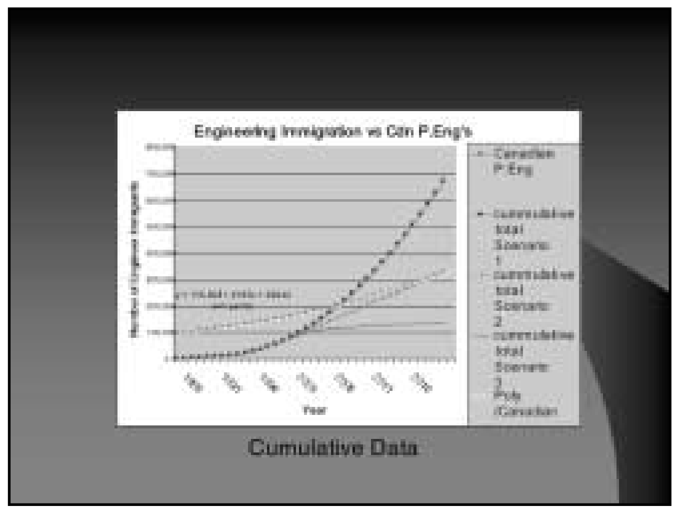


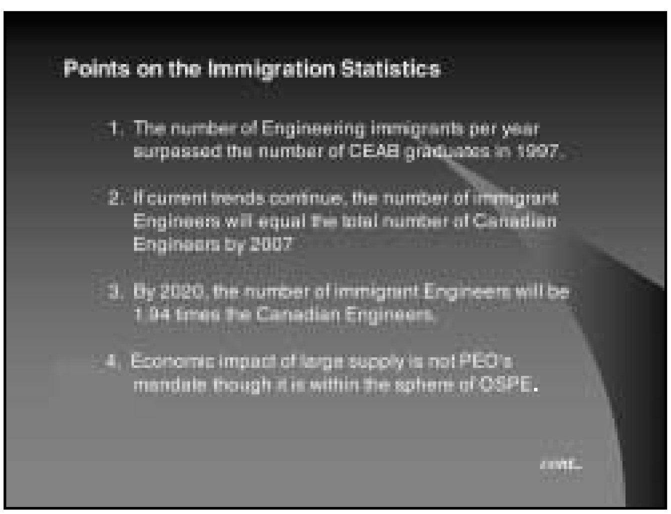


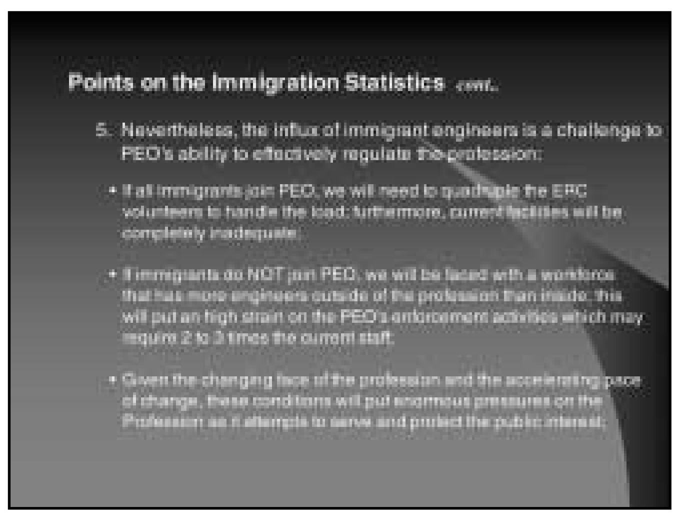

The Changing Face of Engineering
1997
2020
Discipline
#
%
Civil
Geo
Environmental
Mechanical
Electrical
Computer
Software
Chemical
Bio
Eng Sci/Phy
other
total
141,302
323,467
Source:


The Impact
of Immigration


CEAB Grads/yr vs Immigration
Numbers
50000
40000
30000
20000
10000
0
1991
1997
2003
2009
2015
Year
immigrants 1/yr
immigrants 2/yr
immigrants 3/yr
CEAB Grads /yr

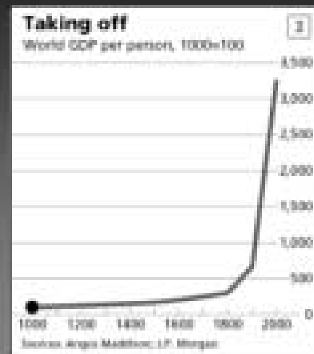

Engineering Immigration vs Cdn P.Eng's
Canadian P.Eng
Year
Cumulative Data


Points on the Immigration Statistics
1. The number of Engineering immigrants per year surpassed the number of CEAB graduates in 1997.
2. If current trends continue, the number of immigrant Engineers will equal the total number of Canadian Engineers by 2007
3. By 2020, the number of immigrant Engineers will be 1.94 times the Canadian Engineers.
4. Economic impact of large supply is not PEO's mandate though it is within the sphere of OSPE.
cont.


Points on the Immigration Statistics cont.
5. Nevertheless, the influx of immigrant engineers is a challenge to PEO's ability to effectively regulate the profession:
• If all immigrants join PEO, we will need to quadruple the ERC volunteers to handle the load; furthermore, current facilities will be completely inadequate.
• If immigrants do NOT join PEO, we will be faced with a workforce that has more engineers outside of the profession than inside; this will put an high strain on the PEO's enforcement activities which may require 2 to 3 times the current staff.
• Given the changing face of the profession and the accelerating pace of change, these conditions will put enormous pressures on the Profession as it attempts to serve and protect the public interest.

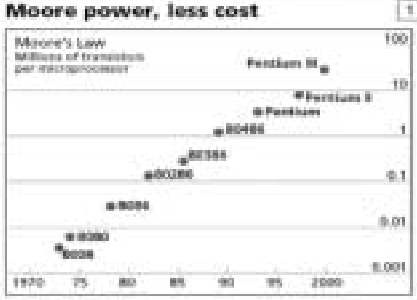
4. Challenges to the Profession

The Pace of Innovation



- about 90% of all the scientists who have ever lived are alive today.
- the pace of innovation does not just seem to be faster: it really has increased.

Moore power, less cost



Price of power and speed, $

	1970	1999
Cost of 1 MHz processing power	7,601	0.17
Cost of 1 megabit storage	5,257	0.17
Cost of sending 1 trillion bits	150,000	0.12

Sources: The Bank Credit Analyst; Federal Reserve Bank of Dallas

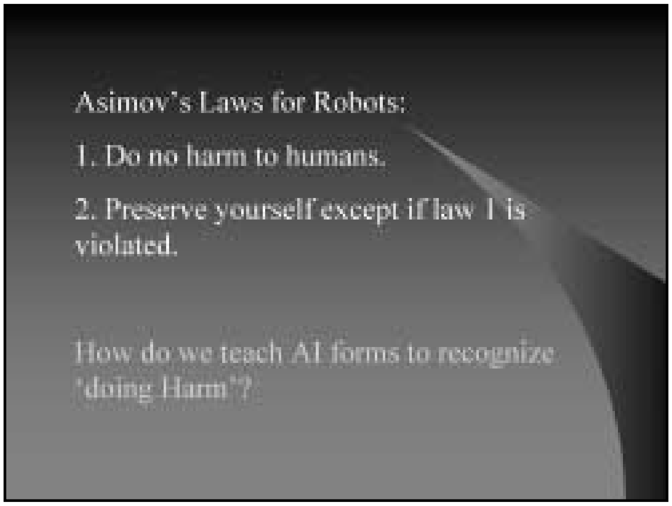
Over the past three decades, the real price of computer processing power has fallen by 99.999%, an average decline of 35% a year. The cost of telephone calls has declined more slowly, but over a longer period. In 1930, a three-minute call from New York to London cost more than $300 in today's prices; the same call now costs less than 20 cents—an annual decline of around 10%.

These price plunges are much bigger than those in previous technological revolutions.

By 2020, Computing Power will be 10,000 times what it is today.

Artificial Intelligence will become a practical reality.

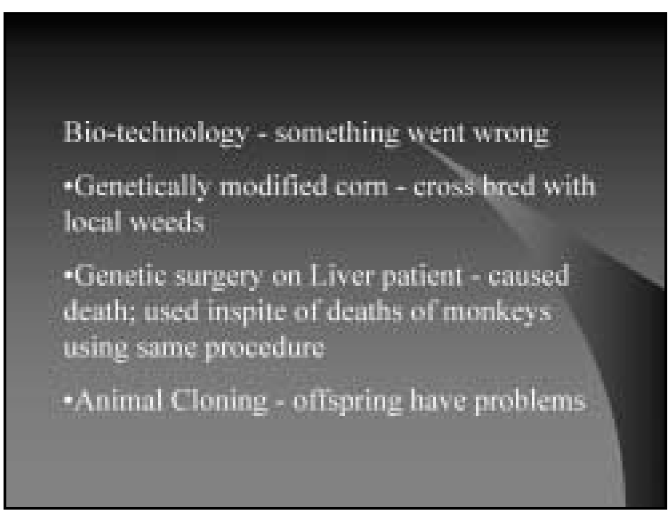
More than half of the world's 750,000 industrial robots can be found in Japanese factories, welding cars, assembling consumer-electronics gadgets and, obligingly, building other robots.


Asimov's Laws for Robots:
1. Do no harm to humans.
2. Preserve yourself except if law 1 is violated.
How do we teach AI forms to recognize 'doing Harm'?


'there is nothing human or divine that is absolutely good except a good will'
Kant in his
"Foundations of the Metaphysics of Morals"

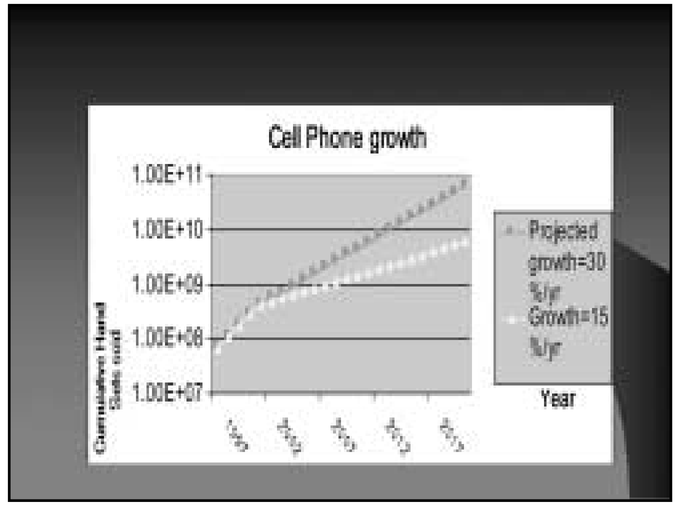

How do we give Robots "Good Will"?
How do we teach ethics to machines?

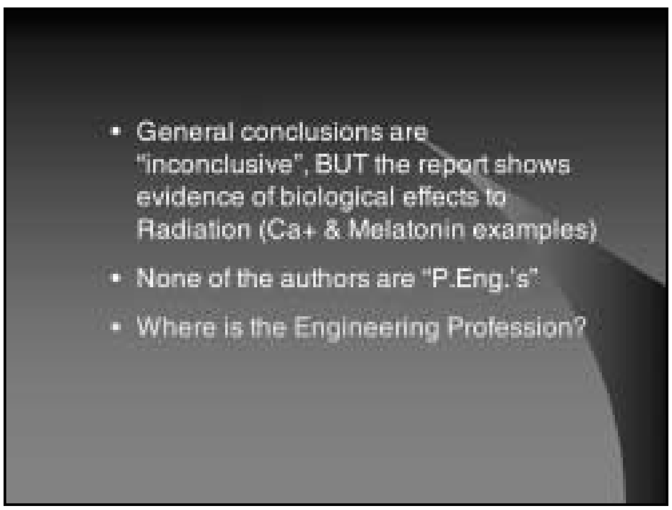

BIOENGINEERING
Bioengineering feats
• low-carbohydrate beer made from yeast which breaks down starch
• genetically engineered tomato that ripens slower
• cows that give greater milk supply
• enzyme used to treat emphysema
• protein which fights bacterial infections
• hormone that stimulates the production of red blood cells
• "Biosafety protocol" first agreement regulating trade in GMO's

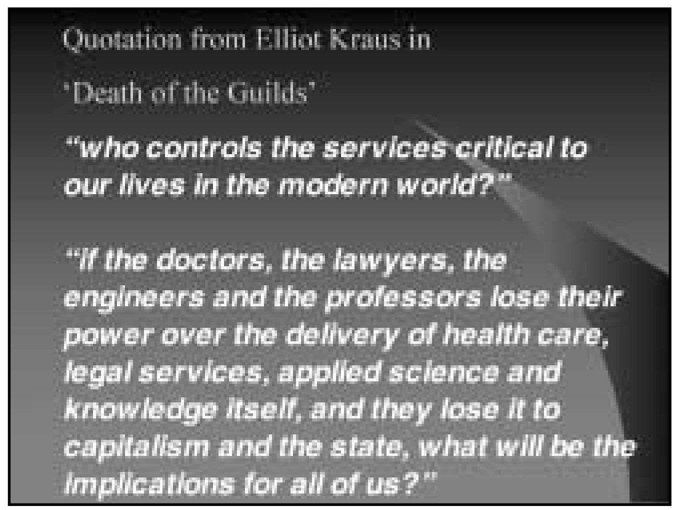

Bio-technology - something went wrong
•Genetically modified corn - cross bred with local weeds
•Genetic surgery on Liver patient - caused death; used inspite of deaths of monkeys using same procedure
•Animal Cloning - offspring have problems


Issues
•ethics of the practitioner
•care in serving the public interest


Electromagnetic Pollution?
A Review of the
Potential Health Risks of Radiofrequency Fields
from Wireless Telecommunication Devices
An Expert Panel Report prepared at the request of
the Royal Society of Canada
for Health Canada
The Royal Society of Canada/
La Société royale du Canada
March 1999
RSC.EPR 99-1


Cell Phone growth
1.00E+11
1.00E+10
1.00E+09
1.00E+08
1.00E+07
Projected growth=30 %/yr
Growth=15 %/yr
Year


• General conclusions are "inconclusive", BUT the report shows evidence of biological effects to Radiation (Ca+ & Melatonin examples)
• None of the authors are "P.Eng.'s"
• Where is the Engineering Profession?


Quotation from Elliot Kraus in
'Death of the Guilds'
"who controls the services critical to our lives in the modern world?"
"If the doctors, the lawyers, the engineers and the professors lose their power over the delivery of health care, legal services, applied science and knowledge itself, and they lose it to capitalism and the state, what will be the implications for all of us?"


5. The growth in 'certifications'


The growth in 'certifications'
• BRRAG, CHREI and IEEE's Software Engineer
• an expression of the public's desire and need to identify qualified persons so that they can achieve a measure of protection by using competent practitioners.

The growth in 'certifications'

- Licensing can be viewed as certification with legal enforcement added.
- The Profession must recognize this implied need of the public for competence assurance, and respond proactively.

The growth in 'certifications'

- These certifications are highly specific to distinct areas of practice.
- To increase the relevance of the P.Eng licence, the profession must learn how to implement "Discipline Sector Segmentation", in order to effectively respond to these needs.

6. The Challenge of Emerging Disciplines

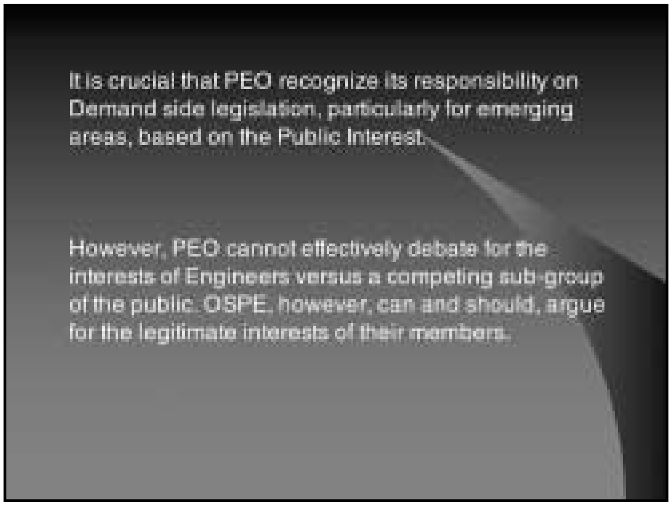
As new areas of practice emerge, the profession must become more proactive in identifying them

PEO's Key Role

"The most critical strategic factor that impacts PEO's long run survival is PEO's ability or 'effectiveness' to respond to the on-going expansion of science and technology."

Two Main PEO Functions:

1. Work with the Faculties of Engineering, Scientists and Industry to Define new Core Bodies of Knowledge
2. Work with government to establish new Demand Side Legislation in order that the public interest may be served and protected in these new areas of practice


It is crucial that PEO recognize its responsibility on Demand side legislation, particularly for emerging areas, based on the Public Interest.
However, PEO cannot effectively debate for the interests of Engineers versus a competing sub-group of the public. OSPE, however, can and should, argue for the legitimate interests of their members.


7. The need for New Engineering Leadership


The accelerating pace of change and the pervasiveness of technology places far more demands on the future engineer

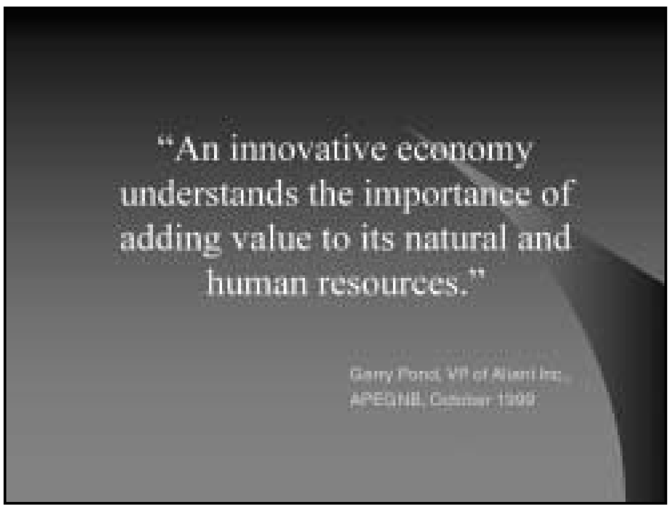

The common person is less able to discern the impact of new technologies.


• Engineers must take more responsibility in human affairs.
• Engineers must take more leadership roles in general society.


8. Requirement for Skills Improvement


• The making of our Future Engineer will require more than our current 4 years of undergraduate education.
• All three steps - academics, experience and ethics - in the making of an engineer need to be enhanced.


• it is time to consider a post graduate degree as the minimum educational requirement for entrance to the profession.
• enhance our Internship programs by working with industry.
• A fresh look at what to include in a broader meaning of Ethics.


"An innovative economy understands the importance of adding value to its natural and human resources."


The End

Roundtable Discussion

Moderated by Dr. John Runciman, P.Eng., Assistant Professor, School of Engineering, University of Guelph

Dr. John Runciman opened the roundtable discussion, saying that throughout most of the presentations, speakers had articulated their own perspectives for the future of engineering, based on their own experience. He said that because of technological changes in the tools engineers use, practitioners have become more effective and faster, but their role has not changed. He said that his own career move from mechanical engineering to specialization in biomedical engineering parallels the changes one can expect to see in the profession as it moves into the future.

During the presentations, he said, the issue of the interdisciplinary nature of engineering was highlighted as contributing to the changing role of engineers in society. It was emphasized that to compete globally, practitioners have to understand global issues, be able to travel globally, and must apply their skills from a global perspective. Practitioners must be ethical, agile, creative, innovative and professional, with perspective on what they are doing for society. One technique will not carry practitioners through a career. The most significant issue raised is that to remain relevant, practitioners must be deserving of the responsibility placed upon them by society.

He said four areas were highlighted during the presentations:

1. The skills and technical tools engineers need to learn as we move into the future;
2. Education and its continuing form or role as engineers develop;
3. The role of industry; and
4. The role of societies and government.

1. The skills and technical tools engineers need to learn as we move into the future

The following issues were raised:

- It is necessary to make a clear distinction between the use and the development of high technology tools. Practitioners who are creating new technologies have a different paradigm to the way they approach the world. Technology is changing rapidly and as a profession both views need to be kept in mind.
- Developers of software need to understand the perspective of the users of the technology.
- Does today's fast-paced learning environment, which was non-existent 50 years ago, make a difference or impact students? Students should learn tools of analysis and decision making at the undergraduate level rather than on the job. Students should be exposed to and taught to respect disciplines other than their own.
- PEO's software practice guideline is explicit that practitioners using software packages for design work are responsible for the design outcome. They should satisfy themselves that the tool is performing appropriately. This may become more difficult to achieve as the tool does more of the work and in more complex situations. How can practitioners know if the tool worked? Legally, it is the engineer's responsibility, not the supplier of the tool.
- In current engineering education, it is important to expose students to other disciplines at the beginning of their studies so that students recognize when they are stepping outside their areas of competence. It is incumbent upon engineers to engage the services of professional engineers from the appropriate different specialty, if they are entering an area beyond what they do.
- The speed of a tool may make it more difficult for practitioners to fully understand what it has done. The educational process must emphasize the importance of practitioners understanding what they are doing, i.e. understanding the process more than the tool.
- Rather than focusing on specific skills, education should produce a skilled generalist. Specific skills should be taught in a specific environment with student and employer forming a relationship.
- Tools and technology are created to help engineers work together, but what is happening is that tools developed in one discipline are being transferred to another discipline. Subsequently, there is a need for training to use the tool in the new discipline to which it's been transferred.
- There should be one interdisciplinary project or problem-oriented course yearly.
- There is no correlation between marks in university and competence.
- Maybe we should ask universities to test for knowledge that is interdisciplinary and problem-oriented, rather than discipline-specific.

2. The role of education

The following issues were raised:

- Notion of "push and pull" where universities "push" and industry "pulls".
- Industry wants to take over the teaching of specific skills.
- Universities need to produce leaders, people who will do things that have never been done before.
- Universities are trying to push out engineers with well-rounded, general training so that they can fit into most environments.
- A two-pronged approach is required, i.e. industry, with its resources, and universities have to work together so that industries' specific demands are met.
- Universities must fulfil their obligations to the public and at the same time produce engineers with great capabilities who can assimilate into the general market. Can they achieve this in four years? A five-year university experience may be the answer. Or should universities actively promote professional education after graduation?
- There are two types of students who enter engineering school: one in pursuit of the intellectual side of technology, the other to get the best job after graduation. To produce intellectual engineers, you must screen for intellectual students. And the future of engineering needs universities to produce intellectual engineers.

3. Role of industry in education, employment and demands for students

The following issues were raised:

- What does industry expect students to learn, and should they learn it in industry or in university? Industry has a responsibility to train people in the areas that are industry-specific; the issue is who speaks for industry? Where do people learn the material that is industry-specific? Is that part of the curriculum, or is it part of what an employer has to teach an employee in order to produce a trained professional who is industry-specific?
- The European student learns more theory than the Canadian student, who learns more practical information, e.g. design. The Europeans appear to want the North American educational model—less theory more practical information—because of graduates' ability to adapt to the needs of the company and creativity. However, particular European companies might not fit this picture.
- Canadian industry is very aggressive and competitive. Training employees is the means to survival. Whether employees are trained in school or by the company is not the issue. If employees are not trained, a company will not survive.
- The criticism heard most often from people that build what engineers design is that engineers must not have built anything to have come up with the particular design. Co-op programs are extremely helpful in this regard. Engineers receive an important part of their training by seeing what has been done, and they are able to calibrate their common sense. This is critical. Tools are putting engineers further up the ivory tower and are disconnecting them from physical reality. It makes it difficult to satisfy the needs of the people that have to work with what is produced.
- Universities should concentrate on teaching students how to learn. Being an engineer is a lifelong learning process.
- There may be more programs like the Master Engineering Telecommunications, a program fully funded by a $25,000 tuition that's shared between a company and its employee. This program is not supported by the taxpayer.
- Is four years enough to graduate engineers? A model being experimented allows top fourth-year students to take extra graduate courses over and above the normal undergraduate courses and speed up their Masters degree to within five years.
- The role of universities is not just to teach students how to think; the role is also moral and mental training.

4. Role of Societies and Governments

The following issues were raised:

- Will regulation be essential, necessary or relevant to engineers in the future?
- What is society's role in encouraging engineering careers?
- The engineering profession must speak out on issues that relate to the health and welfare of society.
- The role of engineering societies is to increase awareness and interest in technical fields (PEO/TVOKids co-production Engineers are Everyday Heroes was cited as an example of early education and role models.)
- Universities must create engineers who are deserving of the responsibility placed upon them.
- Industry must learn to appreciate the fact that engineers have a responsibility to protect society: Industry is impacted by its bad products. Engineers' paramount duty to protect the public actually is a benefit to industry.
- PEO, industry and universities must work together to encourage students to become professional engineers.
- The P.Eng. licence must be either required by legislation or its value as a quality signal shown.

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