CHALLENGES FOR ENGINEERS IN THE NEW MILLENNIUM- WASHINGTON ACCORD

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World'S population by 2030 is expected to reach to 8 billion from its current level of 6.5 billion. Dr. Paul Crutzen, the Nobel laureate in his special address on "The Anthropocene: The Current Human-Dominated Geological Era: Human Impacts on Climate and the Environment," introduced various scientific findings that suggest population growth and increased human activities are becoming serious burdens to the environment.

The question is, what should be done now and in the near future to ensure that the basic needs of all humans are fulfilled. The United Nations General Assembly of September 18, 2000 well defines this task as "Millennium Development Goals" (United Nations Development Programme, 2003).

It is obvious that this growth of population will create unprecedented demands for energy, food, land, water, transportation, materials, health care, etc.

The role of engineers will be critical in fulfilling those demands at various scales. Engineers have a collective responsibility to improve the lives of people in the planet. Engineering has driven the advance of civilization throughout human history. This is demonstrated from the metallurgists who ended the Stone Age; through the mechanisation of the Industrial Revolution; to the unprecedented pace of achievement in the 20th century where advancements including automobiles, air travel, computers and the internet revolutionized human existence in developed countries.

Maurice Strong, Secretary General of the 1992 United Nations Conference on Environment and Development, said, "Sustainable development will be impossible without the full input by the engineering profession."

Most engineering achievements of the past were developed without consideration for their social, economic, and environmental impacts on natural systems but now those are considered to be even more important than the technical aspects.

An issue of equal importance is the education of engineers interested in addressing problems specific to developing countries. These include water provisioning and purification, sanitation, power production, shelter, site planning, infrastructure, food production and distribution, and communication, among many others.

Engineering education, in general, has been undergoing significant changes in recent years with the arrival of groundbreaking technology.

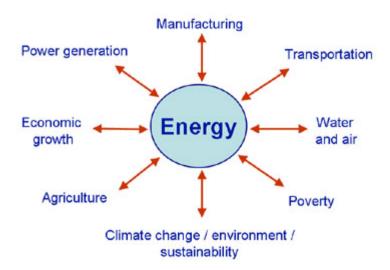
Furthermore, engineers will be critical to addressing the complex problems associated with refugees, displaced populations, and the large-scale movement of populations worldwide resulting from political conflicts, famine, shortages of land, and natural hazards. The engineer's role is critical to the relief work provided by host governments and humanitarian organizations. According to the World Health Organization (WHO), 1.8 billion people (30 percent of the world's population) currently live in conflict zones, in transition, or in situations of permanent instability.

It is clear that engineering education needs to be changed to address the challenges associated with these global problems.

A new, promising concept called earth systems engineering (ESE) has emerged as an alternative to the usual way engineering has looked at the world. ESE acknowledges the complexity of world problems and encourages the use of more holistic and systemic tools to address interactions between the anthrosphere (i.e., the part of the environment made and modified by humans and used for their activities) and natural and cultural systems.

In 1998, Allenby (1998) introduced the concept of ESE with reference to industrial ecology. The latter is defined as "the multidisciplinary study of industrial systems and economic activities, and their links to fundamental natural systems" (Allenby, 1999).

The engineer of the future applies scientific analysis and holistic synthesis to develop sustainable solutions that integrate social, environmental, cultural, and economic systems. Creating a sustainable world that provides a safe, secure, healthy, productive, and sustainable life for all peoples should be a priority for the engineering profession. Engineers have an obligation to meet the basic needs of all humans for water, sanitation, food, health, and energy, as well as to protect cultural and natural diversity. Improving the lives of the five billion people whose main concern is staying alive each day is no longer an option; it is an obligation. Educating engineers to become facilitators of sustainable development, appropriate technology, and social and economic changes represents one of the greatest challenges faced by the engineering profession today. What can we do to help ensure that our courses and curricula are optimally designed and delivered to provide disciplinary depth while at the same time helping to broaden the student's horizons and enthusiasm to address these and other globally urgent sustainable development challenges? Course curricula should be such that help students to begin to develop the multistakeholder, multi-disciplinary skills that are essential to helping them to be effective in sustainable development related issues when they are in their professional lives. Energy is central to sustainable development. According to the United Nations Development Program, energy affects all aspects of development-social, economic, and environmental-including livelihoods, access to water, agricultural productivity, health, population levels, education, and gender-related issues. None of the U.N. Millennium Development Goals (http://www.un.org/millenniumgoals/) can be met without major improvement in the quality and quantity of energy services. Needless to say, global energy consumption is expected to grow, especially in rapidly growing industrial countries like China and India. Major trends affecting the energy industry involve retooling, regulatory issues, the need for new refineries, and the promise of new "smart technologies," with fuel cells, superconductivity, clean coal technologies and renewable energy leading the way.



According to the Canadian Academy of Engineering, Engineering is a profession concerned with the creation of new and improved systems, processes and products to serve human needs. The central focus of Engineering is design and that:

- 1. Engineering graduates should be broadly educated and technically sound in their respective disciplines of study. They should be knowledgeable about the society in which they live.
- 2. Leaders of Engineering faculties should ensure that their faculty members have the vision, values and behaviours needed for their evolving role in preparing undergraduate and graduate students to function effectively in our rapidly changing world.
- 3. The original creative work done in Engineering faculties namely research and design, should be characterized by excellence, by relevance to industrial and social issues and by concern for the life of preparation of the graduate students involved.
- 4. Engineering faculties should reach out beyond their own students and help in providing a modern liberal education for all university students. They should also help in improving the technological literacy of all university graduates as well as the general public.

The best engineers will be the ones who can organize and work with others. Engineers who understand and apply systems engineering principles, regardless of their discipline, and who have the knowledge and background in product and process development, and those who possess project management skills, will take the forefront. The best opportunities will belong to engineers who know when to lead and when to follow, and can do either at the appropriate times. Engineers must be better managers, broader in their scope of knowledge, and keen visionaries. Students attracted to engineering today will work in a future of rapid innovation and changing social priorities.

The National Academy of Engineering, of the United States, has recently described a list of the grand challenges for engineering in the 21st century (http://imechanica.org/node/2908):

- Making solar energy affordable: How do you convert and store the power of sunshine at a cost competitive with fossil fuels?
- Providing energy from fusion: How do you sustain a controlled fusion reaction for commercial power generation?
- Developing carbon sequestration methods: How do you capture the carbon dioxide produced from fossil-fuel burning, and confine that excess carbon underground? Also conversion of Carbon dioxide to useful chemicals.
- Managing the nitrogen cycle: How do you develop countermeasures for fertilizer use, and other activities that contribute to pollution?
- Providing access to clean water: How do you address the short supply of water for personal use and irrigation in many areas of the world?
- Restoring and improving urban infrastructure: How do you renew aging infrastructure while bringing cities into better ecological balance?
- Advancing health informatics: How do you identify the specific factors behind wellness and illness, and follow through on the promise of personalized medicine?
- Engineering better medicines: How do you find new treatments for age-old scourges as well as newly emerging diseases?

- Reverse-engineering the brain: How do you unlock the secrets of brain function, to heal human diseases and advance the field of artificial intelligence?
- Preventing nuclear terror: How do you head off threats from agents who are bent upon bringing ruin to industrial society?
- Securing cyberspace: How do you protect the global information infrastructure from identity theft, viruses and other threats without bogging down the flow of data?
- Enhancing virtual reality: How do you use computer technology to create imaginative environments for education and entertainment?
- Advancing personalized learning: How do you move from a "one-size-fits-all" style of education to more engaging, computer-enhanced teaching techniques?
- Engineering the tools for scientific discovery: How do you improve our methods for exploring the frontiers of life, the atom and the cosmos?

In this global knowledge age --- with its serious problems and great opportunities --- we need the best and brightest to enter engineering schools. And we need a larger percentage of them to earn Ph.D.s in areas of engineering that can lead to innovations that will keep us free, secure, healthy, and thriving within a vibrant economy.

Globalization is forcing colleges and universities to change their approach to education and instruction. Globalization poses unique challenges for engineers, one of which is to understand the dynamics of the global marketplace. At the same time, engineers of one discipline should not be confined to knowledge in that particular discipline only, for example mechanical engineers will also be challenged to expand their learning beyond traditional single-discipline technical skill sets into multidisciplinary areas involving chemical, biological, and electrical systems.

The globalization of engineering is casting accreditation in a new light. There exists today a rising interest in international educational equivalency agreements and international practice agreements as the basis for recognizing engineering education programs across geographical borders.

The existence of many bilateral agreements prompted six countries in 1988 to meet and to develop the original Washington Accord, known then as the Six Nation Accord, which was signed in 1989. This was effectively the first major attempt to establish a benchmark for not only the level and content of the degree for engineers but also the accreditation process.

It is essentially a quality assurance process and is based on world best practice.

The Washington Accord, signed in 1989, is an international agreement among bodies responsible for accrediting engineering degree programs. It recognizes the substantial equivalency of programs accredited by those bodies and recommends that graduates of programs accredited by any of the signatory bodies be recognized by the other bodies as having met the academic requirements for entry to the practice of engineering. It is anticipated that the Accord will facilitate international mobility of engineering graduates and contribute to improving the quality of engineering education through benchmarking.

The signatories:

- 1. Accept that accreditation procedures are comparable.
- 2. Accept one another's accredited degrees from the date of admission as a Full Member.
- 3. Agree to identify and encourage implementation of best practice.

- 4. Accept mutual monitoring.
- 5. Accept that it applies to accreditations in home jurisdictions only.
- 6. Accept the need to encourage licensing and registration authorities to apply the agreement.

Membership:

Country	Institution	Year of joining
Australia	Engineers Australia	1989
Canada	Engineers Canada	1989
Ireland	Engineers Ireland	1989
New Zealand	Institution of Professional Engineers NZ	1989
United Kingdon	Engineering Council UK	1989
United States	Accreditation Board for Engineering and Technolo	ogy 1989
Hong Kong Chi	na Hong Kong Institution of Engineers	1995
South Africa	Engineering Council of South Africa	1999
Japan	Japan Accreditation Board for Engineering Education	ion 2005
Singapore	Institution of Engineers Singapore	2006
Chinese Taipei	Institute of Engineering Education	2007
Korea Acci	reditation Board for Engineering Education of Korea	a 2007

^{*}Institutions accepted as provisional members are potentially suitable for the purposes of the Accord. Qualifications accredited or recognized by organizations holding such provisional status including that of NBA-AICTE are not recognized by the signatories and as such the courses offered by NBA accredited institutes will not be eligible for full benefits under the Washington Accord which include credit transfers.

Provisional members*

Germany	German Accreditation Agency for Study Programs in Engineering and Informatics
India	National Board of Accreditation of All India Council for Technical Education
Malaysia	Board of Engineers Malaysia
Russia	Russian Association for Engineering Education

Engineering is a powerful and transformative force in this world. The engineering community must continue to assert its global leadership and take advantage of its recognition in emerging markets to succeed in meeting the present and future challenges of our world.

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