Innovation and Creativity in Electric Engineering Education – In the Past and Today

[1]Edita Hejatkova, [2]Boleslav Psota, [3]Ivan Szendiuch

Brno University of Technology, FEEC, Department of Microelectronics, Údolní 53, Brno 602 00, Czech Republic, E-mail: hejatka@feec.vutbr.cz[1], xpsota03@stud.feec.vutbr.cz[2], szend@feec.vutbr.cz[3]

Abstract

This paper deals with innovation processes that should be implemented in all branches of the electric engineering education program to improve the quality of educational process and contemporaneously also school leavers. For successful application it is necessary to associate the educational process with business aspects. This relevant factor can be achieved by the right choice of study prospectus that gives a student concrete possibility for decision about technical orientation. Withal cohesion of University with industrial subjects makes fundamental part for successful output. The next important activity is to establish some control system for evaluation of single subjects. Some reasons, as the impact of technology integration, and some concrete activities are described in this paper.

1. Introduction

Three quarter of the Century ago was complete theory of electric engineering comprehensive in a couple of books. One half of the Century ago started era of semiconductor chips that got beyond in electronic revolution. This development continues according to the spirit of Moor's law, which was spooked by Gordon Moore in year 1965. That brought strong progress in industry and especially in electric/electronic sectors where semiconductor chips are used (microelectronics, telecommunications, car industry, consumer electronics and also rise of plenty new branches with many specializations, as for example cosmonautics, informatics, biotechnology etc. Today is sector of electric engineering so extensive that almost any who is involved in this sector can introduce in education program some new subject. But there is question which is the contribution and practical output of that subject for science and praxis.

Today there are innumerous subjects worldwide, and also great deal of subjects in each University. Generally subjects can be divided into three categories:

- basic (main modules, fundaments for each single branch),
- special (secondary modules, skilled on one technical sphere),
- multifunctional (tertiary modules, are interconnected with other branches).

Basic subjects have to fit onto University focus and they are obligatory. Special subjects are accordant with specialization of the faculty and there is obligatory to choice some of them. Third category – multifunctional subjects are usually not compulsory and are related to other specialization.

This last batch of subjects needs to be composing on the basis of local request regarding national and international directives and laws concerning technical and environmental problems of the life etc. But time is changing and there is paradox the increasing level of living asks increasing saving of cost. And electric sector is very important from this standpoint because electronics is ubiquitous. All the people keep in touch with electric and electronic devices and equipments.

That is reality the electronics industry is a major component of the world economy, where energy and material consumption make significant part of world usage. For example, home and office appliances consume more than 25% of final electricity use, and domestic lighting is responsible for 17% of all residential energy use, with a high proportion of this energy going on wasted heat rather than light generation. When an electronic product is placed on sale it is likely that it has been made from a variety of globally sourced and manufactured parts, which perhaps have already travelled several times around the world. The complexity of electrical and electronic devices has heterogeneous character which means they contain a large variety of materials, some specific to electronics, some known as hazardous for humans and the environment. All these are reasons, why the electronics industry has in our daily life an important role to play, especially when environmental protection is spooked.

In Fig. 1 is shown development in personal informatics devices in the last five years, where after PC run very quick innovation through PDA, UMPC, to MID. In so doing, all run according to the spirit of smaller, better, cheaper and fast time to market.

Fig. 1: Development in personal informatics

2. General Impact of Technology Integration

That's fact electronic technology today makes an important part of electrical engineering and electrical engineering makes very important part of the general engineering education. The reason is simple; the electronics is ubiquitous and electronics technology has changed completely its significance. Electronic components, circuits and systems are all the time smaller but more complex and sophisticated. There are other requests on reliability, life cycle time, environmental impact, but also on low price. This development asks foremost strong progress in two fundamental areas which are:

- materials
- processes

Both, materials and processes are based on fundamentals of chemistry and physics, and while development of new materials asks prime research after parameter request, processes are based on the improvement and innovation of the output knowledge for concrete application. This situation is inherent in the notion of “Technology Integration”.

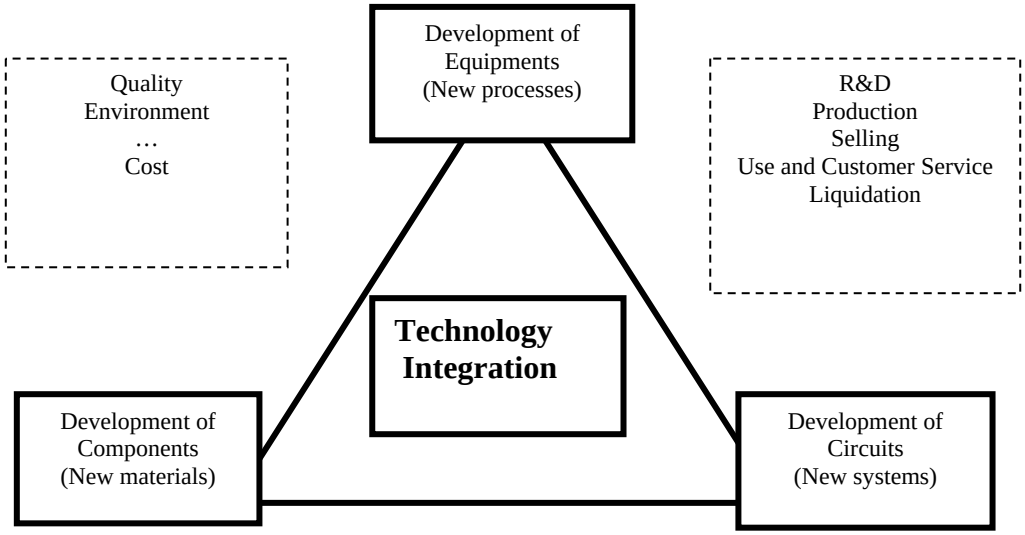

Fig. 2: Term “Technology Integration**”**

This situation is more detailed shown in Fig. 2. If we look at this picture, we can imagine that all three main sectors that mean materials, processes and systems are more and more bind together as integration continues to smaller dimensions. That indicates contents of electronics technology curriculum that has to teach majors the basic skills needed to design, produce, operate, maintain, install, repair and dispose of electrical and electronic equipments.

This fact is engaged in increasing importance of the basic knowledge of selected subject matter, because this impact is always stronger not only on production and on equipments, but on design, processes as well on their usage and handling including liquidation too. That means fundamentals of electrical engineering are necessary not only for electric engineering branches but in some helpful standard for all.

3. The Cohesion of University with Praxis

The real ability of new graduated young scientist is scalable only on the basis of capability to the incorporation in research engaged to practical output, which mean projects leading to final product that has to be someway introduced in the production process or directly in the market. That is considerable reason for the establishing of collaboration between University and production subject. The establishing of optimal collaboration between industry and research sector must be pushed from the University (research staff), as well as from independent research and production institutions closed to a particular industry branch. The basic principle of the system approach is shown in Fig. 3.

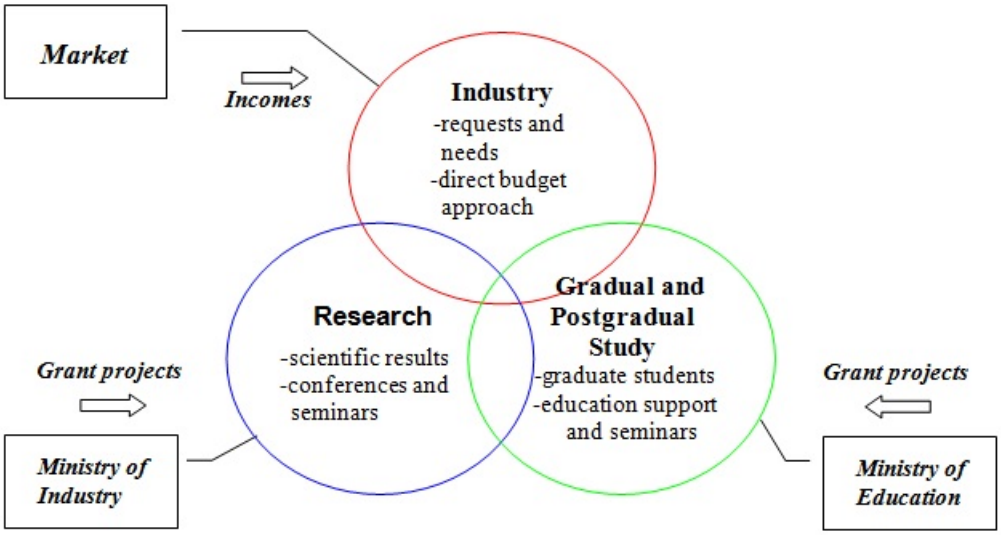

Fig. 3: General system for achieving of progress in education

Research activities at the Faculty of Electrical Engineering and Communication (FEEC) in Brno University of Technology are funded from national grant projects as well from EU projects. Progression of Research and development funds is shown in Fig. 4 in the last five years.

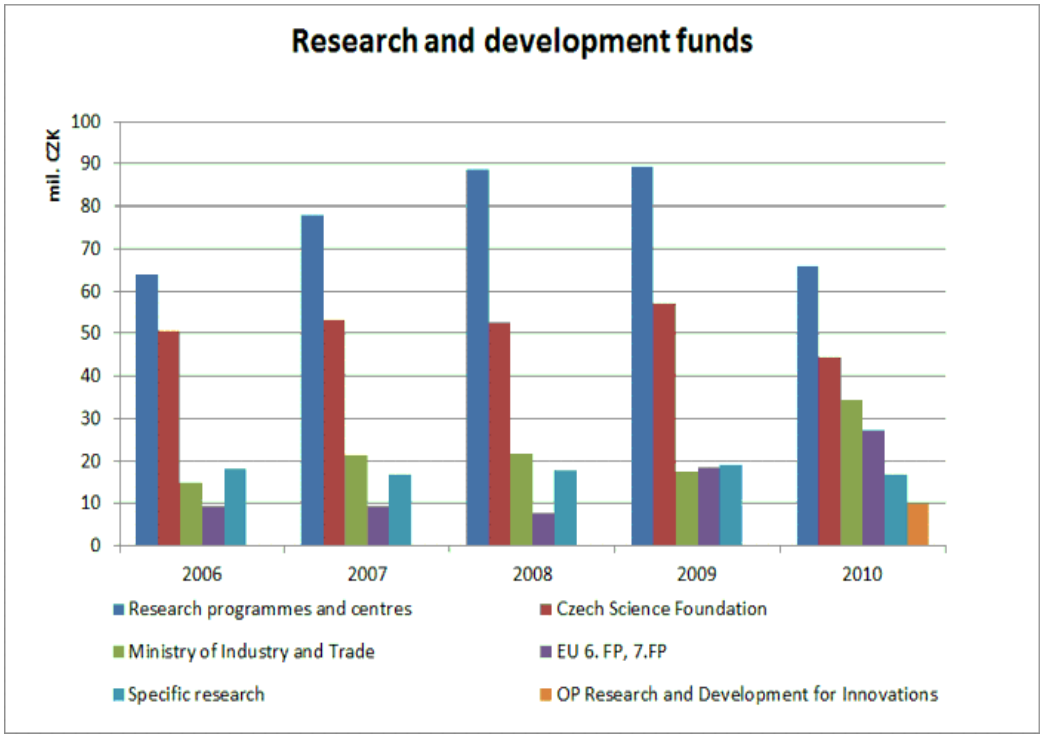

Fig. 4: Research and development funds

4. Quality implementation in the educational system

Quality and cost form inseparable part of each technical solution that tackles with the technological performance of electrical circuit, equipment or system. This fact has to be taking into account by draw up educational program as well. The supporting of the education with data from praxis is very efficient solution. The educational process is composed as any other processes from single steps, which could be improved based on the principle of a common quality system. The quality management has to be put into practice as part of University teaching program. That requires what is necessary to work with information in full range. The input information is not only internal (from education of students) but also external (industry request, geographical factor, etc.). That means the methods of process modeling and their optimization are taking an overgrowing role increasingly. Students as well as the industrial sector must import input data for this system.

Implementation of Quality Degree in the form of accreditation is an important step in the educational system - equivalent to the ISO standards. It is based on the description of an educational program and services by attaching credits to its components. The definition of credits might to be realized on different parameters, such as student workload, learning outcomes etc., include selected company information. It must lead to controlling and improvement of all activities, which affect the student education and forming his profile. Quality management in the educational system has to be to aim at following areas:

- Education system and its methods,
- Data gather, process and utilizing, communication with students and facilities,
- Transparent and efficient structure of all facilities.

This situation is designed in the widest context in Figure 5. The significant factors are indicated to reach good and powerful results.

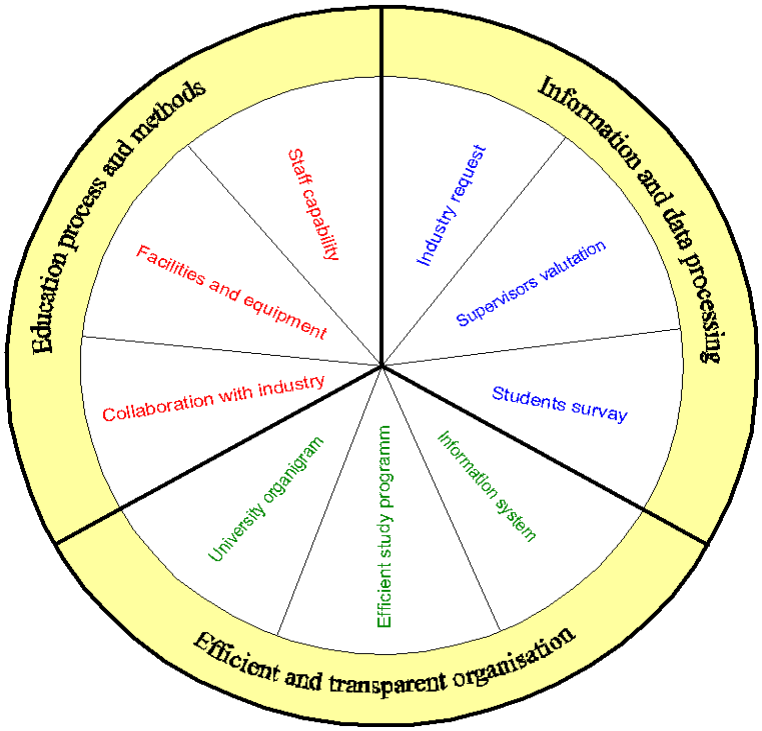

Fig. 5: Main parts of Quality Management system in the educational process

One of the fundamental steps in general quality management approach is to eliminate possible error occurrence. Which errors can come out in the educational process? It is difficult to find evident and distinct results valuation because mostly part of it depends on human factor. The products of University are students; also each staff member of University must be educated for quality system analogous to factory workers. The evaluation system in University must be an inseparable part of a quality system.

To have serious input information we need to take data from an inquiry or some other true sources. A survey has to be done both, in industry and in wide range of different categories of students, which means in the first semester as well as in the last one. It is clear if we want to have serious information we need to have some independent department able to assemble and to work up them. This department should be responsible also for teachers' education, which means it is necessary educate only students but teachers too.

5. Conclusion

Microelectronics Technology is today one of the fundamental areas of Electrical Engineering and as well Information Technology. There must be accomplished education system to assure groundwork for marketable products, which means products lower in cost and higher in quality. To push the growth in this area it is necessary systematically educate and train widest human resources and also to involve consecutively new topics. As example can be mentioned topics "Eco-design and environment" or "ANSYS for practical use in electronics". Because the ability to apply these knowledge in the practical life bears cost saving and environment protection, basic knowledge must be known not only for students of electric engineering but also in the modified form for engineers of other branches. Reason is simple: the impact of technology (not only electrical, but also mechanical, edificial, chemical and others) on quality and cost and currently on environment and human health are ever stronger and in the near future necessary to ensure the world. As the waste pollution from mining, steel manufacturing, and energy production with coal was significant in the 19th Century, emission gases from automobiles, air conditioners, oil burning, water consumption and pollution in the 20th Century. Now the electronic industry is becoming to be a main source of environmental pollution in the 21st Century. Fortunately there are activities that serve for reduction and control of this impact through directives (RoHS, WEEE, EuP) and registration process (REACH).

The paper results a sum of both theoretical and practical experience in the microelectronics technology area obtained during last twenty years in the education sector as well as in research and management activities in praxis. An overview of some basic principles in innovated education system of microelectronics technology at Brno University of Technology, with emphasis on development in interconnection and packaging area, is in development. Moreover, there is a fact that a significant part of students who passed this study specialization at Brno University of Technology continues their study abroad and/or works worldwide.

6. Acknowledgements

Funding for this research was obtained through grant project from the Czech Ministry of Education (MSM 0021630503 MIKROSYN „New Trends in Microelectronic Systems and Nanotechnologies") and the Grant project MSMT FRVS 250/2011 "Innovation of Microelectronics Education Process by Introduction of HIC´s in the Lab Curriculum" and FEKT-S-11-5 "Research of excellent technologies for 3D packaging and interconnection".

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