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SELECTED PROBLEMS OF CAD EDUCATION DIRECTED FOR INDUSTRIAL PRACTICE

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Ця стаття присвячена проблемам навчання автоматизованому комп'ютерному проектуванню засобами CAx (CAD, CAM, CAE), що базується на промислових технологіях. Показано, що значення сучасних освітніх процедур в технічних галузях є істотним чинником в процесі інтегрованого проектування виробів.
Ключові слова – комп'ютерне проектування, навчальна процедура

This paper is devoted to the problems of Computer aided engineering CAx techniques (CAD, CAM, CAE) education directed for industrial practice. It is shown that the role of modern educational procedures in engineering fields are an essential factor in the process of integrated product development.
Keywords – Computer aided engineering, education procedure

Introduction

One of the main aims of modern CAx educations is learning the possibilities and methodologies of parametric modelling concept. Nowadays, the feature based 3D modelling is the standard of mechanical design. Today study of CAx systems and CAx engineering applications is an integral part of product design, manufacturing and development in various branches of industry [1, 2].

Computer aided engineering CAx techniques (CAD, CAM, CAE etc.) are becoming more and more significant in the process of design, production and introduction of a new product onto market. They reduce considerably the time-period of introduction of a product's release version for sale. This leads directly to lower costs of a new product design and testing its prototypes with the help of virtual 3D models as well as quicker introduction of the final version of a product. Development of modern CNC techniques as well as Reverse Engineering and Rapid Prototyping techniques requires application of CAx tools.

Dynamic development of the existent CAD systems and appearance of new ones result in the fact that the choice of the appropriate product is becoming more and more difficult. The costs of purchase, service and training should all be taken into consideration, the first one being probably the most important in the case of commercial use. Another important issue is the possibility of adjusting the system to the requirements of a particular industry (branch, production profile, cooperation with partners, etc.), i.e. what tools are offered in the so called basic version, whether there are additional tools (and at what price) working in a given CAD environment (specialised tools, CAM and CAE programs, libraries and standards,) [3].

CAx education for industry

1.1. Implementation of CAD systems

The following factors have a determining influence on effective implementation of CAD systems in industrial firm of mechanical branch:

- PRICE!!! (software, hardware, workers training, service);
- a large number of users of concrete CAD system in particular country and worldwide;

- Availability of graduates using CAD, CAM, CAE systems;
- engineering education in local technical universities with usage of concrete CAD system;
- possibility of CAD system accommodation to establishment requirements (branch of industry, profile of production, collaboration with cooperating parties);
- modular structure of CAx system based on the environment of the main CAD modeller;
- possibility of import-export of 3D models in standard neutral file formats and others popular CAD systems file formats;
- easy access to software updating (Service Pack);
- CAD system version in the native language;
- access to libraries of typical elements and 3D models of leading producers;
- professional online and local representatives support;
- rapid reaction to user's problems (technical service);
- availability of PDM/PLM software working in specific CAD system environment.

1.2. Progression of requirements in CAx branch

Modern engineering education should be directed for quickly varied needs and requirements of industry, among other things in mechanical engineering. This can be realized by many ways, i.e. as follows:

- collaboration with industry in aspects of their expectations and skills of new, modern generations of engineers;
- recognition of requirements in particular branches of industry from graduate of engineering fields;
- development in education institutions of new technology of product design and manufacturing;
- probing at the start and the end of CAx student's education process and their understanding and skills of design terminology, meaning, methodology;
- work out by CAx specialists the general rules of design process in engineering education allowing rapid development of CAx techniques for.

1.3. Development trends of CAD systems

Development of CAD systems, in principal measure, is directed on following issues:

- advanced surface modelling tools (surface styling, tools for surface continuity analysis, free-form surfaces modelling);
- functional modelling (consideration of functional aspects of CAD model by designer – not for determine of features sequence in design-history tree, e.g. SolidWorks Intelligent Feature Technology (SWIFT) introduced in SolidWorks 2007 and systematically evolving);
- design based on KBE (Knowledge-Based Engineering);
- development of expert tools e.g. for detecting and solving problems in sketches, dimensions and features on the part level or mates on the assembly level;
- development of specialised tools for converting existing 2D drawings to 3D models (2D to 3D);
- possibility of publication and presentation of product as a virtual 3D model (e.g. Adobe 3D PDF format, eDrawing, virtual reality VR, Internet 3D presentation formats, advanced rendering and animation);
- trends to consolidation tools for scanning and processing „point clouds" with popular CAD systems (e.g. add-in tool „ScanTo3D" from SolidWorks 2007 and its collaboration with commercial „NextEngine" scanner).

1.4. Professional trainings

Trainings of designers and engineers using CAx tools should be a continuous process. The following reasons should be take into consideration in industrial practice [4, 5]:

- nowadays, new software versions bring absolutely innovative modelling techniques and tools, therefore, among other reasons, it takes too much time for an intermediate user to master all the novelties;

- employers now realise that professional training courses organised by authorised units for designer help them use their potential more fully;
- employers costs of designers participation in training courses, workshops and conferences will very quickly pay dozens of times;
- at present, lack of progress in CAx techniques means passive retardation and unavoidable decrease in a company's competitive ability;
- software distributors offer trainings in primary and advanced scope and specialised tools (e.g. what new in new version, 2D drawings, tools for mould, sheet metal, weldments, surface modelling, piping and electrical system, CAM, CAE, PDM, ect.);
- possibility of individual training based on materials available in particular CAD system www portals.

1.5. Student's and academic teacher's certification

Software distributors and producers provide access to certificates of the acquired knowledge of design methods and tools in a given system to students of technical universities. For example, students of the Faculty of Mechanical Engineering of Bialystok Technical University have been undergoing SolidWorks certifying proceedings conducted by CNS Solutions (Warsaw, Poland) annually during the last five years (Table 1).

Table 1

Specification of Student SolidWorks Certificate acquired in Faculty of Mechanical Engineering on Bialystok Technical University

Academic Year	Number of certificated students
2003/04	26
2004/05	22
2005/06	34
2006/07	29
2007/08	24

Certificate issued by an independent external auditor creates a good opportunity of finding a job for will-be graduates of technical universities.

Another significant advantage of student's training is an opportunity for academic teachers of CAx subjects to confirm their qualifications and skills in the form of e.g. professional certificates (Fig.1).

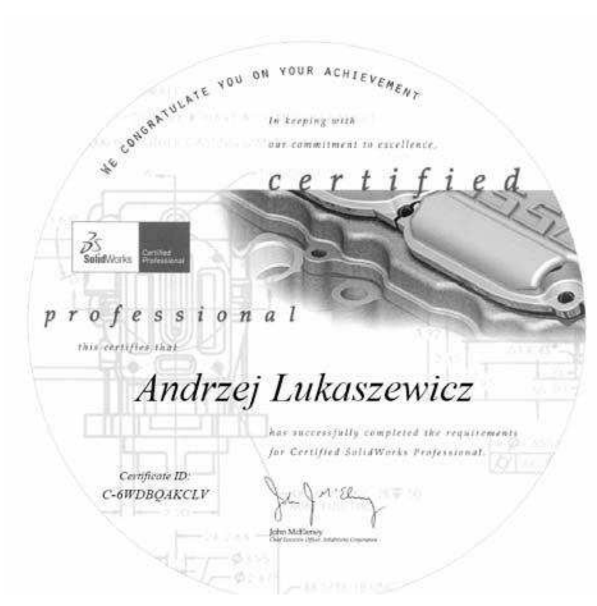

Fig. 1. Certificate of a SolidWorks Professional (CSWP), SolidWorks Corporation, USA, obtained by A. Łukaszewicz in 2007 year

Principal rules of parts and assemblies modelling in parametric CAD systems

Education development of geometrical design methods should be directed to increase the knowledge of advanced part and assembly modelling. Present CAx systems called „middle level" (for example: SolidWorks, SolidEdge, TFlex, BriksCAD) are based on the main geometry modeller and work in 3 environments: „Part", „Assembly" and „Drawing".

A geometrical model is the main common feature characteristic of engineering computer tools irrespective of the CAx system being used. Therefore, it is fundamental to identify correctly and effectively the geometrical features of a virtual 3D model. The method of geometry modelling in CAD systems functioning on the basis of the structure of defining a 3D model features, which is also called History-Based CAD, is essential. It is mainly connected with a CAD designer getting to know the philosophy of defining „intelligent" and „elastic" models [6]. One should consider design guidelines, which give the information about the sequence of the features used and dependence between them. Current research in cognitive science leads to the conclusion that 3D solid modelling CAD knowledge should be reconceptualised to include three types of knowledge: declarative command knowledge, specific procedural command knowledge and strategic knowledge [7].

The following attributes combine to give an efficient and robust part model with the proper design intent:

- correct part orientation in 3D space;
- optimum model origin;
- correct sketch plane selection for base feature sketch;
- correct base feature;
- appropriate use of symmetry planes;
- simple sketch geometry;
- correct sketch relations;
- fully defined sketch geometry;
- correct feature sequence;
- proper parent-child feature relations;
- correct feature defining;
- correct feature duplication;
- correct part design intent.

The main principles of assembly modelling having influence on effective and robust virtual model:

- advisable division of devise on structure with many levels of sub-assemblies resulting mainly from functionality particular subsets;
- adequate choice of first component in space of pre-defined planes in assembly environment (e.g.: frame, mount, casing, etc.);
- skillful use of component patterns (e.g.: patterns based on a feature);
- using standards available from a libraries;
- imposing a mates resulted from mobility character (taking away the degrees of freedom)
- non-defining useless mates (e.g.: in connecting elements)
- using of assembly configuration;
- appropriate use of mobility sub-assemblies in main assembly in flexible or rigid mode;
- proper work with "large assemblies" (there are three suppression states for assembly components: in fully resolved, lightweight, suppressed).

Author's proposed procedure of CAx education in mechanical engineering

In this chapter procedure of CAx techniques education has been used and developed by author since 2002 year in Faculty of Mechanical Engineering at Bialystok Technical University were described. This approach is supported by many awards have been received by A. Łukaszewicz's students (Fig. 2)

The following steps in educational process, according to the author, are indispensable to give a high quality of students' knowledge and skills in computer aided mechanical engineering:

♦ for all mechanical specialities:

- standard prerequisites: descriptive geometry, engineering drawing, fundamentals of machine building;
- 2D drawing CAD (e.g. AutoCAD);
- background of „middle level" parametric CAD system;
- carried out a virtual part as a solid model from real object;
- carried out a solid part from standard 2D drawing;
- fundamentals of numerical analyses in CAE software;
- individual modelling of assembly;
- background of CAM,

♦ additionally for CAx mechanical specialities:

- surface and hybrid geometrical modelling;
- import-export of 3D models in standard neutral file formats, repair and editing of imported object;
- background of „high level" parametric CAD system;
- specialised tools (tools for mould, sheet metal, weldments);
- FEA, kinematical- dynamical and flow analysis;
- KBE, API;
- modern manufacturing techniques (Rapid Prototyping, Rapid Tooling);
- 3D scanning and Reverse Engineering;
- visualization and animation of 3D models, Virtual Reality, product presentation on the Internet.

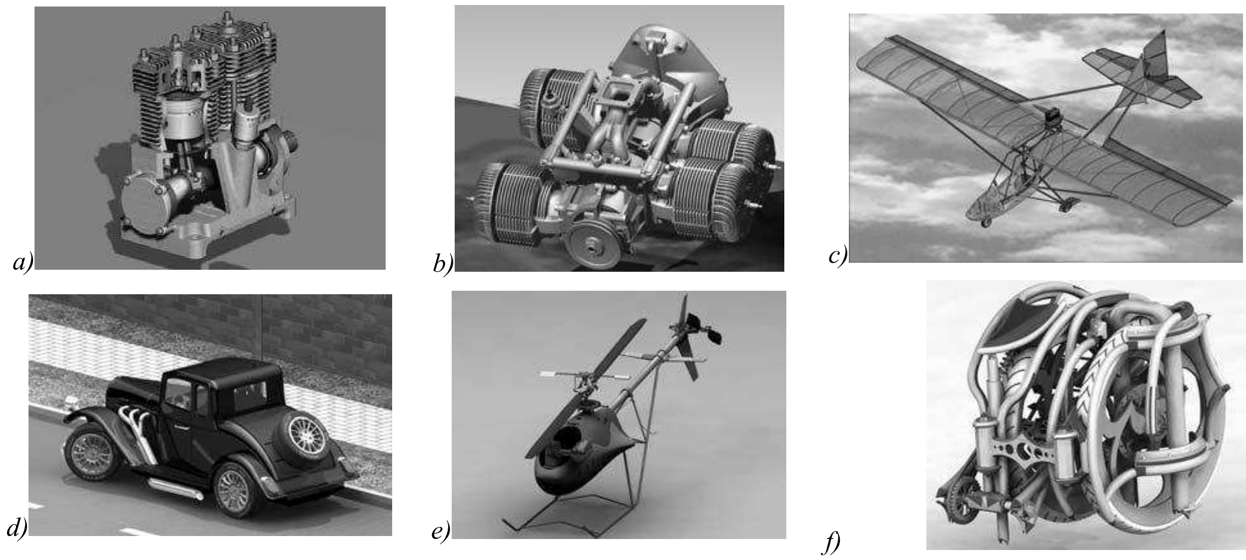

Fig.2. Mechanical system designs performed by A. Łukaszewicz's students:
a) author: A. Piwowarek (2-nd place in II Edition of Poland SolidWorks Student Design Contest), academic year 2002/2003;
b) author: P. Zubrycki (2-nd place in III Edition of Poland SolidWorks Student Design Contest), academic year 2003/2004;
c) author: K. Łukaszewicz (2-nd place in IV Edition of Poland SolidWorks Student Design Contest), academic year 2004/2005;
d) author: D. Jabłoński (5-th place in V Edition of Poland SolidWorks Student Design Contest), academic year 2005/2006;
e) author: Ł. Korenkiewicz (2-nd place in 2007 Edition of World Education SolidWorks Design Contest);
f) author: D. Fionik (1-st place in VII Edition of Poland SolidWorks Student Design Contest), academic year 2007/2008

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

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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.