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EDUCATION FOR INNOVATION

Number 14
November 2007

WFEO

Committee on Education and Training
World Federation of Engineering Organizations

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

COMMITTEE ON EDUCATION AND TRAINING

JOURNAL IDEAS N°14, November 2007

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

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

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EDITORIAL

Education for Innovation

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

Among many definitions of Innovation – following seem to justify the importance of shaping innovative characteristics of engineer's personality and his professional profile.

> *The process of translating new ideas into tangible societal impact*
>
> *Krisztina Holly, Vice Provost, University of Southern California, and Executive Director of USC Stevens Institute for Innovation*
>
> *The successful exploitation of new ideas*
>
> *Department of Trade and Industry, UK*
>
> *Change that creates a new dimension of performance*
>
> *Peter Drucker (Hesselbein, 2002)*
>
> *An important distinction is normally made between invention and innovation. Invention is the first occurrence of an idea for a new product or process, while innovation is the first attempt to carry it out into practice*
>
> *The Oxford Handbook of Innovations, 2004*

Participants of the International Conference "Supporting Small- and Medium-Sized Enterprises in Engineering and Technological Innovation Activity" held 17–18 May, 2007 in Cracow, Poland, discussed the growing needs for engineers-innovators, on the role of the co-operation university-enterprise in implementing technologically new products and processes as well as on the so far experience in education and training for innovation (e.g. the courses organized in the Institute of the Continuing Engineering Education in the Budapest University of Technology and Economics or the business-university co-operation activities of the Universidade Federal do Rio de Janeiro).

Building potential for innovation seems to be the chief motivating factor for creating the European Institute of Technology (EIT) and innovation has been mentioned in official documents and statements as its main educational and research mission.

Education for Innovation is a challenge for engineering education institutions. How to teach engineer "to carry out an idea for a new product or process into practice". How to co-operate with innovative companies in educational programs and curricula. In which semesters the courses on innovation should start. How long could be a typical post-graduate course of innovation for engineers and what could be its contents. These and many other similar questions seem to justify the need for continuing international exchange of views on the subject.

A 2005/6 MIT survey of innovation in technology found a number of characteristics common to innovators working in that field:

1. they are not troubled by the idea of failure,
2. they realize that failure can be learned from and that the "failed" technology can later be re-used for other purposes,
3. they know innovation requires that one works in advanced areas where failure is a real possibility,
4. innovators are curious about what is happening in a myriad of disciplines, not only their own specialism,
5. innovators are opened to third-party experiments with their products,
6. they recognize that a useful innovation must be "robust", flexible and adaptable,
7. innovators delight in spotting a need that we don't even know we harbor, and then fulfilling that need with a new innovation, and as such,
8. innovators like to make products that are immediately useful to their first users.

The above characteristics seem to be worth consideration not only by the educators of engineers but by the managers of innovative companies and organizations supporting innovation as well.

The 14th number of IDEAS has been dedicated to "Education for Innovation". I would like to thank the Distinguished Authors for their contributions to this publication. Their papers have been grouped under the following three topics:

1. Organizations supporting innovation
2. Universities and innovation
3. Innovative companies experience

The Chronicle of Events has recorded the most important WFEO-CET activities and events covering the period after the 35 CET Meeting (8 March, 2006 in Budapest) till WFEO General Assembly (15–16 November, 2007 in New Delhi).

Different international organizations' approach to innovation as well as national experience in supporting innovative companies by governmental and non-governmental organizations have been presented and discussed in the papers of: Dr. Peter Greenwood, Dr. Jim Birch, Armando Augusto Clemente, M.Sc., and Prof. Paulo Alcântara Gomes, Eng. Abdulrahim Fakhro, Prof. Ryszard Borowiecki and Barbara Siuta-Tokarska, Ph.D., and Prof. Xila Liu.

In the papers of Dr. Tony Marjoram, Antoine Abche, Ph.D., and Prof. Abdel Menhem Alameddine, in the paper of Prof. Leizer Lerner, Eng. Gerson Lerner, Prof. Paulo Alcântara Gomes as well as in the paper of Prof. Vollrath Hopp, then in the paper of Eng. Pavel Hercik, Prof. Růžena Petříková, Eng. Alan Vápeniček, as well as in my paper – different aspects of innovation in association with university education programs as well as linkage and co-operation between universities, research institutes and innovative companies have been discussed.

Experience of the selected Polish small and medium-sized innovative companies has been presented in the papers of Bogdan Niewczas, Ph.D., and Dr. Zbigniew Zienowicz.

The reason for choosing "Education for Innovation" as a subject of No.14 IDEAS was to share with our Distinguished Readers the ideas and thoughts on the impact of the observed in many countries and regions of the world growing demand for innovation and innovative engineers – on the engineering education, engineering practice as well as on activity of engineering organizations.

Let me thank WFEO-CET Members for help in selecting the contents and Mrs. Teresa Domańska, Secretary of WFEO-CET and Mrs. Anna Jachimowicz for preparation of this edition of IDEAS.

ORGANIZATIONS SUPPORTING INNOVATION

WFEO Activities Support Small and Medium-sized Engineering Enterprises

Presented by Dr. Peter Greenwood HonFIEAust, CPEng, EngExec. on behalf of the President and President-Elect, WFEO

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

Abstract

The paper gives a broad description of WFEO and its goals and activities.
Some of the relationships being developed are described, for example with UNESCO and other world bodies like the World Energy Council.
An important aspect of these relationships involves the encouragement of ethical practices and networking against corruption.

WFEO is particularly keen to improve the participation of women in engineering and to encourage young engineers in their careers and in their involvement in development projects.

A key educational interest of WFEO is the facilitation of good standards of engineering qualifications and practice, and the opportunities to study and practice globally.

1. INTRODUCTION

The World Federation of Engineering Organisations is the internationally recognised leader of the engineering profession. WFEO represents engineering organisations in about 90 countries, to other world professional bodies and Governments.

Its main assets are its network of millions of engineers and its standing in the international community. It can have an influence on the funding of major international projects although its own funds are limited. It can also be a force for development through is member organisations and their individual members.

WFEO is a natural partner of the United Nations as a result of which it has a keen interest in the Millennium Development Goals (MDG). Capacity Building is such an important part of the MDG that WFEO devotes one of its standing committees to the task.

WFEO operates through its executive and standing committees with biannual general assemblies and other meetings with parallel major international conferences. For example, there will be a World Congress on Urban Infrastructure in Developing Countries in Delhi during the next General Assembly and the next World Engineering Congress will be in Brazil in 2008 when the Executive Council meets.

WFEO also makes a contribution through arranging conferences and workshops and by promoting and participating in a range of engineering projects of different types and sizes.

2. WFEO'S VISION AND MISSION

VISION
WFEO is the internationally recognized and chosen leader of the engineering profession and cooperates with national and other international professional institutions in being the lead profession in developing and applying engineering to constructively resolve international and national issues for the benefit of humanity.

MISSION
- To represent the engineering profession internationally, providing the collective wisdom and leadership of the profession to assist national agencies choose appropriate policy options that address the most critical issues affecting countries of the world.
- To serve society and to be recognised by national and international organisations and the public, as a respected and valuable source of advice and guidance on the policies, interests and concerns that relate engineering and technology to the human and natural environment.
- To make information on engineering available to the countries of the world and to facilitate communication between its members nations of worlds best practice in key engineering activities.
- To foster peace, socio-economic security and sustainable development among all countries of the world, through the proper application of technology.

3. GENDER ISSUES

GLOBAL COLLOQUIUM FOR WOMEN ON ENGINEERING AND TECHNOLOGY
June 6–8 2007, Tunis, Tunisia

WFEO is committed to provide equal opportunity for all to enter the engineering profession, and to pursue their engineering activities freely throughout the world.
This milestone Global Colloquium is geared to promote and support gender equality, to increase professional skills and networking, and to empower women in decision-making, which will enable them to overcome inequity and poverty in their communities. It will assist them in tearing down obstacles to their participation and advancement in engineering and technological careers, and aid them in achieving greater international collaboration.
It is planned that there will be about 300 attendees from the 90 member countries of the WFEO/FMOI. The Colloquium participants have been invited from academia, government, NGOs, and industry. The Colloquium will allow practicing and collegiate women engineers and technologists, researchers in technology to discuss careers and issues relevant to women and technology worldwide, advocates for women in engineering and technology. The themes are: Women in Engineering and Technology Workforce; Women in Engineering Education; Women as Entrepreneurs of Small and Medium Enterprises; Women Enabling Technology in Communities. I am pleased that Air Vice-Marshall Julie Hammer, who will become Engineers Australia's first woman President later this year, will be a presenter.

4. STANDING COMMITTEES

There are six standing committees concerned with Capacity building, Technology, Energy, Environment, Education, and Communication. A vice-president that has an automatic seat on the Executive Council chairs each one. The standing committees are WFEO's way linking with national institutions and relating to individual engineers. They are expected to help WFEO formulate and carry out its strategic plans and contribute to achieving its goals.
For example:

Committee on Technology
ComTech, chaired by Puerto Rico, has continued to be represented on the UN-CSD — Commission on Sustainable Development — Workshops 13 and 14, covering significant issues related to water in poorer countries. Complementary sanitation education is being undertaken with the support of Latin American Engineers in Guatemala, Honduras and Bolivia.

Committee on Energy
A task force report on wind Power has been published and is available on the WFEO website.
A Task Force on Nuclear Power has been formed with a chair, who is seeking some additional members. Members for a Solar Energy task force are needed but are proving difficult to recruit.

CE was represented at UN-CSD in New York in May 2006 making a submission and subsequently a contribution to the papers for a report on energy to be written by the Secretary Generals.
A conference on Engineering for Sustainable Energy in Developing Countries has been organized for August 2007 in Rio di Janeiro.
The World Energy Council and CE agreed to sign an MOU subject to Executive Board approval. WEC was particularly keen to tap into CE's membership for peer review of its reports. This strategy is a good example of how WFEO can add value to existing national and international organisations without duplicating projects or wasting scarce resources.

Committee on Engineering and Environment
The Committee on Engineering and the Environment (CEE) aims at developing through appropriate activities and education, a worldwide understanding and commitment to sustainable development.

The theme adopted by CEE is that the "Engineer is a catalyst for social development". This exemplifies WFEO's position and links with the upcoming World Congress on 'Urban Infrastructure in Developing Countries' in October 2007. Future activities and events will encompass this theme.

A quarterly newsletter outlining the advances in environmental engineering is published and distributed to all member countries in English, Spanish and French. The CEE has requested that member countries contribute short papers / abstracts that explore issues relating to environmental disasters.
Project Examples

WFEO's programs and activities fit with Agenda 21 of the UNCED World Summit that are applicable to engineering.
African countries are seeking ways to revive economic growth and expand their role in the global economy, but their efforts are hampered by poor infrastructure.
The growing interest in investing in Africa's infrastructure provides an opportunity for the continent to strengthen its engineering capabilities.

Poor infrastructure and inadequate infrastructure services are among the major factors that hinder the continent's development. Without adequate infrastructure, Africa will not be able to harness the power of science and innovation to meet development objectives and be competitive in international markets.

Infrastructure promotes agricultural trade and helps integrate economies into world markets. It is also fundamental to human development, including the delivery of health and education services. Infrastructure investments further represent untapped potential for the creation of productive employment.

REGIONAL PROJECTS such as the proposed modernisation of the Kenya-Uganda railway can serve as a critical foundation for building domestic engineering capabilities.

But more concerted international efforts are needed to address Africa's engineering needs.

A first step in moving ahead will involve challenging the worldwide engineering community to come up with solutions relevant to Africa. An example is provided by the Grainger Foundation through the US National Academy of Engineering (NAE), which is offering $1 million for an economical way to treat arsenic-contaminated groundwater in Bangladesh and other countries. African countries could launch complementary challenges.

Another example of WFEO's development activities, which might emerge from a standing committee, is: The Millennium Villages Program.
The MVP is a project of the Millennium Promise Organisation in partnership with the UNDP and others, in response to the United Nations' Millennium Goals.
This is a massive project trying to determine what representative villages in all zones of Africa need to improve their circumstances in a sustainable and largely self-sufficient way. The CEO was facilitating the involvement of governments, national and international agencies in this long-term plan.
The key elements of the approach involve Africans helping Africans; Train the Trainer and Jobs not "allowances".

5. ANTI-CORRUPTION

Task Group on Anti-Corruption
Set up in October 2005 by President Ayadi and chaired by Past President Medem has made significant progress.
The Anti-Corruption task force will work with the World Bank and Transparency International (TI).
Significant progress has been made on the Engineers Charter with many countries and individual engineers agreeing to abide by the charter.

6. SUSTAINABLE DEVELOPMENT

WFEO aims to develop through appropriate engineering activities and education, a worldwide understanding and commitment to sustainable development. To achieve this it will solicit case studies of successful solutions for application of sustainable technologies that will provide an engineering dimension to established sustainability websites in the name of WFEO

It will also promote as pilot projects, through organisations such as the Global Environment Facility and other appropriate bodies, engineering partnerships to promote improved understanding, technology transfer and cooperative undertaking.

The theme of WEC 2008 is Engineering: Innovation with a social responsibility.

The program lends itself to the topic of sustainable development and the participation of many of the groups mentioned in this paper.

7. WORKING WITH UNESCO AND OTHER AGENCIES

WFEO/UNESCO LIASION

WFEO is working with UNESCO on a proposal for STRENGTHENING OF THE ENGINEERING SCIENCES AND TECHNOLOGY AT UNESCO AND PROPOSED UNESCO "INTERNATIONAL PROGRAMME ON ENGINEERING"

Statements being presented in part are:

1. Considering the importance of the engineering sciences and technology, engineering education and capacity building in driving sustainable economic and social development, poverty reduction, sustainable development and the other UN Millennium Development Goals (MDGs), as emphasised by many Member States at recent sessions of the UNESCO Executive Board and General Conference, World Engineers' Conventions in 2000 and 2004, World Summit on the Information Society in 2003 and 2005, World Summit on Sustainable Development in 2002, World Conference on Science in 1999, in recent reports of the UN, G8 and other international bodies and in particular relation to the UN MDGs, bridging the "knowledge divide" and promoting intercultural dialogue and cooperation,

2. Recognising increasing international concern regarding the declining interest and enrolment of young people in engineering and impact on human and institutional capacity in engineering, particularly in developing countries, and consequent negative effects on social and economic development,

3. Noting that science, engineering and technology are part of a close continuum of activity, and the need for emphasis on applications of the engineering sciences and technology, especially in developing countries,

4. Also noting the role and importance of engineering in related activities in the Science and other programme sectors of UNESCO – in water supply and sanitation, public health, engineering ethics as a component of the ethics of science and technology, the link of engineering education to technical and vocational education, the role of engineering in the knowledge and information societies, and the fact that much of our material cultural heritage was built and is maintained by engineers,

5. Underlining the need for human, institutional and infrastructure capacity building in the engineering sciences and technology, particularly in developing countries,

6. Noting with concern the decline in human and financial resources and capacity in core areas of the engineering sciences and technology at UNESCO – in which UNESCO was once strong and has a unique mandate, and the consequent ability of UNESCO to assist member states, particularly developing countries, in the application of the engineering sciences and technology to development and addressing the MDGs,

7. Referring to the 160 EX/11 and EX/52 decisions regarding the reorientation of UNESCO's programmes in the sciences to take account of the conclusions of the World Conference on Science, the 162 EX/9 and EX/54 decisions regarding progress

achieved in the follow-up to the World Conference on Science, the 165 EX/9 decision referring to capacity building in the basic and engineering sciences, the 171 EX/54 decision regarding the development of cross-sectoral activities in technical capacity building at UNESCO and related proposal (30 C/DR.94, 1999) regarding a world network of technological universities,

8. Responding specifically to recommendations 37 and 40 of the Science Agenda – Framework for Action of the World Conference on Science regarding engineering education and capacity building, and the importance of engineering and technology in addressing pressing developmental problems,

9. Noting the recommendations of the World Engineers' Conventions in Hanover, 2000 ("Humanity, Nature and Technology"), and Shanghai, 2004 ("Engineers Shape the Sustainable World"), regarding the importance of engineering in social and economic development and need for capacity building, and noting that the third World Engineers' Convention will be held in Brasilia in 2008 ("Engineering: Innovation with Social Responsibility"),

10. Invites Member States to:
    (a) increase participation and support for an enhanced programme of activity in the engineering sciences and technology regarding engineering education, capacity building and the application of engineering and technology for secure and sustainable social and economic development, poverty reduction, emergency and post-conflict relief and reconstruction in response to national needs;
    (b) inform the Director-General of programme activities in the engineering sciences and technology that they would be prepared to support through extra budgetary funds and to cooperate at an international level in training;

11. Invites the Director General of UNESCO to:
    (a) establish an "International Engineering Programme" as a priority for UNESCO in the natural sciences, focusing on engineering education, capacity building and the application of the engineering sciences and technology for social and economic development, poverty eradication, sustainable development and the other MDGs,
    (b) reinforce human and financial resources in the engineering sciences and technology to support the establishment, organization and activity of an "International Engineering Programme" that will complement the International Basic Sciences Programme (IBSP).

8. ENCOURAGING YOUNG ENGINEERS

MONDIALOGO ENGINEERING AWARD

The Mondialogo Engineering Award, which encourages engineering students in developing and developed countries to establish international teams to work on projects that seek to implement the Millennium Development Goals (MDGs). It is a joint initiative of DaimlerChrysler and the United Nations Scientific, Educational and Cultural Organisation (UNESCO).

WFEO is also encouraging young engineers by working closely with the various organisations like Engineers Without Borders whose members involve themselves in development and environmental projects at home and overseas.

Mobility of engineers, described in the next section, is another area where WFEO can help young engineers. Young engineers generally actively seek overseas experience and many want to make a contribution to needy clients.

9. MOBILITY OF ENGINEERS

WFEO and its stakeholders are vitally interested in the mobility of engineering skills. In its broadest sense mobility can include engineering students, engineering graduates and mature engineers.

Mobility can help to increase a country's human capital as well as its physical assets. It is an integral part of the transfer of technology. Mobility helps individuals to develop themselves and companies to maintain and enhance their employee skills. Clients and funding agencies are also beneficiaries. Higher skill levels and greater professionalism should also help to make expenditure on engineering projects more effective and might even reduce corruption.
Engineering students may move between universities using transferable credits for units they have completed. Graduates may want to study for further qualifications in a different university, which might be in a different country. They might also want to gain particular experience, which is not available in their home country — or simply experience engineering practice in a foreign country.

Mature engineers might travel for the same reasons or they might undertake an overseas project for their employer. It is worth noting that in this era of globalization engineers can work on overseas project without leaving their home office. Some employers are even moving that home office overseas by buying foreign companies. That way they can provide overseas experience for their engineers to avoid losing them into a very competitive world market.

Recognition of degrees, accredited by different agencies, facilitates the mobility of graduates. Accreditation can also facilitate the recognition of individual units from a degree program and transfer credit for such units.

Mobility of mature engineers is often related to work, which is regulated or governed by legislation. International recognition is necessary if visiting engineers are to avoid wastefully duplicating assessment of their qualifications and experience. Any necessary checks can then be minimized.

The majority of engineering work is not in fact regulated. But even in the case of such work employers and their clients still need to feel comfortable with the qualifications and experience of a candidate. Accredited degrees and recognition of experience then become the quality mark of an engineer or engineering gradate.

There are several education accords and mobility forums that provide the international recognition necessary for mobility. Some are long established and others are emerging. They include the Washington, Dublin and Sydney Accords, and the system emerging from the Bologna Declaration. They also include the Engineers Mobility Forum, the APEC Engineer (operated by member countries of the forum of Asia and the Pacific Economic Cooperation), the Engineering Technologists Mobility Forum and the FEANI register. As well as the multi-national agreements many countries have bi-lateral agreements, which are complementary or are used as alternatives.

This section has largely talked about engineers but there are agreements for technologists and engineering officers, some of which are listed in the last paragraph.

Accreditation and experience discussed in this section applies to first qualifications and experience gained in the early to mid-career. A debate has emerged about the level of this first qualification. While this is important, debate is also needed about qualifications and experience for the other three decades in an engineer's career and the competencies that will be required in the future. In short a whole-of-career approach is needed.

WFEO cannot and should not replicate what the international accreditation and mobility agreements are doing, which has taken many years to achieve. WFEO can encourage these agencies to work together and, in doing so, achieve its own goals. WFEO's role will be to ensure all its members are aware of and are able to aspire to good engineering standards. It can use its representative position to encourage the UN and its agencies and the funding agencies to sponsor programs to help WFEO member countries meet good engineering standards. WFEO can be a showcase for the mobility arrangements of other agencies.

10. CONCLUSIONS

WFEO is involved in representing engineers and engineering organisations internationally to other world bodies and facilitating projects intended to encourage capacity building.

The outcomes are aimed at better infrastructure, sustainable development and better qualified and experienced engineers able to operate globally.

WFEO's goals have an altruistic social element, which is often part of an engineer's code of ethics and is particularly important to young engineers.

These activities can benefit small business both directly and indirectly. For example, they aim at providing well-qualified and experienced engineers and infrastructure projects in which companies might participate. Other benefits depend on the type of business and its location.

Helping Small Business Survive the Skill Shortage — an Australian Perspective

Dr. Peter Greenwood HonFIEAust, CPEng, EngExec. Member of WFEO-CET

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

Abstract

The paper describes employment conditions and the attitudes of engineering staff and employers in Australia and overseas. Current circumstances are causing uncertainty and difficulties amongst small engineering businesses as they strive to understand how to make the most of their inherent advantages. They also face an employment market-place skewed by international shortages.

However, there is considerable information and help available from learned societies and universities. Their efforts to help their members and graduates are open to participation and partnering with small engineering businesses.

Engineers are now more discerning than ever about their technical, career and social needs. The paper comments on how small engineering businesses can understand, acknowledge and respond in recruiting, retaining and regaining their technical staff. A

whole-of-career approach is recommended which includes engineering management and advanced engineering competencies.

Although the paper uses engineers as the example, most of the material applies equally to technologists and technicians. In fact some of the material also applies to other professions.

1. SMALL BUSINESSES

Most of my remarks are about small engineering businesses but they could apply to non-engineering businesses that employ people with engineering qualifications.

Small businesses are described statistically as having fewer then twenty employees (sometimes called Small to Medium Enterprises) But size is not the only factor: a small business could have the same number of engineers as a business with up to one hundred people.

Similarly the work of a small business might need all its engineers to have the highest grades, while the work of a bigger company is more likely to need a range of abilities. Whatever the work, I believe the business should require its engineers to be fully qualified, and equipped with up to date knowledge and skills through ongoing training.

Engineers are increasingly looking for a quality mark (or bench mark) to confirm to themselves or employers that they have reached and are maintaining this standard. As time goes by, being up-to-date and trained becomes more relevant than the first qualification obtained.

Small engineering businesses compete with bigger companies for engineers so they have to try to do better, or be more innovative at recruiting, retaining and regaining good staff. At the same time, young engineers particularly are becoming more skilled in interview techniques and in assessing employers. It has never been truer that a job interview is a two-way process with each side trying to choose a match for its own needs. Size is no handicap in providing interesting and satisfying work. Small size could be an advantage, particularly if the owner is a hands-on enthusiastic entrepreneur.

All businesses employing engineers must understand the difference between education and training. Employers have to provide training, which could include vacation, initial, or on-going training and retraining. Small size is a handicap in providing training but small businesses can overcome this individually or through partnerships.

Many students in Australia are graduating with double degrees combining engineering with some other discipline. The accreditation system requires such combined programs to deliver equivalent engineering skills and knowledge to those defined for the host Bachelor of Engineering program underpinning the double degree.

Non-engineering employers often seek graduates with combined degrees. This is a particular example of people being employed for their engineering skills such as project management, analysis or mathematical modeling and is a credit to the courses and the graduates. In a non-engineering environment, a special effort is required to maintain engineering competence through continuing professional development (CPD).

The same applies to the separate case of engineers employed as managers. They will have their own CPD needs. Small businesses may need external help to manage their scarce training and assessment resources in both these cases.

2. ENGINEERS NEEDS — RECRUITMENT AND RETENTION

Surveys of the needs of young professionals are published regularly. Young engineers, as members of one of the major and more structured professions, show the same pattern of needs. The overall survey results are usually available in the media, but the details are often on restricted circulation. Employers, who ignore this vital information, or worse, believe that high salaries solve all problems, will inevitably suffer high turnover. In one recent survey report salary was described as a “blunt instrument” in recruiting.

Larger businesses have human resource professionals to monitor and give advice about these issues. Small businesses must also somehow keep abreast, perhaps through their own young professionals. Some of this sort of data is available in journals (or magazines) but much of it is not published formally in the learned society sense.

Simple averages of survey responses may be misleading and not do justice to the depth of feeling on some issues or the range of issues. This is illustrated in Figure 1, showing how engineers rank a good salary against an interesting job.

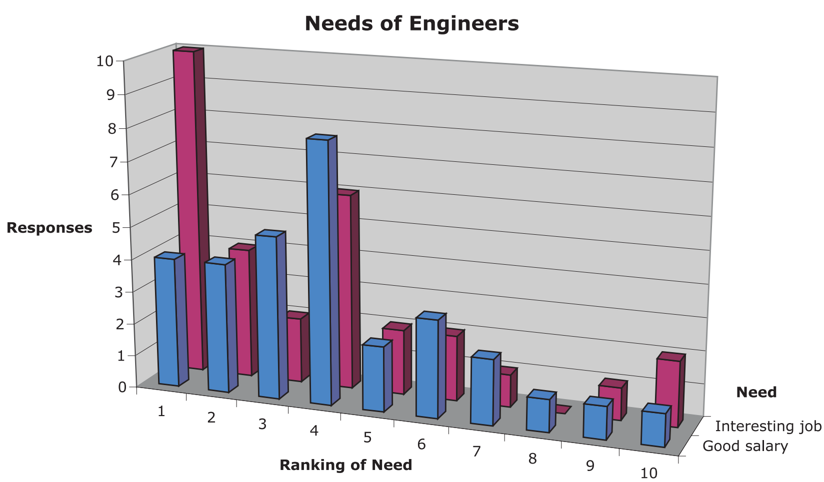

Fig. 1 Some recent results (Source 1)

Young engineers want a graduate development program, prospects, interesting work, continuing development, a communicative CEO or manager and a reasonable salary, often in that order. In interviews they are looking to satisfy these needs. They have the confidence to leave jobs after relatively short periods when employers don't satisfy their needs. Some recent surveys are described in Source 2.

Table 1. Generational Years and Characteristics (Source 3)

Generation	Birth Years	Example Attitude
Baby Boomers	1946–1962	Career orientated
Generation X	1963–1978	Distrusting of authority
Generation Y	1979–1988	Internet orientated

A related topic, which has emerged in the last decade or so, is the study of generational needs and differences. Generation X and Y characteristics are important in recruiting young engineers. Employers are often governed by the characteristics of the so-called Baby Boomers, which may well conflict with those of younger generations. A thoughtful understanding of these issues could well be an advantage to small business. A key driver is that work must match skills and interests.

The needs of women in engineering and mid-career and older engineers have so far received little or no attention in surveys. It is important to study these groups separately since their inclusion in surveys aimed at young engineers would probably distort the findings.

3. HELP WITH NEEDS

Learned societies and universities can help small business to satisfy the needs of an engineering employee.
In fact the whole concept of a learned society has been changing over the years. The emphasis on research or development papers and presentations has shifted towards practice notes, commentary on standards and how to apply them, and other information that is much more specifically applicable to engineers in everyday work. Most learned societies host a bookshop for technical works. Many provide short courses, joint studies with universities and management studies and training. In Australia, learned societies have come to accept that they must work closely with employers in order to help their members.

A major example of this cooperation is the Professional Development Program (PDP), Source 4. In the case of Engineers Australia (EA), this involves a three-way agreement between an engineer, his employer and EA. EA provides a training framework into which the company inserts its training. The employees have their competencies tested by EA, which provides the quality mark.

When a graduate engineer achieves competency and becomes a practising engineer, they also take on a commitment to maintain their competency through CPD. Monitoring CPD is now done electronically and audited. An engineer could provide their results to their employer as an input to the company professional development system.

Engineers Australia has recently done a comprehensive study of CPD to gather data on what is available, further needs, and what is happening to delivery mechanisms. A brief picture is shown in Figure 2. This a major work in progress for EA and its education and publishing subsidiaries, Source 5 and 6.

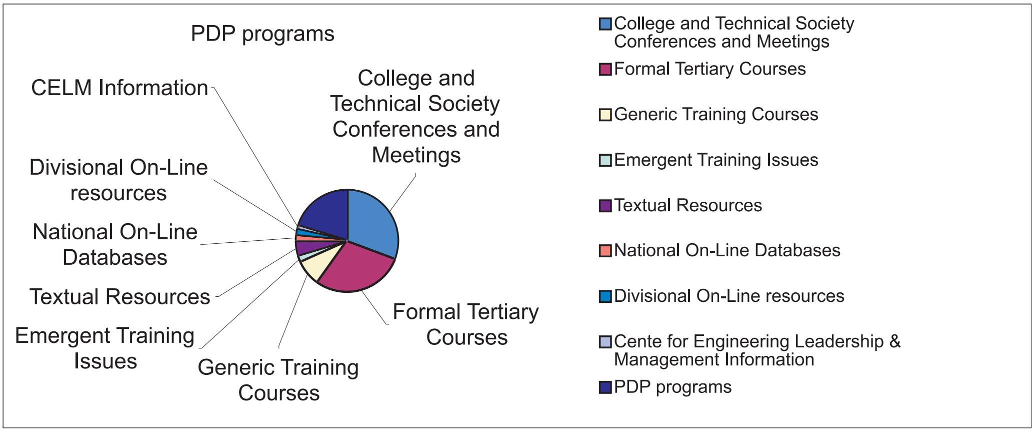

Fig. 2 Approximate Availability of CPD

Universities in Australia work closely with EA in a number of ways beyond course accreditation arrangements. The universities provide much of the training and further studies needed by engineers, but they also look to businesses to provide vacation training for undergraduates.

Universities also want to work closely with employers to establish appropriate curricula and welcome participation in industry advisory arrangements. Universities also need undergraduate projects and topics for higher degree studies.

Many small businesses see these opportunities as ways of finding good engineers and perhaps contracting out some of their R&D needs. Government funding may also be possible through an industry-university partnership approach.

Extending initial years of study, perhaps involving a master's degree, or curricula moving too much away from mainstream engineering activities such as design manufacturing and construction, can have a serious impact on small business. Small business associations have to let universities know of the impact on their members of such changes.

4. QUALIFICATIONS

Learned societies can also help small business understand overseas qualifications, the competencies needed for international recognition and mobility. Learned Societies often provide the national quality mark for competent engineers. This recognition and on-going monitoring can be used by the staff appraisal systems of small businesses.

In engineering it is particularly important to link undergraduate studies with post-graduate training and practice. One development will help this.

The importance of essential skills such as speaking and writing, also keeps coming up in graduate surveys. Engineers and employers alike often list them as important deficiencies. They are an example of professional competencies that need to be addressed first in undergraduate programs. Emphasising the relevance of such capabilities to professional practice would help make students aware of the competency system and let them acquire some credits towards their professional assessment before leaving university.

As well as maintaining old and adding new technical skills, writing, presenting and dealing with the media are examples of non-technical skills that benefit from regular top ups.

5. MOBILITY AND A WHOLE-OF-CAREER APPROACH

Base qualifications are a fundamental requirement in the process of becoming a competent practising engineer. In Australia qualifications are acquired in Stage 1 of the multi-stage process shown in Figure 3. Stage 2 involves a further period of adding experience and gaining the competencies to be declared capable of independent practice. Stage 2 can be achieved within a few years of graduation and is the foundation of an engineer's career.

But what of the remaining three decades or so of an engineer's career? Taking the whole-of-career approach Engineers Australia has added Stages 3 and 4 to its competency framework. The complete picture is shown in Figure 3.

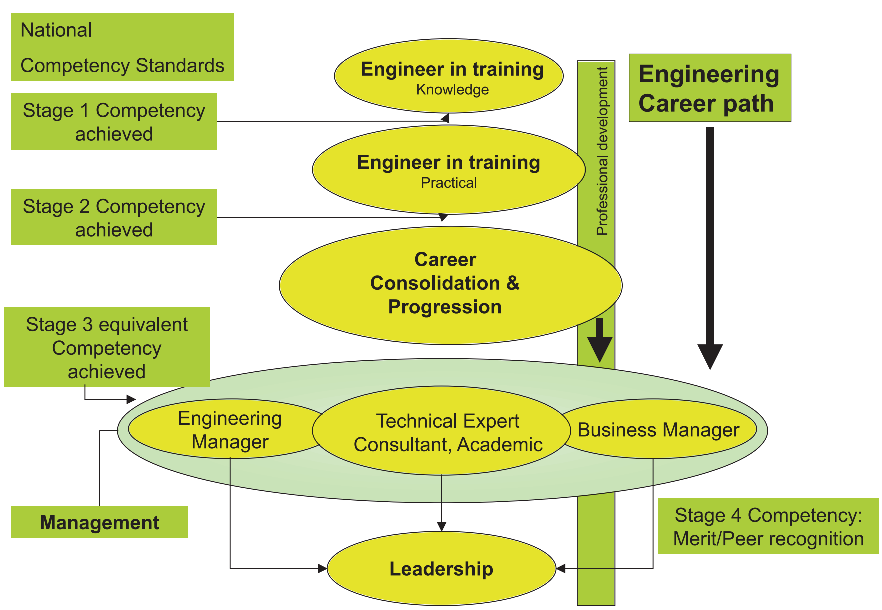

Fig. 3 Stages of an Engineer's career

Stage 3 has parallel paths which reflect the differing roles of engineers in mid-career. One path involves management competencies and a post nominal, which are already in place. The other path with advanced engineering competencies is under development at the moment. Ironically, specifying work and defining competencies usually precedes the offering of training courses. We have to assume that this process has been followed intuitively because there are many long and short management and advanced engineering courses presently on offer. Hopefully this situation will regularise itself as more thought is given to the work done in later working life and the appropriate timing of training.

Stage 4 is additional to the other three stages rather than purely sequential, but engineers with significant experience and responsibility will need such competencies. Project management competencies may be found, depending on the size of the project, in Stages 2, 3 and 4 and are a good example of the concept of career stages. Corporate governance, expert witness and insurance audits are further examples that might need competencies at the Stage 4 level. As for Stage 3, Stage 4 is a work in progress.

A whole-of-career approach to professional development helps in considering the timing of further qualifications and training — offering a menu from which an engineer can consider their career choices.

Stage 2 is also the foundation of the processes of registration, international recognition and mobility. Engineers Australia is a signatory to several education accords and mobility forums, as well as many other bi-lateral agreements, that provide the international recognition necessary for mobility. The agreements include the Washington and Sydney Accords. They also include the Engineers Mobility Forum, the APEC Engineer (operated by member countries of the forum for Asia and the Pacific Economic Cooperation), and the Engineering Technologists Mobility Forum.

There is further comment on mobility in the WFEO paper elsewhere in the conference proceedings.
Small businesses can participate in or benefit from all aspects of mobility and career development through their engineering managers or their engineers.

6. SERVICES TO MEMBERS AND OTHER STAKEHOLDERS

Most learned societies use websites and electronic newsletters to advertise services related to employment, professional development and practice material. Some of the material is limited to members but there is much in the public domain. It is available through on-line bookshops or subscriptions together with on-line libraries and search engines.

The information includes courses, conferences, transactions, practice notes, design data (for example Rainfall and Run-off) including electronic versions, jobs advertisements and surveys of conditions of employment.

Recent developments such as pod casting, video streaming and blogging reflect emerging delivery channels for CPD. The developments will also help in reaching regional and overseas members of Engineers Australia who have difficulty accessing material face-to-face. The developments also indicate that engineers want to time shift and be efficient with their time.

Some of EA's restricted services are made available to engineers who are registered on a PDP program, which is particularly useful to small businesses.

7. SKILLS SHORTAGES

There is an international shortage of engineers at the moment, which is very severe in some engineering discplines such as mining and electricity supply. There are many and varied reasons for the so called skills shortage including lack of planning, lack of training, cost shifting, and computers replacing labour.

The underlying signs are very evident: lack of interest in enabling subjects in schools, engineering struggling for funds and students in many universities, and vacancies in industry being filled through increased migration. Other countries face the same issues, so the situation is not sustainable globally.

That engineer shortages and deadlines will cause neglect of training and long-term planning is a worry. The shortage of engineers is presently distorting salaries, and seems likely to continue for a number of years. Employers and engineers may regret career decisions based on salary in years to come if they neglect professional development and other workplace needs.

There are incentives to solve the problem and some good signs are evident. For example, companies are providing international experience in house to avoid engineers leaving. When recruiting, companies are now also advertising their image and other characteristics, as well as the jobs on offer. Engineering applicants as well, have become more discerning in checking a company's ability to satisfy their needs.

This picture should not dismay small business because it contains pointers to actions they can take to make themselves more attractive in recruiting and retaining engineers.
The paper has largely talked about engineers but it does apply to technologists and technicians as well. There are technologist and technician counterpart agreements to the Washington Accord and Engineers Mobility Forum.

8. CONCLUSIONS

a. An appropriately qualified staff is more crucial to small engineering businesses than to their bigger competitors.
b. Job applicants are becoming more discerning and generational differences are more evident than ever before.
c. Learned societies and universities have much to share with the small engineering business sector, including CPD and other career needs, for technical staff and managers.

d. Small business has to understand the background to quality marks for engineers in a global employment market.
e. International shortages of engineers are influencing salaries and attitudes to mobility and time for training, and the aberration is likely to last for a number of years.
f. A whole-of-career approach to professional development helps with understanding and planning.
g. Small engineering businesses are not necessarily disadvantaged by current circumstances and may have specific advantages linked to size and specialisation.

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The Feani Position on European Support for Innovation

Jim Birch, B.Sc. Ph.D. CEng, FICME
Member of the FEANI Executive Board

Jim Birch, B.Sc. Ph.D. CEng, FICME, Member of the FEANI Board Dr Birch is a metallurgist by training, did research on engineering ceramics, and is a foundry-man by profession. Following an extended period in contract R&D working on improving casting processes, he spent fourteen years with a foundry trade association, latterly as its Secretary, providing marketing and technical services and representing the industry at home and abroad. He joined the Engineering Council in 2000 and is currently Head of International Recognition. His time is spent negotiating, monitoring and implementing mutual recognition agreements with overseas engineers' organisations and in dealing with the legislation which The FEANI Position on European Support for Innovation.

Abstract

The European Federation of National Engineering Associations provided input to the EU consultation on the 7Th R&D Framework and subsequently published a position paper on R&D. FEANI observed that, given the external trade importance of manufacturing and of technical services, engineering is vital to achieving the Lisbon Agenda. EU funding needs to be targeted at technology transfer (at which engineers excel) – especially with regard to SMEs.

FEANI recommended that:

> *The EU budget should be rebalanced with a greater proportion being directed to funding innovation and technology and with the emphasis on economically relevant research*

> *Links, including exchanges of personnel, between research centres and businesses to be actively encouraged, particularly in relation to SMEs*

> *The development of a European wide patent system needs to be urgently taken forward*

Further action should be taken to promote the uptake of science and engineering education, to support research training and to facilitate the mobility of skilled third country personnel.
impacts on professional mobility and the supply of services. He is a Board member of the European Federation of National Engineering Associations.

INTRODUCTION

FEANI is a federation of the national engineering associations in 26 European countries and hence is the voice of the professional engineers in Europe. Through engagement in production of materials, manufacturing, communication, and infrastructure engineers constitute a major source of EU economic power and social cohesion.

Engineers play an essential role in many economic sectors, including manufacturing, infrastructure and communication. While all are important, one key element in maintaining a sustainable European economy is to promote innovation and development in the manufacturing sector as this accounts for over half the EU GDP. (The 22 percent of GDP represented by direct manufacturing is multiplied two to one by the value of manufacturing related support industry). Such a large proportion cannot be realistically replaced by reliance on service industries, particularly as some services, for example engineering consultancy, may require an indigenous industry in which to develop saleable knowledge.

Engineering and associated activities are major contributors to Europe's balance of trade with the rest of the world. The EU25 may have an overall deficit of €60 billion in trade in goods but manufactured products generate a surplus of €130 billion. Trade in engineering and construction services (plus associated architectural and technical consultancy) is in surplus by €10 billion, which constitutes around 25 percent of the total EU25 trade in services surplus.

REBALANCING THE EU BUDGET

In March 2000 the European Council launched the Lisbon strategy – an ambitious agenda for reform. The heads of states and governments committed themselves to make the EU the most dynamic and competitive knowledge-based economy in the world. However, the reforms have not had sufficient impact yet. The growth gap between North America and Asia on one side and Europe on the other has widened over recent years. Furthermore, Europe is at the same time facing the challenge of demographic change, a diminishing workforce and an ageing population with increased needs, combined with a low European economic growth rate, which will halve over the coming decades and reach just over 1 percent per year. Faced with these challenges Europe needs to put much more emphasis on competitiveness enhancing programmes.

FEANI supports rebalancing the EU budget to a much more competitive profile. At present only 9 percent of the EU budget is spent on innovation and technology whereas

40 percent is spent on agriculture. These figures need to be more in balance if Europe wants to be competitive. More EU investments must be made in large-scale infrastructure and public projects, which drive research and innovation along the whole industrial chain, as well as directly in R&D.

GIVING PRIORITY TO APPLIED RESEARCH

The focus of EU funding for research has shifted in recent years towards an increased support for general basic research and single academic teams. With governments currently resistant to increased payments for the EU budget, the result is that these research objectives are being met at the expense of targeted innovation and industrial and market relevant research.

FEANI believes that, as regards research and development, much more focus must be given to the objective in the Treaty of the European Community that:
“The Community shall have the objective of strengthening the scientific and technological bases of Community industry and encouraging it to become more competitive at international level” [EC Treaty, article 163.1].

FEANI recommends that measures be taken to move the focus of the EU Framework Programme funded research to make it more industrially relevant. In this context the introduction of Technology Platforms has been very useful as they provide a boost to developing lines of research which answer the requirements of industrial markets.

FEANI suggests that the Technology Platforms and the Joint Technological Initiatives evolve to become significant tools for fostering European competitiveness. This should be reflected in the financing and in the political commitment.

FEANI believes that the EU should promote trans-national approaches especially in those engineering sectors where individual national size is below the critical mass needed to support significant R&D.

BRIDGING THE GAP BETWEEN SCIENCE AND BUSINESS

More must be done to exploit and develop research achievements. At present there is a gap to be bridged between the research communities on one hand and the business community and the corporate sector on the other. Engineers have a crucial role to play here as they are trained to take blue sky innovations and turn them into useful, commercially viable and/or socially beneficial products, services and infrastructure.

FEANI recommends that a best practice analysis should be made in order to get a clearer picture on how to ensure beneficial cooperation between academic research institutions and industry. Funding must be reserved within the framework programme to facilitate technology transfer from scientific research to the company level. This could include funding exchanges of academic and industrial personnel.

FEANI suggests developing a Technology Transfer Facility within the framework programme, which could play an important role, in collaboration with existing local technology transfer initiatives, in taking projects from universities or research centres to a development stage where venture capital could be forthcoming.

FEANI also recommends that the EU evaluation criteria take the industrial relevance of project proposals and their alignment with the need of European industry into consideration. To support this FEANI suggests increasing the number of industry experts in the evaluation teams.

STRENGTHENING THE RESEARCH AND DEVELOPMENT IN SMES

Small and Medium-sized Enterprises (SMEs) are the backbone of European Economy. They constitute 99 percent of all European enterprises and provide some 75 million jobs and contribute 65 percent of Europe's BNP. Supporting SMEs in their research and development activities is important, since SMEs have been shown to provide a fertile breeding ground for new ideas and innovative ways.

The level of competence of their workforce is vital for innovation activity in SMEs. Companies employing academic workers are two to three times as innovative as companies with no academic workers. A recent Danish research report points to the fact that SMEs employing their first academic worker on average end up employing five additional blue-collar workers.

SMEs which cooperate closely with higher and further education institutions and research centres have a considerably larger innovation potential than other SMEs. Thus more attention and resources should be allocated to establishing such cooperation.

Not-for-profit organisations play an important role in bridging the gap between science and business. Especially with regard to SMEs who do not have resources themselves to get involved with external researchers, not-for-profit organisations can act as important contact facilitators.

FEANI suggests that Community financial contributions to not-for-profit organisations activities should be able to reach a maximum of 100 percent of the total eligible costs. This will enable not-for-profit-organisations to facilitate contacts between researchers and SMEs.

ENCOURAGING A EUROPEAN WIDE PATENT SYSTEM

If Europe is to catch up with the United States and Japan in terms of private R&D investments, and in terms of being able to transform research results and new technological and scientific know-how into industrial and commercial success stories, businesses need a legal framework for the protection of intellectual property rights, which is accessible and cheap for SMEs.

In the US, a patent protection costs around €10.000. In Europe, the same protection costs around €50.000 and it can only be achieved in 8 EU countries. Consequently, EU companies are filing fewer patents than their American competitors. In 2002, US companies filed 301 patents per million of population, compared with just 60 per million by European businesses.

The establishment of a Community wide patent system would give companies an opportunity to obtain a single patent, which would be legally valid throughout the EU; thereby removing the competitive handicap, suffered by Europe's innovators, stimulating investment in R&D and strengthening European competitiveness.

FEANI believes that the development of a cost-effective and efficient Community wide patent system is one of the important tasks facing European policy makers.

INCREASING THE NUMBER OF TECHNOLOGY STUDENTS

It is necessary to create an educational structure to underpin a strategy for market-driven innovation. Employees must have the skills to manage such a development. It is not enough to emphasise and invest in R&D if we do not have the required foundation in terms of human resources. The Bologna process should facilitate the development of this foundation through enhancing the mobility of students and employability of European higher education graduates thus ensuring competitiveness of European higher education on the world scale.

At present, too few students choose the natural sciences and the technical disciplines, even less so for female students. At the same time the demographic changes in Europe in the coming decades make it even more urgent to encourage more young people to graduate from universities and technical institutions. A modern high-tech engineering sector, that competes globally, needs sufficient highly skilled employees if we are to avoid labour market shortages in the future. To achieve this objective efforts need to be targeted at all stages of education from kindergarten to post-graduate level.

ATTRACTIVE ENVIRONMENT FOR RESEARCH AND DEVELOPMENT

More emphasis must be put on measures to attract and develop the skills demanded by European companies in order for them to stay competitive in the 21st century. The apparent decline in student enrolments in science and technology in many European countries is viewed with concern. New data show that Europe will need at least 700,000 additional researchers if the target of 3 percent investment in R&D is to be met by 2010.

FEANI acknowledges the renewed emphasis being given to supporting training and career development of researchers. It is extremely important that the programme addresses those disciplines that are in greatest demand by European companies. The programme must also be capable of meeting the need for continual updating of the cutting edge knowledge of engineers and scientists in industry. Life long learning is vital to Europe maintaining a technological lead and is a concept to which the engineering profession is fully committed.

EUROPEAN GREEN CARD

The availability of a skilled workforce, both quantitatively and qualitatively, is of paramount importance to optimise research in the knowledge-based society. But Europe is facing drastic demographic changes that will have a major impact on its ability to fulfil the Lisbon objectives. The Commission estimates that by 2030 the EU will be short of 20.8 million (6.8 per cent) people of working age. The number of people 65+ will rise by 52,3% (40 million), while the age group of 15–64 will decrease by 6,8% (20,8 million).

A similar pattern can be identified for most other regions in the developed world. The result will be an even more intense global competition to attract labour, not least the highly skilled, specialised and creative knowledge workers, who are the backbone of an innovative, competitive society.

Winning this competition – being able to attract and sustain a larger and more competent work force – demands a common, comprehensive approach operating at EU and national levels and including several measures, one of which is a work permit system that welcomes skilled labour.

Some countries have already adopted green cards – specific resident permits for foreign researchers. But the development of a European-wide area of competitiveness and growth demands the adoption of common rules, which would address the issue of immigrants' right to move around the EU, thereby making it easier for companies to hire the specialists they need and for researchers to develop their expertise.

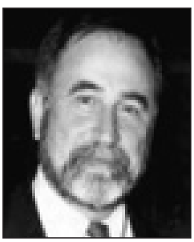
SUMMARY

FEANI recommends that:

- The EU budget should be rebalanced with a greater proportion being directed to funding innovation and technology and with the emphasis on economically relevant research.
- Links, including exchanges of personnel, between research centres and business be actively encouraged, particularly in relation to SMEs.
- The development of a European wide patent system needs to be urgently taken forward.
- Further action should be taken to promote the uptake of science and engineering education, to support research training and to facilitate the mobility of skilled third country personnel.

Strategies for The Support to the Development of the Very Small and Small Companies Due to New Brazilian Politics of Incentive to the Innovation

Prof. Paulo Alcântara Gomes – President of REDETEC
Armando Augusto Clemente, M.Sc. – Director of REDETEC



Paulo Alĉantara Gomes, Master of Sciences and Doctor of Science in Civil Engineering, in the field of Structural Analysis. Retired Professor and former Rector (President) from the Federal University of Rio de Janeiro, currently is the Rector of Universidade Castelo Branco. He is also President of the Technological Net of Rio de Janeiro (RedeTec). Until July, 1994, he was the President of the Council of Rectors of the Brazilian Universities (CRUB). He is a member of two Brazilian academies: Brazilian Academy of Education and National Academy of Engineering. He is also a member of the Portuguese Academy of Engineering and of the Panamerican Academy of Engineering. From April, 2004, Paulo Gomes is one of the five Brazilian active members of the Club Of Rome, which mission is to act as a global catalyst of change that is free of any political, ideological or business interest. He has published 110 works on the Theory of Elasticity, Structural Dynamics, Theory of Plates and Shells and Utilization of Numerical and Computational Methods in Structural Analysis, and recently, subjects related, to Technological Innovation, to Science and Technology Policies, Engineering Education and University Management. He provided guidance for 28 Master and D.Sc. thesis on the aforementioned subjects. He has been awarded several commendations and prizes, among them the "Vector de Oro" awarded during a meeting of UPADI (Pan-American Organization of Engineer Associations) held in Costa Rica in 1996, the National Scientific Medal of the Brazilian Government, the Brazilian Medal of the Cartographic Order of Merit, also as "Commendator", the Order of Academic Palms, granted by the French Government, as "Chevalier", and "the Manuel Rocha Prize", granted to distinguished European and World engineers by the National Laboratory of Civil Engineering, Lisbon, the Government of Portugal.

Armando Augusto Clemente is Master of Sciences in Production Engineering in the Product Engineering. Professor from the Federal University of Rio de Janeiro (UFRJ), nowadays is the Director of Technology Network of Rio de Janeiro (REDETEC).

Abstract

The quest for the competitiveness has taken government and Brazilian companies to the construction of new mechanisms in so much that to assure that the innovation effectively arrives at the products, adding new values and assuring a bigger presence of the Brazilian company in the flow of international trade. Such mechanisms had appeared based on the model of scientific and technologic development, established on 1960, centered in the university, with small participation of the industry and, consequently, with lowest rates of aggregation of value to the production for the innovation. Several measures had been adopted, which "Deep Sectorial" is detached, originated mainly from resources of the privatization of the state-owned companies, and destined to support the research and the innovation in the companies in strategic areas for the development. The approval of the "Innovation Law", destined to regulate it and to stimulate the national technologic innovation in companies, university, research centers and, more recently, the approval of the "Micro Enterprise General Law" that eliminated many of legal mooring cables that hindered the legalization of these companies and make possible to build the "culture of the innovation" in the micro and small companies environment. The aims of this work are to exhibit and to argue governmental and enterprise strategies and programs destined to support the innovation of micro and small companies in Brazil. Specially, the "Subvention Economic" are commented; financing without financial return for companies who are engaged in innovative projects; the "Inova Engineering Program", created by Nacional Industrial Confederation and destined to redirect the education of engineering and the technologic education mainly for attendance to the new necessities and the "Inovar Program", resulted of the partnership between Ministry of Science and the Technology and SEBRAE (Brazilian Service of Support the Micro and Small Companies), which incorporates Projects such as: "Risk Capital", "Capital Seed" and Interest Zero" — all directed to innovation in the very small and small enterprises.

Key words: *Technological Innovation, Industrial Property, Very Small and Small Business.*

I. INTRODUCTION

The panorama observed along the last years in the nations development has been characterized by extraordinary and continuous faster transformations, partially resulting from the science and techniques advance and "market" behaviors. To face new challenges it is determinant to create new culture in enterprises, universities and governments, that should must be able to act with crescent competitiveness. The speed with which the technologies become obsolete imposes the achievement of qualifying actions and the professional empowerment that allow the migration to new professions, the supply of new diplomas genres and a strong component of interdisciplinary in education. At the same time, significantly in developing Nations, it becomes overbearing to assure an effective participation of the Universities in development process, through the achievement of projects aiming innovation, for technology appropriation and transfer.

In Brazil, post-graduation is becoming one of the main board education agents for the productive sector and in decisive instrument for the science and technique advance and for technological innovation. Post-graduation in the country, however today it is characterized by the great relevance for Brazilian university development, was only established in the current model in 1961, from the installation of the master's degree programs in the Aeronautics Technologic Institute (ITA), followed by the foundation, in 1963, of the Coordination of Post-Graduation Programs in Engineering (COPPE) of Federal University of Rio de Janeiro and, still in the same year, by the creation of the first master degree programs of Pontifical Catholic University of Rio de Janeiro. The model then adopted, that prevailed until nowadays, replaced the "free-teaching", genre of competition executed to promote the professors and that comprehended tests and the presentation of a thesis, with original contributions, was the only alternative to obtain doctoral diplomas until the end of the 50's. The establishment of the first master's degree programs created new concepts in the Brazilian University organization, among them we highlight "whole time culture", education, research and extension are not separable and the demand of academic titration (master degree and doctoral degree) for the progress in the teaching career.

To the pioneer initiatives aforementioned followed many others that ended up reflecting in a very positive way about the graduation courses and about the articulations with the enterprises, even though in smaller dimensions that the required for the fulfillment of the expectations and needs of industrial development.
At the same time, the fast post-graduation development in areas considered strategic for the productive sector, significantly the engineers and technology and managements, resulted in a search for new approaches University-enterprise. Thus, there began the cooperation programs with the enterprise segment, among them we can highlight the COPPETEC, organization linked to the Federal University of Rio de Janeiro, and that ended up in notable support device for the industrial development and for the management modernization in national enterprises. The model of a synchronized post-graduation with relevant activities for the productive sector soon spread and became determinant for the success of the programs of many of the master degree and doctoral degree programs. Such model resulted, for example, in the installation of the research center in Telecommunications (CPqD), with great links with the State University of Campinas.

The university agencies of cooperation with the industry ("rendering services") had the double mission of provide that the young masters and doctors who finished their courses and stayed working in universities in full-time (by that time something new in Brazilians

Universities), had a better familiarization with the professional activities and also to bring near their research areas to demands and needs of the productive sector.

The work executed by these agencies ended up being a significant mark for Brazilian technology, for instance in the "oil and gas engineering, aiming off-shore exploring" field, computational mechanics, materials, electronics, computing and chemical engineering, and yet in management, contributing effectively for the modernization of management procedures in enterprises.

In the other hand, the scientific and technologic development started to be considered decisive for the economic progress of nations and, in consequence, we verified a growing presence of the state in the financing to post-graduation and research, materialized, also in the 60's, in the creation of the National Fund of Scientific and Technologic Development, subordinated to National Bank of Economic Development, and in the foundation of the Finance Company of Studies and Projects (FINEP), enterprise currently linked to the Ministry of Science and Technology and that has among its main attributions to enable the articulation between the university and the productive sector.

In different moments, but with the same importance, such agencies were fundamental pieces in the approach process between Universities and the productive sector, always through graduate programs and research. For the attainment of the objectives of scientific and technologic development, it was built, also in the 70's, articulation plans between the policies for industrial development and for the graduate engineering and science education associated to the financial support of basic science and research.

II. THE CURRENT CONTEXT

In what concerns universities and their relations with the productive sector, it's important to emphasize that the extraordinary changes verified along the second half of the XX century, in great part caused by globalization and by growing presence of the "information society", ended up promoting structural changes of great dimension in higher education panorama in all nations. In the Brazilian case, we must highlight, *among others*:

- ✓ The large use of new information and communication technologies in the learning process, with the displacement of the axis teaching-learning of unidirectional information professor-student to the participative learning, accelerating the professional qualification process, through new models of undergraduate courses and technological education, and also through courses for graduates.
- ✓ The decrease of the presence of the state in financing the education and research, with the consequent expansion of the private sector and the reduction of expenses with public education. Unfortunately, this fact was not followed by a bigger partnership with the industry.
- ✓ In Brazil, due to the excessive knowledge centralization, characterized by the concentration of research groups (around 75% of the total of the national scientific production are in south and southeast regions) imposed the creation of new research centers in highly populate areas, but still without the infra-structure able to host

technicians, engineers and scientists. In these areas we have a high contingent of enterprises that do not gather yet knowledge and innovation of their products.

- ✓ In Latin American countries, Universities are still the main responsible organizations to conduct programs and relevant research and development to introduce innovations in the enterprises. Thus, the Universities take in their plenitude the inherent role of knowledge management: generation, storage and transfer.
- ✓ Although the number of graduates (masters and doctors programs) have been increasing considerably along the last decades, Data from the Brazilian government estimate that the number of acting professionals in the country do not surpass 0.8% /k hab.
- ✓ The obtained results in technological innovation are still much below expectation, for many reasons, among them we highlight the difficulty of migration of scientists for the industrial environment (while 80% of the researchers and technicians who act in technological innovation, in United States, are located in industry, in Brazil in percentage in not even 11%), and the almost always contradictory in the points of view of University and enterprise, of industrial propriety concept.
- ✓ The accomplishment of the ideal model depends of the financial support, of the existence of expressive contingent of professionals of R&D, and yet of a perfect articulation among the many government sectors that effectively act in the innovation process. In the Brazilian case, we verify that, along the last years, the total of expenses in R&D is around 1,0% of the GDP, much below the 1,8% GDP applied in South Korea. At the same time, the presence of the enterprise in financing to science and technology corresponds about 41% of the total expenses executed in R&D, while in South Korea, these expenses comprehend 73% of the total applied in R&D.

However, it is necessary to recognize the extraordinary growth in the Brazilian scientific activity happened along the last decade, what placed us among the ten countries with bigger development in number of issued articles in index international magazines, and developed from a contribution from 0.8% from the world total, in 1995, to around 1.7% in 2005. Figure 1, below, gives an illustration of the scientific production of Brazil in comparison with other countries.

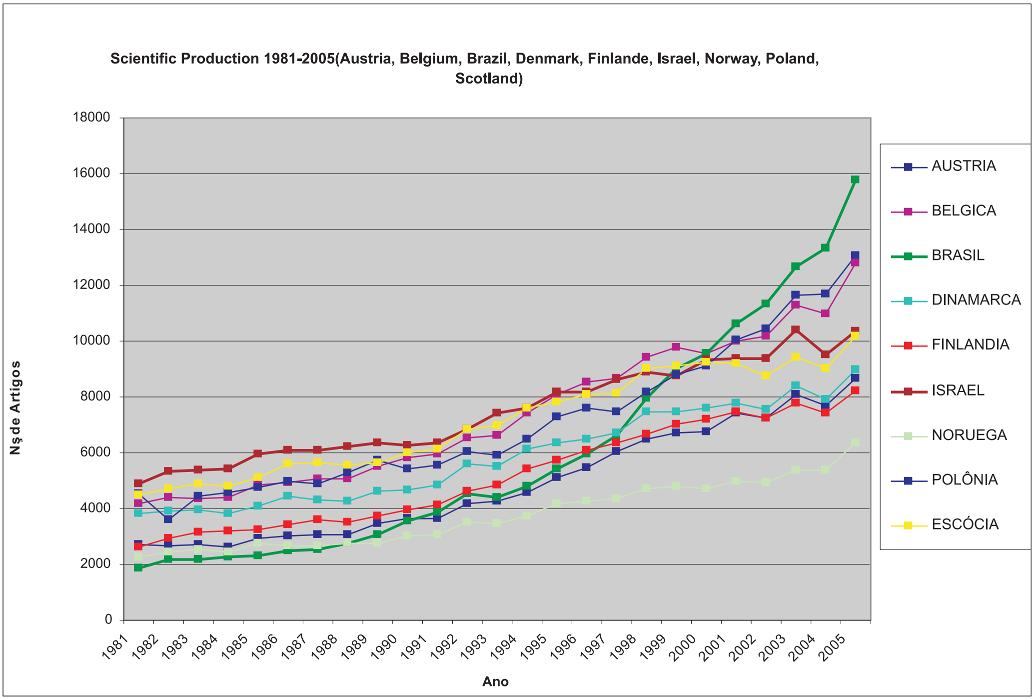


Fig. 1

III. ADOPTED POLICIES

There are no doubts about the importance of the current actions to recover part of the lost time and endow the Brazilian enterprise, always with the Universities and research institutes support, with the conditions to face the new conditions imposed by the market, more globalized and demanding.

The continued education programs offered by universities, in all levels, the growth of the articulation university-enterprise, through the accomplishment of investigative projects in partnership, the fortification of *"entrepreneurial culture"* and, simultaneously, the support for consolidation of a "national net" of enterprises incubators and technological parks and yet the adoption of public policies for motivation to science, to technology and innovation are notable instruments for the industrial development. The laws of tax incentives for the enterprises, the creation of the *Support Program for the Excellence Centers*, financed by the Ministry of Science and Technology and the installation of "sector funds", resulted from the privatization process of state enterprises, are some good examples.

It was necessary to establish some criteria for the ongoing programs keep in progress:

1. The strengthening of a national system of the very small and small enterprises is determinant as way of generating work and income. In the Brazilian case, new policies, extremely important, are being adopted:

- Release the small and very small-enterprises from the legal and bureaucratic ties that restrain and make them loose motivation for legalization and formalization;
- Contribute to guarantee the survival of very small and small enterprises, assuring the proper advice and support during the consolidation period;
- Give conditions for the competitiveness increase for enterprises, in technical way, as well as in management exercise;
- Assure the increase in access conditions to credit to other facility measures for economic-financial viability of micro and small enterprises;
- Introduce the very small and small enterprises in the international trade flow;
  The "Law of Small Enterprise", approved in last December, will allow sensible changed in the current panorama, changing deeply the tax codes, foreseeing the unified collection of taxes and tributes, simplifying the procedures for the opening of new enterprises and, this way, contributing for the regulation of the high number of informal enterprises. At the same time, the Law of Small Enterprise creates facilitator devices for financing for enterprises that intend to develop new technologies, forcing government fomentation agencies to apply 20% of their available resources for small and micro enterprises.

2. The knowledge society dropped borders, generating, as already mentioned, the production decentralization, including the cultural goods, that have not always been followed by the knowledge decentralization. Brazil contributes with around 51% of the Latin American scientific production and with only 1.7% of world production. In what concerns innovation, we can state that the results are still a disaster, since we are in modest 49th in international ranking of innovation.

For the generation of an innovation culture, determining for the fortification of what we could understand as the "Brazilian brand", imperative for the insertion of the micro and small enterprises in the international scenario, the following is being adopted:

- Grant continuous investments with proper amount in basic research;
- Through constitutional reforms, remarkable in the tributary reform, to build tax policies that stimulate the search and development in enterprises;
- Consolidate educational projects, to end illiteracy and assure a higher educational level for everybody;
- Support the creation of new master degree programs and, mainly, doctoral degree, to enable a higher number of researchers.
  A program that has been of great importance is the Project "Inova Engenharia" (Innovate Engineering), initiative launched by the National Confederation of Industries and that aims to promote the articulation of academic institutions, public authorities and enterprises around the articulation university-enterprise and also aims to increase the value of the profession of engineer, searching for new education models. The program has been fulfilling actions that allow improving teachers of mathematics, physics and chemistry in high school, the formation of networks between universities and enterprises to create "Innovation Labs", for research and development of new products, processes and services and yet the achievement of integrated projects to promote structural changes in curricula and in the pedagogical process in engineering courses.

- Increase and assure the conditions to modernize the infra-structure of information and communication, essential to achieve education, science, technology and innovation programs.
- Build an industrial propriety policy able to assure the effective competitiveness to enterprises and generate better conditions for the participation of Brazil in the free trade agreements.

  In what concerns industrial propriety policies, it is important to emphasize that the Law of Innovation was approved on December 2nd 2004 "establishing incentive measures for innovation and scientific and technological research in productive environment, aiming empowerment and In reach of technological autonomy and industrial development of the country". The Law of Innovation, according to the Ministry of Science and Technology of Brazil, reflects the country's need to count on legal devices that contribute to outline an auspicious scenario for scientific and technological development and to stimulate innovation".

  The Law also meets the current Industrial, Technological and Foreign Economic Affairs Policy (PITCE) of the Brazilian Government, while it defends among other objectives, to improve efficiency of the productive sector in the country in order to enable it technologically for external competition, as well as in the required enlargement of its exportations, facing the competitive insertion of goods and services with base in international quality standards, larger technological content and, therefore, with bigger added value.

  The Law of Innovation is organized around three different aspects:

  a) Formation of proper environment to strategic partnerships between Universities, technologic institutes and enterprises.

  The Law considers many supporting devices to constitute strategic alliances and ts between Universities, technologic institutes and national enterprises, among them:

  - *arrangement of international technological researching networks and projects;*
  - *action of technologic entrepreneurship; and*
  - *creation of incubators and technological parks.*

  According the law, *science and technology institutions (ICT), can share, their labs, facilities, infra-structure and human resources with enterprises (including very small and small enterprises) and private nonprofit organizations for incubation activities, or for research activities.*

  b) Motivation for the participation of science and technology institutions in the innovation process.

  The Law allows the Science and Technology Institutions, there included Universities, to sign transfer contracts of technology and license of patent property, to render consulting services, therefore motivating their employees to take part in projects where innovation is the main focus.

  Another motivation policy introduced by the Law of Innovation is the possibility for the public workers in Education and Research Institutes, to receive scholarships from *enterprises or fomentation agency, directly involved in partnership activities with public educational or research institution.*

c) Motivation to innovation in enterprise.

The legal devices in this strategy aim to motivate a higher contribution of the productive sector in relation to the allocation of financial resources in promoting innovation.

The Law foresees the permission, from the government for the utilization of financial, human material and infra-structural resources, to attend national enterprises involved with research and development activities. With specific contracts or agreements, such resources will be adjusted between the parties, considering yet the priorities in industrial policy and national technology.

The specific financial resources may come as a economic subvention, by financing or by corporate participation, being mandatory yet counterpart from the beneficiary enterprise. In the first stage, the Financing Company of Studies and Projects(FINEP), linked to the Ministry of Science and Technology, allocated US$ 300 000 000,00 for application in economic subvention projects, in areas considered strategic for national enterprise.

Finally, the Law foresees the support of research and development activities, that enclose technological risk, as well as the implementation of programs with direct actions especially to promote innovation in very small and small enterprises.

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The Role of Smes in Economic Growth: the Case of Bahrain

Eng. Abdulrahim Abdullah Fakhro
The Bahrain Society of Engineers, Kingdom of Bahrain

Eng. Abdulrahim Abdullah Fakhro, born 1961, worked as the head of Petrochemicals and Plastics Industries in the Ministry of Industry and Commerce and was responsible of Small and Medium Enterprises Unit during the period of 1991 to 2005 at the same time managed to develop many programs in the field of marketing, management, investment and productivity to assist existing businesses and enhance SMEs in general. Eng. Fakhro participated in publishing a book titled "Small Industries Projects" which is thought in Technical and Business schools in Bahrain. During the same time worked with international experts in the field of SMEs development in Bahrain, Korea and Japan. At the moment he is the Head of Economics and Technical Affairs of the Supreme Oil Council in the General.

Abstract

The long-term economic development of The Kingdom of Bahrain and the GCC depends heavily on the ability of small- and medium-sized enterprises (SMEs) to grow, and especially, to overcome the challenge of globalization. Experience in other parts of the world has shown the effectiveness of this sector in channeling entrepreneurial creativity, implementing new technologies, and often, in providing the most dynamic source of employment opportunities.
However, SMEs in the region sometimes lack access to inputs and markets, and a fertile environment to contribute to their growth. As an interested researcher in the field and all we can play a key role in helping to remove some constraints that affect SMEs and in implementing programs to foster their growth. This report reflects the experience of the Ministry of Development and Industry in the Kingdom of Bahrain in supporting SMEs from 1990 to 1999. (The experiences with the SMEU, the BDB and others.)

The long-term economic development of The Kingdom of Bahrain and the GCC states (Bahrain, KSA, Kuwait, Oman, UAE, and Qatar) depends heavily on the ability of small- and medium-sized enterprises (SMEs) to grow, and especially, to overcome the challenge of globalization. Experiences in other parts of the world has shown the effectiveness of this sector in channeling entrepreneurial creativity, implementation of new technologies, and often, in providing the most dynamic source of employment opportunities.

However, SMEs in the region sometimes lack access to inputs and markets, and a fertile environment to contribute to their growth. Many Stoke holders can play an important role in helping to remove some constraints that affect SMEs and in implementing programs to foster their growth. This paper reflects the experience of the public sector in the Kingdom of Bahrain in supporting SMEs.

There are different methods to classify small from medium from large industries. The quantitative and the qualitative methods are the two major criterions. The qualitative method is the one to specific the size of the industrial institution based on the management organization, methods of marketing, technology utilization, and others. The quantitative method is depending on number of employees, properties, total sales, and other parameters.

Reference to a study conducted by Gulf Organization for Industrial Consulting (GOIC) on small and medium industries in the GCC countries, two of the quantitative criterion have been chosen to specify the size of the industries. Those are the number of employees and size of capital. Based on their classification, the following are:

Company	Capital (US$ million)	Employee
Small industries	0.5–1.0	10–30
Medium industries	1.0–5.5	30–60
Large industries	5.5–up	60–up

THE ROLE OF SMES IN AN ECONOMY

The number of business establishments which belongs to the category of SMEs in the kingdom of Bahrain is as high as 96%, as it is even higher in more developed countries. SMEs play important roles in their economies, generating about 60% of GDPs and creating substantial employment opportunities at a relatively low capital cost per unit of job creation, SMEs also provide a vehicle for a more equitable income distribution, contributing to the improvement for the diversification of the economic sectors, and after all, making the economy dynamic.

SMEs have positive impacts on economy, local exports, employment, industrial integrity, and others. A small & medium industry absorbs large sectors of local human resources and assists them with the proper education and training programs. Small and medium industries take different backgrounds such as professional engineers, businessmen, technicians, science students, and other disciplines. Therefore, Small and medium industries are not only providing quantitative jobs but also a qualitative ones.

Small and medium industries provide different potential business opportunities in which it diverts usual and traditional type of investment such as real state, trading, and others to industrial investment. This will offer more jobs, activate more business services, and mobilize liquidity, where in returns better standard of living and redistribution of wealth will be achieved among the local society. Also small and medium industries will help in displacing imported products by manufacturing them locally in which it will shift the national economy from importing to exporting nature.

In addition, small and medium industries will play an important role to integrate different industrial sectors. Therefore, products from basic industries such as aluminum, petrochemical, iron, and others will be utilized locally. Higher added value will be achieved for the local manufactured products and optimum utilization of local resources such as natural gas, water, and electricity. Also, Small and medium industries will encourage the creation of large scale industries such as car industries and other assembly projects if their required products are manufactured locally by those industries.

ADVANTAGES OF SMES

SMEs have a number of advantages from operation and management viewpoints. First of all, SMEs can provide customers with personalized service as they are usually very close to their customers.
SME's are well aware of their customers and markets as they frequently specialized in the products or services. SMEs are closely tied to the communities or specific areas.

Within the organization, SMEs exercise personalized approach with employees. The lines of communication are short and direct.
Another important characteristic of SMEs is flexibility in management. Fewer procedures and little bureaucracy exist in decision-making process. They are relatively free to enter the markets or leave businesses.
SMEs are usually owned by individual venture investors who enjoy freedom and independence to do exactly as they please.
In many cases, SMEs initiate new combinations of resources, introduce new products to market and facilitate innovation.

DISADVANTAGES OF SMES

On the other hand, however, SMEs show weakness in common because of scale and size. Inadequate management skills are found in many of them. They face difficulty in raising capital and are resigned to a weak competitive position.
They are unable to absorb unanticipated losses and meet unforeseen events such as bad debt, product liability and natural disasters.
They are vulnerable to failure because of entrepreneur's incompetence. They frequently demonstrate weakness in the marketing structure.

OPPORTUNITIES FOR SMALL BUSINESSES

Notwithstanding strengths and weaknesses, SMEs can still enjoy opportunities. Business environment has been changing fast and favorably to small businesses. Customers Needs

are in variety. Downsizing has been a trend for large organizations, which are undergoing a restructuring process. Overly grown firms and even nations are becoming inefficient and out of control. Dinosaurs are dying. Small is beautiful and strong.
Large companies are mostly assembly operations, depending on the supply of component parts or specialized products from SMEs.
Information technology is now available for use by small businesses; Paradigm of business has been changing from economies of scale to economies of scope, from Pyramid structure to Network structure. Why not capitalize on these favorable conditions to start up new ventures. Small is Beautiful.

ENTREPRENEURSHIP

It must be kept in mind that there is no guarantee of success in new venture; only selected businesses survive naturally as in the biological world. To minimize risks, entrepreneurship is an essential element in the management. In an Economically vigorous society, entrepreneurs challenge and take risks in introducing innovations. Entrepreneurs must be trained to make right decisions, judging risks. They are usually better than public servants. They are able to adapt to changes and think small.
Even within a large company there is a combination of small enterprises. Therefore, "entrepreneurship" must be nurtured for survival.
Entrepreneurs are made, not born, by proper education and training, soft and high added value industry in service, designs, R&D, intelligence and knowledge, rather than capital-intensive heavy industry, should be developed strategically, particularly in Bahrain where natural resources are depleting and population is growing.

PREREQUISITES FOR THE DEVELOPMENT OF SMES

When SMEs are active, the economy is dynamic and healthy. To create such economy, freedom of business must be ensured. This means that market economy must exist where free entry into the business arena and free enterprise system are guaranteed with a level playing field that provides equal and fair opportunities to all players.

THE ROLE OF THE GOVERNMENT IN THE DEVELOPMENT OF SMES

The role of the government is to create an enabling and conducive environment for the entrepreneurs. Some of the important areas where the Government could contribute are:

- Create the right industrial environment by introducing the right environment, through clear industrial and investment policies, encouraging and enforcing fair competition and efficiency.
- Eliminate barriers to development such as a licensing policy, lack of low cost financing, venture capital etc.
- Providing access to modern technology and infrastructure facilities such as hi tech industrial parks etc.
- Provide information on the latest market trends and developments.

- Providing suitable export incentives.
- A system could be set up to procure business for small firms through government contracts, and encourage offset system, sub-contract work and purchasing orders from large firms.

To sum it up, the government must be the catalyst for enterprises, encouraging entrepreneurs of various types to form networks.
Last but not least, we should not depend on the government for everything!
A successful entrepreneur is one who is resilient enough to overcome initial setbacks, who knows how to adapt and respond to fast changing market requirements and above all who BELIEVES IN HIMSELF!

"Ask not what your country can do for you…..Ask what you can do for your country"
– John F. Kennedy

CONCLUSION

The international economic environment is changing all the time. The world is becoming global village since the kingdom of Bahrain joined the World Trade Organization (WTO), Bahrainis industry has had to face increasingly fierce competition from foreign companies. Companies have had to acquire new knowledge and develop new technology. Innovations are constantly being made in the area of business administration, product lifespan are getting shorter, and customers' demands are becoming more and more diverse.
Enterprises have to work to enhance the added value of their products and services. Globalization and liberalization are now at the heart of the global economy. The trend towards globalization has created major challenges for The GCC States small and medium enterprises (SMEs). It has led to further restructuring of the region industrial structure, and is making it more difficult to establish new businesses, to manage existing businesses, and to grow. However, globalization also creates opportunities for those SMEs which are carefully managed and quick off the mark.
Bahrain economy should develop into a knowledge-based economy, with new strengths. In order to secure a niche for itself in the global economy of the future, Bahrainis industry must position itself to focus on products and services which offer high added value. Bahrain's SMEs need to strengthen the creation and accumulation of knowledge, to add value to knowledge, and the implementation of knowledge. They have to convert knowledge into products and services, into profits and value. As we enter the era of e-commerce, SMEs need to strengthen their IT capabilities, introduce Enterprise Resource Planning systems, and incorporate inter-enterprise transactions within their company's information system so that transaction data can be exchanged rapidly. In this way, they will be able to increase their speed of operation and enhance their efficiency. SME's need to adopt management strategies based on broad vision, promoting Innovation, working to increase speed, and securing niches in the market. Only then will they be able to create value and achieve perpetual operation.
In order to help SMEs to become more competitive, the Small and Craft Enterprise Directorate of the Ministry of Industry and Commerce Administration assists companies

in traditional industries to upgrade and transform themselves, works to promote innovation and R&D, helps to raise the level of product design, promotes e-adoption to increase speed and efficiency, and implements measures to help SMEs create high added value. The goal is to enhance the overall competitiveness of Bahrain. The Directorate also provides assistance to newly established SME's, helping them to undertake innovative research and promotion the development of knowledge-based industries. Techno-mart mechanisms are used to establish platforms for the exchange of capital and technology, and to encourage the widespread adoption of technology in both the manufacturing and service sectors. The aim is to create an environment beneficial to entrepreneurial activity, helping new start-ups to become a new source of motive power for Bahrain economic development. Now let me conclude my speech by stating that where there are many active minds in a society; where talent is monitored and encouraged; where achievement is recognized and reworded many entrepreneurs abound in such countries. And in countries where there are many entrepreneurs it is natural that the economy is healthy and dynamic.

Increasing Competitiveness of SMEs with EU Funds

Andrzej Malinowski, Ph.D.
President, Confederation of Polish Employers, Warsaw, Poland

Andrzej Malinowski, Ph.D., Econ. – President of Confederation of Polish Employers in Warsaw (since 2001), First Vice-President of CEEP in Brussels (European Centre of Enterprises with Public Participation and of Enterprises of General Economic Interest), since 2005, member of the National Council for European Integration (since 2002), representative of the KPP (Confederation of Polish Employers) in the IOE (International Organization of Employers), scientific worker and lecturer at the Poznan University of Economics in Poznan (Poland) and the Adam Mickiewicz University in Poznan. Education: Master of Economics in Poznan University of Economics in 1969, Doctor of Economics in 1975.

Abstract

Introduction of the situation of innovation development in Poland, juxtaposed with other EU countries – in respect to identifying reasons for low level of innovation in SMEs and case studies of tackling barriers in other EU countries.

An overview of the chances brought about by the EU – financing of innovative enterprises and incubators of entrepreneurship. Funds attained for the SME sector and the possibility of creating Regions of Knowledge in frame of the VII Framework Programme of the EU and Structural Funds. With emphasis of the role of SMEs in creating Research Centres, Regions of Knowledge, Technology Clusters, and Integrated Centres of Advanced Technology.

New approaches in acquiring funds for SMEs – with respect to innovative enterprises (i.e. Technological Credit, National Capital Fund, or Public-Private Partnerships) and prognosis for new sources of financing. With particular focus on the Technological Credit Fund – its role in motivation of technology investment and in support of new technology transfers from research facilities.

I. INTRODUCTION

One of the tendencies, observed for years on the global market in field of enterprise development is the systematic increasing of the role of SMEs.

Consequently, SMEs competition will have increasing influence on the global competition, including the Polish economy. Among a number of factors determining the competitive superiority of a company, innovation is undoubtedly the one bringing a lasting advantage on global market.

Today I would like to discuss:
– the degree of innovation of Polish SMEs;
– the factors determining the current situation of innovation in Poland;
– the hitherto available support for increasing innovation SMEs' and how it will be supported with EU aid in years 2007–2013;
– the chances for improving innovativeness of SMEs with support of the instruments planned for years 2007–2013;
– and how these instruments will influence Polish innovation.

II. INNOVATIVENESS OF POLISH SMES IN COMPARISON TO OTHER EU COUNTRIES

There are over 3,6 million economic subjects on the Polish market. Out of these enterprises 95% are micro-enterprises and 4% are small enterprises. The participation of medium enterprises is 0,8% and large ones only 0,1%. Additionally, it is estimated that from among all those registered enterprises, only 1,7 million are active.

In the concerned group of small and medium enterprises in Poland there is only a small amount of enterprises of innovative character. This constitutes one of the lowest innovation indexes in the European Union. In the European Union 25 countries before 1 January 2007, Poland got the 21st place in the field of innovation. The participation of enterprises employing innovation in production processes in Poland was 18% in 2004, while the EU average was 51%.

There are a number of reasons behind this situation, but the most important one is the poor financial situation of Polish enterprises. The expenses of entrepreneurs on innovative activity amount to only around 2% of the GDP. Such low investments in innovation can also result from the fact that enterprises mostly finance pro-innovative activities from their own resources. For example, in 2004 approx. 78% of the costs of innovative activity have been financed from companies' own resources. While only 22% of these outlays were financed from other sources, including bank credits (16%).

Another reason of such low level of Polish enterprises' innovation is the small interest on part of entrepreneurs in conducting research and development activities. Looking at the structure of the investments, 60% of the total expenses result from purchase of machinery and facilities. While the expenses on R&D, one of the most essential sources of innovation, are only 7,5%. Moreover, the expenses of enterprises on purchase of ready technologies in form of documentation and copy rights are only 3% of outlays.

Alongside the size of outlays for innovation, a key-element deciding about the innovativeness of the economy is the ability to implement and commercialize new technologies. To evaluate this ability there are used indicators of participation of import and export of high-tech products in the import and export overall. In 2004 the participation of high-tech products in import was 9,2% while in export only 2,3%.

Discussing innovation and high technology we cannot forget about patents. The number of inventions submitted by Polish inventors remains on very low level of about 2 thousand yearly. In 2004 out of the total of 7 740 inventions submitted to the Polish Patent Office, 69,2% were of foreign origin. In the same year, the invention rate in Poland was over four times lower than the average of the old EU and over ten times lower than the average of OECD countries!

It means only one thing; it is necessary to support Polish innovation and investments in innovation of Polish entrepreneurs.

III. CURRENT INSTRUMENTS SUPPORTING INNOVATIVENESS OF SMES IN POLAND IN FRAME OF EU FUNDS

Up till now, the main instruments supporting the innovative activities of SMEs were programmes realized in frame of the pre-accession funds – PHARE and in frame of structural funds.

PHARE was launched in 1989. Out of the PHARE programmes the one that supported innovativeness to the greatest degree was PHARE 2003 with the following activities:

1. “From Innovation to Business – Loans” – with 7 million Euro available.
2. “From Innovation to Business – Investment Grant Fund” – 7 million Euro.
3. “From Innovation to Business – Investment Grant Fund” – 7 million Euro.
4. “Development and Modernization of Enterprises Based on New Technologies” – 13 million Euro.
5. “Investment Grant Fund” – 17 million Euros.

Those programs supported SMEs investments of innovative character through, among others, subsidization and extending loans for projects based on:
– modernization of products, machinery, facilities, computer hardware and software,
– purchase of intangible assets (patents, licences).

The structural programmes for years 2004–2006 supported the innovativeness of Polish enterprises with following programmes:
1. Improvement of the Competitiveness of Enterprises,
2. Integrated Operational Programme for Regional Development.

Within the Sectoral Operational Programme – Improvement of the Competitiveness of Enterprises (SPO WKP) there were three main activities envisioned to support directly projects of innovative character:

1. Strengthening cooperation of research and development institutions with the economy (Activity 1.4),
2. Increase of competitiveness of small and medium enterprises through investment (Activity 2.3),
3. Support for enterprises making new investments (Activity 2.2.1).

The most influential out of structural funds for years 2004–2006 was Activity 1.4 – Strengthening cooperation of research and development institutions with the economy.

Within the frame of this programme the following projects were implemented:

– specific-target projects including applied works of research and development in frame of industrial and pre-competitive research led by enterprises or groups of enterprises, either individually or with cooperation of R&D institutions;
– investments linked with construction, modernization and furnishing of laboratories providing specialist services for enterprises, realized by scientific entities;
– investments linked with construction, modernization and furnishing of specialist laboratories for Centres for Advanced Technologies and Centres of Excellence, operating in priority fields relevant to the development of the Polish economy;
– specific-target projects realized by Centre for Advanced Technology;
– research projects in area of monitoring and prognosis of technology development.

For the realization of this activity there were 127 million zloty provided. In the end around 140 projects have been subsidized in frame of this activity.

The choice of awarding funding for a project was made of course based on its level of innovativeness, which was measured through:

– the influence of the project on increasing the competitiveness of enterprises,
– possibility of employing the results of carried out research in the economy,
– the demand for the certain product on the market, resulting from carrying out the research,
– influence of the research on the improvement of an existing product, technology, service, or on creation of new solutions.

From the perspective of entrepreneurs, Activity 2.3 – Increase of competitiveness of small and medium enterprises through investment had the greatest influence in improving their level of innovation. The aim of this activity was to increase the competitiveness of enterprises through modernization of their product and technological offer.

In the frame of this activity projects were supported in the field of:

– purchase of R&D results and industrial rights,
– implementation and commercialization of technologies and innovative products,
– the use of ICT tools and other activities contributing to the introduction of significant changes in a product or production process.

In frame of this activity there were 1 400 million zlotys available for entrepreneurs. However, the actual interest of entrepreneurs considerably exceeded this sum. The submitted projects amounted to about 260% of the available sum. Due to this increased interest the degree of a project's innovativeness was the determinant of the awarding process. The more the project was innovative the larger score it received and the more chances it had to receive the funding. The projects that received the best score planned implementation of the innovation on an international level, in other words, innovation that was still unknown and unimplemented in Poland and linked with the information and communication technologies.

Within the framework of the Sectoral Operational Programme the purchase and implementation of innovation was funded also through Activity 2.2.1 – Support for enterprises making new investments. This activity was targeted at supporting enterprises making new investments, especially in field of constructing new or extending existing enterprises, introducing to the enterprise activities making principle changes to a product or a production process and linked with creation of new jobs. In this activity the projects' innovativeness was even more important. Due to the number of submitted applications, only projects which introduced innovations, which have been used for less then a year in the world, had a chance to receive funding.

The award of a project depended also on the following factors:
– weather or not the applicant possessed the relevant patent rights,
– weather or not the project was linked with the goals of the Framework Programme for Science, Technological Development and Demonstration of the European Union,
– creation of innovative companies within the framework of the project, in cases when the entrepreneur was also the inventor of the technology subject to investment.

Large enterprises could also benefit from this activity. And yet 75% of the available funds have been appropriated to SMEs. The Activity 2.2.1 had 1 300 million zlotys available.

As I mentioned, innovative projects could also be financed from the Integrated Operational Programme – Regional Development from Activity 3.4 "Microenterprises". The main intention of the programme was to support innovations of regional character, but many projects implemented by micro-enterprises were also of national and international level. Within this framework entrepreneurs had 75 million Euros and like in the case of the mentioned programmes the resources turned out to be way too small to satisfy the real needs of entrepreneurs
But this is already the past. While the future for innovations is even more promising.

IV. ENVISAGED INSTRUMENTS SUPPORTING INNOVATIVENESS OF SMES IN POLAND IN FRAME OF THE FUNDS FOR YEARS 2007–2013

Within the framework of new structural funds, planned for years 2007–2013 the most important from the perspective of development of SMEs' innovativeness is the Operational Programme of Innovative Economy. Since practically each of the seven priorities of this programme contributes to increasing innovativeness of the Polish economy, particularly through supporting SMEs' innovativeness. The main beneficiaries of the programme are entrepreneurs, scientific units, and innovation centres.

Among the most important instruments supporting SMEs' innovativeness in the framework of this programme are:
1. in the frame of priority 1: Research and development of modern technologies – Activity "Support of target-specific projects" – with approx. 390 million Euro,
2. in the frame of priority 3: Capital for innovation – Activity "Initiation of innovative activity" – approx. 110 million Euro,
3. in the frame of priority 4: Investments in innovative undertakings, several supportive activities will be implemented, i.e.:
   - Support for R&D results implementation – approx. 240 million Euro,
   - Investments connected with R&D activity in enterprises – approx. 186 million Euro,
   - Technological credits – approx. 410 million Euro,
   - New investments with high innovative potential – approx. 1 400 millions Euro,
4. in the frame of priority 5: Diffusion of innovativeness – Activity Intellectual property management – approx. 39 million Euro.

The enterprises' innovativeness will also be supported through cooperative connections of enterprises.

Within the framework of the operational programme, the most important activities supporting indirectly the development of innovativeness of Polish enterprises are:
- Support of R&D projects for entrepreneurs realized by scientific entities – 380 million Euro,
- Development of high R&D potential centres – 700 million Euro,
- Support of centres of innovativeness – 190 million Euro,
- Supporting high risk capital funds – 180 million Euros.

Of course the innovativeness of projects implemented within the framework of the mentioned activities and the influence of the project on increasing innovativeness will be evaluated differently depending on the activities of the programme. However, it should be underlined that from the Operational Programme – Innovative Economy only innovation projects of national and international level will be supported.

Innovation projects of regional character will be supported from Regional Operational Programmes. For activities connected with the development of SMEs and their innovativeness there is planned an average of 24% of the whole allocation in frame of each regional programme. Thus entrepreneurs will have at their disposal over 4 billion Euros. The support for SMEs, realizing innovative activities in each region will be different. Nevertheless in most regions, the innovativeness of enterprises will be increased through:
- direct investments in SMEs,
- strengthening the potential of the technological parks, extension and modernization of the laboratories providing specialist services for entrepreneurs,

– development of cooperative and network connections between R&D institutions and entrepreneurs.

Despite that, that within the frame of Regional Operational Programmes, according to intentions of programmes' creators, the projects that are characterized by innovativeness on the regional level are going to be supported, the bigger chances of receiving funding will have innovation projects of national and international character. Also due to the fact that regions are mostly interested in "grabbing" innovations previously unknown and unapplied in Poland or in the world.

In discussion on European Union funds and innovation, we cannot forget about the already mentioned framework programme. Together with the launch of structural funds, in frame of the new financial perspective for years 2007–2013, a new seventh edition of the programme was also launched. The Seventh Framework Programme in field of research and technological development is the greatest mechanism of financing and forming the scientific research on the European level. The programme budget amounts to almost 54 billion Euro for all Member States. In frame of this programme SMEs projects concerning the following will be supported:

– researches, whose aim is to create new knowledge, technology, or product,
– encouraging participation of SMEs in R&D projects,
– supporting associations and groups of SMEs in the development of technical solutions for common issues for a greater number of SMEs in specific sectors of the industry.

V. CONCLUSIONS

Due to the fact that little time has passed since closing applications for financing the projects within the frame of pre-accession and structural funds for the years 2004–2006 and to the fact that part of these projects are still implemented by beneficiaries, it is difficult today to estimate their real influence on increasing innovativeness of SMEs. However it can be stated with full certainty that the manner of programmes' planning and especially the manner of projects' awarding "forced" entrepreneurs to:

– increase interest in the market of new technological solutions and innovations and in research and development,
– and purchase and implement solutions characterized at least by innovativeness on the national level, since only such projects had, de facto, chances to be awarded with funds.

Additionally, a change took place in the SMEs' perception of their own competitiveness and in more frequent belief that the market is won through quality and innovativeness of products and services and not through their price. The availability of pre-accession and structural funds also changed the view of entrepreneurs on the accessibility to exterior funding for innovation.

Anyway as you had a chance to see a moment ago, we should not lack money. There are 9,7 billion Euros planned for the support of innovativeness of the Polish economy from the Operational Programme – Innovative Economy. An additional 4 billion will come from the Regional Operational Programmes. Though, I would like to wish both myself and you that this would happen. It will mean only one thing – that our innovative ideas are more valuable then those 13,7 billion Euros.

Summarizing my speech, I am afraid of only one thing. Namely, that on the way to realization of all those brilliant ideas of use of new EU funds that both scientists and entrepreneurs wait with, will stand bureaucracy – the prolonged procedures of awarding subsidisation. And that before we are able to implement innovative solutions Europe will move forward and we will only defend our 21st position.

Great Efforts for Supporting Small and Medium-Sized Enterprises in China

Prof. Xila Liu
Shanghai Jiaotong University, China

Xila Liu, Professor of Civil Engineering Department at both Shanghai Jiaotong University (SJTU) and Tsinghua University in Beijing (TU), Vice-Chairman of China Committee for the World Federation of Engineering Organizations (WFEO-China), Chairman of International Cooperation & Exchange Committee of China Civil Engineering Society (CCES), Chairman of Engineering Reliability Committee of CCES, Fellow of the Institution of Structural Engineers (IStructE), Fellow of the Institution of Civil Engineers (ICE), and Fellow of the Association for Bridge and Structural Engineering (IABSE), graduated with honor from TU in 1963. He was later issued a Master equivalence in structural engineering at TU in 1965. At Purdue University, he received Master degree (MSCE) in 1982 and Ph.D. degree in 1985. Dr. Liu received the Raymond C. Reese Research Prize by ASCE. In 1999, he received Honorary Doctor from the University of Blaise-Pascal in France. He was also selected to be the Vice-President of IStructE during 1999–2000 in UK. Dr. Liu is the author or co-author of 4 books and around 300 papers. His major research topics include: Constitutive Modeling of Concrete, Safety Analysis of Structures, Durability Modeling of Structures, Knowledge-based Systems for Structural Design and Damage Assessment.

Abstract

In China, the non-government enterprises have become the main body of whole social economy. But the inside situation of the small and medium enterprises in China is unsatisfied. The inside situation is summarized in the present paper and some suggestions, especially on education and training program, to remove the barrier are also given.

INTRODUCTION

At present, the development has come to our attention by all around the world. Since reformation and opening of China in 1978 the economy of China a great achievement in economy has been done. From 1978 to 2005, the GDP has been increased from 147 billion US dollars to 2200 billions, the annual increment ratio around 9.6%. According to the economic sustained development and urbanization process the urbanization ratio has reached 43.9% in 2006 and China has become the most active and flourishing construction area in the world. The construction scale and speed are at the front line in the world. Some top level projects on high dams, highways, long span bridges, high-rise buildings and large span structures are appearing in China. At same time it should also be noted that China is faced with heavy population load, lack of plantation, insufficiency of resources. The average education lever is lower and the pollution situation is getting more serious. Besides, China is always suffering the natural disasters, such as earth quakes, floods and typhoons.

From economic system point of view the original system in China has been changing from planning system to marketing system. Until now the most considerable point is that the non-government enterprises have become the main body of whole social economy. In China, if the vendition income and the assets of an enterprises are less than 6.5 million US$ it is called small enterprises, if the vendition income and the assets of an enterprises are less than 65 million US$ it is called medium-sized enterprises. By the end of 2005, the weight of non-government small and medium enterprises has reached 65% of the GDP in whole country. The number of small and medium enterprises has reached 40 million, which is almost 99.6% of the total number of enterprises in China.

It has been found that the advantages of the small and medium enterprises are evident in marketing system, such as they could use information convergency effect with their craft brothers, they have many implicit contract relations with others, they could use professional division to make more benefit efficiently, and they may share of products, management, and technical skills with their craft brothers. In other words, the small and medium enterprises have more flexibility instead of stability, and more efficiency instead of dimension.

In China some development barriers of the small and medium enterprises have been found. The first is bankroll, and another one is very short life cycle. It seems that the barriers should be removed from both outside and inside. From outside, the center government should establish more laws and policies, which have been partially done. Such as the Facilitation Law for the small and medium enterprises has been published in 2002 and the Real Right Law of the People's Republic of China has also been done in 2007. From inside, however, it needs more long-term education and training for employee. In the present paper the employee situation in the small and medium enterprises in China will be discussed and some suggestions are given. Since the information limitation the author would appreciate the author of Reference [3], who provide many information on the small and medium enterprises in China.

SITUATION

In fact, the inside situation of the small and medium enterprises in China is unsatisfied, which can be described as follows.

(1) In general the necessary education quality of employee is poor and the technical level of products is lower. It is easily to be found most people, no matter they are employers

or employee, are from countryside without enough education and training. They really need necessary scientific and technical knowledge training. On the other side, the lower technical content of products also makes the add-benefit very low. At same time, the quality level is questionable.

(2) They have no modernized vendition concept. The start point of many small and medium enterprises is to consider their own products, the customers who like the existing products, and relative sales promotion methods. In another words, their vendition thought is product-oriented, which may be useful when the whole society was empty of products. Now a lot of excessive products are coming, it requires that the enterprises must consider the customers requirements to design new products. It should also be noted that the marketing system in China is not mature since it is very common people like to emphasize a certain vendition factor and neglect the combination effect of all vendition factors. For example, they may overestimate the advertising effect.

(3) The capital structure is single, which means that, the development of the most enterprises in China is following self- accumulated way. A few of them dare to get into debt. In general they keep development by their own profit. In fact the single capital structure is not efficient to solve the development fund of their enterprises.

(4) The management level is low. Since in most small and medium enterprises in China the employ controls all business, some of them may be in family way. Since the limitation of employ's ability and energy, following the dimension of enterprises growing up, the personal controlled mechanism may not be safe. It is also very often the employs make the decisions usually by their own experiences and direct feelings, which may be much localized. In this case professional researchers on marketing stratagem are needed.

SUGGESTIONS

It should be recognized that the key point for the development of the small and medium enterprises in China is dependent on that if the enterprise is attractive enough for more talents and if the enterprise can keep them for future development. The following suggestions could be considered.

(1) To build up a dynamic organization

In order to encourage employee to be more creative and working harder although the necessary hierachical system is needed, it is also needed to give employee some opportunities and let them to present more suggestions to the headquarters. Of course the final decision will be done by the headquarters, but more information can be collected by employee, which can make the enterprise more adaptable in the marketing system.

(2) To build up the warning mechanism and to strengthen the concept on talents

It should start earlier to build up a talents bank and to give them more practical training in enterprise even at present it seems not very urgent. Thus when the enterprise really needs them they have already become reliable experts to handle the enterprise busyness. It is much better than to hire fresh persons temporarily and in this case the enterprise development should be much smooth. Of course it is more expensive for the talent training; and the well-trained talents may ask more salaries comparing with the untrained ones. The balance should certainly be considered.

(3) To present more opportunities on employee education and training

It is beneficial to combine the objectives on both enterprise development and personal development. In this case each employee can recognize his or her promotion path, which is a very effective prompting. The basic training should include the theoretical training, practical training and computational training. The education should include the engineering analysis, system engineering, and social engineering. Beside, the training on capacity building is also important which includes adaptability, team sprit, creation or innovation, presentation, and organization. It should be noted also the whole program is long-term program. Some courses available are short-term education; more training in practice may need longer term. Certainly the education and training program will make the whole administration system more complex.

(4) To push more excited bonus policy

It is the most direct and effective method, and also the most wide-used method. For example, it may be prescribed that the person, who was responsible for a new product development, could take a certain proportion of profit as guerdon. In this case, a reasonable effective evaluation system is needed.

CONCLUSIONS

China has become the most active and flourishing construction area in the world and China is also facing many challenges. From economic system point of view the original system in China has been changing from planning system to marketing system. The most considerable point is that the non-government enterprises have become the main body of whole social economy. But the inside situation of the small and medium enterprises in China is unsatisfied. Such as, the necessary education quality of employee is poor and the technical level of products is lower; the vendition concept has not been modernized yet; the capital structure is single; and the management level is low. The most important measures to remove the inside development barrier for future development is to build up a dynamic organization, to build up the warning mechanism and to strengthen the concept on talents, to present more opportunities on employee education and training, and to push more excited bonus policy. Simply speaking, the Development of education and training is essential.

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UNIVERSITIES AND INNOVATION

Engineering Enterprises and Innovation for the Millennium Development Goals

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

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

Abstract

The production and application of knowledge in engineering and technology underpins social, cultural and economic development, addresses basic needs and the UN Millennium Development Goals, especially poverty reduction and sustainable development. Engineering knowledge is applied through the introduction and innovation of technology. The production of knowledge in engineering relates particularly to universities and associated research and development institutes, and knowledge application is often most effectively achieved through small and medium-sized industrial enterprises. In developing countries, the production and application of knowledge is often constrained by limitations in their innovation systems. There are, in general, limited numbers of universities and research institutes, with limited linkage between them, limited industrial infrastructure, and limited linkage between universities, research institutes and industry. This paper will discuss this situation, and what can be done to develop and promote innovation

at universities, research institutes, small and medium-sized industrial enterprises, the linkages between these institutions and associated policy instruments.

ENGINEERING, ENTERPRISE AND INNOVATION

Engineering and technology underpin sustainable social and economic development. Most small, medium and larger enterprises are based on technology and innovation. Innovation relates particularly to technology, and the introduction of technology that is new to the user and user-group. Engineering enterprise and innovation are essential for addressing the UN Millennium Development Goals (MDGs):

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

ENGINEERING ENTERPRISE AND THE MDGS

Engineering enterprise is vital in addressing the MDGs, especially poverty reduction, at two levels:

Macro–economic/infrastructure development,
Micro-level direct applications.

At the macro level, engineering enterprise supports economic, industrial and infrastructure development. At the micro level, poverty is a reflection of the limited access of people to knowledge and resources to address basic needs in such areas as water supply, sanitation, housing, food production, energy, transport, communications, income generation and job creation**.** At the direct, micro level, engineering enterprise and innovation are vital to address such basic needs. Micro-enterprises generate micro-innovation and the need for micro-finance.

KNOWLEDGE, INNOVATION AND DEVELOPMENT

Interest in knowledge societies and economies and innovation goes back to the 1960/70s and such studies as "Wealth from Knowledge: A Study of Innovation in Industry" (Langrish et al, 1972). Current interest recognises the need for knowledge generation and applications for development in developed and developing countries.

The importance of knowledge in social and economic development has been emphasised at the flowing fora and reports:

World Summit on the Information Society, Geneva, Tunis

World Summit on Sustainable Development, Johannesburg, 2002
World Conference on Science, 1999
World Engineers' Conventions – 2000, 2004 and 2008
Decade of Education for Sustainable Development, 2005–2014
UN Millennium Project Task Force report: "Innovation: Applying Knowledge in Development"
Commission for Africa, report: "Our Common Interest"
InterAcademy Council, report: "Inventing a Better Future: a Strategy for Building Worldwide Capacities in Science and Technology"

The InterAcademy Council report emphasized that "we need capacity building in engineering, science and technology (EST) and innovation". Increased interest in innovation and development has also been acknowledged at the G8 – including the Gleneagles commitments on aid, debt relief, export subsidies, development of infrastructure and education in 2005, the African Union Summit on the theme "Science and Technology and Research for Africa's Development" in 2007 and the New Partnership for Africa's Development (NEPAD) programme on science and technology. At UNESCO there is also the Forum on Higher Education, Knowledge and Research, supported by the Swedish International Development Assistance programme.

INNOVATION FOR POVERTY REDUCTION

The role of technology and innovation in development and poverty reduction has been emphasised by the leaders of intergovernmental organisations and the private sector:

> *I challenge all of you to mobilize global science and technology to tackle the interlocking crises of hunger, disease, environmental degradation and conflict that hold back the developing world.*
>
> *Kofi Annan, former UN Secretary-General, 2002*

> *Engineering and technology is vital for development, we need to promote international commitments for engineering and technology to contribute to lasting development around the world.*
>
> *Koďchiro Matsuura, Director-General of UNESCO, 2000*

> *Technology is the key, the essential enabler.*
>
> *Bill Gates, Microsoft, 2006*

The avoidance of poverty and is also a basic human right, and living in poverty is a denial of human rights. As noted in the UN Committee on Social, Economic and Cultural Rights (2001):

> *...poverty may be defined as a human condition characterized by sustained or chronic deprivation of the resources, capabilities, choices, security and power necessary for the enjoyment of an adequate standard of living and other civil, cultural, economic, political and social rights.*

Engineering, science and technology are vital in addressing poverty and there is a right to knowledge in these areas, as outlined in Articles 26 and 27 of the Universal Declaration of Human Rights (Paris 1948):

> *Technical and professional education shall be made generally available and higher education shall be equally accessible to all on the basis of merit (A26).*
>
> *Everyone has the right … to share in scientific advancement and its benefits (A27).*

INNOVATION – HI-TECH AND LO-TECH

Innovation and engineering applications not only relate to hi-tech applications, but include the introduction of technology that is new to the user and user-group. This includes, for example, the development and introduction of a new foot-operated water pump for African farmers (Kickstart "Super-MoneyMaker" pump) and the 'Ujeli' stove with thermo-electric generator in Nepal (Sustainable Technology Adaptive Research and Implementation Center, Nepal, a winner of the DaimlerChrysler-UNESCO Mondialogo Engineering Award):

DRIVERS OF INNOVATION FOR DEVELOPMENT

Promoting engineering enterprise and innovation for development and poverty reduction relates to science and technology policy, and to the inclusion of engineering, science and technology issues in economic and financial policy. In developed countries this involves established interest and lobby groups and "policy drivers" and policy instruments. In developing countries interest and lobby groups, policy drivers and instruments may be less active and well defined, and include internal and external sources – such as donors and intergovernmental agencies. In the context of innovation and development, it is important that engineers are better engaged into this process.

Policy instruments promoting engineering enterprise, innovation for the MDGs include, particularly, Poverty Reduction Strategy Papers (PRSPs) and associated mechanisms for debt relief. Having a policy is only part of the story, however, and the implementation of policies and PRSPs is of obviously equal importance. Policies need effective implementation strategies. There is also a need for science, engineering, technology and innovation policies and better integration of such policies with broader economic and financial policy, need for better linkage of engineering and innovation with development and poverty reduction and the need to share good practice in these areas.
Engineering enterprise is vital in the process of technological innovation, and innovation is also a social process. Poverty reduction should therefore focus on enhancing the access of people living in poverty to knowledge and resources in engineering, through information, innovation and capacity-building at the formal and informal levels.

CHALLENGES FOR ENGINEERING

The main challenges for engineering, enterprise and innovation in addressing poverty reduction and the MDGs relate to:

- human and institutional capacity/capacity building
- social, economic and infrastructure development
- micro-level direct applications
- providing information and knowledge (to bridge knowledge divides)
- promoting international cooperation
- need for future/foresight awareness and preparedness

There is increasing concern around the world regarding the decline in the interest in and number of young people going into engineering. This will have serious consequences for future human resource capacity in engineering and constrain social, economic and infrastructure development, particularly in developing countries. These points have been emphasised at various international fora, including the World Conference on Science in 1999 and the World Engineers' Conventions in 2000 and 2004, and the World Summit on Sustainable Development in 2002.

The decline of interest of young people, especially young women, going into engineering is a particular challenge for engineering education. This decline appears to be due to the following factors:

- engineering is uninteresting, boring
- university engineering courses are hard work
- engineering jobs are not well paid
- engineering has a negative environmental impact

There is an associated need to make university courses more interesting, and includes various approaches regarding the reform of engineering education in such areas as learning materials, curriculum development and continuous professional development, and in standards, quality assurance and accreditation.

The re-engineering of engineering education is also required in order to respond to rapid change in knowledge and the need for synthesis, including issues of ethics, social responsibility, professional practice, applications, innovation, awareness and foresight. There is also an increasing need to learn how to learn – in such areas as lifelong learning, CPD, adaptability, flexibility, interdisciplinarity, multiple career path and just-in-time approaches. A cognitive, knowledge-based approach is required that emphasises experience, relevance, applications, problem-solving, activity- and project-based learning in a teamwork context.

Other, related, challenges that require addressing include the need to re-focus engineering to promote the following issues:

- public understanding of engineering
- equity, participation, women/gender issues
- engineering ethics, codes of practice
- engineering and innovation policy and planning
- engineering applications/innovation for development
- engineering as part of the solution, rather than part of the problem

Failure to address these challenges will lead to borders without engineers and the failure to address the MDGs, reduce poverty and promote sustainable development.

ACTIONS AND OPPORTUNITIES

Actions and opportunities for engineering include the promotion of public interest in engineering through the achievements of engineering to reduce poverty, address sustainable development and the other MDGs. Such achievements include, for example, the work of the Mondialogo Engineering Award, Engineers Without Borders, Engineers for a Sustainable World and Engineers Against Poverty.

Some challenges and needs are related in a simple solution: promoting engineering for poverty reduction and sustainable development attracts young people to engineering and helps address the MDGs and major issues for engineering.

In conclusion, it is important to reiterate that engineering enterprise and innovation are of vital importance in addressing the MDGs, especially poverty reduction and sustainable development. Engineers and the engineering profession need to get more involved in lobbying, advocacy, policy-making and implementation. We need to re-engineer engineering education to promote interest, capacity and relevance, and to promote engineering.

As the Chinese proverb says – "Give a person a fish – feed them for a day, teach people to fish and feed them for life". Such an approach in engineering will help human and institutional capacity building, and will also help address basic needs and promote poverty eradication, sustainable development and the other MDGs and international development goals.

Universities and Enterprises: Toward a Closer and Effective Cooperation

Antoine Abche, Ph.D.
Prof. Abdel Menhem Alameddine
Federation of Lebanese Engineers, Lebanon

Antoine Abche received the B.Sc. Degree and M.Sc. degree in Electrical Engineering from the University of Toledo (USA) in 1984 and 1986, respectively. He received the Ph.D. degree in Biomedical Engineering from Rutgers The State University (USA) in conjunction with the University of Medicine and Dentistry of New Jersey (Robert Wood Johnson) in 1996. Currently, he is an associate professor in the department of electrical Engineering at the University of Balamand. Also, he is the chairman of the Science Committee of the Federation of Engineers in Tripoli, Lebanon since 2006. Dr Abche's research interests are: Virtual Reality, DSP, Image Processing, Analysis and Classification, Telemedicine, Image Registration, Neural Network, Fuzzy Logic, Modeling and System Identification. His interest extends to the improvement of the profession of Engineers.

Abdel Menhem Alameddine received the B.Sc. Degree in Electrical Engineering and M.Sc. Degree in Engineering Management from the University of Southwestern Louisiana (USA) in 1977 and 1981, respectively. He is a Lecturer in the department of Computer Engineering at the University of Balamand. Also, he is the President of The Order of Engineers and Architects – Tripoli, Lebanon, and the Vice-President of the Federation of Engineers in Lebanon since 2005.

Abstract

Bringing Universities closer to the business world provides a support to the small and medium size companies (also large size). This is achieved through:

1) *Creation of an Interface between universities/world business that acts as a platform of information exchange,*
2) *Initiate and provide support for students projects that are common interest to both, university and industry,*

3) *Encourage and sponsor medium-term and long-term joint research projects in common areas of interest,*
4) *Share equipment and facilities between the partners,*
5) *Support and participation in Continuing education programs in a world in which the technologies are very rapidly changing. Consequently, the learning has become a continuing process or a lifelong process,*
6) *Organize conjointly periodic seminars and workshops,*
7) *Cooperation between the universities and world business through consulting,*
8) *Establishing industrial/scientific parks ("Technopole"), which can be a base for incubating enterprise startups and nurturing entrepreneurs.*

I. INTRODUCTION

Nowadays, we are living in a world in which the information, knowledge and technology have become indispensable to the progress of a country at all levels i.e. society, educational, economical, etc. A closer look reveals that the industrialized countries of the world owe the story of their success, partly to the advancement accomplished in the technological field and its agility on one hand, the importance placed on the research department within the enterprise and/or the effective cooperation between the companies, the universities and research institutions in terms of research and development on the other hand. Furthermore, the future of the country, its economical growth and the survival of its enterprises may depend on the ability of the country to link the companies, particularly the Small and Medium-sized Enterprises (SMEs) in an efficient, effective and successful way to the higher educational system. At the same time, this should be accompanied with the desire of the universities to broaden their academic interests [1] that will respond to the needs of the society and the country. Also, the enterprises, especially the SMEs, should be willing to create a long lasting and effective cooperation with the universities, which will strengthen their capacities.

For example, over 80% of the Lebanese companies can be considered as Small size enterprises. Each company has less than 20 peoples on their payroll. Thus, the human and financial (capital) resources are limited, especially if the economic situation of the country is taken into consideration. Furthermore, the capacities of large size companies are not available to the Small and Medium size Enterprises. The immigration of engineers abroad, where the salaries are much higher, aggravates the problem. Consequently, by incorporating into this picture the international economical and political relationships between the countries, a person can have a good idea of the problems faced by such companies to compete and survive in these days. Therefore, the effective linkage of the universities and the SMEs becomes of great importance to the survival of the latter.

In this framework, this paper presents some steps on how the Universities and the enterprises are brought closer to minimize the gap that exists between these institutions and to forge stronger links between them. Consequently, this step could provide a good support for the SMEs to acquire the required technological knowledge and information that could play a valuable role in providing a competitive advantage, especially in the technological field, that could be sustained. In this regards, this relationship is one aspect that is needed to help such endeavor and bringing it to a success. Other aspects could involve a venture capital for a company start-up such as a high tech start-up [3] especially if the product is complex, several types of cooperation between various institutions/ companies at different stages during the lifecycle of the company if the product is small and is targeted to a niche market [4] or by a combination of cooperation and competition in conjunction with e-business [5]. Others have relied on a model to create a Virtual Enterprise (VE) in order to make SME as much as competitive as a large size Enterprise in a particular region of a country [6]. Other aspects that could lead to success includes the level and type of a government support and the effective-policy measures that are enacted to facilitate the endeavor, and the level of the financial support by the government as well as the financial institutions (such as Banks etc.) to encourage small and medium enterprises to flourish, continue their progress and increase their competitiveness. Besides, needless to say, the effect of the mechanisms, which stimulate innovations and should be in place by government, SME and all related institutions. However, the SMEs should assess the level and the core of the cooperation, especially with other companies.

In this paper, several points that strengthen the cooperation between the Universities and SMEs are addressed and discussed. They include: the interface between the university and the enterprise/company (section II), Small term cooperation (section III), Midterm and long term cooperation (section IV), sharing facilities (section V), Continuing Education Program (section VI), the organization of Seminars and workshops (section VII), Consultancy (section VII), the creation of Technopole/Science Park (section IX).

II. INTERFACE

A first step to increase and consequently, to strengthen the capabilities of a particular SME is the creation of an interface between the two concerned institutions: an university and a company. This will alleviate the stereotyping that a SMB is often having a problem in communicating with the academic world and vice versa. Actually, no positive cooperation could exist between any two institutions if the concerned parties do not understand each others, do “not speak” the same technological language of interest and do not communicate effectively. In other words, the company should understand the educational system of the university with which the cooperation is to be forged, their points of strength and what it can offer to enhance the technological capabilities of the enterprise in the field of interest. Similarly, the university should understand what the company/industry provides/produces, its aims, its human resources, capabilities, the requirements and needs to fulfill its goals. Thus, the interface should be a platform to exchange information and communicate ideas through meetings and discussions to have at least a common understanding of the problems to be addressed and to be solved. This interface can play a constructive role in the identification of the problems; recognition of the needs and consequently it can lead to a valuable cooperation and guidance. Therefore, the meetings should be held regularly and the visits to their respective facilities are recommended to keep track of their respective technological advancements. Also, a similar mechanism can be implemented if a multi-lateral cooperation is forged i.e. several universities and companies.

Since the committee is made of individuals, the latter should speak the same technological language to get the most of the cooperation for the benefit of both parties. That is, they should have similar qualifications so that they can relate and understand each others. This should be coupled with common and/or complementary perceptions to tackle the problem at hand. Furthermore, common attitudes are another component characterizing the individuals forming the interface to further strengthen the cooperation between a particular enterprise/industry and the university. Thus, this could be the first block in building the trust between the two institutions toward a suitable and sustainable cooperation.

Similarly, this relationship is further enhanced and strengthened by extending the bilateral cooperation into multi-lateral cooperation among the various universities and companies/industries.

III. SMALL TERM COOPERATION

Due to the lack of resources, a SME may not have the capacities to keep track of the state of the art in the technological field of interest. At first, this shortage can be addressed through small term cooperation. That is, small and common projects, at the undergraduate and graduate levels, can be initiated and supported by both parties. This type of cooperation could also involve practical training (“stage”) within the company. The practical training has become a principal component for the student to acquire his degree. The duration could be between 3 and 6 months. A strong emphasis should be placed on the joint accomplishment of the work, in conjunction with a follow-up by the university and the SME to analyze, evaluate and enhance the cooperation at all levels.

In this framework, a scheme similar to the “Service Education: Experience through Doing (SEED) program”, implemented by the University of Balamand, can be extended, with appropriate adjustments, to SMEs. That is, the SEED program is created to provide technical and information supports to civil entities and the society at large such as municipality, Red Cross, etc. In this context, the student will acquire one credit toward his degree if he performs 40 hours of service. Thus, in this manner, the civil entities that do not have the required resources (human, capital, technological, etc.) could depend on the University through this program to acquire the expertise and perform the required task.

Furthermore, this short-term cooperation could provide a pool of students or interns from which the SME can recruit their future employees. In this manner, the SME becomes more familiar with the university, more aware of its capacities and the competence it can offer. On the other hand, the University becomes more aware of the needs of its partner. This common understanding would strengthen the trust between the two parties. Also, this would increase the awareness of SME on the importance of the Country’s youth in the future of their survival.

IV. MEDIUM AND LONG TERM COOPERATION

This level is reached if the Short-term cooperation is fruitful and the level of trust is increased between the partners. Also, it requires that the SME have the concept and he aggressiveness to promote research and development through innovative-policy measures, which could have a stimulating effect on the SME. At the same time, the university should be ready to broaden its interests. This could lead to a long lasting relationship between the two establishments.

The external research and development companies could be proven to be expensive for a SME. Thus, medium-term and long-term joint research projects in common areas of interest should be encouraged and sponsored with the university. This cooperation can manifest itself through a master thesis or a Ph.D. dissertation. This can also be as an extension or a continuation of the work of the student who was a trainee at the corresponding enterprise/industry, provided that he is capable of performing the work and have acquired the necessary knowledge. Consequently, this occasionally would lead to an inexpensive solution to the task addressed by the enterprise or by both parties. In other words, it can be seen as a cheaper alternative in comparison with the acquisition of the same expertise from external companies. Otherwise, the SME cannot proceed with its advancement and becomes competitive if it does not have the required resources.

Thus, in this manner, a SME could extend its research capacities and increase its specialized knowledge without placing large expenses that could disrupt its normal activities. Furthermore, the tasks could be achieved faster and cheaper than if the work is performed based on their own resources, which could place the stability and the growth of the company in jeopardy.

V. SHARING FACILITIES

Since the visions of the universities and SMEs are different, the equipments and corresponding facilities are acquired accordingly. While one vision is centered on education and research, the company’s vision is based on profit and production. For example, while the company can buy a large machine for line production, the university could acquire a small prototype for educational, training and research purposes. Having the same interests, the facilities can be viewed as complementary and sharing the corresponding resources should strengthen the cooperation. That is, researchers, students and staffs from the university should be given access to the allowable documentation, equipments and facilities of the company and vice versa.

VI. CONTINUING EDUCATION PROGRAM

Since we are living in a world in which technologies are very rapidly changing, the learning has become a continuing process or a lifelong process. In this context, small and medium size enterprises/industries may not provide their engineers and staffs with the possibilities to pursue such advancement due to the lack of human resources or the associated high cost. Therefore, continuing education programs or professional advancement courses should be devised and developed in academia with the future vision of the company in mind. The courses should be presented in an effective manner with a set of laboratory experiments to acquire the desired technological knowledge and information. This underlines the fact that the company has found a suitable university that is a leader in the field. Development of such programs requires a close relationship and cooperation between the university and the particular enterprise/industry so that the program addresses effectively and efficiently the requirements, the educational and training needs of the latter.

Thus in this framework, a Small or Medium sized company can bring its employees up to the level in any particular field, renew their knowledge and information, acquire the needed tools to compete in the world of today. However, this step mainly depends on the innovative behavior of a company and the orientation and/or behavior of the people in charge as well as the eagerness of the employee to learn and to be competitive.

VII. SEMINARS AND WORKSHOPS

The universities have forged cooperation and collaboration with other research institutions and universities abroad to further advance their educational systems and their research capacities. They are in a position to track the state of the art of technology in the field of interest. Thus, the universities can easily transfer the scientific knowledge and technology to their country i.e. especially to the local enterprises/industries in particular, and to the country in general. The transfer of technology can be achieved through common projects that they have jointly accomplished over the past years, the projects that are in progress or through the preparation of future projects. In this regard, they can prepare and organize with their colleagues abroad and the SMEs within the country periodic seminars and workshops. The themes can be selected such that they are of interest to all parties and are in the strategic planning of the small or medium size enterprises.

VIII. CONSULTANCY

The SMEs have the objective to advance, flourish and implement ideas that will ensure their stability, their survival and their economical growth. They are always looking to work on a particular venture. Therefore, the success of such task could require the expertise and the competence that SMEs do not have. Besides lacking the resources (human and capital), the endeavor will be expensive if they acquire the expertise from a consulting firm in the field. Therefore, it can be affordable and less expensive if the consultancy is acquired from the university with which they have a partnership. Thus, the cooperation through consultancy, which is recognized as an excellent means of useful interaction, must be encouraged.

IX. TECHNOPOLE

The establishment of industrial/technology/scientific parks (“Technopole”) can be a place to incubate enterprise startups and small businesses, and to nurture entrepreneurs. It is a valuable approach to facilitate the technology transfer and help the starting up of a new venture business in general as well as high technology enterprises in particular [7], [8]. The creation of such “techno-pole” underlines the fact that the scientific research leads to technological innovation. The research could be done at universities and their research facilities, research institutions or centers, and research department within companies.

The goal of such parks is not to do research and consequently becomes like the other research institutions. Its main objective is to promote the applications of the research, the implementation of new and leading-edge technologies and break-through discoveries and consequently to close the gap between the development of basic research and its commercialization. In other words, it could play a role of catalyst among the various partners: the universities, the research institutions and companies. Even though the percentage is smaller, it should be pointed out that also experimental development could also lead to innovation and consequently to the creation of venture business [9], [10]. In the same context, there are some researchers who have proposed a model to prioritize the directions of the Science/ technological park for future development based on different changing conditions, specifications and requirements [11].

Furthermore, if all related partners (universities, research institutions, government, etc.) support startup companies, the success of such endeavor could be as high as 50% [12]. Needless to say, what this success could bring in terms of profits, creation of jobs, opening of new markets, development of new ideas, and pushing the technology further ahead.

X. CONCLUSION

The cooperation between universities and Small and Medium size Enterprises/industries can be a crucial source of technological innovation that could bring competitiveness to companies and national economies. It can be a valuable factor to their survival in this technological age. It will enable enterprises/industries to face and confront in a shrewd and more efficient manner their needs on the professional level on one hand, and the universities to orientate in an effective and efficient way their students on the other hand. This depends mainly on the innovative behavior of the company, its willingness to make the necessary changes to fulfill its goals, how much the company is willing to engage in an effective and efficient manner and the behavior of the people, especially, who are in charge. At the same time, universities should be ready to broaden their academic interests and create some niches (technological, etc.) that will respond to the needs of the society and the country. Consequently, certain dynamism can be attained by the SMEs and the latter could become sustainable entities in the economy of a nation.

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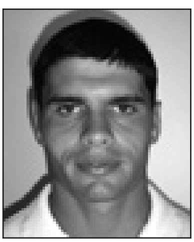
Brazilian Experience on Supporting Engineering and Technological Innovation – the Cooperation University-enterprise and its Effects on the Creation and Development of Small and Medium-sized Business

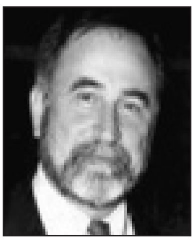
Eng. Gerson Luiz S. Lerner – Hydroelectric Consulting Private Enterprise
Prof. Leizer Lerner – Director of FEBRAE
Prof. Paulo Alcântara Gomes – President of REDETEC



Eng. Gerson Luiz S. Lerner – Civil Engineer graduated "Cum Laude" at the Polytechnic School – University of Brazil – UFRJ (Rio de Janeiro). Under Graduated Specialization Course: Water Resources and Environment. Post Graduated Specialization Course: Environment Management (UFRJ). Master Degree: Environment Management (Energy Management Program COPPE/UFRJ). Conferences: Public Contest Prize: ICOLD 2003 (International Convention on Large Dams), Montreal, Canada. Selected paper – UNESCO – presented WFEO/WEC 2004 (World Engineers Convention), Shanghai, China.

Prof. Leizer Lerner – Graduation: Civil Engineer (1955) at the National Engineering School (University of Brazil). Post-Graduation: Holland (1956), Brazil (1958, 1986), and France (1959). Professional Career: Planning/Construction of commercial and housing buildings. Director of a buildings and public works enterprise. Supervisor of a consulting enterprise on civil engineering. Member of the State Highways Council. Head of the Standards office at the Land Reform Institute (Republic Presidency). Professor Career: at the National Engineering School (University of Brazil) – Regency of several disciplines of the Civil Engineering Course. Head of the Department of Transports Engineering. Member of the University Council. Research Activities: Specialist on Soil Mechanics and Pavements at the National Research Council. Conferences: More than 30 as lecturer (some published). Papers: about 50, in journals and magazines, some other 20 in national and overseas Congresses, Meetings and Workshops. Engineering Societies: Alumni Association of the National Engineering School – Honor President, after 30 years as President and Vice-President; Engineering Club (Rio de Janeiro) – Director and Standing

Member of the Council; Brazilian Federation of Engineers Organizations (FEBRAE) – Vice--President and Member of the Council; Brazilian Association of Professionals Specialized in France – President and Standing Member of the Council; Brazilian Association of Engineering Education (ABENGE) – Member of the Technical-Scientific Council; World Federation of Engineering Organizations (WFEO) – Member of the Executive Council; International Association on Continuing Engineering Education (IACEE) – Member of the Executive Board and Member of the Council; Pan-American Academy of Engineering – Charter Academician and Treasurer of Engineers Organizations (FEBRAE) – Vice-President and Member of the Council; Brazilian Association of Professionals Specialized in France – President and Standing Member of the Council; Brazilian Association of Engineering Education (ABENGE) – Member of the Technical-Scientific Council; International Association on Continuing Engineering Education (IACEE) – Member of the Executive Board and Member of the Council; Pan-American Academy of Engineering – Charter Academician and Treasurer.



Paulo Alcântara Gomes, Master of Sciences and Doctor of Science in Civil Engineering, in the field of Structural Analysis. Retired Professor and former Rector President) from the Federal University of Rio de Janeiro, currently is the Rector of Universidade Castelo Branco. He is also President of the Technological Net of Rio de Janeiro (RedeTec). Until July, 1994, he was the President of the Council of Rectors of the Brazilian Universities (CRUB). He is a member of two Brazilian academies: Brazilian Academy of Education and National Academy of Engineering. He is also a member of the Portuguese Academy of Engineering and of the Panamerican Academy of Engineering. From April, 2004, Paulo Gomes is one of the five Brazilian active members of the Club Of Rome, which mission is to act as a global catalyst of change that is free of any political, ideological or business interest. He has published 110 works on the Theory of Elasticity, Structural Dynamics, Theory of Plates and Shells and Utilization of Numerical and Computational Methods in Structural Analysis, and recently, subjects related, to Technological Innovation, to Science and Technology Policies, Engineering Education and University Management. He provided guidance for 28 Master and D.Sc. thesis on the aforementioned subjects. He has been awarded several commendations and prizes, among them the "Vector de Oro" awarded during a meeting of UPADI (Pan-American Organization of Engineer Associations) held in Costa Rica in 1996, the National Scientific Medal of the Brazilian Government, the Brazilian Medal of the Cartographic Order of Merit, also as "Commendator", the Order of Academic Palms, granted by the French Government, as "Chevalier", and "the Manuel Rocha Prize", granted to distinguished European and World engineers by the National Laboratory of Civil Engineering, Lisbon, the Government of Portugal.

Abstract

Since the beginning of Brazilians' Master and Doctorate Courses in Engineering (1961) some efforts to approach University and Industry have been done to increase small and medium-sized enterprises competitiveness. In the very beginning, the Brazilian articulation University-Industry programs stimulated Universities to contract specific research, to promote activities to better capacitate engineers and technicians, and to give access *to their modern Laboratorial resources, with the main target of supporting enterprises necessities. Nowadays, there are University networks which facilitate the participation of great number of professors and researchers, building up a new culture centered in the addition of value to goods produced mainly by small and medium-sized enterprises. Those human resources cooperate with the small and medium-sized business so they become able to technologically upgrade their products quality. From the historical evolution of University and Business fields approach, this paper reports the actual situation enhancing the enterprises incubators and technological parks and the intense search of innovation – most recently the intensive introduction of a modern concepts: the management of knowledge. Finally, success cases are presented linking Business to some Brazilian Federal Universities, such as the biggest one – UFRJ, in Rio de Janeiro.*

Key words: *Brazilian experiences; Innovation; University-business programs; Added value.*

I. INTRODUCTION

The current work is generic and introductory to other 2 of the total of 3 papers presented to the seminar "Supporting Small- and Medium-Sized Enterprises in Engineering and Technological Innovation Activities", organized by the Standing Committee on Education and Training of the World Federation of Engineering Organizations. This paper aims to offer a panorama on the relations among University-enterprise in Brazil, emphasizing the crescent importance of Universities in forming an Entrepreneurial culture, by education and empowerment of technical and Scientific boards, as through the installation of enterprise incubators and technological parks. The data presented below are an introduction for the following documents, where it will be discussed motivation policies for the articulation University-enterprise, the engineering courses insertion in this environment of articulation and the practical example of Rio de Janeiro State (one of the most important States of Brazil).

II. A LATE BEGINNING OF HIGHER EDUCATION

Brazil can be considered a country with late higher education. Unlike most of the Latin American countries, the first Universities in Brazil were only implemented at the closing of the XVIII century and the first University was settled in 1920, through the consolidation of 3 traditional and independent Colleges: Medicine, Engineering and Law. Those assembled Schools were the pillar of the actual Federal University of Rio de Janeiro, one of the most expressive in the country.

The development policies adopted in the 50's were determinant for the extraordinary growth of the industrial park in the country and strongly contributed for the University education expansion. Nowadays, Brazil counts on 158 Universities and around 1500 other non University organizations, equally dedicated for superior education.

At the same time, with the crescent demand for high school level technicians, a professional education policy was consolidated. This policy was divided into three different sponsors:

a first one financed by the republic government, an other one financed by the states and, finally, a third one financed by the associations joining 3 groups – service and commerce, industry and technology, and agriculture sectors.

This Network acts simultaneously by the formal education, offering professional courses and pos-high school courses, as well by informal education, through courses of qualification and knowledge updating. This Network is certainly responsible for the big raise of the Brazilian enterprise competitiveness and it characterizes one of the most efficient ways of articulation University-enterprise nowadays.

III. THE ENTREPRENEURIAL CULTURE IN BRAZIL

A determining aspect for the development of "Entrepreneurial culture" programs have origin on the technological development model adopted by Brazil in the late 60's by which, following the Iberian tradition, Universities were identified as the main source of technological development. Few exceptions: in the agriculture field (Brazilian Agro and Cattle Company – EMBRAPA), in the power sector (big state enterprises, such as Brazilian Oil and Electrical Company, respectively PETROBRAS and ELETROBRAS), and finally in some recently privatized enterprises (such as the Brazilian Aeronautical Company – EMBRAER, in the aeronautical sector).
For this reason, from the 70's on the public resources designated for innovation and Brazilian technological development were concentrated in forming Masters and Doctors, almost all from programs developed by Public Universities.

Despite of that effort, few masters and doctors migrated from the scientific activity to the field of innovation or technological development in industry. So national production in indexed magazines increase in significant way (figures 1 and 2), but resulted in a weak performance in patent generation.

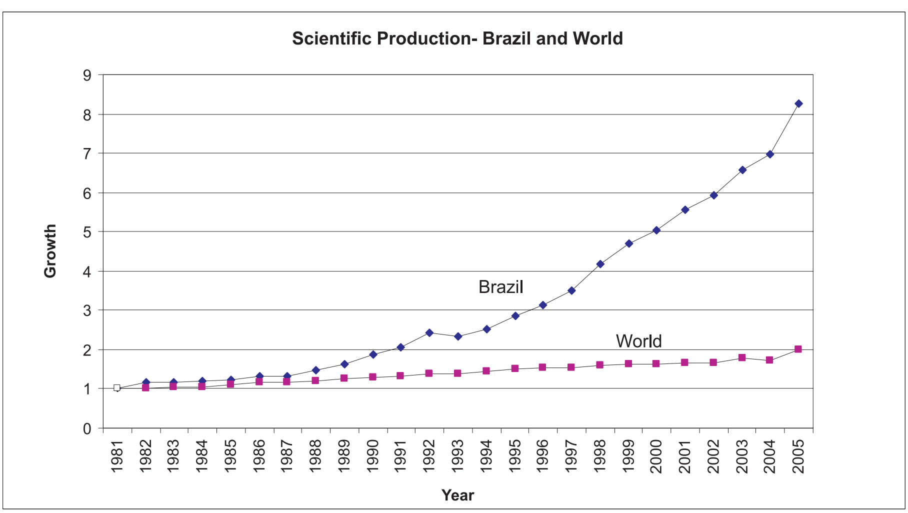


Figure 1 – Growth of Scientific Production- Brazil and World- 1981–2005

Year	Brazil	Latin America	World	% of Brazil in relation of the Latin America	% of Brazil in relation of the world
2000	9511	22589	714171	42,10	1,33
2002	10618	23574	729328	45.04	1.46
2004	12089	24823	745081	48.70	1,62
2006	13328	25343	770404	52.59	1,73

Figure 2 – Number of issued articles in international indexed magazines

As a consequence of the adopted model, although reaching good results in scientific research production, we were not already capable to respond to the needs and demand of Brazilian enterprises.

Let us take as comparison example South Korea. In the early 80's, that country applied around the same amount of resources in science, technology and innovation as Brazil, but directed those resources to the enterprises. It resulted (2001–2006) around 19395 patents in United States, while Brazil registered only 368. Recent data shows the high difference of production in favor of countries with same economic dimension as Brazil – in this sector, nowadays, Brazil occupies the modest 49th place in the international scenario.

It is important to notice, considering the actual world economic context and in reason of the crescent advances in science and technology, the most profitable products for the producing countries are those with added values in technological innovation. Although, we must always recognize that, in the knowledge society, in which we live, frequently appears new types of "commodities" as a result of the effort of each nation in developing new technologies and in producing scientifically.

In the last 15 years there has been a practice of the Brazilian government to generate a space allowing more presence of academic community in program that enable, from one side scientific and technological advances, which are determinants for the countries' progress, and in the other hand more interaction with such segments of industry, commerce and services, technology and agro-business, capable to assure the required standards of competitiveness for the effective insertion of the Brazilian enterprises in the international business flow.

In this direction, several actions were achieved during the 80's. For the first time the Brazilian Ministry of Science and Technology worked in this new direction. This actions are very well exemplified by: (1) the beginning of the PADCT – *Support Program for Scientific and Technological Development*, in partnership with the World Bank, during the 90's, supporting the installation of *technological parks* and *enterprise incubators*; and (2) the implantation of the "Sector Funds", at the end of the 90's, almost reaching the XXI century, which was very important in the establishment of technological innovation policies. Those Sector Funds are constituted with resources from big enterprises, private and governmental, linked to many considered priority areas for the National Economy, such as: oil, telecommunications and infra-structure.

Since the mid 90's it became imperative to redirect the articulation University-enterprise, creating devices to accelerate the enterprise competitiveness and its insertion in international business flow. The generation of Entrepreneurial culture started to be determinant for the success of initiatives that allowed obtaining results in local development, as in attending new globalization demands. Taking academics to Entrepreneurial initiatives is, today, one of the priorities for the technological and industrial development.

The motivation policies for creating technological parks, enterprise incubators and *"junior-enterprises"* in Universities started to be object of expressive support by fomenting Agencies to Science, Technology and Innovation and by SEBRAE (Brazilian Small and Medium Enterprises Institute). Consequently, today, there are 339 enterprise incubators (Images 1 and 2) and 42 technological parks, mostly located in the South and Southeast regions of the country (Image 3) and related to Universities, almost all public (Image 4).

We can so verify that the role of the Universities in creating a network of micro and small enterprises of technological base, as well the increase of national competitiveness, is very relevant for Brazil.

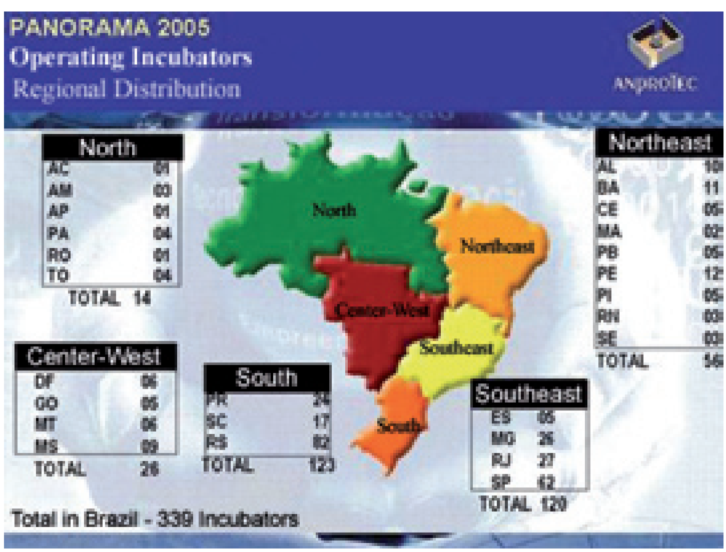


Image 1 – Operating Incubators – Brazil l

ANPROTEC – National Association of Promoter Entities for Innovator Achievements

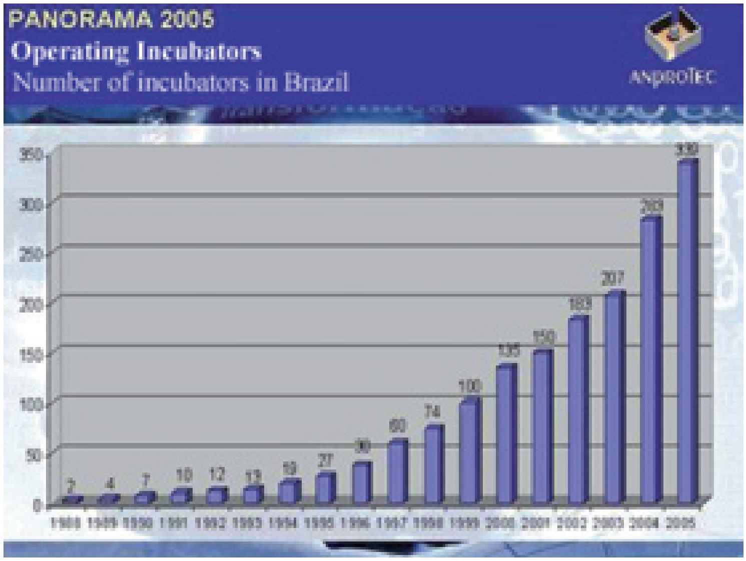


Image 2 – Evolution of Incubators in Brazil
ANPROTEC – National Association of Promoter Entities for Innovator Achievements

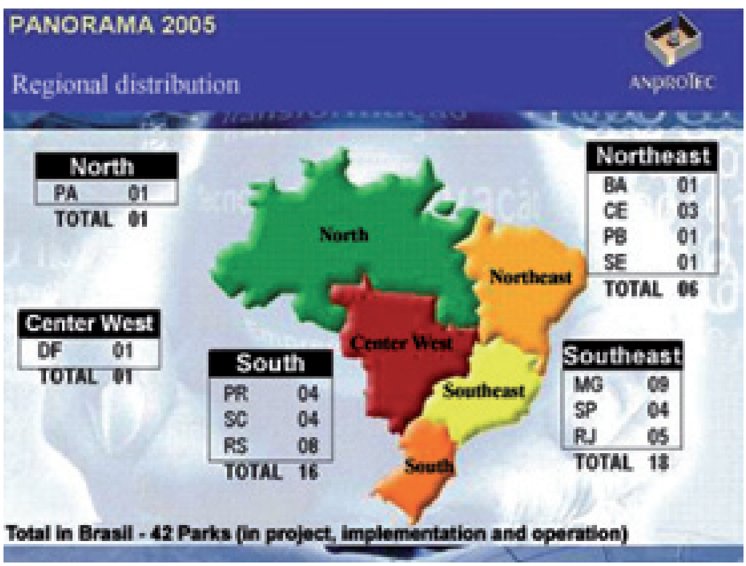


Image 3 – Technological Parks in Brazil
ANPROTEC – National Association of Promoter Entities for Innovator Achievements

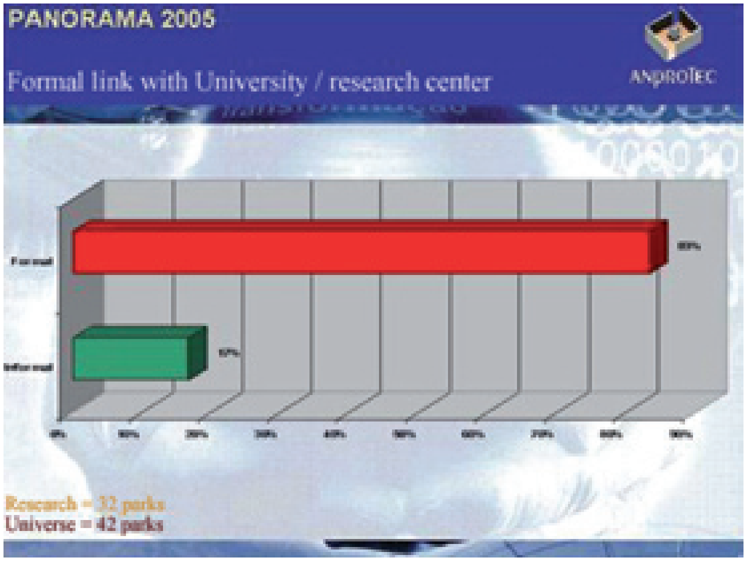


Image 4 – Formal Link to University / Research Center
ANPROTEC – National Association of Promoter Entities for Innovator Achievements

The incubators implementation process has been very important to create an effective entrepreneurial culture. Started in the end of the 80's, these organizations motivated the migration of technicians and researchers for the private sector and, at the same time, an increase in qualification actions of entrepreneurship.
Consequently, today, we verify a crescent presence of Entrepreneurial educational programs in all Universities and institution of superior education. The Entrepreneurial education requires an effective student participation, in programs typically called "hands-on". The motivation model to create *Junior Enterprises* has been successful in creating entrepreneurship and the incubators. Also, technological parks have resulted in important motivation for many entrepreneurial businessmen coming from Universities labs.

Additionally, in a time of globalization we are living, when the connectivity between nation's results in a big change of tracks, of public policies and of economic scenarios, it becomes necessary to understand the role of local development, always fulfilled with "sustainability" characteristics demanded by information and knowledge society.

It is important to consider that one of the engines for local development is the system of micro and small enterprises, always responsible for new work posts supply, competitiveness increase and better income distribution. So the micro and small enterprises at the same time fit the task of attend the demands of local development and to suit the before described demands and needs of globalization challenges.

Today Brazil counts on around 5 million micro and small enterprises, which represent:
- 48% of national production, corresponding to 21% of GDP (Gross Domestic Product);

- 98.5% of all the enterprises of the country;
- 60% of the supply of work posts.

Besides, there are around 12 million enterprises so called informal that, as in other countries, are also responsible for an expressive work posts amount. The creation of an Entrepreneurial culture in micro and small enterprises environment must be enhanced.

The following aspects were mentioned by Professor Piero Fórmica, during the XVIII – IASP World Conference, which can also be applied to Brazil:

1- In the Brazilian case, the argument that Entrepreneurial enterprises create structural innovation is false. That is because in most case they work with adjacent innovations;
2- Greatest number of entrepreneurial businessmen do not have the experience neither the specific knowledge in the field they chose to undertake. So in this case the most important aspect for the business success is the entrepreneurship culture instead of the business area specific knowledge;
3- The entrepreneurial persons start their activities without any structured business plan. In many situation (in Brazil this is the most frequent case), the enterprises are started by the need and not with a well defined proposal. What enables success in this cases is the flexibility for changes;
4- The entrepreneurial businessmen start their business without insured venture capital. The venture capital enterprises only insure financing to a very small number of enterprises. Most of the enterprises start, in the Brazilian case, with own or family capital and the venture capital only appears in posterior stages, when they need to *capitalize successes*.

Finally, in this scenario the relevance of the articulation University-enterprise grows, what happens by following ways:

- By the supply of educational programs for entrepreneurship, with participation of SEBRAE, Federations of Industries, Agriculture, Commerce and Services, and Universities;
- The increase in the number of courses for graduated, many times taught at the enterprises, to accelerate technologies transfer which are developed in the country or adapted here;
- The investigation projects achievement of under contract to support or complement the innovation activity in technological base enterprises;
- The use of labs in Universities as analytical centers for incubators and technological parks;
- The creation of networks that comprehend Universities and Research Institutes on great subjects (as normalization, industrial propriety, metrology, software, analytical chemistry and materials) with the goal of offering to enterprises with technological base the required competitiveness. An example to be mentioned is the Technology Network of Rio Janeiro, which aims to articulate the relations between technology supplies and demands and counts with the participation of 46 organizations, among Universities, research institutes, fomenting agencies, governments and trade associations.

Increase of Efficiency of Small and Medium-sized Enterprises in Small and Medium-sized Enterpreneurship

Eng. Pavel Hercík
Prof. Ing. Růžena Petříková
Eng. Alan Vápeníček
Czech Federation of Scientific and Engineering Associations, Czech Republic

Prof. Růžena Petříková, Ph.D. – Director of the House of Technology Ostrava (DTO CZ, s.r.o.), Professor of Dept. of Quality Management, Technical University Ostrava, Professor of Bata University Zlín, Faculty of Economics and Management. Educational activities in the following subjects: Quality Management, Quality and Human Factor, Systems of Quality Management (ISO 9000:2000), TQM, EFQM Excellence Model, Self-assessment, Environmental Management Systems (ISO 14000), Integral Systems of Management, lecturer of the Czech Society for Quality, lecturer and designer of training programmes in the area of Quality Management and Management of Human Resources (Knowledge Management, Asset Management) for Czech companies, Knowledge Management and Ethics, and Corporate Social Responsibility.

Pavel Hercík, M.A. works for DTO CZ, s.r.o. as a Business Manager. He is responsible for business activities, training, consulting and managing projects such as HRD, HRM and management skills. He has participated in many international educational projects (e.g. PHARE, COST, EQUAL, and SEFI). He is a member of the Czech Association of Scientific and Technological Societies. He is an author of professional articles and co-author of publications dealing with HRD topics.

Alan Vápeníček, M.A., Ph.D., Vice Director of DTO CZ, Ltd. (DTO CZ agency has been working in the field of adult education, management consultancy a personnel certification.) Management consultant, trainer and coach in manufacturing: process management, change management, human resource development, and lean production. Author of more then 50 articles and textbooks on management, quality, HR and LP.

Abstract

Competitiveness and success of small and medium-sized companies depend on their efficiency. It is necessary to increase it continually. The most frequent questions that managers as well as owners of small and medium-sized companies ask are the following: "How to ensure efficiency and effectiveness of internal processes?", "How to lead employees to make them treat company sources as their owners do?", "How to use opportunities for future success?" The critical factors of success are quality, costs, and time. The way leading to the objective, i.e. growth of effectiveness, is to set internal processes, to follow added values in these processes and their continuous improvement. Another possibility is to increase company's efficiency by means of people. The key to this is to develop employees' knowledge, to motivate them, and above all to reach long-term changes in their attitudes. Practice and results of successful companies are a clear proof of this.

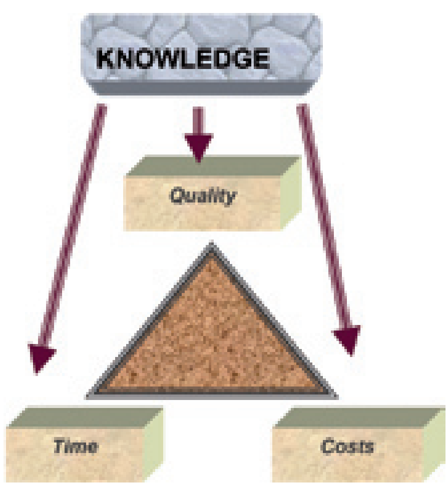
Fierce market which is not only willing and able but also ready to react very well to our faults, weakness, and hesitation. Stiff, fast and uncompromising competitors who pursue us, look for advantages, gaps in market segments, often adopt our best experience and attract our best customers. Omnipresent both domestic and international capital which is ready to promptly engage and connect former competitors that are able to create our new competitor within a few weeks or months. Demanding and very well informed customers who require tailored products and services, customers very well informed not only about prices and characteristics of what they buy but also about follow-up services and supplier's reputation. Customers who want to be satisfied promptly. Customers who require an active and intensive communication. Customers who share their both positive and negative experience, therefore a single dissatisfied voice may discourage many others not from buying our product, but from us being included into a potential selection of suppliers. A big amount of offers, variations of the same product, intensive marketing activities of producers and suppliers. A wide choice of financial products which allow customers to choose not only by price but also on the basis of their present financial possibilities. Such is the environment in which we do business today.

In order to remain in this market environment and to be a successful and thriving company it is necessary to make an effort all the time. Companies have to be ready to react very quickly. Companies have to have a few main activity lines at the same time. It is no doubt to maintain and develop relations with their customers, such as innovations and new ideas. And to be able to be competitive, companies have to constantly increase their efficiency.

If we are talking about an increase of efficiency of small and medium-sized enterprises, we have to take into account that this business sector is highly various and there is not a single pattern that these companies might be included in. On one hand there are self-employed people and on the other hand companies with tens or even hundreds of employees. Some companies may have a turnover of a million Czech crowns, and some even almost billion crowns. There are companies which start their business, they look for their place on the market and there are companies which have been developing successfully for many years. Also, the range of what they produce is pretty various, i.e. from simple products that get to other processors as subcontracts, to finished products aimed directly at consumers and services of all kinds. However, small and medium-sized enterpreneurship share some common features. It can be assumed that SMEs relatively have a low market share. Change of owners is often an exception. It also happens quite often that ownership and managerial functions intermesh. Besides this characteristic, we can say that small and medium-sized enterprises represent a significant importance for economics as they account for over 99% of the total amount of Czech companies which employ 66% of all employees, where 57% of wages in the Czech Republic are paid out and they contribute to almost 35% of gross domestic product. All that is a reason for which it is necessary to constantly look for ways of increasing efficiency of these companies.

The aim of entrepreneurship should also and mainly be to achieve expected efficiency. What should the expected efficiency be like? With a little imagination we could compare the required company‘s efficiency with a flight by plane. It should be stable, i.e. as passengers we would find it difficult to stand turbulences on the right or left, unexpected going up or down. Furthermore, efficiency should be reliable, and should a defect occur, it must not be of a greater importance so that it cannot cause an irreparable damage. Also, efficiency should be repeatable. We, as passengers of the plane, would probably be very surprised if the pilots drank champagne after each flight saying that everything ended up well. It is clear that efficiency should also be predictable. We would hardly board the plane learning the destination in the middle of the flight. And to manage efficiency is not worth mentioning an example, it is enough to use our imagination.
When we, as advisers and suppliers of educational activities, get to companies and we talk with their managers, we very often get similar questions. They can be summed up in the three following questions:

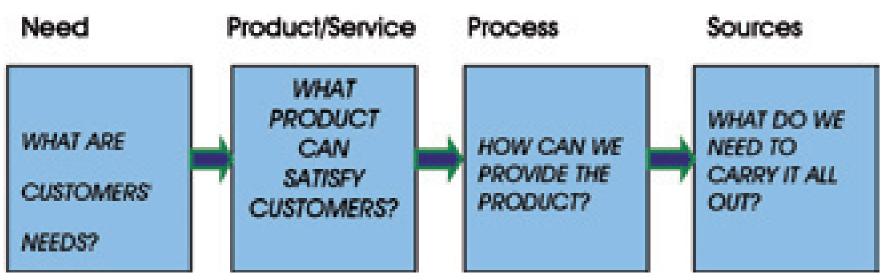
- how to arrange efficiency and effectiveness of internal processes?
- how to lead employees to make them treat company sources as their owners?
- how to use opportunities for future success?



If we want to answer these questions, we first have to realize what critical factors for a company successfulness are. The first factor is quality, i.e. a necessary condition however not sufficient. Customers do not require it. Customers expect it automatically. Therefore it is not an argument when selling, but a characteristic of every sound company. The second feature which decides about a company successfulness are costs. If they are low, they allow to set a competitive price of products or services and to achieve a sufficient profitability even with this price. The third part of this imaginary triangle is time. We may achieve excellent quality, we may maintain optimal prices. However, if we are not able to deliver our products and services to their destination within the given time, we can be sure that our customers will sooner or later contact competitors who are ready to fulfil these conditions. And above all these factors there is the common factor – knowledge and a personal development of people. According to the IPTS study (The Institute for Prospective Technology) from 70 to 80% of company growth at the end of the first decade of the 21st century will be based on knowledge.

The conditions in which companies are working are therefore given. Which ways in this environment then lead to an increase of efficiency? There are two ways and to reach success means to take both of them. The first way is to set and to permanently improve company processes. The other way is to develop knowledge and to motivate people.

Process approach in a company management:



When setting the processes, we should definitely not forget the following steps:

- To define processes.
  It is necessary to define the main and secondary processes, to set what they are to find out and how (processes of purchase, storage, productions, making orders, complaints, development, etc.).

- To define borderlines of processes.
  If there are two processes that are connected, it is necessary to define their exact borderline. Where does the process of purchase end and where does the process of storage begin? In case the borderline is not defined accurately, there might be a threat of duplicating activities in a better case, or not performing activities at all in a worse case.

- To define parameters of processes.
  The defined parameters of processes clearly indicate whether the process runs properly and everything is all right. As an example, there may be a process of storage when we

store screws aimed at assembling. A parameter may be the number of the screws in the warehouse, e.g. 400 pieces is the minimal amount and 800 pieces is the top limit. In case the minimal amount is not kept, we may slow down the final assembling and in case the top limit is exceeded, we may unnecessarily burden the warehouse. Other parameters may for example be time of storing an item, or time which elapses from the request of the production to leaving the storage.

- To define the process owner.
  If we define the process owner, it means that we clearly define the roles and responsibilities of people.

- Flows in processes.
  Besides product and material flows in processes, there are information flows that are of a great importance and that allow to successfully manage the whole company.

- To follow the added value in processes.
  A lot has been written about the added value in processes. A simplified definition of origin of the added value could be the one that says that the added value is what customers are willing to pay for. If it is necessary to cut, turn on a lathe, and drill a special sleeve from an iron rod, then the added value of the sleeve arises during cutting, turning, and drilling themselves. The added value does not arise during transport, storage, or while waiting for the product.

How does the setting of the processes function in real conditions? Last year, the company Dům techniky Ostrava (The House of Technology Ostrava) worked in a company which had 80 employees with an annual turnover over 100 million per year. This company produces plastic windows and doors. After 8 months, the time necessary to execute an order fell from 6 to 3 weeks. Work in progress of the production fell by 30%. The number of discrepancies in the production fell by 80%.

Upon setting the processes there is another way of increasing the efficiency of companies, i.e. to apply tools of lean production. The concept of the "lean production" lies in the production which flexibly reacts to customers' needs and demands and is implemented with the aim to provide customers with:
- exactly what they need,
- when they need it,
- in the necessary quantity,
- without defects,
- with the lowest costs.

The aims of the lean production are the following:
- Minimal production in progress at each workplace, an ideal example is circulation of one piece,
- Production in small amounts synchronized with the transport plan,
- Specification of defect prevention prior to checks and the following repairs of faulty products, quality is built in the process and there is a feedback in real time,

- Production planning is managed through customers' needs and not through the effort to maximally use machinery and people,
- Team organization of work with people who know more professions and with powers to make decisions and to improve operations by means of a few technicians,
- Active involvement of employees in discovering problems and their solutions to increase quality and to eliminate wasting,
- Close integration of the valuable flow from the input material to the final production through cooperation with suppliers and distributors.

The other way is to increase the efficiency of companies by means of people where mainly the development of knowledge, motivation, and change of attitudes are of a great importance.

If we want to develop knowledge, we first have to clearly define organization's objectives. These defined objectives are then a source for an analysis of knowledge needs. First, there is knowledge which is necessary to maintain and to develop in a company. Then there is knowledge which has become outdated and is and will be unnecessary. Finally, there is knowledge which a company completely lacks, but is essential to be acquired for a future successful development. In this situation the company management has to decide whether they want to train the present employees or whether they want to hire new professionals and specialists or whether they want to hire external specialists temporarily.

Employees Motivation

How to motivate employees efficiently? Employees mostly appreciate if a company cares about their personal development, if they are given new objectives which are necessary to be achieved and which are in accord with their existing development.

Another way of involving employees in company activities is not only to show them visions and company objectives but also to show them what their own future in the company will be like.

Let's give people an opportunity to influence development in their company as much as possible. To stop being a "tiny part in a big wheel" will help to increase employees' activity and we often encounter unexpected benefits of this approach.

The most important objective of motivation which we should aim at is always the change of attitudes. Only this change will guarantee that changes in performances induced by motivation will be permanent. And how to change attitudes? Let's show people how, let's show them why and let's involve them in activities.

What to say in conclusion? If present companies want to remain among successful companies, they have to increase their performances. This is possible to achieve through setting and improving processes and permanent development of employees. However, these two ways are impossible to separate and moreover, we have to put up with the fact that neither of these ways is finite.

From the Education and Innovation Crisis to the Social Crisis

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

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

Abstract

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 behaviour.
In a modern democratic nation, 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.

Education, vocational training, advance training are the best conditions for a long life of learning and a basis for a good understanding social living together. People get a sense that they are not alone in the urbanized and industrialized society. And last but not least a good general education is the best condition for knowledge of social, economic, financed, technical and political relationships. People with a good general education are not easily manipulated.

When government finance is short, first it reduces the budgets in the education fields and may be sets the basic for a social crisis.

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 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 (technical energy and physiological energy) for the life and survival of the earth's 6.5 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 behaviour (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, fresh water 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 6.5 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, science of material, nano-science, the tapping of new sources of energy and materials, bio-engineering and genetic engineering (fig. 2 and fig. 6).
3. While fundamental human requirements – which we can summarize under the headings of food, energy, fresh water, clothing, housing and health, a third phenomenon is 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. 55% of the world population are living in towns. The urbanization goes more and more. How will they communicate, live together? What new forms of behaviour will they have to develop in order to create and retain optimum chances of survival? (fig. 3)

Communication and the ability to work in a team are important key concepts in answering these questions (see combining level in fig. 4).

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 European 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, supervisors 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. 5).

- 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 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 37,5-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 FACTORS IN NATURE, TECHNOLOGY AND ECONOMY

A vital economy and a creative society are distinguished by the smooth flow of energy, materials, 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 also for heat, which dissipates from a high temperature level to a ower one (table 1).

– *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)*

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

– *Heat transfer (steady)*

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

– *Ohm's Law*

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

– *Capital-stream*

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

– *Informationstream*

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

Table 1. Examples for compensatory processes

These laws of nature also apply to the flow of materials, energy, information, and financial resources. Curiosity is the driving factor behind the flow of information; the uninformed person, as a rule, wishes to he informed. Suitable engineers must be very curious!

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 colourful social system which is characterized by individualists would turn into a grey, uniform society of which everyone would possess an 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 (table 1).
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.

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

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

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 behaviour.
Identifying the forces at work and the laws of nature behind these forces in these superficially different systems is an essential task facing the 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 social behaviour 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 innovation 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 activate 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 (labour 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.
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 contribution 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 best 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 in 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 or theories and ideas. At the production basis and at the service level, however, skilled workers, craftsmen, 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 nations 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. For example 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 behaviour.

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. The law of combi- and minimum wage in Germany is one step in this socialistic direction.

CONSEQUENCES

In a modern democratic nation, 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 2).

FINAL REMARK

Economic efficiency (production and financing), environmental protection (maintenance of nature's power of regeneration) and social considerations are not mutually exclusive. They complement each other and need to be optimized.

Research aims should be newly defined. The ability to regenerate means more than environmental protection it means health in the widest sense. Nature may be changed, it is not static. But nature must be capable of being regenerated.

Education and knowledge together facilitate and promote contact with other nations and an understanding of foreign cultures. A joint education and communications strategy is an essential first step towards peaceful globalization of the world's energy, fresh water, food, materials and financial structures.

Education, vocational training, advance training are the best conditions for a long life of learning and a basis for a good understanding social living together. People get a sense that they are not alone in the urbanized and industrialized society. And last but not least a good general education is the best condition for knowledge of social, economic, financed, technical and political relationships. People with a good general education are not easily manipulated.

When government finance is short, first it reduces the budgets in the education fields and may be sets the basic for a social crisis.

Table 2:

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 phantasies 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, fresh water, material and finance on the other hand.

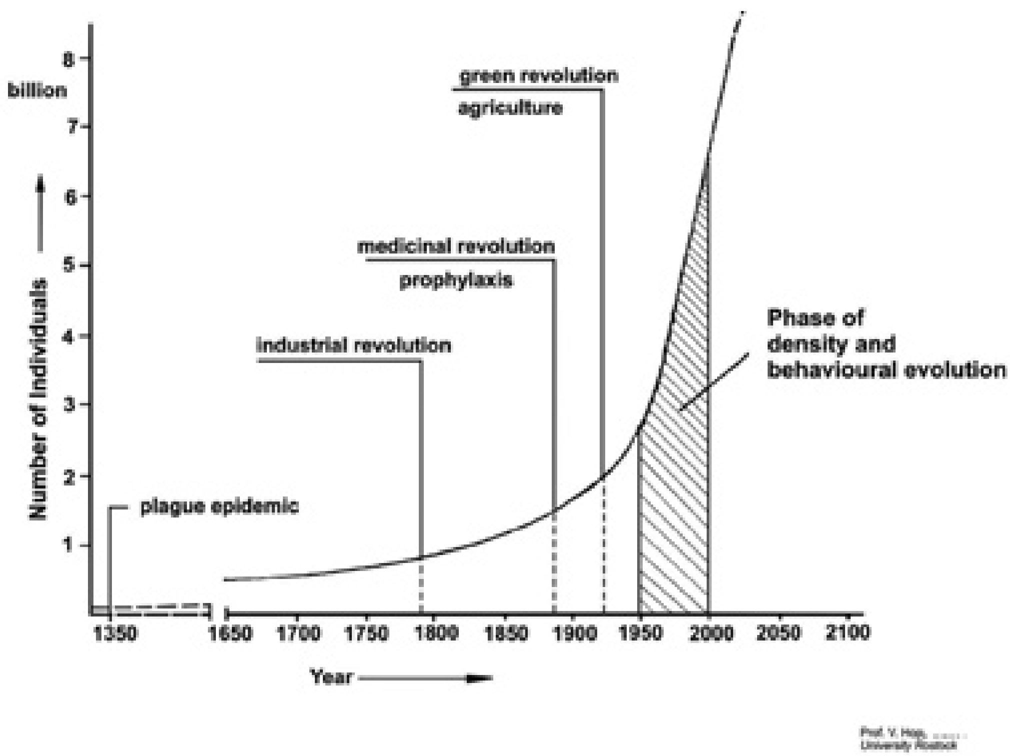


Fig. 1: Growth curve of the population of the earth

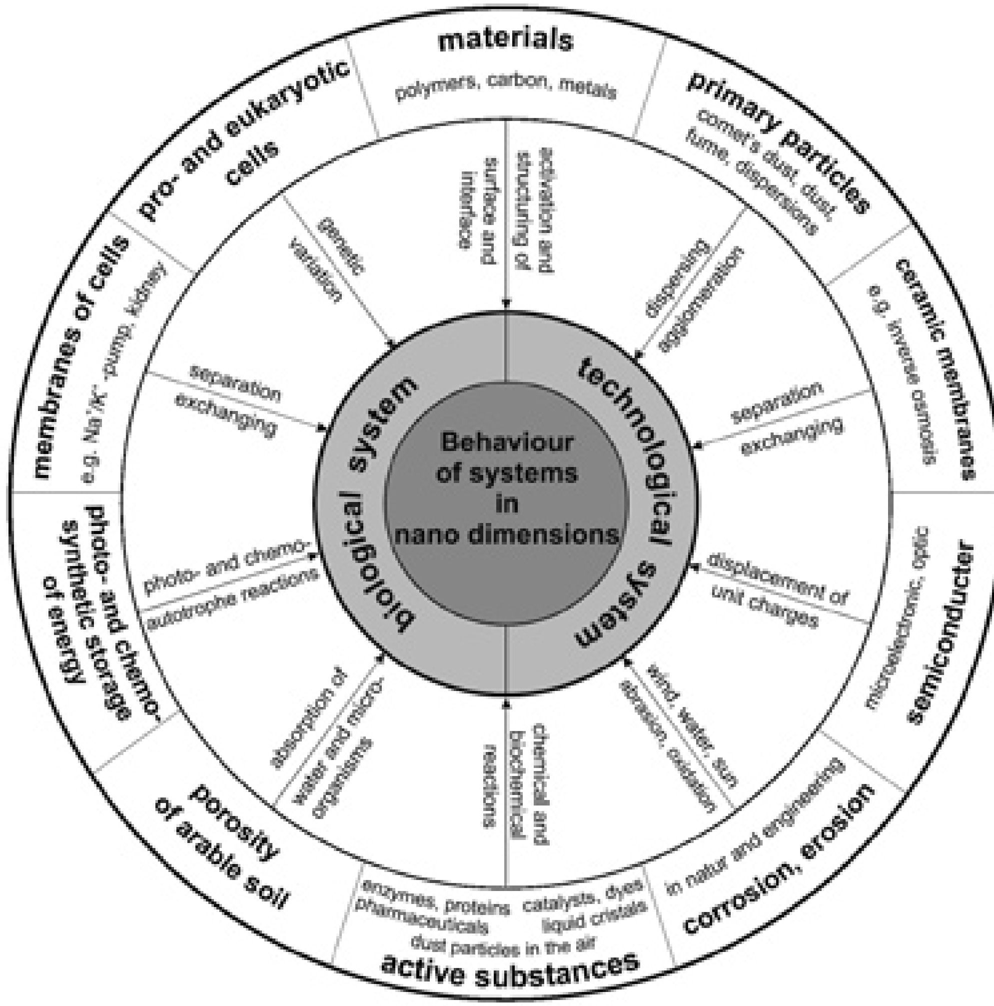


Fig. 2: Nano-science – an interdisciplinary fundamental science

Fig. 3: The world's biggest conurbations (inhabitants in millions) in 2005 AD

In the past centuries the increase in the world population has been accompanied by hunger, epidemics and migration of people.

Since 1930, that means in the last three generations, the world population has increased from about 2 billion to 6.5 billion. That is threefold (fig. 1).

From this number 55% were living in towns, and in Europe 75%. In 2025 there may be more than 8 billion people in the world and about 61% will be urbanized, and in Europe about 83%. About 60% of the people occupy 10% of the land mass of the earth. At present in Germany the population density is 230 people per 1 qkm.

At present there are 22 capital cities world wide. The number of the inhabitants lies between 10 million (e.g. Istanbul) and 34 m. (Tokyo). A further 358 towns have a population varying between less than 10 m. (e.g. Paris) and 1 m. (e.g. Dublin).

This is one of the reasons for many problems in our modern industrialized and troubled world.

The area of agricultural land per head of the population is declining throughout the world.

In 1950 it was 0.51 hectares, in 1975 it was down to 0.34 hectares, and in 2025 it will be only 0.15 hectares.

These large cities create ever growing problems of food-supply, fresh-water, waste disposal, transportation, communication and social crisis.*)

*) Gleich. M.; Maxeiner, D.; Miersch, M. u. Nicolay, F. (2000), Life Counts, Eine globale Bilanz des Lebens, Berlin-Verlag, Berlin.

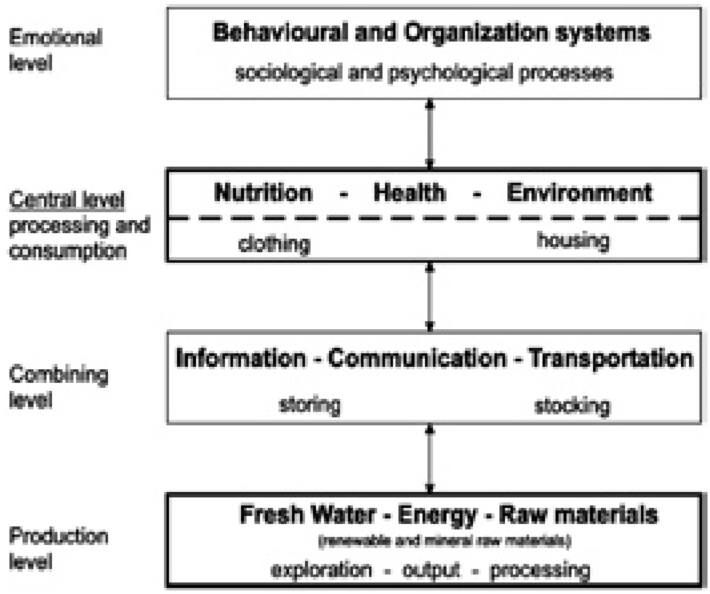


Fig. 4: Concept for applied Life Sciences

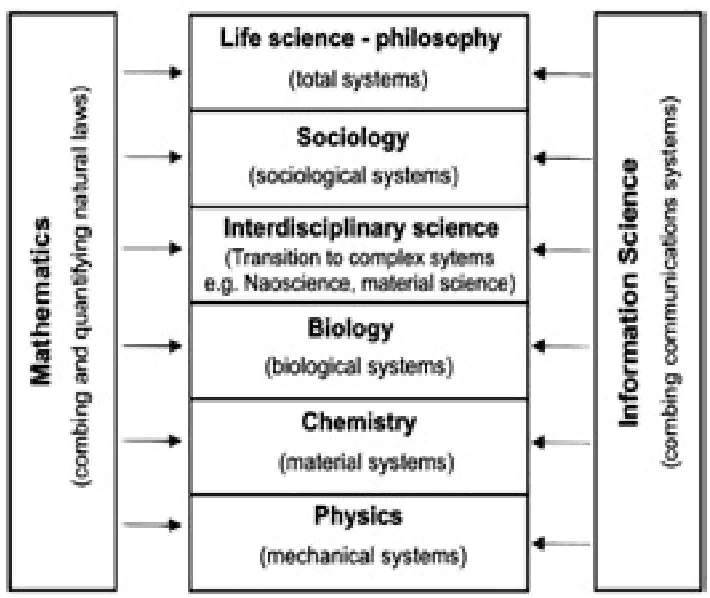
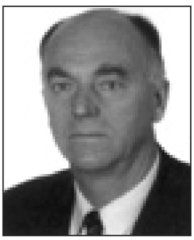


Fig. 5: The fundamentals for innovative technology

Developing the Idea of World University of Technology

Prof. Włodzimierz Miszalski
President of WFEO-CET, Poland



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

Abstract

The idea of World University of Technology (WUT) presented for the first time during the 7th World Congress on Engineering Education in March, 2006 in Budapest has been developed. The comments on the initiated international discussion on the subject have been presented. The idea of World University of Technology have been compared with the European Union project of European Institute of Technology (EIT). The similarities and differences between both ideas have been discussed. The reasons for WUT have been formulated followed by the considerations on its future shape. The financial aspects and resources necessary for creation WUT have been discussed basing on the examples of solutions applied in the EIT project. The paper ends with invitation to further discussion on the mission, tasks of World University of Technology, personal characteristics and professional profiles of its future graduates .

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

INTRODUCTION

The idea of World University of Technology (WUT) has been presented for the first time during the 7th World Congress on Engineering Education held 4–7 March, 2006 in Budapest [2] and immediately has opened broad and stormy discussion on the rationale and possible options of WUT proposed by the author. Since that time the increasing needs of international education of engineers have accelerated the processes of creation international engineering education and research institutions. European Institute of Technology (EIT) has been designed with education as "a key element that distinguishes EIT from other European networks – it will be pitched at postgraduate and Ph.D. levels and will stress innovative teaching programmes, interdisciplinary approaches, entrepreneurial skills, risk and innovation management" [1].
Three following citations also reflect the innovative aspects of EIT mission.

> *"The EIT will help make Europe competitive on the global scene. It will unlock Europe's potential for innovation. We should not be constrained by barriers between research, education and business."*
>
> *(José Manuel Barroso, President of the European Commission).*

> *"EIT main mission is innovation, but its architecture is innovative as well. As a flagship of excellence, the Institute will be able to attract the best students and researchers world-wide."*
>
> *(Ján Figel', Member of the European Commission in charge of Education, Training, Culture and Youth).*

> *"The EIT will put innovation at the heart of the knowledge triangle. I welcome the fact that businesses will be core partners at the Institute's strategic and operational levels."*
>
> *(Günter Verheugen, Vice-President of the European Commission in charge of Enterprise and Industry).*

During the International Conference "Supporting Small- and Medium-Sized Enterprises in Engineering and Technological Innovation Activity" held in May, 2007 in Cracow, Poland – the idea of "Engineering Education for Innovation" has been discussed as a motivating factor for small and medium-sized businesses of engineering and technological profile all over the world as well as a challenge for educators and creators of international engineering education institutions. Participants stressed the role of the co-operation university-enterprise and necessity of international exchange of experiences and solutions in this area.
Meanwhile author has received numerous emails and letters supporting and arguing with the idea of WUT. Thanking cordially the Distinguished Discussants – whose comments and remarks have encouraged me to make a step further – in this paper I will try to develop certain suggestions and proposals presented during the Budapest Congress and

then published in IDEAS [3]. In that publication possible profiles of WUT have been discussed and the outline of several initial steps on the way to the World University of Technology has been proposed. International discussion on the purposes of creating WUT (rationale, mission, tasks) has been suggested as the first step – and what surprised the author – was spontaneous response to that suggestion – so the assumption that the first step has been already taken seems to be justified. Among numerous comments received by the author the comparisons have appeared between the ideas of the EIT and WUT and the non existence of world institution corresponding to European Commission (as sponsor or creator of the EIT powerful and wealthy enough to materialize the idea) has been raised as an argument against WUT. The rejoinder coming to author's mind is that not only power and wealth have shaped this world so far.

1. THE REASONS FOR WORLD UNIVERSITY OF TECHNOLOGY

In the already cited European Commission Directorate-General for Education and Culture information [1] following six reasons for the EIT have been presented:

1. Lack of critical mass: The EU' s higher education and research systems are too fragmented, leading to dispersed innovation efforts.
2. Not enough top-class excellence: There are too few internationally renowned, excellent EU Universities.
3. Low business involvement: Low level of involvement of business in education and research.
4. Education and research structures tend to stifle entrepreneurial initiative and rapid response to social and economic needs.
5. Brain-drain: Working environments fall to attract or keep best talents in Europe.
6. Lack of funding: Insufficient private funding for education and R&D.

Summing up the so far considered statements on the EIT – education for innovation seems to be dominating rationale for educational functions of EIT. There are of coarse certain similarities but also significant differences between the purposes of creation the EIT and WUT. They result from the differences between the World- and Europe-scale engineering problems as well as from the differences between the Europe and World needs for engineering education. The disproportions in technological advancement as well as in allocation of engineering potential between different regions of the World would argue for putting education for mobility and education for development together with education for innovation as a rationale for creating WUT. This means that future WUT graduates as well as its research results should satisfy not only the requirements of super advanced engineering projects but also the needs for executing relatively simple projects and enterprises facilitating and improving the quality of human life in the poorest regions of the world, the needs for engineers participating in disaster relief actions and humanitarian aid activities.
The cited above six reasons for the EIT reflect the specificity of Europe which "is good at inventing, but falls short in exploiting the results of its research work" [1] – but the reasons for World University of Technology would result from the quite different category problems. While Europe's problem is how to make better use of the already existing potential – the World's problem is how to built potential to meet global engineering challenges.

Following reasons for the WUT seem to be resulting from the so far discussion:

1. Lack of institution conducting the research on the global-scale engineering problems and technological challenges.
2. Lack of institution shaping the new globally-oriented personality and professional profile of engineer – free from national or regional biases – prepared to handle global challenges, to deal with worldwide scale engineering projects, mobile, flexible, able to work effectively in any country, any region of the world.
3. Dispersed efforts in the research on the global-scale threats which require engineering and technological response.
4. Appearance and development of global systems like: computer networks, satellite communication and navigation systems, worldwide pollution control systems, climate monitoring and weather control systems, disaster monitoring and relief systems, spaceships launching, guidance and landing engineering, international energy production, conversion, distribution and transmission systems, international logistics engineering.

The list of the above reasons has not been closed. There are probably many other detailed purposes for creating the WUT as well as counterarguments against the idea. The 8th World Congress on Engineering Education scheduled March, 2009 in Malaysia could be a good opportunity for continuing the discussion.

2. SHAPE OF THE WORLD UNIVERSITY OF TECHNOLOGY

In the 7th WCEE presentation and in the author's publication in No.13 IDEAS [2,3] several possible options of future WUT have been considered as an inspiration to the discussion on the shape of the proposed institution.

1. Federation of several so far existing (in different countries) universities.
2. Multi-campus, distributed university with separate international management staff.
3. Single-campus, full-scale university with own unique world-oriented curricula and research programs.
4. Virtual university based on the distance learning educational programs and the most advanced multimedia and communication techniques.
5. Mixed real-virtual university of small scale located by one of the famous universities – basing on the faculty, equipment and infrastructure of the university.
6. The postgraduate only – prestigious international educational establishment conducting the top quality "masters" courses led by famous worldwide known engineers.

It has been surprising for the author that the majority of the expressed opinions and comments have been in favor of the third option in spite of author's predilection and expected discussants' preferences for "smooth start" with 4th or 6th options. In certain comments the suggestions appeared that the WUT as a single-campus university should be located in one of the countries of the Third World.

The 3rd option has been treated in the previous author's publication [3] as certain "program maximum" and considered in details as single-campus university with the world-oriented identity – basing on specially selected international core faculty working mostly on site plus visiting and invited professors and lecturers from different countries. Students from all over the world (awarded international engineering organizations' scholarships), participating in engineering projects and research works connected with worldwide engineering activity. Own unique curricula and research programs. Extended system of post-graduate curricula oriented towards the global scale engineering projects (separate post-graduate courses for engineers-managers). Unique diplomas of high prestige recognized and appreciated all over the world. Special employment and professional career system for graduates (possibly under auspices of UN) connecting their professional development with the worldwide scale engineering activities.

Current concept of the European Institute of Technology however seems closer to the 2nd option (distributed university with separate international management and campuses in different countries i.e. the already existing well-known technical universities' campuses, integrated research program, developed post-graduate and Ph.D. candidates courses).

The EIT will be composed of [1]:

1. A Governing Board of high profile people from science, academia and business, supported by a small staff. It will set the overall strategic priorities, select Knowledge and Innovation Communities (KIC) and evaluate and coordinate their work.
2. The Knowledge and Innovation Communities. Distributed across Europe, these will be the EIT operational level, performing and integrating innovation, research and education a Activities.

The Governing Board will have 15 Members, balanced between business experience and academic/research experience. There will be also representative Members, drawn from among the staff and students of the EIT and the KICs. The Board will select KICs on the basis of a competitive, open and transparent process and monitor and periodically evaluate their activities, ensuring quality control. Once the EIT is fully operational, the Governing Board will require a support staff of around 60 persons.

The counter arguments against the "distributed" option of the future World University of Technology have been of "geographical" nature mostly – stressing the disadvantages of "dispersion" – possible difficulties in managing the worldwide distributed institution and in keeping the world oriented identity as well as education and research directions. It also seems interesting that significant group of discussants supported the 6th option ("masters courses" profile). In authors opinion (after that stage of discussion) – the joined options 3 and 6 (or option 6 included in option 3) could be considered as well.

3. DETERMINANTS AND LIMITATIONS

Although the advancement, momentum and determination in materializing the ideas of the European Institute of Technology and the World University of Technology have not been comparable so far (the already prepared legislative documents in the first case and initial discussions and concepts in the second) – the financial aspects and other resources' limitations determining the future size, potential and tasks of the WUT could be considered taking into account the differences and similarities between the both ideas.

Creating the EIT is ambitious, large-scale, future oriented project. The vision of EIT by 2015 [1] is following:

– 10 Knowledge and Innovation Communities,
– 4 000 to 5 000 scientists,
– 6 000 Master's students,
– € 1.5 to 2 billion annual budget.

Meanwhile the projected costs of the EIT for 2008–2013 will be around € 2.4 billion [1]. This would come from:

– the European Union – through a dedicated EU budget line funding EIT directly. Furthermore, The KICs will be able to apply for funds from the Structural Funds, the 7th Framework Programme, the Lifelong Learning Programme and the Competitiveness and Innovation Framework Programme;
– the Member States, including local and regional authorities;
– business or private organizations, foundations, or any other national bodies or institutions;
– bequests, donations from individuals or institutions;
– revenue generated by the EIT's own activities and outcomes (e.g. Intellectual Property Rights) or capital endowments including, possibly, an EIT Foundation;
– contributions from third countries and international bodies and institutions.

As it results from the current stage of discussion – the World University of Technology would be significantly smaller scale project than the EIT. In the case of WUT – it would be difficult to find sources of funds corresponding to the mentioned above first and second subjects – but the other sources could be considered *per analogiam*. The costs of the WUT of coarse will depend on its shape and size, which have not been determined so far – but even the preferred by majority of discussants option 3 – seems to be much less expensive than the EIT.
Other significant difference between current concepts of EIT and WUT lies in different approach to human resources .The expected human resources of the EIT – 4 000 to 5 000 scientists working in Knowledge and Innovation Communities dispersed across Europe – mean huge intellectual potential oriented towards integrating innovation, research and education activities from different fields, sectors and regions of Europe and concentrating on important subjects which have commercial possibilities.
Different mission of the WUT would consist in shaping the new personality and professional profile of engineer able to handle global challenges as well as in conducting research work connected with the worldwide scale engineering projects. The mission would require different approach to the WUT human resources. In the case of the currently favored (in the discussion) options 3 and 6 – human potential of the future WUT would be small specially selected international core faculty supported by visiting and invited professors and lecturers from all over the world including famous worldwide known engineers leading the top quality "masters" courses.
The most arguable in the field of the WUT resources seem to be questions of: campus infrastructure, laboratories' equipment, library etc. Many solutions could be considered – from adaptation the already existing campus (located in the country which would declare hosting the WUT) – to building a new campus from scratch. Views of the discussants on this matter have been divided so far – significant group has been in favor of designing and building new campus with its architecture reflecting and symbolizing the intellectual and ethical values recognized by the world engineering community.

CONCLUSIONS

The unexpected response to the idea of the World University of Technology has encouraged author to continuing the reflection on this challenging subject. Although many comments, arguments for and against as well as concrete proposals of possible solutions have appeared so far – the idea seems still to be *in statu nascendi*. Going back to the proposed in the previous publication [3] sequential steps on the way to the World University of Technology and assuming that the first step: international discussion on the purposes of creating the WUT has been already initiated – let me invite Distinguished Discussants to the next steps and comments on the rationale, mission and tasks of the WUT as well as on personal characteristics and professional profiles of its graduates – future "World Engineers".

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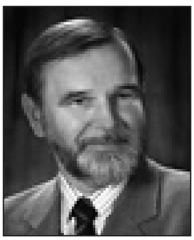
INNOVATIVE COMPANIES EXPERIENCE

Kwant – Innovative Micro Company

Bogdan Niewczas, Ph.D., Measuring Apparatus Plant Ltd.



Bogdan Niewczas Ph.D. is a specialist in the field of combustion process conducted in power generation boilers. He is the author of numerous publications and patents in particular devoted to systems for monitoring combustion parameters of pulverized coal. In 1997–2007 he established Zakład Aparatury Pomiarowej KWANT and throughout these years remained the Company Chairman. Under his supervision KWANT developed the technology implemented in the following measuring systems: APF for monitoring PF parameters, AWP4 Carbon-in-ash monitor, ASG Triboelectric Gas Stream Monitor and also many others. Currently Bogdan Niewczas is a supervisor of the project devoted to implementation into Polish energy sector a novel technology for optimisation the combustion process in industrial boilers and furnaces. The main effect of this technology is also reduction of harmful gases emission as well as improvement in boiler efficiency.

Abstract

The paper presents the history and current activity of the Measuring Apparatus Co. Ltd "KWANT" (Zakład Aparatury Pomiarowej KWANT sp. z o.o.) – the winner of POLISH PRODUCT OF THE FUTURE competition. The company manufactures specialist apparatus based on its own intellectual property rights and used in power plants for control of the combustion process such as carbon-in-ash monitors, automatic ash samplers, pulverised fuel flow-rate monitors. The second part of the paper gives the brief analyses of the opportunities and threats facing the micro innovative companies in Poland. Among the main opportunities the author mentions well-educated and skilled staff, easy access to technical university research engineers, and relatively low labour costs. One of the main threats are difficulties with entering new foreign markets due to lack effective representation of Polish entrepreneurs abroad and insufficient funds for products commercialisation. Another one is lack of law and tax regulations enhancing the co-operation between Polish big companies and small innovative ones and not efficient enough motivation tools created by the local government for innovative activity support.

1. HISTORY (ABOUT KWANT)

Zakład Aparatury Pomiarowej KWANT Co Ltd. was founded in April 1997. During first 10 years of its activity in the Polish market, the company developed and implemented the manufacturing of various products used mainly in the power generation sector. All products offered by KWANT utilise innovative technologies developed and patented by the company, who is the sole owner of Intellectual Property Rights resulting from these patents.

In the year of its foundation, the start-up capital of the company had the insignificant value of 6 000,00 PLN (~ 1 500,00 €). Since the beginning of its business activity, the company has based its development strategy on intellectual potential. KWANT cooperates with 5 researchers with Ph.D. degree and 7 people with M.Sc. title. What is more, over the years, the company has developed a successful and efficient relationships with leading Polish Research and Development centres, such as University of Science and Technology in Cracow, Warsaw University of Technology, Silesian University of Technology and Wrocław University of Technology. Currently, the capital stock of the company has the value of 1 100 000,00 PLN, exclusive of the intellectual property value, estimated at further 2 500 000,00 PLN.

Spectacular growth of company value from 1 500,00 € to 1 000 000,00 € over 10 years, was enabled by investing regularly as much as 85% of company annual profit into research and development works and commercialization of new products, combined with significant experience of the company management in development and commercialization of innovative high technology products. The company success would also be impossible without a team of highly qualified and experienced professionals, both employed by the company and subcontracted, who contributed to the progress of research, development and implementation works.

Over ten years of its business activity, the company has submitted 13 applications for protection of Intellectual Property Rights, securing one industrial design, seven Polish patents and one US patent.

In 2000, one of the systems developed by ZAP KWANT was nominated to the prestigious Polish Product of the Future 2000 Award. Last year, KWANT's technology for Pulverised Fuel Combustion Control in Power Generation Boilers won the Polish Product of the Future 2006 Award. Main award in this high-profile event organised under the patronage of the Prime Minister of the Republic of Poland, represents a considerable success for our company, confirming the efficiency of the development strategy adopted by ZAP KWANT.

2. PULVERISED FUEL COMBUSTION CONTROL IN POWER GENERATION BOILERS – TECHNOLOGY AWARDED THE TITLE OF POLISH PRODUCT OF THE FUTURE

More stringent NOx emission limits from power generation boilers will be introduced after the implementation of the EU directive no 2001/80/WE. Keeping the value of NOx below 200mg/Nm^3, at 6% O_2, (E200) will become the most significant problem for boilers of nominal output >500 MW_t. For pulverised fuel (PF) fired boilers (OP650 and larger units), it would be very important if the demanded emission threshold could be achieved using the so-called primary methods, based on optimisation of the combustion process. It is possible to introduce the expensive secondary NOx reduction methods (SCR, SNCR), however, with these methods the return on investment is very slow and would take a long time after the implementation of the 2001/80/WE directive. Financial and logistics-related issues add to the problem because, in order to meet the restrictive emission limits, about 120 boiler in Poland must be thoroughly modernised by 2016.

Additionally, long term operation at such low NOx emission levels is realistic only in boilers fitted with air and fuel staging in streams of varying concentration. Such systems may be used in boilers with wall-mounted swirl burners as well as in boilers with tangential furnaces [1]. To be able to identify the optimum combustion conditions, it is advisable to fit the boiler with a system for on-line monitoring of PF concentration in all PF ducts connecting boiler mills with the burners. Application of the concentration monitoring system would make it possible to define the optimum local excess air values on respective burners (λ_{pal}). Such system would also prove useful in the monitoring of uneven temperature distribution in superheaters, resulting from the non-uniform pattern of fuel supply to the burners. What is more, recent research shows the positive effect of PF flow rate monitoring on the reduction of water wall corrosion.

Progress in the development of solid fuel combustion technologies achieved in recent years, has resulted in significant reduction of excess air value on the furnace outlet. Low NOx emission combustion systems (with air or air and fuel staging) allow to operate the boiler at $\lambda_{kp\ wyl} \cong$ 1,15. Even lower excess air values may be achieved using systems for flame monitoring.

Maintaining the correct fuel to air ratio at each burner of a boiler under all operating conditions is the key to optimising pulverized fuel (PF) combustion in power plant boilers. In addition, control of excess air λ_{pal}, either individually for each burner or for a group of burners, introduces the possibility of eliminating low-oxygen fireside corrosion and reducing NOx emissions. Optimised combustion also reduces carbon-in-ash content as well as ensuring a uniform distribution of temperatures in the boiler and improving boiler efficiency. Ideally, each burner in a boiler should receive accurately controlled flows of PF. Measurement of actual PF flows has shown that, despite the attempts to control PF distribution, the actual distribution is far from the assumed values. The main cause of this problem is forming of concentrated PF streams within a PF duct (a phenomenon known as 'roping') [1, 2]. After the bends of PF ducts, a concentrated PF stream containing from 50 to 70% of the whole mass of PF [2] forms. PF distribution between respective ducts, done in splitters, significantly differs from the assumed values. Figure 1 shows formation of a PF rope.

Fig. 1. PF roping at bends and bifurcations

KWANT Ltd has developed the APF measuring system which enables on-line monitoring of PF velocity, concentration and flow rate in cylindrical ducts. On-line monitoring of these parameters makes it possible to correct the λ_{pal} value by controlling the amount of air and/or fuel supplied to individual burners on-line.

In typical boiler operating conditions, boiler load and coal parameters (such as calorific value, moisture content, reactivity, milling properties) vary. This may adversely affect the combustion process resulting, for example, in the increase in carbon residues content in fly ash. Because excessive carbon-in-ash (C_{pl}) content compromises subsequent ash saleability, boilers are often operated at high excess air values. On-line monitoring of carbon-in-ash content (C_{pl}) makes it possible to determine the optimum l values for various operating regimes. Monitoring of carbon-in-ash proves also useful in defining instantaneous boiler efficiency and calculating the CO emission. On-line carbon-in-ash monitoring is likely to become more important in boilers fulfilling the E200 norm, which will be more exposed to the danger of excessive C_{pl} content. To remain competitive in a very demanding market, KWANT has developed a microwave carbon-in-ash (C_{pl}) monitor.

Both instruments described above form a coherent system enabling the monitoring of the most important parameters of pulverised fuel combustion.

THE APF SYSTEM FOR PF FLOW RATE MONITORING

The structure of the APF system is given in Figure 2.

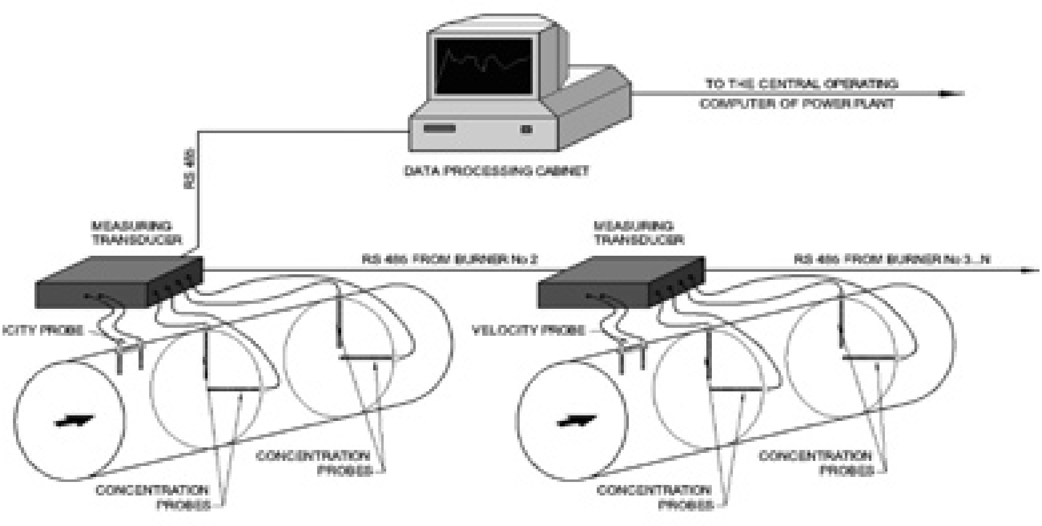


Fig. 2. Layout of the APF system

The APF system consists of the following main components:

- velocity probes,
- concentration probes,
- measuring transducers (inside data acquisition cabinets),
- control / data processing cabinet.

The APF system calculates PF concentration on the basis of the measurement of a cut-off frequency of an electromagnetic radiation (EMR) generated within a PF duct. PF velocity within ducts is measured by cross correlating 2 triboelectric signals from adjacent probes. Intellectual Property Rights (IPR) covering the measurement method are currently processed by the Polish Patent Office. The development of the APF system was part funded by FST NOT(The Innovation Centre of the Polish Association of Engineering Associations).

The measurement method is highly sensitive – at a concentration of 1000g/m^3, changes of 2g/m^3 are measurable. The system monitors the following parameters on each PF duct: velocity, concentration and flow rate of pulverized fuel, as well as the primary air flow rate.

The APF System also monitors:

- The amount of PF fed to a single burner (or a group of burners), as compared to the overall amount of PF fed to the boiler,
- The amount of PF fed to a burner, as compared to the mill throughput,
- The amount of primary air supplied to a given burner or a group of burners, as compared to an overall primary air flow rate.

Figure 3 shows the control / data processing cabinet of the APF system. Figure 4 shows a PF duct D_n 508 of an OP650 boiler with installed measuring probes.

Fig. 3. Control / data processing cabinet of the APF system

Fig. 4. Measuring probes of the APF system installed on a PF duct of an OP650 boiler

The APF system gives the option to visualize the monitored values against time as well as presenting the instantaneous values. Data from the APF system is transmitted to the boiler control system.

The sub-system for monitoring the average PF velocity, forming a part of the APF monitor, may also be used for measuring the average velocity and flow-rate of primary, secondary and OFA air.

Advantages of this method include its high accuracy (about 2%) and the fact that only 2 measuring probes are installed in a duct of circular or rectangular cross-section. The probes may be installed in temperatures up to 800˚C. The effect of moisture content and particulate content in air on measurement accuracy can be described as negligible.

MICROWAVE CARBON-IN-ASH MONITOR

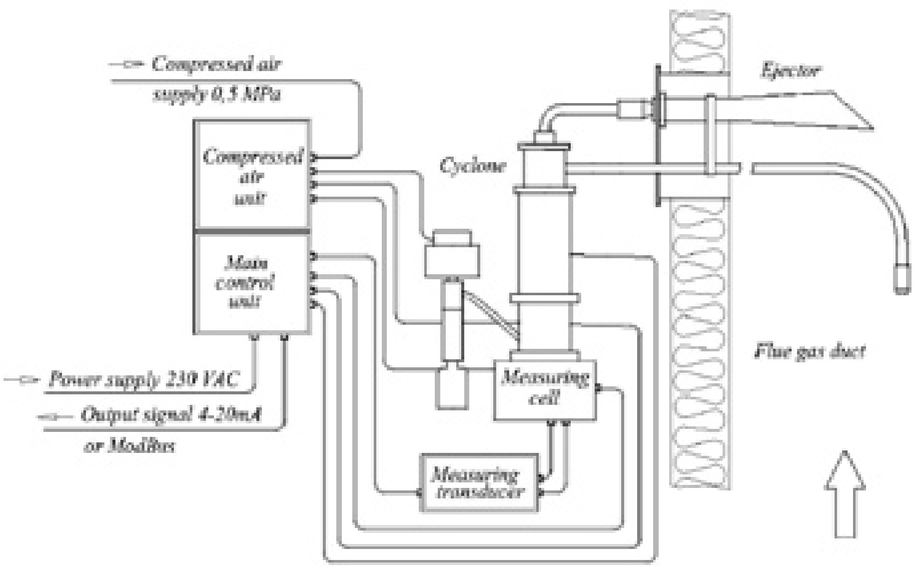


Fig. 8. Construction diagram of the AWP4 monitor

The new AWP4 monitor calculates the mass fraction of carbon in a fly ash sample by analysing the resonance parameters of an electromagnetic wave in the measuring cell, where the ash sample is located during the measurement [3].

Flue gas with suspended ash particles is drawn from a flue gas duct through the sampling probe into the cyclone. Inside the cyclone, ash is gravitationally separated from the flue gas and falls into the measuring cell of the AWP4 monitor. Subsequently, an ejector redirects the flue gas into the flue gas duct. After the measuring cell has been filled with ash, the measurement of electromagnetic radiation parameters is done inside the cell. After the end of a measuring cycle, the control unit of the monitor opens the compressed air valve and the ash sample is removed to the flue gas duct.

After the compressed air valve has been closed, the ash starts to fall into the measuring cell again, and another measuring cycle is initiated. Depending on the boiler load, a measuring cycle lasts from 2 to 4 minutes. During calibration or while verifying the accuracy of the device, it is necessary to draw a sample from the resonator chamber in order to calculate C_{pl} using laboratory methods. To be able to do this, the instrument has been fitted with an automatic ash sampling system that extracts a sample from the resonator chamber and places it in the sampling bottle. Thanks to appropriate pressure distribution, the sample is pneumatically transported from the resonator chamber to the sampling bottle. The relationship between the parameters of electromagnetic resonance and the carbon-in-ash (C_{pl}) value established by means of laboratory analysis, allows to calibrate the instrument or verify its measuring accuracy. The effect of coal type/grade on measurement accuracy is negligible – ash components other than coal do not have as big an impact on the measured signal as coal, so their varying content in ash does not affect the accuracy of C_{pl} measurement. Correction measurements have become redundant – they are necessary only in systems utilizing the optical method. AWP4 system requires only a single calibration measurement during commissioning of the instrument. The relative measurement error is twice lower than in case of the optical measurement method. The new microwave carbon-in-ash monitor requires almost no input from the end-user – its servicing has been reduced to periodic replacement of mechanically worn components (abrasive wear of their surfaces caused by ash). Remote diagnostics of the instrument is possible, thanks to a modem built into the device. This allows the manufacturer to assess the performance of the instrument and, if required, remotely modify its settings. The AWP4 carbon-in-ash monitor provides the end-user with near real-time information on the combustion process, which makes the information suitable for use in a PF combustion optimisation process. This is a considerable advantage over conventional C-in-A monitors sampling from the ESP (electrostatic precipitator) hopper, which give the end-user information delayed by 30–90 minutes and hence useless in terms of combustion optimisation. It should be pointed out that, unlike in the LOI (loss-on-ignition) method, where these compounds may cause considerable errors, sulfates and carbonates contained in fly ash do not have any effect on the measurement accuracy. The system disadvantage is that, at varying ash moisture content, AWP4 readings are highly erroneous. The effect of ash temperature on measurement accuracy can be described as negligible (in the temperature range above the dew point). The AWP4 carbon-in-ash monitor installed on a wall of an OP-230 boiler is presented in figure 9.

Fig. 9. AWP4 carbon-in-ash monitor installed on an OP-230 boiler

Industrial trials were carried out at Łódź Heat and Power Plant (EC IV – boiler OP 230). At the moment, in Poland there are 7 installed and operational AWP4 carbon-in-ash monitors.

Both measuring systems were developed with financial support from the Innovation Centre of the Polish Association of Engineering Associations, granted within the scope of the following projects: ROW-229/2003 and ROW-573-2004.

3. OPPORTUNITIES AND THREATS FACING MICRO INNOVATIVE COMPANIES IN POLAND

The obvious opportunities for the development of innovative micro companies in Poland include:

- Size of the Polish market,
- Increasing number of foreign investments in Poland,
- Well educated university graduates,
- Relatively low labour costs.

However, there exist also a number of factors hindering the development of innovative technologies in Poland. Among the negative factors, two should be listed as most important ones:

- The lack of legal regulations prompting large companies to subcontract research works to universities, RTD centres or highly specialised innovative companies. The examples were set by the USA in the years 1980–81 when “The Stevenson-Wydler Technology Innovation Act” and “The Economic Recovery Tax Act” were passed. Introduction of these legal acts in the USA brought about dynamic increase in research subcontracted to universities and RTD centres, particularly in the fields of pharmacy and biomedicine. Of course, the future legal regulations in Poland would have to take into consideration some of the negative consequences that were observed in the USA, as well as the specific character of Polish economy.

- The lack of legal regulations encouraging to write, submit and protect intellectual property rights in general and patents in particular. On the one hand, such a legal act should give strong motivation to authors and innovators to patenting their solutions and, on the other hand, should provide grants for patent owners covering some of the costs of patent application process. If the development of innovative and patentable technologies and products is to be fostered, both described mechanisms are of vital importance. It can easily be proven that even if several percent of patents subsidised in the course of patent application process were successfully commercialised, profits from introducing new products into the market would reimburse the grant costs.

Further factors adversely affecting the development of innovative technologies in Poland include:

- The lack of effective support for innovative micro companies in the form of tax breaks and grants for research and investments (eg. into laboratory infrastructure or test stands),
- The lack of support for micro companies enabling effective distribution of their high-technology products abroad. An innovative micro company with a technologically and commercially competitive product, needs firm support to be able to establish business relationship with appropriately placed and reliable distributors abroad. Additionally, a partial refund of first sale costs in the new market would be a very valuable support instrument for micro companies,
- It is worth to point out such governmental initiatives as “the technological loan” or the latest instrument made available to companies – “the technological initiative I.” However, problems with these instruments include: (1) limited availability of technological loans (relatively low budget of this scheme combined with restrictive surety requirements); (2) very complicated application procedures; (3) different grant availability for Research and Technological Development Centres and small innovative companies, despite the fact that very often research works of similar scientific standard can be carried out in both these types of institutions.

4. SUMMARY

The paper provides concise description of the history, achievements and the key technological developments of KWANT, an innovative micro company based in Cracow. From its beginnings in 1997, KWANT’s business activity has concentrated on design, development, fabrication and installation of highly specialised pulverised fuel combustion control systems for the power generation sector. In 2006, a technology for “Pulverised fuel combustion control in power generation boilers” developed by KWANT was awarded the prestigious title of the “Polish Product of the Future.”

Opportunities and threats facing innovative micro companies in commercialising their high-tech products have been characterised, allowing for KWANT's considerable experience in this field. Governmental initiatives fostering innovation-oriented actions of companies have been described as very valuable. However, it was also pointed out, that the support mechanisms intended to prompt the development of innovative products and technologies are still in their early stage and require intensive actions oriented towards preparation of appropriate legal regulations, increasing the financial resources for basic and industrial research and encouraging large companies to subcontract research works to RTD centres. What is more, it is very important that the innovation-oriented support schemes offer assistance to innovative micro companies which, utilising their considerable potential, are able to effectively carry out research works as well as commercialising the developed high-tech products.

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[2] NIEWCZAS B., KITA M.: Optymalizacja procesu spalania z wykorzystaniem ciągłego pomiaru przepływu mieszanki pyłopowietrznej [Optimisation of the Combustion Process Utilising the On-Line Monitoring of Pulverised-Fuel Flow-Rate.], Energetyka 11/2004.

[3] NIEWCZAS B.: (2005); Mikrofalowy analizator niespalonego węgla w popiele lotnym [Microwave Carbon-in-Ash Monitor], Mat. IV Konferencji Naukowo-Technicznej Eksploatacja Maszyn i Urządzeń Energetycznych Szczyrk, 23–25 XI 2005.

Hydromega – the Innovation Company

Dr. Eng. Zbigniew ZIENOWICZ
President of HYDROMEGA Board

Born in 1958. In 1981 he has finished master studies on Mechanical Engineering Department at Technical University of Gdansk. During 1982–1988 had worked for Gdynia Shipyard in Design Department as a designer of hydraulic drives and control systems. In 1988 started independent activity, co-founder of Hydromega. In 1999 takes a doctor's degree "Research of pulsation flushing of pipelines" at Technical University of Gdansk. Since 2001 Member of Program Council of MTG hydraulic Drive and Control. In 2002 gains the doctor degree of engineering science in filed of engineering and exploitation of machines. Since 2002 member of Scientific Council of Pomeranian Scientifically – Technological Park. Author of numerous publications about hydraulic drives and controls. Active socially – vice-chairman of Council of Orłowo District and Society of Orłowo Friends. Many times decorated and awarded, privately and as a President of Board of Hydromega: 70 years Medal of Gdynia City, 80 years Medal of Marine Educational System, Badge of "Rationalizer of Gdynia Shipyard", Golden medal on Hydraulic Trades in Gdynia "Master of Hydropneumatica '96" Professional achievements: implementation to industry of pulsatory flushing method of industrial pipelines and start-up of serial production of sophisticated power packs for flushing. Project of prototype of heavy terrain vehicle with hydrostatic drive for army – Lewiatan 5 SG, in cooperation with specialists from Technical University of Gdansk. Start-up of serial production of hydraulic power units with electric and petrol engines. Technological and scientific cooperation with foreign producers from hydraulic and pneumatic branch.

Abstract

Years 80's and beginning of 90's was a period when needs of Polish national economy were not considered what resulted that development was relinquished.
During a very short period of time a big distance between research work and industry expectation appeared.
The role of research and development works were always appreciated by the company management and it was profitable.
The Pomeranian Quality Award opened the way for Hydromega to take profit from R&D works co-financing in the framework of goal-oriented projects, also known as targeted projects.

Hydromega, as the first manufacturer in Poland, have expanded the production of oil pump with gerotor teeth system made of plastic materials.
Oil pumps gerotor plastic teeth project is a good example of efficiently invested company funds as well as highly profitable financial support of the state budget by means of subsidies for R&D works, which were received through the Polish Federation of Engineering Associations – NOT.
A prototype of the Lewiatan salvage vehicle, constructed as a targeted project was the milestone for Hydromega. Today it is the first remote control vehicle in Poland.
Development through new technology and innovation products should be very carefully planned by many years of intensive training of engineers and production staff.
We can see that in Poland the gap between market needs and supply possibility is increasing.
Paradoxically, this situation can become a great chance of developing for small and medium companies. We should not waste this opportunity.

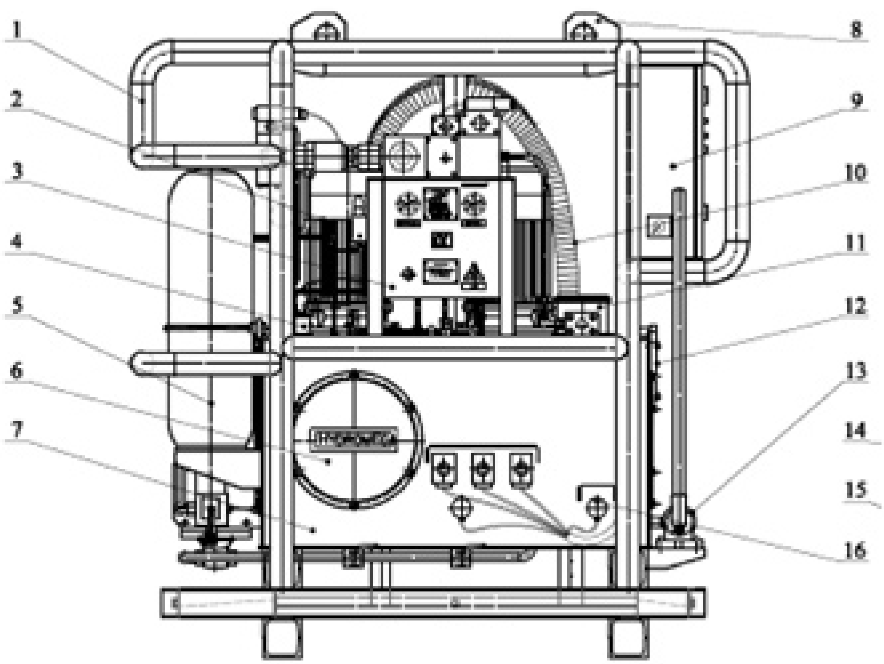
From historical necessity Poland was always an innovation country. In past Polish society was managing with the most difficult situations, thanks to this we have gained experience. This experience is used to build a new, positive picture of polish country.
After 1981 decreasing image of polish industry could be seen. Very often it was created by unaddeptable management not fitted to develop in near changing future. Blocking its development

Hydromega, established in 1988 as a company with shipyard industry roots, was built on the solid basis of experience and innovative ideas. This limited company was founded by engineers Zbigniew Zienowicz, Piotr Kubicki and Wiesław Bączyk, the former employees of The Gdynia Shipyard.

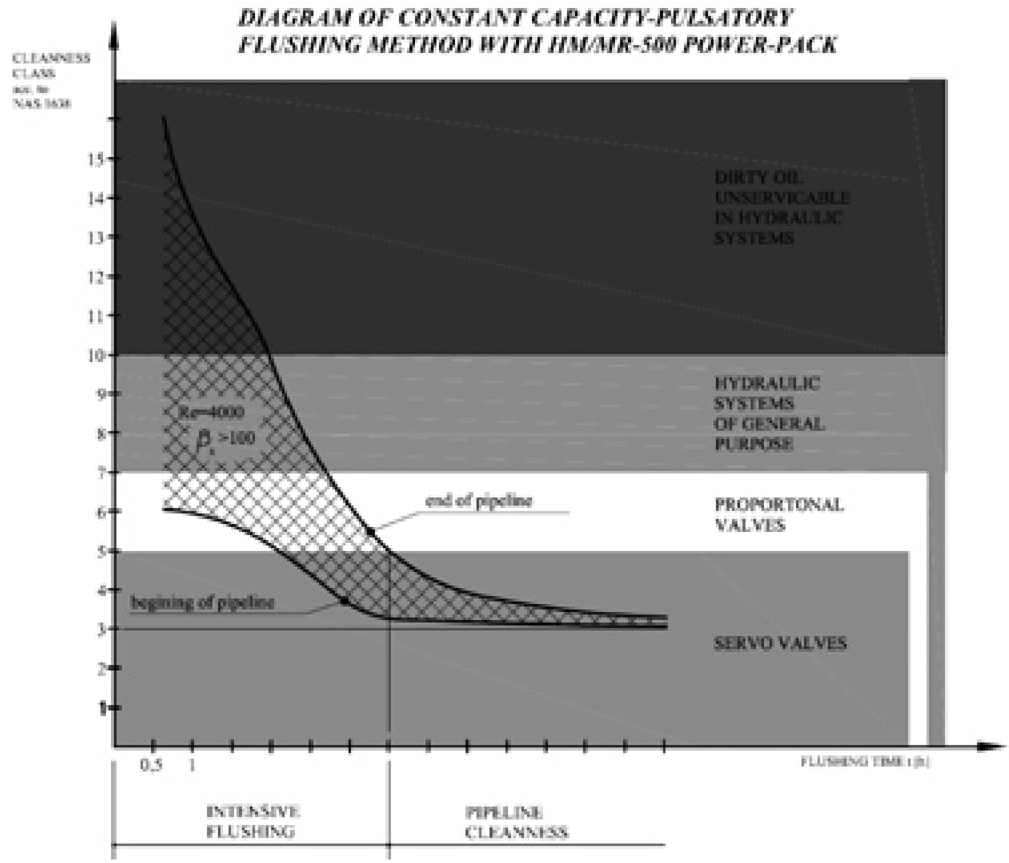
Initially, funds for the company development were taken from exporting its own technical solutions, especially to German companies. Prototypes and research works were financed from own funds of the company and many a time from the company customers, who rapidly developed production, exploiting new technologies and innovative solutions from Hydromega.
First important documents, which were created at the beginning of Hydromega activity, were:
– company mission and
– quality policy.
Assignment of purposes directed on development of company through realization of innovation policy, was a big innovation at self. During these days knowledge, professional experience and intuition with a bit of luck had big influence on companies development.

The role of research and development works were always appreciated by the company management and it was profitable. The first major success came in 1996 during Hydraulics Fairs in Gdynia, when the company won gold medal award and the “Master of Hydropneumatica ‘96” honor for hydraulic power unit HM/MR-500 and the technology of oil pipelines pulsatory flushing.

Photo 1. Flushing device HM/MR-500



Dwg. 1. Construction of flushing device HM/MR-500
(for more details please visit: www.hydromega.com.pl)



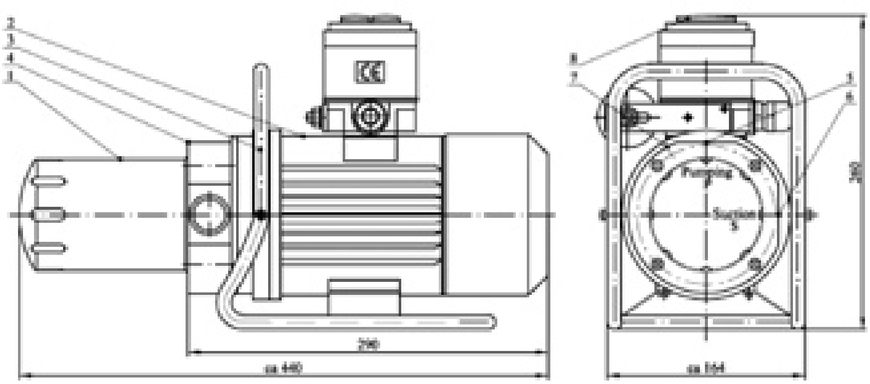
Dwg. 2. Diagram of efficiency of flushing.

By bringing this construction to the market and purchasing it to clients, Hydromega solved one of most serious shipyard industry technical problems, emerging from seventies of twentieth century. Secondly, merits of this solution were appreciated by honorable mention in the “Polish Product of the Future” competitions.
The “Pomeranian Quality Award” opened the way for Hydromega to take profit from R&D works co-financing in the framework of goal-oriented projects, also known as targeted projects. The first such type of project was done by Hydromega in the years 2002 / 2003 in cooperation with the Military Institute of Armour & Automotive Technology, Sulejówek near Warsaw. Subsequently in the years 2003 / 2004 the pump unit constructed as goal-oriented (targeted) project co-financed by Polish Federation of Engineering Associations FSNT-NOT, Warsaw was developed in cooperation with Mechanical Department of Wroclaw Technical University.

Hydromega, as the first manufacturer in Poland, have expanded the production of oil pumps with gerotor teeth system made of plastic. Initiating and continuing a mass production of gerotor pump systems appeared to be a big success of Hydromega.

Photo 2. Pump set.

PUMP SET HM/PW-10-10



Description of elements:

1. Spin-on filter .... acc. to HM/54-10
2. Electric motor.
3. Stand of the set.
4. Gerotor pump.
5. G⅜ junction – pumping – P.
6. G⅜ junction – suction – S.
7. G⅜ junction – minimes type.
8. START and STOP buttons.

Application:

Pump set HM/PW-10-10 is purposed to pumping over hydraulic oil. Gerotor pump [4] used in pump set is driven by an electric motor [2]. Oil is filtrated in the filter [1], during the set work. Everything is mounted on handy stand – grip [3]. Suction and pumping junctions are placed on a pump cover, as well as minimes junction, which provides connecting e.g. oil cleanness analyzer or filter cleanness indicator.

Table 1. Technical data.

Parameter	Value		
Power	0,75* [kW]	0,55** [kW]	
Capacity	10 [dm^3/min]		
Pressure	0,5 MPa		
Filtration precision	5 µm	10 µm	25 µm
Rated voltage	230 V		

* – recommended electric motor power for continuous set running.
** – recommended electric motor power for discontinuous set running.

Dwg. 3. Construction of Pump set.

Oil pumps gerotor plastic teeth system project is a good example of efficiently invested company funds as well as highly profitable financial support of the state budget by means of subsidies for R&D works, which were received through Polish Federation of Engineering Associations – NOT.

To a large extent, expansion of the company was stimulated by regular growth of expenses for research and development works as was assumed in long-term strategy. A prototype of the Lewiatan salvage vehicle, constructed as a goal-oriented (targeted) project was the milestone for Hydromega. The first Polish non-manned vehicle as the result of cooperation with WAT Military University, Warsaw was the next step in the same direction. Today it is the first Polish unmanned vehicle.

Photo 3. Lewiatan.

Photo 4. Lewiatan.

“The Pitchfork of Innovation” award with the Innovation Certificate for the year 2006 as well as the honorable mention of Pomeranian Innovation Leader in advanced product category were prestigious prizes for this non-manned vehicle.

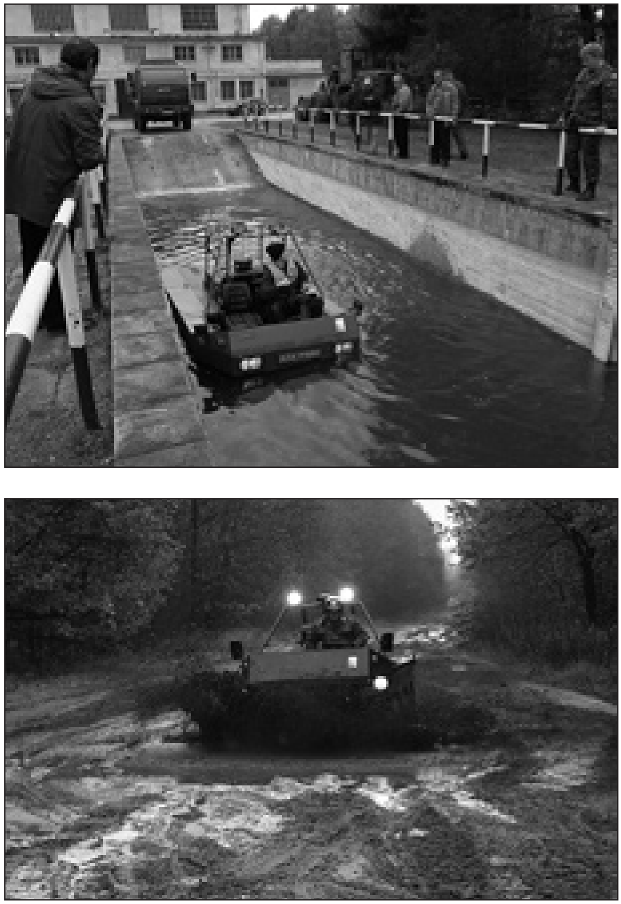


Photo 5. Lewiatan during tests.

“Science for Innovation” conference arranged by the Ministry of Higher Education and Science as well as the Polish Federation of Engineering Associations FSNT-NOT combined with the “Polish Innovators” exhibition was an opportunity for Hydromega to present this non-manned Lewiatan salvage vehicle. An arousing big interest of participants and visitors was a real confirmation of its success.

Photo 6. Lewiatan during “Polish Innovators” trade.

The team of 51 employees works for Hydromega, which is a good example of an SME working with a huge cooperation network. The major strength of the company is its staff, being graduates of Gdańsk Technical University with wide experience in engineering and constructing, gained in industry hydraulics projects.

Cooperation with industrial institutes and higher education schools is profitable. Numerous contacts with scientists who understand industrial needs help national innovation to be expanding branch of economy. Nevertheless, the amount of commercialization of scientific researches is too low.

It could be said with a bit of satisfaction that each zloty, each euro, each dollar invested in R&D works give multiplied profit for the company, gaining a good money year by year. These are the strongest points in Hydromega projects succeeded in its activity:

- Hydraulic installations flushing technology with hydraulic power unit HM/MR-500 which were appreciated by honorable mention in the ‘Polish Product of the Future’ competitions as well as a bronze medal of World Fairs of Inventions, Scientific Researches and New Techniques, Brussels EUREKA 2005;
- Lewiatan salvage vehicle with hydraulic instrumentation comprising the project itself as well as its preparing to mass production. It could be used for rescuing actions after disasters being prepared to work in a non-manned manner in radioactive and chemical contaminated environment.

Hydromega run R&D activity also on its own. It was combined with investments in measurement, monitoring and control systems, also comprising additional training and competences upgrading for employees. Results of these works also help to cope with current challenges which make matching clients needs to be hard and complex.

- Harbour devices could be good examples of them – two-level loading-platforms as well as one-level ones were just installed at Gdynia harbour for the Stena Line Ferry Terminal.

Photo 7. Platform during unloading.

Photo 8. Movable platform.

Photo 9. Movable platform with A1 motorway at back.

Photo 10. Platform during night.

Hydromega is an eighteen years old company – its maturity means that the Innovative Company is a good, if not the only solution for gaining success today and in the future as well. Consistency and systematic work appeared to be a profitable idea for the company prosperous progress.

Innovativeness of Polish SMEs in the Context of Integration with the European Union

Prof. Ryszard Borowiecki
Barbara Siuta-Tokarska, Ph.D.
University of Economics in Cracow

Prof. Ryszard Borowiecki – Executive Chancellor at the University of Economics in Cracow and the Head of the Department of Economics and Organization of Enterprises. Directions of his research and scientific output include: theory, functioning and development of enterprises; economic analysis and diagnosis; management of economic organizations and institutions; strategies of capital management in enterprises; restructuring and privatization of enterprises; methodology and practice of enterprises' valuation. Author, co-author or scientific editor of 58 monographs, studies and dissertations, 18 manuals and lecturer run off on the duplicator, 99 scientific articles, 84 conference papers, 63 scientific for the general public, interviews and editorial discussions. He is also the author, scientific supervisor and co-author of 104 non-published studies, scientific grants and expert reports.

Barbara Siuta-Tokarska, Ph.D. Econ – lecturer at the University of Economics in Cracow in the Department of Economics and Organization of Enterprises. The author or co-author of more than 30 articles and presentations concerning especially: the functioning and development of SMEs, foreign direct investment and innovativeness in enterprises. In 2007 the author of the doctoral-work entitled: "The economical and social consequences of integration of Poland with European Union for the functioning and development of SMEs in Poland".

Abstract

In the article entitled "The Innovation of SMEs in Poland in the Context of Integration with European Union" the situation concerning the innovation in Polish industrial and service enterprises has been presented – the present and traditional one. The authors pointed on some changes and possibilities of increasing the innovation in SMEs after the accession of Poland to European Union with using European Union funds and business connections of Polish SMEs with companies operation in EU market. Also some relations *of macro and micro-environment to the resources of enterprises have been described. Other categories of factors influencing on innovation activity have been included in the article.*

1. INTRODUCTION

The requirements of the contemporary market force the enterprises to make themselves distinguished from their competitors. One of the factors which contribute to the maintenance of this requirement and at the same time influence the development of an enterprise is innovation. The term innovation was introduced for the first time to the economic sciences by Joseph Schumpeter in 1911. Schumpeter related the term innovation to five cases[1]:

- "introduction of a new product which the consumers have not known before, or a new species of a product;
- introduction of a new production method so far not tested in a given area of industry;
- opening of a new market, i.e. such market on which a given type of domestic industry has not operated before, disregarding the fact whether this market existed before or not;
- obtaining a new source of raw materials or semi-finished products and disregarding the fact whether the source has already existed or had to be created;
- introduction of a new organisation of a given industry, i.e. creating a monopoly or breaking it."

It is worthwhile to emphasise the fact that Schumpeter distinguished three subsequent stages in the process of introducing an innovation: invention, innovation and distribution. In this case there is a distinction between the inventive activity and innovation, which requires that new processes and products have economic values, which is indicated by their commercialisation[2]. Therefore, inventions which have not been implemented cannot be treated as innovations.

According to the current Oslo methodology,[3] also referring to the innovation statistics – innovative activity is understood as "… a series of activities of scientific (research) character, technical character, organisational character, financial and trade (commercial) character, whose objective is development and implementation of new or significantly improved products and processes, whereas these products and processes are new at least from the point of view of the company introducing them"[4]. On the basis of the above

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[1] W. Janasz, K. Kozioł, "Determinants of Innovative Activity of Enterprises" [Determinanty działalności innowacyjnej przedsiębiorstw], PWE, Warsaw 2007, p. 12.

[2] "Innovative Activity of Enterprises in the Services Sector Between Years 2001–2003" [Działalność innowacyjna przedsiębiorstw w sektorze usług w latach 2001–2003], Central Statistical Office of Poland, Warsaw 2005, p. 127.

[3] The Oslo methodology was designed at the end of the 1980's by the OECD experts, under the aegis of the NESTI group on the basis of the experiences of the Scandinavian countries, Germany, France and Italy. It constitutes a generally accepted international methodological standard, which is currently used in all countries conducting statistical research on innovations, and published in the international methodology book – the Oslo Manual.

[4] "Innovative Activity of Enterprises in the Services Sector Between Years 2001–2003" [Działalność innowacyjna przedsiębiorstw w sektorze usług w latach 2001–2003], op. cit., p. 118.

methodology, four types of innovations can be distinguished: products, innovations – processes, organisational innovations and marketing innovations. Pic. 1 presents types of these innovations on the basis of the criterion of a carrier and subject of innovation.

According to J. Gordon, assuming the criterion of the range of impact, it is possible to distinguish innovations which take place within an enterprise and outside an enterprise[5]. On the other hand, among the major types of innovative activity are[6]:

- research and development activity (R&D);
- purchase of knowledge in the form of patents, licenses, technical services, etc. (the so-called immaterial technology);
- purchase of the so-called material technology, i.e. "innovative" machines and equipment indispensable for implementing new process and production of new products.

P. Drucker distinguished seven major sources of ideas which may inspire development of enterprising innovations[7]:

1. unexpected event (success or failure);
2. inconsistency (between individual economic realities in a given industry, between the reality and its perception, between the imagined and the real needs of the customers, between scientific methods e.g. of soil cultivation and the possibilities of their practical application, e.g. in field conditions);
3. process needs;
4. structures of industry and market;
5. demography;
6. changes in the manner of perception;
7. new knowledge.

The source of enterprising innovations may also be the activity within the sphere of management, market and institutional environment. Pic. 2 presents areas of origin for inspirations for enterprising innovations.

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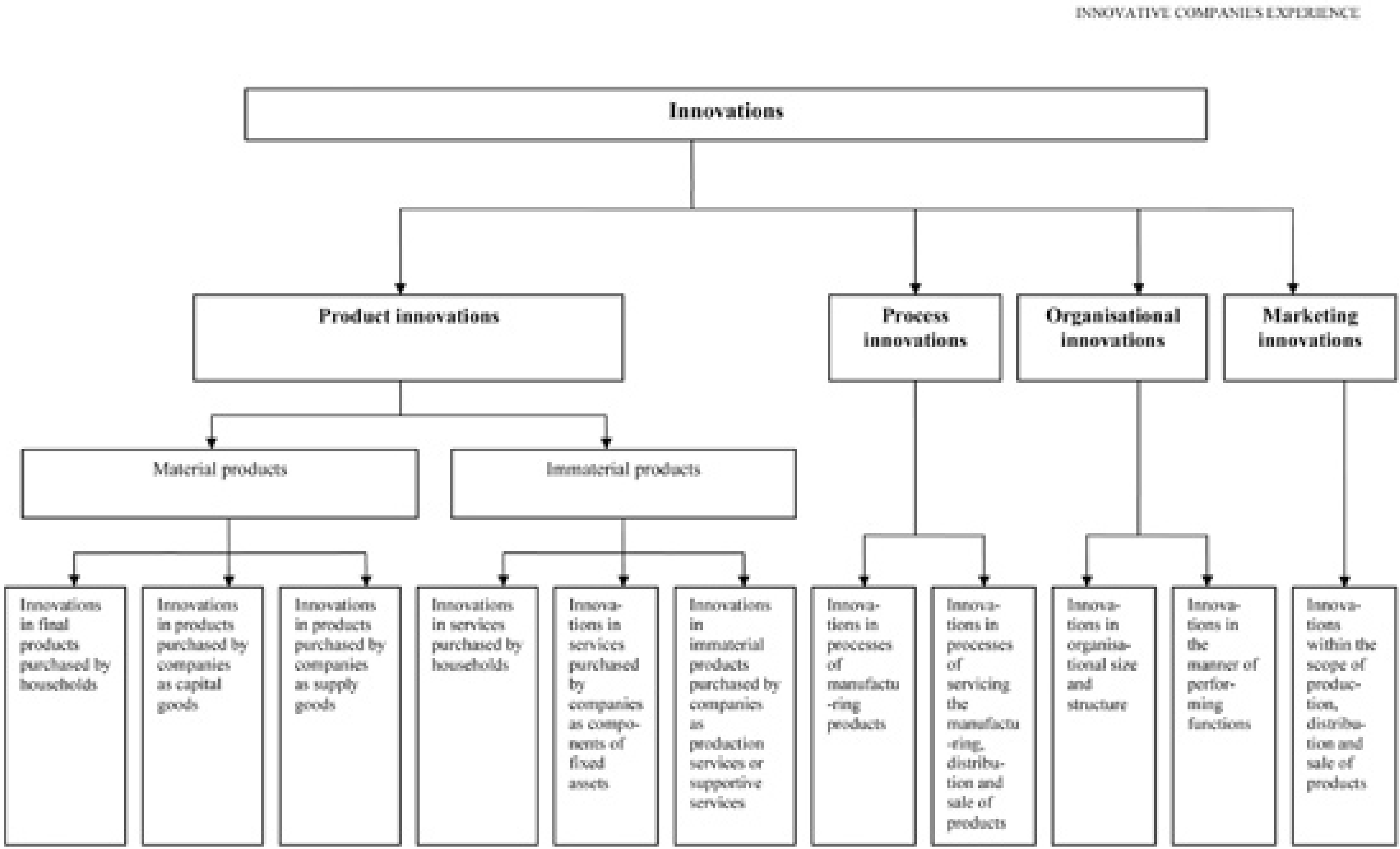
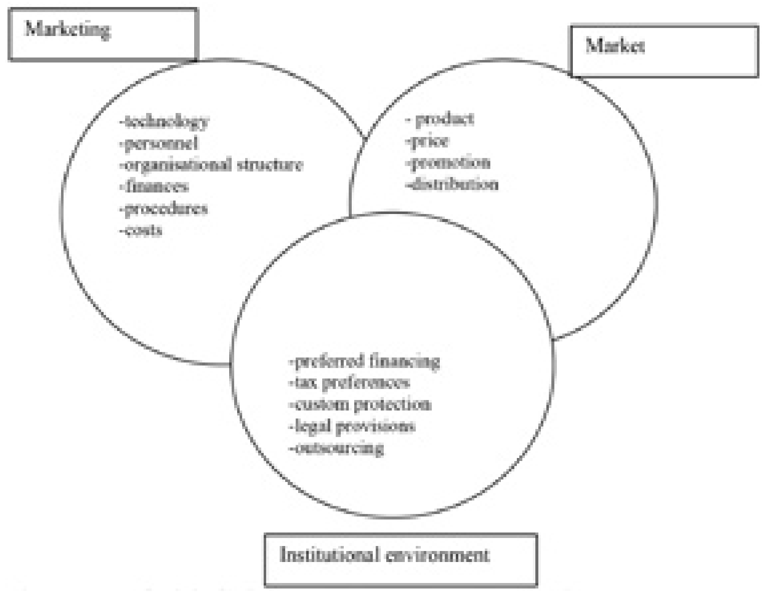
[5] Ibidem, p. 123.
[6] J. Gordon, "How to Pave the Way for Innovations?" [Jak utorować drogę innowacjom], Życie Gospodarcze, 1978, No. 31.
[7] P.F. Drucker, "Innovation and Entrepreneurship" [Innowacja i przedsiębiorczość], PWE, Warsaw 1992, p. 39–143.



Pic. 1. Types of innovation distinguished on the basis of the carrier criterion and the subject of innovations

Source: Own analysis on the basis of: W. Świtalski, "Innovations and Competitiveness" [*Innowacje i konkurencyjność*], Wyd. Uniwersytetu Warszawskiego, Warsaw 2005, p. 90.



Pic. 2. Areas of origin for inspiration for enterprising innovations
Source: B. Rogoda, "Entrepreneurship and Innovations" [*Przedsiębiorczość i innowacje*], Wyd. AE w Krakowie, Kraków 2005, p. 20.

The term "innovation" denotes a tendency and an ability of an enterprise to develop and acquire new and improved products, provide services or apply technologies[8].

An enterprise is considered innovative when it complies with specific conditions, such as[9]:

- conducts development and research works in a wide range or performs purchases of projects, new products or technologies;
- assigns relatively high financial resources for this activity;
- systematically implements new scientific and technical solutions;
- represents a large share of novelty in general production referring to products and technologies;
- constantly introduces innovations to the market.

Making a reference to the theory of economy referring to innovation – in a definition formulated by J. Schumpeter – it is assumed that small and medium-size enterprises introduce innovations rarer than large enterprises. In order to verify the validity of this definition on the example of Polish enterprises – with particular attention given to the small and medium-size enterprises sector – statistical data were analysed referring to innovativeness of these enterprises and the results obtained in this respect.

[8] W. Janasz, I. Leśkiewicz, "Identification and Implementation of Innovative Processes in an Enterprise" [Identyfikacja i realizacja procesów innowacyjnych w przedsiębiorstwie], Wydawnictwo Naukowe Uniwersytetu Szczecińskiego, Szczecin 1995, p. 46–47.
[9] A.H. Jasiński, "Innovations and Innovative Policy" [Innowacje i polityka innowacyjna], Wydawnictwo Uniwersytetu w Białymstoku, Białystok 1997, p. 36.

2. INNOVATION OF INDUSTRIAL AND SERVICE ENTERPRISES IN POLAND, WITH PARTICULAR ATTENTION GIVEN TO THE SMES SECTOR

In the research conducted by the Central Statistical Office of Poland regarding innovative activity of enterprises, published in an article entitled: "Innovative Activity of Enterprises in the Services Sector In Years 2001–2003", the group of service enterprises included companies conducting the following types of business:

- wholesale and consignment trade, with the exclusion of trade in vehicles and motorcycles;
- land transportation, pipeline transportation, water and air transportation;
- activity supporting transportation (activity related with tourism);
- post and telecommunications;
- financial agency;
- IT;
- science;
- activity within the scope of architecture and engineering;
- technical research and analyses.

The term "innovative industrial enterprises" encompasses enterprises operating in three major activity sections:

- mining;
- industrial processing;
- production and provision of electric energy, gas and water.

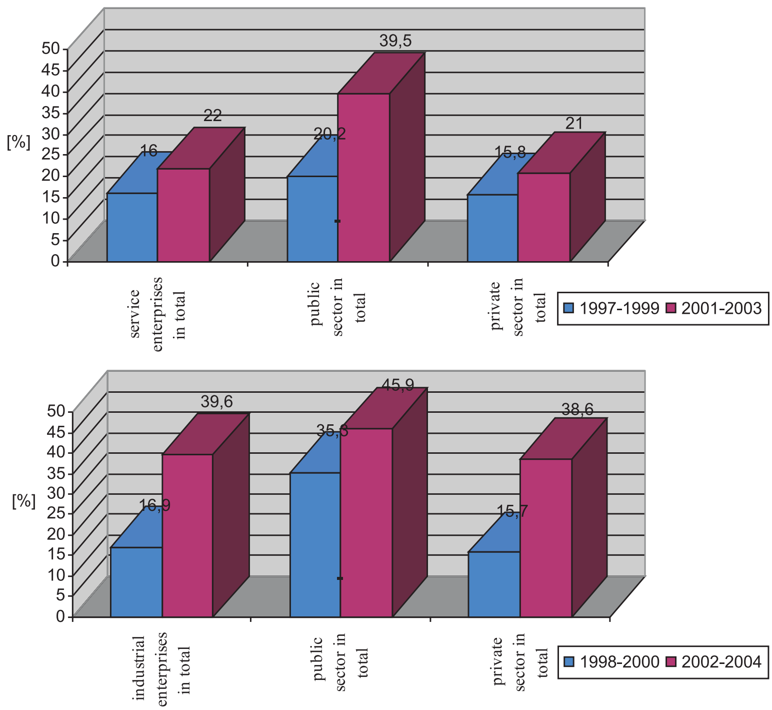
In the research of the Central Statistical Office of Poland regarding innovativeness of industrial enterprises in years 1998–2000, units with more than nine employees were taken into account (i.e. small, medium-size and large enterprises) in the section of industrial processing and units above forty-nine employees (i.e. medium-size and large enterprises) operating in the section of mining and production and provision of electric energy, gas and water. Similar research was conducted by the Central Statistical Office of Poland and published in the form of a report entitled "Science and Technology in the year 2004"[10] where the research included only enterprises with more than forty-nine employees.

Pic. 3 illustrates innovativeness of service and industrial enterprises according to the sector of operation.

Depending on the type of activity, the level of innovativeness of enterprises in Poland is diversified. It is higher in industrial enterprises (in total approx. 40% in the years 2002–2004) in comparison with service enterprises (in total approx. 22% in the years 2001–2003). The higher level of innovativeness in public sector enterprises is noted both in industrial and service enterprises. In industrial enterprises, the level of innovativeness is not as diverse depending on the sector of operation (in the years 2002–2004 in private sector – 38.6% and in public sector – 45.9%) in contrast to service enterprises (the difference was almost two-fold in the years 2001–2003).

[10] Science and Technology in Poland in the Year 2004, Central Statistical Office of Poland, Warsaw 2006.

The research conducted by the Central Statistical Office of Poland in industrial enterprises indicates that only 17% of small, 40% of medium-size and 67% of large enterprises implemented innovations between the years 2002 and 2004[11]. The number of enterprises which undertook the initiative of implementing innovations (not always completed successfully) was much higher, i.e. 21% of small enterprises, 50% of medium-size and 90% of large enterprises; however these numbers are much smaller than in the EU countries (the first 15 member states), where as many as 39% small enterprises, 60% of medium-size enterprises and 77% of large enterprises undertook such an initiative[12].



PPic. 3. Innovativeness in service and industrial enterprises in Poland according to sector of activity in years 1997–2004 (in % of enterprises in total)

Source: Own analysis on the basis of: Innovative Activity of Industrial Enterprises Between Years 1998–2000,
Central Statistical Office of Poland, Warsaw 2002, p. 41, Science and Technology in the Year 2003,
Central Statistical Office of Poland, Warsaw 2005, p. 100, Science and Technology in 2004, Central
Statistical Office of Poland, Warsaw 2006, p. 117, Innovative Activity of Enterprises in the Services
Sector between Years 2001 and 2003, Central Statistical Office of Poland, Warsaw 2005, p. 33

[11] Report on the Status of Small and Medium-size Enterprises Sector in Poland between Years 2004–2005, Polish Agency for Enterprise Development, Warsaw, 2005, p. 38.
[12] Ibidem, p. 38–39.

Service enterprises and industrial enterprises financed their innovative operation mainly from their own resources. Another source of financing for innovative activity of service enterprises were funds received from the state budget and in the case of industrial enterprises – bank credits.
Table 1 presents the value of outlays on the operation of industrial enterprises and service enterprises according to the objective of allocating them and classes of enterprise size in the year 2003.

Table 1. Outlays on innovative activity in industrial and service enterprises in Poland according to the type of innovative activity and classes of enterprise size in the year 2003 (current prices in PLN million).

Specification	**Enterprises in total**	**Small enterprises**	**Medium-size enterprises**	**Large enterprises**
Outlays in total, where:				
Industrial	15511.6	-	2801.3	12710.3
Service	9318.2	1189.3	2050.0	6078.9
1. Research and development activity				
Industrial	1716.3	-	181.8	1534.5
Service	2638.2	182.0	935.3	1520.9
2. Purchase of technology in the form of documentation and rights				
Industrial	743.7	-	54.4	689.3
Service	577.0	13.8	59.1	504.1
3. Software				
Industrial	-	-	-	-
Service	728.0	100.2	150.5	477.3
4. Investment outlays on technical machines and equipment				
Industrial	9813.9	-	1726.2	8087.7
Service	3526.1	612.4	569.8	2343.9

Specification	Enterprises in total	Small enterprises	Medium-size enterprises	Large enterprises
Outlays in total, where:				
5. Investment outlays on structures and lands				
Industrial	2417.0	-	728.9	1688.1
Service	1135.9	200.6	228.6	706.7
6. Training of personnel related with innovative activity				
Industrial	26.7	-	4.3	22.4
Service	159.2	23.5	21.4	114.3
7. Marketing related with innovative activity				
Industrial	213.0	-	22.6	190.4
Service	234.8	47.6	77.5	109.7
8. Other preparation to introduce technological innovations				
Industrial	-	-	-	-
Service	319.0	9.2	7.8	302.0

Note: Absence of entries in the third column regarding small industrial enterprises and in point 3 and 8 according to the allocation of outlays in industrial enterprises is caused by the absence of appropriate data in the publication “Science and Technology in the Year 2003”.

Source: own analysis on the basis of: Innovative Activity of Enterprises in the Services Sector in the Years 2001–2003, Central Statistical Office of Poland, Warsaw 2005, p. 40, Science and Technology in Poland in the Year 2003, Central Statistical Office of Poland, Warsaw 2005, p. 103.

Service enterprises most often allocated their funds to the purchase of: technical machines and equipment, this value amounted to PLN 3,526.1 million, which constituted approx. 38% of the total funds allocated for innovative activity. An important position was occupied by research and development activity – PLN 2,638.2 million, i.e. 28.3%.

Taking into account the classes of enterprise size it has to be stated that small and medium-size enterprises spent PLN 1,117.3 million on the R&D activity, i.e. approx. 42% of the total outlays made for this activity by all enterprises in the services sector.

A large share of small and medium-size enterprises was also noted in outlays made for marketing related with the conduct of innovative activity – PLN 125.1 million, i.e. 53% of the total outlays made for this type of innovation.

Small and medium-size enterprises made relatively small outlays within the scope of innovations regarding other preparations for introducing technological innovations (PLN 17 million, i.e. approx. 5% of total outlays among innovative enterprises for this type of innovations) and innovations regarding purchase of complete technology in the form of documentation and rights (PLN 72.9 million, i.e. approx. 13% of total outlays incurred for this type of innovation).

Table 1 also includes the value of outlays for innovative activity in industrial enterprises. The data indicate that the main objective of outlays for innovative activity among industrial enterprises were outlays for investments in the form of purchase of machines, equipment and means of transportation. An important objective of the innovative activity of industrial enterprises was also outlays incurred for buildings, structures and lands. Medium-size enterprises (similarly to large enterprises) incurred outlays mainly for investments comprising purchase of machines, equipment and means of transportation and buildings, structures and land.

It is necessary to note that the relatively small share of outlays allocated for research and development activity is quite an alarming phenomenon. This share amounted to approx. 0.6% of the National Gross Product (where only 25% were business funds), whereas other countries in the EU allocate approx. 1.8% of the National Gross Product for this objective[13]. Small and medium-size enterprises conduct research and development works less often, which is influenced by high risk, as well as long duration of such works. In the period 2002–2004, in Poland on average 9% of enterprises in total made investments in the R&D activity, including 5% of small companies, 14% of medium-size companies and 34% of large companies[14].

The structure of innovative outlays in our country is characteristic for countries with traditional economy, where mainly purchased technologies are implemented. This refers to the SMEs sector in particular, which is dominated by investment outlays which in Poland constitute on average 87% of outlays for industrial innovations. In the first 15 member states of the EU investment outlays constitute only approx. 22% of innovative outlays[15]. Modernisation and change in the structure of innovative outlays of the Polish SMEs seems necessary, so that investment outlays contribute to creating a technical database in enterprises with the aim of conducting their own research works.

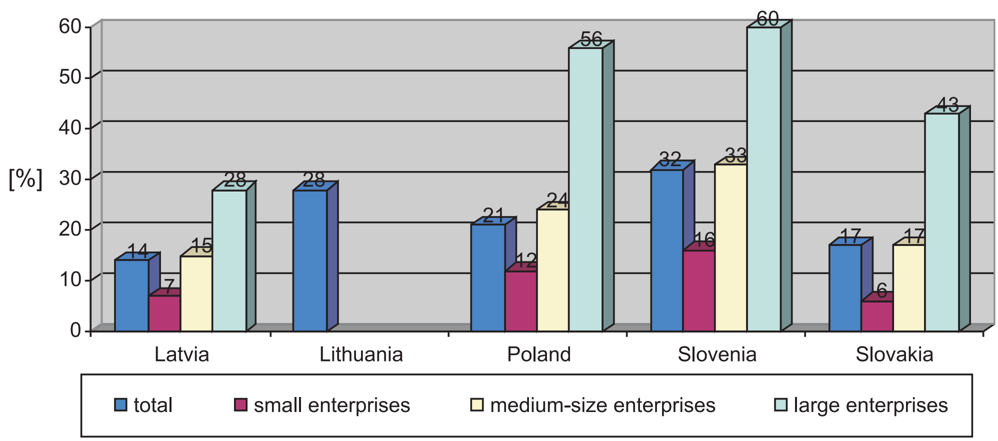
Purchase of a complete technology in the form of documentation or rights constitutes only 2% of innovative outlays of SMEs, whereas in the first 15 member states of the EU ("EU-15") purchase of licences, patents and software amounts to approx. 4% of these

[13] Report on the Status of the Small and Medium-Size Enterprise Sector in Poland in Years 2004–2005, Polish Agency for Enterprise Development, op. cit., p. 40.
[14] Ibidem, p. 40
[15] Ibidem, p. 42

outlays on average[16]. Also outlays on training related with innovations introduced in Poland are 10 times lower than in the enterprises in the EU-15 countries.

3. EVALUATION OF INNOVATIVENESS OF POLISH ENTERPRISES IN THE PERIOD BEFORE POLAND'S ACCESSION TO THE EUROPEAN UNION IN THE LIGHT OF INNOVATIVENESS OF ENTERPRISES OF SELECTED EUROPEAN COUNTRIES AND THE POSSIBILITY OF ITS INCREASE IN THE POST ACCESSION PERIOD

Comparison of the level of innovativeness of enterprises in countries which were candidates to the European Union (10) is permitted by the data presented in Pic. 4. They refer to the share of innovative enterprises operating in industries of five countries, i.e. Latvia, Lithuania, Poland, Slovenia and Slovakia. The picture illustrates a share of innovative small, medium-size and large enterprises without taking into account micro-enterprises. The European statistical data show that the level of innovativeness of micro-enterprises is lower than small and medium-size enterprises[17].



Pic. 4. The share of innovative industrial enterprises according to size classes of enterprises between years 1998–2000 in selected European countries

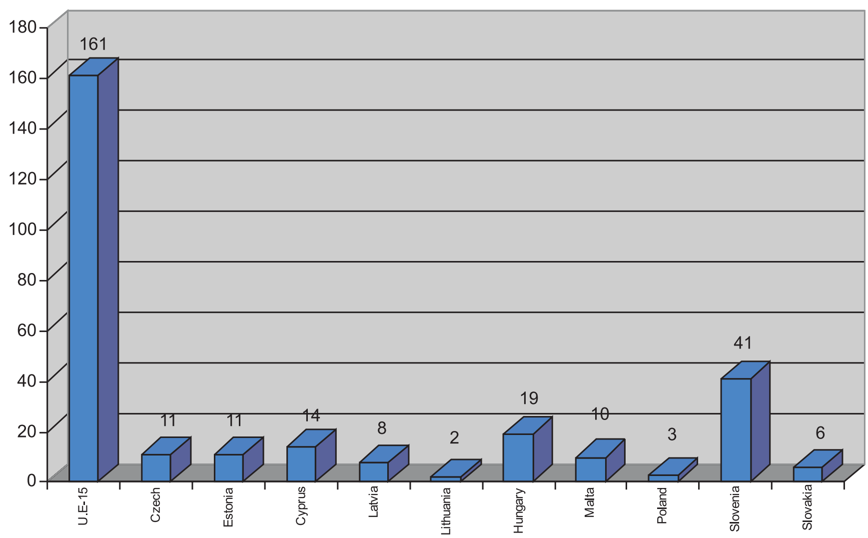
Source: M. Schiemann, SMEs in the Candidate Countries, Statistic in Focus, Industry, Trade and Services, Theme 4-5/2004, European Communities, Luxemburg, 2004, p. 6.

Data presented in Pic. 4 referring to the selected size classes of enterprises in five countries between years 1998–2000 indicate that the proportions with respect to the growth of share of innovative enterprises are a function dependent on the size of enterprises[18]. The larger the class of an enterprise, the higher the share of innovative enterprises.

[16] Ibidem, p. 43.
[17] SMEs in the Candidate Countries, European Commission, Eurostat, theme 4, Industry, Trade and Services, Luxemburg 2003, p. 58.
[18] Ibidem.

One of the determinants of innovativeness of enterprises is the share of patent applications to the European Patent Office per one million inhabitants, which is presented in Pic. 5 with respect to the European Union and the candidate countries (10).

Among the distinguished countries, the highest number of patent applications to the European Patent Office (EPO) per one million inhabitants was recorded in the year 2001 in Slovenia (41), in Hungary (19), in Cyprus (14), and in the Czech Republic and Estonia (11). In Poland, the number of such applications in the analysed year was only 3, which testifies to very unfavourable situation in this respect, in particular taking into account the fact that Poland had the highest number of enterprises among the selected European countries (10).



Pic. 5. Patent applications to the European Patent Office per one million inhabitants in 2001 in the European Union-15 and in selected European countries (10)
Source: SMEs in the Candidate Countries, European Commission, Eurostat, theme 4, Industry, Trade and Services, Luxembourg 2003, p. 59.

Undoubtedly, the Polish SMEs have the possibility of using the Community funds for increasing the level of their innovativeness. The main Community programmes addressed to the SMEs were the so-called Long-Term Programmes for Enterprises and Entrepreneurship, like the third Long-Term Programme (1997–2000) or the fourth Long-Term Programme (2001–2005). Activities included in such programmes were aimed at creating a favourable environment for the SMEs by simplifying administrative procedures, as well as making an impact on the development of SMEs by means of regulations, taxes, finances and social environment (BEST programme) and increasing the availability of information (the Euro-Info-Centre) network, promoting entrepreneurship, increasing the competitiveness of SMEs, improving their financial environment or establishing favourable legal, administrative and environmental conditions for development of innovativeness and entrepreneurship.

Implementation of specific Community programmes undoubtedly had a specific impact on the level of innovativeness and competitiveness of the SMEs which made use of them. The increase of availability of financial funds was performed by implementing the following programmes[19]:

- supporting technology-oriented activities (European Technology Facilities);
- guarantee facilities for SMEs (SME guarantee facility);
- access to capital for high-risk investments (Joint European Venture).

Also research and development programmes, such as VALU I, VALU II, NTBE-s had a specific impact on the development possibilities of the SMEs, even more due to the fact that their share in these programmes in the period of their implementation indicated growth tendency. The SMEs also had an opportunity to make use of professional trainings, mainly conducted by the European Social Fund within the framework of the Leonardo and ADAPT programmes.

Polish enterprises in the SME sector in the pre-accession period made use of PHARE and ISPA funds, which were addressed to the SMEs from the candidate countries. Among well-known programmes implemented in Poland on the basis of the Community funds it is possible to mention the following:

- programme STEP (I and II) – aimed at increasing the competitiveness of SMEs and extending their activity onto European markets;
- programme STRUDER – aimed at supporting economic development in regions afflicted by results of economic restructuring;
- programme EXPROM II – aimed at increasing the competitiveness of Polish SMEs in foreign markets;
- programme Phare 2000 – National Development Programme of SMEs, aimed at subsidising enterprises related with implementation of quality systems, introduction of new technologies and preparation of enterprises for operating at the Uniform European Market;
- programme Phare 2000 – National Export Development Programme related with granting subsidies for conduct and development of export activities;
- programme Phare 2000 – Social and Economic Cohesion offering advisory and training subsidies, as well as investment subsidies;
- and others.

The range of Community assistance expressed by the value of funds received by Poland from the European Union budget in 2004 amounted to EUR 2,793 million, where EUR 547 million was allocated to the PHARE fund, EUR 172 million to SAPARD, and EUR 273 million to ISPA[20]. The net value of transfer of Community funds (after deducting the contribution) amounted to EUR 1,554 million. Since May 1, 2004 (the date of Poland's accession to the European Union), increase and diversification of transfer of funds from the Community budget in Poland was recorded. Disregarding changes in this respect, after May 1, 2004, Poland has also had the possibility of using funds other

[19] Blajer A., Zielenkiewicz M., "Poland's Accession to the European Union – Chances and Threats for Small and Medium-Size Enterprises" [Akcesja Polski do Unii Europejskiej – szanse i zagrożenia dla małych i średnich przedsiębiorstw], Department of Micro-Economy, University of Gdańsk, Gdańsk 2007, p. 5.

[20] How to Do Business in Poland, Ministry of Economic Affairs, Warsaw 2005, p. 65.

than previously within the scope of the jointly implemented Community policy, which increases the chance of the Polish SMEs in their operation on the Uniform European Market and improvement of the level of innovativeness and competitiveness.

4. SELECTED FACTORS DETERMINING INNOVATIVE PROCESSES

The most popular classification system of factors determining innovative processes of enterprises is their division into internal factors – related with the enterprise, and external factors – resulting from the enterprise's environment.
Among internal factors are[21]:
- "financial strength of an enterprise which decides about the fact how many unsuccessful attempts does an enterprise have before achieving success; this is a very important factor, due to the fact that the R&D activity is usually burdened with high risk;
- sense of the market which decides about the fact whether a given innovation will stir the customer's interest;
- size of an enterprise, which is often related with innovativeness dynamics;
- continuity of the enterprise's management, which is related with long-term innovative processes;
- readiness and motivation of the management to undertake risks;
- threshold of entering the market, which imposes concentration (also financially) on a smaller number of project, but with the intention of achieving the highest market share possible."

On the other hand, among external factors are[22]:
- competition on the market;
- growth tendency of the market;
- rate of technical progress;
- economic conditions;
- scope of the state's impact on economy.

A different division of factors related with innovative activity is related with the policy pursued by the state and infrastructure, economy, the style of management and the standing of an enterprise. It is illustrated in Table 2

[21] W. Janasz, K. Kozioł, "Determinants of Innovative Activity of Enterprises" [Determinanty działalności innowacyjnej przedsiębiorstw], op. cit., p. 51.
[22] Ibidem, p. 51.

Table 2. Factors influencing innovative activity of the SMEs

Enterprise	Economy	State policy and infrastructure
Type of company strategy Strong and weak points of the company Education of the owner Qualifications of employees Economic impulses for employees Machine park Financial funds Economic and financial results of the enterprise Market research Information about novelties Size of the company Growth of the company Direction of activity Age of company	Competition of foreign companies Cost of implementation Risk of implementation Market characteristic	Tax system Credit Policy Environmental protection law Government support Infrastructure supporting business

Source: H. Mizgajska, "Innovative Activity of Polish Small and Medium-Size Enterprises in the Process of Integration with the European Union" [*Aktywność innowacyjna polskich małych i średnich przedsiębiorstw w procesie integracji z Unią Europejską*], Wyd. AE in Poznań, habilitation theses No.4, Poznań 2002, p. 49.

Yet another division of innovation determinants is introduced by P. Whitfield, who assumes the relation with innovator as the classification criterion. Among factors positively influencing innovativeness are[23]:

- tradition of company's achievements;
- technical progress;
- demand for innovations;
- access to funds for risky enterprises;
- competition;
- policy with respect to developmental works;
- contacts with scientific institutions.

On the other hand, among factors negatively influencing innovativeness P. Whitfield includes[24]:

- weak organisational links between departments;
- organisational inertia;

[23] P. Whitfield, "Innovations in Industry" [Innowacje w przemyśle], PWE, Warsaw 1979, p. 140–142.
[24] Ibidem, p. 140–142.

- high costs of changes;
- low position of the innovator in the company.

The factors having a negative impact on innovativeness are also dependent on economic and social factors in macro-economic scale, i.e. the economic situation, patent protection, educational system, governmental policy and the prestige of the innovator in the society[25].

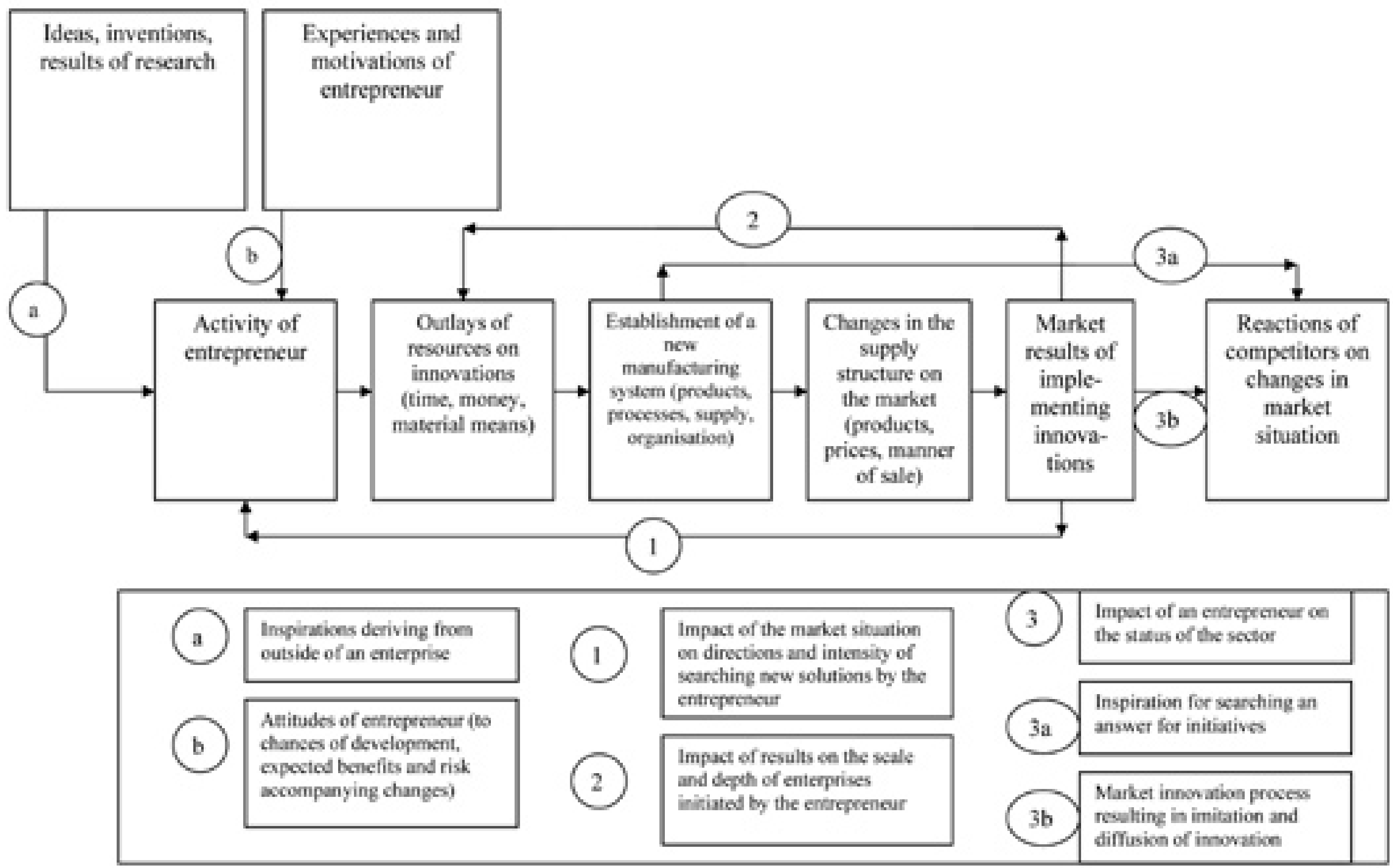
The issue of comprehending the innovative process in a small enterprise is presented in Pic. 6 in the form of a flow chart, deriving from the concept of J. Schumpeter. The developed chart was based on the assumption that innovative enterprises are initiated by an entrepreneur who is the owner and manager of an enterprise. The process chart presents the character and the manner of operation of individual relations. Loop No. 1 presents the phenomenon of observing the market situation and the impact of results of market research on directions and intensity of searching for an opportunity for introducing a change[26]. A motivation for innovations is not only the desire for profit, but also the necessity of facing the competition.

The second loop of the feedback characterises the learning process of the entrepreneur on the basis of experiences obtained from previously undertaken innovative activities. This mainly refers to the manner of implementing an innovative idea referring to the type and scale of outlays, selection of a market, etc. In a lesser degree it refers to the idea itself. The core of the idea refers to the manner of reducing the costs of manufacturing a product, lowering its price, improving the quality or introducing the product to new territorial markets. In the described situation the enterprise does not conduct its own research and development activity, but uses the services of external units if there is such a need.

Presentation of selected factors determining innovative processes in an enterprise has great significance, because it provides a basis and a possibility for evaluating the impact of these factors on the course of innovative processes in an enterprise.

[25] Ibidem, p. 140–142.

[26] W. Świtalski, "Innovations and Competitiveness" [Innowacje i konkurencyjność], Wyd. Uniwersytetu Warszawskiego, Warszawa 2005, p. 129.



Pic. 6. Diagram illustrating the process of creating an innovation and market verification of an innovation in a small enterprise

Source: W. Świtalski, "Innovations and Competitiveness" [*Innowacje i konkurencyjność*], Wyd. Uniwersytetu Warszawskiego, Warsaw 2005, p. 128.

5. CONCLUSIONS

1. Innovativeness of domestic SMEs in the period before Poland's integration with the European Union was relatively low, even though in the last years it has been gradually increasing both in industrial and service enterprises.
2. Innovativeness of the SMEs sector companies is a very important factor deciding about their development and competitiveness on economic markets, therefore it is necessary to constantly analyse, support and actively impact this sphere of operation of enterprises.
3. The innovativeness of SMEs is determined by a number of factors, dependent on the entrepreneurs themselves, the organisational, technical and economic conditions of an enterprise, state policy and local authorities' policy, who, being aware of the SMEs importance in domestic economy should support their innovative activities in a greater degree. This contributes to the fact that the enterprises function better on the Uniform European Market, and in particular in the context of Poland's accession to the European Union, as well as the fact of obtaining specific benefits by the country.
4. The issue of increase of innovativeness in Polish SMEs requires constant monitoring and evaluation of the impact of variable and diverse determinants – in order to determine the possibility of undertaking effective actions by the state, including the conditions of operating of SMEs in the Community market.

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CHRONICLE OF EVENTS
(APRIL 2006 – NOVEMBER 2007)

April 2006

Accomplishment of a thorough analysis of the conclusions from the 7th WCEE. It has been decided to include an item "Discussion on the WFEO Strategy of Mobility resulting from the 7th WCEE in Budapest" (in line with recommendations of President Kamel Ayadi) in the Agenda of the 36 CET meeting.

May 2006 – June 2006

On request of Prof. Jean Michel, Editor of the European Journal of Engineering Education (EJEE) – Official Journal of SEFI – a team of reviewers (out of CET members) was organized. Prof. Michel is preparing a joint issue of EJEE and JEE (American one) about globalization in 2007. The title of that Special 2007 Issue: Engineering Education – Pedagogic and Didactic Aspects in the Context of the Emerging Knowledge Society.

Beginning of November 2006 – October 2007

Eng. Hisham Shihaby, Vice-President of WFEO-CET & Vice-President of WFEO actively participated in discussions with Colleagues from the Institution of Engineers, Malaysia – Prof. Abang Abdullah Abang Ali and Prof. Megat Johari Mohd Noor on issues related to organization of the 8th WCEE and took part at the 8th WCEE Organising Committee meetings in Kuala Lumpur, Malaysia.

29 November – 1 December 2006

Prof. Abdel Menhem Alameddine, Lebanon, represented WFEO-CET at the UNESCO Forum on Higher Education, Research and Knowledge II Colloquium in Paris.

The most important part discussed at that meeting was the relation Industry – Government – University.
The central premise for the Colloquium was that research was a key ingredient in the institutional identity of universities and an indispensable prerequisite for a successful program of teaching and public service. The principal question that the Colloquium had

to deal with was why major differences in research intensity and capacity existed among the world's universities, and what could be done to moderate and overcome them. The Colloquium addressed the related issues of research capacity, research productivity, and research relevance and utility: research capacity was necessary, but not a sufficient condition for research productivity, and research productivity had to be assessed in terms of the utility and relevance of the research produced. The colloquium gave an overview to research capacity: the ingredients, problems and agenda for the future. It gave insight to research productivity pointing to 7 pairs of Contrasting Trends (globalization trends – national context; applied research – basic research; accountability – increased autonomy; competition – collaboration; public sector – private sector, English publications – other languages; intellectual property – intellectual philantrophy).

Some General Conclusions:

The Precarious Nature of Research in Higher Education

- Research is an endangered species, although to different degrees and for different reasons in the North and the South
- Universities (and societies) suffer from the absence, weakness, or irrelevance of research
- Basic research is particularly vulnerable because of its cost and lack of immediate utility

Major Cleavages in the World of Research and Higher Education

- Different research capacities
- Different research agendas
- Different research contexts
- Different research criteria
- Different research climates
- Different research partnerships

Looking Ahead

- Networking, cooperation, clustering
- The key role of research capacity-building
- The need for a critical discourse on the criteria for "good" research
- A new politics of research
  - Recognizing the politics of knowledge
  - Developing a political culture of research support
- The role of the Forum
  - Help overcome the isolation of scholars in the South
  - Foster research cooperation and networks south-south, but also south-north
  - Stimulate and support research on research
  - Publicize good research and good research practice
  - Become both a clearing house and a catalyst for promising programs of research training.

17–18 May, 2007

On May 17–18, 2007 an International Conference "Supporting Small- and Medium-Sized Enterprises in Engineering and Technological Innovation Activity" was organized in Cracow, Poland, by the Secretariat of WFEO-CET in cooperation with the Polish Federation of Engineering Associations. The proceedings were organized in three sessions:

- The Opening Session
- Session I – "Polish Experiences in Supporting Small- & Medium-Sized Enterprises in Engineering and Technological Innovation Activity"
- Session II – "International & National Experiences in Supporting Small- and Medium-Sized Enterprises in Engineering and Technological Innovation Activity".

The Opening Session and Session I were chaired by Prof. Józef S. Suchy, Vice-President of the Polish Federation of Engineering Associations. The Session II was chaired by Prof. Włodzimierz Miszalski, President of WFEO Committee on Education and Training (WFEO-CET).

The first day of the conference – Thursday May 17, 2007

- The Opening Session

Prof. Józef S. Suchy opened the conference and welcomed its participants on behalf of the authorities of the Polish Federation of Engineering Associations, and especially Dr. James Birch, member of the Executive Board of FEANI, Eng. Hisham a Malik Al-Shehaby, Vice-President of WFEO and Vice-President of WFEO-CET, Dr. Anthony Marjoram from UNESCO, Senior Program Specialist, Basic and Engineering Sciences, Natural Sciences. Dr. Adam Skrybant, Director of the Department for Foreign Affairs of the Confederation of Polish Employers (KPP), who represented President of KPP Dr. Andrzej Malinowski.
Prof. Włodzimierz Miszalski welcomed members of WFEO-CET.
The greeting words to the participants of the conference were delivered by representatives of: FEANI (James Birch), WFEO (Peter Greenwood) and UNESCO (Anthony Marjoram). The Opening Session ended with a paper of Andrzej Malinowski "Increasing Competitiveness of SMEs with EU Funds" delivered by Adam Skrybant.

- Session I – Polish Experiences in Supporting Small- and Medium-Sized Enterprises in Engineering and Technological Innovation Activity

Papers and Presentations:

- Short Introduction to the Role of the Polish Federation of Engineering Associations in Supporting Small- & Medium-Sized Enterprises in Engineering and Technological Innovation Activity. Programs & Achievements presented by Józef S. Suchy, Vice--President of the Polish Federation of Engineering Associations. The presentation was illustrated by a DVD film – "Presentation and Promotion of Target Projects for SMES Implemented in 2001–2005 from the Budgetary Means Assigned & Distributed by the Center of Innovation of the Polish Federation of Engineering Associations".

- “KWANT – Innovative Micro Company” by Bogdan Niewczas from “KWANT” Measuring Apparatus Co. Ltd, Cracow
- “HYDROMEGA – the Innovation Company” by Zbigniew Zienowicz and Marta Bukowicz from HYDROMEGA Co. Ltd, Gdynia
- “Actions Taken to Raise the Innovativeness of Polish Foundry Industry” by Jerzy Tybulczuk from the Foundry Research Institute in Cracow
- “The Innovation of SMEs in Poland in the Context of Integration of Poland with the European Union” by Ryszard Borowiecki and Barbara Siuta-Tokarska from the Cracow University of Economics

The second day of the conference – Friday May 18, 2007

- Session II – “International & National Experiences in Supporting Small- and Medium-Sized Enterprises in Engineering and Technological Innovation Activity”

Papers and Presentations:

- “Engineering Enterprise and Innovation for the Millenium Development Goals” by Anthony Marjoram from UNESCO
- “WFEO Activities Support Small- and Medium-Sized Engineering Enterprises” by Peter Greenwood on behalf of President and President Elect of WFEO
- “The FEANI Position on European Support for Innovation” by James Birch from FEANI
- “Helping Small Business Survive the Skills Shortage – an Australian Perspective” by Peter Greenwood from the Institution of Engineers, Australia
- “The Role of SMES in Economic Growth – the Case of Bahrain” by Abdulrahim Abdullah Fakhro from the Bahrain Society of Engineers
- “Increase of Efficiency of Small and Medium-Sized Enterprises in Small and Medium-Sized Enterpreneurship” by Pavel Hercik, Růžena Petřiková, Alan Vápeníček from the Czech Federation of Scientific and Engineering Associations – ČSVTS, Ostrava
- “From the Education and Innovation Crisis to the Social Crisis” by Vollrath Hopp from the University of Rostock in Germany
- “Universities and Enterprises: Toward a Closer and Effective Cooperation” by Antoine Abche and Abdel Menhem Alameddine from the Federation of Lebanese Engineers, University of Balamand, Tripoli, Lebanon
- “Brazilian Experience on Supporting Engineering and Technological Innovation – the Cooperation University – Enterprise and Its Effects on the Creation and Development of Small- and Medium-Sized Bussiness” by Gerson Lerner from Hydroelectric Consulting Private Enterprise, Leizer Lerner from FEBRAE and Paulo Alcântara Gomes from REDETEC, Rio de Janeiro, Brasil
- “Strategies for the Support to the Development of the Very Small and Small Companies Due to New Brazilian Politics of Incentive to the Innovation” by Armando Augusto Clemente, Paulo Alcântara Gomes from REDETEC, Rio de Janeiro, Brasil
- “The Relation between Offers and Demands of Technology as Decisive Parameter of the Success in the Process of the Brazilian Industry Development – the Case of Rio

de Janeiro" by Armando Augusto Clemente from REDETEC and Evandro Peçanha Alves from SEBRAE, Rio de Janeiro, Brasil

- "Great Efforts for Supporting Small and Medium-Sized Enterprises in China" by Xila Liu from Shanghai Jiaotong University in China.

Presentations were followed by discussions. Papers/presentations are available at the WFEO-CET website (http://www.not.org.pl/wfeo/).
The conference turned out to be a forum of international exchange of experience on: supporting engineering and technological innovations, co-operation university-enterprise influence on creating and development of small and medium size businesses. Participants stressed that because of the importance of the subject for countries being in transition as e.g. Central European and developing countries a need appeared to make the conference cyclic – organized e.g. every two years in different countries – to enable further exchange of experience among different countries and get familiarized with various solutions.

19 May, 2007

The 36th WFEO-CET meeting (the second Committee meeting under the Polish Presidency) was organized in Cracow after the International Conference on "Supporting Small- and Medium-Sized Enterprises in Engineering and Technological Innovation Activity". Apart from the Committee Members at the meeting participated as invited guests also Mrs. Tahani Youssef, Executive Director of WFEO, Dr. James Birch, Member of the Executive Board of FEANI, Dr. Anthony Marjoram, Senior Program Specialist, Basic & Engineering Sciences, Natural Sciences from UNESCO and Eng. Abdulrahim Abdullah Fakhro from the Bahrain Society of Engineers.
Main topics of the meeting covered by the Agenda: summing up the results of the Conference, discussion on the WFEO Strategy of Mobility and setting up a Working Group on WFEO Strategy of Mobility, organisation of the 8th WCEE, 2009 in Malaysia (Prof. Abang Abdullah Abang Ali) and discussion on the subject of the Congress (Continuing Engineering Education and Professional Development), Education and Training Scenario for Engineers in 2020 (Dr. Peter Greenwood), publication of IDEAS No.14, presentation of the WFEO-CET Homepage.

June 2007

In June 2007 work contacts have been established with IFEES and the Cartagena Network of Engineering to be continued in the immediate future.

June 2007 – September 2007

Eng. Hisham Shihaby, Vice-President of WFEO-CET participated in discussions with the Colleagues from the Institution of Engineers, Australia and especially with Dr. Peter Greenwood (Member of WFEO-CET) on the "Education and Training Scenario for the Engineering Team in 2020". The Committee adopted "Scenario" as its document (available at the WFEO-CET website http://www.not.org.pl/wfeo/).

30 September 2007 – 1 October, 2007

Prof. Abdel Menhem Alameddine officially represented WFEO-CET at the First IFEES conference.

The IFEES first conference was held between September 30 and October 1 in the city of Istanbul, Turkey. The conference was an effort of the Americans (North and South) to organize a new Federation on Engineering Education. All the meetings took place at the campus of Bogazici University in Istanbul.

All the European countries were represented there. The organizers of the conference invited the policy officer for international Scientific cooperation from the European Commission Mr. Upton van der Vlet, who is a part of the Directorate-General for Research.
Representatives of the NSF (National Science Foundation) from the United States were also represented at the conference.
The first subject was concentrated on the accreditation of universities and the way to coordinate when any student go from one system to another. Representatives of FEANI, the French accreditation body and ABET participated at the meetings as well as a representative of Germany (Dr. Iring Wassner).
The second and most involving subject was the research and how we should involve local industries to support that field. One of the distinguished speakers was Dr. M.P.Ravindrea, Senior Vice-President, Head of Education and Research at INFOSYS, India.
The last subject was the decrease in the attendance of engineers in the colleges. Most agreed that the probably reason was the motivation in business market that is attracting students.
The WEFO-CET was an observer at the conference. However, we shall be invited to join IFEES as a member soon. It is advisable for WFEO-CET to become member of IFEES because of the great potential of their work, and their interest in education and technology.

3–5 October, 2007

Mrs. Teresa Domańska Secretary of WFEO-CET participated in the FEANI Annual Business Meetings in Valencia, Spain among others at the General Assembly meeting of FEANI.

14–16 November, 2007

Prof. Włodzimierz Miszalski, President of WFEO-CET participated at WFEO General Assembly and Executive Council meetings in New Delhi, India and at the WFEO Anti-Corruption Forum.

Photo 1. Conference 17.05.07 – Opening Session-Presidium
From the left: K. Wawrzyniak – Secretary General of Polish Federation of Engineering Associations, J. Suchy – Vice-President of Polish Federation of Engineering Associations, W. Miszalski – President of WFEO-CET

Photo 2. Conference 17.05.07 – J. Birch, FEANI

Photo 3. Conference 17.05.07 – P. Greenwood, WFEO

Photo 4. Conference 17.05.07 – A. Marjoram, UNESCO

Photo 5. Conference 17.05.07 – B. Siuta-Tokarska, Poland

Photo 6. Conference 17.05.07 – Audience

Photo 7. Conference 18.05.07 – Presidium
From the left: W. Miszalski – President of WFEO-CET, H. a Malik Al Shehaby – Vice-President of WFEO-CET, Vice-President of WFEO

Photo 8. Conference 18.05.07 – P. Alcântara Gomes, Brasil

Photo 9. Conference 18.05.07 – G. Lerner, Brasil

Photo 10. Conference 18.05.07 – Xila Liu, China

Photo 11. 18.05.07 – Conference participants' visit to AGH University

Photo 12. 19.05.07 – Conference participants' visit to AGH University

Photo 13. 36. WFEO-CET Mtg., 19.05.07
From the left: H. a Malik Al Shehaby – Vice-President of WFEO-CET, Vice-President of WFEO, W. Miszalski – President of WFEO-CET, T. Domańska – Secretary of WFEO-CET

Photo 14. 36. WFEO-CET Mtg., 19.05.07
From the left: A. Fakhro, A. Marjoram, F. Ocampo Canabal, T. Youssef, A. M. Alameddine, Z. Sárközi Zágoni, J. Ginsztler, E Łukasik, A. Jachimowicz

Photo 15. 36. WFEO-CET Mtg., 19.05.07
From the left: J. Birch, P. Greenwood, Xila Liu, L. Lerner, H. Al Shehaby, W. Miszalski, T. Domańska, A. Fakhro, T. Marjoram, F. Ocampo Canabal

Photo 16. 36. WFEO-CET Mtg., 19.05.07 – Group photo

Photo 17. 19.05.07 – Celebrity Dinner with Folklore


International Conference
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IN
ENGINEERING AND TECHNOLOGICAL INNOVATION ACTIVITY
17th – 18th May 2007, Hotel Atrium, Cracow, Poland
organized by: WFEO Committee on Education & Training (WFEO-CET) and
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