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Increasing the Attractiveness of Engineering Education in the Area of Electronic Communications

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Introduction

The concept of engineering education has been developing for decades, giving the system a stable form, employing traditional elements, i.e. lectures, seminars and laboratory exercises. Such approach was satisfactory when auditoriums and textbooks were the only communication channels between lecturers and their students and the speed of technological development allowed the professionals to keep pace with recent news in a relatively wide area.

Computers and especially communication networks have brought a revolution into the society, introducing new possibilities that influence the educational activities in terms of their content as well as their form. The social changes come hand in hand with technological innovation, and both of them interact with the economy. The world will never be the same; we are facing new problems, but still there are some old questions: What is the purpose of engineering education? What is the mission of teachers? And what really makes sense in the perspective of the coming years?

Let's have a look on the current situation, most important factors that have to be taken into account when designing the courses, and also values and trends that influence the attractiveness of engineering education.

Current Situation

The current world has been enjoying the illusion of relative stability since the 90's. However, when we think about some recent events for a while, we can see how fragile this illusion is. In fact, radical changes influencing the whole society may come within days or even hours.

The geopolitical situation, as well as global economy, reacts to many details that are sometimes difficult to predict. One of the examples is the economical recession and its current consequences for the Euro zone, and in fact the entire EU – but in the near future we could face much more serious challenges with direct impact on security and even the existence of Europe in the present form.

It is evident that the changed conditions imply changed priorities of the economical system, which also means that the education of future experts has to be adapted in an appropriate way. Let's come back to the question what the purpose of engineering education is.

Considerations

Each historical era has its specific needs. With respect to the fast development that is characteristic for the new millennium we have to see into the future and estimate what our students should be prepared for. It is not our goal to teach them to master technologies of yesterday or today, but of the future – i.e. something that perhaps does not exist yet. Of course they have to learn about the historical development of technology and about modern devices and systems, but their knowledge cannot freeze in 2010; their main advantage will be if they are able to adapt their skills continuously, according to the current needs.

Strategic EU documents perceive education and lifelong learning from the viewpoint of employment and development of human resources. We can take into consideration for example [1] and [2]. On the national level, attention should be paid to governmental documents concerning continuous education, as well as education in general, such as [3].

However, it is not only technical knowledge what our future graduates should acquire, but also the common values that are shared by our society, although it is increasingly difficult to identify them. Moral relativism and the shifted meaning of "political correctness" can easily atomize our civilization in very near time horizon. Without a firm foundation, i.e. answering the basic questions of our identity and role, the knowledge itself does not have the proper sense, and it may become even dangerous. The society needs experts who will be aware of their responsibilities and contribute to its development, not to its sneaking destruction from inside.

Values and Trends

Technical universities are today in a difficult position. The main purpose of higher education institutions is undoubtedly to educate and train young people who should become the leading force of the society. National systems of providing financial support to universities may slightly differ, but still the fundamental condition is quite simple – enough students.

It is a common trend that the percentage of people with university degree is increasing, mainly in the central and Eastern Europe where their number used to be smaller compared to the West in the past (due to politically motivated regulations). Nevertheless, the absolute number of young people in the typical age for entering university is currently decreasing, and this situation will last for several more years. There is also less demand for studies in technical disciplines that are perceived as more demanding than humanities, natural sciences, arts etc. Last but not least, the prospective students are distributed among an increasing number of higher education institutions as there have emerged plenty of private universities and other alternatives to the traditional system. These reasons force us to think even more thoroughly about actual needs and preferences of our students.

So, what are the interests of people between 18 and 24 years, what are their priorities and values, and what can be most attractive for them? We are afraid that their attitudes are deformed in many aspects, which is caused by the contemporary consumption-oriented "culture" or lifestyle that prefers instant, zero-effort solutions (this is also probably the reason why there are so many affairs around compilations that often replace original students' work). On the other hand, we can hardly blame the children for the current situation that we can observe in media and that is projected into the whole society (too much information offered in a clip-like arrangement, many different activities available, and the resulting scattered attention). Students are often under pressure as they have to look for part-time (or even full-time) employment during their studies in order to make money for living (which is much more visible in the time of recession). And we also have to admit that when they get really interested in something, they can really go for it – so we have to accept this, and our goal should be to win their attention and interest.

Again, our answer to this challenge should be basically twofold: attractive content provided in an attractive form. In other words, we should think about innovated subjects and the whole curricula, and a flexible study system that offers more freedom, respecting the students' time possibilities.

Unlike some other countries (e.g. France), students in our area are not obliged to pass an internship period; however, direct contact with the industry and the practical experience are certainly very important for understanding how things really works as well as for the future professional career. This can be, to a certain extent, substituted by the part-time (or even full-time) employment mentioned above, but not all students are involved. We are convinced that a renewal of this practice, i.e. several weeks spent in an industrial company and participating in a real project, would greatly improve student's attitudes and abilities and introduce new impulses for their individual work as well as for research activities. Unfortunately there are only few opportunities for this type of cooperation in the Czech Republic today, and most companies are not interested (in fact, in many cases they explicitly refuse to invite students who represent a burden for their routine operations or even a direct threat for their know-how). Probably there could be a way in arranging such cooperation with the industry on an international basis, possibly together with partner universities abroad that already have the relevant contacts established.

Modern Forms of Education

Sustainable development of educational activities requires invention also in the various forms that accommodate actual students' needs. We have to realize that in our target group in the "battle for students" there are not only fresh graduates of secondary schools, but also professionals who need to get a degree – they usually study in a combined or distance form, their time is precious and their schedules tight. Also the level of knowledge is highly individual, and the ideal system would offer individual approach and pace to every student. Other aspects to be taken into consideration include the current state of the technology and society, and also the capabilities of the individual teachers (i.e. their specialist subjects, schedule, other activities – such as research projects, etc.).

Probably we can stress that students are satisfied when they can choose the time for study – this is the element of attractiveness that supports introduction modern and alternative education forms, such as e-learning, distance learning, blended learning, remote and virtual laboratories, etc. However, the experience shows (and students also realize it themselves) that there must exist some minimum requirements and some reasonable control – otherwise the students (although they are adult people) could be in danger that other activities would consume all of their time.

One more note should be made on languages. It is more than advisable to offer the subjects (preferably all of them) in local language and in a foreign one (which is usually English in Europe today). This is not only a necessary condition for invitation of foreign students to fully accredited study programs, but also a great advantage for local students who are preparing for their professional career in an international company.

Examples of Practical Exercises

In the following paragraphs we are going to briefly describe several laboratory exercises as an illustration of modern topics that are both attractive and useful. All of them focus on some specific area of electronic communications and they are regularly updated in accord with the current technology development.

Digital Television Standards. The exercise is primarily focused on DVB-T system, the implementation of which is currently underway in many European countries including the Czech Republic. The workplace is

equipped with different receivers that allow comparing of signal reception in different places and conditions.

Another technology considered in this exercise is DVB-C, which is introduced using a TV set with integrated CATV receiver. DVB-S, on the other hand, has slightly different context and it is included in the exercise dealing with satellite systems.

As for the DVB-H standard, its future use is questionable as it does not offer much added value (if any) compared to DVB-T (portable DVB-T receivers are becoming quite common), the broadcast of which is free; moreover, it is not possible to analyze the input signal easily due to the integration of the receiver with a mobile phone. It would also be a problem to pay the service fees from the operating budget. Therefore, DVB-H is not included in these exercises.

We must not forget about IPTV that also serves for distribution of digital television. The exercise consists in analysis of captured data packets during operation (see illustration in Fig. 1).

Fig. 1. Analysis of IP-based multimedia services

Data Transmission in Mobile Networks. Ubiquitous networking is becoming everyday reality and mobile data transmission has taken over the role that formerly belonged to dialup connections. Therefore it is more than desirable that students of engineering can experience direct contact with different systems that are not very common in personal use (unlike standard mobile phones) and get prepared for their practical applications.

Students establish data connection and transfer files using various mobile technologies – i.e. HSCSD, GPRS, E-GPRS (EDGE), CDMA and HSDPA / UMTS – in networks of different operators and evaluate the characteristics for both directions of transmission (e.g. effective transmission speed or delay). The variety of devices and technologies is continuously increasing (see Fig. 2).

Data Transmission over Power Lines. There are two abbreviations – PLC (PowerLine Communication) and BPL (Broadband PowerLine) – that represent future of networking for homes and small offices, without the need to build specialized data cabling or to use wireless transmission. BPL is becoming increasingly popular – it is enough to plug the modems into electric outlets, connect them to the computers, and we can enjoy the effective speed of hundreds of megabits per second.

Students can setup the system and its parameters, and also analyze the data signal in time and frequency domains. Then they can evaluate the behaviour of multimedia services (such as VoIP or IP videotelephony) in different configurations using subjective tests and objective measurements.

Fig. 2. Devices for data transmission in mobile networks

Satellite Services. Sometimes we do not realize that satellite services are all around us, because satellites themselves are invisible to us, but still many people use satellite television, navigation systems or telephones. The laboratory exercise deals with TV signal reception and GPS data evaluation.

Due to frequency limitation of the available equipment it is possible to analyze the DVB-S signal only between LNB converter and the receiver in different situations (e.g. antenna positioning). Various functions and services can be demonstrated.

In the second part of this exercise students analyze NMEA messages provided by a receiver within NAVSTAR GPS system using computer software. Other tasks include measurement of absolute and relative geographical position (horizontal and vertical), examination of screening and shielding and their influence of the accuracy of measurements.

Modern Coding Methods. Besides the practical exercises described above, the main purpose of which is to offer “first contact” introduction and basic hands-on experience, there must be also some more sophisticated ones that go deeper in the theory and combine computations and simulations with real experiments. One of them focuses on modern coding methods, combining MATLAB work (that explains theoretical principles) with measurements (i.e. practical confirmation of the theoretical conclusions).

An outstanding tool for this type of experiments is TIMS (Telecommunications Instruction Modelling System) consisting of many plug-in modules with different functions (both analogue and digital), which is optimized for education in telecommunication engineering (see Fig. 3). It allows elementary experiments as well as sophisticated measurements (also for the purposes of diploma theses). Its use is very straightforward and illustrative, and students usually appreciate that they can see the principles working, without the need of putting

many different devices together, and they can make many experiments during a single lesson.

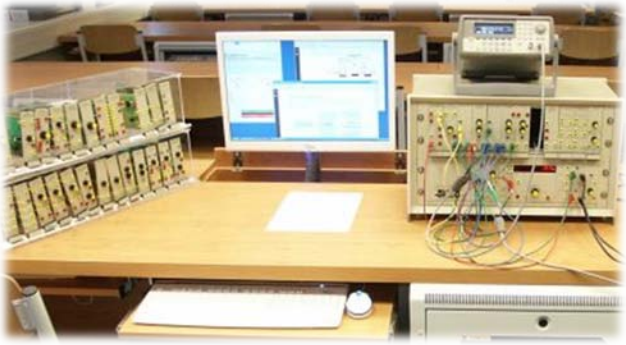

Fig. 3. TIMS modelling system

Conclusions

Modern engineering education must follow the current trends and needs – that may change very quickly – in terms of its form and content. It seems rational not to develop extensive and expensive solutions that should last for ages, but rather to build flexible systems that allow smooth adaptation to a new situation, whatever it is. Balanced combination of available educational techniques and approaches seems to be the right way. But still it is the teacher's personality what makes the difference and brings the real motivation.

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Engineering education is not an isolated "ivory tower" that could remain unchanged for years – it has to reflect changes in society and technology, to which it is linked tightly. The question is what innovative topics should be introduced to students and how the education process should be made more attractive. This is even more important in a situation when we can observe decreasing interest in technical sciences and inclination towards humanities. The purpose of this paper is to analyze the current situation in the specific conditions of European technical universities, particularly in the area of electronic communications, to predict the development in several coming years, and to propose suitable approaches in terms of specific topics and methods. Ill. 3, bibl. 3 (in English; abstracts in English, Russian and Lithuanian).

Уа. Храд, Т. Земан. Повышение интереса к изучению программ электроники // Электроника и электротехника. – Каунас: Технология, 2010. – № 6(102). – С. 79–82.

Указывается, что сегодня значительно уменьшился интерес студентов к изучению технологических наук. Для повышения интереса необходимо более интенсивно читать иновативные темы во всех курсах и в каждом модуле в отдельности. На основе опыта технологических университетов мира предлагается разработать проблематику научных исследований и способы их решения. Ил. 3, библ. 3 (на английском языке; рефераты на английском, русском и литовском яз.).

J. Hrad, T. Zeman. Inžinerinės mokslo krypties patrauklumo didinimas elektronikos ryšių srityje // Elektronika ir elektrotechnika. – Kaunas: Technologija, 2010. – Nr. 6(102). – P. 79–82.

Inžinerinis mokymas neturi būti izoliuotas, nesikeičiantis daug metų. Jis turi atspindėti visuomenės ir technologijų pokyčius, su kuriais yra glaudžiai susijęs. Svarbu teikti studentams inovatyvias temas ir taip didinti mokymo proceso patrauklumą. Tai tampa dar aktualiau, kai mažėja domėjimasis technologinėmis studijomis, palyginti su humanitariniais mokslais. Būtina išanalizuoti dabartines sąlygas Europos technologiniuose universitetuose, numatyti keleto ateinančių metų plėtros kryptį ir pasiūlyti tinkamų sprendimų. Il. 3, bibl. 3 (anglų kalba; santraukos anglų, rusų ir lietuvių k.).