The Journal of Polish Society for Geometry and Engineering Graphics
Volume 15 (2005), 30 – 34

IMPLEMENTATION OF INFORMATION TECHNOLOGIES IN ENGINEERING GRAPHICS EDUCATION

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Abstract. Implementation of the modern information technologies in Engineering Graphics education provides a good foundation for acquisition of knowledge and skills which are necessary in engineering practice. In general, we seek to develop creative invention in future engineer: he should be not only a user of CAD systems, but he should have practice of customization of the CAD software to his specific needs. This will ensure fluid adaptation of the contemporary engineer to change according to rapid development in technology. Therefore, there is of utmost importance to incorporate contemporary computer aided design technologies into teaching of engineering graphics. This paper focuses on a teaching methodology of engineering graphics within AutoCAD frameworks. Experience with visual programming languages indicates that visual languages for design might be able to provide the programming capabilities required for building parameterized designs, while at the same time integrating more closely with the drafting and solid modeling aspects of the computer design system. Support for parameterized designs is also provided in the AutoCAD, but it is quite rudimentary. AutoCAD supplies AutoLISP for programming. So the students develop the additional specialized command environment and applications of the parametric design strategy by applying AutoLISP programs. This approach enables us not only to teach students integration technologies with different commercial CAD software but this allows for students to create their own environment of the commands for computer design.

Key Words: engineering graphics, CAD, education.

1. Introduction

Engineering Graphics teaching occupies an important part in the curriculums of the technical education. The modern computer aided design (CAD) software changes dramatically the way Engineering Graphics (EG) have been taught. On the other hand, advanced technological paradigms, such as concurrent engineering (CE) product life cycle design, integrated product and process development (IPPD) have been implemented in industry to enhance productivity [1]. Although significant research has been conducted on improving the product development process and successful cases have been reported Lithuanian industry is not talking the advantage of these product development paradigms. The main reason in that the small and midsize companies cannot afford to develop in-house computer tool environment. Available commercial tools are not tailored to support specific product development needs. So emphasis in Engineering Graphics teaching should be laid on knowledge and skills for adaptation of the general purpose CAD commercial software to specific needs of the small and midsize companies. Wider access to Information Technology (IT) and the rising involvement of engineers into the computer-aided technology lead to the discontinuity in the engineering oriented computer literacy education [2].

Therefore, companies using commercial tools to support segments of their product development have to customize CAD software in order to take a full advantage of the new design paradigms. So the students have to learn how to adapt commercial CAD software for a specific application requirement. Lithuanian industry has begun to seek students who have been well trained in CAD technology and expected universities to make students equip, the modern technologies as a tool to solve engineering problems and decision-making process.

The Engineering Graphics course can be considered as an integral part of CE – related courses. The course has the following objectives: 1) to have students learn to use advanced

ISSN 1644-9363 / PLN 15.00

2D and 3D modeling strategies; 2) to have students understand parametric design paradigms by programming in AutoLISP environment; 3) to have students be able to customize and adopt for specific need the user graphical environment; 4) to have student develop concurrent work experience. The first objective is common for the most modern CAD courses, and second, third and fourth objectives reflect modern tendencies in engineering design. In this paper some aspects of a new engineering graphics course are presented.

2. Pedagogical aspects

The complexity of use of new technologies requires training and high level of qualification [3]. The teacher is compelled 'to go forward' and to represent the knowledge to the students observing the information on new technologies.

At Vilnius Gediminas Technical University we are attempting to teach both engineering graphics theory and modern technologies of computer aided design. Structure of this course is based on the knowledge transference's paradigm.

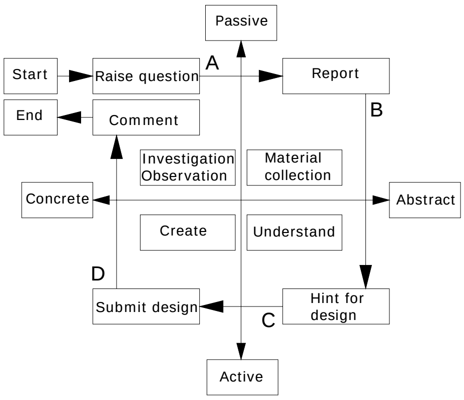


Fig. 1. Four steps for getting knowledge

The process of acquisition of knowledge by students consists of four steps [4]. Schematically all the process is shown in figure 1. The left side represents concrete knowledge based on engineering practices. The right side is abstract scientific knowledge. Vertical axis represents the way of gaining knowledge by students actively or passively. Step A represents knowledge generalization from intrinsic place through experiment or observation by passive input. Step B corresponds to active learning of existent knowledge. In step C students order their fragments of knowledge into unified system. In step D students should practice how to use the knowledge for the future. The organization of the present course in engineering graphics is constructed in the same way, starting with step A and finishing with step D.

Finding the textbooks to support is quite a challenging problem. Traditional textbooks on engineering graphics focus too much on manual drawing aspects. On other hand, majority of the textbooks dedicated to CAD technologies, in fact is the collection of possible ommands applying specific CAD software.

3. Graphical and informational aspects

The vital spatial skill for engineers is the ability to correctly visualize three dimensional objects when they are represented in two dimensions, such as in CAD software or in detailed part drawing. The use of 3D modeling by CAD software during EG course has been shown to improve the spatial ability skills of engineering students. The students must learn the effective technologies for creation of graphical objects. We can distinguish the following ways:

1) write down AutoCAD commands using command line;
2) develop macro commands serve, where by single icon several consecutive commands option will be performed;
3) integrate additionally LISP programs in to AutoCAD environment.

The first way seems to be quite effective, but CAD user has to repeat each time the routine commands. The second way is the development of macro commands in Menu Macros environment. In essence Menu Macros language can be treated as AutoCAD language. The second approach is more efficient and has less probability for the errors, more comfortable and represents the shortest path to achieve the goal in engineering drawing.

The main objective is to teach the students to develop their own commands in AutoCAD environment and very quickly develop temporal command for onetime routine operation. One of the components in adoption process of GUI (Graphics User Interface) in AutoCAD is construction of specific user's toolbars.

The AutoCAD GUI has to represent needs and habits of the single CAD operator. The GUI has to contain the minimum number of necessary toolbars. The number of the toolbars depends on operator's skill: the higher skill, the less number of toolbars in the GUI. Consequently, a larger part of the monitor is devoted to drawing area. We teach the students for the creation of the new command icons. Despite of the fact that AutoCAD 2002 already has 466 command icons, the new command icon enables to perform engineering drawing in the most efficient way including specific requirement of the engineering object and specific skills of CAD operator. Working in Menu Macros environment the students learn syntaxes of the AutoCAD commands and management of consecutive commands.

This customization process includes the following steps:

- change the place of command icon in the toolbar;
- insertion and deletion of command icons in the toolbars;
- creation of user's command icon with a new picture and make short cut to AutoCAD commands.

For the purposes of the illustration of student works let us consider customization of the specific toolbar. The user of professional CAD usually develops his own **OSNAP** toolbar. The selection is made in menu **Drafting Settings** window. It is clear, that it is more efficient technology compared to traditional approach. Sometimes it is necessary to change initial set only temporally, and later to go back to the initial set. For this purpose we develop to new command icon for the selection specific **OSNAP** toolbar case.

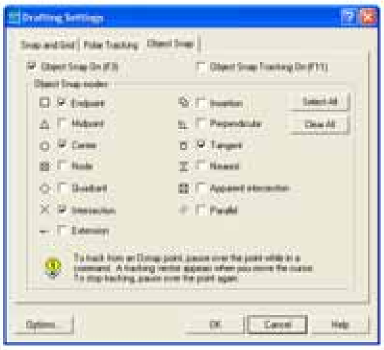


Fig. 2. **OSNAP** Setting window

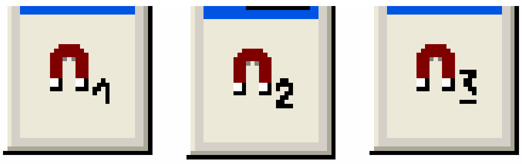


Fig. 3. Icons of command which open **OSNAP** Settings window

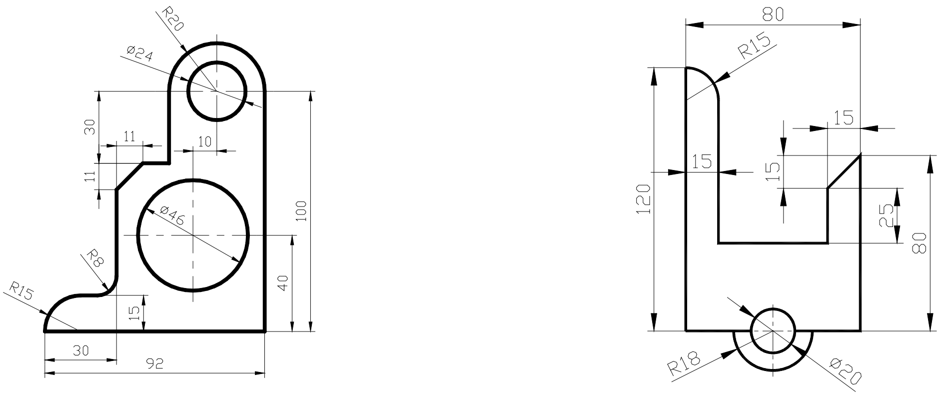
We represent typical student work – **OSNAP** toolbar customization for creation of the 2D objects (fig.2). The icons of command (fig. 3), which open OSNAP window student, create by him in order to remember this icon easily.

Commercial CAD systems propose only the framework for engineering design. So CAD operator has to create the AutoCAD applications representing specific product development needs.

Modern CAD software proposes the means for adaptation of general CAD features for specific user's needs. Therefore in EG course we have included introduction of programming in CAD systems. We have used AutoLISP in order to have automated control over the functions of AutoCAD and adopt functionality of AutoCAD for specific designer's needs. Thousands of useful utilities written by AutoLISP are available.

For example the students have to create program, by which a new drawing will be made. The drawing produced by the same program may vary in dimensions, in elements in types of sections, in text part of the drawing and so on. The time needed to produce a drawing by this approach in incomparably shorter than time needed to produce the same drawing by graphical interface. The most important thing is that any engineer can learn this technology even with the introductory knowledge of AutoCAD.

The work done by students to cover this objective is also related to parametric methodology of modern engineering technology. This work is devoted to creation of 2D object. These 2D objects consist of points and lines. All points of the segments can be described programmically, by the input of coordinates of these points. Applying AutoLISP assignment, data input, mathematical and logical function, students easily develop AutoLISP programming skills and visualize in VisualLISP environment of the AutoCAD software (fig. 4).



Homework Test

Fig. 4. Drawing created by AutoLISP program

Collaborative design is a term that denotes more than just co-operation. In co-operation participants work together to achieve mutual benefits but without having a common goal. They will retain their own resources, sharing only the minimum required for the co-operation. In collaboration however, the participants are committed to a common mission and are willing to share the knowledge that is necessary to fulfill that mission [5,6].

The students develop the collaboration experience by the performing assembly drawings. Two or three students get working drawing the assembly and they have to make separate parts working drawings (Fig. 5). We apply such an approach:

1) sketch their own parts;
2) students develop 3D model;
3) put separate 3D models of the parts into single assembly 3D model.

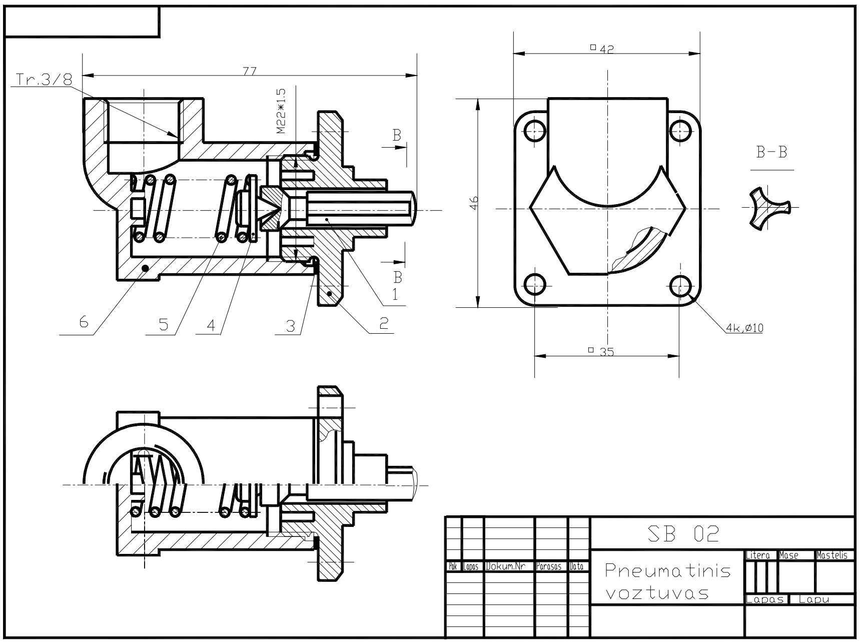


Fig. 5. Assembly drawing

4. Conclusions

Computerized systems have become standard engineering tools in the manufacturing industry. To be competitive in the industry, student must have reasonable knowledge of efficient application of commercial CAD systems in engineering design. The main objectives of engineering graphics course within AutoCAD framework have been dismissed.

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IMPLEMENTACJA TECHNOLOGII INFORMACYJNEJ W NAUCZANIU GRAFIKI INŻYNIERSKIEJ

W pracy zaprezentowano nową metodologię nauczania grafiki inżynierskiej wprowadzaną obecnie na wileńskim Uniwersytecie Technicznym im. Gedymina. Nauczanie to realizowane jest przez poznawanie obsługi komercyjnych programów graficznych, tworzenie własnych środowisk poleceń generowanych w języku AutoLISP w trzech aspektach: pedagogicznym opartym na paradygmacie zdobywania wiedzy, graficznym (geometrycznym) wyrażającym się w poprawnej wizualizacji trójwymiarowych obiektów i poprawnym ich zapisie w dwóch wymiarach oraz informatycznym przejawiającym się w nauce syntaktyki i semantyki poleceń AutoCAD i AutoLISP.