is commonly accepted, that in the United States are found most of the cutting-edge developments brought about by academic research and graduate education. This is evident when the enrollment figures for the past 20 years are analyzed. Undergraduate (the first professional degree) education has less than 1.5% of foreign students (approximately 60,000 baccalaureate degrees are earned by U.S. students, 4,000 by foreign students). This reflects well on the quality of first professional degrees offered in the foreign countries; their quality and content is more than adequate to meet the local needs.

However, graduate education presents a different picture. Approximately 30% of the U.S. students baccalaureate degree holders seek a masters degree, and 5% strive for a doctorate (taking an average year, 20,000 masters degree are earned by U.S. students, 10,000 by foreigners; 6,000 doctorates by U.S. students and 3,000 by foreign students). These are average figures but clearly reflect the strength of U.S. engineering education at the graduate level.

The above figures also reflect the composition of the engineering work force, where the ratio of those who are doing and need a basic education to those who need specialized knowledge is on the order of 100 with a general background to 30 with a specialized education to 5 with a sophisticated, cutting edge, research background.

The above is further emphasized by industry which seeks personnel for their enterprises. When asked what they prefer in an undergraduate engineering curricula, the answer is along the lines of keeping the current basic engineering discipline, with a good mathematics and science background, and with added knowledge in economics, business administration and communications. The development of specialties becomes a joint responsibility between the industry and the individual engineer. Graduate or specialty education within the industry itself or in an academic setting is then considered as part of the development and career pathway of the individual engineer. This can be within engineering or in another field such as business administration, management, personnel, law, or others. The choice is made by consensus between the individual and the employer.

In the U.S. the entry level degree to the engineering profession is the baccalaureate or undergraduate degree. It is a four year university program (though most students - 70% - take more than 8 semesters to complete). It is a very rigorous program which requires from 140 to 148 semester credit hours (other baccalaureate programs require 120 semester credit hours). Law, medicine and several others are offered in professional schools and require that their students obtain an undergraduate degree prior to being considered for admission to the professional school. The quest for professional school status within the university is very difficult and requires a change in university culture. Engineering has not been able to obtain that distinction. Rebackground to join a specialty. The undergraduate curriculum does not attempt to do more than to give the basic knowledge tools (mostly theoretical) that will allow the student to begin (under proper supervision) to practice. Inherent in all educational programs is the lesson that the door is opened for further life time learning to maintain competence and keep up with demands of the discipline or the specialty.

One must distinguish that engineering is an academic pursuit in today's world which can be a basis for many types of other professions. Engineering can be a foundation for a law, medical, economics, business, and other careers. The basic education of an engineer gives many tools that are useful in other professions, thus many engineers become very successful in other fields of endeavor, and do not pursue a career in their engineering discipline or specialty. This engineer is the one that does not need to pursue continuing updating in his engineering discipline or specialty. This engineer is the one who goes into management, administration or other areas of productivity.

Another basic characteristic of engineering is that it is not generally practiced on an individual basis, it is a team effort, with many specialities coming to bear in the solution of any one problem or project. Engineering is seldom practiced as a solo enterprise, the expertise of an individual engineer is blended into the expertise of the other members of the team. When a certain knowledge is needed that the team does not possess, an expert is called upon as a consultant. The practice of consultants is limited to areas of specialty, these are individuals that keep their competency keenly honed to the latest technology in their specialty field.

A careful analysis of the world of engineering shows that there are various groupings, they can be distinguished by their involvement in the practice environment. They each have a basic engineering education, however their depth of engineering expertise varies depending on the demands of their practice. Not all are dependent on current state-of-the-art specialized knowledge, unless their work situation demands such knowledge. Many drift in to areas of management and administration where specialized knowledge is required from other non-engineering disciplines; others become highly specialized in engineering areas; others go into other professional pursuits where the engineering background gives them a scientific, technological basis to better carry out their commitment to the new enterprise. In the modern world, where economics appears to be the controlling factor in most all endeavors, such as politics, industry, law, and the professions, engineering is the only profession that creates the material items that make it possible for the world to enjoy the standard of living that it has. The material environment in which mankind lives is a product of engineering.

In the global world the United States is the world's power. In engineering it is considered, in most disciplines and specialties, as a leader. In engineering education, it

Support the learning and development of others:

- Be prepared to act as a mentor
- Encourage employers to support professional development
- Share professional expertise and knowledge
- Provide support for the learning of others
- Contribute to the activities of a professional body

Achievement of CPD

The challenges and opportunities of work experience provide the central method for continuing professional development. This can be supported by structured activities which include:

- In-house courses
- External courses
- Work-based learning
- Distance learning programmes
- Self-directed private study
- Preparation and delivery of lectures and presentations
- Attendance at lectures, seminars or conferences
- Coaching, tutoring, monitoring, teaching
- Secondment and special projects
- Relevant voluntary work

Engineering Institutions advise members on a recommended style of a professional development record and plan, relevant means of undertaking CPD in their area and details of any specific CPD requirements. CPD cannot be specified to a fixed amount, but relevant benchmarks such as Occupational Standards can be valuable for defining needs and achievements.

Monitoring of CPD

The Code of Conduct requires registered engineers to take all reasonable steps to maintain and develop their professional competence and knowledge. CPD is, therefore, a key obligation on engineers and technicians. Evidence of professional development and of compliance with the CPD Code are requirements for registration.

The professional institutions, as recognised bodies of the Engineering Council, are required to promote and support CPD and, in particular, to monitor the CPD being carried out by their members. They may use opportunities of registration, upgrading (for example, from Members to Fellow), and other relevant occasions to review evidence of the CPD planned and undertaken.

and for using occupational standards to encourage competence based CPD. Engineers need to provide evidence of their CPD and to transfer their learning as their careers develop.

A central aim is to encourage individual engineers and technicians to take responsibility for their career development. A booklet entitled *Career Manager*, is aimed at assisting engineers and technicians to analyse CPD needs and plan appropriate action to progress their career. The publication *CPD - Practical Guide to Good Practice* is available to assist individuals and employers to plan and take action on CPD. In a joint venture between the Engineering Council and the professional institutions, a Professional Development Manager has been developed. This is a computer-based system enabling engineers to maintain a record of their knowledge, skills and experience; analyse development needs and achieve these on a continuous basis; and build confidence through improved self-awareness.

There is evidence that engineers are increasing their involvement in CPD. A survey by the Engineering Council indicates that most engineers carry out at least 5 days CPD each year. 18 per cent have achieved a postgraduate qualification, often including Business and Management subjects. 30 per cent of engineers have a plan for their CPD and over 60 per cent have a record of their professional development.

Code for CPD

The Council, in partnership with the institutions, has developed a Framework of Standards for CPD; this includes a model Code of Practice. This Code places obligations on engineers to:

Take responsibility for and manage CPD:
- Identify and prioritise development needs and opportunities
- Use appropriate guidelines and competence benchmarks (eg from profession, employer)
- Plan and carry out development action using a range of appropriate opportunities
- Record development achievements
- Evaluate achievements and review against needs

Demonstrate commitment to maintaining professional competence through self managed CPD:
- Note professional and any legal/commercial requirements for evidence of CPD
- Understand the uses of evidence in appraisal/employment/recruitment
- Be aware of useful sources and forms of evidence
- Have available and, if required, provide suitable evidence

7. Is the system of world-wide information comprised of only Internet, or should there be also other systems, and if so, then what?

8. How to prepare people for life within the society of the technological era? Opportunities and threats resulting from this, and the role of engineers in this.

9. How to prepare engineers for co-operation in liquidation of results of disasters?

I think it is possible and necessary to undertake joint work in the international forum in order to try to answer these questions. It is possible to develop jointly the systems, as the time, when each country was a separate island, has already been over. Now we have mutual ties and interrelationships, and whilst maintaining a certain difference, there is, however, the need to find universal solutions.

efficiency. However, a serious problem, pointed out also on the international forum by other countries, is lecturers' level of competence and the need to raise their qualifications by the teaching staff. This applies to both a scope of specialist knowledge possessed, and didactics, inclusive of the skills to apply up-to-date medium forms, as well as use of the computer.

It seems to be necessary to create a system of education and further education of lecturers. This will be a very difficult task, as this professional group claims they know everything, and they seldom see the necessity to improve their knowledge.

It was emphasised in conferences that a good specialist can be a very bad didactician, and the student suffers from that. Competence does yet not guarantee an ability to convey the knowledge. Moreover, these staff are often quite conservative, and they unwillingly apply technical novelties in didactics. Still, the most readily they use the blackboard, flipchart and marker, sometimes transparency, but not always prepared correctly.

Having in mind a delicate nature of these matters, may be the international co-operation would yield here the best results. It is also commonly paid attention to the lack or existence of poor didactic materials for the student, what is of a significant importance in the case of continuing education.

5. Summary

Technical education, having in mind the era of technology from which there is no return, will have to start very early and last practically over the whole life, and engineers not only will excel, but they will also be responsible for this education. Therefore, a number of questions-issues emerges:

1. What knowledge and in what proportions ought to be provided to engineers in the course of their studies, and what in the system of continuing education?

2. What knowledge is indispensable as regards work with supranational companies?

3. What should the today's and tomorrow's lecturer be?

4. What should the system of lecturer education be?

5. What should the system of curricula accreditation be?

6. What should forms of education be? What are their advantages and disadvantages?

the knowledge possessed, and, after all, it is not all. The advanced countries do not wait till we narrow gaps and join them. The developing world economy means both a fast technical progress and international companies, or national companies, but being established abroad. Such an activity wrings to supplement knowledge not only in the area of technology, but also economics, international management, theory of culture, study of religions, knowledge of foreign languages, etc. This knowledge must also be acquired by engineers of economically advanced countries. This is a challenge. In many international conferences I have taken part in, this topic is very often discussed. Technical knowledge and its updating are no sufficient any longer. Countries open their frontiers to foreign capital, a single organism of the European Union is being created, and whilst retaining all individual features, there will the knowledge of these countries and people, among whom you will live and work, be indispensable. Therefore, a very serious problem is emerging: what knowledge and to what an extent should engineers possess? What should the high school provide to them, and what should they acquire within the framework of the system of continuing education? What organisational forms will be the best here?

We know that till now, there most often were stationery forms of education. Today, both highly limited time and, frequently, costs not always allow to raise qualifications. Therefore, new solutions must be offered. Many countries have already prepared also systems of distance education and systems of open teaching/learning. In Poland, introduction of these forms has already been started, although it is difficult to speak of a system yet. Time limitations are for many people a barrier, and the rate of technology development forces to seek after good and fast sources of information. Will the satellite education, just beginning in the United States of America, resolve this problem? Will we succeed in use of Internet? Perhaps yes, but today, they are quite expensive forms, and available not for all (I am leaving psychical barriers out of account.)

I suppose we are currently facing one of the greatest in the history of the mankind threats of social stratification. Some will be able and will have conditions to use all information contained in Internet, whilst others will not go beyond the paper and pen, or a typewriter, and this creates a civilisation gulf. A very fast technical progress must lead to a deep partition of the society. Therefore, the system of further education becomes such an important question.

3. Elements of the System of Continuing Education in Poland

The Polish Federation of Engineering Associations NOT has undertaken an attempt to establish a system of continuing education. They have passed their draft document to the Ministry of National Education, but there is nothing saying that the very subject matter could become a an issue of interest of this Ministry in the nearest future. In order not to be inactive, the actions aimed at creation of elements of to the necessity to obtain new qualifications, to a change of working place or merely to a raise of feeling of professional safety.

4. To attain knowledge in the area of organisation and management, indispensable in the case of organisational advancement, as well as in the case of creation of personnel background and in the case of fulfilment of individual plans of professional career.

5. To obtain the economic and general knowledge, indispensable to both a good functioning in one's own country and abroad, in the case of work in foreign or international companies.

The system should, among other things, provide, on the one hand, comparability of definite post-graduate studies, courses or professional practice and, on the other hand, it should encourage organisers and providers to carry on classes on a high level. It also should enable to raise qualifications depending on the needs of working places and expectations of engineers themselves.

In the countries that had begun their systems transformation after 1989, hence also in Poland, continuing education was on a very poor level. In Poland, education of engineers in high schools had been on a high level, but the system of continuing education practically had not existed, as it had been unnecessary. There had been some different post-graduate studies and courses, but they had been attended by a small number of people, and it is difficult to speak of the system here. Such an activity had been rational. As there had not been any competition, relating to both products and qualifications, and the question of professional promotion had been very often decided by factors different from those of merits, therefore there had been no justification to waste time on further education, practically being useless. As a rule, the entire production output had been sold, and its volume had depended on the plan imposed from aside. Lack of competition had not forced to apply any progress, and non-existence of unemployment had not stimulated to raise qualifications. There had not existed any competition on the labour market. The state had been responsible for employment of all those whom they had educated.

The changes that were introduced together with the shift to the market economy were tremendous, and for many people shocking. As a matter of fact, the greatest problem concerned people's mentality, their habits and way of thinking. Many have failed to find themselves in the new reality till now.

These changes, among other things, are also the emergence of the labour market and competition. Competition forces a technical and technological progress, as well as an organisational efficiency. If only these alterations occurred, there would appear the necessity to raise qualifications, to change qualifications, to supplement be prepared for benefit from the "global sourcing" of education.

Not only business is becoming global, but functions and supporting operations, such as employee competence development are becoming global and more homogeneous.

The University-Industry-Science cooperation could be an important tool for improving the CEE strategies. UNIDO and UNESCO have agreed to take joint action in the promotion of human resources development and in enhancement of cooperation between industry and science in developing countries.

The WFEO Committee on Education and Training could play an important role in working out an internationally-worldwide-acceptable evaluation system of those results, which the employees gain after successfully have finished short courses.

The Institute for Continuing Engineering Education of the Technical University of Budapest (the oldest such Institute in Europe, established in 1939) is ready to take part in establishing a proper evaluation system, to be discussed widely, before its international acceptance.

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One can only succeed through a new deal of public-private cooperation, involving a wide-ranging set of actors, including firms and education, training and research institutions - but with some internationally recognised rules of CPD.

International engineering - educational organizations like WFEO, FEANI, UPADI, SEFI, UNESCO, etc. may play a determining role to establish the "rules of the game". Let me allow to mention, that for example FEANI (The European Federation of National Engineering Associations) approved its Policy on Continuing Professional Development by its General Assembly in Lillehammer, Norway, on 26 September, 1997.

FEANI encourages all National Member Organizations and their affiliated organizations to:

- include the promotion of CPD as an important element in the organization's mission;
- establish a clear CPD policy in association with relevant organizations or authorities;
- establish standards towards which members are encouraged to work;
- encourage quality in all CPD;
- make the organization's CPD policy and standards along with the FEANI Guidelines on CPD for engineers in Europe available to all their members.

Evaluation of results

Many researchers state that competitiveness can only be generated by investments in company-specific training. The competitiveness of a certain industry requires more open company-training, and also general, non-job-related education.

Everyone must take more responsibility on updating and upgrading their own working skills and competencies. This has several consequences: degrees and diplomas become important in a world-wide job market and employees must have an opportunity to obtain a degree. Therefore, company training becomes linked to public education.

Universities must find ways to provide education in a motivating mode. Universities in CEE do not teach, instead they coach and learn themselves. The methods of teaching and learning must be re-evaluated. More individualism is needed. Universities must also learn new management and thinking. Adult students and industry as customers are demanding. Customer - orientation is a new issue for most universities. Universities should have more result-oriented management.
Globalization of industries also means globalization of education. New educational technologies and tools have no borders. The framework for lifelong learning should

appreciation of rates of development. There was a **danger of transplanting Western dominated models.**

7. Problems that might arise were identified. These included **lack of international collaboration** between governments, industry, universities and engineering bodies, conflict between aspects of **sustainable development and profits,** inadequate knowledge of concepts of global practice, non-resolution **of protection of intellectual property** and difficulty of **developing a common ethic.**

8. **The roles of engineering institutions were identify as:**

- Definition of broad basic, **educational engineering standards**
- **Accreditation,** certification and **quality assurance**
- Opportunity for engineering "appreciation" course for **other disciplines**
- Expansion of **mutual recognition**
- More collaboration and **partnerships** between **institutions of different countries.**

9. **Local concerns included:**

- The expansion of **exchange programmes** with special requirements
- **Appropriate** technology, not necessarily **low technology**
- **Global engineering** should not conflict with **national initiative**
- "Global Engineers" should **liase with local engineers and engineering organisations**
- Continuing professional development **(CPD)** will need to **include international content**

10. **The pathways workshop** agreed it was necessary to identify the objectives of creating pathways to global practice. Participants agreed that engineering was moving rapidly to global practice, and there was **need to open up pathways to global practice**, and remove obstacles, to enable enquires of all countries to participate-rather then have the field dominated by a few. It was recommended that WFEO undertake this task, in conjunction with UNESCO and the World Trade Authority, and in concert with national and regional/international members, and having regard to their concerns.

11. The Workshop agreed, and **Recommended** that World Federation of Engineering Organisations should:

- **Define a common code of engineering ethics** (including requirements for sustainable development).

- Emphasise that throughout their professional lives engineers will encounter a variety of cultures which are continuously changing and to which they will have to contribute and adapt.

- Stress to Universities that future engineers **must acquire an awareness of culture** in their present society, and in the variety of environments in which they will live and work.

- Encourage to all engineers through their National Organisations **to participate in community affairs** and law and policy-making. To develop an awareness of the issues, have confidence in their engineering skills and knowledge, and **take a leadership role in society.**

5. **Another sub-group considered the questions:**

"Are our young engineers educated to ask appropriate questions when defining problems?"

"How are our young engineers best prepared to find multi-dimensional solutions?"

and **Recommended** that the World Federation of Engineering Organisations should:

- Ensure the contribution/**role of women** is fully recognised as **fundamentally important** to the role and responsibilities of engineering and engineers to humankind's well being and wealth creation.
- Emphasise that **university promotion** should be based on **curriculum development** and **problem based learning** as well as the traditional research/publication channel.
- Recognise the importance of holistic engineering achieved through **systems thinking and multi disciplinary project based learning.**
- Recognise the distinct and **complementary roles and responsibilities** of technologist engineers and professional (chartered) engineers in their specific contributions to solving problems which are increasingly complex and multi disciplinary.

6. **The second Workshop,** identifying pathways, made an initial examination of the pitfalls standing in the way of global practice. These included a lack of understanding of differing cultures, underestimating **the importance of language and communications**, the danger of not recognising **changing environmental factors**, and of **transplanting norms** in one country to another. There were differing understandings of business responsibilities, and inadequate

to create, organize and apply it but also to take part in the management, in the technological process. Engineers that are capable of taking the decisions and the financial and political risk this implies, which means that they must be prepared to understand the strategies of the political world and business management and marketing, as well as for the exercise of leadership.

EDITORIAL

ENGINEERS FOR A GLOBALIZED WORLD

Extract of the Welcome Address to the participants of the 4th World Congress on Engineering Education and Training. Sydney, Australia. November 1997

Prof. Miguel Angel Yadarola
Past President of the WFEO
Committee on Education and Training
Member of the WFEO Executive Council

Those of us who have had the privilege of accompanying the World Federation of Engineering Organizations during the four congresses held in Kathmandu, Havanna, Cairo and now Sydney, must be grateful for the possibility that has been given us to associate these beautiful places with the discussion of fundamentally important subjects for the future of engineering education. Engineering is today the profession most dynamic and exposed to changes in this interdependent world, and for this reason we need to permanentely review the systems for the formation of engineers and put to test proposals that will serve our universities not only to accompany the changes, but also to anticipate them.

The fundamental change, in which we are already immerse is the supremacy of knowledge that means a new approach in the concentration of power of a nation. A power that does not lie exclusively in capital, in the production media or in the labour forces, but in the minds of engineers, workers, administrators and directors.

Our technological and organization tools associated to practical knowledge methodically sythethized are allowing acceleration of research and scientific development. They are also helping to perfect and accelerate the process of learning. "The metabolism of knowledge is becoming faster"

Universities cannot remain apart from the change of attitude of the business world that has definitely left behind a culture traditionally based on natural resources, on capital investment and in physical plant and machinery, towards investments in people and knowledge as key resources.

To limit ourselves to make our traditional curricula more efficient is not enough to form engineers capable of facing the challenges. We must be aware of this fact because there are many universities that continue to over emphasize the phases of scientifical knowledge and fail to educate professionals who can apply the discoveries of science to the development and manufacture of products or services that satisfy users needs in economical ways and in varying social and political environments. We must therefore remember that the engineers we are forming must not enter the labour world as unconcerned specialists, but that they must accept their total human responsibility in the handling of technology, that is, not only capability