



THE IMPACT OF CAD TECHNOLOGIES ON ENGINEER'S EDUCATION

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1. Introduction

Several serious causes and recent works as [Briggs 2001] and [Lyons 2000] motivated authors to consider situation in education of mechanical engineers, especially in light of great breakthrough of Computer Aided Design and general computer appliance in engineer's every day work, and to propose tendencies in syllabus in purpose of harmonization with demands in production. Most important cause (cause 1) is actual significant unemployment rate of young but also and aged bachelor engineers in Slavonian county. Reasons for unemployment could be found in decreased production, recent bad privatization and often bankrupts of production companies, although great reasons also lays in engineer's knowledge gained during time of study and in students profile. Namely, in last decade good students more often decide to study economy or law rather than technical studies. Another cause (cause 2) is lack of specific knowledge that manifests in increased demands to faculties and educational centers for additional CAD courses. Those demands come from both employed and unemployed engineers but more often from older engineers. Young engineers rarely ask for CAD courses since such courses are in syllabus of most technical faculties in last decade.

Beside CAD courses there are often demands for courses in computer appliance (cause 3). Aged engineers more often look for courses in basic computer appliance, while younger and unemployed engineers look more for advanced courses and programming skills. Demands for CAD courses from companies are very often inspired because of the increased cooperation with the foreign companies that mostly used parametric and feature based part and assembly computer models in their production. Through cooperation our companies are farfetched to use CAD system to survive on global market. Market risks and requests are even greater with intent of the government to open local market and to become a member of the European Union. Department of the Organization and Information Technologies at the Mechanical Engineering Faculty in Slavonski Brod recently organized special courses about object and network oriented programming for unemployed engineers (cause 4). Courses were financially sponsored by Croatian Employment Office, by city and county authorities and in equipment by Siemens company. Siemens also made employment contract with twelve from twenty attendants and Office believes that the other eight will easier find job may be even in Siemens too. From here one can ask: Do people who pay taxes must pay twice for expensive education of engineers? Obviously they do not and should not, especially for additional education. They already pay highly qualified university personal to educate engineers whose education should be driven by market as much as possible [Holt 2001].

2. Present state

Currently on the Mechanical Engineering Faculty in Slavonski Brod, students can listen several courses dedicated to the computer appliance and especially to CAD. Based on cooperation with similar faculties it could be written that other Croatian mechanical engineering faculties also have a

very similar program. The only course dedicated to the general computer appliance is "Computer Appliance". Its syllabus is mostly occupied with lectures about a procedural programming language FORTRAN. FORTRAN is pretty time – worn and it is hard to find on open market FORTRAN compiler for modern operating systems (OS). His procedural nature makes him hard for a use in graphical user interfaces (GUI) of modern OS. GUI are usually performed as set of objects and sometimes even programmed in object oriented programming languages. Besides programming in OS, another important program developing environments are those built – in applications. For example, in the Microsoft® Office® is incorporated Visual Basic for Application® (VBA) while in the most popular CAD system – Autodesk's AutoCAD® are incorporated and supported even three programming languages: VBA, AutoLISP® with Visual LISP™ interactive development environment (IDE) and the most powerful ObjectARX™. ObjectARX is the AutoCAD Runtime Extension programming environment which includes C++ libraries that are the building blocks user can use to develop AutoCAD applications, extend AutoCAD classes and protocol, and create new commands that operate in the same manner as built –in AutoCAD commands. All counted programming languages are object oriented. Faculty employees often receive from engineers demands for help in a development of specific program routines and applications in those built – in languages.

Course specially dedicated to CAD is "Computer Aided Design". In it students learn basics about CAD systems and mainly practice a technical drawing on a computer, popularly called 2D (two dimension) drawing. In most cases AutoCAD is used in the class. The usage was initiated by Autodesk's donation of their CAD systems AutoCAD and Mechanical Desktop® to all technical faculties in Croatia several years ago. Unfortunately, distributors of other CAD systems until today didn't recognize benefits for them in such action so there is no significant breakthrough of their CAD systems in Croatian production companies. On the other side, between faculties is recently started initiative for common obtaining CAD systems through Croatian Ministry of Science and Technologies. Based on previous Ministry's agreement with Microsoft about use of Microsoft's product on universities, it could be written that there is a good chance that the initiative be successful. In consideration of the present state is interesting to quote that in the course "Technical Drawing" students don't use computer, but they do all the drawings on the classical way on the drawing board. And this is probably the last place where they could use or even see the drawing board since most companies use some of a computer drafting system. Or to paraphrase Douglas Adams: at least none company worth speaking of.

Several other courses cover more specialized areas of computer appliance like Computer Integrated Manufacturing, Computer Work and Production Management. All of them are based on work in Information System developed on Department of Organization and Information Technologies in cooperation with ININ company in Slavonski Brod. Through a correspondence with several colleagues on foreign universities it has concluded that similar programs exists in their establishment. For example, Ph.D. Schützer from Laboratory for Computer Application in Design and Manufacturing on Methodist University of Piracicaba in Brazil stated that his students use a lot of object oriented programming language in their work, but they don't have such course during studies. BSME von Gyldenfeldt from Technical University in Darmstadt, Germany, gives following interesting answers:

Q: "Have you learned programming on your study?"

A: "Yes, all Mechanical Engineers do at the first semester. I learned Fortran 77 (some years ago), at the moment they learn Java."

Q: "Are you using object oriented programming language like C++ in your work?"

A: "I am, because my work often is programming scientific software prototypes. Where I have the chance, I try to do this in an OO way with C++."

Q: "Is there a need for mechanical engineers with such a knowledge in your environment/country?"

A: "Difficult to answer. I have the feeling, that for real programming the computer scientists ("Infomatiker") are preferred. But mechanical engineers with knowledge how programming works have good chances to get a job. It's then not the implementation, but the sales, the project management, project definition, managing the interfaces between departments in a software developing company, etc."

Obviously there are deviations in present syllabus, as from required engineer knowledge [Chan 2002]

as from syllabus on universities in developed countries. Therefore, following chapter deals with tendencies and proposals for changes in syllabus of Mechanical Engineering Faculty.

3. Tendencies

The most of the tendencies in an engineer education due to CAD technologies and overall computer use came out from previous analysis. Modern engineer must have certain multidisciplinary knowledge to succeed on the market [Chan 2002]. Strong competition cannot accept verb “should” instead of “must” in last sentence anymore, because such irresponsible and doubtful behavior could cost students their future jobs. Primary tendency is that engineer must have basic knowledge of computer use. Such knowledge today includes work in an operating system (OS) with a windows based graphical user interface and work in a standard office applications (text processors and spreadsheet calculators).

Secondary, in his he job engineer more often must be prepared for programming tasks. Although one could debate about a programming language, one language came out through the years as a real standard and it has developed in several ways. It is C. Since the C served as basis for a development of object oriented C++ and recently for a network oriented JAVA, it can be the right choice for first programming language on faculty. Knowledge of an object oriented programming language is desirable but not often essential for engineer.

Furthermore, engineer must be able to work in some of a computer aided drafting system and more often to work in a CAD system for feature – based parametric modeling of parts and assemblies. The knowledge of some CAM and CAE system are also very desirable on the labor market, especially in the European Union where tends Croatia and may be even more than Croatia tend Croatian engineers. Faculty syllabus and also faculty policy should respect previous tendencies therefore in next sections are suggested some changes in syllabus and policy.

4. Suggestions for changes in syllabus

Suggestions on syllabus are induced from bottom up considering time – order of particular course in syllabus.

- I. The biggest hole should be fixed first: basic knowledge of computer use should be received at the beginning of study. Therefore, author suggests introducing of a new subject on a very first semester of the study in which students will learn to work in an operating system with windows based graphical user interface and work in standard office applications. It should be done regardless to student's education gained in primary or high school because of big differences in syllabus between schools. The new subject could be named as "Basic Computer Appliance" or current subject "Computer Appliance" can be changed and moved sooner in a subject schedule.
- II. Subject about computer programming in C should come after "Basic Computer Appliance" in 2nd or, as it is now, in 3rd semester of study. It could be named as "Computer Programming" instead actual name.
- III. In subject "Technical Drawing" (2nd semester) about 30 – 40% of time should be set aside for teaching students to work in computer aided drafting system so they can use it in drawing extended subjects like “Machine Elements I and II”.
- IV. If last suggested change is realized then subject “Computer Aided Design” in 6th semester can focus on CAD systems for feature – based parametric modeling of parts and assemblies. Based on previous years when majority attend it and on demands stated in introduction, subject “Computer Aided Design” should become obligatory instead of elective.
- V. New elective subject should be introduced in 7th or 8th semester about computer-aided engineering. In it students should learn to use computer tools for engineering analysis like finite element method analysis and to solve real design problems with them.
- VI. New elective subject should be introduced in 7th or 8th semester about computer aided manufacturing in which students should learn to use computer tools for designing a manufacturing process and quality control process.
- VII. As Mechanical Engineering Faculty in Slavonski Brod also offers the post – graduate degrees, its management should consider opening new course dedicated CA-x technologies. Such

course could have several subjects more closely dedicated to object oriented programming in modern IDE for CA-x systems like AutoDesk's ObjectArx and similar.

5. Suggestions for faculty policy: open courses

In the faculty policy, suggestion to management is to open all courses on faculty. The main idea of open courses is that faculty offer to non – students (like finished engineers, production masters... generally civilians) possibility of a listening and certifying subjects by their own choice during a regular school year. It could be done without an enrollment on study but with a fine for listening and certifying particular subjects. Civilians could only listen chosen subject without an obligation to pass subject examination if certificate is not needed but only the new knowledge. The appropriate certificate should go with examination to prove accepted knowledge. Open courses could be very interesting to an employed engineer, manufacturer, craftsmen and others who needs to improve knowledge only in particular fields or even young unemployed man who need additional education for easier employment. Certainly, before opening courses, some prerequisites should be accomplished like publishing the list of open subjects or determining the fine for attendance of particular subject etc.

6. Conclusion

Intention of paper was to suggest or to accentuate new tendencies in engineer's education but it will be more valuable for authors if it provokes critics that could reach university board and relevant professors. Critics and noise about changes can be the most powerful initiators of changes beside causes named in introduction.

Avoiding of proposed changes could cause two main undesirable effects: insufficient engineer's education and increased costs of engineer's after-school education. Two main effects cause chain reaction, which again leads to causes stated in introduction. Therefore, every while is necessary to take corrective steps to avoid or at least to diminish undesirable effects.

Changes can be done gradually or at once. Gradual approach takes less time for implementation and causes less reaction and antagonism. It can be a good way to start process of continuous changes and revision of syllabus. On the other side, faculty management can start with several experimental open subjects.

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