ENGINEERING GRAPHICS OVER THE YEARS

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ABSTRACT

In this article the author talks about the development and transformation of the subject "Engineering Graphics" over the last 15 years. Author analyzes the content of the parts of the particular subject – descriptive geometry, civil engineering drawing and computer graphics and describes the relation between them. Author gives the examples of themes and the statistics of hours and talks about her experience.

KEYWORDS: Engineering Graphics, Descriptive Geometry, Education

INTRODUCTION

The education in Latvia has gone through drastic changes during the last years. The same has happened with the subject Engineering graphics. The reasons were different – political, economical, ideological and subjective. Here I want to talk about outcomes of these changes. My work is connected with students of Faculty of Architecture and Faculty of Civil Engineering and in this paper the content of learning programs for those specialities is analyzed.

1. STATISTIC

15 years ago number of hours for our students was double in comparison with today's number of hours (Table 1 and Table 2). Both of the tables extend to the descriptive geometry and classical drawing. In this situation we were compelled to decrease number of tasks and themes. There were some themes which were deleted from program at all.

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Table 1.
Number of hours for students of Faculty of Architecture in years 1994 and 2009.

Year	Course	Semester	Hours per week	Weeks	Hours per semester
1994	1	1	4	16	64
1994	1	2	3	16	48
			Total in year 1994		**112**
2009	1	1	2	16	32
2009	1	2	2	16	32
			Total in year 2009		***64***

Table 2. Number of hours for students
of Faculty of Civil Engineering in years 1994 and 2009.

Year	Course	Semester	Hours per week	Weeks	Hours per semester
1994	1	1	3	16	48
1994	1	2	3	16	48
1994	2	3	2	16	32
			Total in year 1994		**128**
2009	1	1	2	16	32
2009	2	4	2	16	32
			Total in year 2009		**64**

Total number of hours for our department decreased in first years and then it started slowly to increase. Why? It went up because our department got some hours for a new subject - Computer graphics. Unfortunately those hours are for optional subjects. Nevertheless it is better to have a few optional hours than none at all.

2. CONTENT OF SUBJECTS

Today the Department of Computer Aided Engineering Graphics at Riga Technical University works with many educational programs which can be grouped according to; three general directions:

- Descriptive geometry – includes theory, methods and constructions (today only for architects). The theory of descriptive geometry is essential forever, but we can reduce complicated manuals constructions and hard theoretical proofs [1];
- Engineering graphics – includes introduction of descriptive geometry, projection drawing, civil engineering drawing and mechanical

engineering drawing. There we have reduced number of tasks and examples. It is a pity, the part of descriptive geometry is minimized, but "Descriptive Geometry" is unique in the way how it induces spatial reasoning, which is so fundamental for each creative activity of engineers, and how it trains the ability to express spatial ideas graphically so that they become understandable for anybody else [2].

- Computer graphic/modeling – includes general overview about application, development and kinds of computer programs and BIM modeling (obligatory subject only for architects) and training courses for programs AutoCAD, ArchiCAD, Revit, SEMA and SolidWorks. The two main objectives – imaging and analysing of 3D objects [3] are common for both - descriptive geometry and computer modeling. Producing attractive illustrations is the common objective too.

During the training course we use not only examples of tasks from classical course, but themes of classical geometry too. Thus some themes which were eliminated from the obligatory standard program were put in the computer graphics as examples and tasks. It is the way to minimize losses by decreasing the number of hours. Which themes of descriptive geometry are applicable for computer graphics? Actually all, but I would like to point out exactly the eliminated themes.

3. COMMON THEMES

The themes of descriptive geometry can be used in two-dimensional computer drawing and in three-dimensional computer modeling. The abundance of graphic information reduces to the essential amount [4] by itself, because the primary aim is to teach software. By two-dimensional computer drawing we discuss the following themes:

- Connections. This theme has been the first task in the training course for two-dimensional drawing in AutoCAD for years. It relates not only to common commands in AutoCAD like Chamfer, Fillet, Trim, Extend, Join and so on, but requires to make geometrical constructions as well.
- Intersection of surfaces. This theme is deleted from the standard program at all and students often have problems to understand how to draw (in two-dimensional drawing), for example, two intersected pipes (two cylinders) or some other parts of detail witch intersect each other. Nevertheless such constructions enhance mental orientation in 3D space.

By three-dimensional computer modeling we discuss the following themes:

- Surfaces. The theme "Surfaces" in the standard program is limited by the basic forms like prism, pyramid, cone, cylinder and sphere. For more complicated surfaces we have not a sufficient number of hours, whereas within the framework of three-dimensional computer modeling we can talk about different kinds of creation of surfaces and we can model all of them. Of course, we discuss the kinds of surfaces whose modeling is available in software. The most popular in different software are surfaces created by extrusion, revolving, sweep and blend and composition of their solid and void parts. Creating of surfaces is an important theme because in program AutoCAD 3D, Revit and others there are possibilities to make a building from *massing* object.
- 3D views. In standard program only axonometric views are included. Five kinds of axonometric views are available in ArchiCAD and students can easily make their object in different axonometric views and compare them. Axonometric view is default 3D view in Revit. So our students know what axonometric views are. The situation is completely different with perspective. Theory of perspective views has been preserved in the standard program only for architects. Other students know nothing about it after completing the standard program. So I must explain them principles and kinds of perspective views in the computer training course. Why do vertical lines sometimes look vertical, but sometimes not? Why does a perspective view made by computer sometimes look so strange? Is such a view correct? It is essential to know the theory, because perspective views are in the base of animation – walkthrough, which can be created only by computer. Not in a classical way. To get good walkthrough student must know basic rules of perspective views and it is easy to demonstrate them by computer. Descriptive geometry makes the contribution in computer software and vice versa – computer graphics sets new targets to descriptive geometry for example connected with animation design. [4].

4. STATISTIC TODAY

All the above mentioned is usable only for civil engineering students because today's situation with graphical subjects for architects is the following (Table 3):

Table 3. Number of hours for architects in year 2009

Course	Subject	Semester	Hours per week	Weeks	Hours per semester	Status
1	Descript. geom.	1	2	16	32	Obligatory
1	Descript. geom.	2	2	16	32	Obligatory
2	AutoCAD	3	3	16	48	Obligatory (not in our department)
3	Computer application	5	2	16	32	Obligatory
				Total	**96** + 48	

For architects there are small opportunities to channel some themes to computer graphics because, unfortunately, the AutoCAD is not taught by our lectors. Subject Computer application is not suitable for teaching geometry. Students of Faculty of Architecture have a possibility to choose from among optional subjects, but unfortunately, lately our architects prefer having languages Japanese and Chinese included.

In Table 4 we can see distribution of number of hours for Faculty of Civil Engineering. Engineering graphics for civil engineers consists of introduction to descriptive geometry and projection drawing. Then, in the second course they learn AutoCAD, optional, but in large quantities and in the next semester they make civil engineering drawing with AutoCAD. While AutoCAD is an optional subject, we cannot force students to make their drawings with computer.

Table 4. Number of hours for civil engineers in year 2009

Course	Subject	Semes-ter	Hours per week	Weeks	Hours per semester	Status
1	Eng. Graph.	1	2	16	32	Obligatory
2	AutoCAD	3	2	16	32	Optional
2	Civil eng. drawing	4	2	16	32	Obligatory
3	ArchiCAD or Revit or SEMA	5,6	2	16	32	Optional
				Total	**64 + 64**	

So there is a possibility to draw with a pencil, too, and it is interesting that many students choose pencil drawing only for some tasks, for example for quoted projections. Obligatory subject Civil engineering drawing includes introducing 3D modeling with ArchiCAD as well.
Optional subject Computer modeling in the third course proposes training courses for BIM modeling with programs ArchiCAD-next level or Revit or SEMA. Year by year our civil engineers chose a couple of them and in great numbers.

5. CONCLUSIONS

- Computer graphics is part of graphical education of engineers.
- Computer graphics is the sum of knowledge about geometry and knowledge about software.
- Computer graphics can capture part of the themes of classical descriptive geometry for itself.
- Classical descriptive geometry can reduce a number of methods and constructions, but theory is essential for both – descriptive geometry and computer modeling.
- The right balance between imparting knowledge on the one hand and the intelligent use of powerful computer programs on the other, is a topical problem of methodology.
- Anyway, descriptive geometry and computer modeling have a common additional aim to develop and refine the students' spatial abilities and problem solving skills.

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