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EDUCATION FOR DEVELOPMENT

Number 15

December 2008

WFEO

Committee on Education and Training
World Federation of Engineering Organizations

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WORLD FEDERATION OF ENGINEERING ORGANIZATIONS
FEDERATION MONDIALE DES ORGANISATIONS D'INGENIEURS

COMMITTEE ON EDUCATION AND TRAINING

JOURNAL IDEAS No15, December 2008

IDEAS is a publication of the WFEO Committee on Education and Training, addressed to engineering educators, educational officers at Universities and leaders responsible for establishing educational policies for engineering in each country. The articles it contains reflect the concern of people and institutions linked to WFEO, to provide ideas and proposals with the object of improving formation of engineers.

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Editor: Prof. Włodzimierz Miszalski,
PL-00-043 Warszawa, ul. Czackiego 3/5. phone: +4822 827-16-86
e-mail: wmiszalski@wat.edu.pl

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Contents

WFEO-CET CHRONICLE OF EVENTS

EDITORIAL

Education for Development

Prof. Włodzimierz Miszalski – President of the WFEO Committee on Education and Training

The tribute to Hisham Shihaby written by Dr Peter Greenwood opens the 15th number of IDEAS. The sudden death of Eng. Hisham Shehaby has both astonished us and painfully touched. We have lost Vice President of WFEO, Vice President of WFEO Committee on Education and Training and what is worse – a good sincere and understanding friend who helped me to manage the Committee since the beginning of my term. He did not move in this world as somebody who is "entitled to" or whom something was ought to. His presence always told us: "here I am, ready to contribute, what can I do for you?". His commitment to his work, his generosity to our causes and all the care he took to "get things right" impressed me so much. I remember his immense sense of humor and his warm smile. He was and is an inspiration for engineering education community. We all will miss his generosity, his attitude before life and people, his kindness and wisdom. His life and work are excellent examples of dedication to international engineering movement, to engineering education, to education for development which is the motto of IDEAS No.15.

The notion of *development* as the opposite of stagnation, slowdown, regression, slump or decline – seems to be more precisely defined when related to certain goals, certain more advanced states or certain positive tendencies – considered within the determined system of values. The UN Millennium Development Goals described in Dr Tony Marjoram's paper with references to knowledge, science and technology help to define social, economic and cultural development and to realize the challenges faced by engineering education community. Prof. Miguel Angel Yadarola devoted his presentation to the expectations and hopes that the developing countries of Latin America are waiting to be fulfilled through the activities of a new generation of well trained engineers. The list of the new or redefined abilities as a result of the formation of a new type of engineer for Latin America has been presented. In my paper – consecutive in the series of articles devoted to the idea of World University of Technology for which one of the mission components would be engineering education for development – I tried to justify the proposed outline of the organizational structure of the University.

Prof. Hae Ja Shin in her article on career development of South Korean female scientists and engineers employed in small and medium industrial enterprises – presents the well statistically supported survey of their job satisfaction, competence and difficulties in job performance. This paper among others helps the reader better understand the relations between academic programs, choice of job and career development. Career development – particularly in terms of international assessment and recognition of engineers' qualifications in order to promote the mobility – has been also the subject of Dr Peter Greenwood's paper. The ideas and conclusions included in this paper – after discussion during the 38th CET Meeting in November 2008 in Brasilia and after presentation to WFEO Executive Council – have been approved as the foundations of the WFEO policy on mobility. The energy and climate change problems as well as the consistency of technological development with the laws of nature have been presented in Prof. Vollrath Hopp's paper on the role of engineers in the worldwide discussion on the mentioned above issues. One of the conclusions consists in stressing the importance of teaching students of engineering political thinking and increasing the participation of engineers in political bodies.

The Chronicle of Events covers the period between October 2007 and December 2008 and records the most important CET events and activities.

Thanking the Distinguished Authors for their contribution to this edition of IDEAS – I would like to recall: **"Education for Mobility", "Education for Innovation" and "Education for Development"** – as the three recent subtitles of IDEAS which reflect the three great challenges for engineering education at the beginning of 21st century – also the CET areas of interest during recent three years as well as the Committee contribution to WFEO works. I would like also to thank the CET Members who helped me to select the contents, Mrs. Teresa Domańska CET Secretary and Mrs. Anna Jachimowicz who prepared the edition of IDEAS No.15.

Hisham A Malik-Al-Shehaby

farewell from everyone involved in WFEO Committee on Education and Training

Engineers respect and value many things related to their profession and the people they work with. These attributes include competence, professionalism, hard work, leadership, loyalty, ethical behaviour and culture.

Sometimes “working with” even means “live with” physically on some projects, and in these days of electronic communications, it can even mean “live with” metaphorically on long international projects. All need good relationships.

Every so often someone comes along with many more of these characteristics than normal. Hisham Shehaby was one of these people. He also had a sense of humility and a great sense of humour. He formed many friendships.

Serendipity plays a part in many of the things we remember in our lives. I first met Hisham because the delegations of Bahrain and Australia were seated next to each other in the General Assembly in Tunis in 2003. I sat next to Hisham just five years ago.

It was my first WFEO attendance. Barry Grear was pointing out important people and making introductions. In the lead up to the General Assembly I listened to the things Hisham was saying in committee and council discussions. Many were points to which I related strongly and I empathised with his thoughts. Hisham and Barry had work closely on governance matters and were clearly very highly regarded by the delegates. Hisham was also very interested in education and training which had always been important issues for me.

I then had close up demonstration of Hisham's thoughtful contributions, sitting next to him during a long meeting. In one of the breaks Hisham talked about a project he was doing for his government. He had heard I might have experience of similar things. That conversation began a regular exchange of communications and ideas.

Hisham was a tireless worker and a true forward thinker trying to bring education and training opportunities to our wider membership. He spoke passionately but persuasively for his beliefs. Behind the scenes he was also a very effective counsellor and conciliator, bringing people together to share their skills and their cultural differences to form a WFEO view on education and training.

He was a crucial supporter of CET who will be difficult to replace. He will be greatly missed for his CET role alone but it was only one of his WFEO contributions.

With Prof. Włodzimierz Miszalski, Chair of CET, at the SMES Conference in Cracow, 2007

Such a significant standing-committee role is usually all WFEO delegates can find time to do and all WFEO would hope for from them. But Hisham repeated his CET contribution in the Executive Council and Board as well as in the wider governance of WFEO. He continued to do important work on the constitution and strategic planning.

Hisham's talents were recognised by all the delegates. Those delegates could also see and recognised his leadership role among Arab countries. Much of his invaluable work I believe was done behind the scenes with individuals and between the various critical groups that make WFEO work.

It goes without saying that Hisham was recognised for the underpinning attributes of an engineer I mentioned earlier. His loyalty, ethical behaviour and friendship, were outstanding. Hisham was loyal to his profession, his organisations, his friends and his beliefs. He was also fiercely ethical.

With Tahani Youssef, WFEO Executive Director

I have left culture to the last. Hisham was loyal to his culture. It was evident that it was part of him. He also acknowledged the many cultures of the other WFEO delegates. But he saw his culture fitting into the broader environment of WFEO, which in turn sits within the ideals of UNESCO and the United Nations itself.

With Tony Marjoram, UNESCO Senior Program Specialist in Cracow, 2007

I do not know anyone who didn't admire Hisham a Malik Al-Shihaby's contribution and respect the things he did and the way he did them.

We offer our condolences to Hisham's family and thank them for the time he spent with WFEO, when he was not with them.

Peter Greenwood, colleague and friend.

Engineering and Development, Foresight and Risk

Dr Tony Marjoram, CPEng, FIEAust
Senior Programme Specialist, Head of Engineering Sciences
Basic and Engineering Sciences, Natural Sciences Sector, UNESCO, Paris

Dr Tony Marjoram is the Senior Programme Specialist responsible for Engineering Sciences and Technology in the Division of Basic and Engineering Sciences of the Natural Sciences Sector of UNESCO, and has worked for UNESCO since 1993. Dr Marjoram has over 25 years international policy, planning and management experience in engineering, science and technology for development, relating to innovation, foresight, poverty reduction and emergency response, and has worked in university, intergovernmental and NGO contexts. He has a B.Sc. Hons in mechanical engineering, an M.Sc. in science and technology policy and his Ph.D. is on technology for development. He is a Chartered Professional Engineer and Fellow of the Institution of Engineers Australia, and is a member of the UN Millennium Project Task Force on Science, Technology and Innovation. Dr Marjoram has worked at the universities of Melbourne, Manchester and the South Pacific, has published over 50 papers, articles and reports in national and international journals and is a member of the boards of several journals and organisations.

Abstract

Knowledge is vital for social and economic development and addressing the UN Millennium Development Goals (MDGs) – especially poverty reduction and sustainable development. Knowledge includes, most importantly, engineering, science and technology (EST) and innovation. Knowledge, especially in EST, is shaped by society and in turn shapes society as a major factor in social change and transformation. Knowledge application has costs and risks as well as benefits, however, and requires knowledge and wisdom. Knowledge also requires capacity – human and institutional, infrastructure and applications, which in turn requires education, training and capacity-building, dissemination, diffusion and foresight regarding EST and social change. The importance of knowledge in social, economic and cultural development has been emphasised in many international meetings, reports and by many world leaders. EST and innovation are vital in addressing the MDGs at two levels – at the macro–economic level and in micro-level

applications. Innovation and engineering applications are not just hi-tech, however, and also includes the introduction of technology that is new to the user and user-group.

Engineering, science and technology and innovation are vital for sustainable development – which is not just an environmental issue, and addressing climate change is one of our most specific and pressing needs. The Intergovernmental Panel on Climate Change has emphasized the importance of mitigation, adaptation and technology. Climate change is one of the biggest risks and challenges faced by humanity, and relates particularly to engineering, science and technology. Approaches to risk and disaster have been technocratic – risks are multidimensional, and there is a need for a multidimensional approach. There is also a need to re-think risk regulation, education and standards, and the use of foresight to better analyse, assess and address emerging risks. In addition to the need for knowledge and wisdom, there is also a need for policy assistance in technology innovation, foresight and risk. This presentation will discuss these issues, UNESCO activities and challenges in these areas, and challenges for now and the future.

KNOWLEDGE AND DEVELOPMENT

The generation and application of knowledge drives social, economic and cultural development, and is essential for addressing the reduction of poverty, sustainable development and the other UN Millennium Development Goals (MDGs). Knowledge relates particularly to engineering, science and technology (EST), and the importance of such knowledge, application and associated capacity-building has been of increasing recent interest, in the context of “knowledge societies”, “knowledge economies”, “clever countries” and similar epithets. The reality is that knowledge has always been a vital factor in human development – homo erectus is the tool making ape, and our use if tools is reflected in the very names of the Stone Age, Iron Age, Industrial Revolution and Information Age (and, as someone once said, the Stone Age did not end because they ran out of stones). Technological knowledge development, sharing and application will be vital in addressing the major sustainability challenge – climate change mitigation and adaptation. Despite this, the importance of engineering, science and technology in development is often overlooked. This is another major challenge.

Knowledge and knowledge application in EST not only drives development, it is also a major factor in shaping social change and transformation – technology reflects the political-economy of decision making. At the same time, EST and related socio-technical systems and technological trajectories are shaped by society, and EST is an essential part of culture. Major issues and challenges relating to knowledge and development include access and application, and the increasing knowledge divide between rich and poor countries. Knowledge divides us, especially knowledge in EST – the “knowledge divide” is more serious than the “digital divide” (which is a part of the larger knowledge divide) or divisions based on economic criteria (which are driven by knowledge).

Important considerations relating to knowledge and development in EST include the following:

- How well does EST and related socio-technical systems that were developed in industrialised countries address changing sustainability needs around the world?

- How well does EST and related socio-technical systems transfer to developing countries, with less technological infrastructure?

- How well does EST address broader developmental needs and relate to the values and cultures of developing countries?

These consideration underline the complexity and importance of knowledge management and transfer. Knowledge production and application has costs and risks as well as benefits, and requires thoughtful understanding and careful management, especially as the power of knowledge increases and the potential for unforeseen consequences, as epitomized in the discussion of climate change, and reflected in a wider catalogue of risk and disasters.

Knowledge in EST for development requires:

capacity – human, institutional, infrastructure, and applications.

This in turn requires:

education, training, human and institutional capacity-building.

Which also requires:

knowledge dissemination and diffusion, and
foresight – regarding EST, social change and transformation.

The importance of knowledge in social, economic and cultural development has been emphasised at major international summits and conventions:

- World Summit on the Information Society, Geneva, Tunis, 2003/5

- World Summit on Sustainable Development, J'burg, 2002
  and Decade of Education for Sustainable Development, 2005-14

- World Conference on Science, 1999

- World Engineers' Conventions – in 2000, 2004
  (the 2008 WEC will focus on innovation and social responsibility)

The importance of engineering, science and technology and innovation for development, and associated capacity building, has been emphasised in recent reports, including:

- UN Millennium Project Task Force report:
  "Innovation: Applying Knowledge in Development", 2006

- Commission for Africa, report:
  "Our Common Interest", 2005

- InterAcademy Council, report:
  "Inventing a Better Future: A Strategy for Building Worldwide Capacities in Science and Technology", 2004

Increased interest in innovation and development is also reflected international meetings of heads of government:

- G8 – Gleneagles commitments on aid, debt relief, export subsidies, development of infrastructure and education, 2005

- African Union Summit on the theme "*Science and Technology and Research for Africa's Development",* 2007 (which stressed the importance of science, technology and human resources in supporting the continent's efforts to alleviate poverty and achieve sustainable development, and was the first overseas commitment of Ban Ki-moon as new UN Secretary-General)

- New Partnership for Africa's Development (NEPAD) programme on science and technology

- "Global Forum on Building Science, Technology, and Innovation Capacity for Sustainable Growth and Poverty Reduction", World Bank, February 2007

These sentiments have been endorsed by UN and industry leaders:

Koïchiro Matsuura, Director General, UNESCO

> *Science and technology are vital for development around the world – we need to promote international activity in science and technology for lasting development.*

Ban Ki-Moon, Secretary General, UN

> *One of the most effective channels for eradicating poverty, creating wealth and enhancing competitiveness is through the acquisition, adaptation and application of relevant technologies.*

Kofi Annan, former Secretary General, UN

> *I challenge all of you to mobilize global science and technology to tackle the interlocking crises of hunger, disease, environmental degradation and conflict that hold back the developing world.*

Bill Gates, Microsoft – to President Hu

Technology is the key, the essential enabler.

EST FOR POVERTY REDUCTION AND THE UN MILLENNIUM DEVELOPMENT GOALS

There are eight UN MDGs, together with 18 quantifiable targets that are measured by 48 indicators. The eight MDGs are:

1. Eradication of extreme poverty and hunger.
2. Achievement of universal primary education.
3. Promotion of gender equality and empower women.
4. Reduction of child mortality.
5. Improvement of maternal health.
6. Combating HIV/AIDS, malaria and other diseases.
7. Ensuring environmental sustainability.
8. Develop global partnerships for development.

Engineering, science and technology and innovation are important in addressing all MDGs, especially MDGs 1 and 7 – the reduction of poverty and hunger and promotion of sustainable development. Poverty is mainly a reflection of the limited access of people to knowledge and resources with which to address basic and related needs – these include water supply, sanitation, housing, food production, energy, transportation, communications, income generation and job creation.

It is interesting to observe, however, that reference to knowledge, science and technology was almost overlooked in the MDGs, and is only mentioned in one of the targets relating to MDG 8 - in the context of the use of new technology and ICTs in developing global partnerships for development. As noted above, the importance of engineering, science and technology in development is often overlooked – this is another major challenge.

EST and innovation are vital in addressing the MDGs, especially poverty reduction at two particular levels:

macro-economic/infrastructure development,
micro-level direct applications.

At the macro level, as mentioned, EST and innovation drives and supports economic, industrial and infrastructure development. This is commonly supposed to reduce poverty through a general process of wealth creation, even though economic "growth theory" has been critiqued on grounds of limited distribution or "trickle down" to the poor (by Stiglitz, Easterley and others) and questions of resource sustainability following the "limits to growth" debate since the 1970s, has been seriously discredited. Micro-level direct applications have been seen to be more effective in poverty reduction, especially when the innovation of smaller-scale technology is supported by micro-finance, where necessary. Despite the success of such an approach and support by NGOs, however, support for such activity remains limited among development economists, aid donors and recipients.

EST and innovation is of vital importance in addressing the MDGs, especially poverty reduction. Poverty is a reflection of the limited access of people to knowledge and resources to address basic needs, including water supply, sanitation, housing, food production, energy, transport, communications, income generation and job creation. At the direct, micro level, EST and innovation are vital to address these basic needs, where micro-innovation often requires micro-enterprise and the need for micro-finance.

UNESCO has a particular interest in innovation, development and poverty reduction, and co-organised an international conference on "Innovation for Development" in Paris in May 2007, in conjunction with the European Association for the Transfer of Technology, Innovation and Industrial Information (TII). Speakers and participants included innovation specialists and managers, representatives of international organisations including the World Bank, OECD, WIPO, the European Commission and European Investment Bank, UNIDO, UNESCO delegations and national development agencies. The conference included sessions on technology and innovation for development, north-south university partnerships, exchanges with emerging countries, innovation support policies, services and management, knowledge transfer from the research base, corporate social responsibility and public-private partnerships. The concluding plenary session included a panel discussion and the production of a "Paris Statement on Innovation for Development". One of the main recommendations of the conference was the need to develop a network on innovation for development.

The conference emphasised the importance of innovation for sustainable economic development, and highlighted various support measures, policies and programmes that have contributed to successful innovation, with particular reference to developing countries and the MDGs. The conference also emphasised that innovation depends upon the development of products or services with a competitive advantage, responding to market needs and acceptance, making effective use of natural and financial resources, human and institutional capacity in research and development, in a public environment that is supportive of private sector entrepreneurs and enterprise. Innovation and the transfer of technology is particularly facilitated by the employment of young graduates familiar with current knowledge, financial support for research in key areas, effective intellectual property asset protection and management, the dissemination and commercial exploitation of research results and new technologies through licensing agreements and contract research, spin-off companies that commercialize university research, as well as legal and business support services which help entrepreneurs succeed in complex business environments.

The innovation community resolved to develop an action plan to address the MDGs and related issues, especially climate change, with the following 11-point plan recommendations to:

1. assist developing countries in promoting innovation, entrepreneurship and associated support policies, capacity building, staff exchange schemes, studentships and information exchange, in order to build comprehensive and efficient innovation support systems;

2. develop strong partnerships with developing country counterparts, especially European research and cooperation partner countries;

3. help increase research and innovation capacities in developing countries with support funds, including European funding facilities, the World Bank and the BERD;

4. support, protect and disseminate research results from developing and emerging countries, through patenting and equitable contract practices, support entrepreneurship, incubation and technology transfer, financial tools and associated policies and investments;

5. assist governments in helping to promote innovation for development and to address the Millennium Development Goals, and calls upon UNESCO and other UN, European, national, regional and financial organisations to be partners in this process, including all stakeholders in innovation and technology transfer;

6. invites partnership in the following areas of service and activity:

    - facilitating dialogue between policy makers and innovation support practitioners in developing and emerging countries to improve the uptake and application of innovation support services,
    - competence building and professional skills development through seminars, workshops, summer schools, quality control, innovation management techniques and the exchange of good practice,
    - increasing education capacities entrepreneurship, technology commercialization and innovation in developing countries,
    - consensus building support among all types of innovation support practitioner through seminars, workshops and advice,
    - information, dissemination and networking activities including the development of website and associated resources, professional directory, events calendar, organisation of international, national and regional activities, monitoring and brokerage with support services and funds.

Examples of innovation and direct engineering applications at the micro-level indicate that such applications include all levels of technology, and that innovation includes introduction of technology that is new to the user and user-group. This is illustrated in the following examples of a foot-operated water pump for African irrigation and water supply and the ‘Ujeli’ stove from Nepal that combines improved efficiency and reduced smoke with thermo-electric generator to power indoor lights (from the Daimler-UNESCO Mondialogo Engineering Award – ‘Ujeli’ means light in Nepali).

EST FOR SUSTAINABLE DEVELOPMENT AND CHANGING CLIMATE

The Brundtland definition clarifies sustainable development as:

> *"Development that meets the needs of the people today without compromising the ability of future generations to meet their own needs".*

This definition was reasserted at the World Summit on Sustainable Development in 2002, where three pillars of sustainable development were adopted that focus on environmental protection, economic development and social equity. These pillars are interdependent and must be addressed at the same time to achieve the Millennium Development Goals. It is important to emphasise that sustainable development is not just an environmental issue, and that engineering, science and technology and innovation are vital for sustainable development, in such areas as:

- environmental/ecological engineering,
- waste management, water supply and sanitation,
- cleaner production and recycling,
- energy efficiency, conservation and renewable energy,
- monitoring and evaluation.

UNESCO is particularly committed to sustainable development, and is the coordinating agency for the UN Decade of Education for Sustainable Development (2005–2014). As noted above, human and institutional capacity, education, training, human and institutional capacity-building, knowledge dissemination and diffusion, and foresight regarding engineering, science and technology and innovation, social change and transformation are a central and essential component of the UN Decade of Education for Sustainable Development. UNESCO activities in this field include:

"International Workshop: Engineering Education for Sustainable Development"
Tsinghua University, Beijing 2006, co-organised with WFEO

"SudVEL Virtual Engineering Library for Sustainable Development"
A pilot project based at the University of Khartoum

"Introduction to Sustainable Development for Engineering and Built Environment Professionals"
An e-publication from the Natural Edge Project, Australia

EST, INNOVATION AND CLIMATE CHANGE

Climate change is the most specific and pressing need for engineering, science and technology and innovation in sustainable development. The Intergovernmental Panel on Climate Change emphasises climate change mitigation, adaptation, technology, finance and investment. Key mitigation and adaptation issues relate to technologies in such areas as: energy supply, efficiency and conservation, transport, building construction, industry, agriculture and forestry.

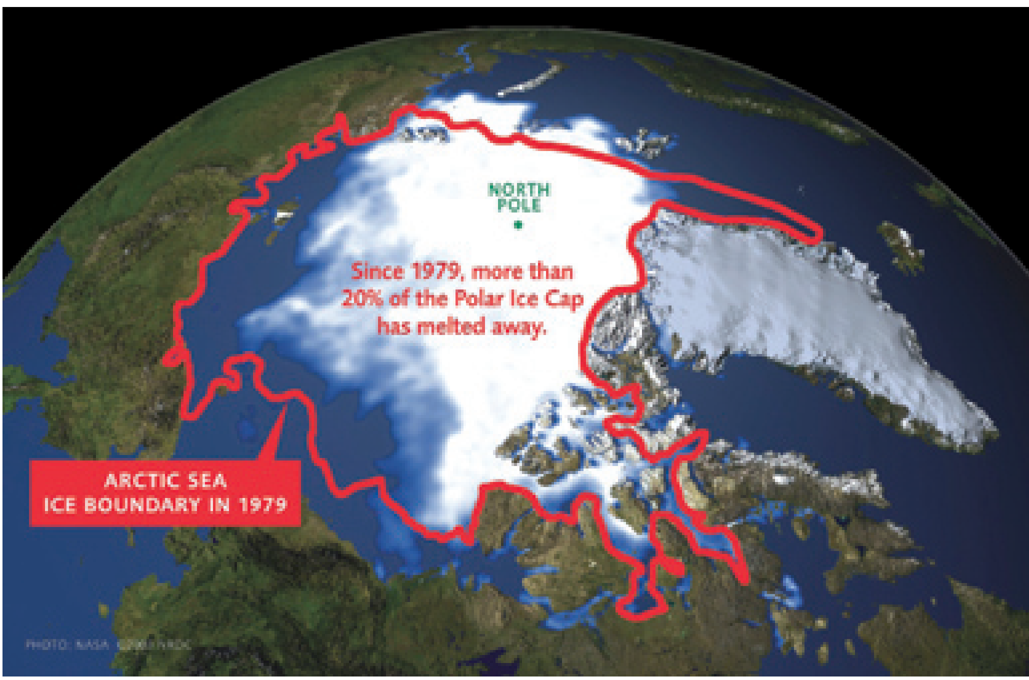
The reduction of greenhouse gas emissions relates particularly to the use of high-emission technologies, the need for more efficient available technologies and the promotion of research, development, demonstration and investment in new technologies, including carbon capture and storage technologies.

The major findings of the Intergovernmental Panel on Climate Change (IPCC) are that:

- the planet has warmed,

- greenhouse gases continue to increase,
- climate models have greatly improved,
- most warming most likely due to greenhouse gases,
- emissions of greenhouse gases will continue to rise through the 21st century,
- global warming will continue through the 21st century (*Graeme Pearman, Australian Climate Group, also review editor IPCC Working Group 2 Report "Impacts, Adaptation and Vulnerability" and contributor Fourth Assessment report "Climate Change 2007"*).

Small changes of temperature can have a big impact in terms of climate change, as indicated by this map of the Arctic sea ice boundary over the last 30 years:



Graeme Pearman, Australian Climate Group

It is also to be hoped that small responses in terms of technology and human behaviour can also have a big impact on climate change. Specific options include:

- improved end-use efficiency,
- higher efficiency combustion technologies,

- new automotive technologies,

- decentralized power generation,

- affordable renewable technologies,

- capture and sequestration of CO_2 from power plants (*Graeme Pearman, Australian Climate Group*).

Climate change affects our environment, our societies and cultures. Finding solutions to mitigate the negative impacts and adapt to changing conditions requires an approach that combines science with society, culture, education and information. UNESCO has an increasing number of activities across these programme sectors, and provides a unique forum for addressing climate change and its impacts on the environment and society. These activities in EST include the organisation of conferences on the theme of technology and climate change: challenges and opportunities for mitigation and adaptation.

RISK AND RISK MANAGEMENT

The concept of risk relates to the chance of hazard, danger, threat or loss to person, property or goods, the level of vulnerability, and potential for impact. Risk is a probabilistic function of three variables (Wikipedia):

1. the probability that there is a threat,
2. the probability that there are any vulnerabilities,
3. the potential impact.

As any of these variables approach zero, so does the overall level of risk. The assessment of risk is the work of an actuary, and the management of actuarial risk is risk management. A list of high-risk hypothetical future disaster scenarios includes the following (Wikipedia):

Overpopulation	Antibiotic resistance
Over consumption	Nuclear warfare (MAD)
Resource crisis	Famine
Energy crisis - peak oil	Terrorism
Water crisis	Technological singularity
Drought	Mega earthquake
Deforestation	Super volcano
Desertification	Mega tsunami
Over-fishing	Meteorite impact
Pandemic (e.g. SARS)	Global warming

Gulf stream shutdown as can be seen in this table, risk relates to geohazards and natural catastrophes (and associated scale and vulnerability), and catastrophes relating to technological, political or social systems, negligence, error, corruption or specific vested interests – man-made catastrophes. Many potential risks and catastrophes relate to the interactions between nature and human activity in engineering, science and technology – EST can be seen as part of the problem, and part of the solution. EST can bring benefits to some, and costs to others. Emerging risks relate to emerging technologies – including nanotechnology, biotechnology and pharmaceuticals, globalisation and "transferred" risks (i.e. risks transferred from one place or time to another – e.g. heavy and polluting industry relocating from developed countries, pollute today and pay the price tomorrow).

Approaches to risk and disaster have been technocratic – risks are multidimensional, and there is a need for a multidimensional approach. The management of risk relating to EST and sociotechnical systems requires greater global cooperation (of which discussions relating to climate change and the Kyoto Protocol are a part). There is also a need to re-think risk regulation, education and standards. The need for greater global cooperation regarding climate change were reflected at the UN Climate Change Conference in Bali, November 2007 – where the delegate from Papua New Guinea in response to the position of the US delegation and the need for action, mentioned that **"We seek your leadership. But if for some reason you are not willing to lead, leave it to the rest of us. Please get out of the way." This lead to a** US back-down, and the way forward to the adoption of the "Bali Road Map" and two further years of climate change discussions.

EST AND FORESIGHT

Foresight relates particularly to visions and scenarios of the future mediated by EST – of costs, and risks, as well as purported benefits. Foresight relates to opportunities and challenges, implications for society, policy and planning, how emerging problems could be better foreseen, and how emerging EST could address emerging problems. As noted above, as well as a greater global need for cooperation, there is also a rapidly increasing need for greater global perception of present and emerging issues and challenges.

There is a particular need to share and discuss the results of foresight exercises and foresight work relating to risks transferred from elsewhere with developing countries, and to support futures and foresight awareness, preparedness and capacity building in those countries.

UNESCO attaches great importance to foresight and related activity, as part of it overall mandate and areas of activity in science, social science, education, culture, information and communications, as a:

Laboratory of ideas and standard-setting
for world conferences, reports, conventions

Clearinghouse
for the sharing of information and knowledge

Capacity building

human, institutional and infrastructure

To facilitate

international co-operation and intercultural dialogue

UNESCO interest in technology foresight relates mainly to the promotion of EST, innovation and foresight for development, including risk analysis, assessment and management. This activity is in the broad field of knowledge management, and relates to EST policy, and the inclusion of EST in economic, financial and strategic policy. In developed countries the promotion of such issues involves established "policy drivers" (such as academic and industry interests, institutions and lobby groups). Such human and institutional capacity is often limited in developing countries, where is a need for information and support for policy drivers This is an important issue and challenge for international cooperation. To address this theme, UNESCO is planning to hold an "International Forum on Science and Technology Futures, Foresight, Policy and Planning" and to develop an activity on "Technology and Climate Change: Challenges and Opportunities for Mitigation and Adaptation in 2008-09".

CONCLUDING REMARKS – SCENARIOS FOR EST AND DEVELOPMENT, GLOBALIZATION AND RISK

At a time of increasing globalization and risk, we face particular challenges, for now and the future, relating to EST, innovation and foresight for the MDGs, especially poverty reduction, sustainable development and climate change. These include:

- human and institutional capacity/capacity building,
- macro-level social economic and infrastructure development,
- micro-level direct applications of technology,
- policy making, decision making, strategic planning, risk analysis,
- providing information and knowledge sharing,
- promoting international cooperation,
- social, cultural dimensions of foresight activity and implications,
- technology awareness, technology watch, technology scan,
- advocacy and awareness-raising regarding foresight, risk.

In this context, there is an important need to develop and share knowledge management and policy instruments promoting EST, innovation and foresight for development. This includes the development of:

- EST and innovation knowledge management, foresight studies and policy development, including risk analysis, assessment and management, and associated knowledge sharing and exchange,

- human and institutional capacity and capacity building and the sharing of information, expertise and good practice in EST and innovation knowledge management, foresight and awareness capability and policy development,

- better linkages between EST, innovation and foresight and broader issues of economic, financial and strategic policy,

- Better linkages between EST, innovation and foresight with international development and the MDGs, especially poverty reduction, sustainable development and climate change,s

- better integration of EST, innovation and foresight issues into Poverty Reduction Strategy Papers (PRSPs), debt relief and associated policy instruments, and effective implementation of PRSPs and associated policy instruments,

- better recognition of the role and importance of technology in sustainable development, especially in climate change mitigation and adaptation,

- need support policy actors, lobby groups, donors and related groups with advocacy material, information and personal contacts to promote EST and innovation knowledge management, foresight studies and policy development for the MDGs, especially poverty reduction, sustainable development and climate change,

- need to engage with relevant national, international and intergovernmental bodies and organisations, such as UNESCO and WFEO, to achieve the above.

The Future of Engineering in Latin America

Presented at the Global Summit on the Future of Mechanical Engineering
American Society of Mechanical Engineers – April 17, 2008 – Washington DC

Prof. Miguel Angel Yadarola, Argentina
Past President of WFEO-CET

Prof. Miguel Angel Yadarola – Civil Engineer at the National University of Cordoba (UNC), Argentina (1955). Chair Professor Department of Physics (UNC) during forty years. Was distinguished when retired as Consulting Professor of the University. Also Plenary Professor University of Belgrano, Buenos Aires. Member of the National Academy of Education and the Academy of Engineering Buenos Aires. President Pan American Academy of Engineering since 2000. Received Argentine Engineering Award 1982 and Pan American Engineering Award 1986. Received the WFEO Outstanding Service Medal 2003. Member since 1977 of WFEO-CET and President of the Committee 1989–1997. Twice National Member of WFEO Ex.Co. 1985–89, 1997–2001. Vice President of UPADI 1997–2001. Presented 150 papers at Congresses and Seminars. Advisor, Ministry of Education (Argentina) for the Engineering Accreditation Standards, Consulting Professor at National University of Cordoba.

Abstract

South America has the privilege of being the first Region of the world that decided to create an international society of engineers gathering the national organizations that existed in each country. This occurred in 1935.
The Pan American Academy of Engineering is the first organization in the world gathering individually engineers from different countries committed to work for the improvement of the quality of life of the nations of the Latin America.
During more then 50 years of existence, UPADI can show a profitable activity to enhance the practice of the engineering profession and for the improvement of the education of future engineers.
In almost all our countries there are already implemented or on the way to implementation, different evaluation and accreditation systems that apply standards and evaluation procedures similar to those of ABET, EMF and others.
Globalization aims at progress with equity and participation and means for our developing countries of Latin America an opportunity to reach economic welfare, social cohesion and political liberty.

How does globalization impact on the formation of the new type of engineer that Latin American countries need?
What are the new abilities induced by globalization?

THE PAN AMERICAN ACADEMY OF ENGINEERING

In August 2000, UPADI, the Pan American Federation of Engineering Societies summoned in Panama the Foundation Ceremony of a new kind of engineering society with the nature of a professional corporation formed by engineers selected initially by the Member Organizations.
The Pan American Academy of Engineering is the first organization in the world of this kind gathering individually engineers from different countries committed to work for the improvement of the quality of life of the nations of the Continent.
The Academy has up to this year 2008, 80 Members of the different countries of the Americas and 8 Corresponding Members coming from Europe and Asia.

During its short existence the Academy has obtained a solid position as a representative group for the concerns of the engineering of the Americas, analyzing and proposing policies that are beneficial for the progress of the engineering profession and for the sustainable development of mankind. There, are the results of the Forums: on Cooperation for the Technological Development held in Tegucigalpa in 2002, on Accreditation in the Regional Context held in Montevideo 2003, on Ethics and Integrity in the provision of Engineering Services in Mexico 2004, on International Practice of Engineers in Atlanta, Ga USA in 2006 and surely will be the results that we can expect from the Forum to be held this year 2008 in Brasilia, on “Strategies to Reduce Global Warming through Engineering”.

THE LATIN AMERICAN REGION

Though the Academy covers with its Members the entire territory of the Americas I was included in the Summit’s previous Program as a speaker for Latin America and this circumstance allows me to orient this presentation to the aspirations and hopes that the nations of this particular Region of the world are waiting to be fulfilled through the activities of a new generation of well trained engineers.
Those of us who live in Latin America cannot understand why this Subcontinent shows symptoms of a slow growth, possessing great natural riches that are strategic resources, in some cases indispensable for life.

All developing countries in Latin America are confident that these and other natural resources properly combined with adequate technologies and the commitment made by all States in the UN Millennium Declaration can “make development a reality for everyone, eradicating poverty but also protecting our planet from environmental degradation”.
This is a great challenge for Latin American engineering that will demand from each engineer a broad vision of his profession and new ways of interacting with the society.

THE ENGINEERING ORGANIZATIONS

Latin America or more precisely, South America has the privilege of being the first Region of the world that decided to create an international society of engineers gathering the national organizations that existed in each country. This occurred in 1935, when the South American Federation of Engineering Societies (USAI) was created in Buenos Aires.

The Second World War interrupted the negotiations of the leaders of USAI with engineering organizations from Mexico, USA and Canada aimed at creating a continental federation and this idea had to wait until 1949 when UPADI, the Pan American Federation of Engineering Societies was created in Rio de Janeiro, Brazil.

During the 59 years of existence, UPADI can show a profitable activity to enhance the practice of the engineering profession and for the improvement of the education of future engineers. Worthy is the work of the Technical Committees, with the participation of qualified experts and the results of the Pan American Congresses on Engineering Education whose 24th version will be held in Brasilia, next December included in the 31st UPADI Convention.

I am convinced of the irreplaceable role that all engineering organizations (EO) are playing in the creation of a generation of engineers committed with the future of humanity.
Through them we engineers can influence the necessary changes in education bearing in mind the weaknesses and faults that we perceive in our own formation as professionals and the needs of the labor market.

THE ENGINEERING SCHOOLS

As professional engineers our attitude of cooperation with the Engineering Schools is particularly relevant in Latin America since in many countries an education full of theoretical and abstract knowledge prevails, that retards and sometimes inhibits the growth of professional attitudes and tends to form engineers with a scientific orientation, very necessary of course, but only to continue linked to the University as faculty members or researchers.

The scientific method differs from the engineering method. A scientist explores what already exists and the engineer creates what has never existed. Science seeks truth, engineering tries to reach objectives.

The engineer that our developing countries urgently needs must be able to satisfy the demands of production of goods and services for which he must know how to practice a real and concrete engineering that includes the development of original and creative projects and complex products based on advanced technologies and the value-added engineering systems in a modern team based environment. Such requirements are intimately related to the quality of the university teaching staff of Engineering Schools (ES) that is perhaps the most critical factor for the improvement of educational outcomes and the practical abilities and skills that are sought in future engineers. These professors should be able to generate in students not only the professional attitudes of their particular discipline, – to "teach how" not only to "teach what" – but also a humanistic and socio-economic criteria within a concept of synthesis, as the students own construction elaborated on the basis of life experiences that professors must be able to motivate.

Many ES of Latin America are adapting themselves to the new criteria of measuring the efficiency of the educational process through the outcomes, which means determining what students have learnt, have retained and can apply.

In almost all our countries there are already implemented or on the way to implementation, different evaluation and accreditation systems that apply standards and evaluation procedures similar to those of ABET, EMF and others. Thus, independent accreditation based on professional peer review will be a key factor for quality assurance in the formation of the next generation of engineers that will enable the nations to perform in a competitive world.

A NEW TYPE OF ENGINEER FOR LATIN AMERICA

The last years of the 20th Century were witnesses of the great alterations in the behavior of society at a world level, influenced by changes in politics and the economy brought about by globalization.

It is widely recognized that globalization is a consequence of science and technology efficiently administrated by engineering, whose undoubted protagonism in the creation of cybernetic culture is throwing down intellectual frontiers to make possible access to knowledge and the creation of common bases, aimed at making the most of human and material resources.
Basically, globalization aims at progress with equity and participation and means for our developing countries of Latin America an opportunity to reach economic welfare, social cohesion and political liberty, goals that in many cases are yet very distant from achievement.

This globalization process is not new. It was anticipated by Karl Jasper in the scientific field in 1932 and was extended to the economic field in 1973, when the Trilateral Commission was created. Today, globalization comprehends all kinds of activities, not only scientific and economic, but also cultural, in communications, transport and fundamentally in knowledge. It is a powerful tool for the diffusion of new technologies, the increase of economic growth and to enhance the quality of life of all the nations, be they rich or poor. But it is undeniable that it means a controversial process that endangers the national sovereignty, erodes local cultures and traditions, molds public opinion and threatens socio-economic stability.

How does globalization impact on the formation of the new type of engineer that Latin American countries need?

The conditions imposed upon all the sectors of the Society and upon the educational sector in particular are, among others:

- To pass from a national vision of the problems to an international vision.
- Overcome the complexes typical of closed communities.
- Take care of resources allocated to education – always scarce – and impose efficiency in their use.
- To develop strong links with secondary level, articulating the improvement of math, science and engineering education at K12 level.
- Encourage the reduction of the number of specialties in engineering and consequently limit the undergraduate programs to the main orientations. The formation of an engineer tends to be more fragile the more specialized it is.
- To cover the specialties through post-graduate studies.
- To not form more engineers than those necessary to cover the future needs of the country.
- To educate future engineers for the real world of the production and services sectors favoring their rapid employability.
- To form engineers with an international culture allowing their mobility.
- Pay special attention to continuing education, CPD, both for graduate engineers and for the faculty sector of ES. Encourage the establishment of programs that also include the levels of direction and administration of the ES.
- Accept the irreversible process of the creation of virtual universities and follow their performance closely, demanding from them excellence and pertinence in their programs.

NEW ABILITIES INDUCED BY GLOBALIZATION

For the countries of Latin America the above mentioned conditions induce certain abilities to be borne in mind in the formation of globalized engineers, some new and others that are the redefinition of the abilities for the traditional engineer:

- Ability for self development and continuous improvement.
- Flexibility to accept diversified functions.
- Adaptation to mobility.
- Know and manage their own emotions, strengths and weaknesses.
- Understand the total business in the organization where they work.
- Get accustomed to proposing and pursuing objectives.
- Accept competitiveness as a natural thing.
- Work in an integrated manner, in multidisciplinary teams.
- Develop systemic thinking and perspective.
- Anticipate the social impact of technical solutions.
- Be aware of the changes in their cultural and socio-economic environment.
- Make all possible efforts to improve his oral and written communication.
- Cross over the barrier of their own language.
- Use intensely computer science and communications.
- Handle in a critical manner the delivery terms.

- Assimilate multiple demands, without losing control of all of them.
- Pay attention to reality, that is at times chaotic and ambiguous.
- Accept, sometimes, marginal tasks that are disagreeable.
- Not wait for detailed and precise instructions.
- Understand that they do not always have the necessary information.
- Work in teams, towards collective goals with persons that they have not chosen.
- Confront the changes in scenery being one step beyond the immediacy.
- Always protect the biosphere.
- Live with a flood of information, identifying what is useful.
- Reject all forms of violation of ethics and show integrity in their professional behavior.

In this list, many abilities can be acknowledged as the definition of leaders entrepreneurs and should be focused in the formation of the engineers that Latin America needs. People intellectually honest trained to orient and give cohesion to the talents of those forming the group and develop in them a Vision. Ability for analysis, reflection and synthesis and ability for the diagnosis of complex situations that require valuing more than one alternative, adopting decisions in conditions of uncertainty and risking strategies for their implementation.

Engineering leaders with these abilities will be able to act as protagonists of changes in the social environment of their countries because they were trained as strategic thinkers and decision makers with capacity to plan and also to be public opinion formers.

THE ENGINEERING FOR THE AMERICAS PROGRAM

Having as goal to promote excellence in engineering education in the American Hemisphere a group of leaders of hi-tech industry companies, educational institutions, the government and professional societies coincided in shaping this Program that aims to build local engineering capacities with open minds for innovation through new and competitive activities that create employment to face poverty and strengthen democratic governance, thus fostering social and economic development.

Recognizing the importance of this Program the Organization of American States, OAS, worked with the initial group preparing a Declaration and Plan of Action that was adopted by the Ministers of Science & Technology of the American countries in November 2004. A Symposium summoned by OAS and with the support of USTDA and some hi-tech companies, held in Lima in December 2005, was a significant step forward in the implementation of Engineering for the Americas Program.

An essential aspect of this program is the impulse it proposes for the mobility of engineers and the high-tech industry, helping to homogenize the knowledge based production and distribution of wealth in the Hemisphere.

Could the EA Program be adopted by all nations?

Educational Structures for Development

Prof. Włodzimierz Miszalski
President of WFEO-CET, Poland

Prof. Włodzimierz Miszalski Ph.D., D.Sc., Professor of the Military University of Technology (Warsaw, Poland) and Director of Institute of Organization and Management. Before receiving M. Sc. degree in Computer Science and Operations Research in 1972 worked as radar devices' engineer. In 1984 was awarded D.Sc. degree in Technological Science (Electronics) and in 1991 Ph.D. degree in Management. In 1993 graduated from National Defense University (Washington, D.C., USA). Prof. Miszalski has 25 years experience in postgraduate education of engineers – particularly in Logistics and Management. Representative of Poland in Studies, Analyses and Simulation Panel, NATO Research and Technology Organization. President of The Committee on Professional Development of Polish Federation of Engineering Associations. Chairman of the Steering Committee of the 5th World Congress on Engineering Education held in 2000 in Warsaw. Since 2005 President of the WFEO-CET Committee. Prof. Miszalski is author and co-author of more than 200 publications (books, academic manuals, scientific papers) on maintenance organization, decision systems engineering, disaster monitoring and relief systems command, postgraduate engineering education programs and curricula.

Abstract

The proposal to start international discussion on the idea of World University of Technology (WUT) has been first put forward by the author during the 7 World Congress on Engineering Education in 2006 in Budapest. Then a series of papers have been published in IDEAS and other periodicals developing the idea and answering questions raised in the discussion. In this paper author has tried to find the relations between the spheres of engineering activity resulting among others from the UN Millennium Development Goals and the areas of research and education conducted by WUT. Then the outline of the organizational structure of WUT have been submitted as a starting point for further discussion on the more detailed issues related to the idea of WUT.

Key words: *engineering education, global, international, structure, technology, university, world.*

INTRODUCTION

The proposal to start international discussion on the World University of Technology was first put forward by the author during the 7th World Congress on Engineering Education in March 2006 in Budapest. Then in a series of papers – published also in IDEAS (No.13,14) – author developed the idea of the international establishment able to conduct the research on the worldwide engineering problems as well as the education of globally oriented engineers prepared to deal not only with large scale engineering projects but as well to execute relatively simple projects facilitating and improving the quality of human life in the poorest regions of the world. The sequential steps on the way to the World University of Technology (WUT) and its alternative models have been subsequently proposed [5]. The idea of WUT has been then compared with the European Union project of European Institute of Technology (EIT). The financial aspects and resources necessary for creation WUT have been discussed basing on the example of solutions applied in the EIT project [4]. Numerous emails and letters supporting and arguing with the idea of WUT have appeared as a response to the author's proposal as well as the suggestions on the mission, possible options and shape of WUT. The discussion on personal characteristics and professional profiles of future WUT graduates has been opened since the first appearance of the idea followed by considerations on educational programs and curricula. In this paper certain suggestions and proposals have been presented regarding the areas of research and education as well as the organizational structure of future World University of Technology.

EXPECTATIONS AND HOPES FOR THE NEW AREAS AND FORMS OF ENGINEERING EDUCATION

The main issues and challenges for engineering, science and technology (EST) resulting from the United Nations Millennium Development Goals (MDGs) and targets have been comprehensively discussed in Dr Tony Marjoram's paper [3] published in this number of IDEAS. The Author has mentioned the areas in which engineering, science and technology are vital for: **sustainable development, climate change, poverty reduction, disaster monitoring and relief, environmental degradation**. Those areas are for example:

- environmental/ecological engineering,
- waste management and renewable technologies,
- water supply and sanitation,
- cleaner production and recycling,
- energy efficiency, conservation, renewable energy, decentralized power generation,
- disasters and catastrophes related to the interactions between nature and human activity in engineering, science and technology.

Prof. Vollrath Hopp in his article [1] also published in this number of IDEAS has analyzed in depth the role of water supply, energy, climate change in global economy and ecology and then has gathered from the considerations certain unique conclusions for future engineering education (e.g. making students of engineering sensitized to politically thinking, preparing future engineers for participating in political bodies and representing the engineers' point of view on political decisions).

For further discussion on personal characteristics and professional profiles of future globally oriented engineers following questions seem to be fundamental:

How to introduce the topics resulting from the mentioned above areas of engineering activity into curricula offered by present technical universities or schools of engineering – and particularly – what seems important for our idea of World University of Technology – how to translate the global challenges for engineering, science and technology into completely new educational programs – and finally – to what degree should be the new educational structure different from the existing traditional ones to meet the requirements of new personal characteristics and professional profiles of future globally-oriented engineers.

In one of his papers published in IDEAS Prof. Miguel Angel Yadarola has analyzed the failures in the formation of engineers [7] finding that "The erroneous construction of the curricular contents in some Schools of Engineering, and particularly in many Developing Countries, is responsible for the formation of incomplete engineers. They have saturated the first years of their careers with a heap of abstract sciences that has retarded and sometimes inhibited, the growth of their professional personality, convincing them, that the scientific method is the basis of the creativity the future engineer must display, letting them find only at the end of their studies, that the engineering method is the only course that will allow the birth and use of creativity and capability of innovation necessary for an engineer to make true, with originality, the project, the construction and operation of a work, a system, an industry or a component, giving the entire work an integrating and multidisciplinary vision". Then – what seems particularly important for the discussion on future organization of the World University of Technology – Prof. Yadarola has written: "Schools of Engineering fail when they prepare their curricula oriented specifically towards a discipline, emphasizing specialization, teaching methods and technologies that for sure will be obsolete in a few years. Formation of engineers should be integral if we wish an engineer to continue to play a protagonic role in society, leading the rapid changes that will occur more and more rapidly".

Dr Kazuo Kuroda [2] when discussing the inefficiency of higher education in developing countries has found that "higher education tends to give students higher expectations for their future jobs. Some highly educated people do not take jobs below what they expect even if the jobs are available". And then: "Brain drain is another obvious factor contributing to the inefficiency of higher education investment in developing countries. University graduates in developing countries, especially in the fields of engineering and science, tend to seek job opportunities in developed countries where they can earn a much higher income than in their home countries". The both cited above Authors' opinions should be taken into account if the intended result of the formation of engineers at WUT would be **globally-oriented engineers prepared to deal not only with large scale or high-tech advanced projects but also to execute relatively simple projects facilitating and improving the quality of human life in the poorest regions of the world, to take part in disaster relief operations and programs.** Different options of WUT have been considered but in the discussion on future shape of the World University of Technology many voices have appeared so far for the option of a single-campus university located in one of the countries of the third world. This is one reason why the author has decided to initiate more detailed considerations starting from this option.

ORGANIZATIONAL STRUCTURE OF THE WORLD UNIVERSITY OF TECHNOLOGY

Taking into account its role, mission and tasks as well as personal characteristics and professional profiles of its future graduates – the WUT could be subordinated to WFEO. This solution would guarantee the international orientation of the institution, freedom from any national or regional biases, keeping the global perspective of engineering education goals and accordance with the WFEO ideas and aspirations.

All the legal aspects and formal determinants and limitations of the suggested solution should be of coarse analyzed together with the required necessary changes of statute, bylaws and other documents including legal interpretation and clarification of the term *subordination* for this particular case. Also other different options of the WUT subordination could be considered (e.g. UNESCO or specific international foundation established under the auspices of UN) – but WFEO seems so far to be the best representative and forum of world expectations and hopes addressed to engineering education. Another important legal problem would be probably recognition of the WUT diplomas and qualifications of graduates but it also seems possible to solve taking into account the WFEO prestige, the so far initiatives and activities in the area of mutual recognition of engineers' diplomas and qualifications. Although the organizational structures of the existing technical universities and schools of engineering are different in different countries and in different regions of the world – one could find however certain similarities. Generally the structures could be divided into "traditional" and "non-traditional" ones. The "traditional" structures seem to be strongly connected with traditional professional profiles of engineers [6]. **Faculties (Colleges, Schools) of Mechanical (Electric, Chemical, Civil, Transportation, Mining) Engineering** are typical organizational units. Needs for new professional profiles have resulted in appearance – within traditional structures – the new units (Faculties of: Computer, Nuclear, Space, Environmental Engineering) as well as "joint" or "hybrid" units (e.g. Faculties, Colleges, Schools of: Mechatronics, Electronics and Automatics, Electronics and Computer Engineering, Automatics and Robotics, Computer Science and Management, Bio or Medical Engineering etc.) – combining two or even three disciplines of engineering or even certain non-technical disciplines and engineering. The "non-traditional" structures seem to be even more diversified. Starting from the "flat" structures without traditional faculties or colleges and based upon the relatively small elementary units (chairs, sections, laboratories) – to the "problem-oriented" structures organized around technological problems rather then disciplines (reliability, safety, quality, risk etc.) or "system-oriented" structures based upon the selected large scale technical or humano-technical systems (e.g. energy production, conversion and transmission systems; logistics systems; satellite communication and navigation systems; distributed production systems; computer networks systems, agriculture production and processing systems etc.). Discussion on the formation of the globally-oriented engineers with required personal characteristics and professional profiles – important before sketching the outline of WUT organizational structure – should result in specifying the well-grounded areas of education.

On the present stage of the discussion following six areas seem to be the candidates:

- environmental engineering (including climate change and pollution monitoring);
- logistics engineering (including: water supply and sanitation, waste management, recycling, renewable technologies);

- disasters monitoring and relief systems (including technical and environmental threats and catastrophes);
- energy production, conversion and distribution systems (including: renewable energy, energy conservation and decentralized power generation);
- information systems and computer networks;
- global infrastructure and architecture.

Assuming that the main units of WUT would be adequate to the areas of education we could try to sketch the "first approximation" outline of its organizational structure (Fig.1).

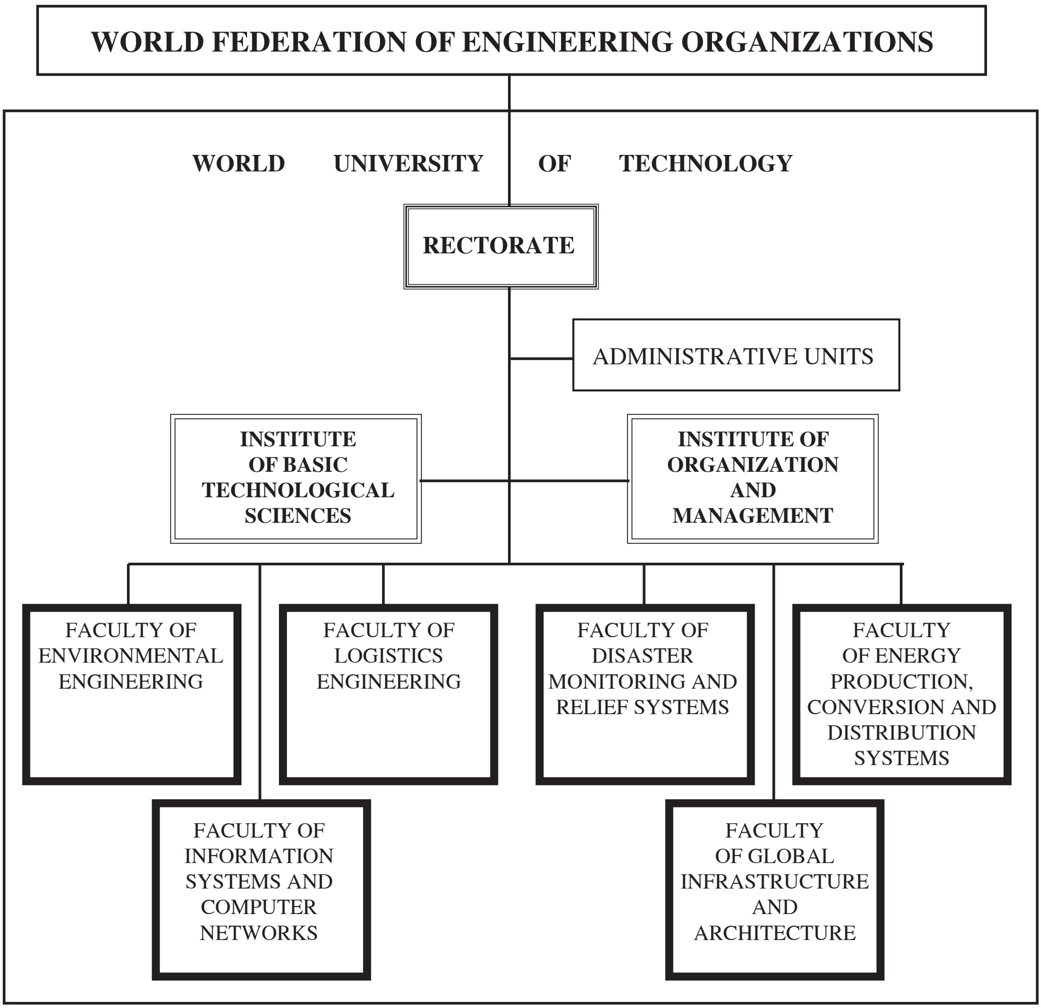


Fig.1. Outline of the proposed organizational structure of World University of Technology

Apart from the main six organizational units, which names could be optional ("faculty" has been used only to reflect the size of the unit) – there are two "institutes" (the name is optional as well) – supporting the main units. The Institute of Basic Technological

Sciences would provide the courses of: mechanics, technical physics and chemistry, electrotechnics, electronics, engineering graphics, applied mathematics etc. within the scope necessary for particular faculties whereas the Institute of Organization and Management would be responsible for organizational and managerial knowledge given to future WUT graduates. It seems to early to talk about the Rectorate and Administrative Units organization, which probably would depend among others on the established relations between the WFEO Authorities and WUT – but it could be the subject of further discussion as well.

CONCLUSIONS

The discussion on the idea of World University of Technology seems useful even if the idea could not be materialized in the closest future. The so far presented opinions and proposals reflect not only the global challenges to engineers and engineering activity or tendencies of international integration of engineering education but also the aspirations to increasing the worldwide mobility of engineers and equalizing the distribution of engineering potential in global scale. The proposed outline of the organizational structure of WUT should not be interpreted as the recommended solution – it could be the starting point rather of further exchange of views on the more detailed issues than those hitherto discussed. Inviting Distinguished Readers to the discussion author would be grateful for all the opinions and comments on: the idea of World University of Technology, its shape, mission and tasks, professional profiles of graduates, areas of research and education, curricula, location, subordination and organizational structure. The forthcoming 8th World Congress on Engineering Education (2010 in Argentina) would be a good forum for summarizing the discussion which has been continued since the 7th Congress in Budapest as well as for comparing the so far presented proposals and solutions and then working out a common position on the selected matters related to the idea of WUT.

REFERENCES

[1] Hopp V., The role of engineers and scientists of the world in the discussion about energy and change in climate. IDEAS No.15, WFEO-CET, December 2008

[2] Kuroda K., The Special Needs of Developing Countries in the Field of Engineering Education. IDEAS No.12, WFEO-CET, November 2005, pp 34–38

[3] Marjoram T., Engineering and Development, Foresight and Risk. IDEAS No.15, WFEO-CET, December 2008

[4] Miszalski W., Developing the Idea of World University of Technology. IDEAS No.14,WFEO-CET, November 2007, pp 102–108

[5] Miszalski W., World University of Technology – Solution for Mobility. FEANI News No.2, January 2008

[6] Miszalski W., 21st Century Engineer – Personality and Professional Profile. IDEAS No.7, WFEO-CET, November 2000, pp 15–21

[7] Yadarola M. A., The Challenge of the Knowledge Society to the Permanent Updating of Engineering Teachers. IDEAS No.6, WFEO-CET, October 1999, pp 13–19

Career Development of South Korean Female Scientists and Engineers in Industry

Ph.D. Hae Ja Shin
Environmental Engineering Major, Division of Applied Bioengineering,
Dongseo University, Busan
Director General of the Busan Ulsan Gyeongnam Institute for Supporting Women in Science and Technology (BIS-WIST) appointed by the Korea Ministry of Science and Technology.

Hae Ja Shin obtained her B.Sc. in Chemistry from Pusan National University, South Korea in 1981 and her M.Sc. & Ph.D. in Biochemistry from University of Alabama, USA in 1984 & 1988, respectively. She worked as a post-doctoral researcher at University of Alabama at Birmingham, USA from 1988 to 1991. She was a vice president of Korea Women in Science and Engineering, Busan & Gyeongnam District from 2003 to 2005, actively setting up many programs for training women in science and engineering. She also developed the Research and Education Program for young geniuses in science in Korea. She is an associate professor at the Division of Applied Bioengineering (Environmental Engineering Major) of Dongseo University and also holds the position of Director General of the Busan Ulsan Gyeongnam Institute for Supporting Women in Science and Technology (BIS-WIST) to which she was appointed by the Korea Ministry of Science and Technology from 2006 to 2012.

Abstract

This study addresses the status of South Korean female scientists and engineers (S&Es) in small and medium industry in terms of their job satisfaction, competence and difficulties in job performance, discrimination, and requirement for their career development. The majority of female S&Es employed in industry were satisfied with their current job, showing relatively high confidence in their job performance, without experiencing considerable difficulties. They want to pursue their career track and economic activity, despite discrimination against them at work. Female S&Es are expected to have a wide range of qualifications including specialty-related requirement such as work responsibility, confidence, and information technology knowledge. However, none-specialty related requirement like office work ability was also demanded irrespective of job kind and position. Role conflict is a major deterrent leading to discontinuation of *female S&Es careers. Social bias must be resolved to utilize female S&Es as important workforce in South Korea.*

Key words: *career development; female scientists and engineers; industry*

INTRODUCTION

Female scientists and engineers (S&Es) in South Korea have been recognized as an important workforce as the political, social, and economic demands of science and engineering increase. An initiative for motivating and supporting female S&Es in these fields has been undertaken in various policies and programs supported by Korean government. As a consequence, over the past ten years, participation and achievement of young women in science and engineering are either equal to or higher than those of boys in South Korea (Gilbert & Calvert, 2005; Viefers, Christie & Ferdos, 2006). However, this achievement has not been accompanied by corresponding increase of female S&Es in science and technological sectors of the workforce.

The gender inequality problem in the science and engineering workforce may result from widespread stereotyping of science and engineering careers as largely 'masculine' jobs, which often makes these fields unattractive to women (McLean et al. 1996). Several solutions have been suggested to change the chilly climate experienced by women: training in leadership, communication and management skills, and problem solving ability, as well as availability of female role models (Daudt and Salgado 2005, Meier et al. 2000, Martin et al. 2005, Ravesteijn et al. 2006, Du 2006, Pisimisi and Ioannides 2005). However, such solutions are usually not critical to a woman decision to remain in science and engineering (Gilbert et al. 2005). Instead, these approaches tend to deal with the symptoms rather than the underlying causes, leading to more women being pushed into the pipeline (Goodman 2003).

Several policies directed towards female S&Es have been launched, including the establishment of institutes in South Korea for supporting women in science and technology. These initiatives would be helped by careful examination of the current situation for female S&Es in Korean industry. This paper aims to assess the current status of Korean female S&Es in industry in terms of their career development. Three hundred female S&E employees and 300 employers from small and medium industries in the Busan, Ulsan, and Gyeongnam districts of Korea participated in the survey. Various aspects of job performance were extensively examined. The necessary attributes for female S&Es having successful careers in industry are discussed in terms of their future prospects.

METHOD

Three hundred small and medium industries in the Busan, Ulsan and Gyeongnam regions of South Korea were randomly chosen for the survey interview, with 100 companies chosen from each region to ensure an even distribution. The companies represented a wide range of industrial fields, capital expenditures, employee numbers, and sales volumes. The participants were chosen to represent differences in gender, status, age and academic background. Three hundred female S&E employees and their industrial employers were asked to provide biographical information and to respond to issues regarding requisite job satisfaction, confidence and difficulties in job performance, discrimination, and professional attributes.

Data were collected through a structured interview. Questionnaires were used to collect data and were then analyzed quantitatively. Interviews allowed the researchers to interact with the participants and to explore the answers to the questions more deeply. A challenge for the interviewers was to draw out descriptions of specific experiences, which brought out richer and more contextual data. This was attempted by asking questions in the format of 'Tell us more about that …' Data from the interviews and structured questionnaires were obtained between 23 April 2007 and 9 May 2007. The raw data were edited, coded, and entered into an SPSS (Statistical Package for the Social Sciences) data file. The reliability of the data was represented by 95% confidence intervals with a range of ±5.66%.

RESULTS AND DISCUSSION

Female S&Es' job satisfaction

Job satisfaction is a comprehensive parameter for career development of female S&Es in industry. Job satisfaction was assessed by the following questions (Table 1): Are your duties consistent with your academic program and major at college? Are you satisfied with your choice of field? If not, do you intend to change your field? Are you satisfied with your current job? Why are you satisfied or dissatisfied? Thirty one percentile of female S&Es responded that their current work was related to their major at college, 29.3% unrelated. About thirty percentile of respondents agreed that their current job was in their chosen field. On the other hand, 37.7% of respondents responded that their current job was not in their chosen field and indicated that they may have selected their job just to be employed, without making any long-term career considerations. However, only 27.4% of respondents wanted to change their field, and most female S&Es were more or less satisfied with their current job (72.4%). The majority of female S&Es (65.7%) indicated that their work was consistent with their level of academic training, while the remainder indicated that their work was at a level either above or below their level of academic training (data not shown). When the reasons for being either satisfied or dissatisfied with their current job were assessed, respondents were satisfied because (1) they wanted the job, (2) they were evaluated in terms of their accomplishments, (3) they were not discriminated, and (4) they could apply their expertise. The reasons for dissatisfaction with their current job included no hope for promotion, excessive work requirements, and lower salaries. From these preliminary data, it is speculated that quite a few South Korean women chose their job according to the demands of making money to support their family or themselves, instead of considering their academic backgrounds and future careers. Moreover, although the job market situation and working environment may be biased against women, South Korean female S&Es have a strong desire to be involved in economic activity and to pursue their careers.

Table 1. Views on job satisfaction

Categories	Strongly disagree	Disagree	Agree or disagree	Agree	Strongly agree
Duty consistence with major	9.3	20.0	39.7	26.7	4.3
Satisfaction with field	9.0	28.7	31.7	24.7	6.0
Intent to change Field	5.0	32.7	35.0	20.7	6.7
Satisfaction with current job	3.7	24.0	0.0	64.7	7.7

Note: all numerical values are percentages.

Female S&Es' job performance

To gain more understanding of female S&Es' work competence, their performance in industry was surveyed (Table 2). Overall, female S&Es in industry demonstrated fairly good confidence (28.7~42.6%) in various aspects of job performance: professional knowledge and ability, acknowledgement of accomplishment, opportunities for accomplishment, productivity, and influence on decision-making. This result is unexpected, and quite different from that reported elsewhere (e.g., Pisimisi and Joannides, 2005; Evans et al., 1993; Scott and Yates, 2002). Considering that Korean women tend to be humble when expressing themselves, the responses from the female S&Es is also most likely an underestimate of self-confidence in job performance. Also noteworthy, the response for confidence in leadership was only 22%, the lowest value among the surveyed categories. There could be several reasons. First, the most predominant enterprises in the Busan, Ulsan and Gyeongnam regions of Korea are small and medium-size. Given that these companies are less global than large ones, they might recruit women who are rather docile. Second, women employed in such industries might not have access to leadership programs. Finally, chilly workplace climate and traditional Korean societal context toward females, as well as their low ranking positions in industry may further limit leadership opportunities. Together, these biases significantly reduce female confidence of leadership in industry.

Table 2. Degree of confidence in job performance

Categories	Strongly Disagree	Disagree	Agree or disagree	Agree	Strongly agree
Professional knowledge and ability	2.0	13.3	54.3	28.3	2.0
Acknowledgement of accomplishment	1.7	13.7	48.3	34.3	2.0
Opportunity for accomplishment	2.7	10.7	44.0	37.3	5.3
Productivity	2.3	11.7	51.0	30.0	5.0
Influence on decision making	5.3	19.3	46.7	25.7	3.0
Displaying Leadership	6.3	18.3	53.3	19.3	2.7

Note: all numerical values are percentages.

Next, the difficulties female S&Es faced in performing their jobs were assessed (Table 3). Female S&Es disagree to a large extent on difficulties in business trips (64%), off-duty Korean dining tradition (53%), fieldwork (49%), and overtime working (41%). However, a smaller percentage disagrees on difficulty due to motherhood (39.7%), minority (37.7%), and physical limitation (36.4%). Workplace difficulty seems to be most often confronted in socially biased areas or due to physical limitations. Interestingly, female S&Es experience relatively less gender-oriented difficulty. This is surprising because although engineering and sciences are assumed to be essentially neutral, objective, genderless knowledge, they tend to be represented as being masculine; that is, the disciplines have an 'image problem' (Gilbert and Calvert, 2003). Thus, presumed physical limitations of female S&Es in performing their duty in industry may simply be a side-effect of this gender-bias: many men claim "engineering is not for women but for strong men," expecting female S&Es' to be unable to accomplish engineering work, whether or not it is truly physically demanding. In this study, 36.4% female S&Es disagree on difficulty due to physical limitation and 33.6% of them agree on this issue. It is worth noting that female S&Es do not feel that much difficulty in leadership (52.3%), even though they reveal weak confidence as mentioned above. It may be presumed that they have potential or presumably hidden aspiration for leadership positions.

Table 3. Difficulties in job performance

Categories	Strongly Disagree	Disagree	Agree or disagree	Agree	Strongly agree
Physical limitation	10.7	25.7	30.0	27.3	6.3
Field work	18.7	30.3	29.7	18.0	3.3
Business trip	34.0	30.0	24.0	9.0	3.0
Overtime working	15.7	26.0	27.3	23.0	8.0
Off-duty Korean dining tradition	20.7	31.7	29.0	13.3	5.3
Leadership	23.0	29.3	33.3	12.0	2.3
Motherhood	14.7	25.0	37.7	16.0	6.7
Minority	13.0	24.3	32.7	25.3	4.7
Boss's sex discrimination	15.3	29.0	35.7	16.3	3.7
Sexual prejudice by others	13.3	26.7	33.0	22.3	4.7

Note: all numerical values are percentages.

Employer perspective on female S&Es' job performance was also evaluated. Overall, they were satisfied with job performance of female S&Es. The reasons for employer satisfaction are shown in Figure 1A. It is noticeable that most employers (69.4%) appreciated the careful work done by female S&Es. These results indicate that female S&Es play their roles very well, regardless of their position or whether their job is reated to their expertise. Women's high performance is a fruitful outcome that results from hard work, diligence, and rule-following behavior, as discussed in other literature (Gilbert & Calvert, 2003). Although most employers acknowledge careful work done by female S&Es, they have a hard time just accepting the female presence in a traditionally male-dominated field, let alone allowing women to take on leadership positions (see below for more discussion).

The reasons for employer dissatisfaction with female S&Es included (1) a lack of expertise, (2) role conflict, and (3) job limitations because of their gender (Figure

1B). Lack of expertise may be due to a competency gap existing between the level of performance employer's expectation from their engineers and what the engineers actually deliver. Inconsistency with education and training due to misallocation also contributes to lacking of expertise. More importantly, the mostly male employers tend to have different standards for female S&Es with regard to job expectations and limitations. In particular, traditional societal bias against women and the masculine image associated with science and engineering work together to biased employers' perceptions toward supposed job limitations conferred by gender. As a striking example, the majority of female S&Es have at sometime been told, after making a mistake, "You, women should stay home and raise kids instead of working and making mistakes like that," even when the mistakes are no different than those made by their male counterparts of the same rank. This implicates a surface-level 'sexism' through which women are excluded, marginalized, devalued, victimized, or made invisible in engineering and science as discussed in Gilbert and Calvert (2003). Along similar lines, role conflict of working mother was also a significant source of employer dissatisfaction with female S&Es. A substantial proportion of South Korean women with children are urged to quit their jobs. For most working Korean women, childbirth becomes a dilemma: should they quit their job and be a mother, or try to be a career woman and remain childless, knowing that either choice can be a struggle? This is a substational problem and is one that universities and the wider society must solve for the sake of female S&Es' future career development.

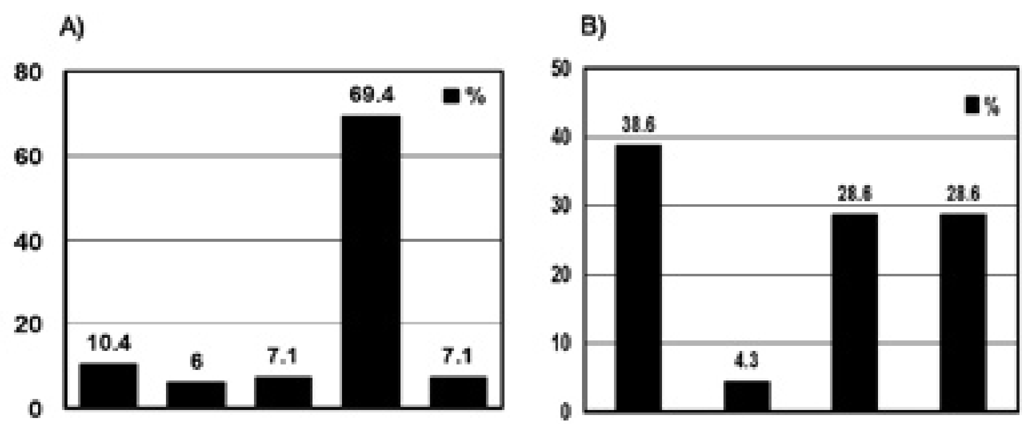


Figure 1. Reasons for employers' satisfaction (A) or dissatisfaction (B) with female S&Es' job performance. Columns of (A): 1st, superior expertise; 2nd, good human relationship; 3rd, economic efficiency; 4th, careful job performance; 5th, other reasons. Columns of (B): 1st, lack of expertise; 2nd, lack of human relationship skills; 3rd, role conflict; 4th, job limitations due to gender; 5th, other reasons.

Issues in the careers of female S&Es

To determine the reasons why women are driven away from science and engineering, any discrimination that might occur during the careers of female S&Es was analyzed. Compared with their male counterparts of the same rank, female S&Es indicated that they experienced discrimination in promotion (44.6%), salary (42.7%), work allocation (40%), recruitment (35.4%), evaluation (34.0%), and to a lesser degree in respect to educational and training opportunities (20.9%). In particular, our finding of discrimination in promotion and salary is on par with other reports that have recognized such discrimination as the most commonly raised gender issue (Bentley and Blackburn 1992, Goodman 2003, Ihsen 2005, Gorman 2006, Viefers et al. 2006, Marschke et al. 2007). Discrimination in work allocation is also consistent with our finding that female S&Es must be proficient at processing official paper work to have a successful career. However, employers believe that, except for work allocation, they do not significantly discriminate in all areas of education, evaluation, promotion, salary, and recruitment. This controversial disagreement may be due to the great influence of the equal employment opportunity law legitimated by the Korean government on employer attitudes toward discrimination. For legal and superficial value for the industry, no employers will admit discrimination occurs.

Next, it was addressed whether discrimination affects female S&Es' advancement potential and their career duration. The advancement potential of female S&Es is shown in Figure 2. Note that these women are not too optimistic about their prospects for promotion in Korean industry. Most female S&E employees expect promotion to a deputy level (the lowest head position), while most employers expected them to attain the position of section chief (the second lowest head position). Workplace discrimination most likely leads female S&Es to experience low self-esteem (Sagebiel and Dahmen 2006), since about a fourth of them thought they had no hope of being promoted.

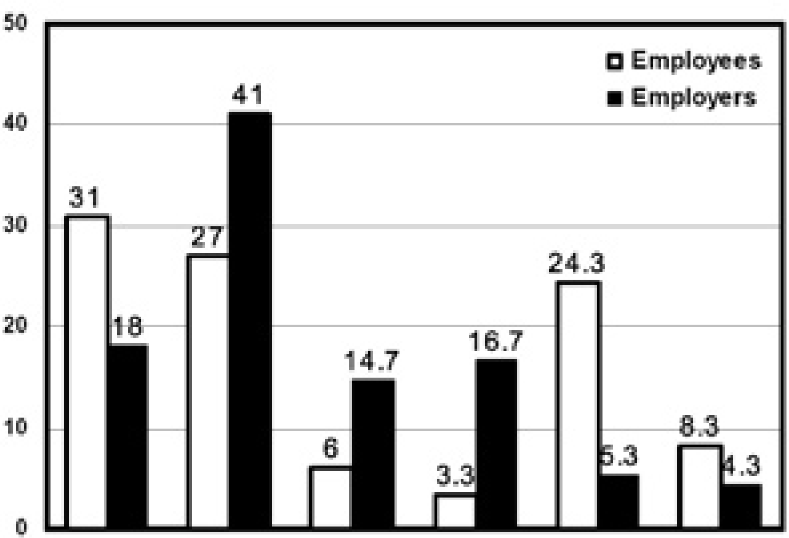
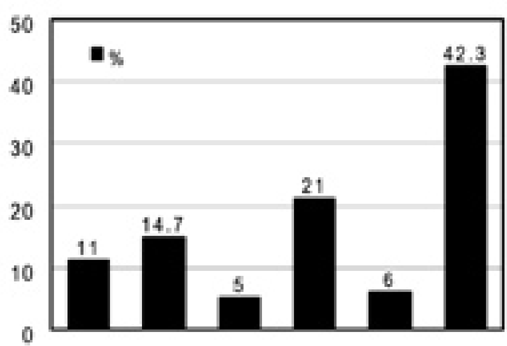


Figure 2. Advancement potential of female S&Es
Column sets: 1st, deputy class; 2nd, section chief; 3rd, department chief; 4th, director; 5th, no hope for promotion; 6th, others.

However, a significant proportion of female S&Es wanted to continue their careers as long as they remained healthy and able to do so (Figure 3A). This result also indicated their strong desire for economic activity or independence and their own careers, as described before. In fact, young couples called Double Income No Kids ('DINK') have become one new extreme in Korea; they want to enjoy their life without paying high education cost and responsibility for children. In fact, great enthusiasm for child education has made Korea's education costs jump each year, despite depressed consumer sentiment. The predominant social consequence is dedicating almost all income into childhood education, occasionally creating new family style that involves mother and children being separated from dad, and living abroad to facilitate a child's education. Some of the surveyed women have considered resigning their job because of marriage, childbirth, and childcare, indicating that the role conflict is a large obstacle for a woman's career. This situation necessitates career breaks in what is the continuous use of a trained workforce in engineering. If these women have to resign from their job, the reasons for doing so could be (1) role conflict, (2) wanting to do other work, and (3) having no hope for the future (Figure 3B). Thus, this role conflict and a lack of hope due to discrimination restrict such women from taking the necessary steps to advance their careers. Therefore, a successful career depends on their enthusiasm and commitment to overcoming enormous difficulties created by systematic and subjective discrimination, and on social structural changes aimed at reducing the family responsibilities of women.

A



B

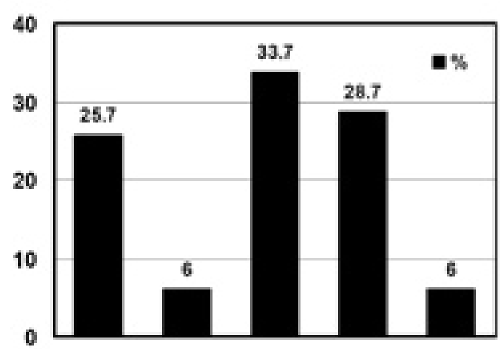


Figure 3. Expected career duration (A) and reasons for resigning (B)
Columns of (A): 1st, until marriage; 2nd, until childbirth; 3rd, until child enters school; 4th, until significant achievement; 5th, until retirement; 6th, as long as they remained healthy. Columns of (B): 1st, no hope for the future; 2nd, no competence; 3rd, role conflict; 4th, want to do other work; 5th, others.

To determine the barriers to employment of female S&Es, industrial employers (excluding employees) were asked for their views on the matter. As shown in Figure 4, the main reason why industrial employers found it difficult to hire female S&Es was role conflict, which has already been highlighted as a significant source of dissatisfaction with female S&Es' job performance (Figure 1). Employers in small and medium enterprise may think it is a big burden and probably a loss of productive labor to give female S&Es maternal or parental leave to fulfill mother role. Women in Korean society still have great family responsibilities such as raising children, performing household chores, etc.; such responsibilities are seen to distract female S&Es from their work duty. One resolution would be to encourage equal participation of both spouses in the family unit and good reliable daycare facilities for infants must be pursued. The problem of role conflict must be resolved, given that it is considered as a barrier to female S&Es' career development, and thus is viewed by employers as a limitation to women's success in the workforce market.

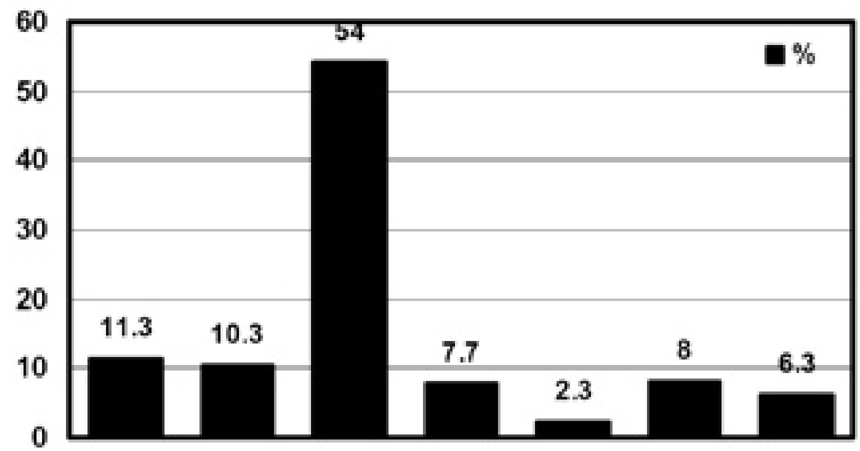


Figure 4. Difficulties in hiring female S&Es
Columns: 1st, lack of knowledge; 2nd, lack of professionalism; 3rd, role conflict; 4th, lack of adapting to working environment; 5th, lack of duty- performing ability; 6th, lack of human relationship skills; 7th, lack of problem- solving skills**.**

Requisite attributes for career development of female S&Es

The views of both target groups were sought on the professional needs required for a successful career in industry for female S&Es. Needs mentioned by more than 50% of both target groups were responsibility, having a sincere and positive attitude, knowledge and expertise, understanding job requirements, knowledge about information technology, and clerical work abilities. However, leadership qualities such as planning ability, initiative, cooperation, negotiation, information analysis, and problem solving were considered to be less important. It was surprising to discover that foreign language skills, which were important for recruitment, were not considered as quite so important attributes in industry, even though such skills are indispensable for the global role that might be played by female S&Es. Also, leadership was not perceived as being a necessary skill. The initial findings in this study are, though preliminary, interesting in that they do not support many of the ideas that have previously raised to solve the 'pipeline' problem in engineering and science field (Daudt and Salgado 2005, Meier et al. 2000, Martin et al. 2005, Ravesteijn et al. 2006, Du 2006, Pisimisi and Ioannides 2005). It seems likely that female S&Es are expected to do their best in their regular duties. This finding might be related to the current situation in which female S&Es are less likely to be promoted to a position requiring leadership. However, considering the social status of female S&Es in small and medium enterprises in Korea, our findings most likely considerably underestimate the overall status or situation of female S&Es in Korea. Extensive investigation including more diverse range of enterprises will be required for comprehensive conclusions. It will be interesting to assess whether the issues discussed in this study are applicable to other large enterprises. It appears that there is little movement towards equal status for men and women in industry of Korea.

CONCLUSIONS

This article is based on a survey designed to explore successful career development of South Korean female scientists and engineers (S&Es) in industry. Only a small percentage of female S&Es successfully develop careers in the field of engineering and difficult sciences such as Mathematics and Physics. Personal attributes such as responsibility, sincerity, expert knowledge, and clerical ability, but not leadership and foreign language skills, were considered to be necessary for female S&Es' development of a successful career. Role conflict is perhaps one of the most significant problems for their career discontinuation, which must be resolved as a social issue for the sake of female future career development in science and engineering. Although, the Korean government has initiated various policies and programs to motivate and support female S&Es as a future workforce in these fields, careful examination of the current situation is necessary to better pursue such aims at the initial stage.

ACKNOWLEDGEMENT

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REFERENCES:

[1] Bentley, R.J. and Blackburn, R.T., Two decades of gains for female faculty? *Teachers college record*, 1992, **93**, 697–709.

[2] Bird, S., Litt, J. and Wang, Y., Creating status of women reports: Institutional housekeeping as "women's work", *NWSA J.*, November 2004, **16**(1).

[3] Daudt, J. and Salgado, P.P., Creating a women friendly culture in institutes of higher engineering education, *Eur. J. of Eng. Edu.*, December 2005, **30**, 463–468.

[4] Du, X., Gendered practices of constructing an engineering identity in a problem-based learning environment, *Eur. J. of Eng. Edu.*, March 2006, **31**, 35–42.

[5] Gilbert, F., Challenging accepted wisdom: looking at the gender and science education question through a different lens, *Int. J. of Sci. Edu.*, 2005, **25**, 861–878.

[6] Goodman, S., Europe is pushing to get more women scientists into industry and academia, but can the commission legislate for gender equality? Sally Goodman investigates, *Nature,* November 2003, **426**, 210–211.

[7] Gorman, E.H., Work uncertainty and the promotion of professional women: the case of law firm partnership, *Social Forces*, December 2006, 86.

[8] Ihsen S., Special gender studies for engineering? *Eur. J. of Eng. Edu.*, December 2005, **30**, 487–494.

[9] Marschke, R., Laursen, S., Nielsen, J.M. and Rankin, P., Demographic inertia revisited: an immodest proposal to achieve equitable gender representation among faculty in higher education, *J. of Higher Edu.*, January/February 2007, **78**, 1–26.

[10] Martin, R., Maytham, B., Case, J. and Fraser, D., Engineering graduates' perceptions of how well they were prepared for work in industry, *Eur. J. of Eng. Edu.*, May 2005, **30**, 167–180.

[11] McLean, C., Lewis, S., Copeland, J., O'Neill, B. and Lintern, S., Masculinity and the culture of Engineering. *In Third Australasian Women in Engineering forum*, 1996 (Sydney).

[12] Meier, R.L., Williams, M.R. and Humphreys, M.A., Refocusing our efforts: assessing non-technical competency gaps. *J. Eng. Educ.*, July 2000, 377–385.

[13] Pisimisi, S.S. and Ioannides, M.G., Developing mentoring relationships to support the careers of women in electrical engineering and computer technologies. An analysis on mentors' competencies, *Eur. J. of Eng. Edu.*, December 2005, **30**, 477–486.

[14] Ravesteijn, W., Graaff, E.D. and Kroesen, O., Engineering the future: the social necessity of communicative engineers, *Eur. J. of Eng. Edu.*, March 2006, **31**, 63–71.

[15] Sagebiel, F. and Dahmen, J., Masculinities in organizational cultures in engineering education in Europe: results of the European Union project WomEng, *Eur. J. of Eng. Edu.*, March 2006, **31**, 5–14.

[16] Viefers, S.F., Christie, M.F. and Ferdos, F., Gender equity in higher education: why and how? A case study of gender issues in a science faculty, *Eur. J. of Eng. Edu.*, March 2006, **31**, 15–22.

WFEO and the Mobility of Engineering Professionals — a Position Paper

Dr Peter Greenwood, Hon FIEAust, CPEng, EngExec.
Leader, CET Working Group on Mobility of Engineering Professionals

Dr Peter Greenwood was Engineers Australia's National President in 2002 and 2003.
Peter Greenwood is an electrical power engineer by training. He has qualifications in engineering and management. He has worked in several countries in the electrical supply industry, research laboratories, and universities.
His main EA interests are involvement with Young Engineers, links with employers, education and training and international relations.
After many years with the Hydro-Electric Commission, Tasmania since 1991 he has been an engineering and management consultant, advising companies on power supply contracts and national grid developments, and working on major project evaluations. He is a member of the Tasmanian Electricity Regulator's Reliability Panel. Educational background: M.Sc. (Technological Economics) — Management science, economics course, 1978. Ph.D. (Elec. Eng.), 1983 M.Sc. (Elec. Eng.), 1967 Diploma in Electrical Engineering (IEE), 1963 Diploma in Electrical Engineering (1st class), 1963 Company Directors Diploma, 1991.
Affiliations: Fellow of the Institution of Engineers, Australia, Fellow of the Institution of Electrical Engineers (UK), Senior Member of the Institution of Electrical and Electronic Engineers (USA).

Abstract

WFEO in its pre-eminent position in the engineering profession has a key role to play in the formation and assessment of engineers around the world. Representing its members to major international agencies, it is ideally placed to facilitate exchanges between:

1. *the organisations that set the engineering-education standards for accreditation and the assessment of professional competence,*
2. *the employers of engineers and users of engineering products and services and*
3. *other organisations affected by the quality and number of professional engineers.*

WFEO members need to understand the standards (quality marks) and the assessment (benchmarking) of engineers, which is not easy. But it is necessary in order to establish a WFEO policy and determine WFEO's best role.

This paper is about what engineering mobility means. It goes on to talk about what sort of position WFEO might adopt taking account of its opportunities, responsibilities and resources. The action taken by the Committee on Education and Training (CET) is listed and the importance to other standing committees is introduced.

Acting as a central information source and facilitator between international organisations, WFEO would be a major contributor to accreditation and mobility and take a significant step towards achieving its goals.

WHAT IS ENGINEERING MOBILITY?

The phrases engineering mobility or the mobility of engineers are not well understood. Engineering mobility has tended to be regarded as engineers moving around the worlds getting involved in engineering tasks. We are really talking about international benchmarking which helps engineers change employment, change country of residence and access restricted work in new jurisdictions. Benchmarking also lowers an employer's risk in hiring engineers.

During the last decade permanent migration has increased as a result of the global skills shortage. Migration mobility can be regarded as a sub-set of engineering mobility; so much of what I am going to say applies to both. I will talk about engineering mobility first and then make some specific remarks about migration.

Engineering mobility describes the movement of engineers providing engineering services and making engineering products around the world. The engineers are usually working in a different jurisdiction to the one in which they were qualified and acquired professional standing. Not all of this work is regulated but the standards I am talking about are just as desirable in non-regulated engineering work.

Engineering mobility involves mutual recognition of standards by regulatory authorities in different countries, that:

1. can lead to the regulation and registration of engineers,
2. enables engineers to practice in restricted areas of engineering outside their own countries and
3. enables governments and users of engineering products and services to have confidence in engineers coming into their country,
4. facilitates the migration of engineers.

These arrangements may be bi-lateral or multi-lateral and are a form of quality control. Good engineering education and training underpins the mobility of engineering professionals.

Engineers operating international accreditation and mobility systems think that, numerically, migration mobility may have overtaken traditional regulated mobility. Statistics are very difficult to obtain because migrant engineers may do regulated or non-regulated engineering work.

WFEO has an interest in all aspects of engineering mobility but migration mobility is particularly important to WFEO members and its stakeholder agencies. I will say more about this further in this paper.

WFEO has to have a role in fostering and helping this important global activity.

WHY?

WFEO urgently needs a formal position on engineering mobility to inform its members and their engineers, to achieve its goals and as part of its activities representing the profession to world bodies.

WFEO has a key role to play facilitating links and relationships between accreditation and mobility organisations and key international stakeholders. WFEO can also promote cooperation and harmonisation between new and emerging bodies to maximise the benefits and opportunities of mobility and help to alleviate any disadvantage.

Mobility affects all our member organisations and particular standing committees such as Education and Training, Capacity Building and Anti-Corruption.

WFEO can make a major contribution by:

1. collecting, sharing and displaying information and ideas,
2. offering a "shop window" for members (and individual engineers) about what is available to them in their region and circumstances,
3. networking with key stakeholders,
4. brokering good relationships among accreditation and mobility organizations and encouraging good practice among WFEO members,
5. facilitating member involvement in mentoring and training,
6. offering templates for Codes of Ethics and Practice and perhaps engineers' attributes.

THE MAIN REASONS FOR ACQUIRING PROFESSIONAL ENGINEERING STANDING.

1. To become registered and capable of doing particular engineering work, which is often covered by legislation. The main reasons for regulation via registration are where the engineering work affects public safety or where the recipient of the engineering work has little or no engineering knowledge. The latter reason is common to many professions and is sometimes called Asymmetry of Knowledge — the client knows much less than the professional and needs protection.

2. To do any work requiring an engineer in those countries where the title "engineer" in legally protected.
3. To use it in an immigration application for which an internationally recognised degree may be a pre-requisite for engineering work.
4. When individual engineers want the personal satisfaction of knowing they have achieved a certain standard. They also avoid having to assert their competence or having to justify it with each new employer or client.
5. Companies want to measure their engineers in an independent system.
6. Governments and companies can satisfy themselves that companies have the appropriate intellectual capital and human resources to complete engineering projects.
7. Development and funding agencies can satisfy themselves that the engineering-human-resource risk of funding engineering projects is acceptable.
8. Professional standing includes a commitment to practice ethically and competently.

I have placed Migration at No. 3 because of its recently increased importance. I make no judgement about the origin or destination of migrant engineers but the topic is clearly of importance to WFEO and its members and stakeholders. The topic also has economic as well as engineering and other ramifications

WHAT IS NEEDED TO BECOME MOBILE?

Engineers demonstrate that they have reached the professional level by being assessed by a recognised authority. Within their own country this usually done by:

1. the government — called simply "Regulation",
2. their national engineering organisation — called "Self-regulation" or
3. by the government and the national engineering organisation together — called "Co-regulation".

The outcome involves some form of individual recognition for the engineer such as post-nominals and a public register that can be consulted by clients, employers and other interested parties.

Similar arrangements are available internationally through agreements between governments or national engineering organisations. Quality control of courses, training and experience is applied through these arrangements. I describe international agreements in Section 5.

Figure 1 below gives an example of the process of assessment and recognition in early career. It also shows stages in mid-career and later.

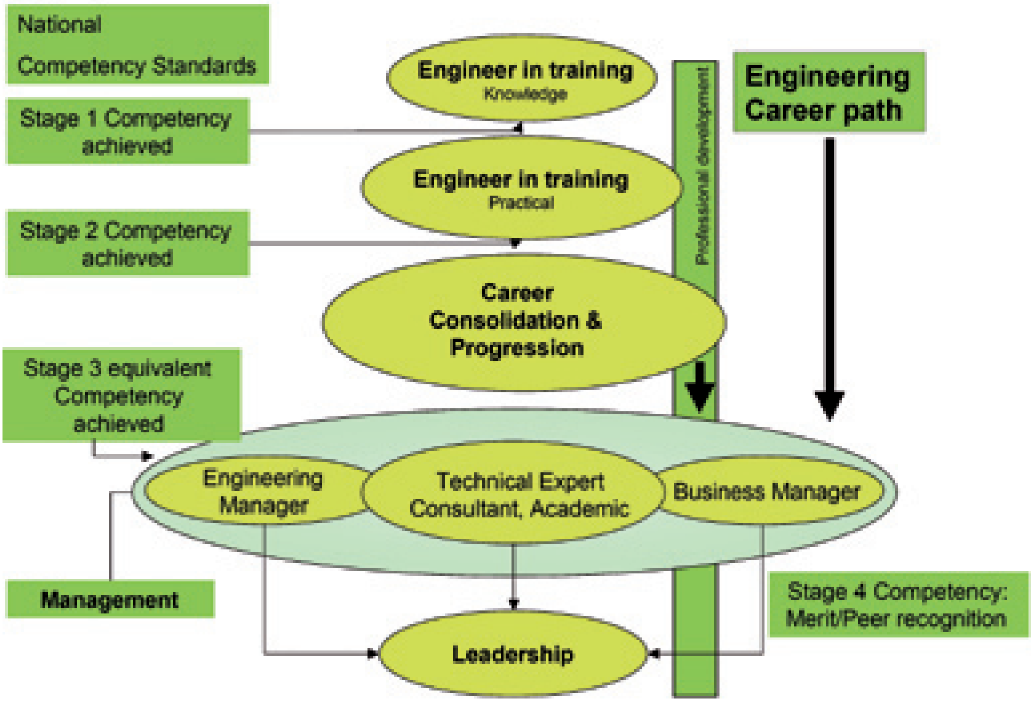

Figure 1. An example of career development and assessment in 4 stages

To work internationally in a regulated environment engineers need a:

1. recognised degree,
2. period of formation and training,
3. demonstrated competence as a mature and independent practitioner,
4. commitment to work ethically,
5. commitment to maintain the competencies required in their area of practice and
6. commitment not to work outside their area of expertise.

A good engineering education can be acquired in a number of ways, but the most common route is by graduating from an accredited engineering degree course.

Following graduation engineers must learn to apply their academic knowledge in an engineering setting. A graduate development program in an engineering company is often the best way to do this. A recognised program will cover a suitable range of documented training and reports, leading to formal assessment of professional standing. A structured program is also the quickest and the most efficient path to professional standing.

Engineers who have been successfully assessed by a recognised body to be competent and capable of independent practice may call themselves a professional engineer and use a post nominal such as P. Eng. — sometimes referred to as a quality mark.

In the engineering profession, with few exceptions, engineering graduates are not professional engineers. They are people with an engineering degree who may be working towards professional standing. They are unlikely to be recognised in legislation or by regulators as competent professional engineers.

Engineers who have not been formally assessed may still be competent. However, they are likely to have to demonstrate that competence whenever the matter is raised formally.

Governments assessing migration applicants are finding recognised qualifications and quality marks very useful. For example, in New Zealand a Washington Accord degree is an immigration requirement for entry with maximum job points.

WHO IS INVOLVED IN CREATING AND ASSESSING STANDARDS INTERNATIONALLY?

Accreditation

The International Engineering Alliance (IEA) globally and the European Federation of National Engineering Associations (FEANI), with the European Network for Accreditation of Engineering Education (ENAEE), which is the body responsible for operating the Accreditation of European Engineering Programs (EUR-ACE) Framework in Europe and neighbouring countries, are the major organisations leading the way on accreditation and mobility at the moment. These are examples of multi-lateral agreements. Both IEA and FEANI have been involved for many years.

The present measure of an internationally acceptable qualification for engineers is the standard set by IEA's Washington Accord (WA) accredited degree. European Education Ministers will fully implement the Bologna Declaration about university degrees, including engineering, by 2010. Good signs of cooperation between ENAEE and the IEA education accords are welcomed.

A group of non-EU members have also expressed interest in joining the EU degree accreditation process.

A number of other, regional, organisations have an emerging interest in accreditation. Some are moving towards a system that will produce degrees to the Washington Accord standard.

Other countries are also discussing the possibility of a different standard, which is sufficient to meet regional requirements. Some of the bigger countries with perhaps a thousand universities are mindful of the difficulty of achieving general quality control. They may start with a proportion of their universities and decide later how far they will extend the process.

The Pan American Federation of Engineering Associations (UPARDI) and the Federation of Engineering Institutions of Asia and the Pacific (FEIAP) are moving into the field of accreditation.

The Washington Accord has rules to allow a signatory to accredit a neighbouring country's engineering courses under special circumstances. The rules apply to a country that has only a small number of universities and is unlikely to be able to establish an accreditation system for many years. A university that can demonstrate the international standing of its engineering courses may be accredited by the Washington Accord signatory and the courses listed on the signatory's website as being of Washington Accord standard.

This arrangement is of particular interest to WFEO and its stakeholders.
The arrangement should not be confused with mentoring help given by Washington Accord signatories to countries working towards becoming a signatory themselves.

IEA also has accords for Engineering Technologists and Engineering Technicians.

MOBILITY

The arrangements for mobility present a similar picture. The Engineers Mobility Forum (EMF), which is a non-government arrangement, and the Organisation for Asia Pacific Economic Cooperation (APEC) Engineer forum is part of the IEA. The member governments of APEC back the APEC Engineer. IEA also has forum for Engineering Technologists

In Europe FEANI operates its own European Register (EurIng). Within the EU the competent authorities of the Member States administer the legal mobility arrangements.

It is worth noting that the main thrust of accreditation and mobility movements is to produce engineers to work internationally. Little if any evidence is available, but those involved think that only about 20% of engineering work internationally requires registered engineers. Data will be sought in the WFEO mobility project to get a better understanding of the proportion.

Details of the organisations I have mentioned can be obtained from their websites, listed in the bibliography.

Multi-lateral recognition agreements don't yet permit complete freedom of mobility. Reliance on bi-lateral mutual recognition agreements will therefore remain for a number of years until the special requirements of individual countries are minimised or removed. Mutual recognition agreements also help engineers seeking non-regulated engineering work even in a regulated environment.

WHO IS AFFECTED BEYOND THE PROFESSION AND RELATED STANDING TECHNICAL COMMITTEES?

A number of international agencies and organisations have an interest in the mobility of engineers. These include the United Nations, UNESCO, the World Trade Organisation (WTO), Development Banks, Transparency International, and all levels of government, which might register engineers or use engineering services.

The International Federation of Consulting Engineers (FIDIC) is a worth a separate mention. Like WFEO, FIDIC has a major interest in the activities of the accreditation and mobility organisations and the promotion of their work. It is already cooperating with WFEO on Anti-Corruption and is likely to be an enthusiastic partner in the representation and information dissemination role being proposed.

WHAT CAN WFEO DO?

WFEO can use its information systems and its channels of communication to provide information on mobility.
It could:

1. act as a single comprehensive information resource with contact details, on what its members and the accreditation and mobility organisations are doing on this topic regionally and globally,
2. offer a neutral forum for exchanges between different participants in accreditation and mobility practice and standards setting e.g. conferences, forums between providers of accreditation and mobility registers and users,
3. facilitate the provision of help (mentoring, training and possibly even document translations) needed by members wanting to develop their own engineers and ensure the quality of engineering services they require,
4. include mobility in its role of representing the profession to international agencies.
5. offer commentary on the skill levels needed in a generic sense as we do with the Code of Ethics,
6. help with maintaining standards affecting safety, professional practice and probity,
7. monitor changes over time.

With its limited financial and human resources — its weaknesses — WFEO must build on its strengths. These are largely its member network and its good relationships with international agencies. It would be a wasteful duplication if WFEO tried to get into the business of accreditation and assessment. It is unlikely that WFEO could find the necessary funds. WFEO could not expect to use the expertise of its members because that expertise would already be committed to the existing mobility organisations.

8. WHAT CET IS DOING?

1. The Committee for Education and Training has discussed the topic and put it on the committee’s strategic list.

2. The educational and training aspect of mobility fits within CET's terms of reference and there is a clear need to develop a position and prepare advice for the Executive Council. A working group of CET members has been established. Additional members including those with knowledge of regional activities are being sought.
3. CET has adopted a future scenario, which includes mobility of engineers, and a paper on accreditation and mobility has been submitted for inclusion in the WFEO/UNESCO Engineering Report.
4. Presentations will be made at the UPARDI/CCB meeting and the Students' and Young Engineers' Forum, both at WEC 2008.
5. The Committee on Capacity Building has been invited to propose members for the CET working group and a similar invitation will be extended to the Committee on Anti-Corruption.
6. The plan is to seek information on involvement and needs from WFEO members so that information pages can be included on the WFEO website and a policy statement can be recommended.
7. Cooperation with accreditation and mobility organisations is being sought.
8. A draft WFEO accreditation and mobility policy is being prepared.
9. Web page format and content will be discussed in Brasilia.

As well as the reporting mentioned above a progress report will be made to the Executive Council in Brasilia in 2008 and the policy proposal discussed in time for the General Assembly in 2009.

9. FUTURE DEVELOPMENTS

In the short term WFEO must concentrate on establishing its policy and the information process for its stakeholders.

The next step would be to help members, who want to establish accreditation systems and standards for mobility, to liaise with organisations that might work with them. Establishing their systems includes adapting to:

1. output based education and training,
2. competency based assessment and
3. longer emerging course structures, e.g. 3 + 2 in Europe and elsewhere.

The step would also involve encouraging international agencies to, firstly, recognise the standards and mobility organisations and then work with them to assist WFEO member countries to meet their needs.

Developing countries may need particular help in arranging contracts and monitoring in-coming professional engineers and the provision of engineering products and services including building infrastructure.

The present educational standards focus on first degrees and the level of competence needed for independent practice, mainly at the beginning of an engineer's career.

A third step might look at:
1. a whole-of-career approach to education and training (see Figure 1.),
2. education and competencies for senior engineers and
3. suitable arrangements for engineering managers.

There is a related global demand for engineering technologist and possibly engineering technicians. The paper uses engineers as an example but the paper also applies to technologists and technicians where appropriate systems are available.

10. CONCLUSIONS

WFEO is vitally concerned with the qualifications and training of members of the profession to enable engineers to maximise their contribution to national and international engineering activities.

A WFEO contribution to the availability of competent engineers around the world and ensuring a proper understanding of the profession by non-engineering stakeholders would have a significant impact on achieving our goals.

Adopting a key central facilitation role and showcasing the work of long-standing and new accreditation and mobility organisations would make best use of WFEO's widespread but limited resources.

11. BIBLIOGRAPHY AND GLOSSARY

[1] WFEO/UNESCO Engineering Report — section on mobility World Federation of Engineering Organisations (WFEO), www.wfeo.org (and see links)

[2] International Engineering Alliance (IEA), www.ieagreements.com

[3] International Federation of Consulting Engineers (FIDIC), www1.fidic.org

[4] European Federation of National Engineering Associations (FEANI), www.feani.org

[5] Pan American Federation of Engineering Associations (UPARDI), www.upadi.org.br

[6] Federation of Engineering Institutions of Asia and the Pacific (FEIAP), see www.hkie.org.hk

[7] European Society for Engineering Education (SEFI), www.sefi.be,aaa

[8] Washington Accord (WA), see IEA

[9] Organisation for Asia Pacific Economic Cooperation (APEC) Engineer forum, see IEA

[10] European Network for Accreditation of Engineering Education (ENAEE), www.enaee.eu

[11] Accreditation of European Engineering Programs (EUR-ACE), see FEANI site.

12. ACKNOWLEDGEMENTS

This paper has been prepared with the help from several members of WFEO with further helpful comments from staff of member and related organisations. The author gratefully acknowledges their contribution.

The Role of Engineers and Scientists of the World in the Discussion about Energy and Change in Climate

Prof. Dr.-Ing. Vollrath Hopp,
University of Rostock, Germany
Member of WFEO-CET

Prof. Vollrath. Hopp has studied chemistry and technology at the Technical University of Berlin, and received a doctorate in 1960. He worked in the chemical industry in Germany. In 1966 he joined Hoechst AG as head of vocational and advanced training in science and engineering. He was offered a guest lectureship at the Tongji University, Shanghai, in 1986, subsequently becoming a Honorary Professor. In 1991 he was appointed Professor at the University of Rostock in the areas of chemical technology. He is a full member WFEO-CET. 1998 he became an Honorary Member at the University of Rostock. Prof. Hopp has published extensively in journals on issues of chemical engineering. He is the author of five chemical engineering textbooks. He has received several prizes and decorations for contributions to co-operation between education and industry.

Abstract

More than 50 years ago, after the end of the second world war, 1945, the governments of the nations complained about the hunger of the people in the world, and of the shortage of energy resources e.g. crude oil, natural gas and last but not least of the epidemic of infectious diseases and of late about the scarcity of fresh water.

Although fresh water is only used or consumed but does not become less. Through recycling processes it returns to its original pure state. Nevertheless it has become more and more scarce.

The United Nations also discuss very intensively the importance of pollution control and of a supposed change of our climate.

None of these problems has been solved in spite of numerous international conferences and arrangements. What is the reason for this? What is wrong here? The laws of nature are ignored by our industrial, economic and political decisions and modern society acts as if these laws did not exist, e.g. the principles of thermodynamics or Newton's third axiom: action = reaction.

The principles of thermodynamics have been replaced by the laws of shareholder value and the maximizing of profit. The requirements of ordinary people have become secondary in importance e.g. they would like to have sufficient food, clean fresh water and to be free from epidemics and everyone must have access to the modern energy network.

Each incorrect decision is followed by a further wrong decision. In this way mistakes are continued by the nations and societies respectively stumbling from one problem to another. The dimensions of the wrong decisions eventually become ever bigger. Each action is followed by a reaction. This is the statement of Newton's third axiom.

Intensive research is one task today. We must find the true reasons for the effects and impressions gained from nature. For this purpose it is necessary to think in terms of interdisciplinary fields. Knowledge of specialists must be linked.

The physicist and Nobel Prize Winner Werner Heisenberg (1901 – 1976) formulated in his book "Ein Teil und das Ganze" (the part and the whole: "The whole is more than the sum of its particles"). This statement is valid also for social-economic systems.

THE ROLE OF FRESH WATER

The agriculture, the global production of food, the industry and the provision of useful energy are directly dependent on a sufficient supply of fresh water.

Cities, villages and private households require a lot of energy to maintain their technical infrastructure and motorized traffic (fig. 1).

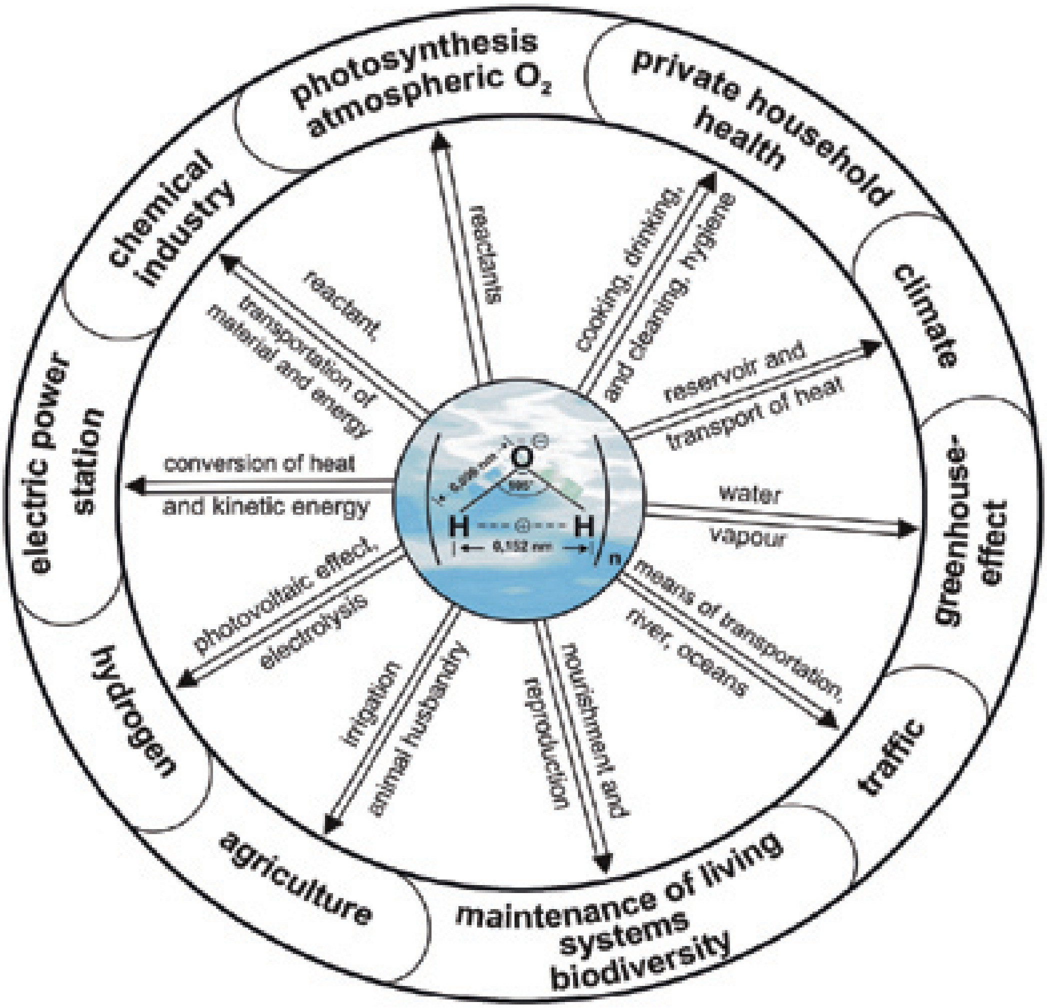

Fig. 1: Water, a system of linking molecules and key-product in nature and technology

The most important energy sources of the world are the fossil fuels e.g. coal, crude-oil and natural gas; alternatively supplemented by water power and nuclear energy (table 1).

Table 1: Water, a medium of energy conversion and transport

Recources of energy	Stored Energy	Reactor of transformation of energy	Potential differences (driving gradients)	Medium of conversion and transport	Location of conversion	Net energy (useful energy)
Fotosynthesis solar radiation	electromagnetic energy	biological cells: chemical energy	differences of wave length and frequences	water	bacteria, algae, plants	chemical energy (food)
Photovoltaic	solar energy	semiconductor, solar cells	differences of electric potential	electron displacements	silicon single crystal disc	electrical energy
Thermal solar power station	solar energy	parabolic reflector	differences of temperature and pressure	synthetic oil and water steam	parabolic reflector trough and absorber tube with oil	electrical energy long distant heat
Solar Chimney power station	solar energy	glass roof hot air collector	differences of levels in the chimney	streaming hot air	wind turbines with generators	electrical energy
Power stations coal, crude oil, natural gas	chemical energy	combustion chamber, steam generator: heat	differences of temperature and pressure	water, steam	turbine, generator	electrical energy, long distant heat
Nuclear power stations uranium	nuclear energy, fuel elements	nuclear reactor, steam generator: heat	differences of temperature and pressure	water, steam	turbine, generator	electrical energy
Geothermal power stations crust of the earth geysers	geothermal energy	earth pit: heat	differences of temperature and pressure	water, steam	turbine, generator	electrical energy, heat of processes and heating installation
Hydro-electric power stations water	potential energy	rivers, waterfalls, dams: kinetic energy	differences of levels	water	turbine, generator	electrical energy
Tidal hydro-electric power stations gravitational energy moon-earth, sun-earth	kinetic energy	off shore of sea: kinetic energy	differences of gravitational energy; change of high and low tide	water	turbine, generator	electrical energy
Wave hydro-electric power stations wave motion of seas	kinetic energy	off shore of sea: kinetic energy	differences of amplitudes of sea-waves	water	turbine, generator	electrical energy
Wind driven power station	kinetic energy of the wind	atmospheric air	differences of pressure and temperatur in the atmosphere	wind	turbine, generator	electrical energy

THE CHALLENGE FOR ECONOMY AND ECOLOGY

A significant challenge for the economy and the ecology is the harmonizing interaction between technical processes and the preservation of the ability of regeneration of nature, especially in relation to farmland, forests, rivers, lakes and oceans.
All these are closely bound together and may well be among others the main causes of international conflicts.

Political conflicts must be avoided. The worldwide controversial discussions about ecological problems are full of contradictions. It becomes very clear in the lively debates about the human causes of CO_2-emissions and their influence on the changes in climate. These complex subjects throw up many questions of a natural-scientific and technological nature.
Engineers and scientists must possess a solid basic knowledge and well developed abilities in interdisciplinary thinking in the studies of natural science, life science, agriculture and medicine. Well founded studies of these subjects are the preconditions for an appropriate expertise.

In which way can engineers and scientists at national and international political level influence government policy? Neither individual engineers in influential positions nor the great associations of engineers are able to influence decisively the ideological talks in political committees. Is it a lack of commitment of the individual engineers and scientists or their organizations? Most engineers and scientists give the impression that they are not courageous enough to stand up for their own knowledge and technical experience. They have forgotten that more recent knowledge of science and engineering always has a direct or indirect effect on political trends. One must accept that scientific, economic and social developments are very closely connected. Scientists and engineers are elected seldom as Members of Parliaments or appointed as ministers. What is the reason? Is it possible perhaps that this group of qualified citizens is indirectly excluded from the political decision-making levels by the politicians-themselves? On the one hand the people and the governments require an excellent education, vocational training and further education. On the other hand people find it very difficult to accept the laws of nature and technology and the consequences there-of. It seems that many an engineer or scientist acts as if she or he had forgotten the elementary principle laws as soon as they have been absorbed by the routine of professional practice.

The mission of engineers and scientists is to acquire for knowledge independent of the ideology, political and economic trends in thinking.

Production of bio-ethanol, a misuse of basic foodstuffs
Bio-ethanol is a modern name for the well-known ethyl alcohol. It is produced through an anaerobic process with yeast of *saccharomyces cerevisiae*. Starting sources are cereal, rice, maize, pure sugar and other sugar containing fruits.
But the conversion of cereal, maize and sugar into bio-ethanol for petrol is a wrong way to substitute fossil materials to minimize carbon dioxide emission (fig. 2).

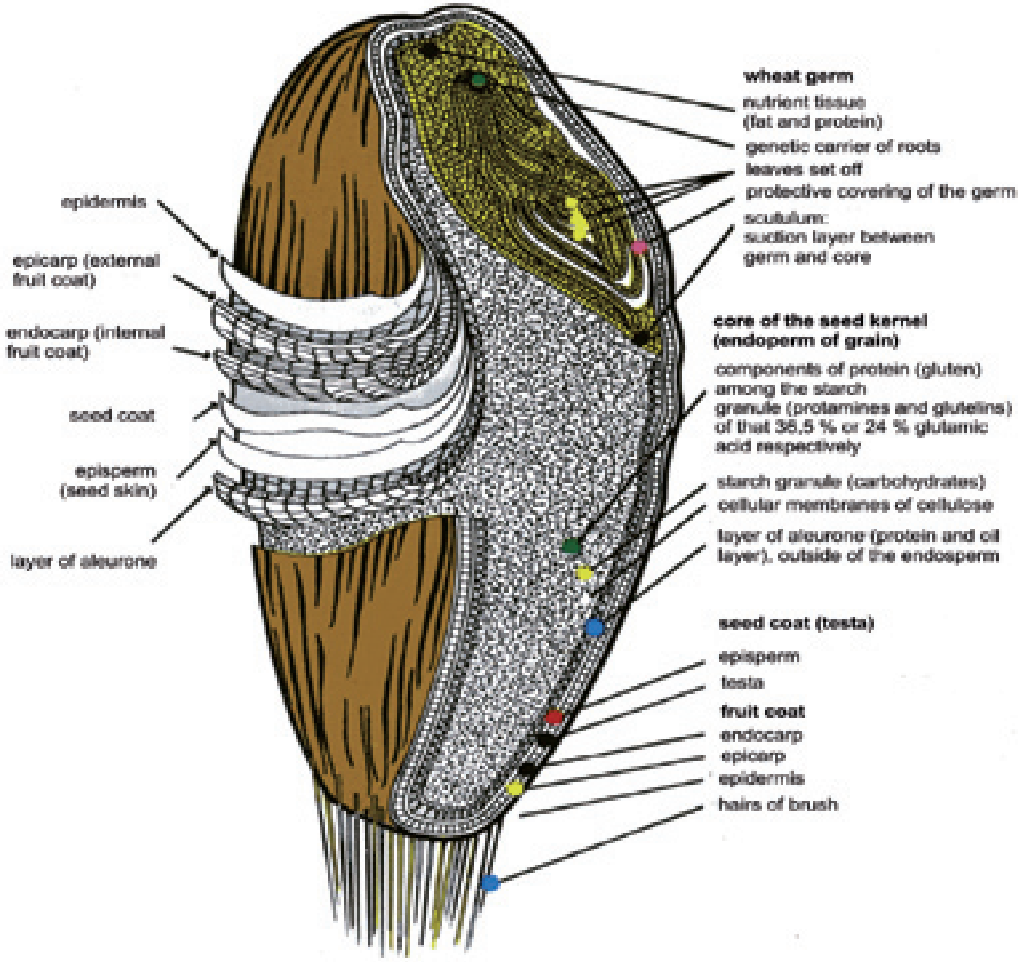

Fig. 2: Longitudinal section of grain of wheat (enlarged approximately 150 times)
The layer of aleurone contains valuable minerals and the vitamine B-complex. The germ contains the vitamins A, D, E, fat and protein.

Cereals and sugar are products of photosynthesis. Carbon dioxide is also emitted during the combustion of bio-ethanol. It is again bound photosynthetic by plants (fig. 3).

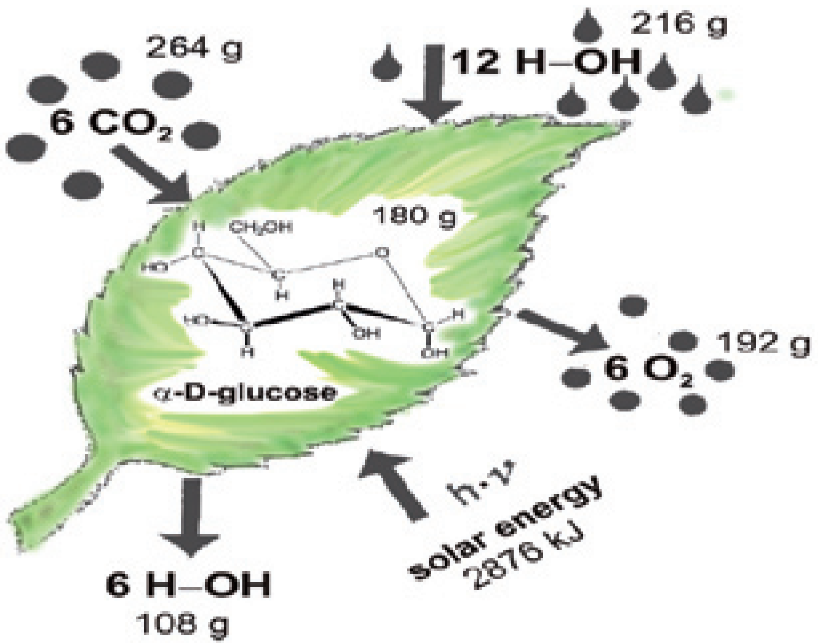

Fig. 3: Photosynthesis in a leaf as a membrane and bioreactor

The consequential problems of the use of ethanol as a petrol substitute are the insufficient supply of the population with food and in addition the degradation of arable land.

Cereal such as wheat, maize, rice, legumes and vegetable oil are the most important sources of foodstuffs. A cow fed on 9 kg cereal produces 1 kg of meat.
More than 1,000 million people in the world are undernourished and suffer hunger. The application of the mentioned products of plants for the motor fuel enters directly into competition with the provision of food.
The irresponsible utilisation of cereals and other staple foods for technical use will result in a scarcity of nutrients. Likewise the ability of the soil to regenerate itself will be considerably minimized.

The size of topsoil particles measure between 20 µm and 200 µm (micrometer). The structures of pores are subdivided into fine, medium and coarse. Fine pores are less than 0.2 µm. Medium pores are between 0.2 µm and 50 µm, they are especially suitable for the increase of bacteria and the absorption of water. Coarse pores are greater than 50 µm. They are suitable for the growth of bacteria but not for the storage of water. Water storage and permeability of pores characterize the sponge effect of topsoil (fig. 4).

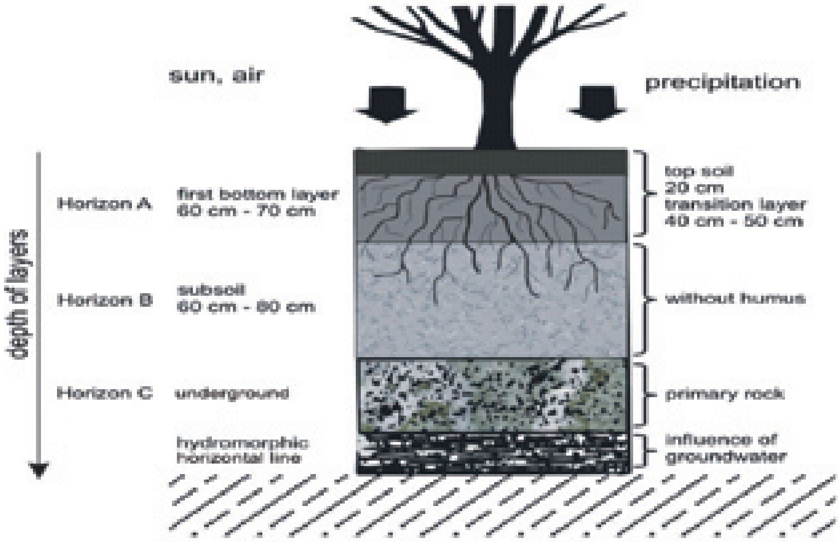

Fig. 4: Layers of arable land

Fertile farmland is a biological system consisting of three essential complex parts. These three parts are:

1. the natural composition of earth with its special profiles,
2. the water as groundwater, percolation water, capillary water and surface water,
3. the humus layer with its micro organism systems, small earth creatures e.g. earth worms, insects, organic residual material and finally with its typical pore structure.

The components are permanently influenced by climate, erosion and by cultivation through the use of heavy farm machines.
In recent years the farm horse has been replaced by heavy and efficient farm machines to cultivate the land and afterwards to harvest crops. These machines are so heavy, that they cause the soil to be compressed. As a result the soil rapidly loses its ability to absorb atmospheric water and to regenerate itself.

The water on the sensitive soil structure drains off quickly from the compressed layers, having a completely altered soil structure. A danger of increasing erosion and degradation results. One of the reasons for the disastrous flooding rivers in the autumn of 2002 in Germany was the compression of the arable land by farm machines. Compressed soil absorbs less water. Crop-yields decrease and this makes planning impossible. If spring is very wet the plant roots are forced to stand in surface water. If the soil dries out very quickly in summer root-growth is delayed. The roots of the plants are no longer able to absorb minerals in the completely damaged humus. Tractors of 8 tonnes to 20 tonnes are far too heavy for arable land. International tests have found that such machines should not exceed a weight of 5 tonnes. Pressure on the soil expands three-dimensionally in all directions to a depth of 100 cm. Soil damaged in this way requires up to ten years to regenerate itself.

The area of arable land per head of the population is declining throughout the world. In 1950 it was 0.51 hectares, in 1975 it was down to 0.34 hectares and in 2025 it will be only 0.15 hectares per head.

It is not logical, when on the one hand farmers get money from the state not to cultivate arable land and on the other hand world wide, hundreds of millions of people suffer hunger.And it is furthermore a contradiction when one would like to save energy and at the same time establish costly luxurious and unnatural areas for recreation.

Globalization, a modern slogan

Globalization is a modern slogan for the worldwide connection of traffic, exchange of goods and information and the transfer of finance. This development is acclaimed as an enormous progress. Strong interdependences between the nations have developed. Because of expanding globalization numerous countries are no longer capable of independently supplying basic foodstuffs.

They have to be integrated into the international branches of the transport system. This wastes a lot of energy. Food is transported by sea from continent to continent or by air. A lot of basic foodstuffs could be cultivated and consumed in the prevailing native country. The population would be more independent. The quick spread of infectious diseases and epidemics is not to be underestimated as concomitant form of globalization.

Engineers and scientists create the technical preconditions for this modern infrastructure. But the politicians and financial experts are responsible for the strategies. The guidelines for their actions are financial profit and with that connected exercising power. Engineers and scientists become their labourers.

At economic decisions and plannings are not considered the connection between geological, biological and climatic courses in nature. Besides it is not noted that economic and sociological developments a closely linked. All these courses are long time processes. By comparison money flows like to multiply in short times.

For example, biological and thermodynamic principles are ignored, likewise the preconditions for maintenance of the ability of regeneration of arable land and in the widest sense of nature.

An example of ideological confusion

The present discussion in the world about carbon dioxide emissions into the atmosphere and the change in climate caused by the combustion of fossil fuels is the height of the ideological confusion. The ecology is converted into a political doctrine of ecogolism. Increased emissions of carbon dioxide into atmosphere from ocean water and the surfaces of the continents is a consequence of a warming of the atmosphere close to the Earth.
Examples for causes of variation in temperature and in change in climate on the Earth over the geological history:

- changes in solar activity (sun spots),
- changes in cosmic radiation,
- changes in the angle of inclination of the Earth axis (from 24,5° to 22,5°) in periods of about 41000 years,
- changes in the field of geomagnetism and in gravity,
- heavy volcanic eruptions.

It is said today that an increased carbon dioxide emission causes a high greenhouse effect and as result in the surface of the Earth warming up. Molecules of carbon dioxide absorb only very little solar radiation. The absorption spectrum of carbon dioxide verifies that. Approximately 88% of the greenhouse effect is caused by water vapour in the atmosphere (fig. 5 b).

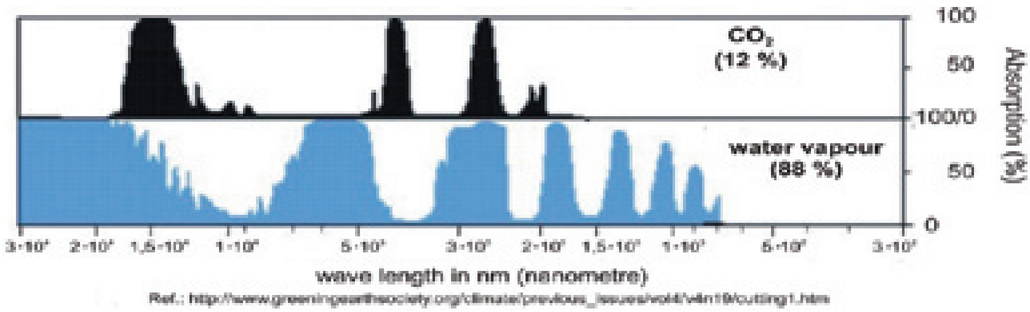

Fig. 5a: Absorption spectra of water vapour and carbon dioxide in the atmosphere

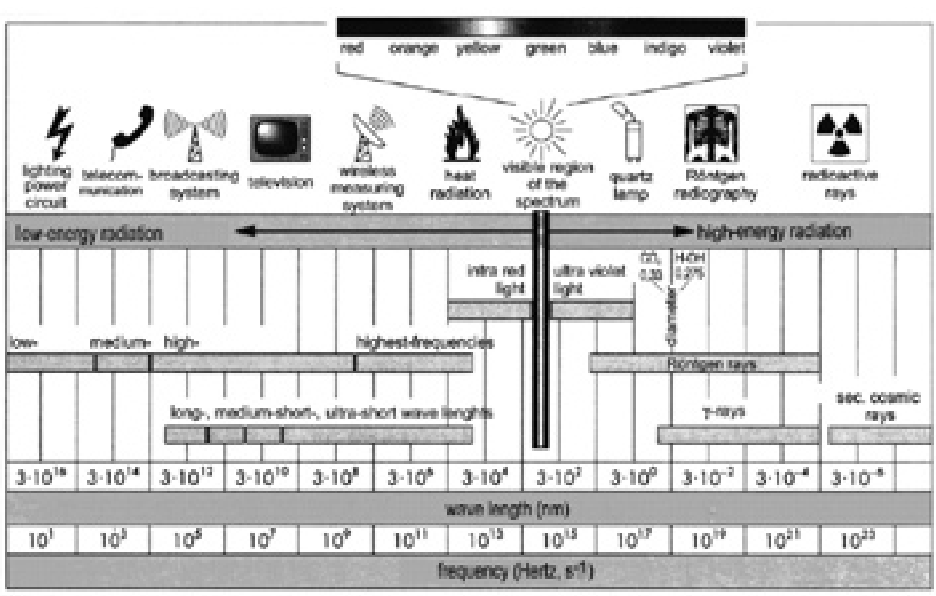

Fig. 5 b: The spectrum of radiation energy in nano-dimensions (diameter of water molecule 0,275 nm, diameter of carbon dioxide molecule 0,33 nm kinetic and 0,4 nm static)

The remaining 12% of the effect is attributable to the gases, ozone, methane, carbon dioxide, oxides of nitrogen and other (table 2).

One should remember that the greenhouse effect has a positive influence on the heat regulation on the surface of the Earth. Without a greenhouse effect, the temperature on the Earth's surface would be below -18° centigrade. Scientific research is often ignored, if it does not conform to already accepted ideas of modern ecologism.

And meanwhile laws are legislated by the parliaments and governments. They favour the trading of nonsensical waste emissions certificates. They are an indirect tax collection of governments. The emission certificates are letters of indulgence of the modern age. Industry and every individual citizen must ensure that the environment is not polluted too strong and the ability of regeneration in nature is not destroyed. Therefore it is necessary to know the laws of the processes in nature and its environment.

CONCLUSIONS – WHAT ENGINEERS AND SCIENTISTS HAVE TO DO IN THE NEAR FUTURE!

- They have to obey the laws of nature, which they have discovered themselves. More scientists and engineers have to engage in political committees and they must influence their own associations so that they do not reach political conformist compromises.
- Students of engineering and science should be sensitized to politically thinking by suitable compulsory lectures at the universities. Political thinking is a part of culture. It should be sharpened in interest of the culture of the own country. In this way quarrels may be avoided.
- Although all governments accentuate the importance of education and science the reality is quite different. The promotion of young people for independent thinking is much neglected; also in countries which believe they embrace an ideal picture of democracy.

Table 2: Some calculated and estimated data of the carbon dioxide-, CO_2, and carbon-, C_x, cycles in nature respectively

CO_2-emitting processes	Amount emitted in 109 tons per year	
	CO_2	C_x
• Combustion of fossile fuels	39.7	10.8
• Production of iron and steel by reduction with coke in the blast furnace (worldwide production 1.322 bn tonnes in 2007)	0.781	0.213
• Production of aluminium by fused salt electrolysis of bauxite (worldwide production 38 million tonnes in 2007)	0.047	0.013
• Cement production (2.6 bn tonnes in 2007)	1.05	0.29
• Volcanic eruptions (there are 1300 active volcanos on the Earth)	2.2	0.6

CO_2-binding processes		
• Rising of deep water to the surface e.g. on the equator and on the continental edges (subduction)	385.0	105.5
• Release of CO_2 by warm surface water of the oceans	330.0	90.0
• Respiration of marine organisms and rapid decomposition of dead organism in cold surface water of the oceans	51.0	14.0
• Respiration of marine organisms and rapid decomposition in warm surface water of the oceans	95.3	26.0
• Respiration of microorganisms in the soil are emitting CO_2 into the atmosphere	216.3	59.0
• Respiration of land organism including 1.5 bn cattles of the world in consideration of methane CH_4 ($71,2 \cdot 10^6$ t)	183.3 0.452	50.6 0.123 0.053
• Respiration of the world population (6.5 bn. people in 2008)	1.6	0.44
• Deforestation of the forests and land	5.5	1.5
• Falling of leaves and decomposition of the roots in the soil	220.0	60.0
• Absorbing of CO_2 by the cold surface of the oceans	330.0	90.0
• Sedimentation of dead marine organisms from surface water into the deep oceans (inorganic and organic carbon)	73.3	20.0
• Sinking of the cold surface water (mostly near the poles)	353.0	96.2
• Sedimentation on the seabed (inorganic and organic carbon)	2.2	0.6
• Horizontal transfer of warm surface water	36.7	10.0
• Transportation of carbon compounds through river estuaries into the oceans • Production of urea as fertilizer (113 mio. tonnes in 2006)	2.26 0.083	0.6 0.023
• Photosynthesis of marine organisms in cold surface water of the oceans	29.0	8.0
• Photosynthesis of marine organisms in warm surface water	117.3	32.0
• Photosynthesis of phytoplankton	378.0	103.3
• Photosynthesis of land organisms	403.3	110.0

REFERENCES

[1] Crutzen, P. J.; Mosier, A. R. Smith; K. A. and Winlwarter (2007), N_2O release from agro biofuel production negates global warming reduction replacing fossil fuel; Atmos. Chem. Phys. Discuss; 7, 11191 – 11205.

[2] Deutscher Bauernverband (2008), Trends und Fakten zur Landwirtschaft, Situationsbericht 2008, 10117 Berlin, Claire-Waldoff-Str. 1, Germany.

[3] Global Climate Change Student Guide Department of Environmental and Geographical Sciences; Manchester Metropolitan University, Chester Street, Manchester, M1 56D, United Kingdom.

[4] Greenhouse Gases and Global Warming Potentials (updated April 2002), US Environmental Protection Agency.

[5] Institute for Energy and Environmental, Research Heidelberg GmbH, Ifeu (2003), Final Report: Life Cycle Assessment of Biodiesel: Update and New Aspects, Project Nr. 530/025 Heidelberg 2003, Germany.

[6] Key World Energy Statistics (2007), International Energy Agency, 75739 Paris, Cedex 15, France.

[7] Müller, A. (2007), Wheat, maize and sugar cane: foodstuff or energy source, Sun and Wind Energy, 2, 2007.

[8] Oss, van H. G. (2008), Cement US Geological Survey, Mineral Commodity Summaries, Jan. 2008.

[9] Reichholf, Josef, H. (2007), Eine kurze Naturgeschichte des letzten Jahrtausends, 5. Auflage, S. Fischer Verlag GmbH, Frankfurt am Main, Germany.

[10] Schönwiese, C. (1995), Klimaänderungen – Daten, Analyse, Prognosen; Springer Verlag, Berlin, Germany.

15 Editions of IDEAS 1993–2008

IDEAS created in **1993** – thanks to the initiative of **Prof. Miguel Angel Yadarola** President of the WFEO Committee on Education and Training in the years 1993-1997 – has been systematically edited since that time.
It seems interesting to review the subtitles as well as number of pages of the so far published issues which reflect the development of the Committee itself and evolution of its areas of interest and activities.

1.	Distance Learning in Engineering	1993,	20 pages
2.	Accreditation of Engineering Studies	1994,	40 pages
3.	Accreditation and Professional Practice	1996,	38 pages
4.	Accreditation, Engineering Education and Practice	1997,	40 pages
5.	Continuing Professional Development	1998,	58 pages
6.	The Impact of Globalization on the Engineering Education and Engineering Practice	1999,	112 pages
7.	The Necessary Basic Knowledge and Abilities for Engineering Graduation	2000,	52 pages
8.	Internationalisation of Engineering Education	2001,	40 pages
9.	Quality of Engineering Education	2002,	56 pages
10.	Future Directions of Engineering Education and Continuing Engineering Education	2003,	78 pages
11.	Special Needs of Developing Countries in the Field of Engineering Education	2004,	40 pages
12.	University Graduates' Managerial Knowledge and Skills – Way to Global Excellence	2005,	104 pages
13.	Education for Mobility	2006,	104 pages
14.	Education for Innovation	2007,	164 pages
15.	Education for Development	2008,	88 pages

Prof. Włodzimierz Miszalski
Editor

CHRONICLE OF EVENTS (November 2007 – December 2008)

November 2007 – 2nd half

Publishing of IDEAS No.14 devoted to the International Conference "Supporting Small- and Medium Sized Enterprises in Engineering and Technological Innovation Activity" – held by CET on 17-18 May 2007 in Cracow, Poland. It has been distributed by the secretariat of the Committee among CET members, National Members of WFEO, authors of papers presented at the conference, Past President of WFEO Eng. Kamel Ayadi, international engineering organizations, e.g. FEANI, technical universities, libraries and the like. Numerous copies were sent to Secretariat General of WFEO (for Executive Board members and other interested parties).

December 2007 – January 2008

Establishing contacts with FEANI and FEANI Committee on Continuing Professional Development (CPDC), among others with an offer of cooperation between both committees – publication of an article "World University of Technology – Solution for Mobility" Prof. Włodzimierz Miszalski.

12 February 2008

Working out a contribution to section 4 of a UNESCO Report "Engineering: Issues and Challenges for Development" prepared in conjunction with WFEO and CAETS. The title of the said contribution: "Engineers in Education" (Prof. Włodzimierz Miszalski). The contribution was sent to Dr Anthony Marjoram, UNESCO.

December 2007 – May 2008

Preparations for the 8th World Congress on Engineering Education (8WCEE) – meetings and discussions with the IEM (Eng. Hisham Shehaby, Vice President of WFEO-CET)

29-30 March, 2008

The 37th WFEO-CET meeting was organized in Warsaw, Poland. Main topics of the meeting covered by the Agenda: information on WEC'2008 in Brasil, report on progress of preparatory and organisational works of the 8th WCEE in Malaysia in 2009, the general theme and sub-themes of the 8th WCEE, developing WFEO-CET home page, publication of IDEAS No.15, next WFEO-CET meetings and other events, information on the progress of setting up a Working Group on WFEO Strategy for Mobility, its composition and plans for future.

April 2008 – November 2008

Preparations of the 38th WFEO-CET meeting to be held in coincidence with WEC'2008 in Brasilia on November 30, 2008.

16-20 April 2008

Meeting in Warsaw, Poland with a Chinese delegation – advice, guidance and consultations given by WFEO-CET President for China Association for Science and Technology (CAST) on accreditation solutions for engineering and technology in European countries.

13 June, 2008

Solving difficulties with the IEM, the organizer of the 8th WCEE – official withdrawal of the WFEO-CET offer for the IEM to host and organize the 8th WCEE, postpone the Congress to and search for a new organizer (after the previous consultations with the WFEO-CET members): e-mail message to President of the IEM, an appeal to WFEO National Member Organizations and Members of WFEO-CET – at websites of WFEO and WFEO-CET, preliminary contacts with UADI.

September 2008 – October 2008

Sudden death of WFEO-CET Vice President Eng. Hisham A-Malik Al-Shehaby.
Condolences to the family of the sudden passed Vice President of WFEO-CET & WFEO Eng. Hisham A-Malik Al-Shehaby and the Bahrain Society of Engineers.

4 November 2008

After the 37th Meeting of WFEO-CET in Cracow, Poland the Working Group on Mobility was established under the chairmanship of Dr Peter Greenwood, Australia who initiated and started intense works on the following documents: Mobility of Engineering Professionals Information Paper on Mobility prepared for the WFEO Standing Committee on Education and Training (WFEO-CET) and WFEO Policy on Accreditation of Courses and Mobility of Engineering Professionals – documents forwarded to the Executive Council for recommendations.

30 November 2008

The 38th WFEO-CET meeting (the fourth Committee meeting under the Polish Presidency) was held on November 30, 2008 in the Ulyssses Guimarăes Convention Centre in Brasilia, Brazil in coincidence with the 3rd World Engineers Convention (WEC'2008).

Just at the very beginning of the meeting its participants have commemorated the death of Hisham Shihaby, Vice President of WFEO-CET and Vice President of WFEO with a minute of silence. His Colleagues and friends from the Committee – Dr Peter Greenwood, Prof. Abdel Monhem Alameddine and Prof. Leizer Lerner have paid a tribute to him with a short commemorative presentation.

The Agenda of the meeting covered, among others the following items: the Committee Internal Organisation, within which the Committee has accepted Dr Edgar Hernandez Patiño (Puerto Rico) as a new member, has nominated Prof. Abdel Monhem Alameddine new Vice President of WFEO-CET and decided to apply to President of the Polish Federation of Engineering Associations (Polish National Member of WFEO) to prolong the Polish CET Presidency and Secretariat for the next 4-year term (starting with November 2009), publication of the Committee journal IDEAS and development of the WFEO-CET website.

Substantial time and discussion were devoted to the 8th World Congress on Engineering Education (8thWCEE), which will be organised in Buenos Aires and hosted by the Argentina National Member of WFEO – UADI on occasion of the great Argentina anniversary in the period of 18-20 October 2010. The 8th WCEE would be integrated into the Program of the Thematic Congresses ENGINEERING 2010 ARGENTINA – with its own personality sharing the general theme "Engineering Education for Sustainable Development". The congress will be organised also in coincidence with the WFEO Executive Council meeting and WFEO Standing Committees meetings (CET has been already invited to have its 40th meeting in Buenos Aires). The Committee members have also discussed and approved two drafted papers worked out by Dr Peter Greenwood, Chair of the WG Mobility, namely: "Mobility of Engineering Professionals" Information Paper on Mobility prepared for the WFEO Standing Committee on Education and Training (WFEO-CET) and "WFEO Policy on Accreditation of Courses and Mobility of Engineering Professionals", both documents forwarded to the Executive Council for recommendation.

There were 2 proposals of venues for the next CET meeting in 2009: Budapest (Hungary) on invitation of Past President of WFEO-CET Prof. Janos Ginsztler and Past Secretary of WFEO-CET Mrs. Zsuzsanna Sarkozi-Zagoni; the meeting has been planned for 18 September 2009 on occasion of the 70th Anniversary of the Institute of Continuing Engineering Education, Budapest University of Technology and Economics, and Kuwait (first week of November 2009) in coincidence with the General Assembly of WFEO. CET members were asked to vote for one of the proposals via e-mail.

At the 38th WFEO-CET meeting, apart from the Committee members, participated the following invited guests: Eng. Barry Grear, President of WFEO, Dr Maria J. Prieto Laffargue, President-Elect of WFEO, Prof. B.J. Vasoya, Vice President of WFEO, Prof. Miguel Angel Yadarola, Past President of WFEO-CET, Eng. Conrado Bauer, Past President of WFEO, Eng. Mario Telichevsky, President of UADI Argentina, Eng. Luis Vaca Arenaza, President of the Organising Committee "Engineering 2010 Argentina", Eng. Pablo Bereciartua, President of the Organising Committee of the Congress "Young People, Engineering and Business", Lic. Carina Carrasco, coordinator of the "Engineering 2010 Argentina", Eng. Alec Hay – Engineers Mobility Forum (Republic of South Africa), Dr Haro Bedelian, Executive Council Member (UK) and Eng. Naeemah A. Al-Hay from the Kuwait Society of Engineers.

3-6 December 2008

Welcome Address of Luiz Inácio Lula da Silva – President of Federative Republic of Brazil.

This third edition of the WEC, and the first to be held in the Americas, follows previous conventions in Shanghai in 2004, and Hanover in 2000 was attended by over 3000 engineers from 40 countries, including 1,300 young engineers. The main theme of WEC 2008 was "Engineering: Innovation with Social Responsibility", with sub-themes relating to education, environment, development and the Millennium Development Goals. Parallel sessions included a “Women’s Forum” and a “Student and Young Engineers Forum”, and there was Expo WEC – promoting technology with the theme “Engineering for the Future”. WEC2008 was organized by two Brazilian engineering organisations (the Federal Council of Engineering of Architecture and Agronomy and Federation of Engineers’ Associations), and sponsored by the World Federation of Engineering Organisations.

In his opening address, President Lula emphasised the role of engineers and scientists in addressing global challenges. He also indicated that a shortage of engineers in many countries is one of main challenges facing engineering and the world today. President Lula underlined the serious impact this will have on sustainable social and economic development, and the need to stimulate activity in the current economic crisis. In many developing countries this shortage is compounded by the brain drain of engineers from rural to urban areas, and from developing to developed countries.

The closing ceremony included a presentation of the forthcoming WFEO events, particularly the next General Assembly to be held in Kuwait, the World Engineers Week that will be held in Buenos Aires and the WEC2011 that will be hosted by Geneva. A brief presentation on the UNESCO engineering Report “Engineering: Issues and Challenges for Development” – was also made.

Ulysses Guimarães Convention Center

W. Miszalski – President of WFEO-CET and T. Domańska – Secretary of WFEO-CET at the WEC Opening Ceremony, Brasilia

WFEO-CET members actively participated at the 3rd World Engineers' Convention (WEC) which was held in Brasila, Brazil. Its general topic was "Engineering: Innovation with Social Responsibility" focused on the development of the world and its challenges.

WEC compromised diversified forms, such as:

1. panel discussions:
   - Capacity Building and Engineering Education
   - Biodiversity and Environment
   - Disaster Risk Management
   - Engineering for Development
   - Energy for Sustainable Development
   - Great Solutions on Engineering

2. congresses:
   - Engineering: Ethics and Social Responsibilities
   - Innovation without Degradation
   - ICT for Inclusion
   - Advanced Technologies: Engineering with Strategic Vision

3. forums:
   - The Sustainable Development: the Environment
   - Women's Forum
   - Students and Young Engineers Forum
   - The Sustainable Development: the Knowledge

WEC 2000–2004–2008: A NEW RELAY BATON FOR A NEW WFEO TRADITION

At the end of the Closing Ceremony for the World Engineers' Convention WEC 2008 in Brasilia a new WFEO symbol has been handed over: The World Engineers' Convention (WEC) relay baton, created by VDI, The Association of German Engineers (organizer of the first WEC 2000 in Hannover, Germany), passed from VDI via the representatives of the WEC 2004 in Shanghai and of the WEC 2008 in Brasilia and ended in the hands of their Swiss colleagues organizing the next WEC 2011 in Geneva, Switzerland. In the run-up to the WEC2008 VDI had been asked by WFEO to sponsor and to provide this official WEC relay baton for the WEC events to come.

The idea behind this request had been to strengthen the importance of the World Engineers' Convention as a proven and successful instrument in the worldwide co-operation of engineers; at the same time it should express the continuity of the WEC tradition and pay tribute to the first movers and their success as a commitment for the future. The WEC relay baton, on behalf of VDI designed by Hanna Kuepper, a well-known German artist, represents symbolically the engineers' connectivity with the modern world respectively the responsibility of engineers for the global challenges in the 21st century.

Convention ended with the WEC 2008 Declaration.

Photo 1. 38 WFEO-CET Mtg., Brasilia
From the left: B. Grear, A. M. Alameddine, T. Domańska, W. Miszalski, A. Hay, P. Greenwood

Photo 2. 38 WFEO-CET Mtg., Brasilia
Prof. Abdel Monhem Alameddine – new Vice President of CET

Photo 3. 38 WFEO-CET Mtg., Brasilia
From the left: C. Bauer, L. Lerner, C. Carrasco

Photo 4. 38 WFEO-CET Mtg., Brasilia
From the left: M. A. Yadarola, F. Ocampo Canabal, L. Vaca Arenaza, C. Carrasco, L. Lerner, X. Liu

Photo 5. 38 WFEO-CET Mtg., Brasilia
From the left: B. Grear, A.M. Alameddine

Photo 6. 38 WFEO-CET Mtg., Brasilia
From the left: W. Butcher, S. Ioakimidis, H. Bedelian, N. Al-Hay

Photo 7. 38 WFEO-CET Mtg., Brasilia
From the left: W. Miszalski, M.J. Prieto Laffargue, H. Bedelian, B. Grear

Photo 8. 38 WFEO-CET Mtg., Brasilia
From the left: W. Miszalski, H. Bedelian, P. Greenwood, B. Grear, A. Hay, W. Butcher

Photo 9. 38 WFEO-CET Mtg., Brasilia
From the left: F. Ocampo Canabal, P. Bereciartua, L. Vaca Arenaza

WORLD ENGINEERS' CONVENTION WEC-2008 BRASÍLIA - BRASIL

WFEO/FMOI CONFEA FEBRAE

THE BRASILIA DECLARATION

Engineering and Innovation for Development with Social Responsibility World Engineers' Convention, Brasilia

5 December 2008

We, the participants at WEC2008, emphasise engineering as the driver of technological innovation and of vital importance in sustainable human, social and economic development. In the current economic crisis we believe that engineering and innovation with social responsibility will be essential for our survival and progress. It is in this context that we make this declaration.

ISSUES AND CHALLENGES

At the global level, issues facing the world focus on the need to reduce poverty, promote sustainable social and economic development and address the other UN Millennium Development Goals, provide solutions for climate change mitigation and adaptation and facilitate the move into a low-carbon future. These issues also include challenges and opportunities presented by globalisation, the digital and broader technological and knowledge divides. At the local level, many countries are concerned that young people are turning away from science, engineering and technical education, and the effect a declining interest and enrolment in engineering will have on capacity and development around the world, which is compounded for poorer countries by the brain-drain of engineers. These issues and challenges are being further compounded by the recent financial and economic crisis, at a time when we need increased investment in engineering capacity building, R&D and infrastructure. The engineering and scientific communities need to work more closely together on these issues. It is also important to note that the issues and challenges facing engineering change over space and time, due particularly to new needs and new knowledge, and engineering needs to change to face these changing issues and challenges.

The main challenges for engineering are to promote capacity building and access to technology to address these issues through:
promoting awareness of engineering to the public and young people,
the development of technologies, including advanced technologies,
the application and innovation of technologies,
promoting inclusion, especially of women and young engineers of the future,
global cooperation to reduce knowledge divisions.
These issues need to be addressed in the context of strategic vision, ethical and social responsibility.

CALLS FOR ACTION

Engineering is the essential building block and driver of technological innovation, sustainable social and economic development, and engineers need to emphasise this to policy makers and the wider public. An emphasis on innovation and applications also helps attract young people to engineering. Engineering education needs to emphasise the relevance of engineering to the global issues and problems we face - the problem-solving profession needs to revitalise itself through such approaches as problem-based learning. To address these issues, we make the following calls for action to the engineering and related communities, governments and national authorities, regional and international organizations.

THE ENGINEERING AND RELATED COMMUNITIES

We call upon the engineering and related communities, at national and international levels, through WFEO, its members and related organisations, to:

- emphasise the importance of engineering as the main driver of innovation, sustainable social and economic development,
- develop a better understanding of the public perception of engineering, and the promotion of engineering studies and policy,
- promote curricula and teaching methods in engineering education that emphasise relevance, applications and the problem-solving approach of engineering,
- strengthen linkages between elementary school and engineering by enhancing partnerships between engineers, schools, government and the private sector,
- develop, apply and innovate of technologies, including advanced technologies, to global issues and challenges, to engineer a better world, promote inclusion and reduce divisions, with strategic vision, ethical and social responsibility.

NATIONAL, REGIONAL AND INTERNATIONAL ORGANIZATIONS

We call upon WFEO, WFEO members, UNESCO and other national, regional and international organisations (such as the OAS in the Americas), to facilitate and promote the above activities through international networking, cooperation and the sharing of good practice. In particular, we call upon WFEO members and UNESCO to develop an International Engineering Programme to promote engineering education, capacity building and applications for poverty eradication, sustainable human, social and economic development, and to continue the UNESCO engineering report into a second edition to be launched at the World Engineers' Convention in 2011.

GOVERNMENTS AND NATIONAL AUTHORITIES

We call upon governments and national authorities to create enabling environments and support the above activities in engineering education, research and development, capacity building and application of engineering to the Millennium Development Goals and related international development objectives.

15

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