# Mechatronic Education - an important way to improve the technological education for young people in Romania

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*Abstract:* The Mechatronics is the synergetic combination of precision mechanical engineering, electronic control and systems thinking in the design of products and processes. Mechatronics as a highly interdisciplinary domain involves sensors, actuators, data bases, system modelling, locomotion, system control and data acquisition. In Mechatronics there is a need to develop interdisciplinary programs to better prepare graduates to design, build, and operate the products and systems of today and tomorrow. The European Commission recognises that meeting the Lisbon challenge requires to rethink education and training to promote efficient and optimal learning. The tasks and the problems solving in mechatronics requires cognitive and operational knowledge and practical experience about building systems, diagnosis and maintenance-techniques. Any education programme that aims to be useful and to support the local industry has to have a balance between academic and practical work.

*Keywords:* Technological education, mechatronics, systems, analysis, interdisciplinary.

## 1 Introduction

Computer Revolution (the second industrial revolution) marked the leap from an industrialized to an informational society, generating a wave of upgrades in technology and education. Mechatronics is the result of natural evolution in technological development.

Mechatronics was born as a technology and became a philosophy that has spread worldwide. In engineering, mechatronics philosophy determined the shift from traditional engineering sequential to a simultaneous engineering or the competition.

As the market has demonstrated, mechatronic products (appliances, automobiles, integrated manufacturing systems, robots, communication, etc.) with added value that gives them a high grade of advantage, with a constantly growing demand, represents a new level of development, which, once attained, gives strong support for sustainable economic development. Basically we can estimate that the advanced, computerized in industry, society is implemented in mechatronics [10].

Currently, worldwide, mechatronics has a powerful development. Defined as the synergetic integration of mechanical precision with electronics, informatics and systematic thinking with the aim of developing and manufacturing intelligent products, it is the result of computer revolution and it is the gateway for the transition from advanced industrialized society to information society.

Development of mechatronics has opened up new horizons in all fields of research. Making actuators as systems that convert some energy into mechanical energy is a result of this development. Evolution in future technological development means micromechanics, and biomecatronics nanomecatronics. It is a clear trend of miniaturization through integration in the realisation of technical systems and an attempt of catching one's attention for new creations in the field of mechatronic engineering.

An important engine that led to the emergence of mechatronics consisted in the development of informatics and their practical application. Among the milestones related to the occurrence of the term „mechatronics" it also results a number of characteristics of the products included in this area: integration of a large number of functions, high degree of integration of constructive components, emphasized miniaturization of components, artificial intelligence emphasized, the possibility of self-control, adaptability and high flexibility in operation, highly complex technical systems. Mechatronics has been recognized as a continuous evolving reality, both in the economic environment and education [8].

## 2 Multidisciplinary aspects

Mechatronics is an important part of modern confluent engineering due to integration, interaction, interpretation, relevance, and systematization features.

The multidisciplinary mechatronic research and educational activities, combined with the variety of active student learning processes and synergetic teaching styles, will produce a level of overall student accomplishments that is greater than the achievements which can be produced by refining the conventional electrical, computer, and mechanical engineering curricula [6].

The objectives of the mechatronic high education are to teach the new generation of students and engineers, as well as to assist industry and government in the development of high-performance electromechanical systems augmenting conventional engineering curriculum with an ever-expanding electro mechanics core (fig.1) [3].

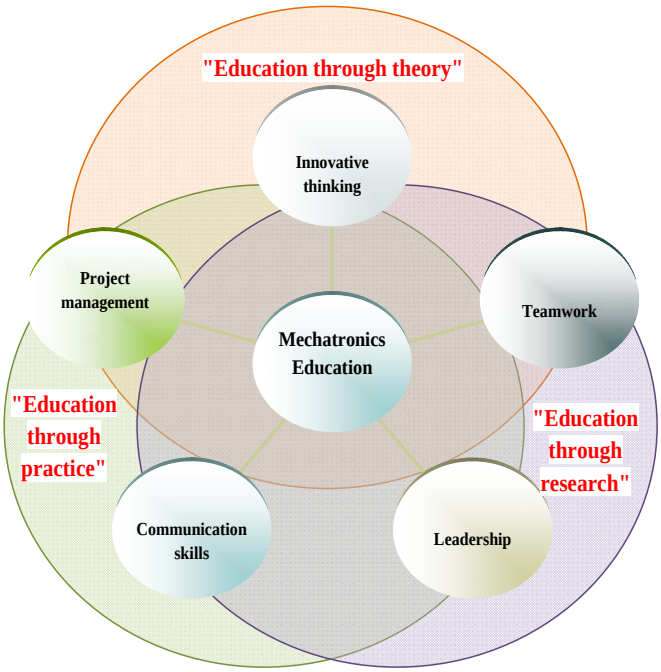


Figure 1

## 3 Mechatronic education

The main responsibility of teachers is to design methods and create student-focused learning environments, with less emphasis on traditional responsibility to send only information. The relationship between student and teacher is a partnership where everyone takes responsibility to achieve learning outcomes. Outcomes are explained and discussed with students in terms of their relevance for development.

Information society and the emergence of mechatronics imposed the establishment a model for education, both at university and high school as a model focused primarily on quality and student / high school student, and later on, on quantity, in order to be able to form students and students gifted with systemic, integrative and flexible thinking, innovative spirit, creative, rich with practical skills and teamwork skills [9]. In the dynamics of any technological process information flows are present along with energy and material flows, and "in mechatronics technology information is the component giving the tune, in relation to material and energy "[7], a product being more efficient as it incorporates more information (thus implicitly intelligence) in relation of quantity of material and energy used.

Being a mechatronic engineer today is understanding and exploiting the synergistic relationship between precision engineering, control theory, computer technology and sensors and actuators technology [2]. Achieving this objective requires a shift: the transition from sequential engineering to simultaneous engineering [8], which requires an integrative educational approach [2] that seeks to develop systemic thinking learners. Mechatronics is an engineering field, so it focused, quite naturally, by training professionals to master the practical skills necessary for mechatronic systems design and maintenance. The new educational principles must be focused on the creative Mechatronics, concurrent design and development process (fig. 2).

The impact of mechatronics technology exceeds the economic sphere, the essential social, cultural and others. The future of technological development in Romania will increasingly call upon and depend on mechatronics expertise to provide equipment and specialised skills that will not only add value to the finished products, but do it quickly, accurately, economically and in large volumes. Those involved in learning and training are looking for tools to transform the learning experience, enable learners to become autonomous and enjoy a truly personalized development path.

The primary emphasis is placed on enhancement and improvement in student knowledge, learning, critical thinking, depth, breadth, results interpretation, integration and application of knowledge, motivation, commitment, creativity, enthusiasm, and confidence. These can be achieved through the new mechatronic curriculum development and implementation.

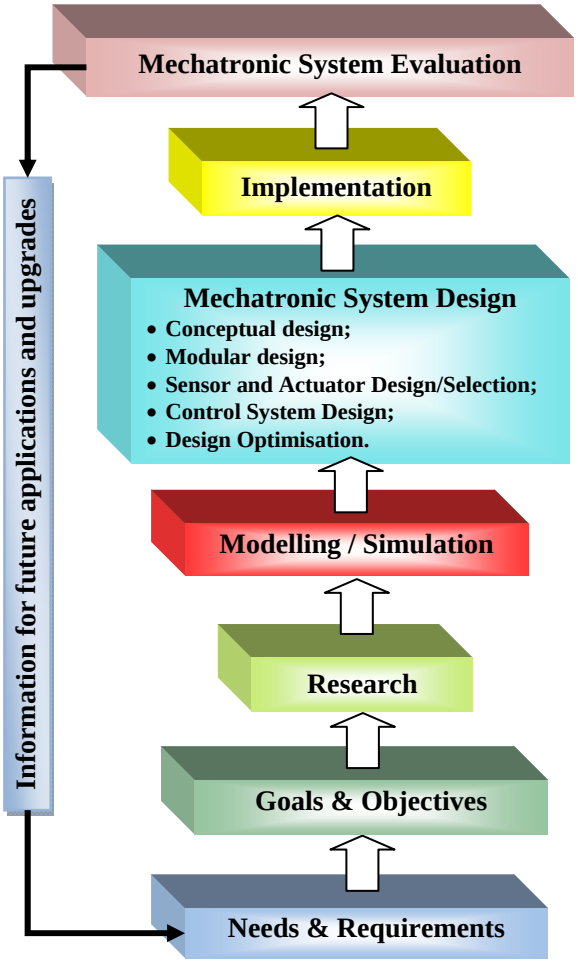


Figure 2

Mechatronics interdisciplinary high education will perform fundamental and applied activities by:

• integrating electromagnetic, electro mechanics, power electronics, ICs, and control;

• devising advanced design, analysis, and optimization simulation and analytic tools and capabilities through development of specialized computer-aided-design software;

• developing actuation-sensing-control hardware;

• devising advanced paradigms, concepts, and technologies;

• supporting research, internship, and cooperative multidisciplinary education programs for undergraduate and graduate students.

Mechatronic curriculum design includes development of goals and objectives, programs of study and curriculum guides, courses, laboratories, textbooks, instructional materials, manuals, experiments, instructional sequences, material delivery techniques, visualization and demonstration approaches, and other supplemental materials to accomplish a wide range of educational and research goals [5].

Mechatronics education ensures action in thought, defining features of the market economy specialist. Mechatronics interdisciplinary laboratories are the basis for the realization of the principles of "learning by doing ',' education through research." Approaches focus on moving the emphasis from information on the formative side.

Educational reality has to be reformulated by: ensuring a balance between innovation and maintenance teaching, insurance of an optimum relation between formal, nonformal and informal education, extension of educational processes to the lifetime of the individual [1]. Mechatronics education is essentially a modern education with a strong inter-and transdisciplinary character, but exploratory, with a special emphasis on learning and research. It meets the needs of the labour market.

The offer of education and training of the Department of Precision Mechanics and Mechatronics from the University of Braşov, structured through implementation of an integrated training course: Undergraduate (Licence) - Master – Doctorate (PhD) - Continuing Formation, includes four undergraduate (licence) programs: Precision Mechanics, Mechatronics, Optometry, Medical Engineering and the master program: Mechatronic systems for industry and medicine (figure 3). These programs are fully consistent with the thematic areas addressed in scientific research in doctoral programs developed in the research department of advanced mechatronic systems, involving the entire department teaching staff of the Department of Fine Mechanics and Mechatronics.

Today, a mechatronics engineer must be familiar with the benefits and limitations of cross-discipline technologies in software and electronic hardware; must be trained on how to apply this knowledge to optimize a mechanical design; and must understand how to rapidly prototype and test various embedded solutions to develop a final solution.

Mechatronics education provides flexibility in action and thought, defining features of experts in the market economy. Flexibility is an essential feature of mechatronic systems. This characteristic is determined by the fact that the link between functional modules is achieved through information, so the same hardware structure can achieve different functions according to software installed.

Close links with industry are considered especially important for an engineering discipline in general and Mechatronic Engineering in particular. The School of Mechatronic Engineering has a lot of connections with companies with mechatronic links.

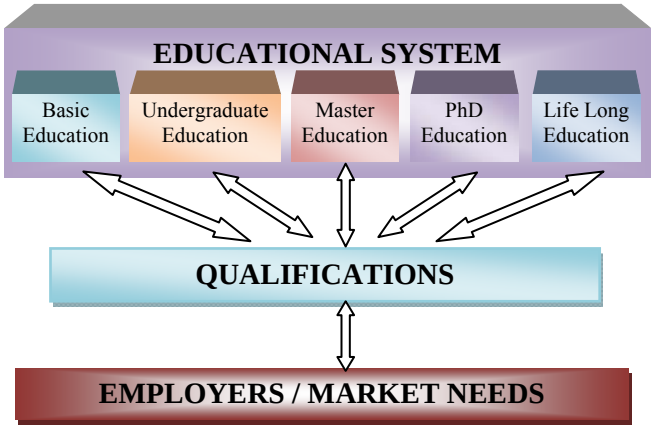


Figure 3

Interdisciplinary design and analysis demand from people trained in traditional disciplines to learn appreciating different perspectives, views, ideas, and approaches from other disciplines.

Mechatronic systems such as robots, cameras and automobile, which integrate the various disciplines, make good topics to illustrate the value of an interdisciplinary approach.

The goal mechatronic education in UTBv (fig.1) is to obtain engineers who are educated in the theories, principles and applications of Mechatronics while improving their competencies in innovative thinking, communication skills, teamwork, leadership, and project management [3]. According with these aspects in our activities we intend to assure a gradual training of our students in order to face effectively the requests of the labour market trough: developing the students' cognitive capacities based on up-to date knowledge taught and assessed in a modern and effective way, developing the students' team working skills as a base of an efficient further social and professional integration, developing the students' effective self assessment skills by using a transparent and formative assessment system. Our labours are equipped according with the new education strategy and mechatronics curricula (figures 4, 5, 6).

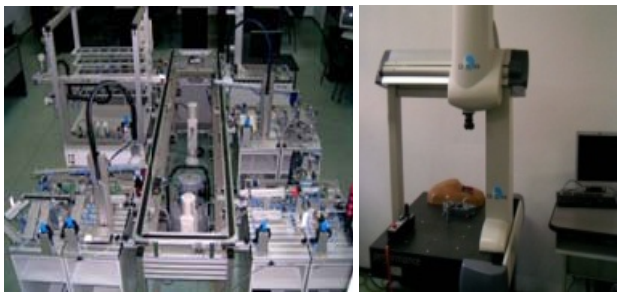

Figure 4.

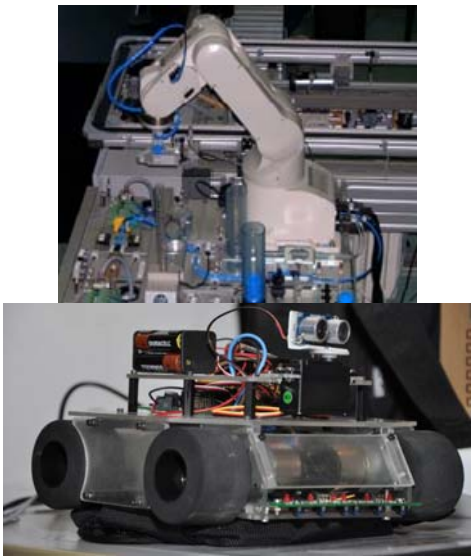

Figure 5.

Figure 6

We questioned the students about the motivation they had to participate to practical activities. From 59 answers (III$^{rd}$ year undregraduate students in Mechatronics) we got the results illustrated in Figure 7.

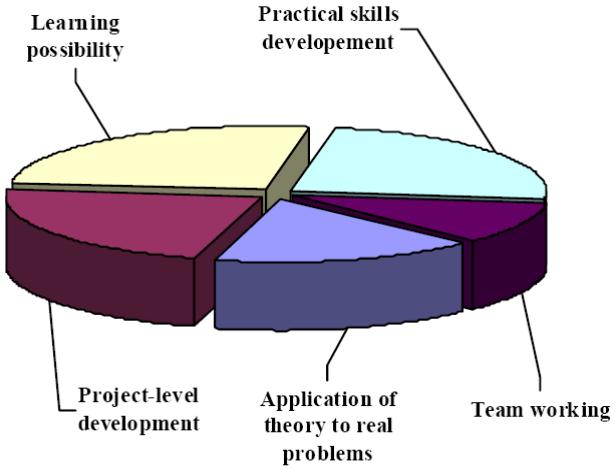


Figure 7.

In our department we try to develop an effective research activity of teaching staff with and for students and we act according to develop an intrinsic motivation for the profession of our students.

## 4 Conclusion

The structure of the Mechatronic programme at the Transilvania University of Brasov fully integrates theory and practice and ensures an interdisciplinary approach. The education philosophy will ensure not only demand for our graduates but provide the mutually vital links with industry by way of collaborative research, consultancies, provision of industry scholarships.

The mechatronics curricula attempts to bring real world experiences for the student and part of this include integrating various engineering disciplines.

The curricula in the Mechatronics field, developed according to European standards, have to assure high performances in design, manufacturing, services, and research, performances perfectly matched with the needs of highly computerized society. It should emphasise a balance of the content between technology, methodology and knowledge of theoretical science.

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