Conclusion

Issues connected with the application of CAx tools and modern manufacturing techniques (e.g.: CNC machining, Reverse Engineering and Rapid Prototyping) lead to a quicker introduction of a product onto the market.

Modern educational procedures in engineering fields are an essential factor in the process of integrated product development.

Research of professional group of CAx experts [8] should be a source of important information about industry expectations and then should be quickly introduced in real educational process.

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INTEGRATION OF CLASSICAL TEACHING AND COMPUTER AIDED MACHINE DESIGN

Ця стаття присвячена інтеграції класичного навчання і комп'ютерного машинного проектування (CAD). Доведено, що досвід практичного інженера може бути отриманий тільки протягом розв'язання і детального розроблення реальних завдань проектувальника, які б завершувались їх промисловим виробництвом.

Ключові слова – САПР, навчання, промислове виробництво

This paper is devoted to the integration of classical teaching and computer aided machine design (CAD). It is proved, that practical engineer's experience can be obtained only during solving and elaborating of designer's tasks finishing with implementing them to industrial production.

Keywords – CAD, education, industrial production

Introduction

Integration of teaching is defined as: "the way of teaching which target is showing connections between all subjects of teaching and showing the science as a whole" [3]. This problem connect all stages of classical polytechnic education and also usage of modern methods and education means. Basic position amongst them has got computer aided machine design CAD.

Didactic classes from computer aided design which are carried out by Chair of Basics of Machine Design of Poznan University of Technology are in basic network:

– on Faculty of Working Machines and Transportation:

for major Mechanics (tab. 1),

for speciality mechatronics of Chair of Basics of Machine Design (tab. 2),

- for postgraduate courses: informatics with information technology and for Technique with communication upbringing,
- in range of students' science association.

– on Faculty of Mechanical Engineering and Management for major Mechatronics,

– on Faculty of Technical Physics (Computer Design Record).

Didactics of above mentioned subjects for students of Faculty of Working Machines and Transportation, major Mechanics, starts from the second semester with classes of computer graphics. Introduction of computer graphics just after finishing classes of technical drawing improved didactical process in range of classical design record. These classes became the basis of proper teaching of the following subjects: computer aid of designing and basics of machines design. Subject matter of class begins with acquainting students with methodology of creating two-dimensional sketches (2D), which are next transformed into solids (3D). In these paper there are discussed functions of creation and edition of sketches 2D and types of geometrical, dimensional and parametrical constraints.

Table 1

Structure of basic computer aided didactical process for major Mechanics carried out by Chair of Basics of Machine Design of Poznań University of Technology

Sem.	Name of subject	Amount of Exams	Amount of credits	Total	Lectures	Exercises	Lab.	Design
	Engineer graphics							
1	Descriptive geometry		1	30	15	15		
1	Technical drawing		1	45	15			30
2	Computer graphics		1	45	15		30	
	Basics of machines design							
3	BMD I		1	30	30			
4	BMD II	1		60	30			30
5	BMD III	1		30	30			
5	Computer aided design		1	60			30	30

Next subject is methodology of creating of three-dimensional models, special care there was taken on practical skills in modelling of complicated shaped elements (superficial and hybrid models). During successive lessons there are presented methodology of creating of two-dimensional technical documentation of elements and units and there are discussed tools for design recording as a 2D drawing.

Changing of model 3D automatically generates changes in drawing 2D, analogically changes in two-dimensional drawing modifies model 3D of element. Nest students are acquainted with methodology of units creating basing on previously made models of elements. Furthermore, there are given the rules of putting assembly constraints, assembly animation, detecting of mechanisms collisions, creating of presentation files and files *.avi. Methodology of models creating of the sheet structures and also generating sheet unwinding and rules of welded units are presented in next lectures.

Complementing of mentioned above problems is getting acquainting of students in creating of elements technologically similar. Special attention should be taken on creation techniques of elements and units keeping their adaptivity, that is ability to accommodation to changes of mating elements. During lessons there are also shown possibilities of visualization of designed elements and units. Laboratory classes are complemented with lectures of 30 hours. Experience resulted from laboratory classes and computer graphics laboratory were collected in form of course book [4].

Issues of teaching subjects in range of computer aided design are connected with creating of new or with choosing of existing software, generally available software CAD/CAE. In eighties and nineties there was popular creating computer software, for making of selected types of elements and machines units, by groups of lecturers. During designing calculation applications, there were used compilers for languages

Fortran, TURBO Pascal, Visual Basic, C++. Made software fulfilled very good its tasks in range of calculations automation, but did not enabled for creating of machines elements three-dimensional models. For special care deserves elaborations: [6 – 10] implemented both in didactical process of technical schools, universities and in industry. Actual tendencies in computer aided designing of machines shows that there is right usage of existing, generally available software from range of basics of machine design, FEM analyses, analyses of material systems dynamics.

Table 2

Computer aided design for specialization of Mechatronics (Chair of Basics of Machine Design)

Semester	Course name	No. of exams	No. of credits	Total	lectures	classes	labs	project
8	Computer aided design II		1	45	15		30	
8	CAD/CAM	1		60	30	30		
8	Computer analysis of construction	1		45	15	30		
9	Modelling, simulation and prototyping	1		45	15	30		

One of such popular software is AutoDesk Inventor Professional (AIP), which has got implemented module Design Accelerator. This module used previously as software Mechsoft and was available in software Solid Works, Solid Edge. Advantage of such solution is integration of engineering calculations environment with possibility of generating of two- and three-dimensional documentation.

Basic target of computer aided design lessons is getting acquainted students with possibility of engineering problems solutions with using of numerical calculations procedures based on standards and dependences from range of basics of machines design. Here are presented procedures of choosing of key, splined, pin, bolt connections and also slide and roll bearings. Besides there are mentioned problems concerning designing of shafts, axles and rods and also procedures concerning brakes. Students come to know with methodology of selecting of transmissions with vee-belt, cog belt, and chain transmissions and procedure of thread and bolt connections designing. Next subjects are designing of welded, soldered connections and springs. During classes students come to know rules of designing of elements with usage of finite elements method and element and units dynamics simulation. There is important thing to use skills obtained during classes of computer graphics and basics of machines design – designing. Besides, the task of these classes determining the place of computer aided designing in computer integrated manufacturing CIM.

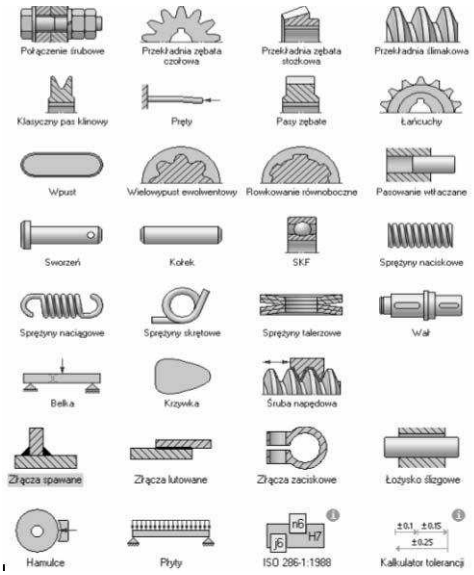

Fig. 1. Software panel AIP applied in CAD didactical process

Subject matter of carried out projects concerns power units: motor -tension transmission – gear transmission. After carrying out of analysis of task and choosing of designing solution, students make calculations of transmission. Thanks to usage of single-purpose software (fig. 1) there is possible efficient verification of calculations connected with generation of three-dimensional models of parts and standard elements.

Experiences resulting from carrying on laboratory classes of computer aided design were collected in form of course book [5].

Speciality mechatronic on Faculty of Working Machines and Transportation at Poznań University of Technology

Establishing of speciality mechatronic on Faculty of Working Machines and Transportation of Poznan University of Technology was connected to interdisciplinary development of basics and theory of designing of Institute of Basics of Machine Design and necessity of teaching students in machine building, electrotechnics, hydraulics, pneumatics, informatics. From inspiration of scientific workers of Institute BMD (now Chair BDM) and of a great experience in designing and in projects implementing, there were formed the following specialist didactical laboratories:

– basics of machine design,
– computer aided design and design recording,
– design theory,
– laboratory of hydraulic and pneumatic,
– laboratory of modelling and mechatronic designs researches,
– laboratory of searching of technical aspects of traffic accidents and machines safety.

Team practical achievements includes tens of appliances designs of advanced technology, which can be fully qualified to mechatronic in its definition confinement, e.g.: design of electromagnetic brake controlled in electronically way in function of slide, appliance for automation transportation and handling of high-dimensional furniture's boards in process of their cutting – implementation in Factory of Furniture in Wolsztyn, stereovision head positioned in three axis – design elaborated together with Chair of Robotics of PUT, appliance for automatic measurements of notches combination in locks and padlocks – implemented in industry, elaboration of conception and design of special machine for milling of notches on keys, manufacturing in automatic way about 78 combinations technology operations – implemented in the factory Metalplast Leszno (1979).

Increase of the team factual competence and consistently and effective interdisciplinary approach to designing, especially with taking into account machines computerization were main arguments to establishing the specialty mechatronic. Conception of its study programme was elaborated together with Faculty of Electrical Engineering and Faculty of Mechanical Engineering and Management of Poznan University of Technology. This establishing was motivated by two targets: establishing of multidisciplinary didactic team of competences adequate to general structure of mechatronic and rational usage of laboratory basis of the University. On preliminary stage there carried out analysis of programmes from different universities which earlier opened majors or specialists mechatronics (in Germany in the year 1998 there were more than 30 of them, and in Great Britain 14). Consultations were carried out with Warsaw University of Technology, where 1 October 1996 was opened first in Poland Faculty of Mechatronics. Didactic classes are carried out on three faculties: Working Machines and Transportation, Electrical Engineering, Mechanical Engineering and Management.

nanaMost of teaching-hours is realised by Faculty of Working Machines and Transportation, but big part of hours, almost 1/4 falls to Faculty of Electrical Engineering and 1/10 to Faculty of Mechanical Engineering and Management. Last two faculties realise the part of didactics connected to informatics and electronics. Faculty of Working Machines and Transportation realises classes concerning structure and acting of mechanical appliances with special emphasis on mechatronical designing. In structure of classes clearly predominate lectures (60%), and the rest 40% is divided into exercise, designing and laboratory classes. All student's designs, term papers and dissertations strictly concern mechatronical problems, thanks to its this specialty graduate beside theoretical knowledge has got also practical experience. Obtained knowledge in its range concerns wide domain of disciplines, giving to graduate proper preparation to realisation of engineering jobs.

Significant group of subjects of specialty mechatronics are computer aided classes. First of them called CAD/CAM was implemented to present for students integrated systems of virtual designing with tools for designing of technology for numerically controlled machines. During laboratory classes there are presented

procedures and software serving to creating of machining tracks for machines numerically controlled. After designing of technology, it is verified on numerically controlled milling machine. Coming to know integrated designing environment, machining simulation and manufacturing is the necessary skill needed on job market. Next subject is: modelling, simulation and prototyping, in which students make analysis of quick prototyping with taking into consideration possibilities and conditioning of their application. The target of subject computer analysis of design is learning methods of structural analysis problems solving: nonlinearity and nonstationarity. Issues of system of linear equations solving and problems of stability loss are dealt in computer confinement. In didactic process there are also discussed problems connected to structure elements with methods of terminal load capacity using literature created in Chair of Basics of Machine Design [2].

Graduate of specialty mechatronics should be prepared to solve engineer's tasks concerning:

- automatization realized with mechanical, pneumatic, hydraulic and electronic appliances,
- implementing of partial or full machines automatization,
- designing, manufacturing, exploitation of industry automatics appliances,
- designing of machines and appliances,
- maintenance of automatized process lines,
- programming of machines numerically controlled,
- efficient usage of technique CAD/CAM,
- carrying out of laboratory searches.

Summary

Contemporary education of engineers requires from teaching staff skills in engineer's experiences integration, classical polytechnic education and also implementation of systems CAD/CAE. Practical engineer's experience can be obtained only during solving and elaborating of designer's tasks finishing with implementing them to industrial production. In order to improve the didactic process, especially in range of night studies there is necessary to elaborate course books and monographs presenting actual development tendencies in CAX systems. One of designers' knowledge actualisation possibility may be organizing of post-graduated studies of speciality computer aided design.

The essence of good designing is that using of computer aided means would not limiting but supporting didactical process in self-contained solving technical problems and preparing further engineers to creative work. There should be paid attention to importance of intuition and also experience both students and lecturers during designing process.

Comparing required knowledge profile of mechanical engineer designer in e.g. Germany, with knowledge profile of graduated designer of speciality mechatronics, there can be seen that there is similar time structure in didactical classes in scientific engineer's knowledge, natural knowledge, informatics and skills in measuring, controlling and regulation technique. Differences are in two groups of knowledge – general scientific knowledge, where level of Polish graduate is higher by almost 5% and production knowledge where it is smaller by 7,5% what is resulted from actually limited laboratory infrastructure of our university [1]. There should be widen our didactical programme for laboratory classes and practise exercises at the cost of lectures. It is integrally connected to funding of modern education majors.

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