

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

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Those of us who have had the privilege of accompanying the World Federation of Engineering Organizations during the four congresses held in Kathmandu, Havana, 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 permanently 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 scientific 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

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.

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

COMMITTEE ON EDUCATION AND TRAINING



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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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AUSTRALIA

PROFESSIONAL DEVELOPMENT FOR GLOBAL ENGINEERING PRACTICE

Conclusions and Recommendations
IV World Congress on Engineering Education and Training
Sydney, Australia, 20-21 November, 1997
WFEO - The Institution of Engineers, Australia

1. **The Fourth World Congress on Engineering Education and Training** was held in Sydney on 20th/21st November 1997. The WFEO Committee on Engineering Education and Training met prior to the Congress, and met at its conclusion to consider recommendations arising from the Congress Workshops.
2. **Congress participants** represented sixteen countries and included practising engineers, engineering educators and those in government and industry. The Congress theme "Professional Development for Global Engineering Practice" was discussed through two workshops that addressed the questions "**How Do We Best change the Culture?**" and "**What are the Pathways to Global Engineering Practice?**".
3. **The Workshop on how we change the culture** concluded it was necessary to change from a traditional, technology-based, perfectionist culture to an open-market, customer-oriented, holistic, community linked approach. Changes would take time and outcomes are uncertain. Change must be deliberately managed to achieve particular ends. There will be continuous changes and there should be a continuing review of the need for change. External drivers of change included technology, society expectations, the economy, needs of industry, population and availability of resources. Responsibility for effecting change rested with universities, industry and professional bodies.
4. **A sub-group addressed the questions:**

"How should engineers participate in community policy matters"

"Do we need to retrain the older engineers or focus on those entering the profession"

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

- 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

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).

- **Encourage national systems of recognition** and certification at various levels, based on evaluation and accreditation of engineering programmes and Continuing Professional Development (CPD).
- **Define the principal requirements for local and global engineering practice** at various levels.
- **Harmonise regional standards** and work towards the establishment of **global standards**.
- **Harmonise national systems** and define and adopt regional and **global agreements** (including concepts of core standards plus national supplements)
- Encourage a **more effective collaboration/partnership** between engineering institutions/societies of different countries.
- Accept the need to give **priority to local engineering and appropriate technology** (which is not necessarily the needs of “low” technology)
- Require **engineers** involved in global practice **to liaise with local engineers** and engineering organisations, and not conflict with national initiatives.

HUNGARY

THE IMPORTANCE AND NECESSITY OF CONTINUING ENGINEERING EDUCATION

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Introduction

Continuing Engineering Education (CEE) is an organic part of Continuing Professional Development (CPD) or of Lifelong Learning (LLL) phenomenon, which is not a recent one.

Lifelong Learning was referred to the fourth century Greeks (fourth century B.C.) like Socrates, Plato and Aristotle; and it means all education and all learning which comes to a person throughout his/her lifetime.

Lifelong learning means continuous training and education.

Towards a Policy of Continuing Education and Training

If youth training was the dominant theme on the European Community political agenda in the 1970s and 1980s, as a response to the curse of massive unemployment, the centerpiece of European strategy for the 1990s and for the coming years must be to widen access to and participation in continuing education and training throughout working life. This is now not only a demographic necessity - with fewer young entrants entering the labour market in the next decade - it is widely recognized as a vital factor in the economic strategy of firms concerned to achieve for themselves a competitive edge.

Companies in some countries now spend more together on training than their governments spend on their university and higher education sector; it is essential to map out a new world strategy for continuing education and training for the future years.

The capacity to acquire new or complementary skills at any point over a lifetime and to be able to change and transfer jobs within and across national frontiers will henceforth be crucial to the curriculum vitae of each and everyone.

The best one can do is to provide a flexible, wide-ranging set of education and training opportunities so that individuals can make rational decisions about their own lives at different points in time.

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

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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POLAND

CONTINUING EDUCATION OF ENGINEERS AS AN INDISPENSABLE FACTOR OF TECHNICAL, ECONOMIC AND CIVILIZATION DEVELOPMENT

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1. Introduction

The profession of engineer has existed since very long. Both Egyptian pyramids and Roman aqueducts, hanging gardens of Semiramis, as well as the Pharos lighthouse, the Great Wall of China (the only construction on the Earth seen from space-ships), and the Greek fire - these are all, by our concept, engineer works.

The difference between engineers of the past and the present consists mainly in a way of qualification attainment. In the past, they were gifted people who were arriving at their knowledge by way of experiments, who were apprenticing over years at old masters'. The knowledge was conveyed, almost by the principle of initiation, only to those most talented, confidential, and it was guarded closely. The pace of life and technical development enabled such a long and steady education.

And the new ages witness an increase of this pace, and the XVIII century starts speed of technology of an unparalleled strength and scope so far. A real explosion of technical achievements occurs, from the steam engine (1712) to landing on the Moon (1969), from the kerosene lamp (1853) to the nuclear energy reactor (1942).

The past thirty years have been the period of great technological development, automation, computerisation, and a microprocessor, i.e. miniaturisation.

Explosion of inventions and a rapid development of industry have caused the enormous demand for educated technical staff. The past years, both in highly industrialised countries and in Poland, are characterised, among other things, by the fact the knowledge and high qualifications, as well as the necessity of their continuing improvement are appreciated. At the same time, a race against time and competitive struggle are lasting, also in labour market. Rapid technological and organisational changes force to supplement knowledge and to widen skills, and because of this pace it is important that one's qualifications are raised quickly. It is also important that such a knowledge, which is primarily useful in practice, is

attained. On the other hand, various people need various knowledge, and they want to affect its choice.

Current transformations in structures and organisation of industry, as well as of the entire economy, resulting from the market economic system introduction, require from technical staff not only the newest technological know-how, but also knowledge of market rules, marketing and up-to-date methods of industry management, inclusive of the role of banks. International ties, relating to exports and imports of products, require knowledge of number of regulations and legal norms, Polish and international, of a good command of foreign languages and information technology media literacy. To meet these requirements we must well educate, train and improve. Systems solutions are indispensable in individual countries and international co-operation.

2. Differences between the Yesterday Continuing Education and the Needs of Today and Tomorrow

A fast development of technology causes that the knowledge attained in the high school becomes outdated, at an unparalleled rate so far. Yet fifteen years ago it was thought the knowledge obtained in the high school becomes outdated in fifty per cent in the case of a traditional knowledge, as mechanics, over the period of 10 years, and in the case of electronics in 5 years. Today, it is thought that even the knowledge in the field of mechanics becomes outdated by a half over the period of 5 years since the completion of the high school, and the knowledge in the field of electronics within 3 years, and in the case of certain specialities even faster, over 1.5 years. This results in the necessity of updating the knowledge, if you want to exercise the profession of engineer. Moreover, new areas of knowledge appear, frequently on the edge of already existing disciplines, what necessitates engineers to acquire further education or, sometimes, to change their qualifications.

The system of continuing education of technical staff should enable them:

1. To update their technical knowledge within individual scientific disciplines, specialisation and specialities.
2. Specialist education compliant with objectives of a given working place, where a given engineer has been working, and resulting from the need to attain definite professional rights in accordance with national or international requirements.
3. To obtain new specialisation, in new or related professions, both where it is relating to a change of a production profile of the present working place, and

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 above. 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

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 near-future. In order not to be inactive, the actions aimed at creation of elements of

such a system, specific 'blocks', that could be incorporated into the system at the moment of its appearance, have been undertaken.

Owing to endeavours of the Federation of Engineering Associations NOT, the professional specialisation of engineers and technicians has been introduced into governmental regulations, with indication of the Federations an institution awarding the specialisation.

The system of professional specialisation of engineers and technicians is an open system, with the possibility of its full improvement and adjustment to definite socio-economic and organisational conditions. These solutions are adjusted to the conditions of the market economy under way of establishment, and they create the possibilities of various professional promotions, e.g. recommendation of engineers to the Polish National Committee for FEANI Register as candidates to the EUR ING, European Engineer, title, provided they meet the terms defined by FEANI. The professional title, European Engineer, EUR ING, is awarded by the European Federation of National Associations of Engineers, FEANI. The Federation associates professional associations of engineers, currently from 27 countries, one from each country. The national member organisations are represented by the so called FEANI National Committees. FEANI has a consultative status of UNESCO, UNIDO and the Council of Europe; it closely collaborates with the European Commission on matters relating to the profession of engineer and on diploma accreditation for the academic and professional purposes.

The EUR ING title provides engineers with:

- a) a specific *passport* and a better start to perform the profession of engineer in the country and abroad. It constitutes a bargaining strength in wage negotiations with employers. Some businesses (in Poland, too) prefer engineers with the EUR ING diploma. This title is also recognised in the USA, Canada and Australia;
- b) the possibility to be employed abroad on the post of engineer *without the obligation to confirm the diploma* (what is a long and costly process);
- c) an opportunity to get into the international network, Internet, and many users of the Internet system are looking just for names of specialists in order to establish professional contacts and exchange of information.

In June 1996 an agreement between the Federation and the Business and Management College (with the right to award MBA degree) on co-operation in the field of preparation, popularisation and carrying on post-graduate studies was concluded. The **Post-Graduate Managerial Studies for Engineers**, which last three semesters (or two semesters plus a summer school), will be run in accordance with the

MBA programme. Moreover, those engineers who will want to, may - having defended the diploma dissertation - attend for the period of one additional semester and prepare and defend their Master of Science dissertation. Then they will receive the title of Master of Management and Marketing. The programme will be submitted to the Association of Managerial Education, Forum, for accreditation.

These studies, as soon as from November 1997, will be run within a modular system that enables students the possibility to choose subjects (besides the set of subjects obligatory for all), which are most necessary for them from their point of view. The programme flexibility should contribute to best possible preparedness of engineers to specific objectives to be faced by them.

Having in mind the fact that most engineers within the economy are people of a middle age, who sometimes think already of themselves in the categories of a lost professional career, what is a mistake, since as a rule they have got great professional experience, and they simply need the knowledge indispensable for them to work in the changed reality, a decision has been taken to introduce for them reductions in tutorial fees. We do hope this will help them to make a decision on further education, as they will manage our economy over many years.

Post-graduate studies are currently also run by technical universities. And, what is interesting, they have, first of all, been running studies in the field of management and marketing, and not technology. This stirs up certain fears. First of all, is a level of these studies proper (there are shortages of specialists), and, secondly, why do they afraid of technology? Probably, they do not have much more to say that they teach in the course of normal studies, and it is not a proper thing to repeat this in the course of post-graduate studies, and they lack of new knowledge. Of course, this does not apply to all high schools, but the problem of staff exists, and we will return to this issue again.

There has also been developed the design of a network of Up-to-Date Technology Centres. The design is aimed at creation for as wide circles of the population as possible of opportunities to learn and be trained in technical and organisational domains, with the help of modern methods, techniques and didactic devices, in the system of open learning, adjusted to time, level, needs and capabilities of each student. The presented concept is not only to enable engineers to update their technical or organisational knowledge, but also to be an alternative for spending leisure time by the youths, be a certain way of living.

4. Lecturers – a Prerequisite for System Efficiency

There are many significant elements in the didactic process. Both the scope of presented knowledge, and methods and materials are significant, but the lecturer is the primary element. His knowledge and didactic skills are the prerequisite of system's

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?

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.

UNITED KINGDOM

CONTINUING PROFESSIONAL DEVELOPMENT FOR UK ENGINEERS

Prof. Chris Senior, CEng,
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at the Engineering Council

Aims

Success as an engineer or technician depends on a number of factors. With increasingly demanding jobs it is critically important to be able to demonstrate continuing professional competence. Personal aspirations, changes in technology and company structures, together with increased international competitiveness, require Continuing Professional Development (CPD) to be high on everyone's agenda.

CPD can be defined as:

'The systematic maintenance, improvement and broadening of knowledge, understanding and skill, and the development of personal qualities necessary for the execution of professional and technical duties throughout the individual's working life'.

Individuals have always had to update their knowledge and skills. Although this is important, CPD, as a key part of lifelong learning, has a much wider function. It should aim to enhance the potential of all staff by encouraging innovation and enterprise. Engineers must manage technology, be innovative and respond positively to a continuously changing world. Success comes from anticipating needs and recognising opportunities. CPD should be a driving force for change.

Role of the Engineering Council

The Council is the co-ordinating body for 38 engineering institutions. It is responsible for establishing policies and promoting practice so that CPD underpins the professional competence of engineers throughout working life. Key roles are:

- to establish a framework of requirements for CPD, together with criteria and guidance on implementation
- to facilitate and support action, especially by professional Institutions, towards the establishment of good practice
- to represent the Engineering Profession in the UK and Overseas in contributing to relevant initiatives and projects:

The Council is promoting CPD to emphasise:

- the responsibility of individual engineers for continuous improvement and development to ensure high competence as professionals throughout their careers.
- the need for development to include a range of technical, commercial, financial and management subjects
- the use of a wide range of structured job-related activities including courses, distance learning, in company programmes and professional institution activities.

There are four main partners in CPD; engineers, employers, professional institutions and providers of CPD, such as universities. The key partnership is between individual engineers and their employers where opportunities for CPD can be identified and action taken. Academic and other bodies support this by providing courses, post graduate programmes and other relevant learning activities and materials.

Professional institutions have a central role to challenge their members to be committed to CPD, and to assist them in carrying out CPD. Promotion and guidance documents are available. Learned society activities and publications provide a valuable source of help. Of equal importance is for engineers and employers to have information and guidance on all aspects of CPD. There is an increased focus on regional and local activities.

Commitment and Action

A commitment to improving and developing competence is a hallmark of professional staff. Under bye-laws registration with the Engineering Council and membership of institutions includes an obligation to maintain professional competence. Engineers should not only be competent but should be in a position to provide evidence of their commitment to remaining competent. They should assess the results of their learning, using relevant benchmarks such as occupational standards and key competences. Assessment through academic or vocational qualifications is encouraged. Evidence of CPD will be required at relevant occasions, eg initial registration and transfer to a higher grade of membership.

Qualifications have a valuable role in CPD as motivators and benchmarks. Work experience, distance learning and courses can be integrated to form qualifications relevant to both individual and employer needs. Modular, flexible, work-based qualifications are being established both in the UK and abroad. The Council is supporting work to develop systems for effectively managing and recording CPD,

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

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.

Investment in CPD is a central business activity aimed at maintaining and improving the technical and management competencies needed for success. For employers their staff should be more capable, both technically and managerially. The benefits for individual engineers and technicians should be increased job performance and employability, and enhanced opportunities for career advancement. The overall aims are high competitive performance for industry, and a positive image for the engineering profession.

UNITED STATES OF AMERICA

CONTINUING ENGINEERING COMPETENCE A LIFE TIME COMMITMENT

Dr. David R. Reyes-Guerra, P.E.
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One of the principal characteristics of a profession is that it is constantly developing with new discoveries, new knowledge, new practice standards, and new applications. This ever evolving expertise is made available to all members of the profession who happen to be interested in their own development, and, through the prescribed curriculum that generates the new human elements that enter the practice of the profession brings a new perspective to the world of practice. Those that are part of the established segment, must stay ahead of the new entrants, must keep up with them, and with all the new knowledge that is constantly developing. Experience and practice, coupled with new and added knowledge places a professional in the cutting edge; such a person will then expand and create new frontiers of knowledge that can be shared with others. This generation of knowledge (either theoretical or practical) is a constant challenge and an ever increasing source of controversy among some segments of the profession: they feel that there is no obligation to assimilate new knowledge apart than that which gave them the right to enter the profession in the first place. To them experience is what is relevant. However practical experience, by itself, without theoretical understanding and learning of the reason why it works, can not assure competence. The distinguishing mark of an active professional who offers his services is: current qualified competence.

Engineering is a very special profession. The body of knowledge that it encompasses has grown exponentially over the last 75 years. The specialties within disciplines have multiplied immensely, to the point that we now have over 258 specialties and over 60 main disciplines which are different from each other to the level that universities offer valid degrees in the disciplines with specialized majors in the specialties. Prior to the start of this century, there were a dozen or so disciplines. The knowledge explosion occurred mostly in the last 25 years and is becoming all pervasive. The interaction with other professions - and there isn't one that doesn't use technology to some extent - is a fact of life that no one can deny or avoid.

Formal, initial professional education does not try to give the student more than the necessary knowledge and tools to qualify to enter the profession. Graduate education does allow for deeper understanding of the vast world encompassed by each field and tries to give the student an opportunity to ingrain himself with sufficient

background 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 specialties 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

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. Re-

cently the Board of Directors of the American Society of Civil Engineers (ASCE) voted that the masters degree would be the first professional degree. This monumental change will bring about a rethinking of the adequacy of the baccalaureate as an entering degree to the profession. Time will tell how the universities react to such a drastic change in policy. The other discipline societies will undoubtedly consider this change in their own policies.

neering practice
Operation 20
uphold
The need for upkeep of knowledge by a professional is always subject to controversy. This is understandable in engineering, which is a team oriented practice, more than other professions which rely primarily on individual practice, such as medicine and law. Engineers, who dedicate much energy to become engineers do not wish to lose that distinction, even though their careers take a different path than that of engineering, and resent as well as oppose regulations that demand their upkeep of engineering proficiency to retain the engineering identification.

The world we live in is a house built and maintained by a technological revolution in knowledge which is applied by engineers, in their many specialties, from their understanding of science and its principles, to transform the forces and materials of earth into products that allow mankind to have a standard of life that was never dreamt of and which opens the vision of humanity to explore the universe. The material world in which we live is molded by engineering. The great accomplishments of this profession must always be tempered by the realization that there are other influences that drive humanity towards its living goals.

There is a need for technological awareness of all people. Engineers are essential to the development of society and the growth of industry and the creation of the many products that we depend on. However, the number of engineers that are needed to keep the research and development part of the formula going, who are on the cutting edge of knowledge are a small percentage of the total engineering spectrum.

The engineering profession has many deep seated problems. The generic term, engineering, is applied to all that have obtained a university engineering entry degree regardless of their future development within engineering or in other human endeavors. To paraphrase a well known expression "once an Engineer, always an Engineer" Respecting the attainment of the status of being an engineer, the situation becomes complicated by several questions that arise:

- 1) Is the right to be called an Engineer, a life-long right?
- 2) In the practice of engineering, how can the public know that the Engineer is competent and is knowledgeable at the state-of-the-art level?
- 3) Who or what is responsible for assuring that the Engineer is competent in the practice of engineering?

The above questions and others are subject of much controversy and discussion. There is an ongoing debate and there does not seem to emerge a given, accepted, answer. In the United States this is further complicated by the "industrial exemption" which allows engineers to practice engineering without being legally registered or licensed, as long as they work for an organization (firm, company, etc.) which has a licensed or registered engineer (PE) who is responsible for the work. Thus as long as there is a responsible PE in the organization none of the other engineers need to be registered or licensed. A company employing literally hundreds of engineers need only one that is registered or licensed. This situation relegates licensing or registering to lesser importance in the career goals of the engineer. This is exacerbated by the fact that it is estimated that less than 10% of the engineering college faculty are licensed or registered.

Industry employs engineering graduates (both undergraduate and graduate degree holders) based on its projected needs in its work force, concentrating on the graduate's engineering expertise, with little or no importance to their licensing or registration. The future employees academic accomplishments and engineering discipline and specialty as shown by their university transcripts are the major consideration.

The work environment dictates that the engineer maintain a level of competency. Any advancement in the work situation is based not only on competitive qualifications but on keeping up with current knowledge and practice related to the discipline and specialty of the industry or firm.

The reality, in the United States, is that of an estimated engineering work force of nearly 1,500,000 only close to 200,000 are registered or licensed engineers. This is further compounded by the fact that each State and Territory has its own registration or licensing requirements that control the practice of engineering within its borders. This forces engineers to seek registration in every State or Territory where their practice or responsibility may take them. This is an expensive and time consuming exercise. Some engineers are registered in many jurisdictions, on the average, an engineer becomes registered in two jurisdictions. There is no nation wide registration, however there is reciprocity usually given for specific projects and with a limited time frame.

The above explains in a way why there is a problem in carrying out the service provisions for reciprocity of engineering practice as called for in the North American Free Trade Agreement (NAFTA) between the United States, Mexico, and Canada. As long as there isn't a national registry in the United States, each State and Territory will protect its own rights and does not give out-of-their-jurisdiction engineers less registration demands that those that are required from engineering graduates from their jurisdiction. This issue is and will affect any free trade agreements that might be sought to implement in the future.

To avoid the proliferation of engineering schools and to make certain that the quality of education leading to the entry to the profession level degree, an accreditation system is in place in several countries. This system has certain standards which must be met by the engineering programs seeking accreditation. In the U.S. it is recognized by government (both Federal and State) as the certifier of minimum quality of engineering programs, thus making its graduates eligible for registration or licensing. Industry also recognizes accreditation as a means of certifying the quality of the curricula. The Accreditation Board for Engineering and Technology (ABET) is the organization responsible for accreditation, not only of engineering but also of technology and related fields. Accreditation is given for individual discipline programs and not to the institution.

Engineering practice has become global, with the ease of world wide communications and transportation, engineering and manufacturing have no political boundaries. Design work is outsourced from one country to others based on work-force requirements. This in itself is creating a problem, as the cost of engineering work is not uniform, and many firms are outsourcing their professional engineering work to countries, where the engineers have the proper credentials and expertise, but where the labor costs are lower. Apart from this problem, the time is here where the need for reciprocity of recognition of engineers across political boundaries is needed. To start this process, the first step is that of recognizing the equivalency of the engineering educational system in each interested country. Accreditation or some system of recognition is needed. Many countries are now implementing a system that will allow them to determine the equivalency of their educational programs to those of other countries. Such an equivalency determination will allow recognition of degrees from one country to another and will pave the way for professional reciprocity.

With the above in mind, as a general background, some of the issues related to current qualified competence can be discussed in the U.S. environment.

Engineers as professionals have a Code of Ethics that has a provision that mandates that the engineer will not attempt to perform any professional work for which he is not competent. This infers that unless he or she has state-of-the-art knowledge the project will not be undertaken. The responsibility of recognizing this limitation is placed on the individual.

The regulatory bodies that give a license for engineering practice, use as criteria basically three requirements: 1) a graduate from a recognized (accredited) engineering program; 2) successful passing qualifying examinations (one to reflect on the academic proficiency in the curriculum with identification of a discipline - which allows the engineer to intern as such under proper supervision - followed, after a prescribed minimum time, by another examination centered on professional practice); 3) residency in the State or Territory.

For many years each jurisdiction had its own examinations. Now there is one organization the National Council of Examiners for Engineering and Surveying (NCEES) is responsible for the examinations. Thus there is a national exam that the neophyte engineer takes, the results of which are accepted by all the jurisdictions.

The license is given for life, but must be renewed every few years. The problem is that the renewal, in most jurisdictions, does not require any proof of continued competency. This drawback of the licensing and registration system is highly criticized. It places the responsibility for continued competency on the individual - based on the Code of Ethics and the work situation which may or may not require, based on the work responsibility, any update of competency.

With the explosion in new knowledge which, in some cases, makes some concepts used as recently as a few years, obsolete, and new techniques which are fast becoming state-of-the-art, there is a need for updating knowledge of the individual engineer. The professional life work span demands a constant acquaintance with new knowledge, as well as a deep understanding of such items of new knowledge that are relevant to the work challenges.

The term "education" connotes a classroom situation typical of a college environment. Continuing Education has the meaning of further college or university work. The adult professional does not necessarily want to return to the classroom. He recognizes the need for "Continued Learning" which can be ministered through a variety of sources and means. It can be in a graduate college setting; it can be in the practice arena; it can be as a result of interaction with colleagues; it can be from self study; it can be from attending professional society meetings; it can be from specific courses given by long distance media such as television; and it can be from a variety of other means.

The learning involved can be determined by appropriate outcome measuring means. They can be as traditional as examinations, or as improvements in job performance.

The professional engineering societies dealing with disciplines and specialties have become aware of the need for their members to seek an up-keep of relevant material to enable them to provide the best and most appropriate knowledge to solve the issues in their professional practice. The engineering societies started offering continuing learning opportunities open to their members. They covered all types of delivery systems as well as different subject content. Some of these offerings were courses offered for college credit and applicable towards graduate degrees, others had no credit. Still some societies designed their own continuing education system with a special credit value applicable internally for credit within the society.

Regulatory authorities, upon learning of the need to guarantee to the consumer public, that their licensed and registered professionals were competent and were keeping pace with developments in their area of practice, began to adopt and encourage laws that would define mandatory continued education for license renewal. By 1997, fifty States required proof of competency through Mandatory Continuing Education for renewal of licensing for Certified Public Accountants and other professions were not very far behind. Engineering had 12 States with MCE and 14 others developed enabling legislation.

There are many ways of analyzing the ways by which an individual can fulfill the requirements for continuing education; there are also differences between what is considered appropriate learning for complying with the requirements, as well as measurement techniques and the value of practical, on-the-job, experience towards fulfilling the requirement criteria.

Continuing learning is difficult to prescribe. It is for the adult, it is at a professional level, and it is learning (which can be based on typical education situations as well as practice environments). It may be proprietary material from a given industry to its employed engineers or material that is offered by a consultant or a given college in a non credit situation.

Continuing education has become a huge enterprise. Though it started as an adjunct offering by the universities, usually as non credit courses, it is now offered by a large number of vendors from individual entrepreneurs to organized providers. Commercial firms that sell services or products are also interested in providing continuing education experiences to professionals, which in many cases are directed to increasing the marketability of their products.

With the wide use of the Internet and the availability of video and satellite live communications, learning through continuing education is available world wide. Distance education is available through electronic means or by the written word. Education is no longer proprietary to the universities, colleges and their faculty.

The International Association for Continuing Education and Training (IACET) whose predecessor was the Council on the Continuing Education Unit (CCEU) is the body that offers a recognition program for those who offer continuing education and wish to be recognized as Authorized Providers. IACET has a comprehensive criteria that providers must meet in order to qualify as recognized providers. This is the standard for assuring quality of offerings. The Continuing Engineering Unit (CEU) is the measurement unit defined as "ten contact hours of participation in an organized continuing education experience under capable sponsorship, capable direction, and qualified instruction". The standards for providers require among other items: a) defined learning outcomes, b) appropriate content and instructional methods, c) as-

assessment of the learning activity, d) satisfactory completion. Before offering a program a needs assessment must be completed.

The CEU is the basis for measuring, just as the credit hour or unit is used for measuring formal college courses at both undergraduate and graduate level. The CEU has been expanded by many groups and identified in different ways to denote the providers particular emphasis, such as the Professional Continuing Engineering Unit (PCEU) which has an examination at the end of the program to ascertain if the learning outcome was realized.

Assistance to professional meetings, leadership positions in professional organizations, presentation of papers, relevant talks, etc. are in many cases considered and given points of credit towards fulfilling some of the requirements for continuing education by the registration and licensing authorities. Submission of relevant engineering practice projects that show maintenance of competence by virtue of the work submitted, are also acceptable.

Regardless of the method used the requirement of the engineer to be involved in a life long learning experience to qualify as having current qualified competence in his/her area of professional practice is demanded for maintaining the identification of Engineer. This requirement means that an engineer who changes career emphasis from an engineering discipline or specialty to some other area, such as business administration, law, economics, or some other profession must attain qualified competency in this new area as it relates to engineering. Continuing Learning is a must for any engineer throughout his or her lifetime of professional practice.

CHINA

REFORM IN CHINA'S ENGINEERING EDUCATION AT THE TERTIARY LEVEL

Prof. Shen Shi-tuan
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I. Structure of China's higher education system.

1. By the end of 1996 there were 1032 institutions of higher learning, including 608 universities and institutes.
2. They fall under three categories in terms of the management structure
 - those directly run by the State Education Commission;
 - those run by the various ministries or commissions of the State Council (the Central Government) and
 - those run by the local (municipal, provincial or regional) governments.
3. Key universities are selected among all the institutions of higher learning in accordance with their academic level, university scale and their role in the development of national economy. There are now 14 key universities in China - BUAA being one of them, whose presidents are appointed by the Premier of the State Council, and who enjoy priority in obtaining investment for their construction and development.

II. Reform in China's higher education

At the turn of the century, governments of various countries of the world as well as people working in the fields of education and business are all exploring ways and means to adapt their higher education to the needs of the 21st century, their common objective being the training of quality personnel so as to help expedite the progress of science and technology, accelerate economic development, and maintain a cutting edge in the ever-intensive international competition.

1. Reform in the management structure of universities and institutes were affiliated to a single government department or agency. Give institutions of higher learning the status of a legal person and permit each of them to manage its institution independently in accordance with the law.

- joint sponsorship of a university by two or more government departments. For example an agreement was signed by the Minister of China's Ministry of Aviation and the Mayor of the Beijing Municipality to jointly build BUAA in 1994. A similar agreement was again signed on October 30, 1997 by the Aviation Industries and Aerospace Industries of China to jointly build BUAA.
- joint sponsorship of universities by universities and enterprises. For example, the China Southern Airline signed an agreement with BUAA to invest jointly in BUAA for a flying college.
- merger of universities: several smaller universities or institutes may come together to form a larger university. The mode may be a merger of two or more strong institutions, or one between a stronger and a weaker institution. Up to the present, 64 universities emerged as a result of the merger of 160 institutions.
- cooperation among universities. Cooperation among universities and institutes to share their resources and give full play to their relative advantage.

2. Reform in teaching.

From a narrow specialized education to an all around quality education.

The new century requires of technological personnel to

- have a high sense of responsibility to society and the human race, the spirit to build a prosperous China, develop her national culture, and the determination to work hard and strive for best results in their work;
- have a high level of professional ethics, a good style of learning and work, sound psychological quality and good health;
- be aware of the relationship between science and technology on the one hand and social development on the other in the light of dialectical and historical materialism.
- have a good command of the basics of mathematics, natural sciences and engineering sciences, and the ability to acquire information by means of modern information technology, have a wide scope of knowledge and the ability to employ the knowledge in engineering practice; have the ability to design and synthesize, to work competently in engineering projects and be innovative and creative in technological work.

- e. display good team spirit of cooperation and the ability to organize, lead, communicate and negotiate with others, to take other people's advice as well as put forward constructive suggestions.
 - f. be aware of environmental protection and economics and the relevant laws and regulations of the State.
 - g. be culturally well-rounded and have the ability to express themselves both orally and in written form in one or more foreign languages as well as in Chinese.
- Reform in teaching is being unfolded in the light of the above requirements in the fields of curriculum, content of teaching and learning, teaching methodology, and revision of university syllabus.
 - Set-up of an evaluation system. An Appraisal Group was set up by the State Education Commission for undergraduate teaching which conducts evaluation of teaching in terms of a) teaching plan, b) teaching faculty, c) learning environment, and d) teaching methodology and teaching quality.

3. Reform in the mode of student employment

In the past, under a planned economy the students were assigned jobs by the government when they graduated. Now, under a market economy, students have freedom to choose their own future career and the employers also have a choice of college students.

4. Tuition.

There used to be no tuition for college education and all expenditure for college teaching was covered by the Government. The situation started to change since 1996 when students had to pay tuition for their education.

Beijing University of Aeronautics and Astronautics (BUAA)

III. Briefing on BUAA

1. Programs offered:

4-year undergraduate programs.

2,5-year master programs.

Doctoral programs of at least 3 years.

2. Syllabus for undergraduate studies.

Basic courses - math, physics, chemistry, computer application, foreign languages.

Basic courses for one major.

Special courses for the major.

Field practice, twice for students, the first time in the University Factory, the second time in a factory or enterprise outside the University.

Graduate design of half a year for engineering students whose projects often coincide with the R&D projects of their supervisors.

Social practice students are organized for social survey during the vacation.

3. Departments and majors

Sources of research projects and funding:

from various foundations

The National Foundation for Natural Science

Key projects in the State's science and technology program

Various ministries of industry

Local Governments

Enterprises

Every year BUAA signs about 600 contracts for research projects.

CZECH REPUBLIC

QUALITY MANAGEMENT IN ENGINEERING EDUCATION

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Dr. Jaroslav Nenadál - VŠB - Technical University Ostrava

So called quality management is an integral part of all usefull management systems aimed to the high customers and stakeholder's satisfaction. There is no doubt that modern universities need also modern management system, including quality management. An international standards ISO 9000 family can serve as basic approach for quality management systems building within industrial sphere. But these standards don't seem to be suitable starting point for creation of quality management at universities. This type of educational institutions asks for special model of quality management system.

We are sure that Czech universities are in bad need of such kind of management model too. Therefore our team tried to solve this problem. For building the model we inspired by Total Quality Management philosophy and principles especially by so called The European Model for TQM worked out by European Foundation for Quality Management (EFQM) in the begining of the nineties. This EFQM model is determined particularly to the industrial sphere and it was necessary to transform it to the model suitable for education. The results of this transformation will be described now in short.

The proposed basic model of quality management at universities has seven key modules:

- M 1 - Univesity leadership
- M 2 - People management
- M 3 - Data management
- M 4 - Process management
- M 5 - Student's satisfaction
- M 6 - Stakeholder's satisfaction
- M 7 - University results

The modules from M 1 to M 4 we view as enablers, the modules from M 5 to M 7 are results.

The linkage between enablers and results must be close and logical (see fig. 1): the university results, student's and stakeholder's satisfaction depends on a level of process management, data management and people management supported by quality

of university leaders.

A short description of the modules follows.

M 1 - University Leadership

This module aims at university top administrators' leadership and involvement in creating and sustaining a student focus, clear targets, expectations and a management style that promotes performance excellence. These key activities are asked for:

- a) elaboration of mission, policy, objectives and strategy of the university,
- b) definition of organisational structure, authorities and responsibilities,
- c) development of the strategy and objectives including quality policy and objectives,
- d) identification of critical success factors and key processes,
- e) releasing of resources for key processes,
- f) benchmarking analyses,
- g) management system review; evaluation of key process effectiveness,
- h) designing the improvement of process quality,
- i) communication between university's management and clients,
- j) communication between university's management and employees,
- k) planning of university development including releasing of necessary resources,
- l) definition of the links between secondary schools training programmes and university education in the CR,
- m) definition of the necessary extent of the documentation of the internal processes,
- n) description of the structure of the advisory bodies,
- o) definition of forms of recognition of employees,
- p) definition of ways of deployment and monitoring of financial resources.

M 2 - People Management

People management category aims to the university staff development, the building and maintaining climate conducive to performance excellence, etc. Key activities here are:

- a) definition of the human resource policy,
- b) planning the development of human resources, including internal and external lecturers/trainers,
- c) development of training programmes for employees including teaching staff,
- d) verifying the competences of lecturers/trainers,
- e) design of motivation programmes aimed at factors improvement,
- f) measurement of the employee satisfaction,
- g) definition of criteria and requirements for individual job positions,
- h) definition of requirements for working environment and workplace facilities.

M 3 - Data Management

This module asks for the management and effectiveness of data usage and information to support overall university performance including education. These areas are to address:

- a) selection of criteria of so-called key data for the university and improvement activities,
- b) definition of responsibility for selection, acquisition and data management for the university's activities,
- c) definition of procedures for the processing and data evaluation by lectures/trainers and managers of the university,
- d) data verification,
- e) definition of level of data confidentiality,
- f) verification of the data usage for the quality improvement of processes,
- g) reviewing the effectiveness of feedback from students/trainees and other stakeholders,
- h) definition of ways and forms of data communication in the university,
- i) computer support of data management,
- j) definition of ways of data archiving and disposal,
- k) definition of the record forms in the university and responsibilities for handling these records.

Remark: As key data may be considered data about employee performance, needs of participants/trainees and other stakeholders, suppliers and other schools.

M 4 - Process Management

An area of process management at universities covers particularly educational and business activities, for example learning-focused education and courses, school services, business operations etc. The main purpose of process management is university performance improving. It is necessary to work out:

- a) definition of the responsibility (ownership) for all processes within the university,
- b) elaboration of procedures for investigating potential stakeholder's needs,
- c) elaboration of the procedures for analysing potential students needs from the viewpoint of interest and possibilities of the schools,
- d) definition of principles and procedures for the professional as well as organisational and technical preparation of training programmes and courses (including their curricula, syllabus, training methods etc.),
- e) definition of principles and procedures for the selection of lecturers/trainers for the education,
- f) definition of criteria and procedures for assessing the competence, professional and pedagogical level of the lecturers/trainers,

- g) definition of the scope extent form of the learning packages (teaching notes and aids) for the training programmes and courses,
- h) definition of the forms and procedures for offering (marketing) the training programmes to students including the definition of means of communication,
- i) definition of means of communication with those interested in the training programmes,
- j) definition of procedures for operational management of the training programme or course provision (entrance examination, opening, delivery, closing),
- k) definition of procedures for verifying achieved competence of students (at entry, delivery and after the finishing of the training students programme or courses),
- l) definition of forms and ways for concluding the education (tests, examinations, certification, etc.) and graduation of students,
- m) definition of the measures and forms of process standardisations in the university,
- n) definition of procedures and frequency of inspection of the quality of training processes or courses,
- o) definition of procedures for the business processes including the definition of responsibilities,
- p) definition of procedures and frequency of inspection of the business process quality,
- q) analyses of the results of process quality inspection and their use for improvement projects,
- r) ways of monitoring the effectiveness of project improvement processes in the university,
- s) description of procedures for process change in the university,
- t) definition of requirements for the technical facilities of classrooms and their maintenance,
- u) definition of criteria for selection and evaluation of the university's suppliers.

M 5 - Student's Satisfaction

This module is focused to the student's satisfaction achieving and improving as students are the most important customers. University shall make these key activities:

- a) description of procedures for monitoring continuing student's satisfaction,
- b) description of procedures for monitoring the student's satisfaction (after training)
- c) description of the means of receiving and communicating new expectations and needs of the students during education,
- d) definition of the extent of supporting services (the accommodation, boarding, use of leisure time, transport, payment conditions, communication with the students, etc.),
- e) monitoring conflicts and complaints of students,
- f) monitoring development trends of the level of the students satisfaction,
- g) description of consultancy and advisory services for students and graduates.

M 6 - Satisfaction of the stakeholders (involved parties)

University must co-operate and communicate with all relevant stakeholders (companies, authorities state and regional, parents, etc.). The level of stakeholder's satisfaction shall be monitored, of course. It seems to be important to do:

- a) description of procedures for monitoring the effectiveness of the application of achieved competence during education,
- b) description of the means of sustaining the relationship with stakeholders,
- c) definition of forms of cooperation and frequency of communication with stakeholders concerning the receipt of proposals, comments and complaints of the involved parties,
- d) description of procedures for measuring the satisfaction and loyalty of involved parties,
- e) monitoring of development trends of the level of satisfaction and loyalty of involved parties,
- f) quality audits performed by other stakeholders (involved parties) directly at the universities,
- g) description of form of university „accreditation“ by other stakeholders (involved parties).

M 7 - University results

This module covers student performance and improvement, performance of university business processes and benchmarking with other schools (including abroad). The key activities are:

- a) monitoring of development trends of key indicators of business activity,
- b) description of ways in which gained financial and material resources (contributions, grants, sponsorship, etc.) are used,
- c) description of procedures for the financial concluding of particular training programmes or courses,
- d) recognition of the achievements of the university on a national and international level.

We suppose that the model described above could be a powerful tool for all university's administrators. These persons, must be very good managers in particular !

We are aware of the fact that the level of thinking of czech universities administrators isn't in close relationship with total quality management principles at present. But our model isn't only about quality management at universities. It is especially about quality of management there !

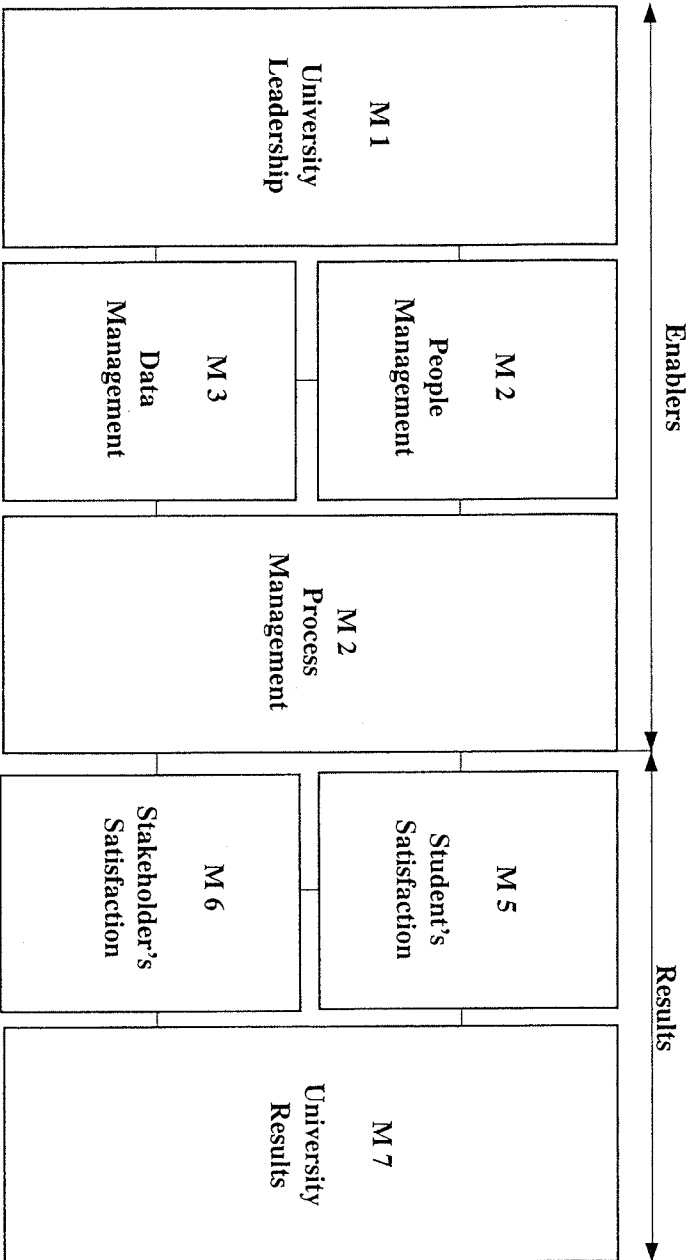


Fig 1: The basic model of university quality management approach

GERMANY

FROM THE EDUCATION AND INNOVATION CRISIS TO THE SOCIAL CRISIS

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Member of the WFEO Committee on Education and Training

Abstract - Introduction

We make use of the advantages offered by science and technology on a daily basis but every now and again, we stumble over the one or the other unpleasant side effect and tend to criticize - all too often inappropriately. In order to understand the direction the future is taking, i.e. if we are making the right decisions in the present for what we want to undertake in the future, a minimum of technical and scientific, and also sociological, basic knowledge is required in order to be able to communicate at a generic level.

Neither high-quality products nor good service nor qualified training can be had for free. Activating the innovative potential of every citizen who is willing to work and to learn is an urgent demand which we must make on our society.

Tasks for the natural sciences, the liberal arts and sociology

A crisis is a change, the causes for which are not yet apparent. Once these causes are known, action can be taken to deal with them.

This is why I have attached the word „crisis“ to each of the words in the title - to indicate that changes in and around us are the norm. Life processes, and therefore also technical processes, are subject to constant change. This is a criteria for life itself. So, when the laws of nature are violated, there is no reason to fear catastrophe, but there is reason for concern.

The concrete task facing the natural and engineering sciences today is to make optimum, careful use of limited resources, both of materials (raw materials, active ingredients, fillers) and of energy (mechanical energy and physiological energy) for the life and survival of the earth's six billion inhabitants. In doing this, particular attention needs to be paid to ensuring that synergies within biological systems are preserved. Human beings are part of these systems, and we must understand that we will only survive if we are properly integrated into the biological system and do not attempt to control it.

The concrete task facing the philosophies and sciences dealing specifically with human behavior (sociology, psychology, pedagogy, theology, political science, etc.) is to deal with the new ways of life, life purposes and values imposed when people must live and get on together in the limited space available on our planet. Alongside food and energy, these aspects will also have an influence on socio-political structures in the coming decades.

The last few decades up to the present day must be viewed as a revolutionary era of the twentieth century for three reasons.

1. There are currently six billion people living on our planet. Population growth is exponential (see fig. 1).
2. In the industrialized nations, population growth is accompanied by a worldwide advance in innovation and methods. Which of these brought about the other is difficult to say. This advance in innovation will find expression in the fields of microelectronics, information systems, laser technology, materials science, the tapping of new sources of energy and materials, bio-engineering and genetic engineering.
3. While fundamental human requirements - which we can summarize under the headings of food, energy, clothing, accommodation and health - will be met, a third phenomenon, about which our predecessors were not able to pass on their experiences to us, will become increasingly important, namely the question of how human beings living in a restricted space will behave. How will they communicate, live together? What new forms of behavior will they have to develop in order to create and retain optimum chances of survival?

Communication and the ability to work in a team are important key concepts in answering these questions (see Fig. 2).

In future, sociology as a science will have an ever greater role to play. The kinds of qualifications required too is subject to constant change. These changes usually happen imperceptibly and are shaped by new knowledge acquired in the natural and engineering sciences, by application of this knowledge, by socio-political and politico-economic influences and by the combination of domestic markets to form larger supranational markets, such as the European Economic Community, NAFTA and ASEAN. For this reason, globalization is today a much-discussed concept.

Innovation

Innovation can be defined as the capacity of a nation to adapt to world-wide changes in nature, technology, and economics, but also as its capacity to influence these. In this connection, population growth will trigger a dominant thrust. Unfortunately, the importance of this phenomenon has not yet been consciously realized. Pressure from the population is what keeps us searching for new solutions towards better chances of survival (Fig. 1).

Innovative potential is determined by the following:

- The intellectual infrastructure of the population
- The technical infrastructure of a country or a nation, i. e. the capacity to transform theoretical scientific findings into technically feasible solutions.
- The historically developed tradition of skilled trades and technical know-how in large sections of the population which are employed in handicraft enterprises as

well as in small, medium, and large industrial companies.

This tradition has given German industry its good international reputation. The present is the result of the past, but how will the present of the future look, which will then be based on our past?

- A well-coordinated education system and a consensus between educational institutions, science, the economy, and society. The role of skilled workers, master tradesmen and technicians has virtually been forgotten in our technology-oriented society, or is at least underrated.

Scientific thinking and skilled know-how create a unit and are the basis for innovative technology (Fig. 2).

- Innovative potential is furthermore determined by a people's basic mental attitude towards the developments at science and technology and
- through the political framework: success in innovations is based on the joy in inventing, the pioneering spirit, the desire to work, the curiosity, and the willingness of individuals to take risks.

These factors can either be restrained or set free by the framework of a state, a federal region, a city, or public opinion. We are not looking for uniform human beings but rather for individuals with their uniqueness, their individual talents, their mentality and their likes and dislikes.

Innovation has something to do with individuality and a sense of elitism. This sense of elitism is not meant in the traditional sense of „thinking oneself to be of a superior status and class“, it refers to a willingness to set an example and take on responsibility for oneself, risks and obligations.

Mediocrity does not encourage innovation and reduces our chances of survival. Seen

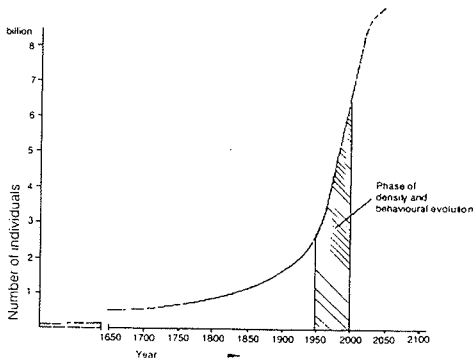
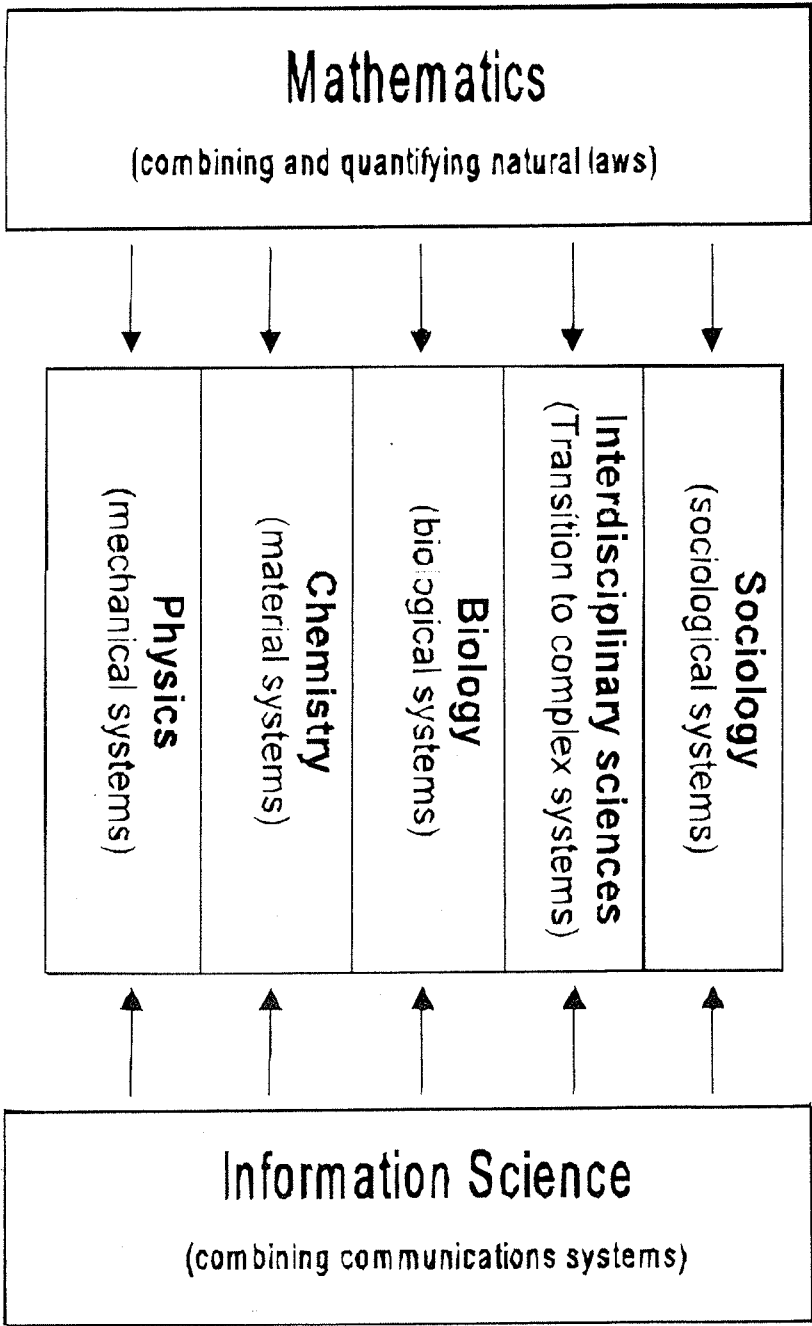


Fig. 1.. Growth curve of the population of the earth

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Fig. 2: Different systems in our nature



in this light, the fact that well-educated, well-qualified young people are unable to find a job, despite the fact that there is enough work for them, amounts to a societal error. It is a waste of national wealth. Lamenting the lack of innovation in our society while simultaneously denying gifted individuals the chance to achieve something is typical of the double-dealing inherent in politics, society and economics. A false conception of society has made work too costly. The suggestion is that work is in short supply and that therefore part-time jobs and even 32-hour weeks are required, and that work must be managed and rationed as a scarce resource.

This is all symptomatic of a society in crisis. We need to take the alternative route, where those who wish to work hard must be allowed to do so, for a corresponding level of pay.

The Driving Forces in Nature, Technology, and the Economy

A vital economy and a creative society are distinguished by the smooth flow of materials, energy, information, and financial resources. It acts in accordance with the laws of potential difference and equilibrium of flow taught to us by nature. Streams, i.e. flowing systems, can be brought to a standstill by two measures:

1. More and more barriers are inserted into a widely branched out flowing system, e.g. an increasing numbers of laws which are introduced into the economy. The system no longer flows. The stream comes to a standstill.
2. The potential differences, i. e. differences in level which serve as a driving force are flattened. A running stream becomes a stagnant pool which, in the worst case, begins to decay because water always flows from a higher level to a lower level. The same holds true for electrical current and

- *Fick's diffusion law (steady)*

$$\frac{\text{Number of diffusing particles}}{\text{time unit}} \sim \frac{\text{concentration gradient, } \Delta c}{\text{distance of diffusion}}$$

- *Filtration (steady)*

$$\frac{\text{volume of filtrate}}{\text{time unit}} \sim \frac{\text{filtration pressure, } \Delta p}{\text{resistance of the filter cake}}$$

- *Heat transfer (steady)*

$$\frac{\text{quantity of heat}}{\text{time unit}} \sim \frac{\text{temperature gradient, } \Delta T}{\text{layer thickness of the heat transmission surface}}$$

- *(Ohm's Law)*

$$\frac{\text{electrical current strength}}{\text{time unit}} \sim \frac{\text{electrical tension, } \Delta U}{\text{electrical resistance}}$$

- *Capital-stream*

$$\frac{\text{money supply}}{\text{time unit}} \sim \frac{\text{return, } \Delta K}{\text{interest rate}}$$

- *Informationstream*

$$\frac{\text{stream of informations}}{\text{time unit}} \sim \frac{\text{curiosity}}{\text{indolence + reciprocal receptivity}}$$

Fig. 3: Examples for compensatory processes

These laws of nature also apply to the flow of materials, energy, information, and financial resources. Curiosity is the driving force behind the flow of information; the uninformed person, as a rule, wishes to be informed.

The flow of money, too, is subject to the laws of streaming and of flow equilibrium. The equal distribution of money, i. e. of income, savings, and ownership structures, would paralyze the innovative potential, the desire to work and the joy of designing a way of life in both our public and our private lives. A colorful social system which is characterized by individualists would turn into a grey, uniform society of which everyone would possess and equally small share.

Law for general compensatory processes

The existence of potential differences – e. g. in concentration, pressure, temperature and voltage – is a prerequisite for the formation of currents, and the same is true of yield differentials in capital flows (see fig. 3).

Streams always flow downwards. This is a compensatory process that, in science, can be described using compensatory functions. The parameter common to all of these functions is time.

If a function is to operate in opposition to a potential difference – i. e. when water is transported from a valley into the mountains – a great deal of energy must be expended.

Qualitatively, the law is as follows:

$$\frac{\text{quantity flowing}}{\text{time unit}} \sim \frac{\text{driving gradient (potential difference)}}{\text{resistance}}$$

Similar correlations can be applied to mental processes, which are the prerequisite for innovation.

One of the driving gradients here is curiosity.

Resistance can be thought of as a combination of indolence and reciprocal intellectual receptivity. Parallels can be drawn with the electrical resistance that corresponds to reciprocal electrical conductivity.

With regard to intellectual correlations, these proportions serve as guidelines only, as they are far too complex for a direct qualitative understanding, even an approximate one. Intellectual processes can only be discerned from their outcome, and then, retrospectively, as a trend.

$$\frac{\text{stream of informations}}{\text{time unit}} \sim \frac{\text{curiosity}}{\text{indolence} + \text{reciprocal receptivity}}$$

$$\text{innovation} \sim \frac{\text{curiosity}}{\text{inhibition barriers for information}}$$

However, the statement that all streams – i. e. quantities of materials, energy, capital and information – come to a standstill as the driving gradient or potential difference is reduced (i. e. tends towards zero) is decisive. This applies to technical systems, economic processes, social systems, biological processes and all natural processes per se.

The size of the potential differences in educational and social systems is open to debate. If the driving gradient falls below a specific D value, all processes come to a halt. However, if potential differences become very large, eruptions and explosions result. Very large potential differences also interrupt flowing systems. In the social domain, this means revolution. These are laws of nature which educational and social systems too must not violate.

The capacity and willingness to innovate are flanked by educational systems on the one hand and social systems on the other, and together these demarcate the space in which potential differences for innovation may flourish.

First comes thought, then comes innovation.

If anything is to change in today's society, the thoughts we carry round in our heads need to change before we can act.

Education is concerned with the creation of words, concepts, thought, curricula and theories. These have a significant effect on our behavior.

Identifying the forces at work and the laws of nature behind these forces in these superficially different systems is an essential task facing the natural sciences, both now and in the future. This will reveal the laws of flow in operation in the different systems and the subtle differences between them.

In this way we can crystallize teachings and instruments for innovation for the future, which provide guidelines for both societal behavior and technical applications.

Social Crisis

Essentially, we need to look for social crisis in the disturbed harmony between the individual and the group. The individual and the group are both dependent on each other, and their chances of survival lie in the interplay between them. A group that degenerates into a rigidly organized collective has no long-term chance of survival, as we learned from the socialist dictatorships. The individual is no longer free to develop in such collectives, and innovations stops.

However, if in contrast individual develop away from or out of a group, if they become part of the so-called “me-generation”, it signals the end of both the individual and the group. Alongside individual freedom, the individual must take on responsibility for himself or herself, obligations and commitment to and within a group.

Individual and group need each other; biological systems teach us that much.

Today’s social system is distinguished by the omnipotence increasingly concentrated in a dominant group (the state). Individuals counter this process by withdrawing from their collective obligations and becoming “singles”, part of the “me-generation”. This cannot come to any good and results in a social crisis evidenced by a number of symptoms and manifestations, in fields such as provision for senior citizens, the health system, the education system, fiscal legislation, working hours, distribution of jobs, etc.

Examples:

- Students no longer vote in university elections and forgot the right, theirs by law, to participate in university life.
- Academics are no longer active in their socio-political environment. There are only a few exceptions to this.
- Parents’ councils do not take advantage of their opportunities.

However, ambitious products, quality services and an effective education system do not come free. An urgent requirement facing our society is to active the potential for innovation present in every individual who is willing to work and learn.

Industrial location crisis

The current location crisis is not only a consequence of the high costs (labor costs, environmental stipulations, etc.) but the result of an innovation crisis and an education crisis. Both crises very slowly developed in their first phase, being virtually unnoticed over several decades, and they are of a socio-political nature. This is a long term process in a nation.

Willingness for innovation has something to do with individualism and elitism. Here, elitism, is not meant in the conventional sense of “being better in terms of status and class thinking” but rather as a model for the willingness to assume responsibility, risks, and duties.

Mediocrity is not conducive to innovation and lowers the chances of survival. Seen from this point of view, it is a social aberration that well-educated and capable young persons cannot find a job despite the fact that there is enough work. This is a squandering of national resources. To deplore the lack of innovation in our society and, at the same time, not to provide the opportunity for talented people to make their con-

tribution is a typical characteristic of the double standards in politics, society, and the economy. Working has become too expensive as the result of an incorrect understanding of social responsibility.

Education Reform – Education Crisis – Innovation Crisis – Industrial Location Crisis – Unemployment – and Social Crisis: All Are Closely Related to One Another

The *education reforms* were guided, among other things, by the misconception that self-realization, a professional career, and a good income could no longer be attained by practical/manual occupations. By placing all the bets on science and university degrees, the importance of mankind's practical/manual talents was neglected and underrated, if not to say devalORIZED. This in turn led to a tacit discrimination of skilled workers and craftsmen.

Today, there are more students at universities than apprentices in the handicrafts and industrial companies. A crisis innovation has ensued from this situation. Innovation can only flourish in places where curiosity, imagination, know-how and pleasure go hand in hand with a profession or a vocation.

An industrial location can only assert itself in the international competition of industrialized nations if all men and women are convinced of their capabilities and identify with their professional tasks. Imagination and impulses for product improvements and the development of new products, as well as better performance in the service sector, must come from the production and the service base and not from the top, from the think tanks and management echelons which are full of theories and ideas. At the production basis and at the service level, however, skilled workers, craftsmen, trade masters, technicians, sales people, purchasing staff and other similarly qualified persons are employed and in them, many interesting and important talents lie dormant. Without them, a highly developed industrial location such as Germany cannot prosper. These talents must be activated.

Unemployment occurs when the quality and the price of products and a corresponding service standard can no longer be maintained. Germany is then no longer attractive as a purchasing market. For as long as rationalization in the economy and the state is limited to discharging high numbers of skilled workers with a capacity for innovation rather than developing cost-effective, high-quality products i. e. quality results, unemployment will continue to rise. This leads to an individual psychological crisis which, in time, will consolidate into a mass psychosis and lead to a social crisis.

A *crisis in society* is an extended social crisis which can no longer be controlled politically and can invalidate all the smoothly functioning democratic rules of behavior. Such a development could ultimately lead to the constitutional "right to work" which results in the "right to work", i. e. the transformation of job offerings into a "duty to work". The consequence is that citizens are incapacitated, innovation of any kind dies out, and the industrial location crisis is reinforced. The circle closes

in the form of a planned economy which is controlled by the state and the reduction of public assistance to the strictest minimum.

Consequences

In an economic location, education – general education, vocational training, and continued education – must be understood as a qualifications factor both by citizens in their private lives and by persons working in politics and in the economy. Its influence on scientific development, i. e. on innovations as well as their economic realization (application in skilled trades, industry, sales, and administration) is crucial. Life long learning, LLL, is the aim in future (Table 1).

Closing remark

Hermann von Helmholtz (1821–1894), who was in his day the leading light of physics, once said that “natural science has the force of law”, while he referred to the liberal arts in the broadest sense as psychology, research into the activities of the soul.

This topic “Education in Crisis – Innovation in Crisis – Society in Crisis” was prompted by a desire to link these two fields, with their different perspectives and approaches.

These remarks are followed by twelve dissertations providing guidelines for the kinds of subjects that should be taught in schools, vocational colleges and universities (Table 1).

Table 1:

Twelve Theses for Lifelong Learning – Education and Continuing Training as an Individual Chance

- Vocational and continuing training mean mobilizing, keeping up and maintaining human skills and knowledge.
- Continuing education strengthens and increases professional efficiency.
- Education and knowledge enable to speak, read, write and calculate and, thus, to inform and communicate.
- Education and knowledge enable to make discoveries and to arouse and satisfy curiosity (drive of curiosity).
- Education and knowledge make individual gifts and talents active and train them.
- Education and knowledge open up and extend chances of adventure and profession.
- Education and knowledge simplify and support getting into contact with other peoples and showing understanding for foreign cultures.
- Education and knowledge stimulate mental and psychological fantasies and support innovative power.
- Education and knowledge surmount fear of technological change in the work place.

- Education and knowledge strengthen the consciousness of being an emancipated citizen.
- Education and knowledge make independent and self-supporting and strengthen the sense of responsibility.
- An education and communication association on the one hand is the prerequisite for a peaceful globalization of an association of energy, material and finance on the other hand.

JAPAN

CHANGING ENGINEERING EDUCATION IN JAPAN

Dr. Kaneichiro Imai
The Japanese Society for Engineering Education

The Ministry of Industry of the British Government launched an inquiry into the Engineering profession. Sir Montague Finniston chaired the committee that carried out this government mandated investigation. The final report titled “Engineering our Future” was published in November 1979. It was a very comprehensive study and farsighted, many recommendations and proposals were postulated, but the single most significant recommendation linking the various sections of the report, stated: “... the Government should establish a new statutory organization – a national Engineering Authority – with power granted by Parliament to advance the engineering dimension in national economic life and particularly in manufacturing.”

The report was given worldwide distribution and its contents impacted the thinking in many countries, both those so called advanced and those called developing. Engineering education as well as Continuing Professional Development (CPD) was impacted by this report. Its concepts coupled with the changes perceived as necessary in our global engineering practice environment, brought about many changes in engineering education which are still underway. Education itself is being changed, outcome assessment is the measuring standard being adopted. In 1997, the American Society for Engineering Education (ASEE) and the Accreditation Board for Engineering and Technology (ABET) co-sponsored a conference in Washington, D. C. in September 1997, on outcome assessment as the basis for the accreditation criteria for the next century in engineering education.

In IDEAS No. 4, July 1997, I reported on “Recent Changes in Engineering Education in Japan”, further changes have occurred since then in engineering education and CPD. These radical changes which are now becoming quite apparent also affect industry.

INDUSTRIAL CHANGE

The market for industry has changed in scale and nature from being local to being international. It has to respond to a global concept. The old paradigms changed bringing a necessary response from industry as illustrated in the following:

NEW PARADIGM	INDUSTRY CHANGE
MARKET GLOBALIZATION	OPEN MARKETS–DEREGULATE
GLOBAL STANDARD	ACCEPT GLOBAL STANDARDS
ENVIRONMENTAL ISSUES	LIFE CYCLE DESIGN OF PRODUCTS

Coupled with the above changes by industry to the new paradigms that have arisen due to the global market place, the Japanese labor market changed its attitudes and expectations, industry responded to these changes. Following are the salient features brought about to this change:

LABOR FEATURE	INDUSTRY RESPONSE
RESPECT FOR EMPLOYEE SENIORITY	PROFESSIONAL COMPETENCE MERITOCRACY IMPLEMENTED
FRIENDLY RELATIONSHIP MANAGEMENT/EMPLOYEE ROTATIONAL ASSIGNMENTS	CONTINUED UNEMPLOYMENT HAS REACHED ALL TIME HIGH OF 3.9% CREATED OUTCOMES ASSESSMENT ANNUAL SALARY RAISE
LIFE LONG EMPLOYMENT	JOB MOBILITY GRADUALLY INCREASING

UNIVERSITY EDUCATION CHANGES

University level education was and is under the control of the Ministry of Education, Science, Sports and Culture (MESSC). Though it was very rigid changes have been instituted based on the needs of the modern world. There was a major attempt to catch up with deemed changes up to the early 1990's. The following illustrates recent changes that are affecting university offerings:

STATUS OF UNIVERSITY CHANGES TO 1990'S	RECENT CHANGES
University in answer to industry prepared good raw material	Increased preparation for work. Some professional competence expected.
University management and accreditation under the control of the ministry (MESSC)	Deregulated control. Self study self assessment required. Third assessment introduced.
Curricula and courses controlled by the MESSC	Diversified to meet social needs
Foreign student/interchange programs encouraged	Welcomed
Precollege education was standardized	Diversified to meet needs
Companies commonly provide financial support to their employees to seek CPD	

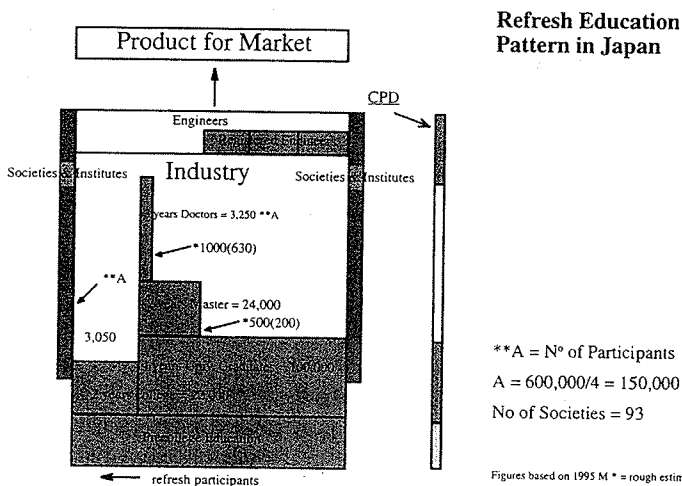
The above changes which are in a state of flux and implementation are reflected by changes in the Human Resources Development (HRD) by the business community. Such changes in HRD by business brings about a response in industry as illustrated by the following:

HRD BUSINESS CHANGES	INDUSTRY RESPONSE
Progress in Production Engineering and of Information Technology	Effective implementation and utilization of Information Technology
Change in Social Needs / Enhancement of Openness	Clarification / Traceability of Enhancement
Progress in Management Technology (MT) / Establishment of Total Quality Control	Establishment of Appropriate Management Technologies in Engineering

REFRESH EDUCATION

The term "Refresh Education (RE)" is the one used in Japan when referring to Continuing Education. In 1992 the Ministry (MESSC) defined Refresh Education as a "system of education for adults by a Higher Education Institute (courses at the graduate, undergraduate, two year college) to give updated professional knowledge and training to refresh their professional competence ..." This system is a part of what we call Continuing Professional Development (CPD).

The pattern of the system for CPD including RE is shown in the following diagram which illustrates the total spectrum of education for engineering.



outside of their company. Support CPD was found in 80% of the companies surveyed. The support was determined to be distributed as follows: a) for Distance Education 82.5%; b) company preparatory study for examination of public professional qualification (licensing); c) participation in outside seminars, lectures 71.2%.

FORMATION OF THE GLOBAL ENGINEER

In house education trends are for changing its previous context and diversifying its curricula to foster individuality and creativity.

Universities, professional societies, educational and training institutes have a positive attitude towards advancing CPD for up-dating engineers in industry. These changes have globalization as a common interest. Some of the salient movements for the globalization concept and the standardization of engineering education and continuing professional development follow.

In 1997 the Japan Federation of Engineering Societies (JFES) organized a Committee for the Formation of Global Engineers. One of the subcommittees is working to define a system of qualifications for a registered engineer to be able to work in the global market. There is an effort towards developing an accreditation system for university level professional education academic programs.

A study committee of the Japan Society for Engineering Education (JSEE) "In-house Education in Industries" was organized in 1997 to exchange information to improve the in-house education system. A new university to promote in-house education was founded.

As previously reported in IDEAS since 1994 under the administration of the authorities from the State of Oregon, U. S. A., the Engineering Fundamentals and Professional Engineers Examination has been given in Japan. The results have shown that the Engineering Education and the Continuing Professional Development in Japan produce engineers that are at a world level.

A program to establish Asian Pacific Economic Conference (APEC) engineers has been discussed, and a draft has been developed to qualify as an APEC engineer. A definition is under consideration for mutual acceptance. A monitoring organization is planned and implementing registration of qualified engineer is to start by the end of 1998.

CLOSING

In Japan, Engineering Education and Continuing Professional Development are diversified and changing to meet the needs of industry and society. The Japanese Government has taken up education as one of the six core national policies. We expect a brighter future for the 21st century.

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