

# Multidisciplinary Aspects in Micro(Nano)electronics Technology Education

Ivan Szendiuch and Cyril Vasko

Brno University of Technology, Faculty of Electrical Engineering and Communication  
Department of Microelectronics, CZ- 602 00 Brno, Udolní 53, e-mail: [szend@feec.vutbr.cz](mailto:szend@feec.vutbr.cz)

*Abstract: This paper shows basic structure of course "Micro(Nano)electronics Technology for Engineers" that is offered from Microelectronics Department in Faculty of Electrical Engineering and Communication in Brno University of Technology to other faculties. Purpose is to involve basic practical knowledge that is important for decisions about electrical equipments purchase, handling and liquidation in the sub consciousness of each engineer that usually must do many decisions and orders during his pursuit. The fundamentals of electrical engineering are important for all engineering education branches, especially for mechanical, and all that concerns management areas. Reason is to build some principal relation with an at least expert approach and to support decreasing of the impact of today's electronics on environment.*

*Index terms* - education, interdisciplinary education, microelectronics, technology integration

## Introduction

Micro(nano)electronics technology, which is important part of the electrical engineering science, becomes highly interdisciplinary area. Of course the electrical engineering makes base for microelectronics technology education, but there are comprised many formerly independent areas in this subject, as material engineering, system engineering, computer practical, thermal management, process management, quality management etc. This fact is closed to the increasing importance of the technological integration, where its impact is always stronger not only on production and on equipments, but on design, processes as well on their use, and handling including liquidation too. That means fundamentals of electrical engineering are important for all engineering education branches, especially for mechanical, and all that concerns management areas. Reason is to build some principal relation with an at least expert approach and to support decreasing of the impact of today's electronics on environment.

This course has a general validity due to increasing effect of electronics technology on ambient and environment (PC, mobile phones, TV sets, various types of recorders, cameras, players etc.). The project took all of the course material and generated a series of computer based lecture notes

that would be modular in format. This way other instructors could select and download portions of the modules. The modules would be made available on a CD-ROM. Each module unit would be designed to stand-alone so that the audience would be able to learn only one topic of their choice.

## Significance of the micro(nano) electronics study

Today all engineers and technicians independent from their branch and specialization have in their professional activities some relation with electrical equipments and systems. Moreover, this contact is every day deeper because electronics became unambiguous and irreplaceable. Issue of this fact is all the time stronger impressive technological integration. The term technological integration means the electronic systems smaller but more sophisticated and more complex.

To achieve the optimal results by introduction of new and modern electronic products in the market asks development and production process practiced in the strong collaboration with other "non-electrical" sectors. The electronics sector is an ever more linked with other branches of engineering because the production of all the time smaller but more sophisticated products is very complicated. There are many processes using and working materials, which causes many variables. In addition, request of new materials and principles is inseparable part of electronics systems design and production stage, which asks participation of specialists from chemistry, mechanical engineering and other branches.

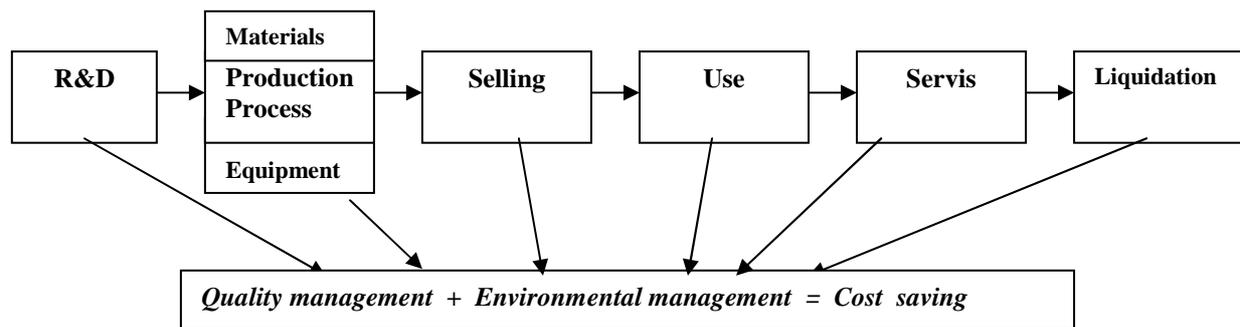


FIGURE 1

: DEMONSTRATION OF SIGNIFICANCE OF THE TERM "TECHNOLOGICAL INTEGRATION"

There is important moment how to involve this interdisciplinary matter in research area. To find the optimal solution and to reach successful results there is necessary to put together as well knowledge as research equipment from all these science areas, which concern modern electronics. That ask deep collaboration inside of technical part of University and outside, with other Universities of science, concrete with departments in physics, chemistry, materials etc. One of this collaboration was established between Technical University in Brno and Masaryk Science University Brno in semiconductors branch. Principle of this collaboration is based on the use of special common labs for educational process as well for research. In more, all these activities are supported by research supported through grant projects of Czech Ministry of Education.

### Proposed course program

The survey results obtained from twenty small and medium enterprises suggest that the manufacturing process aspects of the modern microelectronics technology are very significant field for not only research, development and production, but for users, especially in certain management level too. Therefore, the following curriculum for subject "Micro (Nano) electronics Technology for Engineers" is recommended to give the basic knowledge to all engineers:

- Introduction to Electronics Hardware and Impact of Technological Integration
- What are the Semiconductor Chips and the Importance of Packaging
- Passive Elements including Embedded and its Significance
- Assembly Technologies for Electronic Equipments and Systems
- Soldering as decisive Operation for Electronic Systems Reliability
- Hardware for PC and Interconnection Issue

- Directives in Electronics – WEEE, RoHS, EuP, CE
- Electronics Production Process and SPC
- Quality Engineering and TQM
- Life cycle assessment
- Eco-design and Electronics Impact on Environment

All this matter is arranged in eleven lessons, which concern many activities that must mostly engineers in their daily praxis tray to solve, independent if there are chemists, mechanics, logistics or generally any managers in various control levels. Into the bargain, more knowledge in this branch helps to take overview in the management praxis and to help to achieve optimal decisions. This concerns many activities, for example if must be decided about purchase of new equipment, about investment in new technology, about decrease of impact of products on environment and in many others.

The matter of the single lessons is independent from any special knowledge and is created as complex whole, which can by used without any others. On the other hand all single lessons make the basic view on microelectronic assembly technology, short known hardware. The can help in all steps of product life cycle that are:

- research and development,
- production process including equipments construction,
- commercial and business activities,
- use and handling of electric/electronic equipments,
- service and innovation,
- recycling and reuse of products after their life cycle.

### Methodology

This educational program is based on electronically published curricula, which will be accessible on Brno University of Technology web site in the

TABLE I  
STATISTICS OF MAJOR LESSONS ASKED FROM PRAXIS

<i>Lesson</i>	<i>Number</i>	<i>Percentage</i>
Introduction to Electronics Hardware and Impact of Technological Integration	9	33 %
What are the Semiconductor Chips and the Importance of Packaging	18	65 %
Passive Elements including Embedded and its Significance	13	45 %
Assembly Technologies for Electronic Equipments and Systems	10	36 %
Soldering as decisive Operation for Electronic Systems Reliability	12	41 %
Hardware for PC and Interconnection Issue	27	100 %
Directives in Electronics – WEEE, RoHS, EuP, CE	23	83 %
Electronics Production Process and SPC	21	78 %
Quality Engineering and TQM	20	72 %
Life cycle assessment	12	41 %
Eco-design and Electronics Impact on Environment	26	96 %

Czech Republic. The subject is arranged as one semester course that can be classified in the last year of Bachelor study program or in any semester of Master study program as well in doctorate study program. There is not a need to have special preparation. Mostly subject matter has general character and does not need particular knowledge.

### Curriculum Synopsis

Brief discussions of the single lessons along with an introduction of the concepts that will be covered are contained in the following synopsis.

*Introduction to Electronics Hardware and Impact of Technological Integration* gives the basic point of view on hardware including principal dividing on single parts and makes really introduction in this sector in popular scientific form.

*What are the Semiconductor Chips and the Importance of Packaging* makes the term “chip” much clearer and disappears some nearer look on chip as “black box”. The packaging in modern electronics has significant importance and expresses the technical level of each electronic system.

*Passive Elements including “Embedded” and its Significance* introduce basic principle of passive elements, which are often direct controlled by human hand.

*Assembly Technologies for Electronic Equipments and Systems* includes overview of progressive processes that are used in the modern electronic production. Production methods and levels are one of decisive factors for final reliability and life cycle durability.

*Soldering as decisive Operation for Electronic Systems Reliability* is technology that passes through strong development in consequence with new environmental directives that forbid the use of lead by the way also in solders.

electric fundamentals. In addition, every one lesson demonstrates complex matter independent from all others.

Single lessons were choice based on the practical survey performed in Brno district factories and plants that concern usual daily activities in companies from electronics production sector. In Table I is shown percentual request for preferred lessons, which were selected from collection of valuated 20 topics.

*Hardware for PC and Interconnection Issue* gives the popular view on PC composition with possibility to make the fundamental adjustments and upgrade.

*New Directives in Electronics – WEEE, RoHS, EuP, CE* is very important topic with general validity that has to be implemented in all enterprises and in more makes the base for establishment of environmental management.

*Electronics Production Process and SPC* explains the basic approach to the organization and arrangement of production. The matter is aimed at assembly process realized by surface mount technology and packaging. With this activity is connected systematic management of production process, realized through SPC and other tools.

*Quality Engineering and TQM* is inseparable part of each production that is asked by legislation. Quality means activity, which controls the parameters and function, and save the expenses.

*The Product Life Cycle* refers to the succession of stages a product goes through. Product Life Cycle Management is the succession of strategies used by management as a product goes through its life cycle. This activity is important for electric products that have relatively short life-time.

*Eco-design* is relatively new topic considering with minimizing of electric/electronic products and equipments impact on environment. "Ecology + Economy = Eco-design" is the formula for environmental product design. Eco-design is the systematic consideration of environmental requirements in product design.

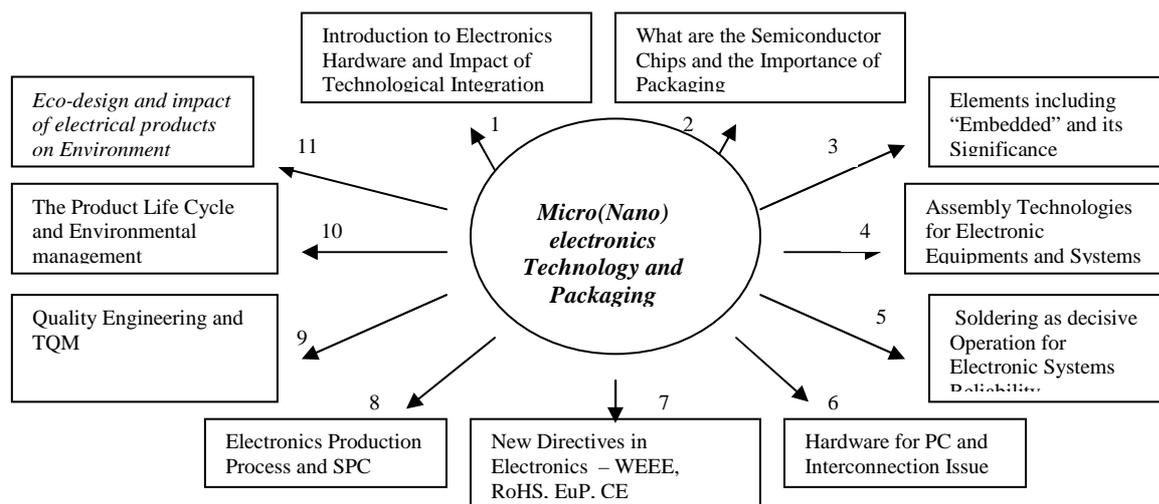


FIGURE 1  
: CURRICULUM OF MICROELECTRONICS TECHNOLOGY FOR ENGINEERS

### Conclusion

Micro(Nano)electronics Technology and Packaging are topics that have general matter and concern wide range of persons. For managers and people in leading positions is necessary to understand basic principles and functions of electronics hardware, to be able make discussion with collaborators and to know some basic for own notion. In more to be able accept the basic rules signify the save the expenses. It is difficult to make any decision about "black box".

This topic belongs to daily activities in the life of managers in different branches and levels. Significant fact is the motivation for this knowledge, which is saving of expenses through strategically practiced decisions. Many small and medium companies do not have experts for making decisions concerning electric/electronic topics. It is easy to ask some specialized company to introduce new electric/electronic equipment but to have own point of view may be particularly important and useful. All industry sectors will need to have a generation of academically trained technical managers who are specialized on their branch, but who have an understanding the basic principles of electronics technology to avoid their negative influence on final products.

This course is a tutorial on the single topics that supporting the fundamental activities and decisions that are done in mostly modern companies. It provides the student with the theory and some praxis necessary to electrically point of view that helps to use electrical equipments in the right form. Today electronics play a large role in the performance of many instruments in various sectors of industry and the knowledge gained in this course philosophy, logic, mathematics, economics and as well electronic hardware. would provide a useful tool for all engineers.

The new contribution is the popular form of curriculum for the electronics hardware and its method of presentation. Parts of the curriculum make tests of knowledge that helps to know the understanding of each single lesson.

There is other important factor that is multidisciplinary character of electrical engineering education. Mostly subjects and branches are here intimately related, yet these relationships are often ignored by teachers who focus on their own areas of specialization and by textbooks which are written by specialists. I believe that anyone engineer cannot learn science independently of his

### Acknowledgment

This research work has been supported by the Czech Ministry of Education in the frame of Research Plan MSM 0021630503 MIKROSYN „New Trends in Microelectronic Systems and Nanotechnologies” and Research project IS 1860037 “Implementation of Lead-free Soldering in Educational process”.

### References

- [1] Zacchaeus Oyedokun: Factors Affecting Selection of Teaching Strategy in a Emerging Institution of Higher Learning with Heterogeneous Learner-Teacher Outlook, ICEE 2005 Proceedings, Vol. 11281-8, Gliwice, Poland, July 25-29,2005
- [2] Haag,S., Forbín,T.: Assessing Corporate Reinvestment in Engineering Education: University-Industry Collaboration, ICEE 2005 Proceedings, Vol. 2, p.328-333, Gliwice, Poland, July 25-29,2005
- [3] Murray, B.: Weaving an interdisciplinary education, Monitor online, Volume 30, Number 5, 1999