

Experience of Implementation of Bologna Declaration in Engineering Branch in the Czech Republic (Including Teaching Measurement and Instrumentation)

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Abstract- New study programmes corresponding to Bologna declaration started in the Czech Republic in 2002 (bachelor study stage), but in electrical engineering generally in 2003. Therefore the first run of master study stage has finished this year. The common experience from the 3 runs of the bachelor study stage concerning engineering in the Czech Republic is presented in the first part of the paper. The second part deals with structure of measurement education in the Czech Republic after implementation of Bologna Declaration and problems pertinent to it.

I. Introduction

The majority of study programmes running in the Czech Republic were till 2002 long master programmes. However, there was a possibility to modify an individual student's study plan from the 5th semester to the 7th one, and to finish study after 3.5 years (in nominal) with bachelor degree. The novelisation of the Czech High Education Law (succeeding the Bologna declaration) supposed that the most of university study programmes (except medicine, pharmacology, law and pedagogy) should be structured into three strictly separated stages (bachelor, master, and doctoral).

The bachelor study stage takes 3 or 4 years in nominal, the master study stage usually 2 years and the doctoral study stage 3 or 4 years in nominal. While the doctoral study did not change, the main changes were expected in the undergraduate study. According to the Higher Education Act: "Bachelor's degree programmes are intended to provide the qualifications for practising a profession as well as for continuing to study in a Master's degree programme. Bachelor's degree programmes draw directly on current knowledge and methods while also including, to the degree required, theoretical knowledge." and "Master's degree programmes are intended to promote the acquisition of theoretical knowledge based on current scientific and scholarly knowledge, research and development and to lead students to apply this knowledge and develop their creative facilities." However, it was ignored in a part of cases and a long master study programme was only formally divided to two programmes (3-years bachelor succeeded by 2-years master) and no preemptory changes were achieved.

Concerning electrical engineering, the change of the whole structure of courses was achieved. The bachelor stage was short cut to 3 years in nominal and additional economical and social courses were inserted. It unfortunately led to the reduction of an extent of all courses [1]. Especially the amount of theoretical courses preceding technological courses rapidly decreased. Some of them are facultative or obligatory only for students wanting to continue in a master study programme. It required change the teaching method also in technological courses where it is necessary to skip some demanding theoretical parts.

The new conception leads also to changes in master stage - the additional courses of theoretical disciplines were inserted here to compensate a low theoretical background in bachelor stage. However, it brought a number of difficulties in practice.

II. Experience from 3 Runs of the Bachelor Study Stage in Engineering

55 long master study programmes concerning engineering were converted to 60 bachelor study programmes and 55 following short master programmes in the Czech Republic according to the report of the Council of Higher Education Institutions [2]. The main aim of preparation of new study plans was increasing the quality of bachelors with aspect to their assertion in practice together with improving the number of successful students, and to preserve the existing good level of master degree. However, this demand can be hardly fulfilled in practice, consequently different approach was applied in particular cases. The result is presented in Figure 1. The majority of bachelor programmes in engineering are oriented more practically while the others prefer theoretical background for master

study stage. About 15 % of programmes were prepared as universal - wider theoretical background supplemented by practical skills and several optional courses in the last year with a view to practising a profession or for continuing to study in a Master's degree programme. The rest arose by dividing of the first part of long master programme to two bachelor programmes – the first one is practically oriented and the second one brings in particular theoretical background for master stage.

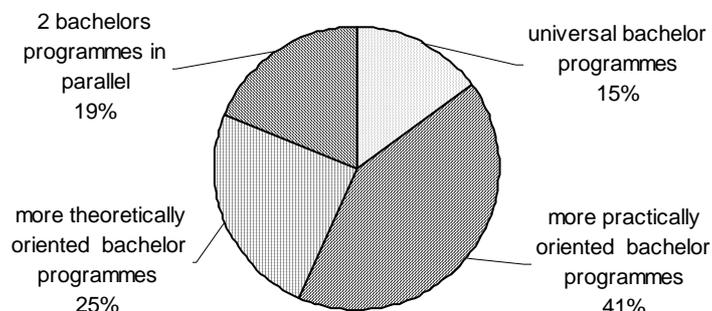


Figure 1. Orientation of new bachelors study programmes

The number of students who successfully finished bachelor study stage in engineering was about 40 - 45 % from commencing students (in contrast to about 55 % in average in other branches) in 2006 and 2007. It roughly corresponds to the situation after the 3rd year of the original long master programmes before conversion to the new structure of programmes. It seems that the idea of improving the number of successful students was not fulfilled for the present. The lower number of successful students in engineering in comparison with other branches is probably caused by low students' interest in engineering branches and a decreasing level of secondary education in natural sciences (mathematics, physics, chemistry). The structure of successful/unsuccesful students in engineering in the Czech Republic is presented in Figure 2 for the 3 runs of bachelor study stage.

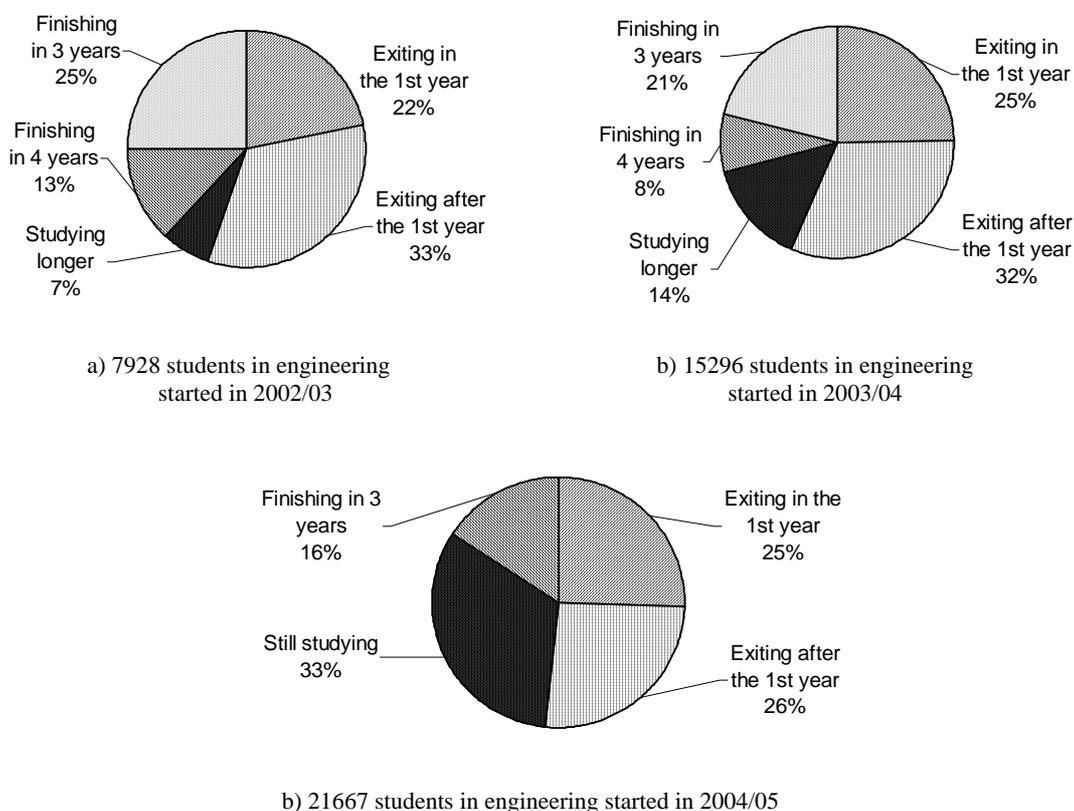


Figure 2. The structure of successful/unsuccesful students in engineering

III. Teaching Measurement and Instrumentation in the Czech Republic after Implementation of Bologna Declaration

A. Bachelor study stage

A basic course in electrical measurement and instrumentation is obligatory in all faculties, which deal with electrical engineering in the Czech Republic¹ (except branches concerning computer engineering, where a special courses are usually offered [3]). The course takes up to common courses as mathematics, physics, circuit theory, electronics etc. An every bachelor in electrical engineering who passed out this course should be able to choose a suitable method and suitable instrument(s) if confronted with a task of measuring an electrical quantity with prescribed accuracy and in given conditions (frequency range, disturbance etc.). The course is placed in the 3rd semester or in the 4th one. The extent of it is usually 2 hours of lectures plus 2 hours of laboratory exercises per week. The contents is sometime partly modified with a view to the branch, e.g. in the case of Electric Power Engineering the part concerning power measurement in a 3-phase power net is explained in detail while some other parts (e.g. concerning high frequency measurement) only in brief.

Principles of digital measuring instruments, basic knowledge of measuring systems and their programming, and measuring converters using operational amplifiers are also dealt with. This course is user-oriented and the teaching process is based on the way “the knowledge of principle” → “properties of instruments or methods” → “the area of their application”. Results of the latest technological achievements should be at least partially reflected in the basic course, because students will be confronted with them after completing their studies.

The deep education in measurement and instrumentation is usually realised in the branch of control engineering (*Cybernetics and Measurement, Automation and Measurement*, etc.). The structure of the courses concerning measurement and instrumentation is nearly the same at all faculties mentioned above. Courses (2 or 3) related to sensors and transducers, signal processing, and telemetry and data transmission are usually obligatory for all students of the branch. The optional courses (also usually 2 or 3) concerning measuring systems, circuits of measuring instruments, microcontrollers in instrumentation and the like are offered for students interested in measurement and instrumentation. The bachelor project of these students is usually focused on realisation and programming simple DAQ systems, signal processing, application of microcontrollers in measurement, special measuring circuit design and realisation etc.

The set of the study to practice or to continuation of study is solved by optional courses at CTU-FEE in Prague. Whilst the additional course in mathematics is essential for continuation in master stage (it can be also passed out in the first semester of master stage, of course), the students that presuppose to leave in practice choose usually some economy and management courses. However, about 80 % of students who successfully finished the bachelor programme continue in master stage.

B. Master study stage

Measurement and instrumentation in master level can be studied at 3 technical universities in the Czech Republic (Prague, Ostrava, Brno) as a specialisation in the branch control engineering. However, the structure of study programmes is different at individual faculties. Whilst common courses of the whole branch cover about 2/3 and courses of specialisation about 1/3 of all obligatory courses in Ostrava and Brno, this relation is 1:1 in Prague. Also the total number of obligatory courses is much smaller in Prague (4 common courses for the whole branch and 4 courses for specialisation) and larger number of optional courses is offered instead (about 6 for each specialisation).

The majority of courses take up and broaden knowledge from courses in bachelor study stage. Consequently, some problems arose in the case that a student has studied the other branch in bachelor stage. In this case, some selected courses from bachelor study stage have to be passed out during the first year of master study stage.

¹ CTU - Faculty of Electrical Engineering in Prague, ZCU - Faculty of Electrical Engineering in Pilsen, Brno TU - Faculty of Electrical Engineering and Communication in Brno, TU of Ostrava – Faculty of Electrical Engineering and Computer Science in Ostrava, TU of Liberec, Faculty of mechnonics

IV. Conclusions

A. Generally

Actual experience indicates that the main aims of implementation of Bologna declaration:

- to improve the quality of bachelors with the regards to their assertion in practice;
- to increase the number of successful students;
- to preserve the existing good level of master degree

were evidently not satisfied in education of engineering in the Czech Republic. Whiles the bachelors in informatics, economy or social sciences are finding a good placement in practice, about 80 % of graduates in bachelor stage in engineering want to continue in master stage. There are three types of problem that Czech technical universities indicate by application of new bachelors curricula.

1. *Assertion in practice*: There are technical high schools in the Czech Republic (the same as „Fachhochschule” in Germany), which educate technicians in the level good enough for the most of industrial firms. The bachelors with higher theoretical background have usually smaller practical background in comparison with graduates at technical high schools. Higher theoretical background can be an advantage for great enterprises with their own system of professional training, where practical skills are gained, but for employment in small firms it is a handicap.
2. *Continuing in master stage*: As far as the bachelor programme is focused on practical education, the theoretical background is usually not sufficient for continuing in master study stage. This can cause trouble for students, which graduate in such programme, because there is small space to pass out additional theoretical courses to gain sufficient theoretical background in the beginning of master stage without prolongation their study.
3. *Mobility*: Paradoxically, the splitting the 5-year study programme into two separate study stages (bachelor and master) complicates the international mobility of students. The former 5-year study programme allowed more easily modify study plans by a study stay abroad considering fulfilment of all study duties. Only the 2nd, 3rd or 4th semester of bachelor stage is suitable for a study stay abroad now (in relation to executing study duties before bachelor project in the 6th semester). The study stay abroad during the master stage leads often to a prolongation of the study.

B. Concerning education of measurement and instrumentation

The problems mentioned above are valid also in education of measurement and instrumentation, of course. In addition, according to our experience:

1. There is a small amount of time for a bachelor project in the last semester in the actual structure of bachelor programme in the branch *Cybernetics and Measurement* at CTU in Prague. Besides, some courses that can be useful for a bachelor project solution are running in the same semester in which the bachelors project should be solved (e.g. Signal and Image Processing). The changes in sequence of courses could partially help – all special (professional) courses concentrate in the 4th and the 5th semester, and in the last semester to insert (in parallel with the bachelor project) only one course (e.g. economical/social course or extended mathematics as preparation for master stage).
2. There is a handicap for students who entered in the master stage from another branch of electrical and electronics engineering and who pass out only the basic course of measurement and instrumentation. These students should pass out some additional courses (usually from the bachelor study stage) that are recommended them based on the results of entrance examination. It usually brings the prolongation of the time of study for a half year.

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