

Arbeitspapiere

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Helmut Winkler and
Janusz Szpytko (eds.)

35

Structures, Problems, Potentials, and
Future Perspectives of Engineering
Education in Poland

Kassel 2002



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Preface

The joint Polish-German research project “General Structures, Problems, Potentials and Future Perspectives of Engineering Education in Poland” funded by the German VW-Foundation (VolkswagenStiftung) aimed at carrying out an analysis of structural developments within the higher education system for engineering in Poland during the last decade. Before starting and after finishing each phase of the joint project, three mutually prepared seminars took place which focused on different topic that helped preparing the next step and discussing the outcomes of the preceding phases. The introduction seminar took place in Crakow, the mid-term seminar which is documented here proceeded in Zakopane and the final seminar was held in Kassel. As the project aimed mainly towards a better understanding of the transformation process of the important national subsystem¹ of higher engineering education one has to observe also its relationship to other polish subsidiary systems (i.e. labour market, industrial and technological development).

Polish higher engineering education is on its way to modernization. Resulting from the 1990's new higher education laws there is a trend towards stronger integration into European and international higher education systems for engineers. Interactions and interdependencies with other national subsystems - politics, economy and industry - particularly within the research-, development-, and production-sector – were one main focus of the analysis.

The research project is conducted as a bi-national joint project consisting of two teams with four scientists each, and one national co-ordinator among each team² therefore all three seminars had participants and contributors from both countries.

For the conduct of the survey competent reporters at the individually included universities had been attracted, who prepared mainly the so-called institutional reports of each higher institute for engineering education in Poland bound to a detailed questionnaire of special questions concerning the structures, potentials and future trends within the Polish higher engineering education.

The subject of the final-term seminar covered the whole set of questions under the heading of “General Structures, Potentials, Problems, and Future Perspectives of Polish Higher Education for Engineers”.

The thirteen contributions by Polish and German authors to the seminar fit into three main foci:

- A) Existing Structures of Polish higher education for engineers
- B) New Developments
- C) Future Perspectives

¹ The program-description of the Volkswagen-Foundation explicitly states: *“With reference to the different case- and country-groups it can be helpful for the understanding of the interdependence problems to analyse single aspects of systemic change. This is especially true for such current processes when transformations are just beginning but when it is not yet clear which direction the systemic solution of the change will take. Findings on progressive and successful transformation processes are capable to be tested whether they mediate stimulation and decision models for a conscious political control of transformations.”*

² National co-ordinator of the German team was Professor Dr.-Ing. Helmut Winkler from the University of Kassel, the Polish research group was co-ordinated by Doc. Dr.-Ing. habil. Janusz Szpytko from the Crakow University of Mining and Metallurgy AGH.

We would like to thank the contributors, as all of them brought new insights and well structured ideas about the past, the present and the possible future of Polish Higher Engineering Education.

A special thank is devoted to Anita D. Wozniak and B. Grünig, who very successfully transferred the contributions into a digestible form.

The editors did their best to standardize and smoothen the contributions by German and Polish higher education experts. Nevertheless, editorial changes have their limits. Although this may seem unusual to readers used to texts written or edited by English native speakers we decided to leave style and expression of contributions as they originally were. To make the access to the contributions easier, abstracts of each of the thirteen texts can be found in the next section.

Helmut Winkler

Janusz Szpytko

Cracow and Kassel, November 2002

Abstracts

I Existing Structures

1 BATKO, W., KALUKIEWICZ, A.: *Evaluation of the Development of the Engineering Education System*

The authors stress the need for an adjustment of Polish engineering education towards the new needs of society and economy in Poland. Engineers of the professional type with a different kind of education are now requested for new positions in management and production facilities. As the situation at the respective faculties can be marked by scarcity of resources the hope for restructuring is based mainly on international co-operation. But still a solution to the problem and a development concept for the Polish case is missing. The situation of the newly founded vocational engineering schools, with which Poland has no experiences up to now is also unclear. Estimations about the kind and number of engineers needed by the Polish industry are rather vague – one only can guess that it will not differ very much from other industrialised countries. Other academic fields than engineering are much more attractive to young people nowadays, engineering programmes attract less qualified candidates than before. There is a fast industrial re-organising process due to global development and raising complexity of technical processes necessary for competitive production. This new industrial structure requires engineers with other and more complex qualifications, namely teamwork-competencies, methodological knowledge, social skills, and international abilities (e.g. languages). High expectations towards the qualifications and responsibilities of future engineers cannot be met easily and instantly by the institutions of engineering education. Weaknesses within the educational institutions make the problems even worse: lack of sufficient knowledge about the future requirements among students and faculty members; isolated, fact-oriented teaching, high specialisation due to teachers own fields and overload of teaching. Higher education takes too long time, industrial training is not sufficient and laboratory equipment is outdated. Graduates do not know much about the reality of production processes, they are trained mainly in analytic methods and descriptive knowledge about technical systems and machinery. Students are not properly trained in team-work. Study programmes lack application-oriented subjects. Co-operation between theory and practice is weak. Assembling all these information and looking at other industrialised countries (obviously also with a view to the VDI-model in Germany) the authors present a model for the core curriculum for engineers which contains the following main areas: 30% mathematical-science basics; 30% technical basics, 20% general and non-technical basics and only 20% exemplary and advanced specialists knowledge. The whole system should be transferable to other countries by introduction of CATS (Credit Accumulation and Transfer System).

2 FRANCUZ, M.: *Quality Management in Engineering Education*

Maria Francuz from Cracow University of Technology stresses in her contribution that quality management cannot be overestimated in modern engineering education. In her concept quality has two dimensions of efficiency and level and range. Nowadays the measurements for evaluating the quality in engineering education are still under development. The newly introduced national exams together with plans for a certification agency on a national level seem to be the envisaged way for

the future. The author finds it useful to refer to the international standard of ISO 9000 which is already introduced in some EU-countries.

Still it is undecided which way quality assurance in engineering education in Poland will take. A guaranteed (minimal) quality standard can be reached either by introducing self-evaluation processes within the institutions supported by central (national) quality criteria and external evaluation or by introducing an (internationally valid) accreditation system. Francuz reports about a research project conducted in the past to reveal the existing strategies and measurements in the departments for building engineering and faculties of medicine to evaluate the quality of teaching. The study was funded by the Main Council on Higher Education. 16 universities took part in the project. Using a rather long list of (22) compliance indicators for the quality of education within the respective departments the project resulted in a ranking within a list of three different levels of quality (A, B or C = very good, medium, very low mark). 6 of 10 universities scored in the A-level, 10 in the middle level, whereas no university was ranked on the non-sufficient quality level. The author concludes that these results are promising for further actions and useful for the conduct of evaluation as source for improved didactical achievements.

3 GASIDŁO, K.: *Practical Training in Engineering Education*

Krzysztof Gasidło from the Silesian Technical University devotes his contribution to practical training in engineering education based on experiences from Politechnika Śląska at Gliwice. Even in modern engineering education model building is a core function necessary for the production of any technological artefact. Together with the more abstract model building the student in engineering has to develop a certain hands-on mentality by being exposed to the real world. This has to be organised – and was offered at the SUT up to the year 1990 – on three levels:

- A) manual training (so called „workshop training”) intending to make students more familiar with the materials, items and appliances (tools, machines);
- B) industrial (technologic) training in order to make students more familiar with production processes; it also has been an opportunity of solving minor technologic or organisational problems,
- C) so called „diploma training” intending to be placed for collecting data for diploma work.

After 1990 the system experienced several major changes:

- manual training was cancelled (instead the university credited prior to study work experiences in the vocational fields);
- after 1995 the number of participating students decreased to 17% in 1998 (from formerly 30% in 1992);
- the role of the university as organiser and stimulator of the practical training was reduced to a controlling function;
- nowadays students see the internships mainly as an opportunity for job-seeking, formerly they considered it as part of their education.
- the kind of ownership of the co-operating industrial companies has changed. Nowadays only bigger private (and international) companies have contracts about trainees with the SUT, formerly the parastatals played this role.

Gasidło sees the reasons for the changes in:

- increasing numbers of students from 8000 to 26000 (the number of regular students increased from 6800 to 18261),

- reduction of number of hours of study from about 4400 to about 3500 during five years master course,
- decrease of state support for students; in 1990 state support covered the total costs of education, in 1998 it covers only 85 %,
- structural changes in industry and unemployment; nowadays the majority of jobs is located in small and medium size firms. In such firms a trainee is rather an obstacle and competitor than a chance for improving its efficiency,
- change of the study course: from two stage – MSc - PhD, to three stage BSc – MSc - PhD
- better educational tools and methods, especially models,
- changes in desired type of graduate towards more generally educated graduates.

He comes to the conclusion, that

- practical training seems to be less important than before but is still a necessary element of engineering education;
- there is a need for a new and different type of practical training according to the new three stage course of study. It could be one semester or one year professional work between study stages, and
- it would be useful to acquire more teachers from industry; they bring in more practical experience.

4 WOŹNIAK, D.A.: *Health Aspects in Engineering Education*

Danuta Anita Wozniak from the Małopolska Regional Centre for Health Management and Promotion at the University of Mining and Metallurgy in Cracow concentrates on the issue of health aspects in engineering education.

This rather arbitrary subject has won attention due to several reasons: Experiences of a large industrial association which introduced health programmes show that promotion of health at workplaces should be based on:

- information/knowledge about risks for professionals and workers at their workplaces;
- elements influencing the life-style of labour force outside the work area.

Basic problems on which health education should be directed in workplace and also in the education of engineers and managers are:

- professional stress;
- heart diseases;
- high blood pressure;
- sickness – absence;
- information about serious threats like aids or hepatitis type B;
- obesity;
- smoking cigarettes;
- drinking alcohol;
- abuse of drugs.

Practical health aspects included in engineering education should touch the following topics:

- identification of dangerous areas in workplace;
- analysis, knowledge and experiences of operators of devices and co-operation of persons,

- elaboration of questionnaires for relations between professionals; stress aspects and psychosomatic symptoms described by workers,
- specialists' round table on health issues,
- proposing technical and organisational solutions for improvements of existing situation and discussing them in circles with interested workers.

II. New Developments

5 KALUKIEWICZ, A., BATKO, W.: *Development of Organisational and Decision Structures in Polish Technical Universities*

Starting from the history of the UMM (University of Mining and Metallurgy, Cracow) the authors point out that the role of a university is to unify many kinds of autonomous scientific activities. A second mission of university is namely its public service i.e. to act for the benefit of the community of a city, district or region using its personnel, expertise and equipment to implement new technologies, improve management methods, improve social communication, administration, etc. In the following the authors present their strategic and operational ideas for the future development of the UMM:

To retain its profile and high rank among the higher education institutions, UMM shall develop new disciplines without abandoning the traditional ones. This idea of a technical university and the current challenges determine the strategic goals:

- flexible adjustment of the structure and profile of the UMM to the requirements of national economy, labour market, and capabilities of staff;
- implementation of educational system based on the 'Statute of the Studies' passed by the Senate in 1994;
- development and implementation of an educational quality system complying with world standards;
- stimulation of scientific research by appropriate mechanisms of financial support and involvement of relevant organisations;
- Improving the promotion of the University in the country and abroad;
- development and implementation of the appraisal system for individuals and teams;
- rationalisation of employment structure;
- continuation of the use of financial systems implemented during former Senate's tenure;
- improvement of the administration and technical support of the university.

They suggest that the structure of UMM should be based on departments as primary units which conform to the following requirements:

- the profile should depend on specialisation(s) taught at the department;
- the same specialisation should not be taught at several departments;
- the department should have full academic authority;
- the department should comply with the requirements of the State Committee for Scientific Research enabling it to be classified in Category A;
- the departments can differ in size but the differences should not be to large;

- the most feasible number of departments can be estimated at 8 to 10, at the present size of the university.

These requirements should be considered as a model for future discussion on the structure of the university.

In respect to the further development of organisation and financial support for research the authors pledge for the following measures:

- The main source of financial support for research at the University of Mining and Metallurgy should be grant-in-aid from the State Committee for Scientific Research for statutory activity. The distribution of statutory funds should not be linked with appraisal of research results.
- The second important source of financial support for scientific research are grants for individual studies. These funds will be distributed to the departments using already tested and well-operating algorithm.
- Grants ordered by the university should be awarded mainly for research and introduction of new technologies which, in the widest sense, satisfy the needs of the university and all groups of its employees.
- In the case of grants for equipment they will continue a rule that funds for the purchase of particularly expensive but indispensable equipment are assigned centrally as a result of competition. They suggest that the regulations for awarding grants for equipment should be supplemented with the rule giving a priority to the applications which can prove that the equipment can be used by many researchers and that its use exceeds certain time-limit.
- To facilitate publication of research results by the employees of the University of Mining and Metallurgy so that their number could reach satisfactory level, it is necessary to improve performance of editorial offices of the university.
- More emphasise should be put on the idea that it is the university's interest to transform research achievements into patents and licences.

To improve the university's situation regarding budget and finances the authors present their position:

- Budget income is composed of three sources of financial support: grant-in-aid for didactic activity from the Ministry of Education (about 50 %), grant-in-aid from the State Committee for Scientific Research (about 30 %) and other sources (about 20 %). It is expected that this budget income structure will be preserved, and it can be considered correct in substance.
- Additional sources of income for the university are: orders from industry, payable education, rents, etc. Every Zloty obtained this way is highly valued as it is an "extra" income which helps to fill gaps in the budget.

6 DRZYMAŁA, Z.: *Development of a New Co-operation System Between Technical Universities and Industry*

In his contribution about the development of a new co-operation system between technical universities and industry. Drzymala describes at first the possible co-operation areas in education of engineers and mutual research in technical fields of universities and industry. Changes in the existing co-operation are mainly induced by the ongoing restructuring processes in industry. The main characteristics of this restructuring processes can be seen in a movement towards "slim" factories with growing flexibility regarding the market needs and short internal transmission paths. This requires

most modern production processes with greater reliability, more automation and logistics together with raised awareness for environmental aspects. From that development some requirements for the structure of engineering education can be stated, which mainly lead to the idea of a more professional oriented engineer. The existing internal structure of the Department of Technological Devices and Environmental Protection of the UMM has to be restructured in teaching and research following the needs of the restructuring processes in the respective industries. The author thinks that the department is prepared for these new requirements by providing improved engineering education, staff development, and services for the interested customers from the industry.

7 GRÜNIG, B.: *Developing New Curricula in Polish Engineering*

Bärbel Grünig from the University of Kassel devoted her lecture to the thematic issue of developing new curricula in Polish engineering. Starting with the classical definition of curriculum Grünig points specifically at the importance of the so-called “hidden” curriculum which consists of “the ideological and subliminal message presented within the overt curriculum”. As the timely development in engineering education requires major changes in the curricula, Grünig concentrates on the process of curriculum development. Main actors and participants in this process are: University, industry, society, professional organisations of engineers, students. Even if universities claim a certain autonomy they are not independent from the rest of the society. Even if they try to develop own aims and ideas about their present and future tasks in society, concepts of education and fields of research the influences from political or administrative structures, economy, industry (national and international), international scientific contacts, media, own staff, funds, students, competition between universities etc. will help or hinder them to introduce changes in curricula. Also students have to be aware that there is a growing need for changed concepts of engineering studies: Their existing study concept and learning techniques should be questioned under recognition of future needs. Also the value of university degrees might change dramatically when graduates are envisaging a changed labour market. It is necessary for the implementation of new curricula to find adequate staff for the new technical or non-technical subjects.

Even if changes in curricula are mostly very time-consuming Polish universities within short time reacted to the international standards in engineering education and introduced new degrees (e.g. BSc and MSc), new fields of study and new subjects (like languages and economy). In order to open the international job market to their graduates, the universities changed their study programmes, they opened their universities to students from other countries and met the demands of international companies and EU-investors. They could be now perhaps in the situation to provide graduates with qualifications which the Polish industry needs nowadays.

Even more crucial than anticipating the future demands on technical engineering qualifications is the planning of non-technical aspects of the curriculum. Most universities introduced computer and management courses in engineering education as well as language training. Some skills that have been regarded non-functional for an engineer in the past are now seen as functional for instance being able to negotiate with clients, work in a team, work on an international level, plan a project, present results and products to non-technicians etc.

Teaching methods also play a vital role in curriculum development. They are more than just the medium to get information into the students’ brains. The concept of learning, the ideas of the student, the aims and the hidden curriculum become more obvious when regarding applied teaching methods. If universities offer lectures as the only teaching method this leads to producing many

consuming and dependent learners with little fantasy in problem-solving, little experience in co-operation or developing own ideas. A variety of methods can increase the success-rate of students. In projects studies and simulations students learn close to their future professional reality: working together and problem-solving. Many key qualifications of engineers are trained by doing: planning a project, working in a team, proving reliability, presenting results etc. Self studies and tutorials offer the chance to find own rhythms in learning and will train independence. Work placement seems to be a good means preparing students for their job, giving them an idea of what their professional life will look like and motivations for their further studies and, on the other hand can be a stimulator as well as a result of co-operations between industry and university. Curriculum development in engineering education is getting more and more complicated as in the wake of fast technological and social changes the requirements for the profession grow multi-various.

A nation in transformation will have to cope with the changes in the profession that are caused by the development of new structures in industry and economy. Polish universities have already mastered main steps towards a European engineering education, but the curriculum development will have to go on in the future years to support the overall transformation process.

8 PIECHOCKI, J.: *Restructuring Process of Engineering Education at the Warmińsko-Mazurski University*

The author describes a very interesting development within the Polish System of Higher Education: the integration of three institutions of Higher Education into one:

- University of Agriculture and Technology in Olsztyn,
- Pedagogical University in Olsztyn,
- Institute of Theology in Olsztyn.

This development of “comprehension” had several reasons and aimed mainly at the integration of the scientific and educational environment in Olsztyn in order to create new perspectives for students and university staff. Due to the integration the students of the Faculty of Technical Sciences can now study several new subjects and can co-operate with specialist of wider range of disciplines than before. There is a strong correlation between industry, the university, quality of teaching, student's interests and expectations, possibilities of finding a job and international co-operation. The new tendencies in that field will be observed in a very near future. Central qualifications of an engineer graduated at the Faculty of Technical Sciences good knowledge in the wide spectrum of fundamental engineering sciences and the ability of successful problem-solving in practice.

9 WINKLER, H.: *Organisational and Structural Changes in Polish Engineering Education*

The author records that the following characteristics of the development of Polish higher engineering education (HEE) can be stated. They can be understood as achievements, sometimes even as problems, still waiting to be solved or as potentials, leaving room for future development:

Decentralisation, deregulation, and raised institutional autonomy for the HEE institutions: The main and dominant development of Polish HEE can be seen in the new legislation after the reform in 1990, when the state loosened his influence and direct control over the institutions for HEE. The development will be carried on by a “New Law” Project which is proposed by the acting Minister of Education in the year 2000.

Technological innovation: Nearly all institutions of HEE have introduced or implemented new fields of study, thereby reacting to the growing and future needs of the country. If this reaction will be sufficient under the conditions after entering the EU and in view to the growing international competition, must be questioned to a certain amount. HEE in Poland has to be further enlarged not only in size, but also by implementing new so-called “key-technologies” or future oriented technologies. If the Polish industry will be competitive in the world markets, the HEE has to be far ahead of the just prevailing needs of today.

Modernisation and raised efficiency: After re-structuring the HEE following the new legislation, most institutions have been eager to modernise their infrastructure, e.g. buildings, laboratories, and computer facilities. Especially the latter was on the top of structural improvements, which are clearly visible for the (foreign) visitor. But the stalling or even shrinking statutory funds from the government make it not very feasible to proceed with further improvements. As long as the industry in Poland will not be in a better position, being able to co-finance the HEE-institutions, especially for R&D performances, the meagre state funds will not be sufficient.

Intensification of academic and administrative work: It is clear from the gained data, that the number of students within HEE has doubled or tripled during the last decade whereas the number of academic and administrative staff could only be raised moderately. Therefore the staff-student ratio has decreased to a level, where already some question marks about the minimum quality of teaching and consultancy for the students have to be raised. A further growth of student numbers is only possible, if certain measurements for staff development are introduced. Especially the salary structure for the academic and administrative staff has not changed remarkably during the last 10 years. Inflation and higher salary in industry and commerce make it unlikely that highly qualified manpower can be attracted in the future by the faculties in HEE.

Although there is enthusiasm for the job – which one can still observe in the most HEE institutions – most academics have several other jobs, to gain additional income to earn their living. This multiplicity of jobs and duties, sometimes is not very conducive for the main occupation at the University.

Broadening activity spectrum for academic work: The attractiveness of positions in HEE faculties has to be raised. The biggest problem seems to be the age-structure of the academic staff, with a high percentage of professors above the age of 55 or even more than 65 years.

Major research funding still in the hands of the state: The composition of funds available to the R&D at the institutions for HEE has not changed remarkably. Shortly after the introduction of the new funding system through the newly implemented KBN additional funding but after 1994 this part decreased again, so that the funding of R&D activities at institutions of HEE still relies mainly on governmental means. Thus the newly gained autonomy is rather shallow and can only be enjoyed if one estimates the participation in the decisions about the funds very high.

Study reform and modernisation of HEE: The existing HEE system shall be modernised and newly structured. One gets the impression that HEE is top of the re-structuring process compared with the rest of the higher education sector in Poland.

Very impressive is the threefold approach of innovation and study reform (which is not yet implemented at all institutions of HEE, far off seems to be the Faculty of machine design and construction at the SUT Gliwice, where the new programme will be introduced this winter, also the TU in Warszawa seems to be rather progressive in that case). The new structure contains three important

elements: the 3-tier structure (BSc, MSc and PhD-level); the modularisation and the introduction of the European Credit transfer System. (ECTS). This makes it very likely, that an integration into the European system will make no problems.

Rather problematic is the decrease in success rates of students in HEE, which can only be explained by growing numbers of part-time students drifting away from studies after finding employment without graduating.

Growing regional and service orientation: The development of institutions of HEE in Poland seems on a first look to be rather equally distributed between the different areas in Poland. There seem only to be differences of size. If one looks at the position of specific institutions in the ranking list the most modern, prestigious and attractive institutions for HEE are located in great cities or in the industrial zones of lower and upper Silesia. Obviously an intervening factor are the job opportunities for engineers, which are much better in these areas than in the northern or eastern provinces. These institutions there have to strive for more regional or even local orientation for two reasons: improvement of job-opportunities for their graduated engineers in the vicinity of the specific institution and to raise private funds from local industry.

Slow movement towards the "evaluative" state: The method of ranking of institutions in HEE is rather questionable, as the „polls“ are asking pupils, who mostly have no precise knowledge about the specific qualities or the rated institutions. The introduction of methods measuring the quality of teaching by questioning the students is not well developed and not evenly spread throughout the country, a systematic assessment of research at the institutional level is not visible. Only the ex-ante evaluation of research proposals from KBN is well established and can secure a certain standard of quality.

The planned accreditation agency on the national level is a matter of future.

Some comprehension is visible: The comprehension of some different institutions in Bydgosz (and also in Olsztyn) is following a specific idea of increased efficiency through integration. Synergetic effects are likely. If a comprehension of UMM and CUT in Krakow is possible, has to be discussed in future.

Hampered decision structures in institutions: So much the new legislation was welcomed with the growing autonomy of the single institutions in HEE, so negative are the most statements about the effectiveness of the decision structures on the institutional level. The councils are too big. they contain too much representatives from groups, who do not have the necessary expertise, the Rectors and Deans are too weak to put pressure on these organs.

Modest internationalisation: The institutions of HEE in Poland had and have close contacts to different countries in the world. In that matter they had better chances and conditions during the communist regime than their neighbouring countries. Some institutions have already close connections to western universities abroad, they provide international joint-degree programmes. Even if they are still small in size, they have the potential for further growth.

III. Future Perspectives

10 FLIZIKOWSKI, J.: *Future Perspectives of Engineering Education*

J. Flizikowski from the University of Technology and Agriculture in Bydgoszcz contributed some thoughts about the future perspectives of engineering education in Poland. The author stresses his doubts about a sufficient research base for the precise formulation of educational goals for engineers for tomorrow, especially in the field of environmental awareness and responsibility. Machinery already in use could be outdated under this new aspects and new design and production of new machines should be aware of the "life cycle" of machinery and their proper liquidation or recycling. But even under this stronger recognition of environmental aspects machine design has still to rely on technological knowledge. But the concept of machine design has to be enriched by more accentuation of engineers responsibility, raised creativity, and less indifference against the natural environment. The author presents a rough outlay of a reformed curriculum following the above mentioned ideas.

The underlying existing research potential seems to be available at the University together with the necessary equipment to do appropriate research work. Also the labour market encircling the university seems to be large enough to provide appropriate employment chances for new graduates in the respective field. The structure of industry in the area is dominated by companies in the fields of food technology, chemical, and wood and paper industry. The industry is aiming at stronger and closer connections and co-operation with internationally operating foreign companies. Transportation facilities are above national average which is conducive for further development, and even some tourist attractions (e.g. the medieval town of Torun) are existing. Summarising Flizikowski can state that the development chances and perspectives for future engineering education for the region surrounding his university are favourable and promising.

11 KACZMARCZYK, A.: *Perspectives of Engineering Education – Certain Questions*

In his Contribution "Perspectives of Engineering Education – Certain Questions" Andrzej Kaczmarczyk from the Instytut Maszyn Matematycznych in Warszawa concentrated on the problem of the broadening spectrum of engineering especially in the field of information technology (IT). He expects that "IT engineers" will become the largest single category of engineers within the next 10 years – in the USA anyway. Knowledge and technology in this area changes rapidly and needs of continuous education are great. Systems of engineering education have to take into account these needs, as well as the necessity to train traditional classic engineers with skills to use more and more sophisticated IT-tools in their fields of work. This has influence on the necessary changes in engineering education. The system of engineering education has to be shaped in a way, that challenges of engineering can be met promptly and effectively. Focus on dissemination of new knowledge and skills is justified as well. And maybe small, specialised centres will catch on this attitude easier than academic schools.

A certificate or licence is necessary for practise in some of engineering specialities, and a university diploma is only a prerequisite in these cases. In the area of IT more and more certificates are given to IT-practitioners by companies selling computer software and hardware. Companies like Microsoft or Novell have already developed such certification systems. Also professional associa-

tions organise certification systems – for example the *Council of European Professional Informatic Societies (CEPIS)* which gives a so-called *European Computer Driving Licence*.

Finally, one can expect completely new ways of education. Education, as information in general, entertainment, commerce, and so on, will expand to the cyberspace. Academia as *Alma Mater* appeared on a certain stage of development of the human civilisation – it seems to be associated with the culture of printed paper. It is probable, that in the cyberspace there will be many narrower, more specialised sources of knowledge and training, and that maybe a new profession of “cyber-tutor” – an educational guru in cyberspace, a rather single person than an institution - will appear.

12 WILAMOWSKA-KORSAK, M.: *Perspectives of the Engineering Education at the Warmińsko-Mazurian University in Olsztyn*

Marzena Wilamowska-Korsak from the Warmia-Mazurian University devoted her contribution to perspectives of the engineering education at the Warmińsko-Mazurian University in Olsztyn. This contribution can be seen in close connection with the paper of Janusz Piechocki about the Restructurisation process of the engineering education on the Warmińsko-Mazurski University.

The contribution of the author adds some interesting details about the development in the education of engineers at the Warmia-Mazurian University.

The Technical Sciences Department offers education for engineers in the fields of:

- building;
- environmental engineering;
- mechanics engineering and machines construction, and
- agricultural and forestry technique.

The graduates can be employed in:

- agricultural machinery factories;
- maintenance services and repair shops for agricultural machinery on the farms of different profiles agriculture advisory centres;
- professional educational institutions at secondary and higher levels and in research and development centres establishing and conducting own businesses connected with agribusiness.

Due to a planned accession of Poland to the EU environment protection requirements necessitate intensification of the works concerning building new purification plants, collectors, sewage system, water-supply services and other objects of this kind in every town or village. To meet this demand Environment Engineering has been established a new educational line, which aims to educate specialists in the field of design and implementation of sanitary and ecological installations. The graduate can be employed in institutions dealing with hydrotechnical objects, sanitary installations, water-supply services, purification plants, and ecological devices.

The Warmia-Mazurian University has started attempts to obtain the certificate of the University Accreditation Committee. Such a perspective creates new educational tasks and necessity to adjust particular organisation units to standards. This will involve plans and syllabuses correction required by the process of accreditation. In the Technical Science Department plans and syllabuses are worked out according to accreditation criteria of FEANI and programme minimum recommended by the National Council for Higher Education. By the end of January 2000 there will be probably introduced some minor changes into the plans, which will update the process of education.

The Technical Sciences Department conducts negotiations with two German Universities of Applied Sciences in order to start scientific and didactic co-operation (Fachhochschule in Offenburg and Fachhochschule in Köln).

Research is conducted at two research centres:

- Laboratory for Material Research, which in 1998 was awarded accreditation according to the requirements of the standard RN-EN 45001,
- the Vehicles Diagnosis Centre.

13 SZPYTKO J.: *Engineering challenges*

Janusz Szpytko from the University of Mining and Metallurgy (UMM) in Cracow refers to the development of modern technology in manufacturing. He sees the following major forces for change:

- a competitive climate;
- sophisticated customers;
- the basis of competition will be creativity and innovation in all aspects of the manufacturing enterprise;
- development of innovative process-technologies will change both the scope and scale of manufacturing;
- environmental protection as a global ecosystem;
- information and knowledge on all aspects of manufacturing enterprises and the marketplace will be available in a form that can be used in decision making for a global distribution.

Competitive environment requires from manufacturing a human oriented enterprise that converts ideas for products into reality, both from raw and recycled materials. Enterprises must be highly competitive and have to link customers of new products more closely to innovators. Products will be distributed globally, producers are parts of larger corporations, they will serve local and international markets and will operate autonomously.

Modern manufacturing must be active and competitive in all operations and shall integrate human and technical resources to enhance workforce performance and satisfaction, as well as reducing production waste and environmental impacts.

Modern manufacturing must rely on new “key-technologies” like:

- adaptable integrated equipment process and systems that can be readily reconfigured;
- manufacturing processes that minimise waste and energy consumption;
- innovative process for designing and manufacturing new materials and components;
- implementation of bio-technology into manufacturing;
- system synthesis, modelling and simulation for all manufacturing operations;
- technologies to convert information into knowledge for effective decision making;
- product and process design methods that address a broad range of product requirements;
- enhanced human-machine interfaces;
- new educational and training methods that enable the rapid assimilation of knowledge;
- software for intelligent collaboration systems.

Conducive for this modern manufacturing the following research activities are recommended:

- raising the understanding of the effect of human psychology and social sciences on decision-making process in the design, planning and operation of manufacturing process;
- managing and using information to make intelligent decision among a vast array of alternatives;
- adapting and reconfiguring manufacturing enterprises to enable the formation of complex alliances with other organisation;
- acceleration of processes for the production of diverse, customised products;
- developing tools to reduce time-to-market and improve quality;
- understanding the effects of new technologies on the manufacturing workforce, on the environment and the surrounding community;
- developing business and engineering tools that are transparent to differences in skills, education status, language and culture, to bridge international and organisational boundaries.

The author expresses his view about the requirements for the future where the engineering education institutions shall be ready to offer students knowledge and skills manufacturers expect in the age of globalisation, especially in micro-electronics, bio-technology, low-waste-production, improved process-control, recycling and re-use of process-waste streams in the years after 2000.



Part I

Existing Structures

1 Evaluation of the Development of the Engineering Education System

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During the two preceding decades the gap between the levels of western and Polish industries deepened significantly. Leading enterprises in the western countries radically altered their organisational structure, introduced interdisciplinary teamwork forms and flexible production systems, employee motivation systems as well as systems of computer-aided management and manufacturing control, etc.

Formation of industrial-consumerist society in Poland, marketing outlet globalisation and extremely tough competition between producers force taking under consideration the requirements of users as well as the processes of combining designing with production. In order to be up to the challenge, the industrial companies have to change their organisational structure, introduce the latest methods of production, lower costs and raise quality, analyse outlet markets, etc. Those who do not comply with the demands will be promptly eliminated.

Necessity of fast adjustment to the new terms have caused demand for highly qualified professionals with a different type of training. The above refers especially to engineers and managers as they are mainly responsible for the prosperity of a production plant.

The technical university education program restructuralisation and up-dating processes have been currently carried out in all countries of developed technology but in Poland with its specific conditions it is an extremely difficult and complicated process because of financial shortcomings, lack of modern research apparatus and low qualification of a part of research-tutoring workers. The above is also clearly noticeable at the faculties of mechanics where research studies and teaching require considerable expenditures. The situation is made complicated by lack of models to follow. Verified solutions do not exist. As a result, the engineering education in Poland is the subject under violent discussion.

It has become obvious that having such limited financial means and shortages in staff, the satisfying progress cannot be achieved in isolation from other countries. Only the programs of international co-operation enable the significant acceleration.

Our higher education, similarly to the entire education system, does not possess any generally known development conception within this scope. Thus, it can be safely said that especially Polish higher technical education faces a reconstructure problem beside indispensable changes of teaching contents and methods as well as the implementation of interdisciplinary education. For the meantime, with reference to the development of the private higher education as well, we deal with a quite uncontrolled interpretation of the education trends lacking adequate and thorough students' knowledge of the studies they choose and what is even more crucial of possibility of their work in the chosen professions not only today but tomorrow as well.

It is difficult to express one's opinion on chances to study in higher vocational schools, formed in compliance with the recently passed bill, and on their impact upon the issues discussed in the paper. The cause of which is found in lack of experience and low knowledge of the subject - as no vocational school has been yet brought into being as a result of the bill passed .

The assessment of the condition of the Polish industry, when its personnel requirements are considered, is quite difficult as it undergoes, together with the progressive privatisation, an increasing restructurisation. However, one can predict with quite high probability that within a 5 to 10-year perspective the needs of the Polish industry will not much differ from the needs of industries in high-developed countries.

Nowadays, candidates for studies at higher education institutions mostly choose non-technical studies although they prefer those which are somehow linked with industry, or rather economy such as: management, marketing, finances, law, etc where the number of candidates exceed the number of places while purely technical lines suffer because of candidates' shortage, have badly prepared candidates who are frequently frustrated because they were not admitted to the studies considered as attractive today.

Thus a question arises whether this spontaneously formed trend regarding the choice of a subject to study is proper and if not, what ways should be applied for its correction. To supply a reliable answer to the question it is essential to determine in which way a future engineer must be trained to meet the requirements of the industry of today and most probably of the industry of tomorrow. On such basis one could try to establish the education trends and - what is very crucial - the contents and methods of teaching adapted to needs of the developing market economy.

In the highly developed countries only 1/4 of all employed people work directly in industry. A transition from an industrial society to a service society has begun there. In connection with the above, a fundamental structural change is taking place in technique, economy and society, characterised by:

- complexity of technical and economical processes,
- internalisation and globalisation of production and outlet markets,
- increased competition together with production moving over to countries of low salaries,
- increasing ecological consciousness,
- ambivalent social attitudes towards technique as such and ambivalence of the very technique.

These changes, and even structural challenges, trigger off an increase of innovational speed in enterprises as well as cheaper and better quality methods of production and service. Frequently they are accompanied by renewing existing organisational structures and teamwork structures. Formerly rigid and fixed vertical and horizontal structures are discarded in favour of open, flexible and client-oriented structures, where:

- hierarchies are flatter,
- many decisions are made at operational levels,
- work areas are more complex.

These new trends in companies require from the already employed workers and from engineers being employed recently a different qualification profile and also different professional consciousness.

Structural changes taking place in enterprises beside knowledge and professional abilities additionally require on the part of engineers:

- team work ability (readiness and skill to co-operate, exceeding knowledge of one's line of speciality, in work-teams and discussion bodies),
- methodical competence (aptitudes and readiness to systematic thinking and acting),
- social competence (integrating of social, political, economic and ethic areas within engineering planning and acting within technique development and application), but also:

- competence of languages, mobility and flexibility (life and acting skills in international professional environments).

Today already, also in Poland, the expectations of leading enterprises towards employees are very high and considerably exceed their professional competence. These expectations can be grouped in three areas:

- extensive qualifications (mastering numerous functions, flexibility when taking over new aims, taking overall interest)
- social competence (ability to co-operate effectively, constructive conflict management),
- responsibility (identification with the goals performed, permanent improvement, self-organisation in work, readiness to feel responsible for oneself and work-teams entrusted).

From the requirements that engineers face, follows the necessity of changing the structure of education, choice of study program contents as well as alteration of teaching methods. Main weaknesses of the current system can be identified as follows:

- lack of sufficient knowledge among the candidates for studies, but also among students in the first place, about the prognosis and tendencies of contemporary societies' development, and then about the entire high education system, possible choice of majors, as well as of the study courses;
- excessive, isolated factographic teaching with students' lacking knowledge of methods of learning and methods of work, ways of problem solving and ability of presentation;
- frequent occurrence of tutors' egoism regarding the excessive importance of the subjects they teach, lack of co-ordination of the taught subjects' program context but also the absence of the innovation spirit among professors;
- students' temporary overburdening with the studies as such as well as their need of extra earning.

Up to now problems connected with the education system as a whole have not been mentioned in this paper, including those referring to candidates' preparatory level. These are problems of crucial importance, closely related to a very high selection of students taking place already among the first year students.

The selection, reaching even 50% of those beginning their studies, beside numerous other faults, undoubtedly causes frustrations among these who at the very commencement of their independent, adult life become defeated. This matter also reveals a certain common concern, as such drastic experiences of a young person may and surely lead to complexes, self-underestimation or to disrespect and discontent.

First of all, studies take too long. Students are admitted to a technical university when 18 or 19 years of age, having spent 12 years in an elementary and secondary school. Then, usually, they are suggested to attend solely 5-year studies, leading to a master's degree. During their first years of studying the stress is put on theoretical bases of technical subjects while the reference to an engineering practice is very limited or none. There is not enough industrial training. Laboratory equipment is unsatisfactory.

Students are overloaded with compulsory classes. With total number of lectures, classes and seminars reaching 30 hours per week, there is not much time left for self-studying. Teaching programs neglect technical creativity, skill of creation of new technical problems' solutions as well as the problems connected with designing in favour of analytic methods and description of existing machines and technical devices (various forms of knowledge of machines and „history of technique”).

Graduates know nothing about industrial realisation processes (production engineering), although they are well prepared in technical sciences. Technical designing has been detached from the production and from production organisation as well as from non-technical problems connected with production start-up and a product usage period.

They are not trained in team-work, an ability indispensable for an engineer. Students with the top average grade, who master individual subjects within an atmosphere of competition among students, are insufficiently prepared to work in teams which solve complex industrial problems.

The programs of studies contain too many subjects with limited orientation towards application. Too many subjects are very far from the real needs of technique. The so called basic subjects lack technical contents and so called technical subjects are presented perfunctorily and descriptively, being overloaded with a factographic content.

Each engineering activity requires co-operation between theory and practice, though in different scope and composition. Research and product development demand theoretic and abstract consideration regarding the arisen problem. On the other hand, the centre of gravity in production, assembling, operation and service is rather located within practical activity scope. An aptitude, a penchant and willingness of students are formed alike. Thus, the teaching system in higher education schools should enable, within variety of education, realisation of students' aims and liking, as well as needs of industry. The problem is of extreme importance because each engineering post in industry should be occupied by a competent and fairly well motivated worker.

Such analyses most probably served as a base to start in recent years separate or partly coupled studies for bachelor's and master's engineering degrees. These problems also were certainly considered at passing a bill on formation of higher vocational studies, carried out in separate schools (colleges). In high developed countries different systems exist in the field, usually following the educational tradition of the country. However, everywhere a possibility of education on a higher level exists, at least on two or three levels, beside studying on a doctorate level.

An engineer's activities are extremely varied and depend on numerous factors difficult to close in narrow and tight frames. It depends on a line, a position, an employer, a size of an enterprise and many other factors. However, even very varied engineering activities have common grounds. These are mathematical-natural science and basic technical knowledge. This basic knowledge is indispensable not only for comprehension of phenomena of nature but is also a ground for the specialists' science. Broad bases are also an important preliminary assumption for the collaboration (communication) between engineers of different lines.

Non-technical contents of study programs become more and more significant. These complementary data are crucial at least for two reasons. The first one is the need to complement the engineering qualifications. Engineers are entrusted with a rising scope of complex goals but the knowledge and skills they have are insufficient for solution finding. The second reason is that the aim of gaining non-technical data is to rise the engineers' preparation level and their readiness to take over managers' posts, not mentioning the need of their high responsibility when solving complex technical problems, and when co-operating with people.

Mastering basic knowledge is not enough to possess competence for work in a given profession. Therefore, already during the studies, a specialist's education should take place, basing on the thorough knowledge received during the solution of a concrete but exemplary problem. The most essential matter is to learn about methods of solving a specialists problem in a more thorough way, in

order to present a student with its extensiveness and multi-levels. The engineers - while creating objects or processes - are expected to understand, from the theoretic as well as practical angle, their increasing complexity. In the face of increasing complexity of contemporary devices and systems, there occurs rising significance of ability to generalise, systemic thinking and skill to collaboration on the level of the whole system with all persons taking part in solving a given problem. What more, the engineers are expected to know problems of operation but also problems related to a sale of produced articles.

The considerable part of specialists knowledge necessary for solving concrete industrial problems is gained by an engineer during his studies following the rule: „learning on the job” as well as during seminars, courses or post-graduate studies. Assembling all these aspects, it is recommended to contain the basic engineering education structure within the time scheme as follows:

- 30 percent mathematical-science bases,
- 30 percent technical bases,
- 20 percent general and non-technical contents,
- 20 percent exemplary, increased specialists knowledge.

The core of an engineer’s studies is to be a wide elementary knowledge being a ground for his/her future, professional mobility. Mastering the bases within the studies is therefore so very important as complementing this knowledge while working professionally is very difficult.

On the grounds of the basic knowledge, the specialistic knowledge in a complemented form, is to be passed on later on an example of *few* technical cases. It should be clearly highlighted that for reasons of a very fast technical progress and the impossibility of the studies’ prolongation, the professional specialistic knowledge of an object type should be taught only in a degree necessary for a graduate’s successful entrance into the specifics of a given profession.

The general knowledge, exceeding-major-subject scope science and non-mechanical contents should be presented not only in a form of separate classes but they should also be included in other professional classes’ programs. Such exceeding-major-subject scope and non-technical classes contain:

- methods of solutions’ winning and recognition in science and technique,
- applied computer science,
- basic technique of systems,
- history and philosophy of technique,
- industrial sociology, investment policy and technique transfer,
- environmental protection,
- management, organisation and economics in industry,
- cost account,
- work law and patent law,
- methods of man-teams’ management,
- methods and means of presentation and moderation,
- foreign languages.

A part of these subjects may be already taught during the first years of studies, as compulsory or optional subjects. However, it should be observed that the subjects - regardless of the semester they will be taught in - were interlinked with the vocational subjects.

The analyses of technical education in Poland reveal numerous shortcomings. Some of them occur in the West as well (however in lower degree), others are typical for countries of the former soviet

block. Particularly, the dramatic transformation of the state centrally controlled economy into the free-market economy has caused necessity of thorough reforms in the technical universities. Even today the Polish economic situation is altering under the influence of numerous, difficult to predict factors, which is also reflected in the higher technical schools. In spite of this, a lot of postulates regarding indispensable changes in the method of technical education may be formulated.

The vocational education oriented towards special type of machines should not be carried out at the technical universities. The traditional attitude towards technical education, putting stress mainly on the technical side of product properties, should be discontinued while it is necessary to determine and consider, in the teaching programs, this what really creates the ground of a professional engineer's practice. The observation of the best industrial enterprises' functioning is extremely useful.

There should be also introduced into the program of studies such traditional contents, considered as non-technical, as management, ergonomics, environmental protection, assessment of a venture risks, social science, ethics, legal issues, etc. The question is whether they should compose separate subjects or an integral part of others. It is important that these problems were elaborated in a way clearly referring to technical problems. The theoretic knowledge should also be presented in a way revealing its technical application.

The technical universities should, in consultation with industry, decide the priority aims of teaching. Because of the specific situation of the higher education in Poland, these priorities can differ from these of the west. One should look with criticism at the proposals of copying the western examples, however, the co-operation with the western universities is one of the indispensable conditions in the introduction of the necessary transformations within the specified period.

Students must be aware that during their career they will have to change their specialities several times. They must be prepared to an independent self-extension of their knowledge, during their whole professional activity. They must know how to work in a team and possess the skill to initiate and realise ventures..

It is very advisable to introduce credit points (CATS - Credit Accumulation and Transfer Scheme) and modularization of tuition programs linked with an integration of isolated „small” subjects into larger blocks of subjects.

Closing, one should put a question how far the changes, discussed briefly in the paper, are possible without additional means. An increase, and in fact a doubling the number of students within the last few years, have run down these chances, within the infrastructure as well as personnel areas. Making the political and economical elite's aware of the problem seems to be a crucial initial condition towards restructurisation and increase of the funds needed for the higher education.

2 Quality Management in Engineering Education

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Each society is interested in efficiency of its educational system. The efficiency of technical training concerns the level, range and durability of knowledge and the skills obtained by pupils or students as well as their success in the job. The quality in education can be also regarded as a problem of level and range of educational services, rendered by schools and universities.

The variety of organisational forms of technical training (concerning workers, techniques and engineers), the lack of educational standards and technical qualifications, difficulties with specifying the research tools, specificity of pedagogical work in many school, limit the possibilities of getting an objective view of pedagogical and technical service quality and the future graduates. At the moment it is really hard to evaluate the efficiency and quality of schools on particular grades and specialisation. Introducing to the educational system the exams carried on by the National Examination Committee, introducing the module and block educating, working out the measurable program's basis and plans for certification the services of education institutions could, in great part, facilitate evaluating the education quality.

Certification is a procedure, where the independent organ confirms that the services are conformable with the requirements, norms and regulations. As a result of this procedure the institution obtains the certificate. The current and important challenge for the universities is a requirement for the precise and complex evaluation of their job. The norms ISO 9000 published and edited by the International Standard Organisation for the European Community should be useful. The application of these norms should take into account the following requirements:

- the process of controlling should include all activities of a given institution, especially those which help preventing drawbacks;
- within the controlling system mechanism of transmitting the reversible information should be created, which would give the customers the possibility of expressing their opinions;
- quality inspections should be introduced, which aim at verifying applied procedures.

As a result of the certificate proceedings the university could be given the accreditation of quality education. The organisers of quality evaluating systems should, however, be aware of the fact, that finding the objective and unambiguous solution to that problem is very difficult.

Quality assurance at universities became a very important topic for many workshops and conferences. Among conclusions of the workshop carried on by Maria Wójcicka, there were one concerning the right of each university to formulate its own aims, adjusting evaluation criteria to the realisation, which were formulated as a university mission. During the conference of the Seym Commission of Education, Science and Youth and Polish Committee for UNESCO affairs, Ewa Chmielecka introduced two ways for quality assurance at universities:

- 1st way: guarantee the minimal quality level by getting the right for diploma conferring after fulfilling the basic criteria. The procedure is mainly based on quantity indicators. License conferring is carried on by national administration organ. It is obligatory, universal and periodical. It has a little influence on quality improvement.

- 2nd way: improving quality by accreditation procedures. Usually local organs carry them on. They are voluntary and paid. The procedures are based on variable criteria, often very high. They have significant influence on quality improving.

One of the ways of education quality evaluation at universities is the education results analysis according to the accepted indicators (external evaluation). Among them there are quantitative data concerning enrolled students and study's efficiency, quantitative data concerning promotion and credit semesters, marks of thesis, graduate's opinions, tests, etc. The external evaluation should be carried on by the proper department, independent from the evaluated institution, which works with the help of statistical data, documents and expert's opinions.

During the recent years in our country, there have been created conceptions for the benefits of improving education quality as well as the different departments were brought into being. The author's and other members' of The Main Education Council propositions reflected in elaborating the foundations of pilot research on education quality evaluation.

The second way is based on the evaluation of strategies which are present in faculty or department activities and settling the relation between conditions and education results, defined as an internal evaluation.

Internal evaluation of education quality is carried out by the university, usually on the base of periodical teachers' evaluation, faculty's opinions or evaluation of institutes. Maria Wójcicka is pointing out that there are two spheres of academic independence: the sphere of research realisation and the sphere of didactic realisation. In both cases as a base for evaluation we accept the scientific achievements, degrees and academic titles. While in case of scientific achievements' evaluation such attitude is correct, in case of didactic work it is rather questionable. Every form of evaluation must be based on the assumption that a quite clear set of expectations exists connected with didactic process realisation. The university should create its internal system of evaluation, regarding student's opinions as well. Internal and external evaluation should be strictly connected with each other and should create the system of education quality assurance.

The new higher education law provides that the Academic Accreditation Commission is to be brought into being, that education quality evaluation will be implemented and accreditation of didactic units will be obligatory and universal.

Following an initiative of the Main Council of Higher Education in 1998 the plan of carrying on the pilot tests of education quality evaluation within two faculties has been established: the faculty of building and the faculty of medicine. It was a favourable coincidence for me, as my interest in this subject is strictly connected with broadly understood education and staff improvement on building faculty (technical, secondary and higher). At the moment I will limit my considerations to the level of higher education. The detailed criteria were laid down, concerning education quality evaluation and qualifications of units on the building faculty and the Polish technical universities were invited to take part in that program. 16 universities took advantage of the invitation (Warsaw Polytechnic did not). It has been tested:

- compliance with the required number of professors at the department and number of lecturers without doctor's degree on didactic classes:
- compliance with the detailed criterion concerning:
- number of offered specialisation
- level of basic and auxiliary subjects

- range and level of optional subjects
- availability of computer net and database
- availability of individual studies on faculty
- level of foreign languages
- availability of the humanities
- selection and connections of thesis with scientific activities
- rules of enrolment
- introducing the credit system of education
- availability of programs and requirements for candidates
- student's scientific sections
- efficiency of didactic classes inspections
- questionnaires among students concerning education quality
- periodical inspections and staff improvement
- consultations with student's government
- general local conditions and rooms equipment
- access to Xerox machine
- aesthetic and cleanliness of rooms

The detailed criteria were the base of evaluation, accepted by the selected group proposed by Prof. Janusz Kawecki. In every field the visiting group conferred the main points and additional ones. The total number of points enable us to qualify the building faculties taking part in the research, to three categories:

166 – 177 points – category A, very good mark

176 – 84 points – category B, medium mark

83 – 19 points – category C, very low mark.

Table 2.1: Universities category (according to the reference book of the Faculty of Land Engineering, Cracow Polytechnic, no II/99)

Category A	B	C
Number of universities 6	10	–
In the order of decreasing score:		
1. Cracow Polytechnic		
2. Wrocław Polytechnic		
3. Łódź Polytechnic		

Groups of experts had no reservation to 16 evaluated units as for fulfilling the qualifying requirements and to the staff on building faculty. Two polytechnics are carrying on the studies within one specialisation, six within two or three specialisation, the other eight within three or more (Cracow University of Technology). Evaluation of the level of basic and specialists subjects gave the following results:

1. Standard mark – 5 points - was given to 6 universities, the rest (including Cracow University of Technology) were given 10 points. For the proposition and level of optional subjects only two

universities (including Cracow University of Technology) were given the maximum number of points (10 points). Ten units (including Cracow University of Technology) were awarded with more than a standard mark for compute database. The availability of humanities was evaluated as quite good in half of all universities. In half of tested units there are entrance exams. Activity in the field of didactic publications met the highest mark in 14 units. The availability of programs and requirements in studies reference book were evaluated rather severe: 8 units gained 10 points, 7 units – 2 points. In the field of student's scientific sections more than standard mark obtained only 3 universities (including Cracow University of Technology). As for questionnaires among students concerning education quality: 8 units were give more than standard mark, 5 units (including Cracow University of Technology) standard mark, 3 units – 0 points.

2. 13 polytechnics gained a maximum number of points for local conditions and rooms equipped with audio-visual medium. The efficiency of inspecting didactic classes in 3 cases was awarded the highest mark, in 12 cases – standard mark, in case of one unit no mark was given (Cracow University of Technology).
3. The lowest marks were given to almost all polytechnics for the availability of individual studies on Building Department and for the level of foreign language teaching.
4. On the base of elaborated reports concerning the evaluation of Building Faculties at polytechnics, self-evaluation of the faculty's committee, scientific achievements and graduate's opinions it could be acknowledged that all higher technical universities are carrying on the Building Departments on at least good level, and some of them on very good level.

Each external evaluation should be useful in improving the university. The working conditions' improvement should be, however, supported by an internal quality evaluation system. Both systems are complementary to each other and could be a base for the process of modernising engineering education. The essential condition is, that all the members of the process should accept the mechanisms postulating the quality change.

The Main Trading School (SGH) introduced an internal evaluation system. The system included: annual evaluation of didactic and scientific staff carried out by superiors, evaluation of staff by students, examination of the graduates' careers (within the system of connection between university and environment), evaluation of university's units (self evaluation of institutes and departments), publishing the didactic offer (including the education programs, popularity analysis, etc.). Other universities were trying to test the education quality level, obtaining very variable results. But among academic teachers the process of recording quality at universities does not have many followers.

In my opinion creating the system of external education quality evaluation (if it does not aim only at settling the order according to the scale), supplemented with internal system of control, should contribute to didactic work improvement. It also seems important to regard the didactic achievements during periodical tutor's evaluation (and not only their scientific achievements), systematic pedagogical improvement of tutors and publicises of marks and student's evaluation improvement (by module education).

The education quality within universities is a very complex and difficult problem. Introducing the above question to the Main Council of Higher Education, carrying on the trial researches on the universities, expected entrance to the European structures and the social demands became a reason for my pronouncement on that subject.

Detailed criteria of internal evaluation at universities

1. The number of offered specialisation.
2. The level of basic and auxiliary subjects.
3. The range and level of optional subjects.
4. Availability of network and computer database.
5. Availability of individual studies within a specialisation.
6. The level of foreign languages teaching.
7. Availability of humanities.
8. Selection and connections the thesis with scientific activities.
9. The rules of enrolment.
10. Introducing the credit system of education.
11. Availability of programs and requirements for enrolment.
12. The activities of student's scientific sections.
13. The efficiency of classes inspections.
14. The results of questionnaires among students concerning education quality.
15. periodical inspections and staff improvements.
16. Education consultations with the students` government.
17. General local conditions and lecture halls equipment .
18. Availability of Xerox, computer and internet.
19. Esthetic and cleanliness of room.

3 Practical Training in Engineering Education Based on Experiences from Politechnika Śląska w Gliwicach

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“One drop of practice is better than ocean of theory” - true or false?

3.1 Practical experience in engineering education

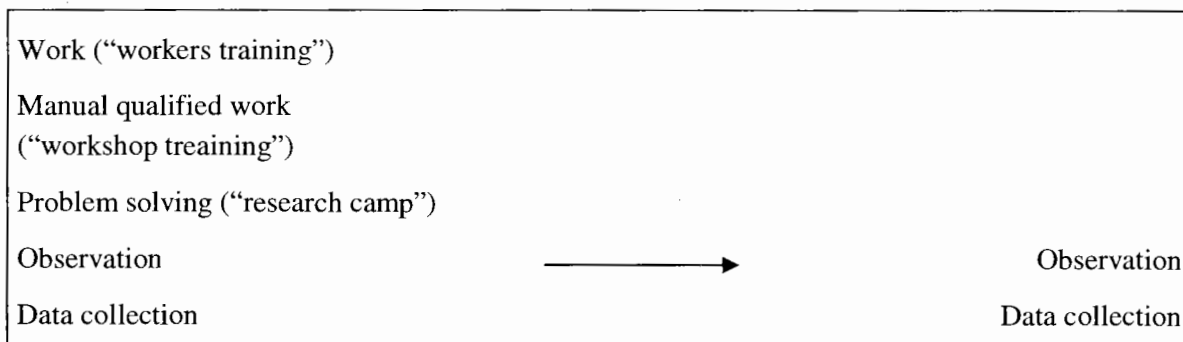
When we are looking at wonderful medieval cathedrals or eternal roman bridges we realise that all those things were made by men who never heard the word “theory”. When we are looking at a carpenter making traditional a Podhale hut we notice that he is performing all operations in a certain order and he is sure what will be the result. He does it this way because he was taught by his master and the master was taught by another master.

None of them had written instructions. There were no books nor handbooks. The only way of engineering and engineering education was practical training. The idea was not separated from the matter (Fig. 3.1a, see page 36).

This separation became possible when models (iconic, mathematical etc.) had been introduced to the technology. Since that moment creation (production) of material things is separated from their invention (designing). The matter engineer works with is abstraction (information). Since that moment education can be separated from the practice because we use models instead of real things (Fig. 3.1b, see page 36). The better the models we teach with are the less practical training we need. Teaching with models is so perfect that an engineer who never been on a plant or on a building site is nothing unusual.

However the ultimate goal of engineering is to create material objects and relations between them. This brings the moment of confrontation between idea and matter. That is the moment engineer needs a little bit practical experience.

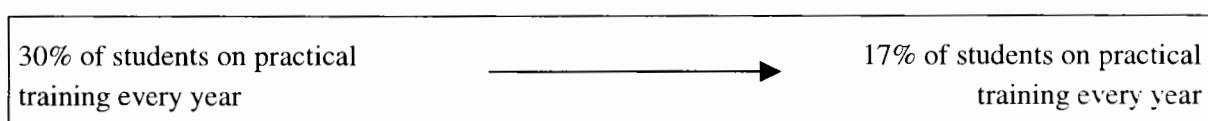
3.2 Changes in quantity, structure, organisation and form of training between 1990 and 1998



Until 1990 the structure of training has been the same in all faculties:

- after 1st course: manual training (so called „workshop training”) intending to make students more familiar with the materials, items and appliances (tools, machines).
- after 3rd course: industrial (technologic) training intending to make students more familiar with processes; it also has been an opportunity of solving minor technological or organisational problems,
- after 4th course: so called „diploma training” intending to be place of collecting data for diploma work.

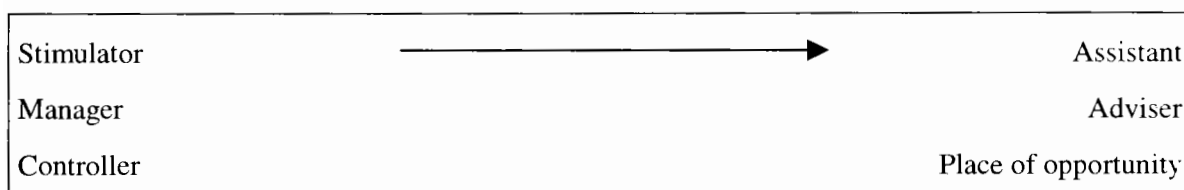
Manual and diploma training have been organised individually by the students, industrial training phases were realised in form of a „research camp” (a group of 10 – 12 students with a tutor). All together practical training within the course of study lasted from 12 weeks in Chemical Engineering Faculty through 16 in Architecture Faculty to 28 in the faculty of Mining and Geology (Tab. 3.1, see page 37).



After 1990 the majority of the faculties cancelled manual training and saved industrial and diploma ones (although with reduced time). In order to save costs the school recognised students’ training phases which they had gone through in previous schools (e.g. vocational). The number of students released in that way increased from 12% in 1992 to 24% in 1995 and stabilised at about 14% in 1998.

Since 1995 the number and time of the practical training is decreasing continuously. Number of trainees increased nominally but in proportion to the number of all students it decreased from 30% in 1992 to 17% in 1998 (Tab.3.2, see page 38), (Fig. 3.2, see page 39). Furthermore, its form is changing. The school organises not longer research camps because this is a too expensive training form. In some cases several visits in a factory instead of regular, continuous training is accepted.

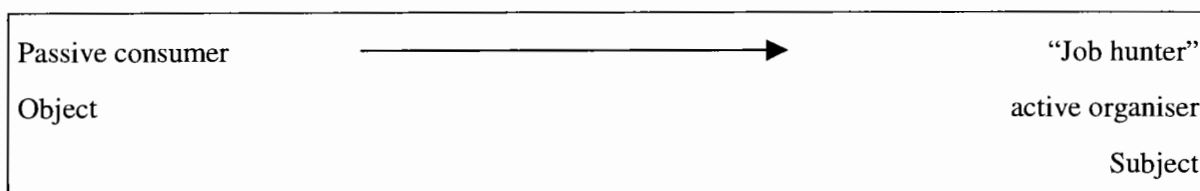
3.3 Changes of the school role in training organisation



Until 1990 the school organised all kinds of practical training. First of all the school was in contact with companies, made agreements and strictly controlled its performance. Also university provided accommodation, meals, commuting and leisure time for trainees. Now most of those problems are solved by the students themselves. They look for a company willing to employ them, they take care of their accommodation, commuting etc.

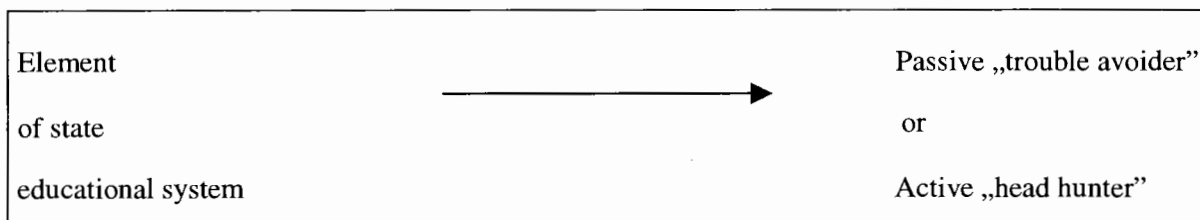
The school’s role is changing from the role of a stimulator and organiser to the role of controller and a place of requirements and opportunities. It depends on student’s own attitude how to meet requirements and how to take a chance.

3.4 Changes of the student role



Before 1990 practical training has been regarded by the students as an element of the educational process. Now in many cases students regard the training as an opportunity of seeking a job. Many students take professional job as early as during their third or fourth course. Special student status allow them change employers and look for the best post. Quest after a place for the training becomes a search for a job and basically becomes a task for the student. The university may only make this task easier giving the student advice, providing contacts, addresses. The student population splits into two groups: one of active persons who know what they want (university can help them with their development) and the other one who meet requirements on minimal level.

3.5 Changes of the company role



Before 1990 practical training took place in companies which co-operated with the university. Because of lack of workers during vacation time they willingly employed students to make manual training. Nowadays the companies do not want trainees. If they accept trainees they need students who are paid by the school. The number of trainees who are paid by the company is low and oscillates around 4%.

The kind of ownership of the enterprises has also changed. Before 1990 many public companies accepted trainees because there was a strain towards co-operation with the state educational system. In 1992 public companies offered more then 535 training posts and in 1998 less then 24%. Obviously there is increasing number of posts offered by private companies but the number of posts does not depend on the kind of ownership. The most important is the strategic aim realised in a company by trainees. Companies with a correct personal policy willingly accept trainees because they always are looking for good employee. For instance „Unilever”, Fiat”, Daewoo” and „Opel” signed agreements with the Politechnika Śląska in this field. „Unilever” organises three months trainings and considers trainees as probationers.

3.6 Reasons of the changes

Between 1990 and 1998 different developments took place at the Politechnika Śląska which influenced the practical training. Most important - among others - were:

- increase of the number of students from 8 000 to 26 000 (the number of regular students increased from 6 800 to 18 261),

- reduction of number of hours from about 4400 to about 3500 during for a five years master course;
- reduction of the state support per student; in 1990 state support covered 100 % of the education costs, in 1998 it reached only 85 %;
- structural changes in industry and rising unemployment; now a majority of jobs can be found in small and medium size firms. In such firm a trainee is rather an obstacle and competitor than a chance for improving its efficiency;
- change of the study course: from two stage – MSc - PhD, to three stage BSc – MSc - PhD
- better educational tools and methods, especially models;
- changes in desired type of a graduate: more general educated.

3.7 Conclusions

- Practical training seems to be of less importance than before but is still a necessary element of engineering education because engineers still act in production of material things (manufacturing, contracting);
- There is a need for a new different type of practical training according to the new three stage study course. It could be one semester or one year professional work between study stages,
- It would be useful to acquire more teachers from industry. They can bring more practical experience.

Figure3.1: Relation between idea and matter in the process of material production: a: integral, characteristic for handicraft, b: separate, characteristic for engineering

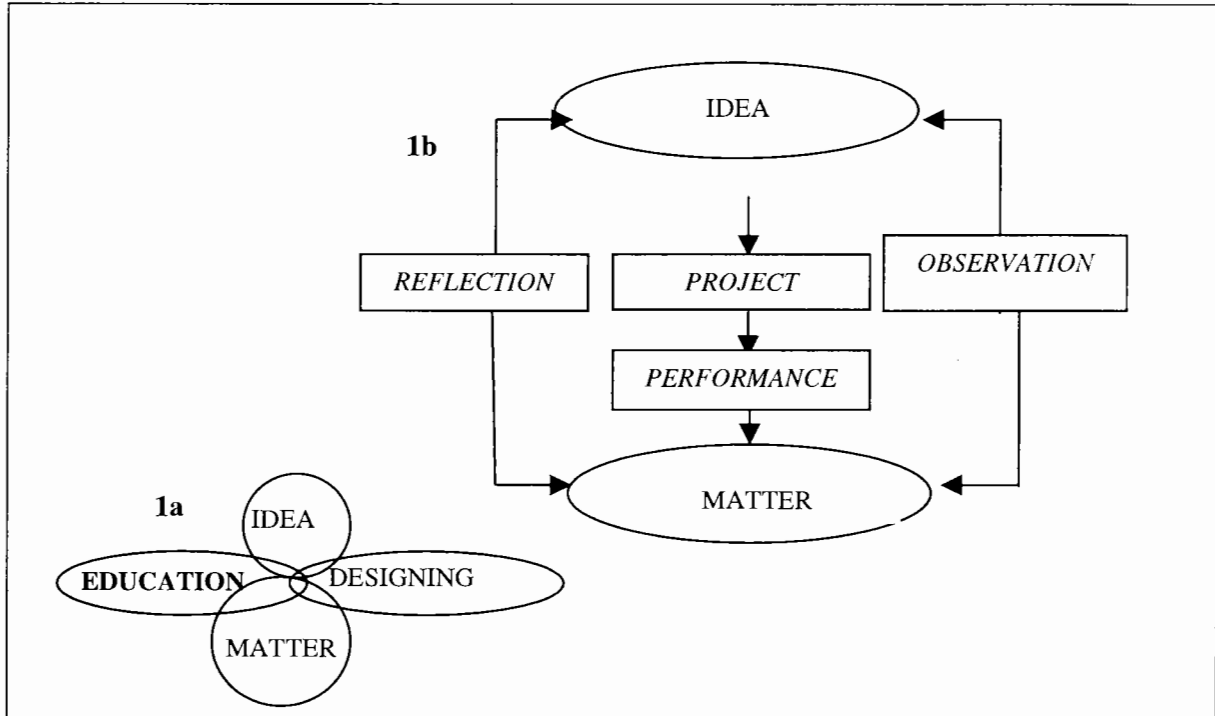


Table 3.1: Changes of number and form of practical training in some faculties of the Politechnika Śląska

Faculty of Mining and Geology			
	1980	1990	1999
1	Manual 4 weeks before 1 st course		
2	Manual 4 weeks after 1 st course	Manual 4 weeks after 1 st course	
3	Observation after 2 nd course	Observation after 2 nd course	
4	Designing (so called „research camp”) 4 weeks after 3 rd course	Designing (so called „research camp”) 4 weeks after 3 rd course	Manual and observational 4 weeks after 3 rd course
5	Diploma training – designing in the course of 10 th semester 12 weeks	Diploma training – designing in the course of 10 th semester 12 weeks	Diploma training – designing in the course of 10 th semester 4 weeks
Σ	28 weeks	24 weeks	8 weeks
Faculty of Chemical Engineering			
	1980	1990	1999
1	Manual 4 weeks after 1 st course		
2	Industrial (in works) 4 weeks after 3 rd course	Industrial (in works) 4 weeks after 3 rd course	Industrial / technologic 3 weeks after 3 rd course
3	Technologic after 4 th course		
Σ	12 weeks	4 weeks	3 weeks
Faculty of Architecture			
	1980	1990	1999
1	Manual 4 weeks after 1 st course		
2	Open air hand drawing 2 weeks after 1 st course	Open air hand drawing 2 weeks after 1 st course	Open air hand drawing 2 weeks after 1 st course
3	Monument cataloguing and surveying training 2 weeks after 2 nd course	Monument cataloguing and surveying training 2 weeks after 2 nd course	Monument cataloguing and surveying training 2 weeks after 2 nd course
4	Urban surveying training 2 weeks after 3 rd course	Urban surveying training 2 weeks after 3 rd course	
5	Building site training 3 weeks after 3 rd course		
6	Design training 3 weeks after 4 th course	Design training 3 weeks after 4 th course	Design training 3 weeks after 4 th course
Σ	16 weeks	9 weeks	7 weeks

Table 3.2: Number of students in practical training

	Faculty	Number of students in practical training									Number of students released from the practical training ³		
		Total			Employed ¹			Sent from the University ²					
		92	95	98	92	95	98	92	95	98	92	95	98
1	Architecture	474	639	617	21	-	-	453	639	617	-	-	-
2	Automation, Computer Sc, Electronics	267	175	278	68	44	115	199	131	163	109	61	54
3	Civil Eng.	248	414	316	94	2	19*	154	412	316*	1	11	70
4	Chemical Engineering	219	70	110	9	-	-	210	70	110	-	-	-
5	Electrical Engineering	113	126	144	2	5	-	111	121	144	3	101	122
6	Mining and Geology	478	82	109	49	-	-	429	82	109	96	28	49
7	Energy and Environmental Engineering	120	164	349	15	37	2	105	127	347	56	182	136
8	Applied Mathematics and Physics	40	21	141	-	-	-	40	21	141	-	-	1
9	Mechanical Engineering	21	85	246	2	3	2	19	82	244	-	-	-
10	Organisation and Management	-	224	350	-	6	-	-	218	350	-	10	-
11	Materials Science, Metallurgy and Transport	158	284	279	85	9	15	73	275	264	2	8	10
12	Centre for Engineers Education in Rybnik	-	118	233	-	30	14	-	88	219	-	11	-
		2038	2402	3172	85	136	167	1692	2266	3024	242	412	442

¹ Students employed and paid by a company, which organise the practical training

² Students paid by the university

³ Students who already had practical professional experience, e.g. graduated from vocational school

* total number of students in practical training is not co-ordinated with those of employed and sent because of a system of short term practical training in several places

Figure 3.2: Increase of the number of students and trainees in Politechnika Śląska in 1990 – 1998 (see Tab. 2)

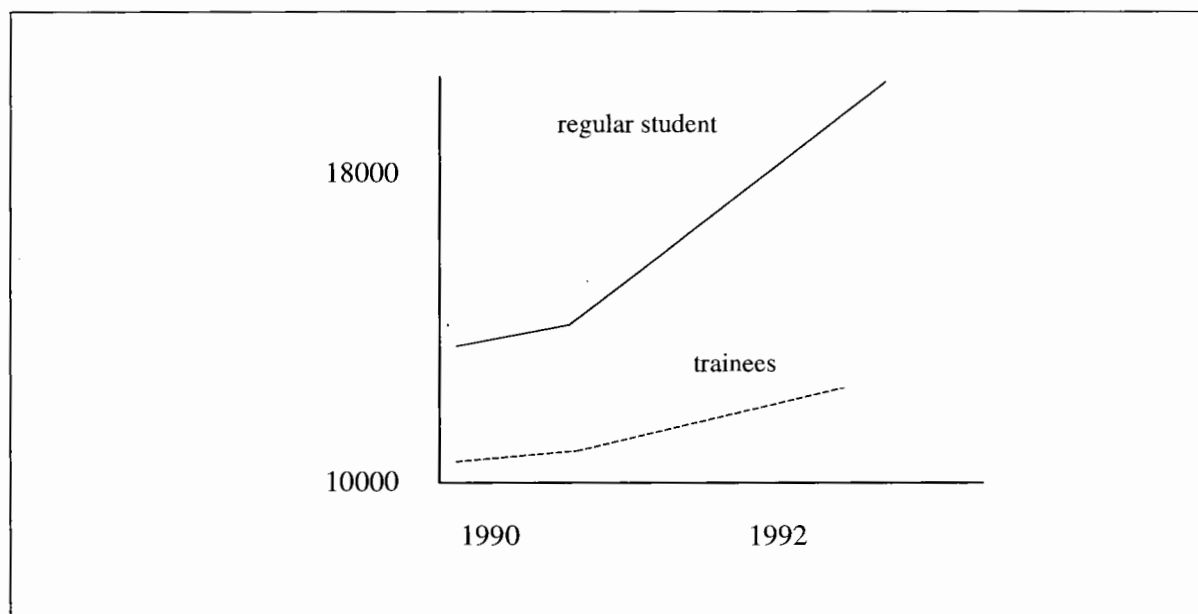


Table 3.3: Number of students according to type of employing company

	Faculty/ year	Number of students according to type of employing company														
		Public			Private		R & D institutions			University			Others			
		92	95	98	92	95	98	92	95	98	92	95	98	92	95	98
1	Architecture	168	-	-	36	103	102	-	-	-	87	536	515	183	-	-
2	Automation, Computer Sc. Electronics	125	31	37	91	114	202	13	10	18	32	13	19	6	7	2
3	Civil Engineering	63	20	26	1	14	218	4	-	3	171	372	217	9	8	21
4	Chemical Engineering	90	44	68	-	-	24	4	1	13	25	25	5	-	-	-
5	Electrical Engineering	91	48	102	32	3	12	-	-	-	-	75	30	-	-	-
6	Mining and Geology	385	61	93	-	3	4	-	-	-	87	7	5	-	11	7
7	Energy and Environmental Eng.	71	53	63	28	63	247	4	5	21	13	5	-	4	38	18
8	Applied Mathematics and Physics	7	-	93	20	-	23	3	1	3	10	20	19	-	-	3
9	Mechanical Engineering	18	46	69	3	31	95	-	8	-	-	-	2	-	-	80

to be continued

4 Health Aspects in Engineering Education

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One of the results of transformation observed in the important spheres of human life is the height of interest in wholesome problems and the attempts for improvement of awareness and effectiveness of wholesome education for the general public. This activity is orientated towards the environment of life and work place especially with respect to:

MAN – TECHNIQUES – MANAGEMENT

In Poland professional activities oriented to health promotion are managed under the umbrella of the National Health's Programme (NHP). The NHP formulated for the period of 1996 – 2005 focus at the following:

1. operating targets:
 - decrease of exposure to injurious factors in environment of life and of work place,
2. methods of realisation:
 - formulation and implementation of modern medical prevention and health promotion at the work place and introduction of a modern system of information technology,
 - education in the field of work place safety and health protection.

To initiate improvements of health in workplaces in aspects of the man – machine system ideas of the total quality management TQM and productive maintenance TPM are employed.

From experiences of large industrial associations, which introduced programmes for health follows that promotion of health in workplaces should be to be well-versed on:

- education of professional risks;
- elements influencing the lifestyle of individuals.

Every employer should be interested in healthy workers. Promotion of health is an essential part in creation and maintenance of safety within the man– machine system. Practical aspects of health promotion in workplace include the following steps:

- identification of dangerous areas (workplace analysis), knowledge and experiences of operators of devices and co-operating of persons,
- elaboration of questionnaire of relating between professionals; stress aspects and psychosomatic symptoms described by workers
- discussion about the existing situation in a circle of specialists,
- proposing technical and organisational solutions for the improvement of the existing situation and discussing them in a circle of interested workers,
- introduction of possible modifications and proposing changes in practice

Basic problems on which health promotion in the workplace should be directed also in process of engineering education are:

- professional stress
- heart diseases
- high blood pressure
- sickness - absence

- diseases (especially serious threats like aids/ hepatitis type B)
- obesity
- smoking cigarettes
- alcohol abuse
- drug abuse.

Fig. 4.1: Different causes of deaths on the world (ILO, 1998)

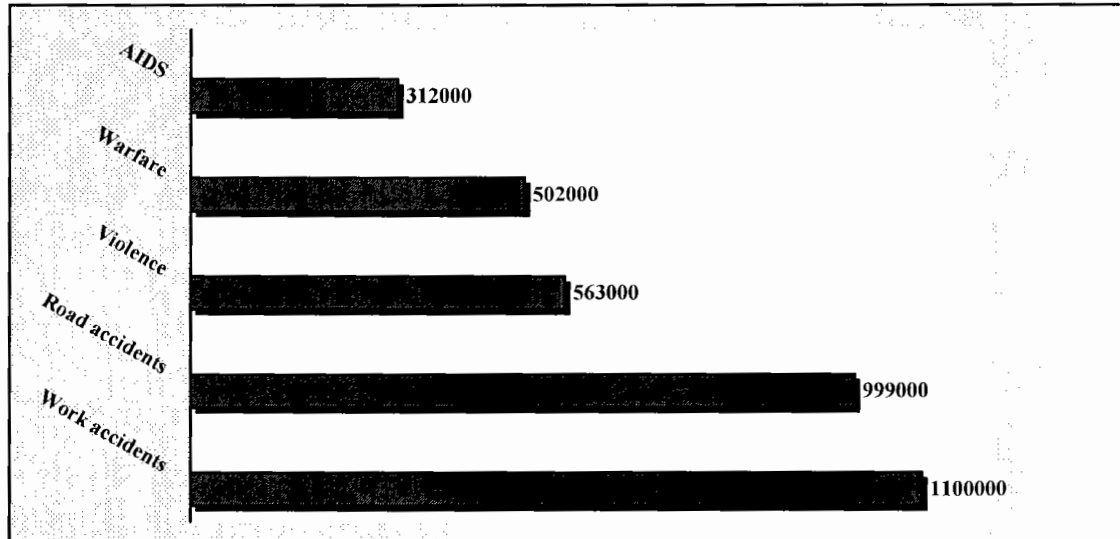


Fig. 4.2: Basic value man and machine

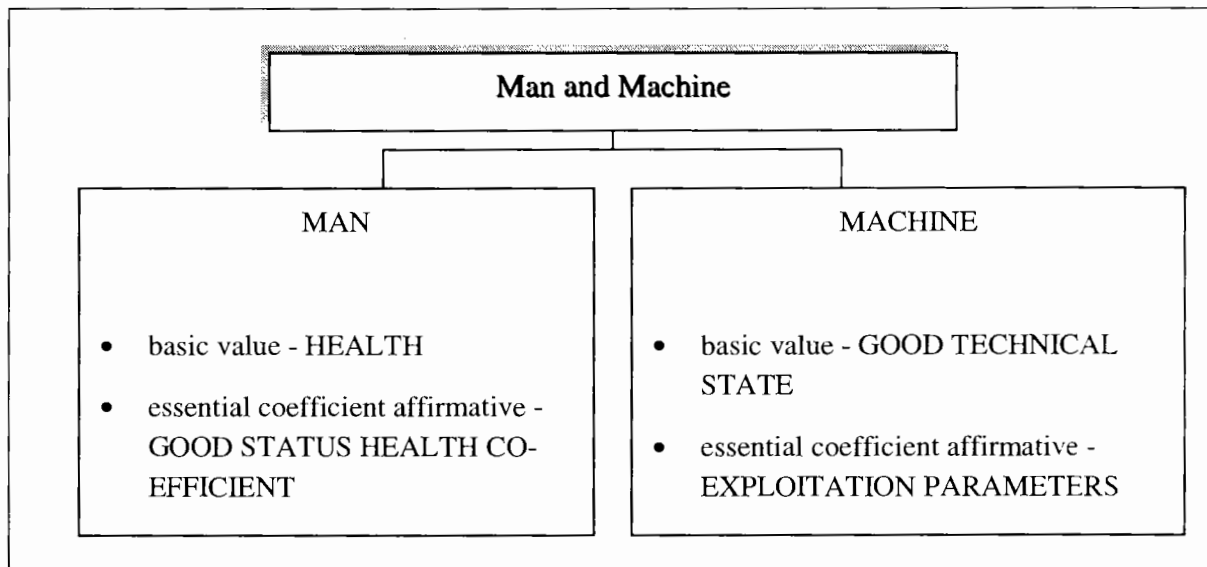
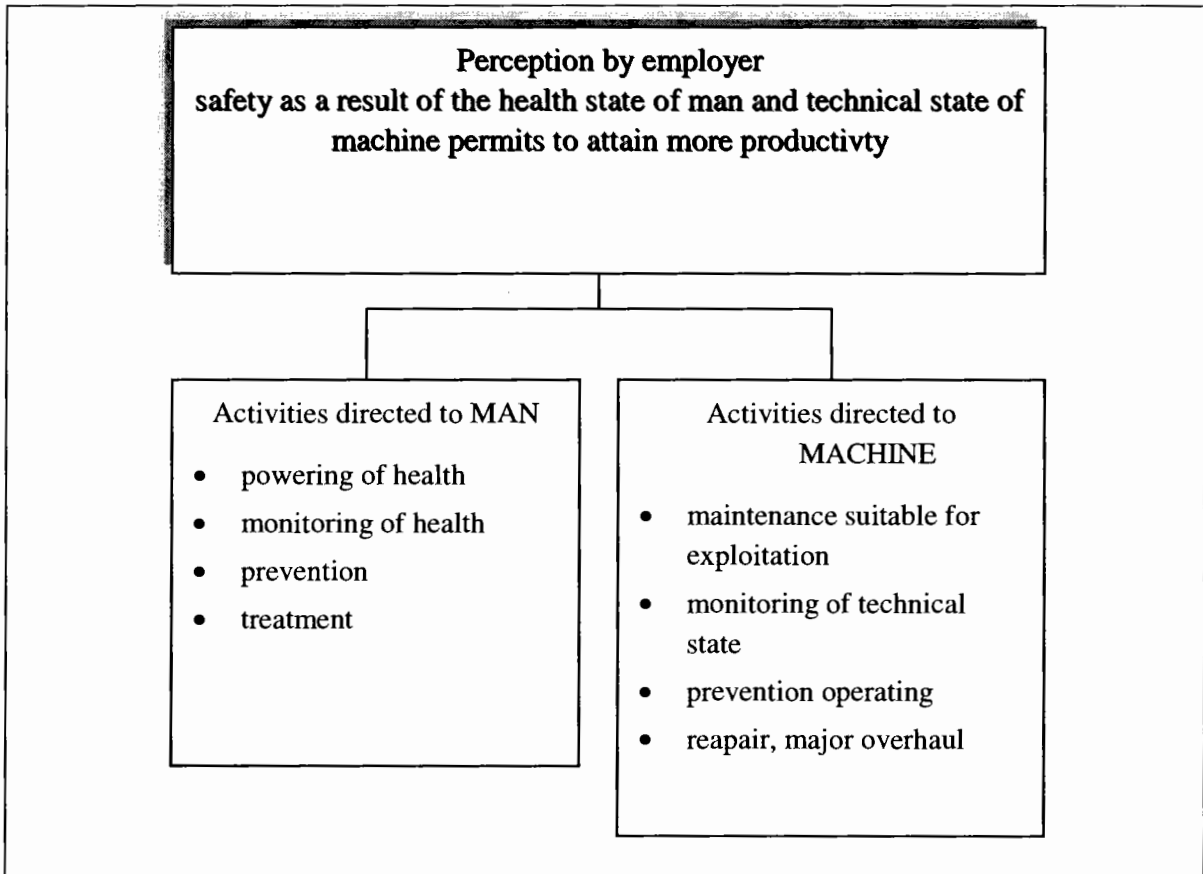


Fig. 4.3: Work safety – two points of view

Part II

New Developments

information technology, mechanotronics, robotics, telecommunication, marketing, advanced materials, medical engineering, to list only several the newest ones. To preserve its profile and high position among the institutions of higher education, our university has to develop new disciplines without abandoning the remaining ones, even those considered traditional. The question regards only the mutual proportions between new and traditional disciplines. Therefore, the university has to develop new disciplines in the scope of technical sciences but not at the sacrifice of the existing ones. Research and teaching of technical sciences, which is an exceptional feature of our alma mater, has to be based on exact and natural sciences and complemented with economic and social sciences. The profile of our university has to be determined by technological departments, which should form the majority of these organisational units. They should cooperate with the departments (or other units) of exact sciences (mathematics, physics, chemistry), natural sciences (geology, geophysics), economic sciences (management, marketing, finances, etc.) and social sciences (law, sociology, philosophy, pedagogy). Although the existing structure of the departments and inter-departmental institutes correspond the above-described profile, it only partially serves the current needs, as it was created in the seventies. The projects of fundamental changes in the structures of departments proposed during the last two Senate's tenures were considered premature by the interested units. For this reason, during the present Senate's tenure, such attempts will not be undertaken without an initiative from the departments. However, we believe that it would be advisable to draft general rules of such reform in case it is put into effect (which is inevitable in longer prospect). We suggest that the structure of our university should be based on departments as primary units which conform to the following requirements:

- the profile should depend on specialisation(s) taught at the department;
- the same specialisation should not be taught at several departments;
- the department should have full academic authority;
- the department should comply with the requirements of the State Committee for Scientific Research enabling it to be classified in category A;
- the departments can differ in size but the differences should not be too large;
- the most feasible number of departments can be estimated at 8 to 10, at the present size of the university.

These requirements should be considered a model for future discussion on the structure of the university.

The following tasks have been proposed to be achieved during the present Senate's tenure:

- conclusion of restructuring of the Department of Fuels and Energy so that the department could confer doctor's degree and then to qualify for assistant professorship, and the application to the State Committee for Scientific Research to change the department's category from B to A;
- staff reinforcement at the Department of Management, especially in the field of economic sciences, and enlargement of office and teaching space;
- development of cooperation system between the departments teaching the same specialisation;
- staff reinforcement at the Institute of Mathematics and the Institute of Social Sciences so that they could increase their research activities which should lead to the establishing such specialisations, and possible transformation of the institutes into departments;
- creation of appropriate conditions for the activities of the newly founded schools, i.e. the International School for Engineers and W. Goethe School of Environmental Protection

Autonomy of the departments, warranted by law, in the field of didactics, and decentralisation of decisions regarding financial issues and employment resulted in such independence of the departments in terms of their educational endeavours that in fact we can speak about thirteen schools but not thirteen departments of the same school. Although we respect the departments' authority in didactics, the Rector's Office and Senate of the university have to be responsible for the integrity of this institution, and thus they have to strive for unification of some rules warranting high level of education at the university as a whole. We are certain that the following rules regarding educational system should be the same at the university:

- system of enrolment of new students;
- number of students enrolled in all forms of education;
- appraisal system and system of credit points;
- criteria qualifying for graduate and postgraduate studies;
- integration of education in general subjects, such as mathematics, foreign languages, etc.
- coordination of educational programmes and ways of their execution between the departments teaching the same specialisation

It will be necessary to appoint a professor-coordinator or a coordinating board for the specialisations taught at more than one department.

The organisation of standard courses in mathematics, information technology, physics, mechanics, chemistry, etc. (even in several versions), appears justified both by merits and economical reasons. They would be taught at the whole university and not only at particular departments. An alternative approach can be the adoption of the solution operating at economic schools which consists in the organisation of the first year of the studies identical for all students who would choose specialisation after its completion.

The number of students at our university almost doubled in the last four years. At the same time, there was practically no increase in staff which caused sharp rise in overtime and labour costs. We believe that a part of these hours of extra work are unjustified as they result from swollen educational programs when the number of students diminished, and too generous granting hours for different forms of tutorship. During the next Senate's tenure, financial conditions will force the following actions:

- "slenderising" of educational programmes, especially in very narrow subjects;
- termination of programme repetitions;
- reduction of obligatory hours of classes in favour of self-education;
- inter-departmental integration of education.

These decisions can be made only by the Department Councils, but the Rector's Office and Senate can create motivational factors accelerating realisation of these tasks.

Despite the fact that the current system of promotion and reward of the employees engaged in scientific and educational actions barely depends on their didactic activity and quality of teaching, we would like to remind all employees of the university that quality, attractiveness and usefulness of education offered by our university decides about its survival on the market.

5.3 Organisation and financial support for research

The system of financial support and organisation of research are the only tools available to the authorities of the university which allow them to influence scientific research. No one can order a person to conduct research since such a dictate is ineffective. Improvement of research quality cannot be imposed because it is a result of creativity of scientists' minds and their intuition. However, conditions can and should be created which warrant profitability of an effort towards a search for new questions worth to be answered using scientific methods. The authors of the best and most valuable scientific solutions should feel appreciated and financially (and not only morally) prized for their achievements. For these reasons, the system of financial support and organisation of scientific research has to be given special concern. All conditions which can stimulate obtaining even more, better results of scientific studies conducted at the University of Mining and Metallurgy should be implemented immediately and without hesitation as it determines the future of the university and its rating.

The main source of financial support for research at the University of Mining and Metallurgy should be grant-in-aid from the State Committee for Scientific Research for statutory activity. It is not sufficient though. Moreover, due to inadequate support from the Ministry of Education, its considerable part is assigned to supply basic needs of the university's units, including particularly the supplements to fatally low salaries of researchers. In such situation, funds allocated for statutory activity cannot be a stimulator of scientific research of teams and individuals. Furthermore, the rules regulating distribution of these funds are stiff and lack motivational elements. However, the attempts to link the distribution of statutory funds with appraisal of research results should not be completely abandoned. We intend to use more extensively for this purpose the appraisal of the statutory research results by the commissions (created by the Deputy Rector for Scientific Development). It seems possible and reasonable to preserve the currently operative division of the commissions' competencies according to five sections at the university, which is not identical with the division into departments. It enables comparison of the research conducted by different teams and at various departments, and favours more balanced appraisal.

Every effort should be made to guarantee that the appraisal of statutory research results determines the allocation of funds to the same teams in consecutive years. Furthermore, research programmes should not be continued if no considerable progress was made (except for justified cases) since it means wasting the resources. With all respect to deans' authority to assign independently statutory funds, the Rector's Office will await explanations in case of flagrant discrepancy between commissions' appraisal of research results in former year and the decision of fund allocation in subsequent years.

The second important source of financial support for scientific research are grants for individual studies. These funds will be distributed to the departments using already tested and well-operating algorithm. At the departments, the grants should be awarded for realisation of clearly defined and controllable scientific programmes, especially those connected with the preparation of Doctor's thesis and dissertations qualifying for assistant-professorship, as well as for the edition and printing of monographic works supporting applications for professor's degree (which is new in comparison with the past practice). The latter should be given a priority since the State Committee for Scientific Research also awards grants for the preparation of Doctor's thesis and dissertations qualifying for assistant-professorship, while it is much more difficult to find independent financial support for the preparation of publications recapitulating many years' work

In view of the fact that there exists an objective contradiction between cost-consuming nature of some scientific research and equipment, and magnitude of funds capable of being allocated in the cascade system of distribution of relatively small resources, it is imperative that their part (30 - 50%) should be assigned for centrally managed funds designated to support already tested and well-operating Grants Awarded by the University.

Both types of hitherto existing grants awarded by the university should be continued with slight changes in their goals and awarding criteria. They are grants ordered by the university and grants for equipment.

5.4 Grants ordered by the university

Grants ordered by the university should be awarded mainly for realisation of the research and introduction of new technologies which, in the widest sense, satisfy the needs of the university and all groups of its employees. The basic criterion is establishing how common and important a need is which a project promises to meet. One of the problems which deserve to be taken into consideration in this regard is the reinforcement of the university's communication system, the broadening of the range of computer network services, ensuring full access to the network and availability of all services to all employees of the university. The project should result in providing common access to electronic mail, organisation of several professional discussion groups, putting into service new servers for data processing and other uses (e.g. computer graphics), broader presentation of achievements of the University of Mining and Metallurgy on the internet (WWW pages), and support of administrative work at the university (especially at the junction of the Finance Department and Deans' Offices). Realisation of such programme will make the University of Mining and Metallurgy the first Polish university with a real computer system. We have an actual chance to realise such task as our employees are considered the best Polish professionals in the aforementioned fields, and the www server of the University of Mining and Metallurgy is now one of the best in Poland. It is recognised in Los Angeles, Singapore and Sidney so it would be good if all employees of our university come to know this (and to use the system). The final listing of the subjects of these grants will be issued by the Senate's Commission for Scientific Research. Grant awarding process will consist in internal competition.

5.5 Grants for equipment

The significance of the availability of the newest equipment for scientific research is so obvious that it does not require further comments. The problem of high and constantly rising price of scientific equipment is also commonly known. In such situation, it seems reasonable and even necessary to continue a rule that funds for the purchase of particularly expensive but indispensable for certain studies equipment are assigned centrally as a result of competition. However, the experience based on previous competitions at the university and standards developed by the State Committee for Scientific Research suggest that the Regulations for Awarding Grants for Equipment should be supplemented with the rule giving a priority to the applications which can prove that the equipment can be used by many researchers (not necessarily from the same organisational unit), and that its use exceeds certain limit (e.g. at least 12 hours per week). Teams awarded Grants for Equipment will be required to keep record of time when the equipment is in use. The Centre of Services for Scientific Research will be responsible for a control whether the actual time of equipment utilisation agrees with the declared value for at least 3 years after the purchase. Research teams awarded

these grants should make commitment that they will cover all expenses connected with equipment use and maintenance. Funds can be acquired from statutory grants or payable services performed using this equipment, the latter being especially worth recommendation. The prerequisite to the application for the grant is to make available an appropriate work space to enable access for all employees of the university (not only the staff of the grantee!).

To facilitate publication of research results by the employees of the University of Mining and Metallurgy so that their number could reach satisfactory level, it is necessary to improve the performance of editorial offices of the university. The present state can be considered acceptable with regard to the publication of textbooks. However, the publication of strictly scientific positions does not serve the existing needs. It is difficult to accept the fact that one of the largest technical universities in Poland issues only several scientific quarterlies which concern traditional fields of scientific studies. There are no periodicals dealing with the newest research directions, such as modern material engineering, automatics, robotics, information technology, electronics, medical engineering, management, ecology, etc. It is definitely unacceptable and should be changed immediately.

It should be mentioned that we are behindhand in this field and needs are urgent. Most of the universities pay much more attention to the presentation and promotion of scientific work of their staff. For example at the Technical University of Warsaw, routinely a periodical is created for each developing scientific discipline, which facilitates presentation of achievements and exchange of views.

Considerable improvement of the performance of editorial offices at the University and adjustment of their work to the important role of an ambassador of scientific accomplishments of the University of Mining and Metallurgy will be one of the main concerns of the Rector's Office during their present tenure. The main library of the university should actively join these endeavours. It should strive for broad presentation and popularisation of scientific results of the university staff using all necessary means for this purpose (e.g. exhibitions of publications of the university staff both in the journals and the university periodicals). Our library should also use contacts with corresponding institutions and address lists to facilitate regular distribution of books, periodicals and other publications, issued by the university to other institutions. These tasks should be considered at least so important as supplying our staff and students with necessary books and publications by other scientists.

The results of scientific studies at technical universities should be the basis for patents and licences. There is particularly much work to do in this regard. There operates the Team for Inventions and Patents at the university and its staff is ready to serve scientists, and provide consultation on which results can be the basis for patent or licence application. They can also deal with all formal procedures connected with obtaining a patent and its possible use as well as with negotiations and entering licence contracts.

We are a technical university, and technical and technological knowledge nowhere in the world is available free of charge. Therefore, we should change the attitude of our staff who always give a publication priority over a patent. The published results cannot be patented, but after patent application, its nature can be described in as many publications as necessary. So after obtaining any scientific result it should be considered first if it can be a basis for a patent and later if it is to be presented at a conference. Other behaviour can be regarded even as an action to the detriment of the university! The employees should be made aware that a patent is equally valuable as publication and it can bring additional advantages (also to an employee who is its author), if it proves sig-

nificant and can be applied in practice. The employees should also know that patents are and should be developed in the framework of grants from the State Committee for Scientific Research (SCSR, KBN) or aimed projects supported by the same body. Moreover, patents are rated very high by sections and groups at SCSR.

We would like to emphasise once more that it is the university's interest to transform research achievements of our staff into patents and licences. Therefore, the Rector's Office will do all they possibly can to facilitate patent applications by reorganisation of the Group for Inventions. However, the staff members should use their services much wider than at present.

The above-described programme did not mention so far two important sources of financial support which hitherto largely contributed to the development of scientific research of individuals and research teams, and supplemented the university's budget. They are grants for research from the State Committee for Scientific Research and orders from industry.

In both cases, financial support is gained as a result of the attempts of individual scientists, and, therefore, these resources are at their autonomous command. The role of the Rector's Office will consist in active assistance to scientists who apply for such grants from SCSR and those who elaborate offers for industry, in such preparation of application or tender documents that could warrant success in competitions, tenders and rankings. The policy which prevents "leaking" of grant money outside of the university (mainly through orders to external contractors) will be continued. We will also counteract awarding grants which actually are realised at UMM to other companies and institutions.

In case of orders from industry, the role of the Rector's Office is relatively lower than in other aforementioned types of financial support, because such contracts and agreements are personal achievements of individual scientists even to a higher degree than in the case of grants.

All units supervised by the Deputy Rector for Scientific Development will be obliged to provide every assistance to all attempts aimed to promote scientific offer of the university in industry and to those who search for new opportunities to receive orders from industry. Among other things, a special fund will be established for this purpose to cover travel expenses and costs of other actions undertaken by the university staff in the aim of offering industry the services of UMM as a performer of scientific research. The fund can be used also for expenses connected with the preparation and negotiation of contracts with industry and other institutions.

The university's aim to offer scientific services to the industry and other institutions cannot lead to the acceptance of every condition and all orders. Priority will be given to contracts and orders, which warrant an interesting research subject, besides satisfactory financial conditions. Such contracts will allow researchers to enrich their experience which can be used in didactic work, among other things. Acceptance of purely commercial orders by the employees, which are not connected with any scientific research will not be approved, the more so that the payments are often underestimated in terms of utilisation of equipment, work space, energy, etc., and in fact the university partially supports these works.

5.6 Finances and budget of the university

Budget income is composed of three sources of financial support: grant-in-aid for didactic activity from the Ministry of Education (about 50 %), grant-in-aid from the State Committee for Scientific Research (about 30 %), and other sources (about 20 %). It is expected that this budget income

structure will be preserved, and it can be considered correct in substance. However, the basic problem is not the structure but the volume of each of the aforementioned sources. Grant-in-aid for didactic activities can be considered relatively stable but very low in relation to the needs. At least, it has not lowered in the last two years. Sustaining an increase in this income depends partially on the university, as it is determined by the parameters taken into consideration during distribution of the resources, such as number of students and structure of teaching staff. Different scientific grants from the State Committee for Scientific Research are much more dependent on the University. Awarding grants for statutory research is based mainly on scientific activity of our staff and its scientific level which is rated yearly by SCSR, while grants for individual studies are a resultant of a number of conferred doctor's degrees and number of persons qualified for assistant professor and professor. Third form of grants from SCSR comprise grants for research and equipment as well as aimed and ordered grants. Their volumes depend only on the activity and initiative of the members of our scientific community. The Rector's Office can only influence indirectly resources assigned to scientific research. They depend directly on deans' policy. The third source of financial support of the university includes: orders from industry, payable education, rents, interest, etc. Every zloty obtained in this way is highly valued as it is an "extra" income which enables to fill some gaps in the budget.

6 Development of a New Cooperation System between Technical Universities and Industry

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6.1 Introduction

The range and forms of the co-operation between technical universities and industry are as follows:

1. education of engineers for the industry – both B.Sc. and M.Sc.;
2. postgraduate studies;
3. doctor's diploma thesis carried out in industry;
4. scientific research within research projects which are financed by the State Committee for Scientific Research (KBN); co-operation between industry and university in the scientific and technical part of projects, i.e.: building of a prototype, testing of a prototype, possibly implementation of the results;
5. accomplishment of international projects of the State Committee for Scientific Research (KBN);
6. research and development projects realised by academic staff or research and development units (50% financed by the KBN)
7. implementation of research and development projects results realised by industry workers (financed by industry)
8. projects given to the universities directly by the industry (expert's reports, research and implementation works etc.) – not more than 30% compared with the total of R&D activities

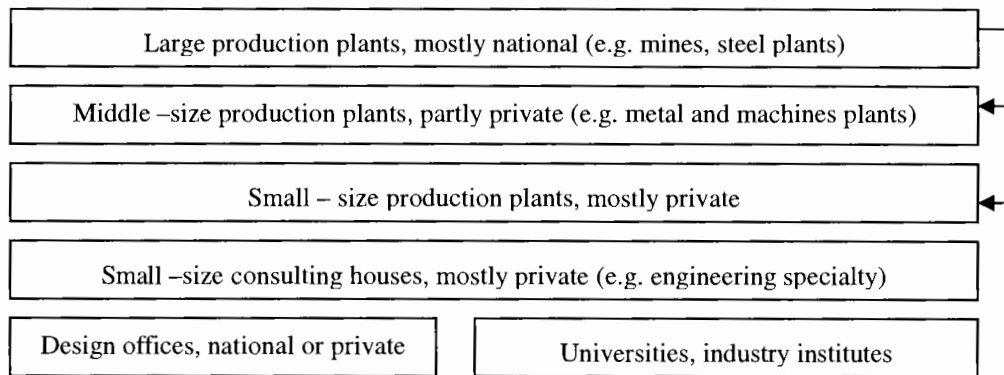
The main aim is the improvement of engineering education, especially of mechanical engineers during the process of the integration into the European Union, especially:

1. with regard to the education process:
 - social needs
 - specificity of economy (industry)
 - student's ambitions and predisposition
2. regarding the science and technical achievements
3. regarding knowledge, abilities and predisposition of people who take part in the education process.

6.2 Evaluation of changes in Polish industry

Changes in the Polish economic development:

- rapid development of new management structures;
- convertible currency aspiration;
- proprietary relations improvement;
- management development increase;
- increase of export;
- development of investment activities;
- expansion of international co-operation;

Fig. 6.1: Organisation and functional structure of Polish plants**Table 6.1: Characteristics of the traditional and so-called slim enterprises by the LEAN concept**

Traditional enterprise	So –called slim enterprise
Specially plants	Flexible manufacture plants
Complex, expensive and high-effective machines	Cheep machines which operate simply
Large loss of time when the instrumentation change	Small loss of time when the instrumentation change
Invested capital freezing in large – size production series	Short series with the customer needs
Non-flexible organisation	Flexible organisation adopted to market needs
Large number of information and their long transmission paths	Selected information, oriented for substantial targets, short transmission paths

Requirements for technological devices and machines

- reliability of activity and disposability;
- minimisation of energy-consuming;
- minimisation of material-consuming
- environment protection
- automation and robotics
- logistic approach to design of machines and exploitation

Fig. 6.2: Study structure at the Department of Technological Devices and Environmental Protection of the UMM

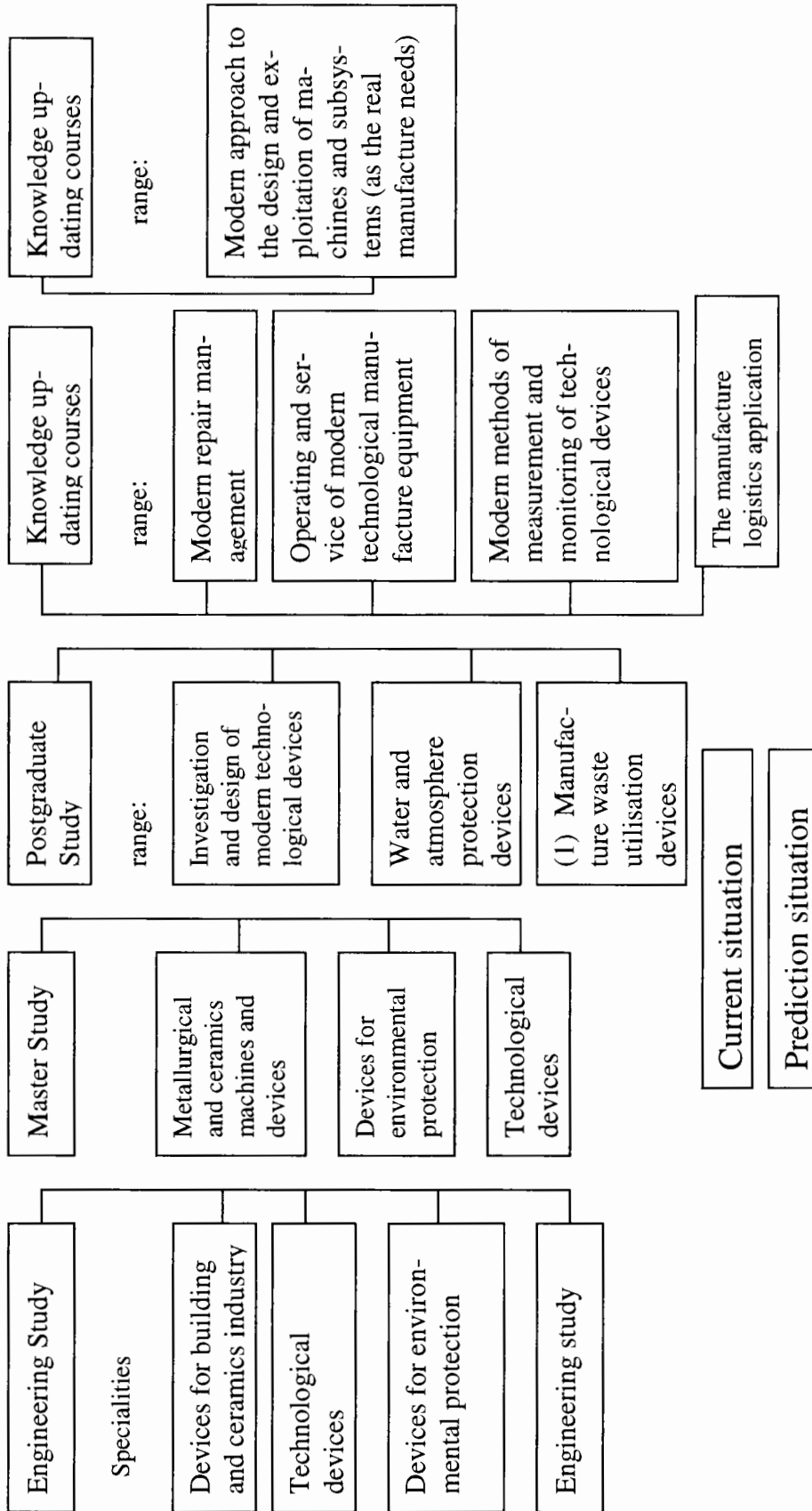


Fig. 6.3: Research activities structure at the Department of the Technological Devices and Environmental Protection of the UMM

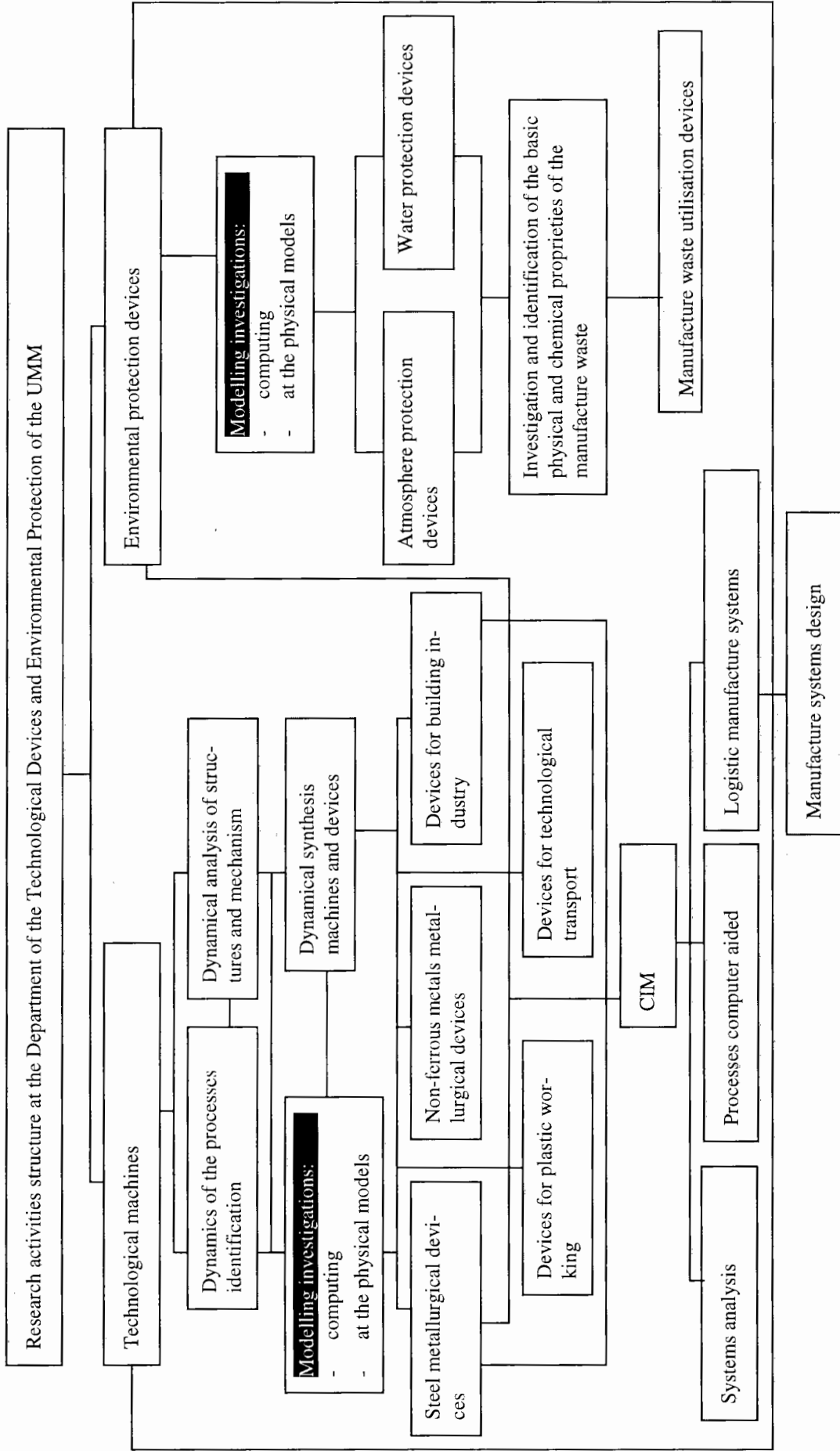
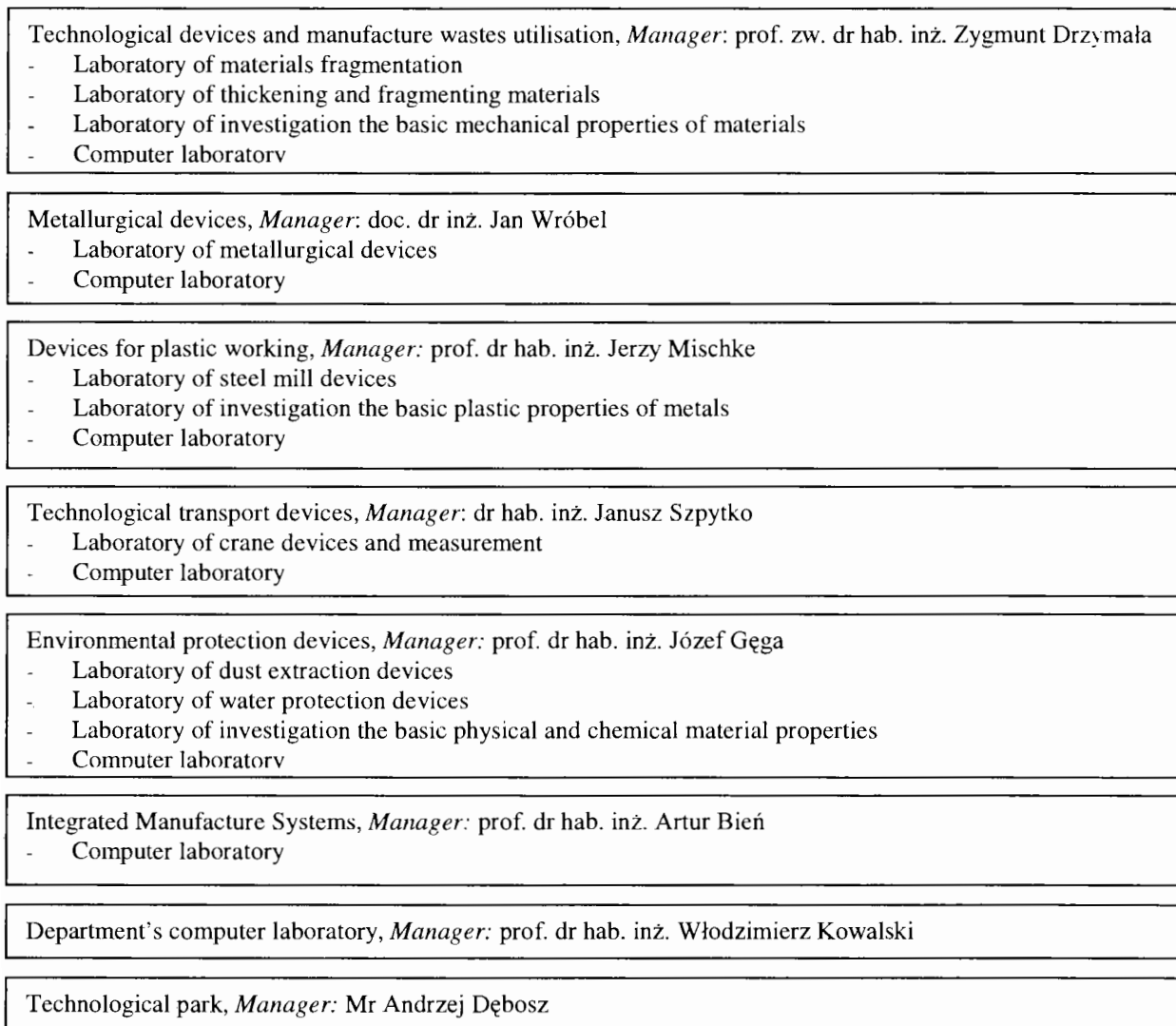
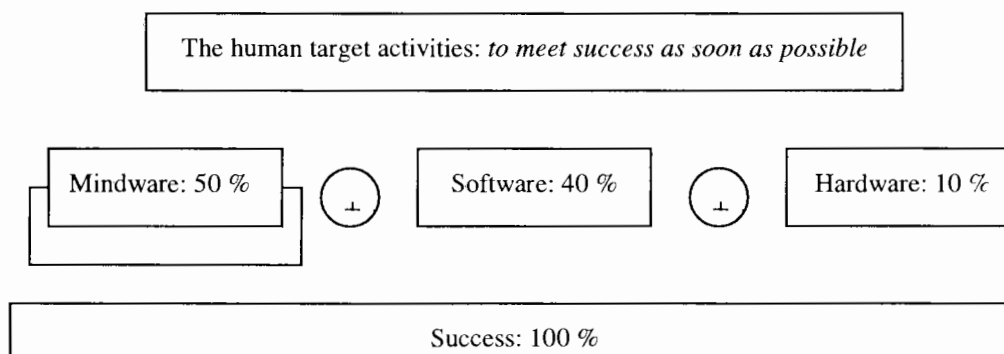


Fig. 6.4: Organisational structure of the Department of Technological Devices and Environmental Protection (UMM)



Protection - teams, laboratories and workshops on department

Fig. 6.5: The success achievement structure



6.3 Evaluation of engineering education in Poland

Requirements for engineers:

- adequate theoretical knowledge;
- adequate knowledge and special competences;
- management abilities, e.g.: organisation, economy calculations, law, TQM, marketing, monitoring.

The structure of engineering education:

1. Engineering study (3,5 years duration): universal profile more practical knowledge and experiences, e.g.: medium and small-size manufacture enterprises, consultancies, engineering offices;
2. Master study (5 years duration): more theoretical set-up; provides selected professional knowledge, e.g.: r&d centres of large companies, manufacture institutes, universities
3. professional advanced training (professional re-engineering):
 - postgraduate study from 1 – 2 weeks, reorientation of professional qualification;
 - updating of knowledge (1 – 2 weeks);
 - seminars for specialists (1 – 2 days).

The structure of the engineering education (worked out as a result of the program Tempus CME):

- engineering studies leading to the B.Sc. degree - duration 3,5 years
- master studies leading to the M.Sc. degree - duration 1,5 year
- doctor's studies leading to the Ph.D. degree in machine design and exploitation – 3,5-4 years
- postgraduate studies, professional re-engineering.

6.4 Summary

1. The co-operation of technical universities with industry is developing in three directions:
 - engineering education
 - engineering staff improvement
 - scientific research
2. Engineering education, especially their postgraduate studies should be carried out based on understanding the real needs which result of scientific research.
3. Original, own R&D (basic and practical) are essential factors for their scientific development, for improvement of the education process and for importance of universities of technology
4. Co-operation between technical universities and industry is necessary for maintaining a proper technical level and industry development as well the social usefulness of universities.

7 Developing New Curricula in Polish Engineering Education

Dr. Bärbel GRÜNIG
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7.1 What is curriculum?

When talking about curriculum development we first should discuss what curriculum itself can mean. Here some definitions in order of their publication date. A curriculum is defined as¹:
„A course; a regular course of study or training as at a school or university.

A course, especially a specified fixed course of study, as in a school or college, as one leading to a degree. The whole body of courses offered in an educational institution or by a department thereof.

Curriculum is all the experiences children have under guidance of teachers.

Curriculum encompasses all learning opportunities provided by the school.

Curriculum is a plan or a program for all experiences which the learner encounters under the direction of the school.“

It has to be added that there is also the hidden, unstudied or null curriculum, which can be described as follows²: „The null or unstudied curriculum consists of those topics not included in the official curriculum. (...) The hidden curriculum is the ideological and subliminal message presented within the overt curriculum, as well as a by-product of the null curriculum.“ These definitions of curriculum referred mainly to primary and secondary schools, but most of the determining structures are similar to higher education, except for a – on the surface – higher autonomy of universities in some decisions.

One of the main differences between the definitions is the added concept of experience and the focus on the learner in the newer ones. There is also the idea of offered opportunities, which results from a different understanding of learning itself. The aim of the curriculum is only in the elder definitions named as the degree. The newer definitions don't mention the degree although of course every educational institution plans its curriculum towards an aim and almost always towards a degree and offers this degree to the successful student. The newer definitions emphasise the progress of the learner, covering also the hidden curriculum and the experiences that wouldn't be necessary for the degree if described only as fact knowledge. The newer curriculum definitions obviously contain a more comprehensive idea of education or obtainable qualification.

7.2 Who and what is involved in curriculum development?

Any curriculum involves educational institutions, teachers and students. Non-personal factors are: the aim, the surrounding conditions. Supervised is the curriculum (if we concentrate on state-controlled education) by public in form of educational administration. The curriculum is the realisation of the aims: it expresses them in subjects, contents to learn, new knowledge as well as practical skills to train, new attitudes to acquire etc.

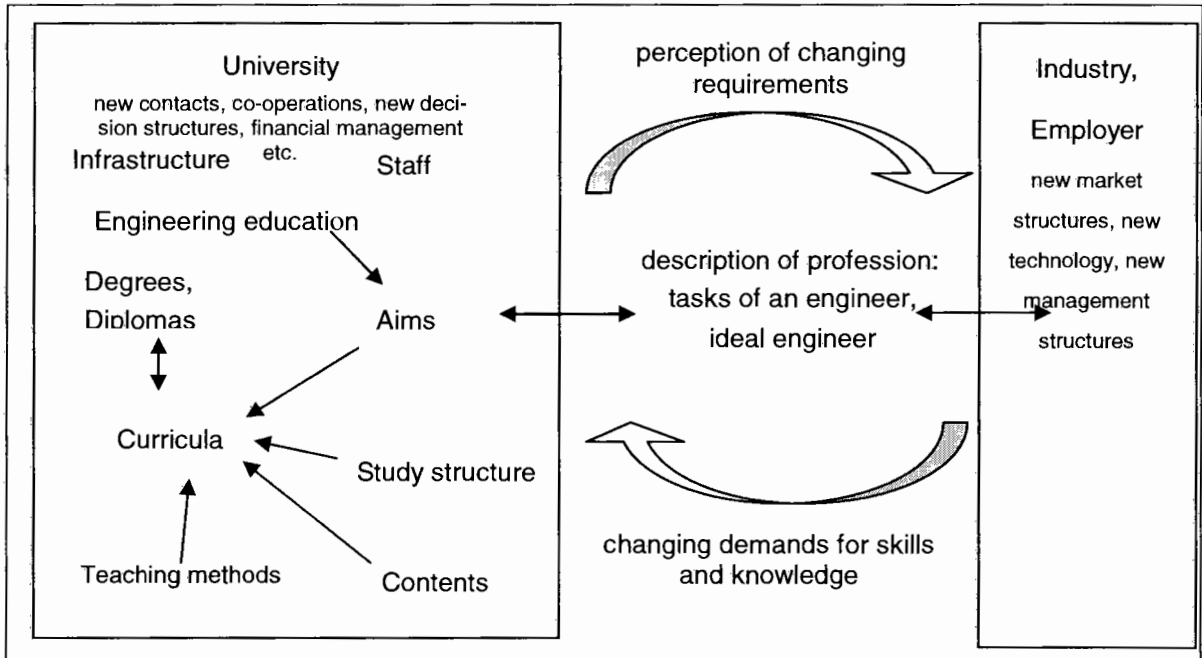
¹ Abridged from: Pinar, William F. et al.: Understanding Curriculum, New York 1995, p. 26
² Pinar p. 27

Changes in a curriculum become necessary and take place when one of the involved factors changes. Looking closer at the involved persons, groups and other factors we find them both independent and depending from social, economic and political structures and developments and showing different and sometimes surprising potentials to initiate a change in curriculum.

A simple model of curriculum development as shown in Fig. 7.1 can perhaps help to explain some of the most common and expectable factors of change and some of the specific problems curriculum development in Polish engineering education has to face.

It is assumed that the university realises the changing requirements of industry. The industry itself goes through a process of transformation as it has to meet new international market structures. This results in changing demands concerning skills and knowledge of engineers. The university, which meanwhile has to cope with its own changing structures caused by transformations in the political, economic and social field, follows certain aims in engineering education. These aims are influenced by the demands of the employers, but are also based on an idea of the profession itself. The definition of the profession changes permanently with new technology and new production methods – and therefore new tasks for engineers – and will perhaps be described differently by university, industry, politicians, engineers themselves etc. The description of the profession will certainly be different between countries, what renders the development of curricula for international degrees even more difficult.

Fig. 7.1



The main curricular problem for the engineering education in Poland could be the change in almost every involved factor, or even worse, the fact that these changes are still in progress and its directions are not always obvious or predictable.

7.3 Further dependencies

Some general factors of curriculum development and some that apply especially for the Polish situation are not shown in the model but have certainly to be taken into consideration.

It is a question if and how far the transformation of society and economy is planned and predictable. Does it follow a minute scheme, do we always know at which stage we are and what follows next? The transformation of different parts and subsystems of society and economy might not always be interrelated or co-ordinated and the participating groups, organisations, persons, parties etc. might not always have the same aim and the same ideas about the proceedings to reach it.

Not regarding their official status of autonomy the universities - as communities of scientists – can be seen and act up to a certain degree as independent structures in their own, developing own aims and ideas about their present and future tasks in society, concepts of education and fields of research. Influences like political or administrative structures, economy, industry (national and international), international scientific contacts, media, own staff, funds, students, competition between universities etc. will help or hinder changes. Public or political control can influence curriculum development in many ways. The efforts to fulfil the conditions for the EU-membership could cause top-down regulations for universities with side-effects on curricula. On the other hand any educational institution may be free to alter curricula to a smaller or larger extent, but in most cases there will be a certain regulation by state/law describing the frames for certain degrees, mainly those that enable the student to follow a career involving far-going responsibility.

The grade of transformation of industry (or other potential employers) might not be homogenous or at least comparable. Differences might show between small or large inland enterprises, former or still state owned industry or international combines regarding applied technology, organisational structures and, of course, expected technical and non-technical qualifications of staff. This multiplicity of industrial structures will call for a broad variety of skills and knowledge from engineers. The description of the profession by employers and public will accordingly be very heterogeneous.

Not only universities but also other sectors of the educational system change. This will inflict the engineering students and has to be taken into regard when thinking about new curricula. They might learn other contents and methods in secondary schools. Their study concept and learning techniques should be taken into consideration. How far is studying and study success influenced by social and economic factors? The value of studying and of university degrees might change dramatically when graduates get poorly paid or no jobs at all.

To realise new curricula universities under tight financial conditions have to find staff for new technical or non-technical subjects and have to care for the academic staff that was specialised on a field no longer necessary.

7.4 Slowness of curriculum changes, speed of technological and society changes

Looking at German universities (the same may apply to other countries) we often find the time elapsing between articulated and published demands of employers concerning changes in curricula of higher education (new subjects as well as modernisation of teaching methods) and the realisation

astonishing long. The main reasons for this lamentable tradition may lie in the indolence of decision structures in the university itself, the inflexibility of academic staff, the persistence of once defined departments and fields of science, and the dependence on governmental administration. On the other hand technological innovations follow each other with growing speed and engineers have to answer to this. A permanent and fast adaptation of curricula to new technologies is necessary.

Curriculum development in German engineering education is also influenced by professional associations, like VDI, VDE, VDMA etc. Such powerful organisations, surveying new technical applications, new management proceedings and the overall industrial and economic development discuss and publish their view of the needed future engineers. Their proposals can certainly be of help in curriculum discussions, but even with their prognosis basing on a – compared to Poland – perhaps more homogenous structure of industry they tend to focus on the demands of huge concerns with high standard of technology, appropriate management structures etc. A multiplicity of company structures, difference in grade of transformation and perhaps an uncertainty about the course of transformation as in Poland in the last decade adds to the general difficulty of predicting the needed qualifications of future engineers and further complicates curriculum development.

It seems, however, that Polish universities and the educational administration have within short time reacted to the international standards in engineering education and introduced new degrees (as BSc and MSc), new fields of study and new subjects (like languages and economy). In order to open the international job market to their graduates, open their universities to students from other countries and meet the demands of international combines and EU-investors the universities changed their study programmes. They could be now perhaps in the situation to provide graduates with qualifications which at least parts of the Polish industry but now realises it needs.

The factors of inter-university competition, international comparison, international exchange programmes and political will was obviously most important for the curriculum development in the first hand.

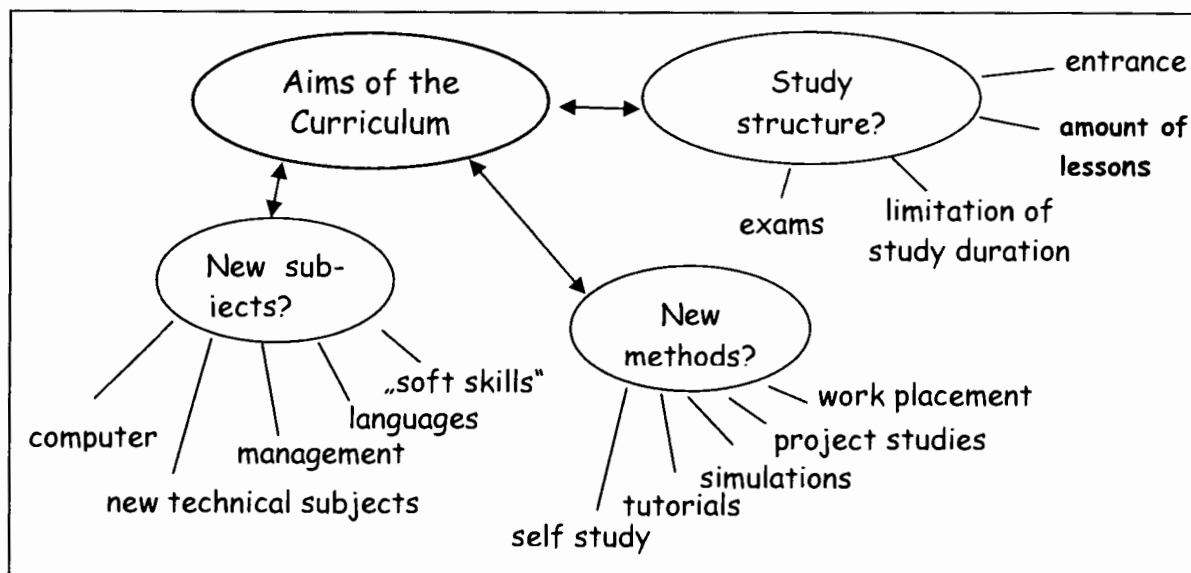
7.5 Some aspects of curriculum development

We will now have a closer look on some aspects of curriculum development that could be regarded as indicators for promising engineering education.

7.5.1 New subjects

Technical development grew faster and faster in the last decades. Quality of education and research, shortage in natural resources, international competition in production costs and growing ecological awareness enabled European countries to concentrate on new technologies. This change happened and happens certainly also at least in parts of the Polish industry. New technologies produce new tasks for engineers and may ask for a new definition of the profession: is the software-engineer an engineer? The descriptions of the profession have probably never before been as wide-ranging as in the present. Predictions about the future development of technology can go wrong, as the discrepancies between the first Delphi inquiry and today's reality show. The problem for universities is to decide which new technology should be included in their curricula. New curricula in Polish engineering education accordingly have to regard new technical subjects that result from a transformation of industry as well as new technologies that are just being developed and could become important in the future.

Fig. 7.2



Even more crucial than anticipating the future demands for engineering qualifications in the technical field is the planning of non-technical aspects of the curriculum. Most universities have introduced computer and management courses in engineering education as well as language training. Some skills that have been regarded as non-functional for an engineer (however sensible and helpful) in the past like being able to negotiate with clients, work in a team, work on an international level, plan a whole project, present results and products to non-technicians etc. have become functional and will perhaps even more in the future. As R. Lauzackas³ states for the Lithuanian universities, the emphasis on the so called key qualifications could also become vital for a country in economic transformation: key qualifications enable the graduate within a changing system to work in different fields and adapt faster to new tasks. Even if they are part of the curriculum, key qualifications can only be taught up to a certain extend. Most of these qualifications are obtained indirectly by using specific teaching and learning methods (see below), some fall perhaps under the "hidden curriculum" and are obtained while learning and living in the individual structures and under the conditions of the university.

7.5.2 Teaching methods

As mentioned before teaching methods do play a vital role in curriculum development. Teaching methods are more than just the medium to get the information into the students' brain. The concept of learning, the idea of the student, the aims and the hidden curriculum become most obvious when regarding the applied teaching methods of any educating institution. Apart from perhaps just being thoughtless a university that offers lectures as the only teaching method could be seen as producing many consuming and dependent loners with little fantasy in problem-solving, little experience in co-operation or own ideas.

³ Lauzackas, K.: „Tendenzen der Curriculumentwicklung in der Sicht der technischen und sozialökonomischen Veränderungen“ in Melezinek, A. and Bruns, K. (eds.): *Ingenieurausbildung und Strukturveränderungen am Arbeitsplatz des ausgehenden 20. Jahrhunderts*, AlsbachBergstraße 1995.

A variety of methods offer different learning opportunities to different learner types and will so increase the success rate of the individual and all students. In projects studies and simulations students learn close to their future professional reality: working together and solving a problem. Many of the key qualifications engineers need are indirectly trained while doing so: planing a project, working in the team, reliability, presenting results etc. Self studies and tutorials offer the students the chance to find their own rhythm in learning and train independence.

Work placement seems a good means preparing students for their job, giving them an idea of what their professional life will look like and motivations for their further studies and, on the other hand can be a stimulator as well as a result of co-operations between industry and university. Introducing different teaching methods in a curriculum also has effects on other elements of the curriculum: some need special equipment, more rooms, and trained staff or seem just to take more time. A self study concept, as some of the Polish engineering universities have established, will only bring good results when students are guided, tutored and surveyed by teaching staff and rooms, libraries, computer pools etc. are provided. The same applies for project studies and simulations.

7.5.3 Study structure

The topics concerning study structure shown in Fig. 7.2 are of course just very few examples for the whole complex, but we can use them to show at least some of the interactions in curriculum development process. The entrance regulations at a university are usually either based on secondary school degrees or on entrance exams the university organises itself. The admission can be free for anybody who successfully attended a secondary school, a combination of secondary school level and vocational training, it can be open just to students with good grades in secondary school degrees or good grades in specific subjects. Entrance exams can focus on subjects that are closely related to the aspired field of study or can give an overall impression of the students general education. The intention of entrance regulations is to guarantee the study success of the individual student as well as to ensure the level of quality in the field of study. The sheer number of students at each university is limited, so naturally the university will try to get the best and most talented students.

With the transformation process one can expect that growing numbers of young people will attend high-level secondary education; as admission to the universities is now in principle open for everybody and no longer dependent on regional, social or political factors, the number of young people heading for the universities could increase. Entrance regulations therefore may change and might become tighter. The regulations itself will reflect the aims of the curriculum and the specific view on the profession: do they focus mainly on maths and physics or do they also have a look on language competence etc.? Entrance exams can be seen as an additional means of quality insurance, but when the whole educational system including school curricula changes universities might be insecure about the value of secondary school degrees and chose this way of selection. Transformations in the educational system inter-link and cause curriculum changes on all levels of that system.

The amount of lessons in Polish engineering education has been reduced when the new international degrees were inaugurated. This reduction, which was dramatically at some universities, became necessary in the first hand to shorten study duration for international comparison, but perhaps also limited numbers of academic staff and equipment forced universities to think about the - bluntly speaking - "efficiency rate of their graduates production". The universities surely desired to support the whole transformation process by providing engineers in sufficient quantity. Reducing

the amount of lessons meant changing the whole curriculum and it certainly has been and still is a painful process. It doesn't necessarily mean that the aim of the course of study had to be changed too, but in all probability the idea of an engineer with a BSc degree is different from another who studied twice as long and is more research-orientated. The reduction of mandatory lessons and subjects goes along with an increase of voluntary lessons and subjects. This implies a different view on the students: they are responsible for their own choice.

7.6 Conclusions

Curriculum development in engineering education is getting more and more complicated as in the wake of fast technological and social changes the descriptions of the profession grow multifarious. A nation in transformation will have to cope in addition with the changes in description of the profession that are caused by the development of new structures in its industry and economy. In this process for example national or regional specialisation of industry or commerce can develop or change and accordingly new profiles in engineering qualification become necessary. Polish universities have already mastered main steps towards a European engineering education, but the curriculum development will have to go on in the future years to support the overall transformation process. Adequate curriculum development in engineering education in the 21st century is probably only to pursue in international co-operation.

8 Restructuring Process of Engineering Education at the Warminsko-Mazurski University in Olsztyn

Janusz PIECHOCKI

Warminsko-Mazurski University in Olsztyn

The Warminsko-Mazurski University in Olsztyn was set up in September 1st 1999 through the connection of three already existing higher education institutions:

- University of Agriculture and Technology in Olsztyn;
- Pedagogical University in Olsztyn;
- Institute of Theology in Olsztyn.

Most facilities of Warminsko-Mazurski University in Olsztyn are located at Kortowo (quarter of Olsztyn) – a university campus surrounded by a wood and two lakes. The University owns 63 ha of land and has the right of perpetual usufruct of 6150 ha, 535 buildings and 310 other objects. It carries on eight investment projects.

Warminsko-Mazurski University in Olsztyn has more than 25 thousand students in 12 faculties and offers 33 courses for regular students and 26 courses for extramural students. More than 3 thousand students will continue education on postgraduate level (after diploma) and almost 500 on doctoral level.

Warminsko-Mazurski University consists of 12 faculties, 6 of which are authorised to award the doctorate degree and 10 faculties are authorised to award the PhD in 14 branches. The basic activity of the University is to educate students and carry out research related to humanities, theology, law, veterinary medicine, agriculture, technical science, biology, physics, chemistry, economics, mathematics and to promote the achievements of science, the art and culture. The total number of 2787 employees including 2737 full-time employees work on these assignments. Out of 1640 university teachers 168 are full professors and 198 are employed as a professor of the University.

The faculties of the Warminsko-Mazurski University in Olsztyn are:

- Agriculture and Environment,
- Animal Bioengineering,
- Biology,
- Food Sciences,
- Veterinary Medicine,
- Environmental Protection and Fisheries,
- Geodesy and Regional Planning,
- Technical Sciences,
- Humanities,
- Theology,
- Management and Administration,
- Pedagogy and Artistic Education.

The following educational courses are offered at the Warminsko-Mazurski University:

- administration and management,
- librarian ship and science information,
- biology,

- biotechnology,
- building engineering,
- philology,
- Polish philology,
- geodesy and cartography,
- regional planning and land management,
- information technology,
- history,
- computer science,
- chemical and processing engineering,
- environmental engineering,
- mathematics,
- mechanical engineering and machinery construction,
- environment protection,
- horticulture,
- pedagogy,
- politology,
- agriculture,
- fishery,
- agricultural engineering,
- food technology and human nutrition,
- theology,
- science of commodities,
- music education for teachers,
- fine arts education for teachers,
- technical education for teachers,
- veterinary medicine,
- zoo-technics,
- management and marketing.

Scientific and research work carried out at the University includes statutory research, own research, university grants, grants financed by the Committee for Scientific Research, research done at the request of outside businesses and project done as joint venture with a foreign partner. The total number of grants carried out at the University amounts to 90. The number of grants carried out at the departments is the following:

- Animal Bioengineering – 10 grants,
- Biology – 10 grants,
- Geodesy and Regional Planning – 11 grants,
- The Humanities – 4 grants,
- Veterinary Medicine – 9 grants,
- Technical Sciences – 6 grants,
- Food Sciences – 12 grants,
- Environmental Protection and Fisheries – 5 grants,
- Pedagogy and Artistic Education – 1 grant,
- Agriculture and Environment Formation – 18 grants,
- Theology – 1 grant,
- Management and Administration – 3 grants.

The Faculty of Technical Sciences existing at present at Warmińsko-Mazurski University in Olsztyn was founded as a result of the merging of the Faculty of Mechanics and the Faculty of Civil Engineering from the former University of Agriculture and Technology in Olsztyn with the Institute of Technical Education from the former Pedagogical University in Olsztyn.

The Faculty is authorised to award the PhD degree in agricultural sciences in the branch of agricultural engineering. The Faculty educates about 2600 regular and extramural students. The Faculty consists of one institute, seven chairs and one division. The organisational units of the department conduct basic and applied research. The scope of research covers among others the following topics: materials with elastic memory, porous alloys, strength analysis of supporting structures of cranes and working machines, separation of agricultural products, material – construction solutions, urban solution in building industry energetic aspects of food production, renewable sources of energy.

The Faculty of Technical Sciences has five engineer courses of engineering education:

- agricultural engineering,
- building engineering,
- technical education for teachers,
- mechanics engineering and machines construction,
- environmental engineering,

and three courses of master of science education

- agricultural engineering,
- technical education for teachers,
- mechanics engineering and machines construction.

There is one course of master of science education in mechanics engineering and machinery construction for graduates of engineer courses.

The Faculty of Technical Sciences consist of following elements:

- Institute of Building and Sanitary Engineering,
- Institute of Technical Education,
- Institute of Agricultural Engineering,
- Department of Mechanics Engineering and Base of Machine Construction,
- Department of Electric and Power Engineering,
- Department of Machine and Material Technology,
- Department of Technical Equipment.

Over 2 400 students study actually at the Mechanical Faculty.

The aim of the transformation of three higher education institutions in Olsztyn was the integration of the scientific and educational environment in Olsztyn in order to create new perspectives for students and university staff. Actually the students of the Faculty of Technical Sciences can study several new subjects and are in a position to co-operate with specialist of wider range of disciplines than before transformation.

There is a strong correlation between industry, our University, the quality of teaching, student's interests and expectations, possibilities of finding a job and international co-operation. New tendencies in this field will be observed in a very near future. The main features of the engineer graduated at the Faculty of Technical Sciences are a good knowledge of the wide spectrum of the funda-

mental engineering sciences and the ability to successfully find solutions for the problems of the real life.

The Faculty of Technical Sciences co-operates formally on the basis of signed contracts with the following foreign institutions of science and higher education:

1. State University of Technology in Kalinigrad, Russia;
2. Institute of Rhysics of Metals, Russian Academy of Science in Yekaterinburg, Russia;
3. State University of Technology in Novgorod, Russia;
4. Institute of Acoustics in Vitebsk, Russia.

The main fields of formal international co-operation are:

1. Exploitation efficiency for technical systems
2. Material engineering
3. Physics of materials.

Faculty of Technical Sciences co-operates also informally (or is near to sign a treaty) with the following foreign institutions of science and higher education:

1. Department of Biosystems Engineering, University of Manitoba in Winnipeg, Canada;
2. Institute of Thermophysics, Ukrainian Academy of Technical Sciences in Kiev, Ukraine;
3. University of Miskolc, Hungary;
4. Institute of Agricultural and Environmental Engineering (IMAG-DLO) in Wageningen, Netherlands;
5. Swedish University of Agricultural Sciences in Uppsala, Sweden.

The main fields of informal international co-operation are:

1. Renewable sources of energy;
2. Infra-red and spray drying of foodstuffs;
3. Applied hydrodynamics;
4. Modern techniques in plants protection.

9 Organisational and Structural Changes in Polish Engineering Education – Impressions from Institutional Reports

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9.1 Main direction of changes in legislation

The Act on Higher Education and the Act on Academic Degrees (both acts from 12th September, 1990) were among the first passed by *Sejm* after 1989. The Act on the State Committee of Scientific Research (KBN) was passed soon after (12th January, 1991). So, within 15 months after the political system had changed, the new legal foundations for higher education had been established in Poland. Both the short period of time in which the legal changes have been introduced as well as the basic principles of the new acts reflected the long lasting struggle for greater autonomy of higher education institutions.

The three main factors of the new legal regulations were:

- raised autonomy for higher education institutions;
- legislation for guaranty of autonomy;
- introduction of new modes of financing (formula based).

Elective bodies for the elections of rectors and deans. Budget decisions decentralised downwards to faculties. Raised power of deans. But still one-man decisions reign.

Kind of Development: *Decentralisation* under raised institutional autonomy.

9.2 Departments, studies- and research-institutions, institutes, emphasis for teaching and research

- New faculties in the following disciplines:
- Environmental protection/engineering
- Organisation and Management in Industry/Production
- Marketing
- Logistics
- Electronic Devices (micro-technology; micro-electronics; nano-technology)
- Material Sciences/Engineering
- Computer Science

Elimination of military training within study programme.

Kind of development: *Technological Innovation*.

9.3 Infrastructure (libraries, laboratories, electronic data processing/EDV etc.)

- Investment in EDP-facilities: PC's, Networks, Software applications, Internet, Intranets; computerisation of library etc.
- Elimination of outdated literature or excess books; reduction of periodicals, increased numbers of documents, monographs; comprehension of smaller units in central libraries.
- Erection of new teaching buildings.
- Elimination of outdated laboratories, integration into bigger units.

Kind of Development: *Modernisation and higher efficiency.*

9.4 Structural data and statistics (personnel, finances, number of students, doctorates, post-doctorates)

- Student numbers doubled, tripled or even quadrupled in the Higher Engineering Education during the period from 1990-99, whereas staff numbers remained constant or in some cases even decreased (see Fig.9.1)
- This resulted in a student-staff ratio which dropped to very low ratios during the 90's and grew only during the last years (see the following figure). As student-staff ratios are indicators for the quality of the teaching process, one can lately observe a decrease in that quality, although compared with other (western) countries the ratio of 16 to 18 still indicates a good quality of teaching in Polish Higher Engineering education.
- Ratio of students per age group raised from 11 % to 18-20 % today. Future trend: 27 – 30 % (EU-average).

Fig. 9.1

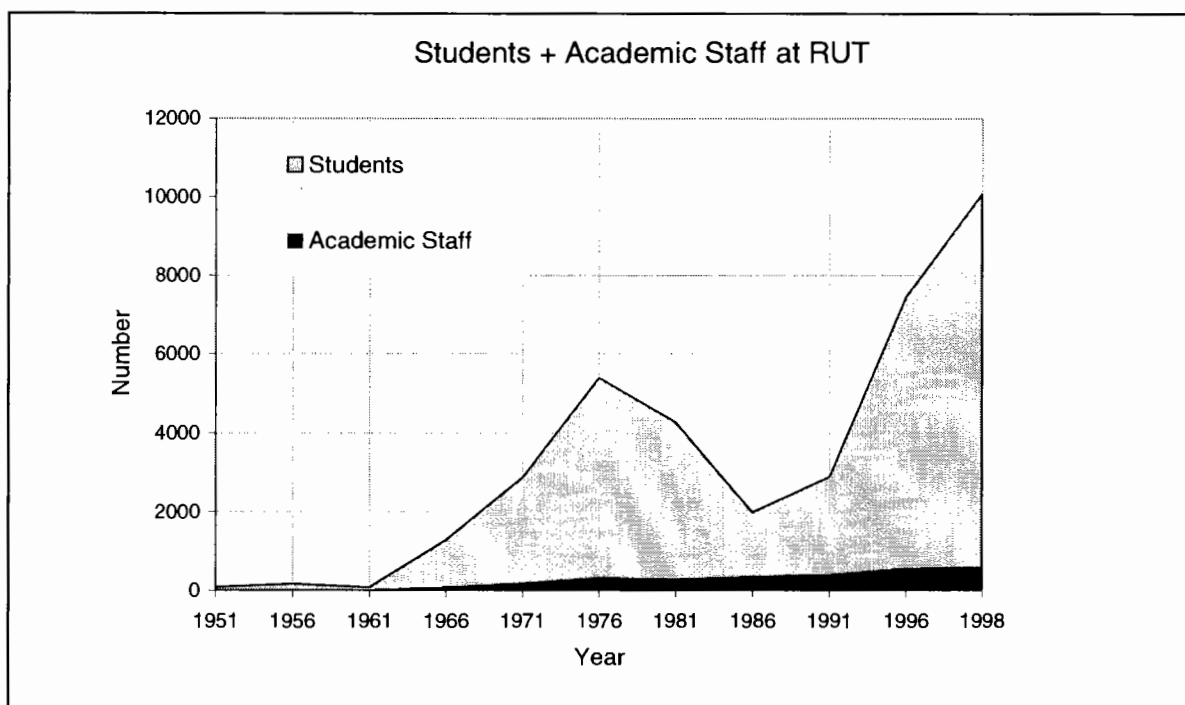
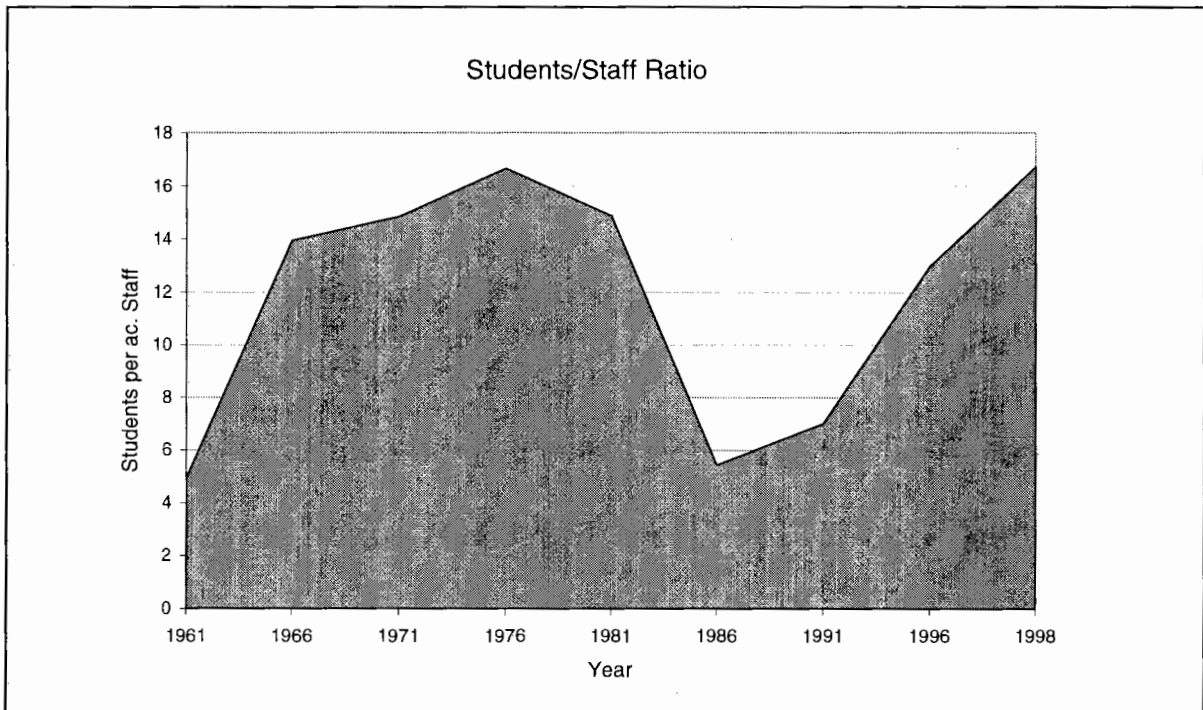


Fig. 9.2

Changing in the staff structure: in 1990 we could see more administrative staff than academics, whereas the academic staff in 1998 is remarkably higher than that of administrative staff. (see the next both figures; data from UMM in Cracow, Fig.9.3, Fig.9. 4.)

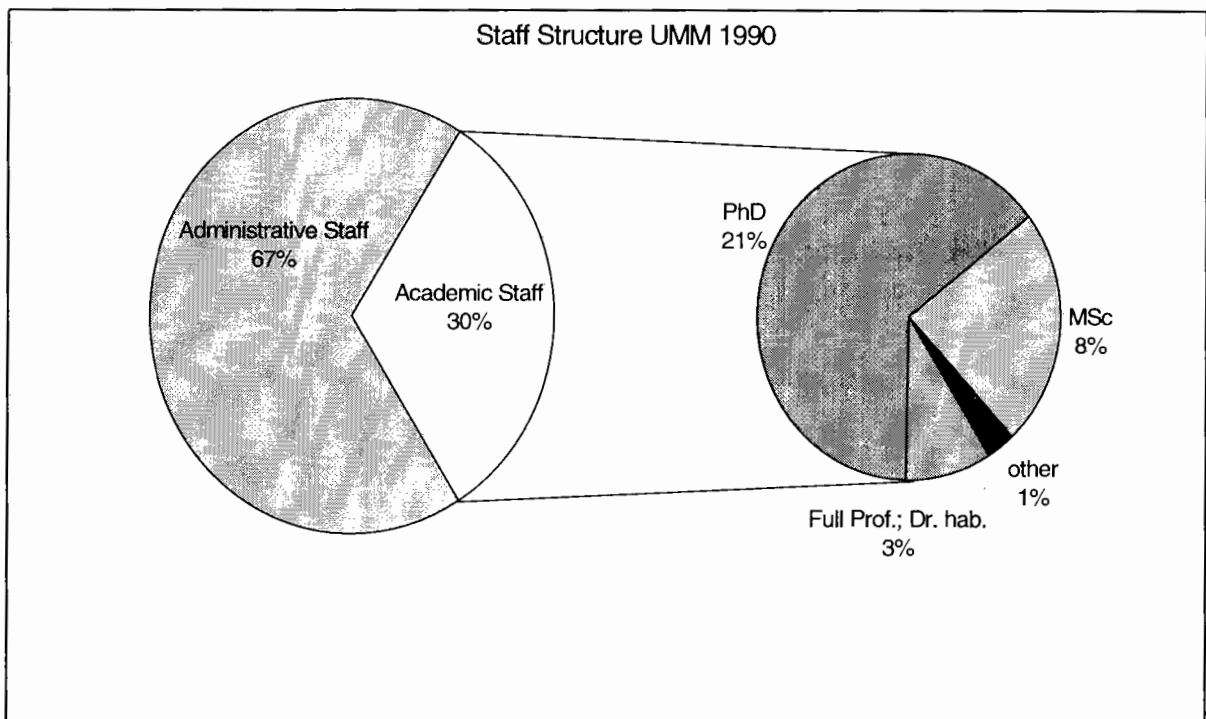
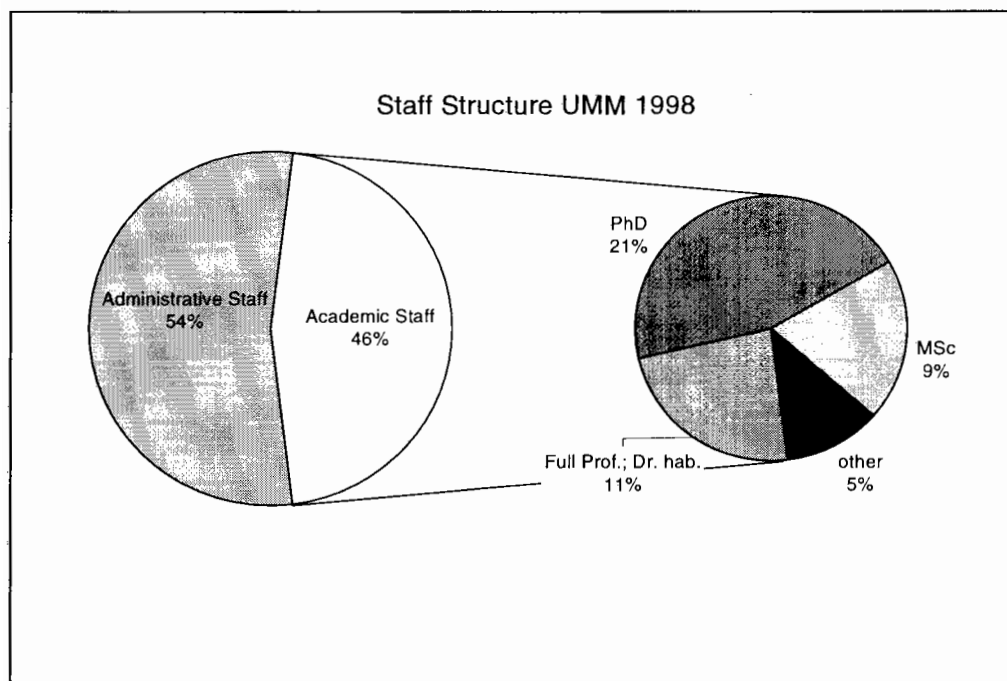
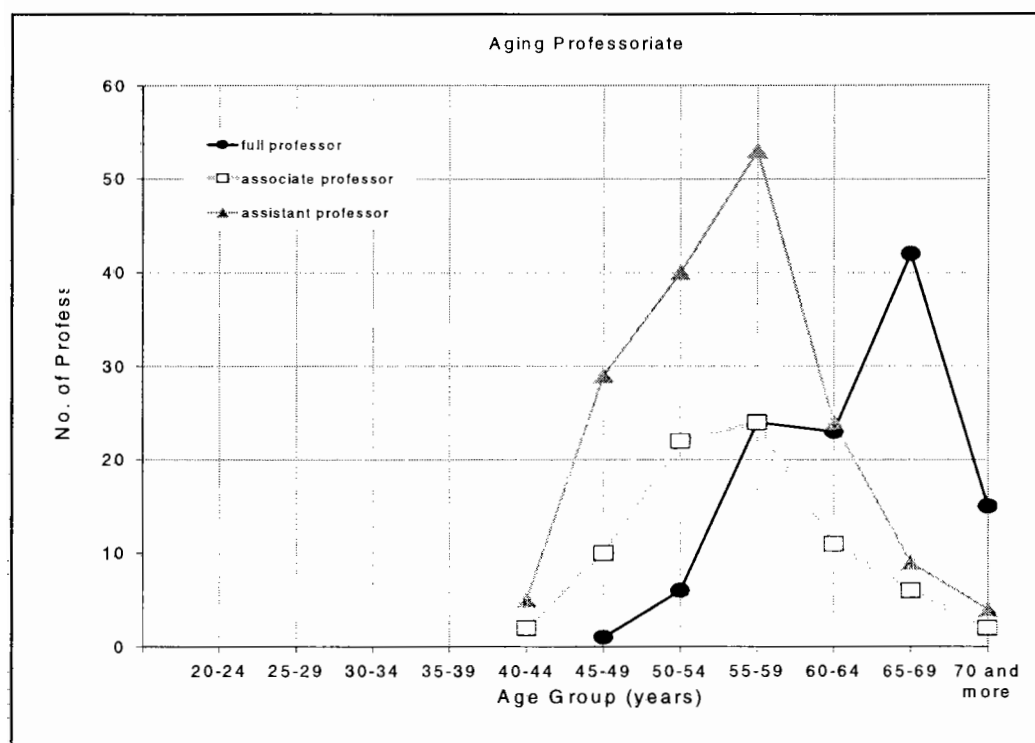
Fig. 9.3

Fig. 9.4



Staff composition by age is problematic: ageing professoriate and middle age gap (see Fig.9.5 and Fig. 9.6)

Fig. 9.5



9.11 Research projects (thematic scale, financing, recruiting of private finances)

Structure of research funding has changed remarkably. A rather competitive system of formula based funding and a new agency (KBN) have been introduced. The total amount of research funds has remarkably grown. (see Fig. 9.11).

Fig. 9.11

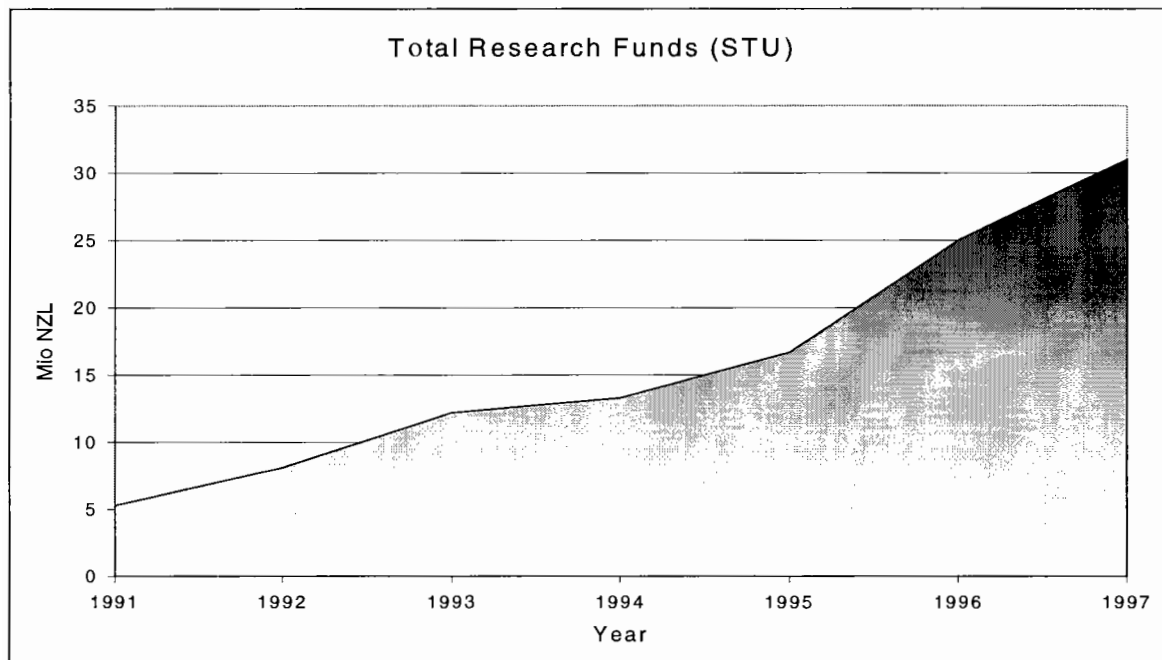
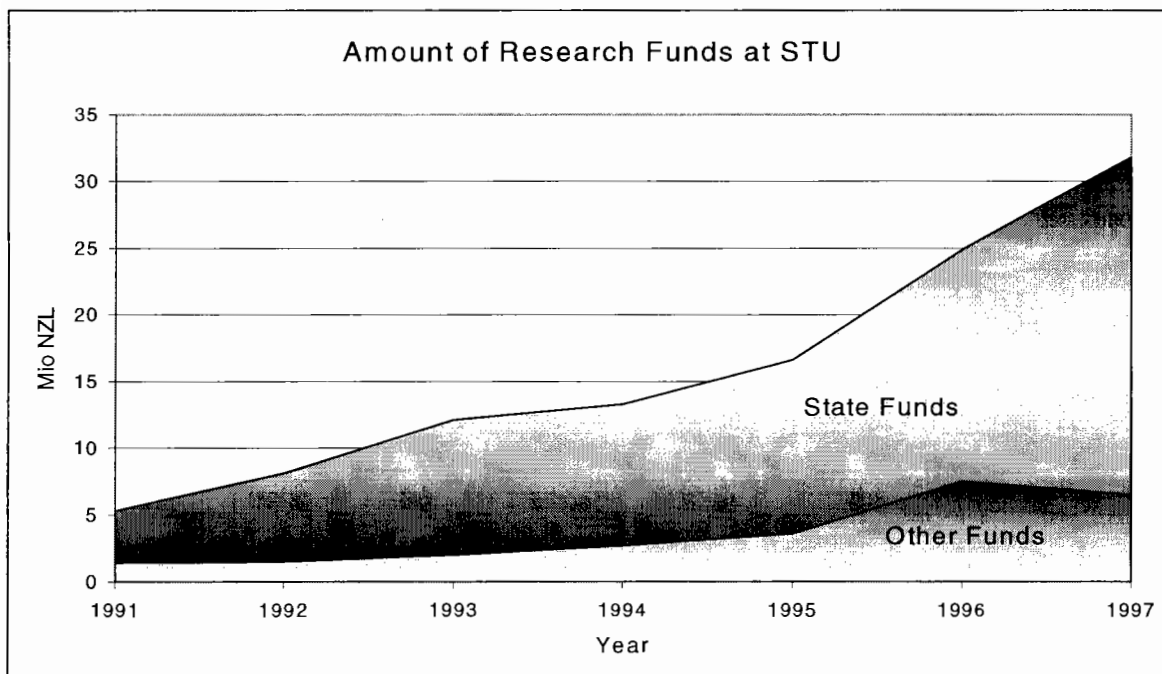


Fig. 9.12

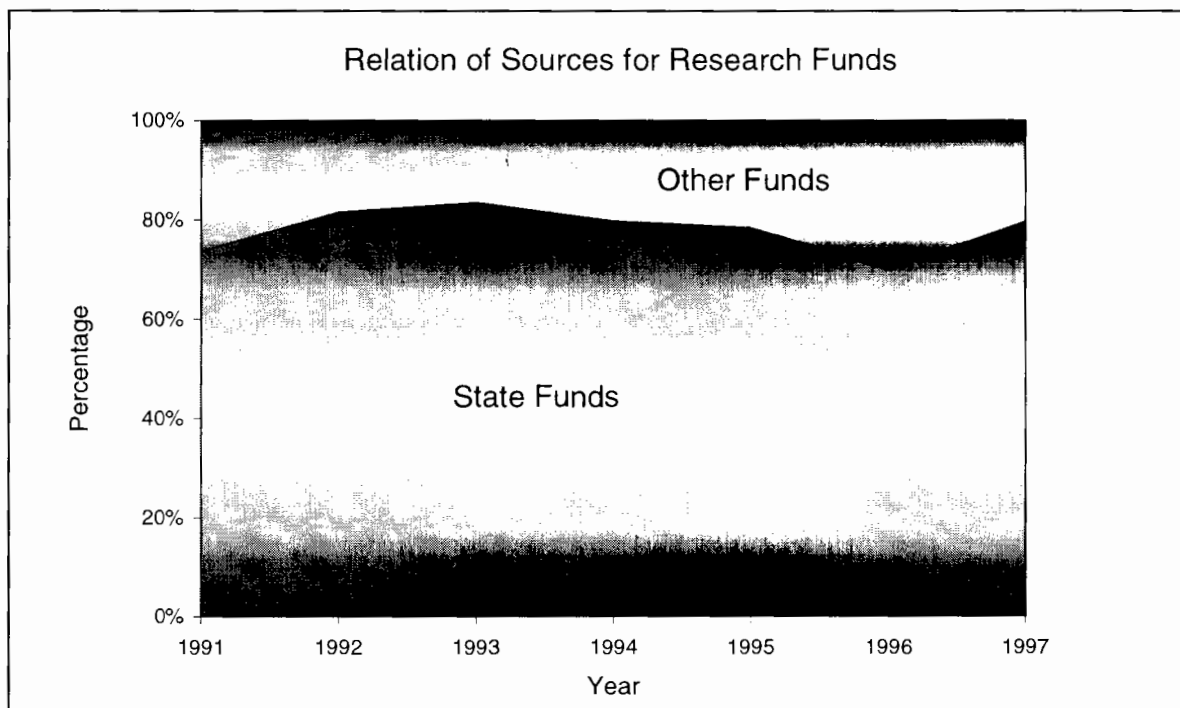


A comparison of the partition of public and private funds leads to the following impressions: After a short period between 1991-96 of growing support from the private sector one can see nowadays

shrinking opportunities to gain support from private sources; the state has again to carry the bigger load in funding research at HEE institutions (see Fig. 9.12, Fig.9.13).

This development results in a nearly unchanged structure of sharing the costs between state and private research funding. As long as the private sector is and will not be able to support the HEE institutions the public funds remain as the most reliable source.⁴

Fig. 9.13



9.12 Regional co-operations (incl. surrounding infrastructures, technology, industries, economy)

- Improved regional and local co-operation in research, consulting and services.
- Installation or planning of Centres of Excellence/Advanced Technologies or Technological Parks, Pilot Plants.

Kind of development: *Growth of regional and service orientation* (rem.: SUN-Project).

⁴ For a discussion of problems and deficiencies, causes of lacks, statements and proposals for their removal see the contribution of Anna Osterczuk in Higher Education Management, 11/1996, Vol. 8, No. 3, p. 59-67.



Part III

Future Perspectives

Table 10.1: Majors and profiles of *machinery construction and exploitation* in the Department of Mechanics of the University of Technology and Agriculture in Bydgoszcz

Major – Machinery mechanics and construction			
Type	System	Speciality	Majors of certification
1	2	3	4
Master's – 5-years	Daytime	1. Technology of machines	<ol style="list-style-type: none"> 1. Machining 2. Technological processes design 3. Plastics processing 4. Welding 5. Heat treatment 6. Plastic working of metal
		2. Agricultural machines and devices	<ol style="list-style-type: none"> 1. Agricultural machines 2. Technology and organisation of repairs 3. Agricultural vehicles 4. Agricultural machines exploitation 5. Diagnostics of agricultural machines and vehicles
		3. Machines and vehicles exploitation	<ol style="list-style-type: none"> 1. Motor-cars exploitation 2. Food-processing machines exploitation 3. Paper machines exploitation 4. Industrial machines exploitation
		4. Technological machines and equipment	<ol style="list-style-type: none"> 1. Forming machines 2. Robots and mechatronic systems
		5. Cars and tractors	<ol style="list-style-type: none"> 1. Technology of vehicle repairs 2. Technical diagnostics of vehicles 3. Motor-cars construction
		6. Machines and devices for chemical and food industry	<ol style="list-style-type: none"> 1. Food processing machines 2. Chemical processing machines 3. Machines in environmental protection

to be continued

Table 10.1 continued

			Profiles of certification
Engineer's – 3,5-years	Daytime		<ol style="list-style-type: none"> 1. Construction of machines and devices 2. Of technology and management 3. Cars and tractors
Engineer-s – 4,5 years	Part-time	1. Technology of machines	<ol style="list-style-type: none"> 1. Plastic working 2. Machining 3. Heat treatment 4. Technological processes design 5. Working machines 6. Welding 7. Plastics processing
		2. Agricultural machines and devices	
		3. Technological machine tools and devices	1. Machining centres
		4. Machines and vehicles exploitation	1. Industrial machines exploitation
Complementary Master's Studies – 2 years	Part-time	1. Technology of machines	
		3. Agricultural machines and devices	
		3. Technological machines and working equipment	
		4. Machines and equipment of chemical and food industries	

10. Mechanical engineering in the field of food/nutrition

- Measuring computer system PSI-GAD III for testing efficiency of cereals grains and plastics braking up,
- Simulator of resistance, sections and characteristics of multi-plate braking up TEST 1:4,
- Measurement system of grain/flour/dough and bread quantity of baking value and caesium activity, ZBPP-1,
- Quasi-shearing of samples of any materials, plastics and raw-materials RQ-5-INSTRON,
- More important computer equipment – PENTIUM II computer sets etc.

- the Toruń Enterprise of Trade of Technological Items „ELMET” in Toruń,
- the Road and Construction Enterprise in Brodnica,
- „TORSEED” the Enterprise of Garden Seeds and Nursery in Toruń,
- the Enterprise of Road Works in Toruń,
- the Enterprise of Road Works in Radziejów,
- the Enterprise of Road Works in Lipno,
- the Enterprise of Road Works in Włocławek.

B. sale:

- the State Enterprise „ARKTA” in Bydgoszcz. Obtained Minister’s of Treasury Agreement for privatisation.
- the Industrial and Trading Enterprise „Centrala Rybna” in Bydgoszcz,,
- the Enterprise of Aggregate Production and Prefabrication in Szubin,
- „Centrala Nasienna” in Mogilno and Żnin.

C. assets in kind brought as a contribution into a partnership:

- the Railway Paving Factory „BYDGOSZCZ” in Bydgoszcz,
- the Production and Trading Enterprise „POLON LABOR” in Toruń,
- the State Enterprise „CENTROHURT” in Toruń,
- the Enterprise of Transport and Equipment for Construction „TRANSBUD TORUŃ”,
- the Kujawy Enterprise POW in Włocławek,
- the refrigerator in Włocławek.

10.3.2 Agriculture

Agriculture, which earlier in the provinces Toruń and Włocławek was the most important sector, has an essential significance in the Kujawy-Pomorze Province. The importance of agriculture in the economy of the regions is testified by the fact that 30% of the working population work in farming. The agriculture of the province has both a big and good natural potential composed of over one million hectares of arable land with 63% of high quality land (Class I to IV, compared to a national average of 51%). The valorisation index of agricultural production space equals 69.7 % compared to a national average of 66.6 %.

The province with its 6.3% of national arable lands produces: 9.4% of national grain, over 15% sugar beets, over 8% rape, nearly 13% of national swine and sheep, 7.3% cattle. The following factors increase the development of chances in agriculture:

- significantly larger mean size of farms (12 ha against 7.9 ha mean national),
- tradition of good, high culture farming,
- many scientific institutions in the region: University of Technology and Agriculture and agricultural schools, institutes, IHAR branches, Institute of Zootechnics, Institute of Veterinary, IMUZ, Institute of Food Industry, and stations of plant growing and animal breeding,
- high level of agricultural consultancy.

The problem of restructuring the country is particularly important in the former province Włocławek where over 50% of the population live in villages. Unemployment rate is higher than 15% and the people in nonproductive age constitute the greatest percentage compared to all the three former provinces.

10.3.3 Transport

The situation near main roads and a regular road network create favourable conditions for further development of the Kujawy-Pomorze Province. The density of paved roads in the province is higher than in the rest of the country. Through the Kujawy-Pomorze Province runs an international transit road, where the construction of the north-south motorway A-1 is planned. In 1998 the first 11 km long segment of the motorway was opened between Lubicz and Czerniewice near Toruń.

The province has an airport in Bydgoszcz, which is poorly exploited despite its convenient situation. Air transport does not play an important role in the country. A few months ago regular passenger flights to Warsaw were reintroduced. It is envisaged that the Bydgoszcz airport will become part of a network of regional ports ensuring convenient domestic and international connections. Toruń and Kruszyn near Włocławek also have working airfields.

The biggest transport investment in Bydgoszcz is a bridge with access roads in Trasa Nowołęczycka. Żegluga Bydgoska S.A. is situated in the region and carries national and foreign goods, does repairs and reloading. Over 68% of Żegluga's transports go to Germany.

10.3.4 Tourism

Non-productive areas of activities provide an essential opportunity for the development of the Bydgoszcz region. The greatest potentials in this aspect are in tourism, which is steadily developing in Poland. It is important to take advantage of the existent business situation encouraging to invest in our tourist attractions, not fully appreciated yet. Tourists have 401 tourist facilities with over 27,000 beds at their disposal. Of all the historic monuments in our region, the biggest interest enjoys the well-preserved medieval old town of Toruń (inscribed in the UNESCO cultural heritage list), Golub-Dobrzyń, where in the romantic scenery of the famous castle carnival balls, international knight tournaments and crossbow competitions take place. Their uniqueness attracts numerous tourists. Chełmno, called the Pearl of the North, belonging to the most beautiful architectural complexes in Poland and an archaeological reservation in Biskupin with a reconstructed defence settlement of the Iron Age also draw many visitors. The promotion of the Piast Track, an unusually interesting route linking the sites connected with the origins of Polish statehood, has great importance for the development of tourism.

Further unquestionable attractions are the health resorts of Inowrocław and Ciechocinek, Poland's most famous "tężnie" or saline drip ventilation towers. Advocates of active rest are attracted by the national park Bory Tucholskie (the Tuchola Forest), one of the largest in Poland as well as many picturesque lake districts and nine landscape parks which are an excellent basis for the development of agro-tourism.

10.3.5 Science

The province may take pride in its scientific potential. Numerous schools of higher education with over 50,000 students play an important role: The Nicholas Copernicus University in Toruń, involved in many European educational programmes (COST, COPERNICUS, TESSA, TEMPUS) and the schools of Bydgoszcz, i.e. University of Technological and Agricultural, Higher Pedagogical School, medical Academy and the Academy of Music.

2. Measurements of loads and voltages in medium and low voltage distribution network and analysis in the range of:
 - energy losses,
 - voltage regulation,
 - load of particular elements within a distribution network,
 - quality of electric energy,
 - load asymmetry,
 - tests concerning economical loads of medium-low voltage transformers under operational conditions,
 - assessments in the range of rational exploitation of medium and low voltage distribution networks.

Department of Machine Tool and Robots, Industrial offer:

3. Innovations in robots and machine tools:
 - design and construction, performance and experimental verification of video-computer aided machine-tools systems,
 - solving of tribological problems connected with rolling and slide, hydro- and aerostatic bearing,
 - design preparation and construction of any type of machine tool and assembling systems, rigidly or flexibly controlled.

Department of Machine Construction Principles, Industrial offer:

4. In the range of machines parts and constructional materials testing:
 - measurements of operational (work) loads and drawing them up by means of stochastic methods,
 - dynamic tests, especially in the range of fatigue durability of construction elements and machine parts sets, centres, joints and couplings in conditions of stochastic, programmed, periodically changeable, percussive and static conditions,
 - testing of constructional materials in the range of: static durability, fragile cracking, fatigue durability (e.g. Wöhler's diagrams), low-cycled fatigue (e.g. Morrow's diagrams, diagrams of cyclic deformation), propagation of fatigue cracks, designing of machines testing methods.
5. In the range of durability calculation and fatigue durability of constructional elements:
 - calculation of fatigue durability in operational load conditions,
 - preparation of computer programs for calculations,
 - calculation of constructional elements by means of digital methods (MES)
6. In the range of construction:
 - construction of unique stands for machine sets, elements and equipment testing.
7. In the range of research and technical assessments:
 - assessments concerning machine failures,
 - estimation of technical condition of machines,
 - estimation of technical projects of machine construction,
 - reviews and estimations of projects and methods of machine testing.

Department of Agricultural Machinery, Industrial offer:

8. Plant production mechanisation:
 - Working out of methods and techniques of applications of various green fodder souring process facilitating agents,

- Estimation of quality of work as well as of technical and operational parameters of apparatus of plant protection and machines for harvesting and transportation of volumetric fodder and potatoes,
- Technical assessments of agricultural machinery and devices,
- Performance of schooling in the range of Department's research activity.

Department of Applied Mechanics, Industrial offer:

9. Industrial investigations:

- Testing and estimation of durability features of constructional materials,
- Determination of mechanical properties of machine and equipment parts,
- Acceptance and arbitrary examinations,
- Examinations and assessments in case of failures.

10. Testing of mechanical vibrations:

- measurements performed in laboratory and on tested objects, with registration and computer-aided vibration analysis performed by means of high grade testing apparatus,
- project of decreasing of the machine vibration.

11. Research of elimination of the noise caused by machines and devices.

12. Tests and calculations concerning flow machines.

13. Assessments in the range of:

- Estimation of technical condition of flow machines,
- Testing, calculations and design of ventilation systems.

Department of Technology and Knowledge of Metals, Industrial offer:

14. Engineering of metals and constructional materials:

- estimation of welding properties of metals and alloys,
- technology of welding process of materials of limited welding properties and of diverse materials, e.g. St3S-1H18NT9T etc.
- estimation of temperature distribution and parameters characterising of the thermal cycle in welding process performed using analytic and computer methods,
- estimation of physical phenomenon in electric arc,
- estimation of deformations and stresses occurred in welding process performed by means of method of absolute elements, using computer technique,
- friction welding and blinding of pipes,
- assessments in the range of welding constructions damage,
- repair and regeneration of elements, using welding techniques.

Department of Food Machinery and Environmental Protection, Industrial offer:

15. Innovation, research and development of:

- Machines of agricultural and grocery processing and storage, especially of breaking up and granulating,
- Measuring and testing devices for grain and flour processing, e.g.: for determination of mass of cleaned grain as well as mass of contamination and pests, for determination of humidity, and grain density in loose state, for determination of granulation, for gluten examination, for examination of fermentation properties of flour and yeast, for estimation of baking value, for measurement of low caesium activity in food etc.
- Technology of surface and underground waters treatment for municipal purposes,

- Carrying out of technical inventory,
- Translation of technical texts (written) and translation attendance (oral) of international technical ventures, contract talks, etc., in English, Bulgarian, Czech, French, German, Russian, Slovenian and Italian languages.

11 Perspectives of Engineering Education – Certain Questions

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Instytut Maszyn Matematycznych, Warszawa

The first question I would like to ask is how the scope of the engineering professions and of engineering education changes: What is engineering, and who is an engineer now and in the near future?

The word *engineering* is nowadays used in a broader sense than before. There are new terms like: software engineering, knowledge engineering, system engineering, business engineering, bio-engineering, genetic engineering, and others. Some of these new “engineers” are rarely or even non-technical. Is it only a new fashion of naming things, or is it an essential change of the subject, that will have consequences in the profile of engineering education?

I am convinced that this is an indicator for essential changes. Engineering becomes to be understood as “systematic application of methods, tools, and knowledge to achieve stated technical, economic, and human objectives”. Respectively, an engineer could be not necessarily a person with particular academic education in a defined technical area, but as well a person without pure technical backgrounds in a traditional sense, prepared to practise particular “engineering”. Of course, opposite opinions are also presented, namely in the discussion carried on in the circles of *the Institute of Electrical and Electronics Engineers* (see *the IEEE Spectrum*, no. 7/99, 10/99).

Although the question generally remains unsettled, there are matters to handle in the area of education in information technology - enlarged or new curricula related to software engineering not necessarily having something to do with technical applications. One can expect that “IT engineers” will become the largest single category of engineers within 10 years – in the USA anyway. The majority of them will be active in programming, system integration and so on, and a lot of them will work without having a classical technical background. However, significance of these engineering and these “engineers” for industry and the whole economy will be enormous. Knowledge and technology in this area changes rapidly and there is a great need for continuous education. The engineering education system has to take this into account, as well as the necessity to provide classic engineers with skills to use more and more sophisticated IT tools in their traditional areas.

The second question is about the focus of the engineering education.

In its actual practice the engineering education is career-oriented: Educational institutions – in the case of engineering almost exclusively technical universities or faculties – shape their curricula to for provide their alumni with technical qualifications, that gives them the opportunity for a successful career on a changing and less predictable labour market.

The other challenge engineering education faces is that of the engineering profession itself. New branches of engineering and new professions appear, new needs of economy have to be met, and new careers types appear. It is necessary to shape a system of engineering education in a way that challenges of engineering can be met promptly and effectively. There is an urgent need to focus on dissemination of new knowledge and skills. May be small specialised centres can meet this requirements easier than academic schools.

My third question refers to credentials given to engineers.

A certificate or licence is necessary to practise in some engineering specialities, and a university diploma is only a prerequisite in these cases; credentials are given by professional associations or administration. In the area of IT, certificates given to IT practitioners by companies which deliver computer software and hardware become more and more important. Companies like Microsoft or Novell have developed complex certification systems. Often the possibility to work for them (e.g. in “software factories”), or with their products without losing benefits like warranty, depends on holding their certificate. Professional associations in this area also organise certification systems – for example, the *Council of European Professional Informatics Societies (CEPIS)* gives *European Computer Driving Licence*, and this certification system has expanded to the whole world by changing its name to *World Computer Driving Licence*.

From this development, a doubt arises, if university diploma from an engineering faculty will be always the necessary prerequisite for obtaining an essential certificate and practise engineering – in IT or another new field.

Finally, one can expect that in far-reaching perspective, completely new ways of education will appear. Education, as information in general, entertainment, commerce, and so on, will expand to the cyberspace. University as *Alma Mater* - appearing on a certain stage of development of the human civilisation – seems to be associated with the culture of printed paper. In ancient cultures, including such well developed as ancient Greek one, higher education went without universities. It is probable, that in the cyberspace there will be many narrower, more specialised sources of knowledge and training, and that maybe the new profession of “cyber tutor” – an educational guru in cyberspace - will appear. In addition, contemporaneous diplomas can be substituted by more differentiated credentials of various types.

12 Perspectives of Engineering Education at the Warmia-Mazurian University in Olsztyn

Dr inż. Marzena WILAMOWSKA-KORSAK
The Warmia-Mazurian University in Olsztyn

The aim of the foundation of the Warmia-Mazurian University was to establish a modern educational institution based on two pillars:

- conducting scientific research at a high level and its dissemination,
- high quality students education.

The Warmia-Mazurian University is the first Polish university with such a wide educational offer, including arts, agricultural, technical and economics studies. This makes it possible for the students to follow two lines, for example technical sciences and pedagogy or technical science and management.

The Technical Sciences Department offers education for engineers in the fields of:

- construction engineering;
- environmental engineering;
- mechanical engineering and machines construction;
- agricultural and forestry technique.

Graduates from construction engineering specialised in building and engineering constructions are awarded a professional title of an engineer and are prepared to work in building, investment supervision, in design companies and other institutions connected with building.

Mechanics and Machines Construction provides education for those who are interested in technical subjects and are predisposed to them. Students can choose between two lines:

- utilisation of vehicles and machines;
- Machines and Equipment in Food Industry (this new line replaced the former one Machines and Technical Devices in Agriculture);

Mechanics and Machines Construction graduates are supposed to be prepared to analyse and solve engineering problems in the field of design, manufacturing, and utilisation of machines and devices. They can work in different institutions, conduct scientific research and implement new solutions, manage staff in production process as well as run their own businesses.

The north-east of Poland is and will remain a tourist and agricultural region. The following courses of study therefore meet with special regional requirements. Agricultural and Forestry Technique with the speciality of Agricultural Engineering are technical and agricultural studies, and their graduates have broad technical knowledge, supplemented by the knowledge of an agricultural background. This helps them to deal with current and future problems of the technology used in agricultural products production, their processing, quality protection while storing, as well as considering the impact of applied techniques and technology on widely understood natural environment. The graduates can be employed in:

- agricultural machinery factories;
- maintenance services and repair shops for agricultural machinery on the farms of different profiles agriculture advisory centres;
- professional educational institutions at secondary and higher levels and in research and development centres establishing and conducting own businesses connected with agribusiness.

Due to the planned accession of Poland to the EU environment protection requirements, necessitate an intensification of the works concerning building new purification plants, collectors, sewage system, water-supply services, and other objects of this kind in every town or village. To meet this demand Environment Engineering has been established as a new course of study, which aims to educate specialists in the field of design and implementation of sanitary and ecological installations. Graduates can find employment in institutions dealing with hydro technical objects, sanitary installations, water-supply services, purification plants, and ecological devices.

During the last five years, there has been only a slight increase in the number of students of about 4.8 % (with a higher rate of 7 % full-time students and 2% extramural students). Qualifications and skills obtained in the course of studies will decide on future careers. This fact forces the Technical Science Department graduates to acquire profound knowledge based on general studies as well as on technical studies. This knowledge will help them take an open attitude, assuring the freedom of individual activity in special conditions. Graduates with general knowledge have better job opportunities, especially in our specific region, where employment offers for specialists are rather limited.

The process of acquiring knowledge should be conducted through special education. The choice of speciality should be led by individual interests, as well as demand on the labour market. Professional qualifications updating should be supported by special courses and post-graduate studies. The Warmia-Mazurian University offers a wide range of post-graduate studies. Currently there are 70 different forms of professional training, which are attended by 2400 students. New attractive forms will be launched soon.

Graduating from the Interdepartmental Pedagogical Studies, where students (starting with the III year) can acquire pedagogical and basic knowledge together, provides qualifications to enable students to work in secondary schools. The syllabus of post-graduate Marketing and Management Studies was worked out in co-operation with the University of Minnesota, among our lecturers there are some from SGH (High Economics School) in Warsaw, Humboldt University, and the University of Minnesota. Graduates will be awarded a two universities diploma – Minnesota and the Warmia-Mazurian.

Very low salaries force the staff to take up extra jobs which leads to lack of motivation to do post-graduate degrees. Despite this fact, during the last three years the number of appointed staff in TSD has almost doubled. It allowed us to introduce some changes: the vocational-engineering course of studies has been replaced by a two-stage master-engineer in the educational line Agricultural and Forestry Machinery (implemented in 1997) and in the line Mechanics Engineering and Machines Construction (implemented in 1998).

On the June 14, 1999 the Department (then – Mechanical at the Agricultural-Technical Academy) was authorised to award Ph.D. degrees in agricultural engineering from the field of agricultural science. A certain increase in the number of tutors coming from a group of assistant lecturers employed in the department could be observed. Currently assistant lecturers are employed only on a part-time basis (1\2) and only if they start post-graduate studies. Assistant lecturers are encouraged to upgrade their educational background. The target educational model of the University are three-stage studies:

- vocational (licentiate or engineer) – 3.5 or 4 years
- master degree – 5 years
- master complementary –1.5 or 2 years

- post-graduate (doctor's degree) – 4 years
- post-graduate studies preparing for the PhD will considerably enforce the development of scientific staff at the University.

The Warmia-Mazurian University has started attempts to obtain the certificate of the University Accreditation Committee. Such a perspective creates new educational tasks and necessity to adjust particular organisation units to standards. This will involve plans and syllabuses correction required for the accreditation. In the Technical Science Department plans and syllabuses are worked out according to the accreditation criteria of FEANT and the programme minimums recommended by the National Council for Higher Education. By the end of January 2000, some minor changes will probably be introduced into the plans, which will update the process of education.

The number of hours in particular educational lines of TSD studies are the following:

- Construction: engineering studies – 2755 hours (184 ECTS points) in general and line subjects – 55 %, special subjects – 45%
- Environmental Engineering: engineering studies – 2895 hours (236 ECTS points); basic studies – 18%, non-technical studies – 12 %, technical subjects – 70%
- Mechanics and Machine Construction: engineering studies – 2800 hours (186 ECTS points). master studies – 3500 hours (233 points ECTS); general studies – 28 %, line subjects – 56 %, special subjects – 16%
- Agricultural and Forestry Technology: engineering studies – 2855 hours (189 ECTS points); master studies – 3400 hours (227 points ECTS); general subjects – 32%, line subjects – 53%, special subjects – 15 %.

The relation between the number of lectures and training hours is 1:1 (M and MC) and 2:1 (other lines). In all lines of studies, three training courses lasting up to 10 weeks are assumed. Students have free access to computers and special software also in non-compulsory training.

Within the studies framework the students have an opportunity to obtain international certificates of AUTODESK in Mechanical Desktop and AUTOCAD 2000. In order to introduce equal chances in the labour market of the EU, the subject Concurrent Engineering is currently being introduced in Mechanics and Machines Construction. That will enable graduates to work synchronously in a virtual team of constructors in a local network and in the Internet. Aiming at keeping competitiveness in the didactic market, we conduct negotiations in order to launch a virtual post-graduate study programme via the internet which is supported by Computer Machine Construction Studies. This will be established within the Authorised Training Centre of CAD.

The Technical Sciences Department conducts negotiations with two German universities of applied sciences in order to start scientific and didactic co-operation (Fachhochschule in Offenburg and Fachhochschule in Koln). Next year we plan to complete our local network with a direct connection on the internet. All research-didactic units of the University will be included in the network, even hostels. The University library is also on the Internet. After the fusion of two educational institutions, the library still has two locations. In the nearest future, we plan to build a modern library, serving the needs of the whole university.

Launching new lines of study has intensified the need for room. That is why lectures start early in the morning and finish late at night. Currently big lecture halls are being modernised. The first one to be modernised and equipped with up-to-date audio-visual devices was the hall in the TSD.

The Warmia-Mazurian University is an autonomous educational institution, where electorals selected among department's staff elect rectors and deans. Candidates for pro-rector and pro-dean posts (pro-dean responsible for students matters) must be appointed by students.

Within departments, the financial system of the university is applied. This system leads to rational allocation of financial resources. The worsening budget situation makes departments look for additional financial sources. This year within the TSB the Centre for Plants Protection Training was launched, which conducts research on technical effectiveness of the equipment used for plants protection as well as training in this field. This centre is one of seven of this kind in Poland. For several years now the Laboratory for Material Research exists, which thanks to systematically modernisation in 1998 was awarded accreditation according to the requirements of the standard RN-EN 45001. The laboratory conducts research entrusted from outside, covers its own costs and purchases modern equipment. Furthermore, attempts are made to update the Vehicles Diagnosis Centre in order to get authorisation to overhaul vehicles.

This department provides conditions to conduct scientific research favourable for getting research assignments from outside the university. We intend to:

- limit the number of research tasks through subject integration;
- conduct more objective and rational evaluation of the projects and research subjects;
- to introduce serious consequences in expenditures calculating procedures;
- to enforce our attempts to get modern scientific research equipment;
- to negotiate co-operation contracts in the field of scientific research with similar scientific units abroad.

13 Engineering Challenges

Dr hab. inż. Janusz SZPYTKO
University of Mining and Metallurgy, Cracow

13.1 Introduction

Future perspectives of engineering education strongly depend on manufacturing challenges in the 2nd millennium. The key technologies to meet challenges will be development and selected fields of research. The research aim will be to establish interdisciplinary R&D programs with an emphasis on research co-operation teams. The above will result in major forces for change. The goal is to find the optimum position in the better, faster, and cheaper way based on human friendly environment and human-machine interaction.

13.2 Visionary manufacturing challenges

Manufacturing challenges will focus on the creation of a natural and competitive environment for enterprises, as well as the identification of key technologies and engineering knowledge and experience for meeting these challenges. Competitive environment for manufacturing means that a human oriented enterprise converts ideas for products into reality, both from raw and from recycled materials. The function of an enterprise will be highly integrated into the function as entity which links customers to innovators of new products. Products will be distributed globally, as a part of larger corporations, being located at and serve local markets and operating autonomously.

Challenges for manufacturing:

- achieve concurrency in all operations – systems modelling capability, modular and adaptable design methodologies, adaptable processes and equipment, materials and processes;
- integrate human and technical resources to enhance workforce performance and satisfaction – systems models for all manufacturing operations, technologies for converting information into knowledge, unified methods and protocols for exchanging information, processes for the development / transfer / utilization technology, new education methods, design methodologies that include a broad range of a product requirements, design methods and manufacturing processes for reconfiguring products, new software design methods, adaptable/ re-configurable manufacturing processes and systems, human-machine interfaces
- instant transformation of information from a vast array of diverse sources into useful knowledge and effective decisions – educational technologies, collaboration technology, teleconferencing / telecontrol / telepresence, natural language processing, data and information filters and agents, system security, artificial sensors and actuators for process and equipment control, integrated modelling and simulation
- environmental compatibility – to reduce production waste and product environment for impact to near zero (ISO 14000), modelling and risk assessment, manufacturing process with near zero-waste, reduced energy consumption, environmentally aware manufacturing enterprises.

13.3 Research recommendation

In any manufacturing enterprise workforce and process technology are playing key roles. The manufacture workforce is looked at in the sense of purpose and satisfaction, added value visible to

the product and human orientation, as well as manufacturing innovation. Human resources will be a part of the integration and the synergistic output of human–machine interactions. Human resources will create valuable new products and make bold and visionary business decisions. Process technology will be oriented at: microelectronics, biotechnology, low-waste production, improved process control, recycling and reuse of process waste streams, result in near–zero discharge processes. The product is well designed to be recyclable and reusable or to stay benignly in the environment.

From thorough evaluation of the future manufacturing, the following research activities are recommended:

- understanding the effect of human psychology and social sciences in decision–making in designing, planning and operation of manufacturing processes;
- managing and using information to make intelligent decision among a vast array of alternatives
- adapting and reconfiguring of manufacturing enterprises to enable the formation of complex alliances with other organizations, process acceleration for the production of diverse, customized products;
- developing tools to reduce time–to–market and improve quality;
- understanding the effects of new technologies on the manufacturing workforce, the environment and the surrounding community;
- developing business and engineering tools which are transparent to differences in skills, education, language and culture, to bridge international and organizational boundaries.

Major forces for change:

- competitive climate;
- sophisticated customers;
- the basis of competition will be creativity and innovation in all aspects of the manufacturing enterprise;
- development of innovative process technologies will change both the scope and scale of manufacturing;
- environmental protection;
- information and knowledge on all aspects of manufacturing enterprises and the marketplace will be available in a form that can be used for decision making in consideration of the global distribution.

13.4 Conclusions

To support process technology and research of the 21st century, engineering higher education institutions must be ready to offer students knowledge and skills expected by industry in the age of globalisation, especially in the fields of: microelectronics, biotechnology, low-waste production, improved process control, recycling, and reuse of process waste streams. Engineering technologies must be ready to answer the manufacturing vision of the 2nd millennium:

- fundamental industrial processes will still be around and will not be much different;
- products and services will be increasingly realised in multiple configurations of alliances;
- networks of flexible entrepreneurial sites will replace large, more rigid central sites;
- products that are built–to–order will create pressure to reduce scale and locate sales and services near manufacturing sites;
- industry will produce more highly customized, high value products;

- new developments in biotechnology and nano-technology will create whole new industries and industrial co-operations based on interactive 3D-simulation.
- visualization of complex structures integrating behavioural, organizational people issues with other analysis
- intelligent communication systems
- sensors for process controls in closed-loop systems
- sustainability, new technologies for handling manufacturing process waste, lighter/ smaller equipment



Annex



German – Polish Joint Research Project
Structures, Problems, Potentials and Future Perspectives
of Engineering Education in Poland

Place of workshop: Hotel Daglezja, 34500 Zakopane, ul. Piłsudskiego 14

PROGRAMME

3.12.1999

Welcome in Zakopane

19.00 Dinner

20.00 *The Institutional Portraits review and conclusions* – PD. Dr.-Ing. Ing. Helmut Winkler (Project coordinator)

20.30 Round table meeting: comments and discussion on the *Institutional Portraits* (all reporters)

4.12.1999

9.00 Breakfast

10.00 – 12.30 Workshop: *General Structures, Problems, Potentials and Future Perspectives of Higher Engineering Education in Poland*

10.00 *Introduction into the Workshop* - PD. dr Ing. Helmut Winkler and Dr hab. inż. Janusz Szpytko (project coordinators – Kassel University and University of Mining and Metallurgy Cracow)

10.10 *International Co-Operation in R&D and Education* – Prof. dr hab. inż. Andrzej Korbel (Vice Rector of the University of Mining and Metallurgy)

10.20 *Evaluation Development of Engineering Education System* – Prof. dr hab. inż. Wojciech Batko, Dr hab. inż. Antoni Kalukiewicz, University of Mining and Metallurgy Cracow (Dean and V-ce Dean of Faculty of Mechanical Engineering and Robotics)

10.50 *Development of New Co-operation Systems Between Technical Universities and Industry* – Prof. zw. dr hab. inż. Zygmunt Drzymała (Head of Department), University of Mining and Metallurgy Cracow

11.20 *Development of organisational and decision structures in Polish technical universities* – Prof. dr hab. inż. Wojciech Batko, Dr hab. inż. Antoni Kalukiewicz, University of Mining and Metallurgy Cracow (Dean and V-ce Dean of Faculty of Mechanical Engineering and Robotics)

11.50 *Organisational and Structural Changes in Polish Engineering Education* - PD. dr Ing. Helmut Winkler, University Kassel

12.20 Discussion

13.00 Lunch

15.00 *Developing New Curricula in Polish Engineering Education* – Dr Baerbel Grünig, University Kassel

15.30 *Restructurisation Process in Engineering Education of Warmińsko-Mazurski University* – Prof. dr hab. inż. Janusz Piechocki, Warmińsko-Mazurski Uniwersytet (V-ce Rector of WMU)

16.00 *Quality Management in Engineering Education* – Dr inż. Maria-Władysława Francuz, Cracow University of Technology (Head of Education Centre)

16.30 Coffee break

16.45 *Practical Training in Engineering Education* – Dr inż. Krzysztof Gasidło, Silesian Technical University

17.15 *Engineering Challenges* – Dr hab. inż. Janusz Szpytko, University of Mining and Metallurgy

- 17.45 *Health Aspects in Engineering Education* – Mgr Danuta Anita Woźniak, Management and Health Promotion Regional Centre (Head of Postgraduate Human Resource Medical Education Centre)
- 17.45 Discussion
- 18.30 Dinner
- 20.00 *Perspectives of the Engineering Education at the Warmińsko-Mazurian University in Olsztyn* – Dr inż. Marzena Wilamowska-Korsak, Warmińsko-Mazurski Uniwersytet (v-ce Dean of the Faculty)
- 20.20 *Future Perspectives of Engineering Education* – Prof. dr hab. inż. Józef Flizikowski, University of Technology and Agriculture Bydgoszcz
- 20.50 *Perspectives of Engineering Education – Certain Questions* – Doc. dr inż. Andrzej Kaczmarczyk, Institute of Mathematical Machines, Warszawa
- 21.00 Coffee break
- 21.15 Round table meeting: *General Structures, Problems, Potentials and Future Perspectives of Higher Education in Poland* (engineering education system, research institutions potentials, labour market for engineers, industry reengineering process, future key technologies, university-industry co-operation perspectives, professional engineering associations), PD. dr Ing. Helmut Winkler, Dr hab. inż. Janusz Szpytko
- 5.12.1999**
- 9.00 Breakfast
- 10.00 Round table meeting - conclusion: *General Structures, Problems, Potentials and Future Perspectives of Higher Education in Poland*
- Departure