

## DEVELOPMENT OF GEOMETRY AND ENGINEERING GRAPHICS CURRICULUM FOR CIVIL ENGINEERING COURSE SOME DIFFICULTIES IN LEARNING FROM STUDENT'S POINT OF VIEW

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**Abstract.** Education of a contemporary engineer should ensure his or her fluid adaptation to changing economic and social conditions. Curriculums of technical education have strict requirements for a contemporary engineer. In teaching geometry and engineering graphics it is necessary to emphasize acquisition of knowledge and skills which are necessary in engineering practice. At university level it is very important to develop creative invention in a future graduate. Curriculum of geometry and engineering graphics has been worked out after perceptive analysis and requirements that a future civil engineer should develop during his practical education. The paper discusses in details issues connected with organisation of didactic process of geometry and engineering graphics at the Faculty of Civil Engineering. The authors cover methodical questions concerning the way of introduction of knowledge and organisation of laboratory classes. Nowadays when computer techniques are so commonly used in engineering practice it is necessary to prepare students to work and design in virtual reality. It is necessary to educate students how to work with CAD systems, but at first the students should be prepared to conception design. Curriculum of geometry and engineering graphics for students of the Faculty of Civil Engineering is an attempt of connection between descriptive methods of designing and using CAD systems.

**Key words:** geometry and engineering graphics, technical and structural drawing, computer aided design

### 1. Introduction

Education of a contemporary engineer should ensure his or her fluid adaptation to changing economic and social conditions resulting from rapid development in technology. Curriculums of technical education must strictly fulfill the needs of a future engineer.

While teaching Geometry and Engineering Graphics emphasis should be laid on knowledge and skills acquisition which are indispensable for a future engineer and, at the academic level, on development of creative initiatives of a future graduate. Undoubtedly, attention should also be put to issues connected with peculiarity of studies course.

After detailed analysis of needs and features of future engineer which should be formed during classes, a curriculum of Geometry and Engineering Graphics has been elaborated at the Faculty of Civil Engineering of Silesian University of Technology, second semester. This subject combines practical knowledge with activities which can shape necessary features of mind. According to needs of an engineer topics and methods have been selected for the classes.

### 2. Subject's characteristics

Engineering Graphics (Technical Drawing, CAD) is taught at second semester at the Faculty of Civil Engineering. For 3 years it has been realized for full time students as a subject of their choice. In academic year 2004/2005 it was also realized at part time and extramural courses as obligatory subject for the first time. Schedule assigns 15 hours of lectures and 15 hours of lab classes in a semester. During this time a student should acquire knowledge on structural drawing and have AutoCAD skills to make 2D drawings.

### 3. Subject's assumptions

During classes each student learns computer program by making complex drawings: architecture –structural drawing of a staircase, structural drawing of a reinforced element and a steel beam.

Due to the time limitation of the classes it is not possible to teach AutoCAD in a traditional way by gradually introducing these commands, which match the drawing assignment. Undoubtedly, there are drawbacks caused by simultaneous learning of standards used in a technical drawing together with learning a new computer program.

The individuality of the classes required proper organization of didactic processes from the very beginning. Realizing that the students will need possibly the most time for AutoCAD learning in a computer lab, the curriculum was realized in the following way:

During lectures the students got to know problems concerning structural documentation in a form of drawings using multimedia techniques. It has been decided that this form of presentation will be better and easier absorbed by students. This time has also been devoted to conceptual preparation of designs in a form of freehand drafts. Drafts at this stage were approved by a teacher so that on that basis a student, who later makes a drawing in AutoCAD can focus on program learning not on the drawing itself.

Supplementary materials elaborated for this subject with basic information on structural drawing and fundamentals of AutoCAD program with proper examples of application, additionally facilitated learning. 2-hour-lectures with classes were conducted in the first half of a semester.

Laboratory classes began two weeks later in the same semester when students have learned drafts which form a base for their first drawing assignment. The form of laboratory classes assumes independent and individual student's work on a computer with constant advice from a teacher. Program presentation is also used here sometimes. The teacher presents principle of operation of selected commands of program by computer projector during laboratory classes.

### 4. Aim and subject of research

Experience from program realization inspired research with the following aims:

- Characteristics of a student who chooses the subject
- Focusing on difficulties in learning from student's point of view
- Checking correctness of preliminary assumptions connected with didactic process (a form of a lecture, form of laboratory classes, supplementary materials used during classes)

### 5. Characteristics of a test group

Table 1: Characteristics of a test group

|                              |
|------------------------------|
| Numer of people – <b>111</b> |
| Including:                   |
| Women – 25 – <b>22,5 %</b>   |
| Men – 86 – <b>77,5%</b>      |

Table 2: Characteristics of a test group with division according to type of studies

| <b>Full time students</b>                        | <b>Part time students</b>                           | <b>Extramural students</b>                      |
|--|---|---|
| Number of people – <b>29</b>                     | Number of people – <b>29</b>                        | Number of people – <b>53</b>                    |
| inc:   | inc:  | inc:  |
| women – 11 – <b>38%</b><br>men – 18 – <b>62%</b> | women – 5 – <b>17,2%</b><br>men – 24 – <b>82,8%</b> | women – 9 – <b>17%</b><br>men – 44 – <b>83%</b> |

The first element which characterizes test group of students is significantly different number of male and female students in a group. It results from peculiarity of science studies (in this case civil engineering) which is still predominantly masculine.

### 5.1. Knowledge of technical drawing

In the questionnaire there was a question about knowledge on technical drawing. Students could choose one of the four answers which stated when at their education process they learnt about technical drawing.

Table 3: Did you come across issues concerning technical drawing at school before your studies?

| Yes, in a primary school | Yes, in a secondary school | Yes, in a primary and a secondary school | No         |
|--------------------------|----------------------------|--|------------|
| 17 – 15,4%               | 44- 39,6%                  | 25 – 22,5%                               | 25 – 22,5% |

The results give characteristics of a test group, determine preliminary level of students' knowledge on technical drawing. More than 20% of the students had no knowledge of technical drawing at school. They can be compared to 7 years olds who start learning reading and writing in primary school. 15% got to know issues on technical drawing in primary school and it can be assumed that it is basic knowledge and the scope of topics needs further research.

For more than a half of students who filled in the questionnaire, the process of learning issues concerning technical drawing is of a constant character and covers both primary and secondary school.

To sum up we have a group of students who in their half are learning the basics of technical drawing and people having some knowledge on the subject.

Consciousness of what level of knowledge a student has when he starts learning a subject is especially important in didactic process. It allows determination of which group of issues is unknown for students and therefore requires more detailed discussions.

### 5.2. Knowledge on structural drawing

Next element which characterizes knowledge of students undergoing the test, is the knowledge of structural drawing. A question has been asked if before their studies at the Faculty of Civil Engineering at SUT they learned structural drawing or had any experience with it in their work.

Table 4: Did you learn structural drawing before your studies ?

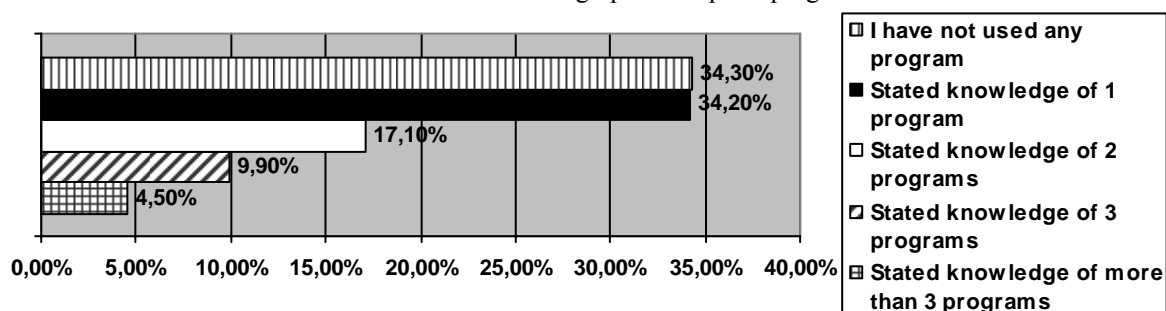
| Yes        | No         |
|------------|------------|
| 51 – 45,9% | 60 – 54,1% |

On the basis of the results it can be stated that more than a half of the students did not learn structural drawing before their studies at the Faculty of Civil Engineering. These issues are for that group new items which they learn from basics.

### 5.3. Knowledge of graphic computer programs

Knowledge of graphic computer programs is a significant element of knowledge of tested students as far as classes and research are concerned. Therefore, it was important to determine if the students have used any graphic programs before their studies and what they were.

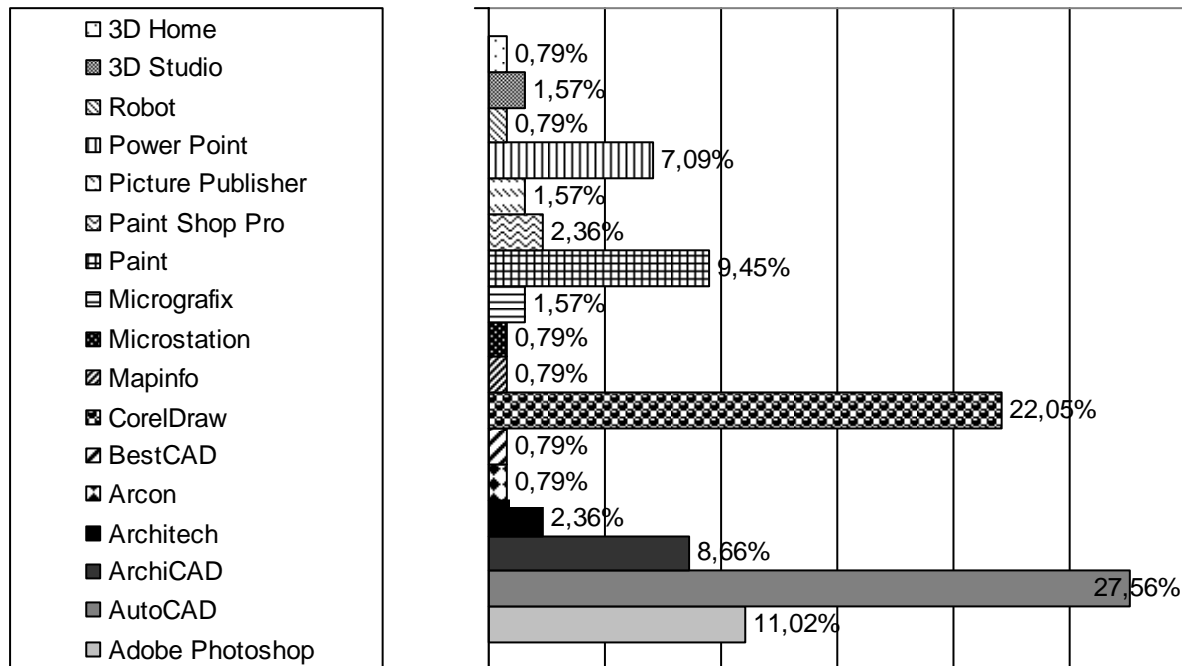
Chart 1. Number of known graphic computer programs



For more than 30% of students knowledge of any graphic computer aided design program is a new phenomenon. Next 30% used at least 1 CAD program whereas the rest of the group of students states to know more than 2 computer graphic programs. They can be seen as experienced users of CAD programs.

After having found what computer aided design programs were used by the students and how can they define such a computer program has become a very interesting issue. The largest group declared knowledge of AutoCAD and CorelDraw, thus the two last seem to be the most popular and 'present' on Polish market of computer programs.

Chart 2. What graphic computer programs have you used so far



## 6. Subject evaluation by students

Assumptions for the subject made at the beginning and their realization in didactic process were evaluated by the test students. What they verified was a form of lecture, usefulness of supplementary materials and also they were asked to show difficulties in learning and formulate their opinions and comments freely about the subject.

### 6.1. Form of a lecture

70% of tested students prefers a lecture in multimedia form. Illustrative form of a lecture is very clear in that form. It also seems that more modern way is of greater value than traditional one –blackboard and chalk.

Table 5. What form of lectures suites you the most?

| Traditional form<br>(on blackboard with chalk) | Multimedia form<br>(projector) | No difference for me |
|--|--------------------------------|----------------------|
| 18 – 16,2%                                     | 78- 70,3%                      | 15 – 13,5%           |

### 6.2. Usefulness of supplementary materials

86% of students evaluated supplementary materials as useful and it can be concluded that they are used in studying.

Table 6. Do you think supplementary materials for technical drawing and CAD help in learning ?

| Yes        | No      | I don't know I don't use them |
|------------|---------|-------------------------------|
| 95 – 86,4% | 5- 4,5% | 10 – 9,1%                     |

### 6.3. Difficulties in learning the subject

For more than half of the tested students learning structural drawing and AutoCAD does not create any difficulty in learning the subject. However, there is a clear group of 30% students who point to AutoCAD as a difficulty.

Table 7. What difficulties do you come across in learning the subject?

| Structural drawing | AutoCAD   | Both structural drawing and AutoCAD | None of these |
|--------------------|-----------|-------------------------------------|---------------|
| 6 – 5,7%           | 32- 30,5% | 6 – 5,7%                            | 61 – 58,1%    |

### 6.4. Free evaluation of the subject- students' opinions and comments

In students' evaluations predominant remarks concern too little time devoted to computer lab (14 students). They also pay attention to too fast pace of classes (1 person). This remark can be connected with the number of lab classes stated in syllabus. There are also suggestions on greater number of hours in computer lab (5 persons).

## 7. Summary of research and final conclusions

Results received in the carried out research confirm the assumptions about organization of a didactic process.

34,30% of students declared that they have not used any graphic program and 30,5% of students showed AutoCAD as a difficulty in learning the subject. So it can be seen a clear correlation between stated lack of knowledge of graphic programs and stating as difficulty in learning the subject – the knowledge of Auto CAD program.

For more than half of a group of students issues of structural drawing are new – for 54,1% of a group. But for great majority of students (88,6%) learning structural drawing is not a problem. This fact can be connected with good usage of materials by students – 86,4% of them estimate that supplementary materials for technical drawing and CAD help in learning. So there is close correlation between usefulness evaluation of supplementary materials and determination of difficulty in learning the subject.

The correctness of choice of lecture as a form of presentation has also been proved. 70,3% of students suit the most multimedia form of lecture.

Based on free evaluation of the subject by student it can be stated that the time assigned to computer work (resulting from syllabus) is not sufficient. This problem is solved currently by additional duty hours.

It seems to be reasonable to change the syllabus and devote 10 hours to lectures and 20 hours to lab classes in a semester.

### References

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## KSZTAŁTOWANIE PROGRAMU NAUCZANIA GEOMETRII I GRAFIKI INŻYNIERSKIEJ DLA KIERUNKU BUDOWNICTWO

Wykształcenie współczesnego inżyniera powinno możliwie najpełniej zapewniać jego płynne dostosowanie się do zmieniających się warunków gospodarczych i społecznych wyni-

kających z niezwykle szybkiego postępu w dziedzinie technologii. Programy politechnicznego nauczania muszą ściśle przystawać do potrzeb przyszłego inżyniera. W nauczaniu Geometrii i Grafiki Inżynierskiej należy stawiać nacisk na nabywanie wiedzy i umiejętności niezbędnych w działalności inżynierskiej. Na poziomie uniwersyteckim jest niezwykle istotne rozwijanie kreatywności przyszłego absolwenta. Program nauczania Geometrii i grafiki inżynierskiej opracowano po wnikliwej analizie cech i potrzeb przyszłego inżyniera, które należy kształtować w trakcie prowadzonych zajęć. Referat w sposób szczegółowy omawia zagadnienia związane z organizacją procesu dydaktycznego przedmiotu Geometria i Grafika Inżynierska. Poruszone zostają zagadnienia natury metodycznej odnoszące się zarówno do sposobu prezentacji obowiązującego zakresu wiedzy, jak też prowadzonych zajęć laboratoryjnych, z wykorzystaniem możliwości sprzętu i oprogramowania komputerowego. Obecnie kiedy techniki komputerowe są tak powszechnie używane w praktyce inżynierskiej koniecznym jest przygotowanie studentów do pracy i projektowania w przestrzeni wirtualnej. Koniecznym jest nauczenie studentów jak pracować z systemami CAD, ale w pierwszej kolejności studenci powinni być przygotowani do projektowania koncepcyjnego. Program nauczania geometrii i grafiki inżynierskiej dla studentów Wydziału Budownictwa jest próbą połączenia wykreślnych metod projektowania i projektowania z użyciem systemów CAD.