One Possibility of Increasing the Interest in Engineering Study

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***Abstract**. The paper describes the changes in the higher education system in the Czech Republic after 1989. The reasons for the decrease in the interest in studying engineering fields are analysed. The ways of improving this situation, used at the Technical University of Brno, are mentioned. In particular, the new interdisciplinary study programme in Mathematics and Engineering was introduced. The graduates of this study programme who are supposed to become secondary school teachers may improve the pupils' attitude to engineering science.*

I.

At present there is not a single global problem that could be solved by a mere instinct without previous education. Education is a key to a happy peaceful life. However, it is necessary to know what we mean by education. It is not a mere amassing of thousands of pieces of information and transforming of the human brain into an encyclopaedia or a computer. It means, above all, a certain level of relationships, cultivation of conscience, joy of discovering new things and effort to understand and see things in mutual relationships. This should be true for the university education in general and for the engineering education in particular.

In the communist era in Czechoslovakia from 1948 to 1989 a strictly directive approach to the administration was maintained. Quantity was the major goal of the economy and, according to the Marxist philosophy, it was supposed to change into quality by revolution. The industries were centred about steel production, heavy industry and arms and the consumer goods were produced only in the least necessary degree. At the same time the whole Czechoslovak economy was entirely dependent on the exports to the Soviet Union to reduce possible links to the western developed countries to a minimum.

These principles could be found also in the policies of universities. Corresponding faculties at different universities were governed by unified courses and study programmes. There were a rigid numerus clausus of each and every study programme at all faculties. The universities were considered to be mainly education institutions and research was primarily conducted at research institutes and institutes of the Academy of Science. Due to the sole existence of state-owned enterprises the study was strictly specialised but only a small percentage of students actually worked in the fields of their own specialisation. As it was not encouraged to discover various relationships and to criticise the given state of the society, the information was merely passed on without encouraging the students' active work and their investigative spirit. All types of scientific research were under constant surveillance of the Marxist ideology and its "scientists". For example in the fifties, cybernetics was viewed as a non-scientific discipline with no place in the communist ideology. When this error was finally discovered, the contact with the other world had long been disrupted. The importance of the scientific revolution was stressed and, consequently, large amounts of funding pumped into it. This funding was, however, very inefficient due to bad organisation and often incompetent interventions.

For the reasons stated above the Czech society after the downfall of communism in 1989 was facing a number of problems and tasks: The directive system of planning had to be replaced by market economy. This entailed the creation of an effective administration. Also the problems of environment protection had been neglected by the communist regime. The system of research and scientific work had to be re-built. People felt the lack of the principles of democracy but had no experience in applying them.

All these problems were also reflected in university sector. The freedom came back to the universities after forty years. The universities became legally independent units. They have been given a right to form their own profile and to introduce new study programmes that will prepare young people for an ever changing labour market. Narrowly specialised courses are replaced by those educating students with more comprehensive knowledge and skills**.** As the universities became more autonomous with a right to design their own curricula, it became necessary to assess and secure the quality of educational institutions and their study programmes. The accreditation done by the Governmental Accreditation Commission is, apart from the allocation of funding, the main tool of the state for controlling the quality and development of the universities [1].

The Czech universities started to co-operate with foreign universities both in teaching and research, international programmes such as TEMPUS played a significant role. The internationalisation of education and mobility of students and teachers were stressed. One of the

pre-conditions for the student mobility is the introduction of ECTS, which was implemented at most of the engineering faculties in the Czech Republic [2].

One of the political priorities of the Czech Republic was to increase the number of university students (see Table I). At the same time the process of diversification of the higher education system has been started. The diversification is defined not only in terms of the curricula but also in terms of the study programme types [3]. On one hand, a new type of short term practically oriented Bachelor's study was introduced and, on the other hand, post-graduate doctoral study was formed aimed at the preparation of the students for research work. The introduction of the doctoral studies has contributed significantly to the increase of the importance of research at universities.

Tab. I. Numbers of students of Bachelor, Master and Doctoral studies at Czech universities (in thous.)

	1989/90	1994/95	1995/96	1996/97
Total number of students (in thous.)	110	133	145	162
Number of graduates (in thous.)	15.7	17.9	20.8	23.8
Number of newly enrolled (in thous.)	22.8	39.4	42.7	46.1
1st year students as the percentage of 18 years old	15.3	18.3	20.5	22.3

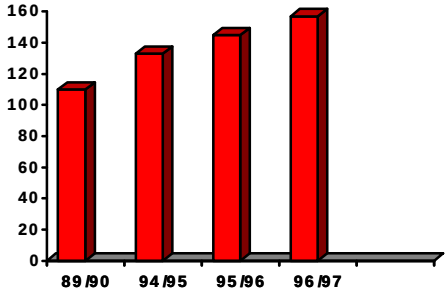

Fig. 1a. Total number of students (in thous.)

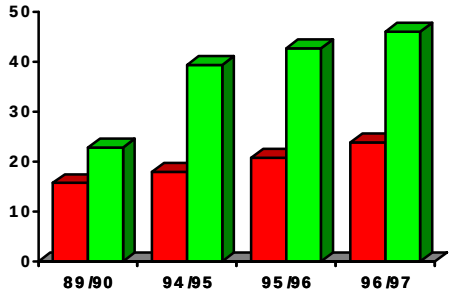

Fig. 1b. Number of graduates (red) and newly enrolled (green), in thous.

II.

In the past the technical universities with engineering education were at an advantage because their curricula were based on exact sciences thus being influenced by the ideology of the previous era only in a minimum degree. It was the engineers' and scientists' hunger for knowledge that kept the technical and science study fields abreast of world trends. Nevertheless**,** with the new political situation the technical universities have had to face a number of new problems. One of the constant problems is to recruit a sufficient number of able students for the engineering fields. This is very difficult

since after 1989 it has been a common belief that it is possible to become rich quickly if one goes into the business. Therefore the major interest among young people has been in the study of economics, management, marketing and business law. This is also strengthened by tendency in the over-sophisticated world of diverting the interest towards the humanities. Some of the problems are solved by themselves. Business organisations, banks, industries and offices are almost saturated by experts at economy, management, marketing and law. However the interest in engineering study is still declining.

Tab. II. Number of students in different fields in the Czech Universities in 1989/90 and 1996/97 (in thous.)

		1989/90	1996/97
A	Engineering	41,0	46,3
B	Science and mathematics	7.8	13.2
C	Humanities, Social sciences, Art, Law	15.7	30.6
D	Economy	15.3	27.2
E	Medicine	10.5	8.7
F	Agriculture and veterinary medicine	7.4	8.5
G	Education	17.4	27.9
	Total	110.0	162.4

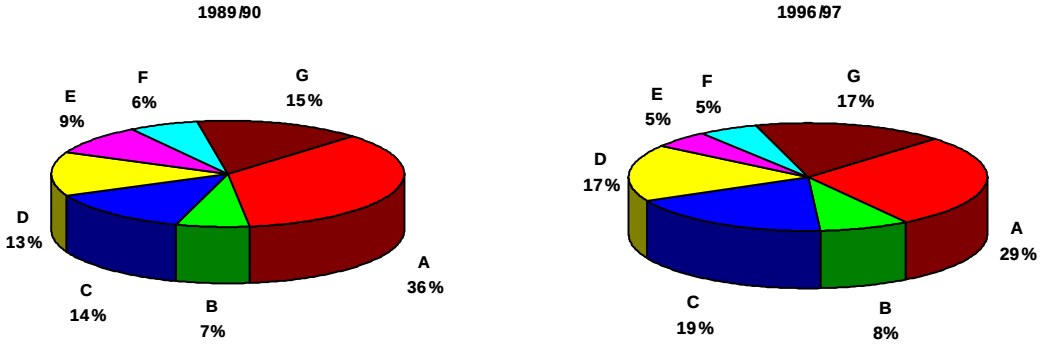

Fig. 2. Percentage of students in different fields in the Czech Universities in 1989/90 and 1996/97

If we look at the percentage of the students in the field of engineering (Fig. 2) we might conclude that the situation is satisfactory. However, we have to realise that, since the interest in the engineering fields is low, the percentage of less talented students grows much more quickly. This, together with the strict requirements of the engineering study, leads to a high degree of drop-outs (it is more than 50% in the first stage of the study) and, consequently, to a small number of graduates.

III.

The recruitment of good students interested in the engineering study is closely related to the system of secondary schools and their quality. The system of secondary schools in the Czech Republic is based on the idea that the grammar schools are to prepare their students for the universities whereas the so called technical secondary schools should prepare students with a view of their direct placement in practical jobs. At present, however, small interest of grammar school students can be observed in studying at technical universities, particularly at the faculties of mechanical engineering (cf. Table III). Thus the technical universities receive increasing numbers of technical secondary school applicants. These students are less equipped with general knowledge and they are suffering from the lack of conception of the secondary school education. This is especially true in mathematics and physics.

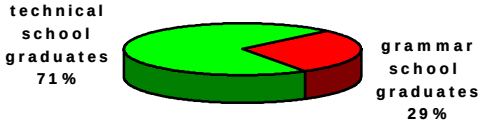

Fig. 3. In-coming structure of newly enrolled in 1997/98

in the Faculty of Mechanical Engineering of TU Brno

One of the reasons why the students are less interested in studying engineering fields is that the secondary school teachers do not educate them in this direction. This may be partly because their own education in engineering and technology has been insufficient. The future secondary school teachers are educated at faculties of science, arts and pedagogy of universities and those that specialise in teaching mathematics and physics have very often studied these subjects in combination with subjects like philosophy, English, history, biology etc. To extend the secondary school teachers' ranks by teachers who are well acquainted with technical problems we have decided to introduce a new type of interdisciplinary study, viz. "Mathematics and Engineering" [4], which is simultaneously taught at the Faculty of Mechanical Engineering of TU Brno and at the Faculty of Science of Masaryk University in Brno.

Tab. III. Numbers of applicants and newly enrolled students in the Faculty of Mechanical Engineering of TU Brno in the last three academic years (all applicants have to sit for the written examination in mathematics and physics)

	Applicants			Newly enrolled		
Year	1995/96	1996/97	1997/98	1995/96	1996/97	1997/98
Total number	1994	2366	2948	1001	1058	1377
out of them (in %)						
Grammar school graduates	22,05	24,58	30,15	17,21	21,75	28,76
Technical secondary school graduates	77,95	75,42	68,85	82,79	78,25	71,24
Male	93,11	89,77	91,39	89,27	83,87	92,16
Female	6,89	10,23	8,61	10,73	16,13	7,84

Curriculum of Master's study programme in Mathematics with Mechanical engineering

(numbers in parentheses represent the ECTS credit points of the course module)

1st Year's modules:

Algebra 1 (4), Algebra 2 (4), Mathematical analysis 1 (5), Mathematical analysis 2 (5),. Seminar in educational mathematics 1 (3), Philosophy 1 (2), Descriptive geometry (8), Machine engineering and designing 1 (5), Machine engineering and designing 2 (2), Materials science 1 (6), Physics 1 (7), Informatics 1 (3), Graphics systems and technical documentation (2), Mathematical software (1), Physical training (3).

2. Year's modules:

Algebra 3 (5), Geometry 1 (5), Geometry 2 (5), Mathematical Analysis 3 (5), Seminar in educational mathematics 2 (2), Philosophy 2 (3), Psychology (2), Materials science 2 (5), Physics 2 (6), Statics (5), Kinematics (5), Strength of materials 1 (5), Informatics 2 (2), CAD (2), Physical training (1), Foreign language (2)

3rd Year's modules :

Discrete mathematics (6), Theory mathematics and theory of numbers (5), Theory of sets 1 (2), Mathematical analysis 4 (6), Geometry 3 (4), Seminar in educational mathematics 3 (2), Dynamics (7), Strength of material 2 (6), Computer methods in mechanics (6), Hydromechanics (6), Pedagogy (2), Computer programming (5), General didactics (2), Physical training (1)

4th Year's modules:

Theory of sets 2 (3), Probability and statistics 1 (5), Probability and statistics 2 (6), Didactics of mathematics 1 (5), History of mathematics (4), Theoretical arithmetics (2), Strength of material 3 (5), Dynamics of machinery (5), Technical experiment 1 (5), Thermomechanics (6), Engineering didactics 1 (4), Numerical mathematics (4), Computer graphics (4), Seminar in Computer science (2), Physical training (1)

5th Year's modules:

Seminar in educational mathematics 4 (3), Seminar in educational mathematics 5 (3), Didactics of mathematics 2 (5), Options (4), Diploma seminars (11), Theory of machine systems 1 (3), Theory of machine systems 2 (3), Technical experiment 2 (5), Engineering didactics 2 (4), Pedagogical praxis 1 (1), Pedagogical praxis 2 (1), Diploma work (16), Physical training (1).

From the curriculum of the study programme it can be seen that the graduates may then become secondary school teachers of not only mathematics but also mechanics (statics, kinematics, dynamics, hydromechanics, thermomechanics, elasticity and resistance, computer science) and CAD. After obtaining sufficient practical experience they may also teach other engineering classes.

IV.

Another possibility how to attract the interest of students is to introduce other interdisciplinary study programmes. At present, there are a number of new curricula at the Technical University of Brno where the traditional engineering courses are complemented by courses in science, economy and arts.

In particular, at the Faculty of Mechanical Engineering, we have introduced, apart from the typically engineering courses, new interdisciplinary study programmes in Materials engineering, Mathematical engineering, Physical engineering, Applied mechanics,, Biomechanics, Mechatronics, Quality control, Industrial design and Manufacturing technology with industrial management. The students graduating in these courses find wide opportunities, they are highly adaptive to various changes in industries and in economy. We believe that the extension of offer will provide more opportunities for women and will increase their interest in studying at technical universities.

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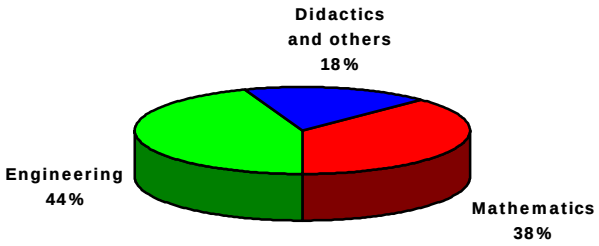

Fig. 4. Percentages of mathematical, engineering and didactics disciplines