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Past, Present and Future of Teaching Mechatronics at the Faculty of Mechanical Engineering and Informatics of the University of Miskolc

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Abstract: The paper presents the development of and changes in teaching mechatronics at the Faculty of Mechanical Engineering and Informatics of the University of Miskolc starting in the 1960s. It is easy to see how fast the University responded to the technical changes in the world, what directions it followed and how it became involved in solving industrial problems of a mechatronic type, and how all these affected engineering education and training. The paper presents a novel example of cooperation between industry and higher education, amounting to an innovative solution. Furthermore, it will also display the extensive opportunities for evolution of a specialist field.

1. Introduction

There are several definitions known about the discipline of *mechatronics*. Each of them includes that it is an interdisciplinary field of science, where synergic integration of mechanical and electronic systems and information technology is achieved.

In the stiff competition of a globalised world, extraordinary intellectual and material resources are concentrated in order to conquer markets, new methods and technologies are applied in developments with greatly reduced cycle times. Mechatronic devices have also entered everyday life, for which a range of examples can be mentioned.

In its directives, the Design Methodology for Mechatronic Systems VDI 2206 describes mechatronics as the resultant of the engineering sciences above, shown in *Fig. 1*.

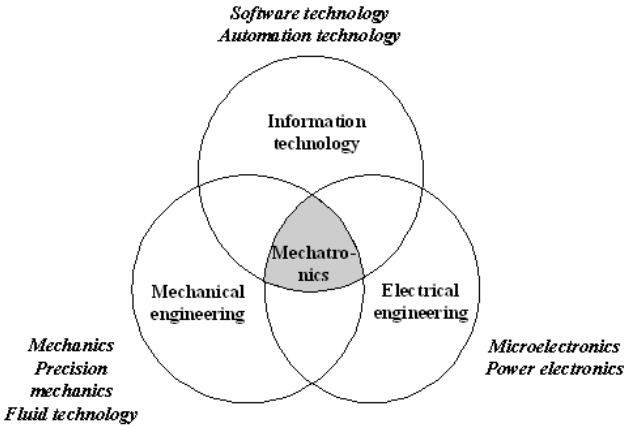

Figure 1: VDI 2206.

2. Establishment of mechatronic engineering programmes in Hungary

In accordance with the new Act on Higher Education, the introduction of the two-stage system, based on the preliminaries, made it possible to establish the BSc programme and the MSc programme in Mechatronic Engineering, which had not existed previously. In the course of the establishment, higher education institutions were also interested. Having previous experience, they elaborated and submitted the documents for establishing and introducing the programmes in a consortium partnership. The documents are available on the web page of the Hungarian Accreditation Committee (Magyar Akkreditációs Bizottság, MAB): http://www.mab.hu/a_tajekoztatok.html. The detailed programme and degree requirements („Képzési és kimeneti követelmények", KKK) for the undergraduate and master programmes are available on the web page of the Hungarian Ministry of Education and Culture (OKM): http://www.okm.gov.hu/main.php.

For comparison, the table below shows the credit point requirements of the "Fields of knowledge definitive for the qualification" for the programmes in mechatronic engineering and the data for the programmes in mechatronic engineering accredited at the University of Miskolc, Faculty of Mechanical

Engineering and Informatics (GEK). The KKK also specifies which topics have to be covered by the fields of knowledge. Within the number of admissions permitted, only graduates of the undergraduate programme in mechatronic engineering can be admitted to the MSc programme with full recognition of credit value. For the other programmes that may be taken into account (mechanical engineering, transport engineering, electrical engineering, engineering informatics, mechanical engineering for agriculture and food industry, and energetics), the admission conditions into the MSc programme can be found on the web page of the above-mentioned Ministry.

According to the latest data, there are nine higher education institutions in Hungary offering accredited programmes in mechatronic engineering. Both BSc and MSc programmes are offered by the following institutions: Budapesti Műszaki és Gazdaságtudományi Egyetem (BME), Budapesti Műszaki Főiskola (BMF), Miskolci Egyetem (ME), Széchenyi István Egyetem (in Győr), Szent István Egyetem (in Gödöllő). BSc programmes are offered by the following institutions: Debreceni Egyetem, Pannon Egyetem (in Veszprém), Pécsi Tudományegyetem, and Szegedi Tudományegyetem.

Table 1: Credit point requirements.

Fields of knowledge	**BSc, 7 semesters**		**MSc, 4 semesters**	
	MAB (cr)	**GEK (cr)**	**MAB (cr)**	**GEK (cr)**
Fundamental knowledge in science	40-50	47	26-36	27
Knowledge in economics and humanities	16-30	16	10-16	10
Professional core material	70-103	96	20-36	30
Differentiated professional knowledge, (degree work)	min 40	51	46-60	53
	-	(15)	(30)	(30)
Total credit points	**210**	**210**	**120**	**120**

3. Background of the programmes in mechatronic engineering established at the University of Miskolc

The Faculty of Mechanical Engineering (today Faculty of Mechanical Engineering and Informatics) at the University of Miskolc was established in 1949 with the purpose of training mechanical engineers. The 60th anniversary of the establishment is celebrated this year. The initial focus of the programmes included machine tool design and production engineering. This focus has been widened by now, meeting various demands. Currently, the Faculty has nine accredited BSc programmes (Energetics, Mechanical Engineering, Industrial Product and Design Engineering, Mechatronic Engineering, Industrial Management, Electrical Engineering, Economic Informatics, Engineering Informatics, Informatics, and Programme Informatics**)** and four MSc programmes (Mechanical Engineering, Mechatronic Engineering, Energetics, and Engineering Informatics), and the accreditation of the MSc programme in Logistics Engineering is under way. It shows the great number of new programmes which have emerged from the originally uniform training; all of them are built on the foundations created by the programme in mechanical engineering offered by the Faculty.

The roots of introducing the BSc programme in mechatronic engineering go back to machine tools and their automation at the Faculty of Mechanical Engineering and Informatics of the University of Miskolc. The programme for specialist engineers in *Machine Tool Automation* began in 1966 as a postgraduate programme and extended over five years. The full-time university programme in *Machine Tool Design* was also introduced in 1966, which was divided into two specialised programmes: *Machine Tool Design* and *Machine Tool Automation* in 1972**.** The latter widely applied the achievements of flexible automation in the courses on machine tools and robots, representing essentially mechatronics.

The technical-technological development and restructuring of the Hungarian industry encouraged education and research to introduce changes. The Faculty became involved in mechatronics, which emerged as a new discipline, with the help of substantial Tempus, PHARE-ESZA and HEFOP projects. These included exchange of experience, laboratory infrastructure development as well as writing textbooks.

The full-time university and college programmes of the *Specialisation in Mechatronics* appeared at the Faculty of Mechanical Engineering in the curricula valid from the academic year 1993/1994, at the same time when they appeared at BME, and they are to be phased out in 2009. These specialisations were included in the professional responsibilities of the Department of Machine Tools founded in 1963, but in close cooperation with the Departments of

Electrotechnique-Electronics and Automation, which were professionally responsible for the university programme of the *Specialisation in Electronics and Automation* in addition to college programmes in electrical engineering.

The results and achievements in mechatronics research appeared in the two Doctoral Schools of the Faculty of Mechanical Engineering and Informatics. The departments of the Faculty achieved highly significant results related to mechatronics in the research and development work commissioned by the industry.

4. Introduction of the programme in Mechatronic Engineering and establishment of the Robert Bosch Department of Mechatronics at the University of Miskolc

The Faculty of Mechanical Engineering and Informatics introduced the BSc programme of *Mechatronic Engineering* in the academic year 2007/2008 with 29 students. It should be noted that the average admission score of the students was among the highest at the Faculty. In 2008 the MSc programme in *Mechatronic Engineering* was also accredited. The programmes belong to the professional responsibilities of the Robert Bosch Department of Mechatronics and the Department of Machine Tools.

The curriculum in the BSc programme includes a single specialisation, Engineering Mechatronics, after two years of studies, and in the MSc programme it includes the specialisation, Mechatronics of Production Tools, after one year of studies. These rely on the achievements of previous programmes and are also aimed at a section of the industry that may be a significant employer of the mechatronics engineers graduating here. In elaborating the curricula and course syllabuses the experts in the major factories in the region were consulted.

Professors of the Duisburg-Essen University, who are involved in the programme as visiting professors, have performed a considerable role contributing to the establishment and promotion of the Department.

In consortium with the Széchenyi István University significant infrastructure and electronic learning material development was performed, also in relation to mechatronics, in the framework of the projects HEFOP-3.3.1-P.-2004-09-0102/1.0. The relevant material can be found at http://www.gepesz.uni-miskolc.hu/.

In order to establish and develop programmes in mechatronic engineering, on July 1, 2005 the Robert Bosch Department of Mechatronics was established at the Faculty of Mechanical Engineering and Informatics of the University of Miskolc *with support by the executive management of Bosch and the Bosch factories in the region.* The Department operated as an enterprise for three

years. The objective of the cooperation between the factories and the University is: *to apply and expand the technical and scientific knowledge in the research, teaching and wide-ranging application of mechatronics, to provide practice-oriented academic programmes and to meet the demand of the factories for engineers.*

The University of Miskolc was pleased to accommodate the first department to be financed by companies since World War II and took over its operation on July 1, 2008. The University also granted substantial funds for the project. The example, although not in the same structure, has been followed by several higher education institutions.

The Department has been funded and supported through the *professional training contributions* and the *innovation contributions* paid by companies. In the latter framework, the Department has completed several R+D projects with the involvement of the staff of the Faculty.

The practice-oriented training of the students of the programme in Mechatronic Engineering is supported by the mechatronics laboratories: hydraulics-pneumatics, PLC, drive technology, sensor technology and mechatronics systems (*Fig. 2*) constructed using the professional training contributions.

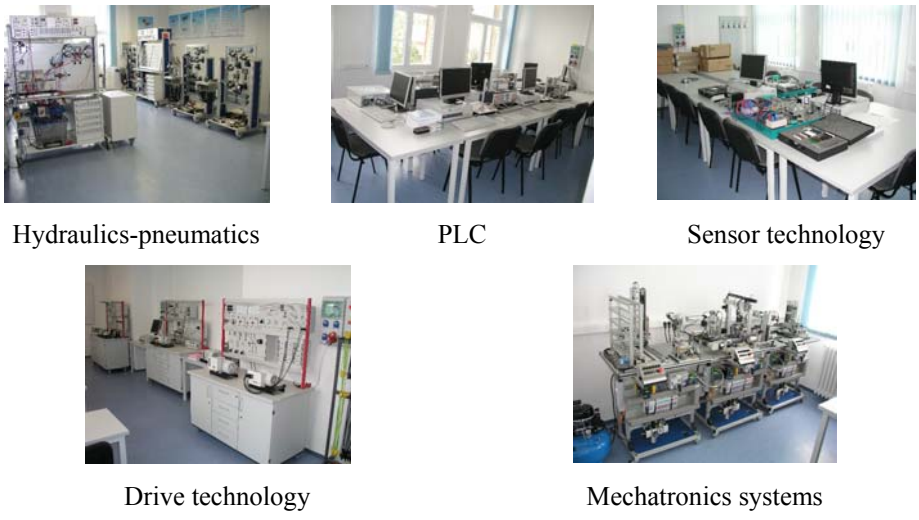

Figure 2: Laboratories of the Robert Bosch Department of Mechatronics.

5. Future of programmes in mechatronics

The development of disciplines giving the basis of mechatronics is unbroken, and the new achievements emerge in products of an increasing range. The pursuit of this integrated science requires students who are both inherently and willingly suitable for receiving complexity and for absorption in one of the fields of mechatronics as well as cooperation.

The particular characteristics and requirements of development in the field of mechatronics also have to be given an increasing emphasis in the academic work, and this has been partially formulated in the directives. Some of them are listed below without striving for completeness:

- accurate formulation of the task (requirement), application of various design methods and development tools (QFD, FMEA, etc.), virtual design, modelling and simulation tools,
- Concurrent Engineering,
- application of a wide range of tools of information and electric technology,
- acceleration of the innovation process, increasing intelligence, and use of techniques such as modularity, change of technology, functional and spatial combination, prototyping, testing,
- possibility of access to databases and interfaces irrespective of location and time,
- systemic thinking,
- cooperation in team work, including the evolution of individual capacities, etc.

In addition, it is indispensable to get to know and use further tools, methods and fields, such as logistic processes, quality control, production systems, production control, reliability, operation and maintenance.

The above requirements clearly show that part of the required knowledge meeting the features of the field for solving the industrial tasks in mechatronics can only be obtained in the BSc and MSc programmes, therefore advanced training programmes are of great importance. An active environment is needed for the abilities to develop and in order to achieve the objectives of the programmes *cooperation between the industry and the university* is essential and is already evident in several areas.

Besides theoretical and practical education, factories manufacturing mechatronic devices or using them in production play a considerable role. In the factories students or trainees on industrial placement can familiarise themselves with the various techniques, they may be given project assignments, topics for degree work and they can be involved in programs and tenders. It is to be noted here that the competitions *'Pneumobil 2009'* and *'Elektromobil 2009'* of the Bosch factories in Hungary attracted student teams from a number of higher

education institutions. The addresses http://www.pneumobil.hu and http://www.olh.hu:80/bosch/cms/elektromobil give all the details of the call. The large number of the teams participating shows that students need such challenges requiring independent and creative work.

Integrating industrial experience and knowledge into education and academic programmes is a very significant factor. One efficient way of doing so is involvement in industrial research and development work, getting students involved and integrating the experience in the academic work. Another important element is what higher education in the developed countries has been using for a long time, namely involving industrial experts in education. Regarding mechatronics, doctoral programmes have made it possible to award higher qualifications to experts.

6. Summary

One may wonder about the perspectives of the programme in mechatronic engineering in the current circumstances and the job opportunities for the graduated engineers. The answers are that this period particularly requires experts who are able to develop and operate intelligent, innovative products and instruments. Another major objective of the programme is to train engineers, who – due to their well-founded, comprehensive knowledge – can offer flexible solutions in changing conditions. The industry offers opportunities for them to find jobs in wide professional fields, for the knowledge they have acquired can be utilised anywhere in the world.

7. Acknowledgements

The authors wish to express their thanks to all the colleagues who have contributed to the foundations for the establishment and introduction of the programme in mechatronic engineering and are currently involved in teaching the courses.

8. References

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