Combining biomedical engineering tuition with ecological aspects

Jiri Jan
Biomedical Engineering Department, Faculty of Electrical Eng. and Communication, Brno University of Technology, Czech Republic, email: jan@feec.vutbr.cz

Abstract **- The BME Department at Brno University of Technology has one of the longest traditions in teaching of biomedical engineering (since 1967). A substantial change in the attitude to the teaching process appeared in 1989 when the concept of the biomedical engineering has been adopted as a solid technological tuition with a good deal of mathematics, biophysics, electronics and informatics plus some extras concerning primarily the ability of communicating with the medical staff. About 4 years ago, a new reformation of the study scheme has been started, effectively replacing the 5-year curriculum by the two-stage study (Bc+MSc). In this frame, a new MSc two-year study branch has been established encompassing not only biomedical technological concepts but also concepts used in ecological measurement and screening. In the paper, details are given on the concept and content of this MSc study; the individual courses and grouping of them will be described and expected possibilities of the graduates evaluated.**

Index Terms – Biomedical engineering, MSc curriculum, environment protection, ecology.

INTRODUCTION

The history of the biomedical engineering teaching at the Brno University of Technology goes long back to the sixties – the Department of medical electronics, as the first BME institutional university establishment in the former Czechoslovakia, was established in 1967 under the guidance of Professor Vratislav Vrana. At that time, the teaching was primarily oriented towards electronic medical instrumentation, at the sensor and circuit level, and was specialized rather narrowly to this area. This form of study remained without substantial changes for over twenty years.

After the political changes in 1989, the study system has been reformed generally at the BUT's Faculty of electrical engineering, and this influenced also the form of the biomedical engineering study branch. Primarily, the study was reformed in order to aim more towards flexibility that was considered, at that time, more important than the narrow specialization. In consequence of that, also the Department concept has been reformed to a wider scope, and correspondingly, it changed its name to the Institute of Biomedical Engineering (BME). The tuition of BME, in the then standard five years MSc (Ing) curriculum, was performed in frame of two rather general branches of study: either in Electronics and Telecommunication, or under Automatic Control.

The basic idea established then was (and still is, even in the changed environment) to produce high quality master-degree electronic engineers with the generic enough education enabling them to cope with the changing labour market. The interdisciplinary biomedical engineering education, as a kind of extra bonus, was formed both by specialized subjects concerning the medical technical equipment, complemented by a system of biomedical courses, providing the ability to communicate well with the medical staff. However, the already well established and consistent study system had to be reformed shortly again when the two-stage study system (BSc – MSc) was introduced based on the European concept of the sc. Bologna declaration. The new two-stage system, reflecting the needs of both the new regulations and the modern concepts of BME study, is the subject of the core of the contribution.

CONCEPT OF THE STUDY PROGRAMME

When conceiving the new curriculum of the BME education concept that had to fit into two years of the master-degree study, the preceding three-year bachelor programme had to be taken into account. Many ideas of the BME study under the previous five-years study system and the experiences with it have been taken over, primarily the idea that BME tuition should not be oriented narrowly towards only the jobs in area but that it should provide generic enough education to enable also other employment in the wide area of electronics, measuring, automation and applied informatics. This way, we are able to accept the relatively high amounts of students who show a clear interest in the BME study without exposing them to the danger of becoming unemployed when the medical and health-care area job offer is just not sufficient (which is still the case at least in central Europe). On the other hand, we believe that the necessary highly specialised skills particular to a concrete BME job (or any other job in electronics) can be acquired more easily when the graduates have a good generic technical background than with a too specialised but not exactly matching knowledge.

What is completely new in the present curriculum is the extension of the standard BME curriculum by the area of the instrumentation used in ecology. This possibly surprising connection comes from two ideas: first, much of the instrumentation used for medical and ecological diagnostics are technically close to each other and therefore the principles can be taught in frame of the same subjects. Second, concerning the interdisciplinarity of BME, it is quite similar to that of ecological applications of technology, at least as far as the measurement field concerns: similarly as in BME, the ecological applications also require not only the good technical knowledge but also at least a basic knowledge of the ecological (or environmentalistic) concepts and terms. This is the reason for quite a parallel way of studying both biomedical and environmentalist concepts from both the human science and technological aspects (although the ecology has to be relatively limited due to time reasons). We believe that this combination is sound and needed, considering the future demands on both the health-care and environment-protection application areas. It seems also that the possibility to study some ecologically oriented problems attracts a part of students who – still thinking primarily technically – generally seem to recognise gradually the need of environmental care.

The details of the present biomedical/ecological engineering (BEE) curriculum can be seen in the table I. The subjects offered can be generally subdivided into two groups: primarily the technically oriented group providing both the generic technical knowledge from the area of electronics, measurement and applied informatics and also the specialised knowledge on biomedical and ecological instrumentation, e.g. imaging systems, diagnostic analytic equipment, therapeutic technology, etc. The names of the courses are hopefully sufficiently self descriptive. It can be seen that the technical subjects are generic enough to provide the qualification not only for just the medical or ecological applications but in the mentioned wider field as well. It does not mean that there is not enough specialised knowledge taught in subjects and specialised BEE projects but we believe that the generic knowledge needs anyway a concrete application to be acquired properly and concentrating the detailed explanation or project work to BEE area enables this without excluding the more generic orientation of the graduates.

TABLE I

OVERVIEW OF THE MAIN COURSES AND THEIR TYPES

First year of study (typically)	Biomedical courses	Biophysics	Biology of man (basic anatomy and physiology)			
	Engineering view of biosystems	Bionics	Modelling of biological systems			
	Specialised BME engineering courses	Analysis of signals and images	Advanced methods of signal processing	Multirate systems in DSP	Diagnostics of bio- and eco-systems	Classical imaging systems in medicine and ecology
	Humanitarian aspects of ecology	Elements of environmental studies				
	Technologist view of ecology	Ecological engineering				
	Other courses	Modern physics	Modelling and identification	Electronic circuit theory		
	Semester project					

Second year of study (typically)	Biomedical courses	Clinical physiology	Health-care and medical ethics			
	Specialised BME engineering courses	Special medical (therapeutic) and ecological technology	Tomographic imaging systems	Design and management of complex systems		
	Applied informatics courses	Computer aided medical diagnostics	Analysis and interpretation of biological data	Hospital and health-care information systems	Ecological information systems	Modern numerical methods
	Other courses	Statistics and operational research	Signal processors	Structure and properties of biomaterials	Intelligent and semicon-ductor sensors	Computer and communica tion networks
	Practical BME training					
	Diploma project					

As it can be seen, important weight is put on the area of signal and image processing and analysis that seems to form a substantial part of both biomedical and ecological engineering at present, and probably even in future (examples of the used text books provided inside the Dept. of BME [3], [4]).

The second, smaller but not unimportant group is formed by the subjects devoted to the interdisciplinary areas of both biomedical and ecological natures. Here, you can find two basically different approaches, represented by individual courses, as indicated in the table. The first group are subjects presented by medical and clinical experts, a biophysicist, and a group of non-technically (biologically, sociologically, historically etc.) oriented environmentalists. The aim of these subjects is to expose the students to possibly all the differences that might be at first shocking for a technical novice in the medical or environmental institution: besides the new knowledge also the different language and terminology, and primarily the different ways of thinking that a technologist should learn before entering such an institution. All these subjects are taught by external recognised medical or ecological experts, hired part-time by the Institute; it is cannon of the Institute not to allow technologically oriented teachers to interfere with this tuition. The technically (or physically, system-theory based) subjects devoted to basically the same problems but presented by technologists are included in the curriculum as well, as seen from the Table I. The comparison (or even clash) of both approaches is a very important feature of the Institute concept of teaching the BE engineering; we believe that this is the proper way of learning to communicate efficiently with the experts “behind the borders” (of the expert areas).

CONCLUSIONS

The contribution describes the new combination of biomedical engineering, forming the basis of the study, with the ecologically oriented (smaller) part of the two-year MSc curriculum. Such a combined programme has been formed in frame of the newly introduced Bologna-declaration-conforming two-stage (BSc-MSc) form of study. Presently, the first batch of students is just finishing their first year of the MSc study; thus, the experience with the programme is up to now limited. However, the first experimental year has so far lead to a very positive response from the students of the BEE branch, which is obviously also reflected in the surprisingly increased demand for the new BEE study among the just graduating BSc students.

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