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Higher engineering education post-2010 focusing on achievements at the University of Miskolc

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ABSTRACT: The precursor to the University of Miskolc (UM) was a *Berg-Schola* (School of Mines and Metallurgy) established in 1735, underwent several changes and it is now located in Miskolc, North Hungary, with three engineering and various other faculties. The engineering curriculum is designed for employment in multinational industries, and small and medium-sized enterprises. In 1999, the Bologna Declaration created the European Higher Education Area and the three cycles BSc, MSc and PhD, represented by the authors in the theory-practice domain, are running well. Knowledge generation, transfer and application serve high-, medium- and low-growth sectors by academic staff, students, up-to-date infrastructure and efficient academia-industry links are presented and discussed in this article. Employment opportunities verify the UM endeavours in the provision of education to graduates who can eventually find top level jobs. The authors state that the product of theory and practice should be consistent across different grades. In recognition of its achievements, the UM received the first *Higher Education Quality Award* in 2008 and the *University of Excellence* title in 2010.

Keywords: Knowledge generation, theory-practice domain, engineering performances, European PhD, university of excellence

INTRODUCTION

The Royal Chamber in Vienna, in the capital city of Austria issued a decree on 22 June 1735 relating to the establishment of a *Berg-Schola* (School of Mines and Metallurgy) in Selmecbánya, the city then belonged to Hungary. The objective of the School, one of the first engineering colleges in the world, was to train engineering and management officers for the exchequer-integrated mines and metallurgical industry and for private industry. The duration of education and practical training was two years and five branches were listed as 1) exploitation of a mine and laws relating to mining; 2) measurement performer; 3) ore preparatory; 4) chemistry and metallurgy; and 5) coinage specialist and gold-examiner [1].

In 1770, the *Academy* rank was awarded by the Queen, Maria Theresa. In 1809, a course of philosophy was introduced involving mathematics, physics and logic and such courses were the basis for the Universities of Sciences. At the beginning of the 19th Century the number of study years was increased to 3.5 and four years increasing the students' experience by six and later 12 months. The number of students at that time was about 200 and one-quarter received a stipend. The language of teaching until 1868 was German and after that time it was gradually changed to Hungarian. Six thousand books, including textbooks by Galileo, Newton, Bernoulli, Agricola, Boyle, and others, comprised a library, now as a Library Museum, working within the University.

In 1846, the duration of theoretical study was increased to four years. After World War I, the city of Selmecbánya was annexed to Czechoslovakia by the Versailles-Trianon Peace Treaty and the University moved to Sopron, West Hungary. University doctor titles in engineering were awarded for the first time in 1931. After World War II, Parliamentary Acts 22 and 25 of 1949 established a new Technical University for Heavy Industry in Miskolc with the Faculty of Mechanical Engineering and with the involvement of the Faculties of Mining and Metallurgical Engineering of Sopron.

Since that time, the University has been expanding and now has three engineering faculties (Mechanical Engineering and Informatics, Earth Science and Technology, Material Science and Technology), including specialisations in information technology, mechatronics, electrical engineering, mechanical engineering, mining engineering, and many others. The academic engineering staff comprises 310 members and the number of students exceeds 4,300. Since 1983, new faculties have been established in Law, Economics, Social Science and Humanities, and Health Care. In addition, a

Music School and a Teacher Training College was attached to the University, thus, the total number of academics now exceeds 800 and there are more than 14,000 full-time students.

UNIVERSITIES IN KNOWLEDGE-BASED SOCIETY

European integration was a great success: foreign and home trade between the European Community/Union countries in the past three decades increased more than 25-fold. In the 1980s, mutual capital investments increased by 30% per annum, i.e. three times faster than foreign trade and direct investments proved to double bi-annually. Capital flow was also remarkable: in the latest two decades direct investments in foreign countries increased four times faster than foreign trade. The large European Single Market receives 75% of export goods produced by European member states in comparison to the former 30% ratio. Capital flow is not a one-way route any more.

There are two different trends in the world such as the globalisation of economy and the fast improvement of small and medium-sized enterprises (SMEs). The largest 100 firms/industry serve as a dominant empire providing one-third of the world economy rate, 40% of world trade and 75% of industrial production of the world. One pillar of the future, three-quarter of research and technological development (RTD) belongs to the developed Organisation for Economic Co-operation and Development (OECD) countries, including Australia and Hungary.

But the picture now is not as bright as it was: in 2000 the OECD member states provided 60% of the world production rate, while in 2010 this figure was 51% only and by 2030 this ratio will go down to 43% (OECD-study).

The *small-and medium-sized enterprises* (SMEs) are getting closer to the general public, serving people's everyday needs and, thus, employing 70% to 80% of the workforce in many European countries (in Hungary this ratio is 70%). New technology-based firms can contribute to technology transfer successfully, since the European ecosystem for research and open innovation requires new and innovative approaches. Young people need to perceive entrepreneurship and innovation venturing through the launch of different forms of recognition for both, successful and failed start-ups.

In 2000, Europe produced one-third of the world's scientific knowledge and occupied a leading role in many fields, e.g. aeronautics and telecommunications. *The European industry in the early 2000s was not what it once was:* although many industries were still to be found in Europe, but other economic blocs, such as Asia, were establishing themselves as the world's principal production sites aided in part by a less costly workforce and the opening up of world markets.

European leaders, therefore, decided in Lisbon in 2000 to found the EU's future on science and technology in which it had always excelled. Knowledge would, thus, secure the future of the Old World through the creation of a *knowledge-based society* based on higher education, innovation and research: these components so fundamentally inter-dependent that they came to be known as the *knowledge triangle* [2]. The *knowledge triangle* has three pillars: higher education, research and technological development (RTD), and innovation (i.e. the share of inventions that actually reach the market).

A *genuine* single market *for innovation* is needed in Europe. By 2030, an open, fair market for innovation will pull new ideas, talent and investment from around the world. EU students should be educated to think and manage according to an internationally strengthening European dimension. Therefore, EU universities must attract the brightest brains from around the world, and EU markets the excellent competitors; a global university area requires *brain circulation*.

European universities' core mission will, therefore, be to educate graduates and to ensure they are equipped to engage in the process of new knowledge creation and the dissemination and application of knowledge. *In future, Europe's added value would thus be based on the new knowledge* created within the European Research Area (ERA), a source of jobs and profit. Thus, RTD systems in Europe are struggling to break free of the national framework. The *fifth freedom* - the *freedom of knowledge* across borders within the EU - will become integrated into the existing rights of people, capital, services and goods to move freely.

By 2030, an open, fair, genuine single market for innovation will pull new ideas, talent and investment from around the world. *The challenges facing the European economy* have not changed: increasing productivity in response to the ageing population; confronting international competition; and preparing for the increasing scarcity of natural resources, starting with fossil fuels. The *EU's sustained productivity growth* depends largely on policies to stimulate science and technology and innovation systems. A high level of educational attainment is also positively correlated with a productive, skilled and adaptable workforce, and is a precondition for lifelong learning as well as for higher labour-market participation rates [3].

EUROPEAN HIGHER EDUCATION AREA

The Bologna Declaration (1999) established the European Higher Education Area (EHEA) and envisaged three cycles: the first, undergraduate or bachelor of science (BSc) cycle has the duration of 3 to 4 years, the second, postgraduate or Master of Science (MSc) cycle takes 2, 1.5 or 1 year(s) respectively and the third cycle is dedicated to the doctoral

(PhD) cycle with 3 to 5 years to award the PhD degree after preparing and defending the PhD thesis. In Hungary, the Bologna Process is working now in higher engineering education, without exemption.

The vital difference between the three cycles is the theory *T* to practice *P* ratio *T*/*P* offered by each curriculum. Thus, this *T*/*P* ratio defines the professional rank or hierarchy of institutions. Bearing in mind that the total time is counted 100% or 1.0 in per unit, thus $T + P = 1.0$ in all three engineering cycles (Figure 1). For the BSc cycle, the *T/P* ratio ranges between 0.35/0.65 = 0.535 and 0.55/0.45 = 1.22 and the average is 0.45/0.55 = 0.818. This deviation is due to the location of the HEE institution, whether it is close to a large industry or not, the need of graduates i.e. the curriculum should be more application-oriented or more engineering science-intensive and how it makes impact on this ratio and, then, the level of newcomers, academic staff, infrastructure and facilities.

The ideal of the university is the open, digitally networked, knowledge institution working in co-operation with industry and society. Some further clustering of universities is expected to gain leadership in one or more emerging fields. A new EU reform will start with this *open knowledge institution*: open to society including production, transport, distribution and consumption. University career structures would change, so that excellence, not time served, will become the criterion for advancement in teaching and research. Striving for excellence is the only choice Europe has. The ideal mechanism is when institutions become the *gold standard* to which all may aspire, but only the best succeed.

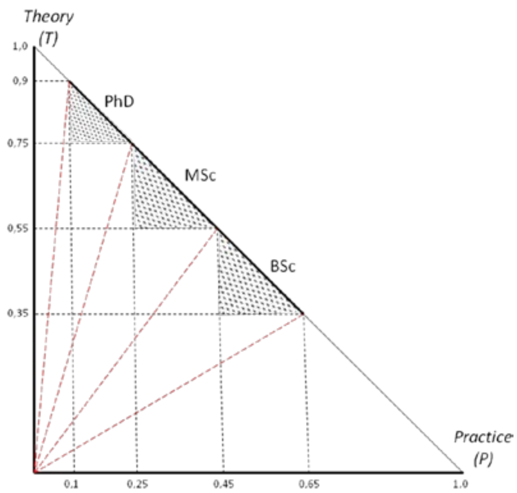

Figure 1: Three higher engineering education cycles in the theory practice domain. One dot represents one student.

University ranking systems are somewhat mono-dimensional (focused primarily on research) and do not fully cover dimensions such as the teaching and learning quality of knowledge transfer. Such mono-dimensional systems use indicators that discriminate only between the most research-intensive institutions and, hence, do not always provide useful feedback on ways forward for the majority of European universities.

The borders between *fundamental* and *applied* research are sometimes unclear and vague, so that the distinction between the two, in some ways, becomes gradually outdated [4]. In many disciplines, the advancement of fundamental science is an absolute requirement for engineering applications (e.g. nano-science and nano-technology, materials science and engineering) and, therefore, in many universities, fundamental and applied science oriented departments and faculties, to some extent, are becoming integrated or co-operating closely. This is why a new term *frontier research* reflects a new understanding of basic research.

On the one hand, it denotes that basic research in science and technology is of critical importance to economic and social welfare. On the other hand, it indicates that research at, and beyond, the frontiers of understanding is an intrinsically risky venture, progressing on new and most exciting research areas, and is characterised by an absence of disciplinary boundaries (European Research Council, 2007).

KNOWLEDGE TRANSFER AND APPLICATION BY ENGINEERING CURRICULUM

The players in engineering knowledge transfer at the UM are: 1) 4,500 students; 2) 1,000 engineering graduates per annum; 3) 100 to 150 industry personnel; and 4) 400 academics improved by staff development. The instruments of knowledge transfer are a sustainable curriculum, teaching materials, books, publications, the Internet academic staff and student mobility schemes, all the players as a whole, plus up-to-date laboratories and infrastructure [5].

The *performances of the UM* regarding knowledge transfer and application are represented by the following facts:

- 53% of academic staff have a PhD and 10.5% also hold a DSc degree (Dr Habil.).
- Six engineering professors are members of the Hungarian Academy of Sciences.

- Number of scientific publications per annum is around 2.2.
- Number of examined students per teacher and per semester ranging from 84 (2002) to 128 (2007).
- The University Great Hall, Sport Hall, classrooms, laboratories, premises, offices, student dormitories, canteen, buffets have 160,000 square metres or 590,000 cubic metres of built-in area; the utilisation rate of teaching/learning premises exceeds 70%, where 52 hours per room means 100%.
- Remote video conferences can be organised in two well-equipped rooms/laboratories.
- Each classroom has a computer-based projector.
- Central Library assists both academic staff and students by its 550,000 books and 98,000 periodicals mainly in foreign languages that are published usually 10 times a year.
- Acceptance/satisfaction indicator for infrastructure, access to libraries, ICT equipment, Internet, quality and management of teaching, laboratory and extra-curricular activities was ranging around 66%.
- Feedback on graduates output received from employers ranges from few good marks across mainly very good and excellent evaluation marks.

The engineering curriculum is composed of three blocks of modules to renew it continuously, they are: 1) *basic and conventional engineering knowledge* with laboratory experiments, industrial practice and project inclusive, experienced and approved world-wide; 2) *new innovative engineering knowledge* generated by the European Research Area and the world's scientists and engineers; and 3) new engineering knowledge created by the *UM academic and research staff*. An additional brief block should integrate *the vision of the respective engineering field.*

Engineering design courses serve as a milestone for engineering work; it is a part of research incorporated in engineering curriculum and a specific application of engineering theory in everyday engineering practice. Industrial engineers have traditionally been prepared to work in large or small enterprises. However, independency on the environment is an important expectation of youngsters, thus, an increasing number of students would like to open their own enterprises having a small *engineering empire* but they cannot compete against large companies. The development of information technology has made it easier for engineers to start their own businesses.

The UM prepares engineering students to work in the globalised environment. The graduates also receive managerial skill in order to manage various enterprises, and sister units of multinational companies in all aspects of human capital management, management of technology, productivity and competitiveness at low (optimal) cost. The *Engineering Manager Stream* prepares the students to work within SMEs even to establish their own enterprise; therefore, special courses are in the curriculum. The target is to stand on their own feet, and for their enterprise to flourish in such a way as to improve the country's economy and finally to contribute to the development of the EU economy.

Tutors and industry supervisors/referees evaluate the theses and submit their joint opinion to the *final examination board* appointed by the Rector with the involvement of industry leaders and specialists as well. All components of final examination such as the results of basic, fundamental and applied engineering courses and the thesis after providing different weighted factors to each component lead to the result of the diploma/degree. This symbolises the knowledge, skills, capability and competence of the graduate in one of the rank such as excellent/outstanding, very good, good or satisfactory marks written in the diploma/certificate. This is the real output of higher engineering education, the all-round engineer of the 21st Century (Details are given in separate certificates).

PHD ENGINEERING PROGRAMMES AT THE UNIVERSITY OF MISKOLC

The new *PhD programmes*, similar to western schemes, were introduced in 1993 *in Hungary*. Since that time the UM has been running four PhD schools in engineering of three-years' duration as *I. Sályi* Mechanical Engineering PhD School, *J. Hatvany* Information Technology PhD School with the fields of electrical and electronic engineering inclusive, *S. Mikoviny* Earth Science and Technology PhD School and *A. Kerpely* Material Science and Technology PhD School.

The *admission criteria* include 1) excellent/outstanding, maybe a very good MSc degree qualification; 2) initial steps in the research community; 3) recommendation of a professor; and 4) an interview. The number of PhD candidates a year is ranging between 70 and 95 for PhD programmes in engineering and the number of enrolled students floats between 60 and 80; however, the dropout rate exceeds 30% mainly due to family or income challenges.

The *PhD programmes* in engineering in the first two academic years consist of the provision of state-of-the-art of respective engineering science courses concerned, and concluding in examinations. PhD students conduct theory and/or practice courses for Bachelor and/or Master programmes since they have a stipend, and the 3rd year is dedicated to a project. Based on project achievements, the thesis preparation follows. After the PhD student completes the *viva voce* (oral examination) of designated courses, the thesis will be finalised and a workshop debate organised with the participation of respective academics holding PhD degrees.

The thesis presentation and defence takes place face-to-face with the PhD Scientific Board. The Board is chaired by a full professor, and consists of a secretary, appointed from among respective principal academics, three professors, including at least one industry leader/specialist, and two independent referees are invited, out of them one may come from industry or from another university. The Board makes the decision by secret vote qualifying the thesis as excellent or outstanding (i.e. internationally recognised mark worth three points) or very good (i.e. nationally recognised with two points) or eventually failed (one point). PhD degree award needs over 66% of the total points of votes to the permissible number of points, which means that the average point by one vote must exceed 2.0. No doubt, secret votes received criticism from foreign professors. Each PhD student has a scientific leader/tutor.

Requirements for the PhD degree also include *publications* in order to familiarise professional forums with the latest scientific achievements both in the mother tongue and in a foreign language(s) in books, periodicals and/or international conference proceedings. Different credit points are awarded to each publication and the minimum requirement has to be met by the student.

The UM tries to concentrate its efforts to finance the *participation of PhD students in international conferences* even in overseas countries, mainly the USA and Canada. It also seeks to provide money for a few weeks' mobility, mainly in nearby universities to gain experience in the state-of-the art of their disciplines in the world, new trends, project management and for delivering the essential of their achievements for academics and industry personnel abroad. In addition, the *e-world is open* to them since the *i2010 EU Strategy* for development of digital economy ensured access to high-performance Internet infrastructures over at least 90% of European territory. Thus, they can exchange concepts, ideas and views easily with other researchers, getting familiar with new achievements and contribute to the implementation of free movement of knowledge (the fifth freedom).

To approach *Euro-PhD standard*, a PhD student should spend six to 10-months teaching, working, undertaking a project, preparing a thesis in another EU country. This criterion can be fulfilled if organised mobility schemes are available, preferably according to the new EC higher education project declaration. However, one should realise that if recent PhD graduates are employed as academic staff, their salary will be much lower than those paid in industry.

The conclusion is that 1) *knowledge generation* can be demonstrated by PhD projects and the thesis, its scientific value will be recognised by the referees and the Board; 2) *knowledge transfer* is carried out by the publications in printed and/or in electronic media by their upload on the Internet and by lectures at professional or other important forums; 3) *innovation* can appear in any form of publication even through other intellectual property forms, such as patents, trademarks or products, but 4) working in other EU countries for several months cannot be afforded, because there are no grants to achieve this goal.

PHD ENGINEERING PROGRAMMES ABROAD WITH UNIVERSITY OF MISKOLC STUDENTS AND ACADEMICS

PhD programmes in engineering run by other EU university with the involvement of the UM academic staff and students were also in the focus of the UM's interest as presented by this case study. In the mid-1990s, Politecnico di Torino (University of Technology, Turin, Italy) approached the UM's Department of Electrical and Electronic Engineering to send a talented young lecturer to pursue a three-year PhD programme in English in the field of electrical engineering/electrical drive control. A suitable young lecturer with good command of English was selected. Having a MSc degree in electronics and control engineering stream and having taken the initial steps in research were the criteria. Having neither a bilateral agreement nor EU legislation for such a programme at that time, the first action was to translate into English the titles of the UM courses and their brief content along with the appropriate number of hours per week and semester, the examination records, the summary of the thesis for MSc graduation and the MSc diploma with comments when needed and accompanied by his professor's recommendation.

The Senate of Politecnico di Torino investigated the documents and recognised the MSc degree issued by Miskolc as being equivalent to the one given by Politecnico di Torino. After simulating the admission examination by face-to-face conversations between the UM professor and the candidate, the latter met successfully all requirements (admission criteria, publications, lecture delivery, project, thesis preparation). He had two tutors: the primary tutor was a full professor of Politecnico di Torino (currently he is the Rector) and the secondary was a UM professor.

The thesis presentation and defence took place at La Sapienza Università di Rome, due to an Italian regulation that required this event to be organised by an independent Italian university, for an international evaluation board, additionally to the Italian academics, with two British and two UM professors inclusive and concluded in an outstanding result.

Two years after this event, another young lecturer of the same UM department progressed into the PhD programme within the same professional field thanks to Torino. He presented and defended his thesis at the University of Palermo.

The first year programmes for both PhD students were financed by EC Tempus projects and the costs for the 2nd and 3rd years were covered by various national foundations after successful applications by the UM department. Politecnico di Torino was extremely generous in providing the cost of tutorials, teaching, the project, infrastructure, etc.

This case study reflects the importance of PhD students' mobility. They serve as *ambassadors* of their home country abroad, getting familiar with other EU university standards, strengthening the European dimension and putting the *fifth freedom* into practice.

ACCREDITED PHD ENGINEERING PROGRAMMES IN ENGLISH BY THE EUROPEAN COMMISSION

The forerunner of the Euro-PhD was the EC Tempus Joint European Project 12429. This project ran between December 1997 and January 2001 and was entitled Accredited PhD Engineering Programmes in English. The co-ordinating and contracting institution was the UM, the project was initiated and implemented by the authors of this article. Efficient development of human capital was *a significant need, in order to provide upgraded senior academics in Hungary who will be compatible with their EU partners*. The output was approximately 50 bilingual (English-Hungarian) young academics and scholars plus 28 internationally recognised senior academics. The target group exceeded 150 academics to participate, and students.

The Consortium, in addition to the UM, consisted of Middlesex University, London; Napier University, Edinburgh; Dublin City University; Politecnico di Torino; Technische Universität, Berlin; the Royal Institute of Technology, Stockholm and the University of Veszprém, Hungary.

Within the framework of the project a few accredited PhD programmes were developed and conducted in English in close co-operation with principal academics from the partner EU universities. Staff conducted courses in manufacturing systems, mechanical-electrical-electronic-control engineering, environmental science and information technology. Establishment of a *large-scale network* was demonstrated by three international Tempus workshops hosted by the UM in Miskolc at which, there were several individual and joint presentations, targeting the familiarisation of participating university academic staff, Hungarian industry leaders, government representatives, with achievements of partners in science and technology, the trends they follow and academia-industry link. Three co-ordinating meetings each year served as milestones in strengthening this network.

The *significant achievement* concluded in five PhD projects undertaken by young academics with the scientific and technical assistance of EU partners. The preparation and defence of theses were implemented and the degrees were awarded some months after the projects had been completed. The project contributed to new engineering knowledge generation, dissemination and application within this network due to real and efficient brain circulation [6].

EMPLOYMENT AND PERFORMANCE OF ENGINEERS – CAREERS FOR ENGINEERING GRADUATES

Employment and career options are fairly good in the EU-27 countries thanks to the recognised performance of all engineering graduates; e.g. one graduate of the UM can choose between two or three jobs offered by enterprises, companies and all sectors of the economy [7]. To sustain this favourable chance, the first indispensable pre-requisite is to *attract more talented young people to higher engineering education* since the quality of EU institutions overall is high. The *brain drain* of excellent students and graduates was a threat before the European pool of talents was established. However, it is a fact that the better the graduates, the more mobile they are (*brain circulation*). The *war for talent has already started* and it must be our fight to motivate young people to engage in engineering research and technology.

Employment in various science, technology, research, industry and private/public economic sectors provide chances for engineering careers in the world where engineers are working and the graduates find jobs from the top level (Grade A) to Grade F, depending on the theory-demand of the respective areas. The fast, medium and low growth sectors are ranked by their overall performance for the period concerned.

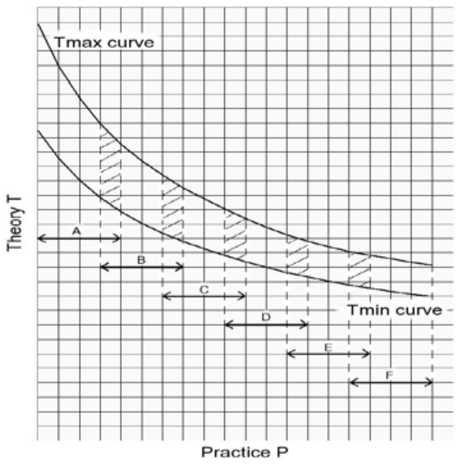

Figure 2: Diagram presents employment/engineering career and/or the performances of engineers in the theory-practice domain.

Theory-intensity is somehow different from the categories of available careers, thus, they depart to some extent from the distribution of the jobs. High theory-intensive jobs such as those in the research and technology area need less practice and *vice versa*, thus, the product of theory and practice is roughly constant, i.e. $T \times P$ = constant. As shown in Figure 2, since there is no strict line between various theory-intensive categories, each category overlaps with the next and back.

Within each career area, both theory and practice range from between a maximum T_{max} and minimum T_{min} curves indicating the various requirements in different industries and jobs. This band is narrow if the requirements are clear in the same sectors, in a region or country.

The explanation of different grades/posts of employment (Figure 2) is as follows:

- Grade A: Top level which stands for the highest grade/post, such as full university professor, senior post in science and research, fast growth or hi-tech industries at which research and university teaching is normally conducted (employment rate, including on the job engineers in OECD countries is 10.6%);
- Grade B: Researchers and engineers working in positions not at the top level (A) but more senior than newly qualified PhD holders, such as university academic staff - strong theory-intensive design, computing and manufacturing sector belonging partly to fast-growth and partly to medium-growth industries (22.3%);
- Grade C: The first grade/post into which a newly qualified PhD graduate would normally be recruited - theory-intensive research and industry project implementation and management sector partly in fast- and medium-growth industry/company (10.0%);
- Grade D: Tertiary programmes which lead to an advanced research qualification (PhD) - medium theory-intensive management and leadership sector in all fast, medium- and low growth industry/company sector (9.2%);
- Grade E: Tertiary programmes to provide sufficient qualifications to enter into advanced research programmes and professions with high skills requirement - graduates and occasionally students - medium theory-intensive marketing, sales, client in all types of industry/company sector (20.5%);
- Grade F: Other jobs such as in the industry services sector, in-service training and vocational training (27.4%).

The *conclusion* is that priority must be given to theory, mainly theory-intensive practice against traditional practice in curriculum design and graduate output, bearing in mind employment requirements, and that the quality of both theory and practice are proportional to the credits/hours dedicated to them, in addition to the students and teachers talents.

EFFORTS AND ACHIEVEMENTS: UNIVERSITY OF EXCELLENCE TITLE – 2010

Gold standard will be a new European category; thus, it has not yet been awarded. For the UM's achievements, the first *Higher Education Quality Award* in Hungary was granted to the UM in 2008. The *University of Excellence* title was also given by the Minister of Education in April 2010.

The motto that concludes the University's mission states that: *Knowledge creates a University of Excellence and after that Research University to build up a bright and wealthy future.*

The mission of the University of Miskolc in a nutshell is presented below:

The University of Miskolc (UM) being a prominent institution of the Hungarian Higher Education and Research Area - working within the European Research Area and governed by the Magna Charta signed by European Universities (Bologna Declaration) plus the Berlin, Bergen and London Declarations succeeded it by - contributes to the development of respective science areas and the Hungarian society by multidisciplinary higher education, research and development activities of high calibre. Enjoying a University of Excellence title and later on as predicted a Research University appointment:

- The UM serves as a *regional key player* in the implementation of knowledge creation and transfer for economic development, assists in the co-operation of competitive enterprises, businesses, the local governing offices and government players, then, in the successful implementation of education, research and development programmes as a whole for the region, the country and other countries, while bridging over the borders;
- The UM is the *intellectual centre of higher education and scientific research* development in northern Hungary in the fields of material science and technology, earth science and technology, engineering and technology science, natural and social sciences, humanities, medical science, music and art;
- The UM carries out *higher education improvement* in harmony with the Bologna process and in accordance with the demands of the labour market; while based on the units of scientific development, such goals are to be achieved by:
    - the preparation, development and implementation of multi-cycle full-time higher education programmes for BSc, MSc and PhD diploma/degree awards, and
    - the smooth running of continuing, adult, postgraduate, and in-service training courses based on the distance education experiences and taking the lifelong learning aspect into consideration.

The total number of academics, researchers, administrative and technical staff was 1,598, the ratio of academics and researchers is 47% and the administrative and technical staff ratio is 53%. The total number of students was 13,940 and out of this number 8,015 students were financed by the government and 5,925 had to pay for course attendance (2009).

The UM has co-operation agreements with 87 EU, non-EU and overseas institutions. In addition, hundreds of other projects, scientific and education co-operation schemes emphasise the international character and diversity of the UM.

The participating faculties in the application were the three engineering faculties, namely Earth Science and Technology, Material Science and Metallurgy, Mechanical Engineering and Informatics plus the Faculty of Arts. There have been some impressive achievements characterising the UM as a *University of Excellence*:

- *Talented students* participating in the *National Student Scientific Forum* (its Hungarian acronym is TDK) are preparing and presenting their project works on a designated topic in close co-operation with their principal academic tutor each year. In 2009, they submitted 250 full papers and after their evaluation 120 papers were delivered by the UM students in the country-wide conference. The best papers receive a Gold Medal named *Pro Scientia* (for Science); the UM students enjoy two to four such medals each year (two Gold Medals in 2011) and their tutors possess a Tutor Gold Medal. Specific care is taken to nurture talented students by offering them access to the *student mobility programme* abroad either through EU or bilateral schemes and other schemes that are running. Since 1997, the UM has been organising a biannual *International Conference for PhD Students* in the summer to which 350 to 450 PhD students come from 15 to 17 countries. It is a real competition for PhD students and a forum for the presentation and defence of their PhD theses.
- *Academic staff* achievements: 500 to 900 publications come out a year within the country and 480 to 600 are published in the international science world. In the latest five years, 357 books and 280 textbooks were published both in and outside Hungary. There are roughly 160 study tours, stipends and other motivation programmes dedicated per annum to outstanding academics and 22 to 27 international and national awards and medals are granted to the best by various authorities. Many of them are key players in the four Engineering PhD schools. The number of citations per annum ranges from 915 to 1,132 and in the international scientific world this number varies from 422 to 559. In the past five years, the income rate coming from research, technological development and innovation sources went up from 18.5% to 22.7% of the total income of the UM.

Research Centres of Excellence are operating within the UM such as:

1. Computer-Aided Simulation/Modelling and Technology;
2. Information Processing;
3. Energy Economy, Environment and Human Kind - sustainable development for human resource management, and also;
4. Other University-attached research institutes and other units run and financed by the Hungarian Academy of Sciences [8].

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