Electronics Hardware – Interdisciplinary Subject for the Engineering Study Programs

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Abstract

This paper deals with the significant importance of the subject "Electronics Hardware", which is prepared in the innovation program for Master Study Program in the branch "Microelectronics" at Faculty of Electrical Engineering and Telecommunication in Brno University of Technology in the Czech Republic. Importance of this subject is based upon the fact that engineers of all branches are daily in contact with electronics hardware. Electronic hardware range from individual chips (make the base for mostly electronic equipments), through circuits, modules and blocks to signal processing systems, which are industrial, consumer, medical, automotive, telecommunication, computer and many others. In principle in all these areas is the electronic hardware to manage, and they also notably affect its influence booth on technical and practical use and also on economical success. That means business success is commensurable to manipulation with electronic hardware that sure depends from profundity of knowledge in this area. In addition there is other important fact electronics hardware influencing very increasingly also living environment and human health. Handling electronics hardware has strong impact on human life standard. There is presented the main structure of Electronics Hardware education program which can be modify in various configuration for single branches of engineering study programs.

1. Electronics Hardware Definition

The structure of electronics hardware understanding contains several basic segments that are following: electronic hardware definition and applications (components with special regard on PC, mobile phones, photovoltaic etc.), base of electronic hardware technology (design and production of components including assembly), electronic hardware quality and reliability (certification and directives), electronic hardware impact on human health and environment (eco-design and life cycle assessment) (see Fig. 1). Actual curriculum is presented in the final part of this paper and is open for discussion.

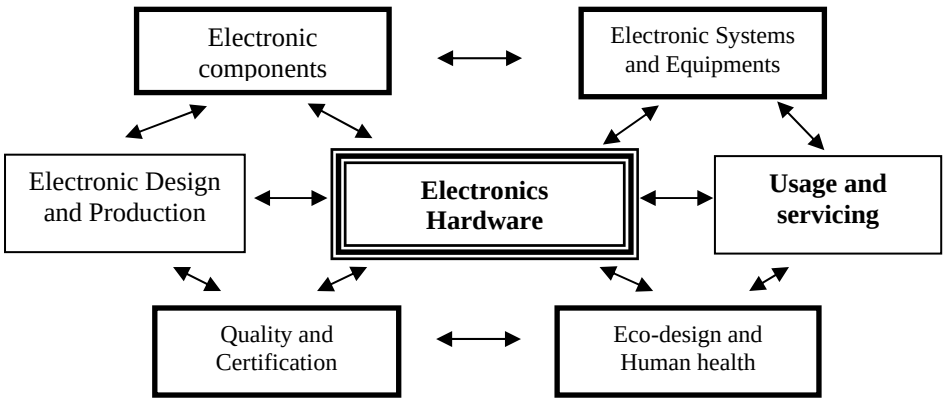

Figure 1: Main parts of Electronics Hardware

There is obvious to handle optimally the electronic hardware as the heterogeneous system asks to have some basic knowledge about its principle and function.

2. Microelectronics Technology

The Merriam-Webster dictionary offers a definition of the term technology as "the practical application of knowledge especially in a particular area" and "a capability given by the practical application of knowledge". Second term “high technology” is described as “scientific technology involving the production or use of advanced or sophisticated devices especially in the fields of electronics and computers” [6]. If we add the term “microelectronics”, then particular area is exactly clear. Then we can voice following definition: “Microelectronics Technology for education process” is science giving the knowledge about design, production, use and liquidation of electronics equipments and systems”.

Microelectronics technology becomes highly interdisciplinary area. There are many formerly independent areas, as system engineering, computer practical, thermal management, quality management etc., which are concerning one way or another with design, production and use of electrical equipments and systems.

It is very important the fact, that the development of each new product needs an integral approach of issues, where are three basic factors influencing final valuation:

- technical,
- economical,
- qualitative.

All are joined and closed together in the different way through lot of concrete factors that have to be evaluated carefully because have significant impact on output parameters. The main parameters of mostly products are today quality and cost.

Under term Microelectronics Technology are the next subpartitions coming out from various aspects. Important is a little bit more concrete term Microsystems Technology [1], which enables more concrete view on single parts relating design and production of Microsystems in electronics sector (Figure 2).

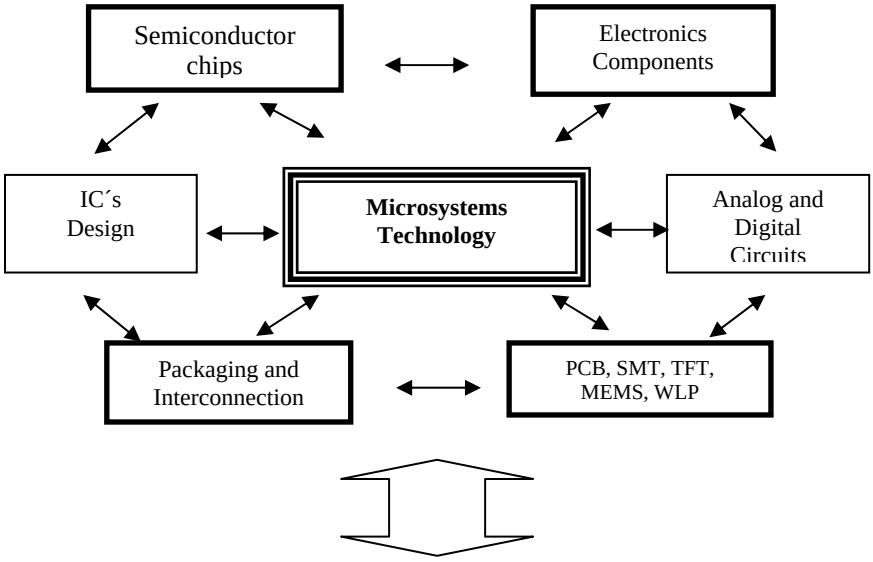

Fig. 2: The main parts generating Microelectronics Technology

There is notable microelectronics technology is created by four main areas that makes individual section but all have to be involved in basic Microelectronics Technology curriculum. These four sections are:

- Semiconductor chips,
- Electronics components,
- Packaging and Interconnection,
- Advanced Technologies.

The fundamental part of today's microelectronics is the semiconductor chip, which in comparison with human body seems to be something like brain (Figure 3). That means for realization of some function or activity there are necessary other apparatus, as heart and all body with sensing and executive parts. In electronics system we need join semiconductor chips with their packaging and interconnection.

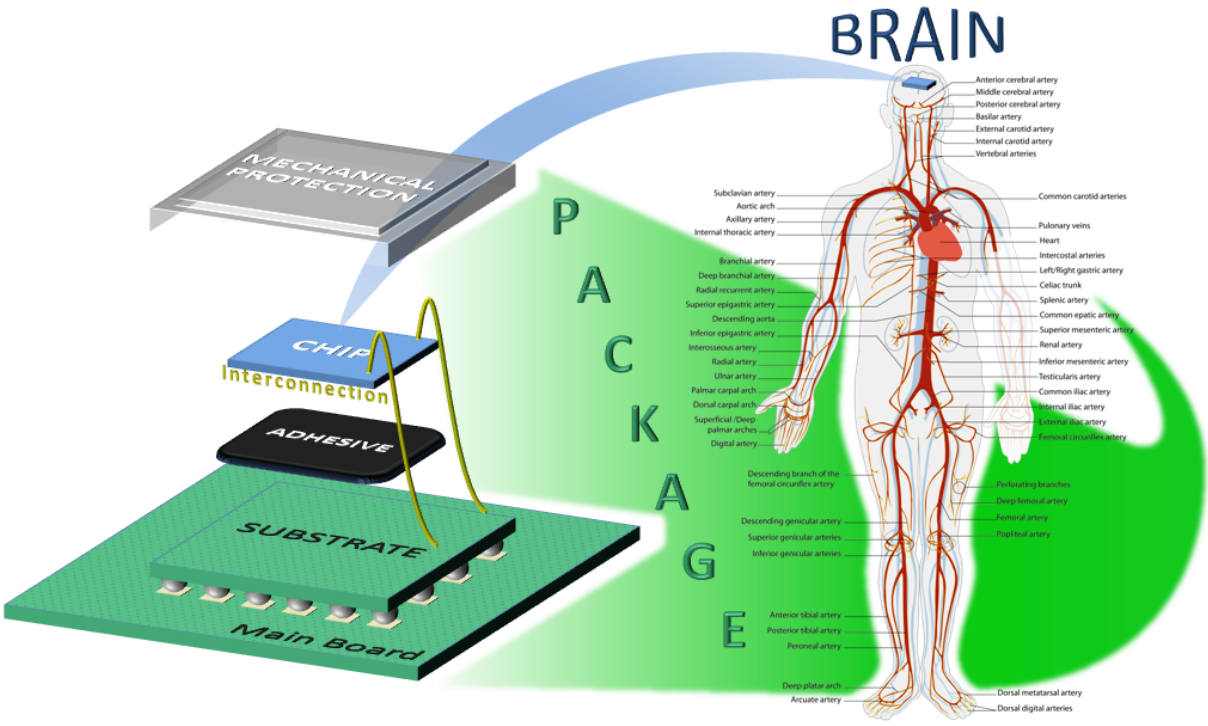

Figure 3: Comparing on of electronic system with human body

3. Electronics Packaging Importance

Coming back to Microelectronics Technology area definition, in term of production process this can be displayed as area consisting from a chain of three fundamental segments that are chip, package and system (Figure 4).

Development of semiconductor chips has made enormous strong progress in the end of last century and this continue without end. The same situation didn't set by packaging, interconnection and assembly technology processes in. That means there is strong need to push assembly technology more intensive to achieve necessary technical level as by semiconductor chips, both from request of final electronic system performance. There are reasons to distinguish electronics technology focused on chip and on system. This first concerning all what is related to chip design and chip production, and the second is in brief branch of assembly technology. All is much closed to economical and environmental impact, which can be different for the same electronic devices. To make the optimal choice by decision about purchase, servicing or repair work of electric/electronic equipments hinged upon knowledge in this area. The same consideration can be done about manipulation and operating with them.

Electronics technology becomes today one of the emerging domains especially in electrical engineering but also in engineering generally. There has been an emerging global focus on these domains in both academia and industry due to its enormous application potential.

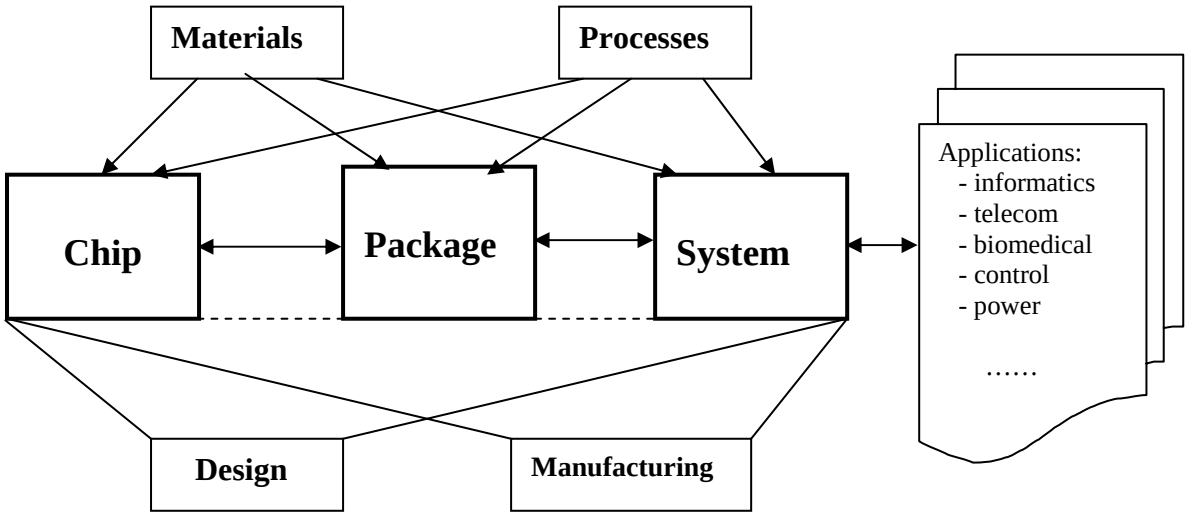

Fig. 4: Demonstration of (Micro) Electronics Technology area

4. Curriculum for Microelectronics Technology

The basic framework for curriculum was established on then base of survey results obtained from about twenty small and medium enterprises. The manufacturing, servicing and business aspects are very significant factors for not only research, development and production, but also for services and users, especially acting in certain management level. Therefore, the following framework for Microelectronics Technology with main impact on assembly techniques was recommended to assure the basic knowledge in this branch:

- Introduction to Electronics technology, Hardware and Impact on Packaging performance regarding Technological Integration.
- Semiconductor Chips, their design a manufacturing, structure configuration in consideration of package selection.
- Passive Components with focus on integration, including Embedded, types and parameters, performance and practical use.
- Substrates and Modern Technologies, advantages and disadvantages of Organic and Inorganic substrates, Polymer Technology, 3D configurations.
- Thick & Thin Film Technologies and HIC´s, including their Non-conventional Applications. LTCC. Wire bonding and chip connection.
- Assembly Technologies for Electronic Equipments and Systems – SMT basic processes, solder paste deposition, component placement, soldering, testing.
- The Electronic Packaging - Fundamentals of Electrical Design and Thermal Management. The Role of Materials in Microsystems Packaging.
- Hardware for PC and Interconnection Issue, Multichip Modueles, Chip Scale Packages, Wafer Level Packaging etc.
- Soldering as decisive Operation for Electronic Systems Reliability, Solder Joint Structure, Lead free, Solder Joint reliability and testing.
- Electronics Manufacturing Process with regard to electronic equipments and systems manufacturing, SPC and Statistical Tools suitable in Electronics.
- Quality Engineering and TQM, Fundamentals of Microsystem reliability, Directives in Electronics – WEEE, RoHS, EuP, CE
- Impact of Electrical Products on Environment, Life Cycle Assessment, Eco-design and economical recycling [5].

This syllabus is arranged in twelve lectures (Fig. 5), which concern various activities that technicians and engineer must tray to solve in their daily praxis. The matter of the single section is partly independent from any special knowledge and is created as complex whole, which can by used without any others.

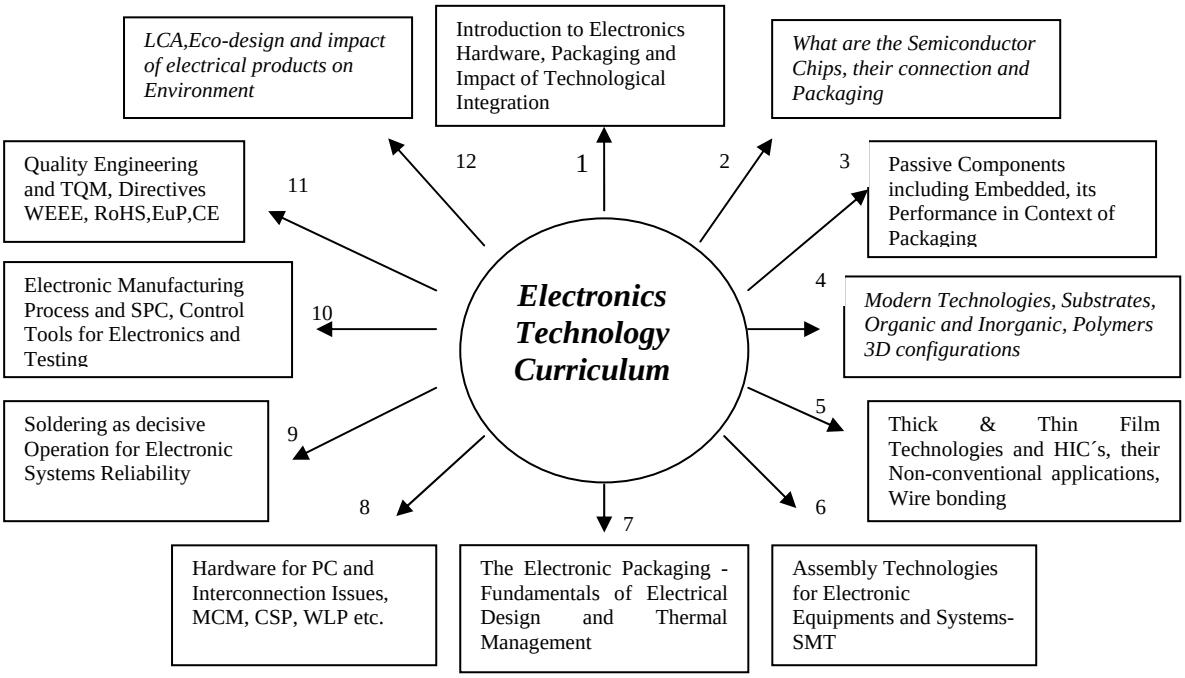

Fig. 5: Syllabus structure of Microelectronics Technology Education

This curriculum is actually arranged in two levels, for Bachelor study program (Microelectronics Technology and Components), and for Master study program (Modern Microelectronics Technologies). Both courses are organized in one semester period (12 weeks), with weakly program consisting from one theoretical lecture (3 hours) and one lab/experimental exercise (4 hours). Various modifications can be adapted and optimized after concrete needs of particular request.

5. Conclusion

Electronics Technology is one of the emerging domains in manufacturing engineering. There exists a strong global focus on this domain in both academia and industry due to its enormous application potential. In this context, there is a need for pushing steady research and development that is not possible without the education. Because semiconductor chips making all the time a big progress, their packaging and assembly and handling must follow the same.

That asks make innovative course and laboratory modules which will introduce these emerging concepts and techniques to engineering education. These must be innovated permanently according to microelectronics technology development abroad the world.

Output is to learn the ability to distinguish between engineering performance and economic efficiency and develop cost efficient solution. The manger that understands reliability models and the information necessary to predict the reliability of electronic components and structures can make better solution as other without this understanding. That is why students master fundamental knowledge of handling electric/electronic devices including their life cycle, energy saving, environmental issues etc.

As strong development in electric/electronic industry sector is accompanied with strategically changes, as well fundamental changes must be applied in educational system too. This matter has a general validity due to increasing effect of electronics technology on ambient and environment (PC, mobile phones, TV sets, recorders, cameras, players etc.).

6. Acknowledgement

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