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Proceedings

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ENGINEERING GRAPHICS EDUCATION

BALTGRAF – 20th JUBILEE

Rein Mägi[1]

1. ABSTRACT

20 years ago in 1991, after revolutionary political events, representatives from engineering graphics departments of three Baltic States founded the International Association BALTGRAF. Since 1992 regular international conferences on engineering graphics have been organized in Vilnius, Riga and Tallinn. The last conference BALTGRAF-10 took place in Vilnius Gediminas Technical University in 2009. The next conference BALTGRAF-11 takes place in Tallinn University of Technology in June 2011

KEYWORDS: Engineering Graphics, Baltic States, Engineering Education

2. INTRODUCTION

20 years ago on 5th November 1991, after revolutionary political events (crash of the Soviet Union), representatives from engineering graphics departments of three Baltic States met in Vilnius Technical University. They declared:
Considering:

- changed political status of our states,

- necessity to coordinate our efforts in engineering education,

- necessity to assure concordance of diplomas (bachelor's and master's degree) of our states,

to found the **International Association BALTGRAF** of engineering graphics departments of Estonia, Latvia and Lithuania.
The aims of BALTGRAF were:

- to coordinate our efforts in methodical and program equipment of departments of engineering graphics,

- to coordinate researches of our departments in sphere of engineering and computer graphics,

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- to coordinate our efforts in adaptation of international standards of technical drawings,
- to organize international conferences refer to problems of engineering graphics departments,
- to consolidate our efforts in sphere of named problems with other universities of Baltic region.

Professor **Petras Audzijonis** from Vilnius Technical University was selected as the **first president of BALTGRAF**.

3. BALTGRAF CONFERENCES

Founders of the Association decided to regularly (every 2 years) organize international conferences on engineering graphics.

The first conference of BALTGRAF took place in Vilnius Gediminas Technical University in 1992 [1]. There were 17 presentations – about descriptive geometry, technical drawing and computer drawing. The introduction of proceedings of the conference points out that the main goal of engineering graphics is **graphical literacy** – ability to create and understand technical drawing. This ability is indispensable for hand-drawing and also for computer-drawing. The serious problem for all participants was diminishing of capacity of graphic subjects in technical universities and secondary schools.

The **second conference of BALTGRAF** took place also in Vilnius Gediminas Technical University in 1994 [2]. 18 papers were presented. One of the conference topics was transition from GOST-standards (standards of the Soviet Union) to international standards ISO. All GOST-standards were absolutely obligatory – non-execution of them was even punishable (*Несоблюдение стандарта преследуется по закону*). ISO standards are in principle voluntary to use, but they are obligatory for creating European and national standards.

The next **3rd BALTGRAF conference** was organized by Tallinn Technical University in 1996 [3]. 18 presentations treated of didactic researches, international standards and also present and future of computer graphics. As the **second president of BALTGRAF** was selected **Rein Mägi** from Tallinn Technical University.

The next **4th BALTGRAF conference** took place traditionally in Vilnius Gediminas Technical University in 1998 [4]. 22 papers were presented. The purpose of some articles is to study specific features of CAD (Computer

Aided Design) for making CAD-process not only modern but also comfortable, quick and economic one.

In the **5th BALTGRAF conference** (2000) in Tallinn Technical University there were represented 22 papers – 14 from Lithuania, 7 from Estonia and 1 from Latvia [5]. Majority of presentations (80 %) were connected with computer graphics. Lithuanian technical drawing standards based on ISO were created.

After conference the **International Association BALTGRAF decided**:

- To contribute to enhance teaching level of engineering graphics disciplines in secondary schools

- To stop the catastrophic decrease of the number of engineering graphics lessons in technical universities

- To develop the effective trends of more contemporary info-technology. In this case it is necessary to innovate regularly computer graphics software and hardware

- To continue and expand up the present successful activity of the International Association BALTGRAF

- To organize the next conference BALTGRAF-6 in the summer 2002 in Riga Technical University.

As decided the next **conference BALTGRAF-6** took place in Riga Technical University in 2002 [6]. It was the most numerous one – 44 presentations. Papers were divided to 4 subsections: 1) CAD in Engineering (14 papers); 2)Graphics Educations (20); 3)Descriptive Geometry and Engineering Drawing (6); 4)Standards of Technical Graphics (4). Professor **Modris Dobelis** from Riga Technical University was selected as the **third president of BALTGRAF**. The new logo of BALTGRAF was selected (Fig.1) and BALTGRAF homepage was created (http://grafika.bf.rtu.lv/BALTGRAF.htm).

Figure 1. The logo of BALTGRAF

The **7th BALTGRAF conference** was organized by Vilnius Gediminas Technical University in 2004 [7]. 41 presentations were divided to 4 subsections: 1) Theoretical aspects (8 papers); 2) CAD and CAD applications (12 papers); 3) Graphics education (16 papers); 4) Standards in engineering graphics (5 papers). The new trend was **e-learning** of graphical subjects. E-learning will open new opportunities for lecturers and students due to wide extension of internet nowadays.

The **8th BALTGRAF** conference took place in Tallinn University of Technology (TUT) in June 2006 [8]. 37 presentations were divided to 5 subsections: 1) Descriptive Geometry (6 papers); 2) Technical Drawing (6 papers); 3) Engineering Computer Graphics (15 papers); 4) Standards of Technical Graphics (3 papers); 5) Graphic Education (7 papers). Quite actual theme was the visualization problem. **Visualization** in engineering graphics can better help to understand the topic. PowerPoint presentations [9], screen-videos [10], learning-videos [11] and animating possibilities of AutoCAD [12] were demonstrated.

At the **9th BALTGRAF conference** (2008) [13] at Riga Technical University, 43 papers were represented – 21 from Lithuania, 8 from Estonia, 6 from Latvia, 6 from Poland, 1 from Slovakia and 1 from Germany. Professor **Daiva Makuténiené** of Vilnius Gediminas Technical University was selected as the **fourth president of BALTGRAF**.

The **10th BALTGRAF conference** [14] was organized extraordinarily in 2009 in cultural capital Vilnius. Maybe due to economical crisis, only 31

papers were presented - 16 from Lithuania, 5 from Latvia, 5 from Poland, 4 from Estonia and 1 from Slovakia.

The current **11th BALTGRAF conference** is organized by Tallinn University of Technology [15]   in the European Capital of Culture 2011 Tallinn. 26 papers were presented - 9 from Lithuania, 8 from Estonia (1 co-author from Germany), 6 from Latvia, 1 from Ukraine, 1 from Poland, and 1 from Austria. All participants are celebrating the 20th anniversary of BALTGRAF!

The next **12th BALTGRAF conference** will take place in Riga Technical University in 2013.

3. CONCLUSIONS

- **The International Association BALTGRAF**, founded 20 years ago, is like a **symbol of the reestablishment of independence** in Lithuania, Latvia and Estonia.
- Regularly organized conferences enable to meet lecturers and specialists of engineering graphics, to **analyze** the present situation and to **plan** new developments for future.

Long live 20-years BALTGRAF!

Figure 2. illustrates the dynamic development of BALTGRAF

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CHARACTERISTICS OF NEW GENERATION OF LATVIAN STUDENTS

Ieva Jurane[1]

1. ABSTRACT

During the last decades the development of new technologies has been rapid and overall. In the presence of computer games a new generation has grown up. Many scholars have researched their way of thinking and Marc Prensky has developed interesting and applicable conclusions. They invite changes in teaching styles. However, these conclusions refer to American students.
The author of this topic aims to understand the validity of these conclusions in Latvia. The main questions addressed in this topic are if nowadays students in Latvia are representatives of Games Generation, which conclusions are correct concerning students of Riga Technical University and how we can use this information for improving study programmes. The material of the research is a questionnaire for students in the Department of Computer Aided Engineering Graphics.

KEYWORDS: Games Generation, Engineering Graphics, Descriptive Geometry, Education, Learning style

2. INTRODUCTION

Marc Prensky, a worldwide speaker on education, is the author of three books, including the recently published *Teaching Digital Natives — Partnering for Real Learning* (Corwin Press, 2010). He has also written many articles about common issues between the learning process and computer games, elements in computer games which could be valuable to be adapted in education and, what is very significant, he has made conclusions how continuous playing of computer games effect human's thinking and action. "Today's students – K through college – represent the first generations to grow up with this new technology. They have spent their entire lives surrounded by and using computers, videogames, digital music players, video cams, cell phones, and all the other toys and tools of the digital age. Today's average college grads have spent less than 5,000 hours of their lives

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reading, but over 10,000 hours playing video games (not to mention 20,000 hours watching TV). Computer games, email, the Internet, cell phones and instant messaging are integral parts of their lives. Some refer to them as the N-[for Net]-gen or D-[for digital]-gen. But the most useful designation I have found for them is ***Digital Natives.*** Our students today are all "native speakers" of the digital language of computers, video games and the Internet. " [3]. In other articles M. Prensky has called the generation who has grown up with computer games as Games Generation. The name is referred to children who initially begin playing games and only later they begin to learn writing and reading or the processes are parallel. He speaks about children who are accompanied with computers, cell phones, play consoles and other IT (Information Technologies) gadgets from their early childhood. Of course, everything he has concluded and described is based on researches and observations in America.

A research by social psychologists [1] shows that people who grow up in different cultures do not just think about different things, they actually *think differently*. The environment and culture in which people are raised affect and even determine many of their thought processes. So, people who undergo different inputs from the media and culture that surround them can, and do, think differently. This made me to be interested if the students in Latvia nowadays are representatives of Games Generation and which conclusions are correct concerning students of Riga Technical University and how we can use this information for improving study programmes.

To find this out a questionnaire was designed and the survey was conducted among 142 first year students of Riga Technical University, Faculty of Architecture and Faculty of Civil Engineering.

3. GENERATION OF STUDENTS IN LATVIA NOWADAYS – ARE THEY REPRESENTATIVES OF GAMES GENERATION?

The first question to be clarified is when our students have begun to use a computer. M. Prensky in his book "Digital Game-Based Learning" [2] has included such quotation "I've *never lived in a house without a computer."*- Michelle Reed, 25-year-old editor of this book. Thus, the first question in the questionnaire was: "Has a computer always been at your house during your life?" 83% of respondents answered "NO". Respondents are the first year students, thus about 18-20 years old.

For the question "At what age did you start using a computer?" (Fig.1) – 15% answered – in pre–school age (until 7 years), 27% started using computer in primary school (7-10 years), 34% - started using in the age of 10-12 years, 23% - in the age of 13-15 years. Only one student answered that he started

using computer in the age of 19 years. Thus, in total 76% students had started using computer and playing computer games until the age of 12 years.
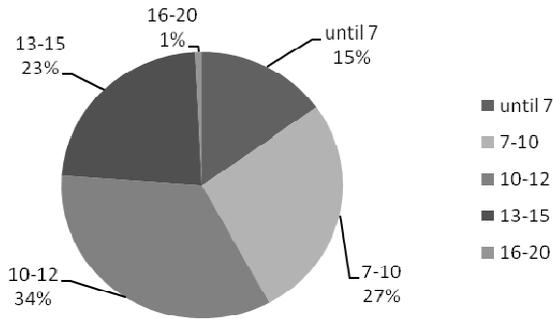
Figure 1. At what age did you start using a computer?

40% said they have been playing computer games every day or 2-3 times per week. Only 7% said they are not playing computer games anymore now.
 In order to change the thinking pattern either by technologies or any other thing, there must be a continuous effect with attention concentration. However a person's thinking patterns do not just change overnight. Scientific Learning's Fast ForWard programme requires students to spend 100 minutes a day, 5 days a week, for 5 to 10 weeks to create desired changes, because "it takes sharply focused attention to rewire a brain." [3]. When asking a direct question "Has there been a situation when you play computer games every day for an hour or more, five days per week during several months?" the answer "YES" was for 32% and 1% said the situation is also continuing now. Thus, it is not yet possible to talk about an overall effect of computer games in this age group according to these criteria. However, 33% is much and using computer until the age of 12 (75%) proves we can assign a great part of our youth to a generation called Digital Natives or Games Generation by M. Prensky. Moreover, a new generation which will be at university after some years is rapidly growing, and the percentage given above will be even higher.

4. CHANGES OF COGNITIVE STYLE BY M.PRENSKY in correlation with the results of the survey

Below there are ten of the main cognitive style changes that M.Prensky has observed in the Games Generation, all of which raise a number of important and difficult challenges for education, training, and business in general:

1. Twitch speed vs. conventional speed
2. Parallel processing vs. linear processing
3. Random access vs. step-by-step
4. Graphics first vs. text first
5. Connected vs. standalone
6. Active vs. passive
7. Play vs. work
8. Payoff vs. patience
9. Fantasy vs. reality
10. Technology-as-friend vs. technology-as-foe

What can be attested from this by a survey? Students can not judge themselves the speed of their perception in comparison with other generations. However, for the question "Do you do several things simultaneously?" the students answered as follows: 15% - Yes, always, 20% - often, 52% sometimes, 13%- never. Thus, in total 35% does it always or often, but the greatest part does not. However, many students pointed out they have been listening to music although they do not perceive it to be a parallel action but a background.
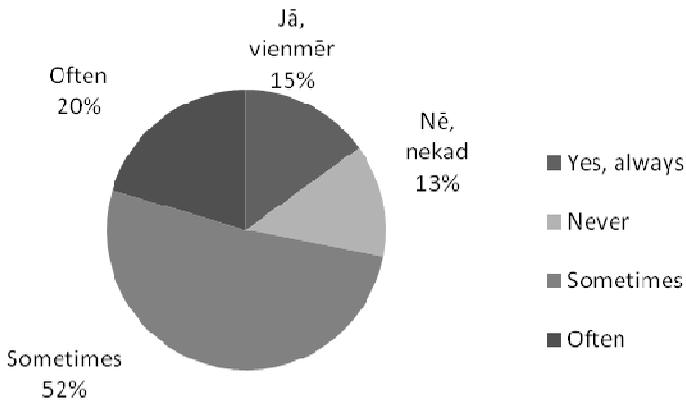
Figure 2. Answers to the question
"Do you do several things simultaneously?"

One expression of the computer game impact on children is changes of information processing process from linear step-by-step processing to parallel processing with twitch speed and random access. They have been adjusting or programming their brains to the speed, interactivity, and other

factors in the games, much as boomers' (a previous generation) brains were programmed to accommodate television. Some scientists suggest at least two other major "brain programmings" in human history—one dealing with the need to deal with radical change and the other to deal with the invention of written language and reading where the brain had to be retrained to deal with things in a highly linear way. Currently an opposite process is going on.

Nowadays many teachers say children do not read books. However, the most part of our students answered they like reading books and during holidays 41% can read books for hours. 7% of students read several books simultaneously.
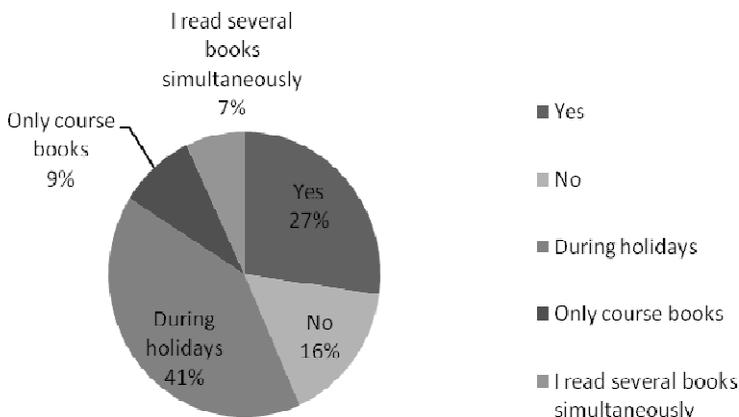
Figure 3. Answers to the question "Do you read books for hours?"

However, the answers to the question "Do you like sequential linear information layout?" were as follows: Exhaust – 20%, bore – 20%, like - 32%, don't like but it is useful – 28%. Thus, in total 60% believe sequential linear information layout to be useful. This does not give a real confirmation in this point for M. Prensky's conclusions. Our students have not been deprogrammed to read books.

When answering the question "Is it easier for you to perceive information from a text or picture?" 77% answered it is easier from a picture 15% - from a text, 8% - together from both. In this way graphic subjects have advantages as all actions are mainly connected with pictures – drawings.

M. Prensky discusses the Games Generation has been raised with, and become accustomed to, the worldwide connectedness of email, broadcast messages, bulletin boards, usegroups, chat, multiplayer games, and instant

messaging. The "connectedness" of the Games Generation has also made them much less constrained by their physical location and more willing to work in the so-called virtual teams.

Mentality and technical possibilities of Latvian people differ from American situation. The most part of respondents (57%) admitted they better study alone and 33% of students use information from books and lectures.
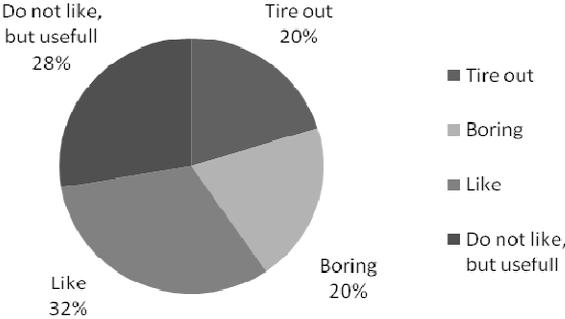
Figure 4. Answers to the question:
"Do you like sequential linear information layout?"

M. Prensky believes computer games and other technologies facilitate people's active attitude towards life and work. 54% of respondents admitted they attitude towards studies to be passive. When asking a question "Do you do only what must be done?" the answers proved even higher passivity - 58% said "YES".

"Play vs. work" means the new generation would like to gain knowledge in a more pleasant way instead of hard work. It sounds to be logical for any generation but 54% answered "NO". There were comments it could be appropriate for small children but not for students. I believe the quality of a game would determine if it is necessary at university or not. While we do not have such games, the answer would be "do not know". This was the answer of 26% of respondents.
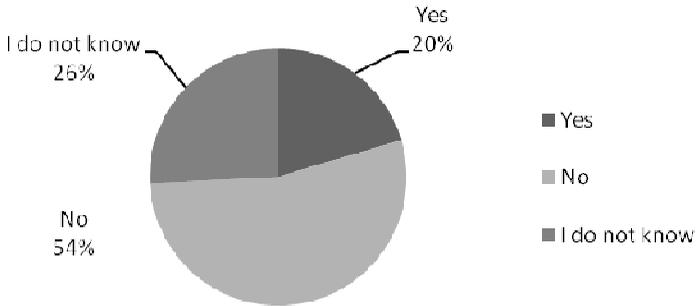
Figure 5. Answers to the question "Do you think it would be useful to introduce computer games for studying?"

My observation proves that 3D computer modelling works similarly to a computer game, i.e. the process excites and involves. Our first year architects acquire it independently and it is not obligatory but it is interesting and useful. Working out physical models (of paper) 43% of architecture students believe to be interesting and 10% to be a game.
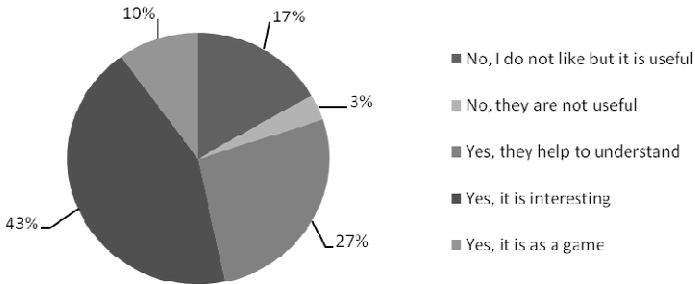
Figure 6. Answers to the question "Do you like creating models?"

One of the biggest lessons the Games Generation learned from growing up with video games is that if you put in the hours and master the game, you will be rewarded—with the next level, with a win, with a place on the high scorers' list. What you do determines what you get, and what you get is worth the effort you put in. Computers excel at giving feedback, and the payoff for any action is typically extremely clear.
The results of the survey do not confirm it. Only 15% confirm it but 25% evaluate it to be similar to interest in the subject and its teaching quality.
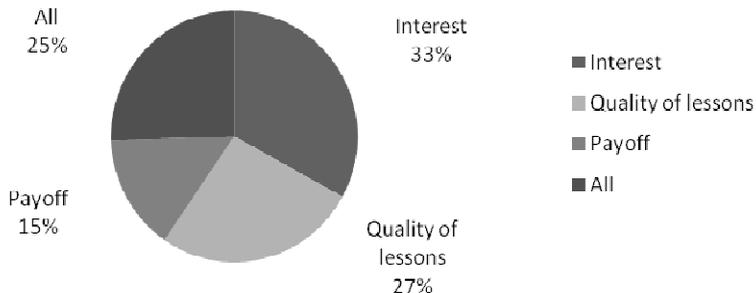
Figure 7. Answers to the question "What effects more your study activity?"

Technologies, films and literature nowadays support and cultivate the world of fantasy. When asking the question "Do you like tasks where you can show your fantasy and creativity?" 70% of respondents answered "YES".

"For adults computer skills are a tool, but for teenagers using computers has become a second language," writes Moore. Latvian students agree with it. Only one respondent admits IT to be a burden and 5% can deal without IT.
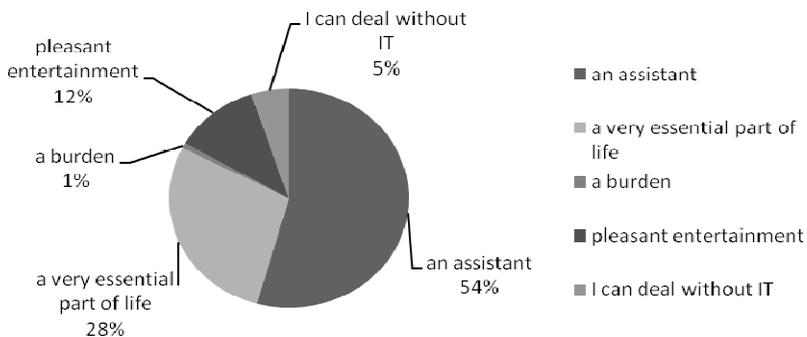
Figure 8. Answers to the question "Do you believe different technologies nowadays to be as …?"

5. SUMMARY OF RESULTS

The summary of the survey shows the effect of IT and computer games in Latvia has not been so great and long to create the changes determined by M. Prensky in the processes of information processing. The fourth, ninth and tenth statements are fully proved. The statement - Play vs. work is partly proved. The second, third, fifth and sixth statements are proved rather not to be truth. The eighth statement is not proved.

The reasons could be not only in the IT access differences but also in mentality, traditions and culture environment. But as a forecast for the future these statements are important and they must be taken into account for improving the study process. I have done a provisory review in my Descriptive geometry programme from this point of view.

6. ANALYSIS OF THE STUDY PROGRAMME

The first three points in connection with twitch speed, parallel processing and random access I connect with the lecture style. It has already been various and contains different ways of presenting information depending on the subject. They are traditional PowerPoint presentations with or without animations, dynamic drawings on a screen in any of CAD programmes, visualizations in 3D modeling programmes. Poster lectures and board have also been used. Physical and digital 3D models are always demonstrated. All in all it provides parallel processing and random access as well as twitch speed, because, apart from the presenting way, the subject is the same. Referring to computer games, M.Prensky says *"There's almost always more than one way to do something"*. The same can be said about Descriptive geometry and study process.

What refers to Graphics first all our work is connected with pictures.

What refers to payoff, students are interested what will follow the lecture – a test, a home task, an individual work or nothing. It has an effect on activity and attention during the lecture. Students use possibilities to have automatic examinations and tests. Thus, I believe the answers in this question were not honest.

Connecting and activity has not become very popular in Latvia because of technology spread, however, the most active students have already been searching information on the Internet for their individual works. This and the last points about fantasy and technology-as-friend I use when I give individual creative works for students architects. 23% from architecture students admitted these creative works to be the most pleasant during the first semester. The results of works show very interesting solutions and reveal the

connection of Descriptive geometry with different life spheres, not only the traditional study course. Provide technological environment and give the task – students will solve it, possibly in an unconventional way.

I never try to teach my students anything.
I only try to create an environment in which they can learn.

-Albert Einstein

7. CONCLUSIONS

- Students in Latvia nowadays can be partly said to be Games Generation.
- Deprogramming of thinking has not fully happened or it does not give the same results as in America.
- Local culture traditions and mentality give their impact (reading).
- Basic tendencies are similar – technologies are helpful and integral part of life.
- The youth changes – according to American model or other.
- The educational system must change according to the changes in students' thinking patterns.

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MANUAL DRAWING IN MODERN ENGINEERING EDUCATION

Zoja Veide[1] Veronika Strozheva[2] Galina Veide[3]

1. ABSTRACT

«Is the Manual drawing is still used in engineering education nowadays?» - actual question which often meets at students' forums. The proper estimation of computer technologies is very important when computers are to be implemented in the educational process. Otherwise, if not implemented properly, the quality of students' education may be seriously imperiled. In this paper we, propose how and to which extent the computerization of education process should be carried out and a necessity of the manual drawings' use for study of compulsory subject "Civil Engineering" for Civil engineering undergraduate 2nd year students of Riga Technical university is considered. Definition of ratio of manual drawings and drawings with CAD software use, as a part of curricula, is a prominent aspect of quality of educational process and motivation of modern students.

KEYWORDS: Engineering Education, Manual Drawing, Computer Graphics

2. INTRODUCTION

Idea about a close link between human's impellent activity and formation of his mental faculties has been developed in ergonomics and engineering psychology in 20 century [1]. Interaction of "live movement" of a hand and an eye estimation of a human is a united cognitive act, which leads to formation of spatial representations. Hand movement, when the human develops and creates external space, is a basis of internal cognitive activity due to which the human constructs and assimilates concepts of space and the spatial organization. Each separate act of movement of the hand in space is

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unique, not repeating the previous acts of movement. However, formed sensomotoric image of space allows the human to make control of external movement of the hand, reproducing thereby the movement act under his space representations.

Repeating over and over again external actions with surrounding space, e.g., making measurements by means of a ruler or by drawing on a blackboard, the human carries out the organization of external space according to his representations and concepts about space [2]. On the other hand, technologies develop very quickly, and modern students perceive necessity to draw by hand in the same way as the modern engineer could apprehend the requirement to make mathematical calculation by means of a slide-rule.

Computer graphics opens up new possibilities for solving problems in three-dimensional space. It is popularly believed that at the present time there is not necessity to study the old technique of manual drawing that is not applicable in modern engineering practice. However, during the learning of modern computer technology, the initial stage of training is quite difficult. The difficulties are not only the study of a great number of CAD program commands, but also the deficiency of basic pre-theoretical knowledge of descriptive geometry, lack of skills of intellectual activity, a underdeveloped spatial representation and imagination, full or partial lack of knowledge of the standards of drawing preparation [3].

For a more effective development of spatial representation (the ability to imagine a three-dimensional objects using flat pictures or drawings) and the spatial imagination (the ability in the mind's eye to create the spatial images on basis of accumulated experience of spatial representations) it is necessary to perform a certain number of drawings and sketches manually using a pencil and drawing instruments. Performance of manual and freehand drawings develops students' graphical skills, ability to analyze the shape and design of real objects and, together with the spatial representation, technical thinking [4]. This makes it possible fill the gap in knowledge and prepare the students for mastering of CAD programs instead of learning of basic engineering graphics in class for the study of computer graphics. Performing of drawing using a pencil inculcates in students a taste for the graphical aesthetics, plants the qualities of a person like accuracy, preciseness, conation harmony. Drawing is the primary vehicle for conveying technical ideas. Drawing is a technical document to which are imposed the strict requirements both in terms of content and in terms of preparation.

3. MANUAL AND CAD DRAWINGS

Preparedness of students for work with CAD programs is characterized by two main components:

1. spatial representation, i.e. knowledge of complex drawing,
2. ability to prepare technical drawings in accordance with accepted standards.

Due to the insufficient number of academic hours specified for the subject Descriptive geometry and engineering graphics, after first study year the knowledge of students on the standards is not systematically [5]. They have also not practiced and not fostered main methods and corresponding skills in the preparation of technical drawing: definition of the necessary elements of the image, the number of projections and their contents, the basic principles of dimensioning. Up to 20% of second-year students have absolute illiteracy on the subject of engineering graphics.

Civil Engineering Graphics is a compulsory subject for RTU Civil engineering undergraduate students. Subject deals with the theoretical background and methods of representation of civil engineering objects onto the plane (building plan, building section and front elevation). Students get acquainted with the basic drawing codes in the industry. Projections with digital marks allow to solve the cut and fill problems during project design. The students develop skills of surfaces intersection determining the roof slopes intersection line. General knowledge about Computer Aided Drafting and Design in civil engineering projects is given.

Students carried out civil engineering drawings using AutoCAD program. In performed drawings a considerable quantity of mistakes, which are linked with ignorance of ISO standards of drawing preparation and insufficient experience of CAD programs use. Many of students carried out drawings not independently by simple copy-pasting. Analyzing the received results, we have come to a conclusion about expediency of performance of civil engineering drawings manually. It allows to acquire knowledge, which necessary for preparation of technical drawing.

Graphical exercise on a theme "Roof Construction" by an example of the decision of a problem on a construction of a line of intersection of roof slopes develops spatial visualization ability and skills of the intuitive decision of spatial problems. The given exercise consists of four parts:

1. performance of the plan and a front elevation of roofs;
2. finding of full size of slopes of roof;
3. performance of a breadboard model;
4. construction of the given model using ArchiCAD.

Students carry out the first part as a sketch. The decision of metric problems is carried out with AutoCAD use. It allows to execute the construction more precisely, save time of students for preparation of development for manufacturing of object model and develops skills of AutoCAD use.

4. CONCLUSIONS

- It is very important to recognize that the implementation of computer aided (CA) teaching of civil engineering graphics is very delicate meaning that the introducing of computers into educational process must be very carefully and prudently carried out.
- CA teaching should be introduced as an additional means which effectively and swiftly gives exact solutions for various representations of objects and for solutions of metric tasks.
- Manual drawing tends to improve spatial skills more than use of CAD methods.
- Carrying out the drawing manually students acquire knowledge and skills which allow to estimate results of automatic constructions applying CAD programs.
- Only people with a profound knowledge in Descriptive Geometry are able to make extended use of CAD programs as the communication is usually based on views only.
- The more powerful and sophisticated a modeling software, the higher the required geometric knowledge.

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ASPECTS OF MODERNIZATION OF TEACHING ENGINEERING GRAPHICS

Birutė Juodagalvienė[1], Sonata Vdovinskienė [2]

1. ABSTRACT

Improvements in the application of information and communication technologies in teaching of engineering graphics entail certain issues concerning the methodology for teaching this subject. The article explores the options to revamp both the course in descriptive geometry and the methodology for its teaching within existing time limitations, identify the ways to improve the efficiency of learning delivery and make qualitative changes in both the process of professional training and its results.

KEYWORDS: Descriptive Geometry, Projection Drawing, ICT

2. INTRODUCTION

The age of information and communication has brought certain changes to the system of education. Lecturers have got liberty in choosing the forms of interaction with students, which means the selection of approaches towards the studying of one or another subject with due regard to individual students' abilities and needs, teaching through discussions, simultaneous design development and critical analysis of the results obtained, unorthodox approach towards existing problems.

Education institutions are now witnessing the forms of educational work, including traditional classroom teaching, acquiring new content since the time saved as a result of ICT (Information and communication technologies) application may be devoted to personal interaction between professors and students, which is vital for professional training. Engineering graphics is one

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of the key constituents of the system of engineering education, which subsequently define the professional technical culture. However, the methodology for teaching subjects requires continual and thorough improvements as well as the rethinking of all existing teaching aids in order to elaborate a streamlined system matching the levels of technical, educational, psychological and social demands of the general public as to the content of engineering education.

3. ENGINEERING GRAPHICS WITHIN THE SYSTEM OF ENGINEERING EDUCATION

Being parts of engineering education system, the descriptive geometry and engineering graphics contribute to the development of spatial thinking and provide training in technically adequate presentation of production solutions.

The efficiency of the course in geometry and graphics depends on the fundamental nature of scientific stances, on one hand, and on the interconnection between the content of the course and the practical engineering work in this area, on the other.

The evolution of computer-aided graphics contributes to the development of teaching methodology and enrichment of the content of engineering graphics course. Simultaneously, the survival of the course has become objectively dependent on a possibility to make an organic combination between its classical graphic methods and new ones, which rely directly on the system of computer-aided design for the performance of numerous graphic tasks.

The studies of graphics provide an opportunity to learn the skills of creating two-dimensional drawings of three-dimensional objects and develop spatial and logical thinking abilities. These skills are vital for competent engineers and designers able to design modern buildings, structures and machines. Any degradation in the standards of graphics teaching will inevitably undermine students' abilities for logical three-dimensional spatial thinking and entail changes in the existing practice of teaching specific engineering subjects based on the sufficiency of engineering graphics knowledge.

In the past each classroom subject was prescribed to contain specific didactic units a student had to learn. Now the content of each subject is being defined by the university itself. The only condition is the acquisition of required competences, i.e. abilities to use knowledge for solving specific tasks, by the student by the end of studies in a specific area.

Today the training of engineers in universities is based on standards, hence the level and the quality of training is directly dependent on the level and quality embedded in those standards.

4. TEACHING OF ENGINEERING GRAPHICS

Being one of the fundamental subjects of engineering education, the descriptive geometry shall and may be brought into line with changes in the overall system of education. Experiments in various areas where the discipline might be updated have been conducted over and over again. With the world changing, the methodology for teaching descriptive geometry, which has been honed to perfection for decades, suddenly becomes ineffective. The courses, which previously consisted of quite a few hours of training in graphic subjects, now seem cut short and logically incomplete as the time of classroom studies is being reduced. Considering the current trends, any increase in the period of time intended for the studies of the subject can hardly be expected. However, the efficiency of training will not improve if the principle of downsizing the so-called "comprehensive" courses, which existed previously, continues to be followed when working out the content of the course. Efforts to retain these "comprehensive" courses have been accompanied by noticeable transfer of traditional descriptive geometry materials in software [1], which enhances the visualization and clarity of the teaching material, yet the link with applied graphics is still missing. Individual efforts to establish that link focus both on the area of descriptive geometry and applied graphics and on the graphic algorithms for solving problems [2], however, such attempts are only being made at the Faculty of Civil Engineering of VGTU.

The main challenge is to update both the course in descriptive geometry and the methodology of its teaching within existing time limitations, identify the ways to improve the efficiency of learning delivery and make qualitative changes in both the process of professional training and its results. A traditional course in engineering graphics begins with the descriptive geometry, which is followed by the projection drawing and constructional drawing as applied areas. Today the engineering graphics module is being taught in almost entirety during the first term of the year of studies at the Faculty of Environmental Engineering of VGTU. As a way to link academic theory with applied practice, the students are given simple parts (which, as it may appear later, may be the components of complex parts) and told to detect missing point projections on the projections of those parts using the point projection algorithm Fig.1. The theory of engineering graphics is thus linked

with its practical application. This method facilitates the students' work. We can see their better understanding of the theory.
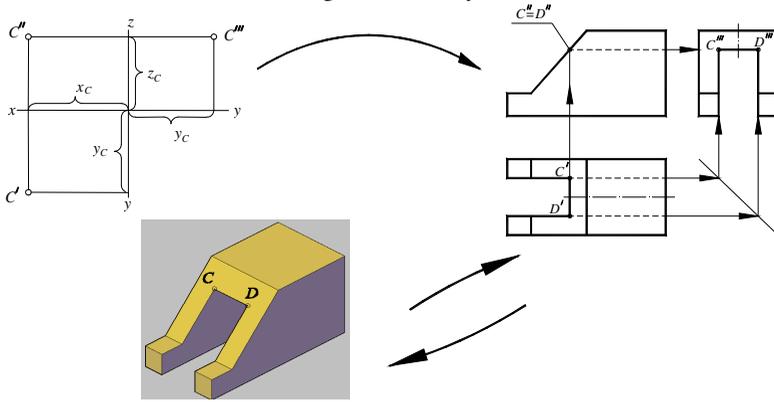
Fig. 1. Detection of projections of points

The training process also involves other examples, which serve to link the theory with practice, e.g. the application of an algorithm for the detection of straight lines projections, which is used to detect missing straight lines and points on the planes Fig.2.
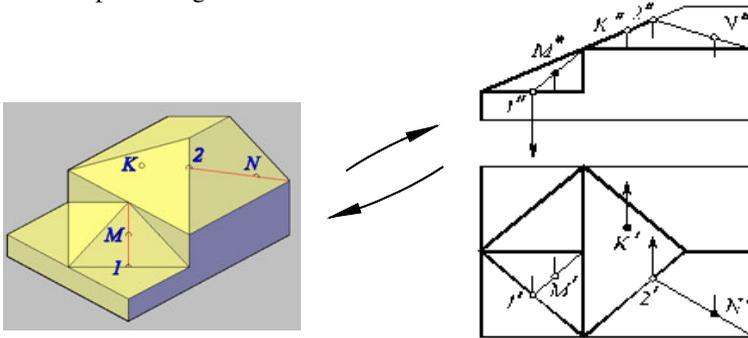
Fig. 2. Detection of projections of straight lines of a plane

The special nature of teaching students in their first years of studies should not be omitted. For students, yesterday's schoolchildren, the first year is a period of adaptation to university requirements and new forms of learning. The development of professionally essential skills shall be initiated simultaneously with the beginning of university studies, which brings forward the necessity to

identify the criteria for judging the efficiency of educatory process with utmost precision.

The planning of educatory process may only begin with accurate identification of learning objectives. The incentives based on professors' work experience are no longer effective. The students are unable to perceive them since they cannot find anything to confirm them in the social realm. This is the main cause of inefficiency of learning – the students do not understand or do not accept the purposes of studying one or another subject. Students are always keen on finding an answer to the question: "How does this subject relate with my future profession?" Professors must give more examples showing the links between the subject being studied with the disciplines to be studied in future or being studied concurrently, with the profession in general, focus on application-oriented aspects of geometry and graphics. The second term of the course in engineering graphics involves the preparation of construction drawings (plans, sections, facades), and the theoretical background in graphics is then needed both for the layout of building elements on those drawings and for the modelling of intersection of surfaces, e.g. the roof and the skylight Fig.3.

Fig. 3. Example of a facade

The trends currently observed in the development of professional education bring forward the independent work of students as the main form of learning. A schedule of studies provided to the students in the beginning of the course encourages the development of students' skills to make their own plans of activities during the term both in terms of time and content Fig.4. Such a

document facilitates the organization of students' independent work since they learn to plan time and assess the scale of work to be done. Moreover, each student has free access to the electronic version of teaching materials. The set of teaching materials include the themes of each lecture and each training workshop, the subject matter and the dates of various tests, the topics for individual tasks and the deadlines for the works to be handed over [3]. ICT allow lecturers to present the teaching material in their own virtual communication space. So students can find there lectures of the subject and study it independently.

Practice has shown that lectures in computer-aided graphics arouse much interest in students, including those with poorer achievements. A possibility to view the model from all sides is particularly significant. Certainly, it is vain to hope that the university could follow the example of Japan's engineering graphics departments [4] and provide a student with an opportunity to manufacture the part he or she has designed. Still, as the students learn to create the simplest 3D models in just two or three lectures, the AutoCAD graphic system definitely contributes to the learning of engineering graphics. Preparation of projections and sections based on a 3D model has been largely automated (a shift from three-dimensional models to two-dimensional drawings), therefore, when using a 2D drawing, a student finds it easier to perform the opposite task, i.e. to imagine the geometrical form of the object. Hence 3D technologies contribute to the development of skills of spatial perception, including the students with poorer achievements.

	Grafikos darbai ir kontrolis darbas	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
							savaitės										
1.	*1 darbas.* Nubraižyti techninių geometrinių kontūrą. (Brėžinio konfigūracijos parametrai (templeitai), braižymo ir redagavimo komandos, naujų sluoksnių kūrimas).		▓														
2.	*1 darbas.* Nubraižyti techninių geometrinių kontūrą. (Braižymo ir redagavimo komandos, linijų tipų ir pločių parinkimas, matmenų žymėjimas).		▓														
3.	*1 darbas.* Nubraižyti techninių geometrinių kontūrą. (Brėžinio apiforminimas, galutinis atsiskaitymas).			▓													
4.	Supažindinimas su erdvinio modeliavimo įrankiais.				▓												
5.	*2 darbas.* Iš duotųjų dviejų projekcijų sumodeliuoti detalę. Panaudojant 3D modelį, maketavimo erdvėje suformuoti tris pagrindinius vaizdus su nematomomis linijomis.					▓	▓	▓									
6.	*3 darbas.* Iš duotųjų dviejų projekcijų sumodeliuoti detalę. Panaudojant 3D modelį, maketavimo erdvėje suformuoti projekcijas su reikalingais pjūviais.								▓	▓							
7.	**Kontrolinis darbas.** Iš duotųjų dviejų projekcijų sumodeliuoti detalę. Panaudojant 3D modelį, maketavimo erdvėje suformuoti tris pagrindinius vaizdus su nematomomis linijomis.										▓						
8.	*4 darbas.* Paviršinio modelio kūrimas.													▓	▓		
9.	Galutinis darbų atsiskaitymas.																▢

Fig. 4. A schedule of independent projects and tests

5. CONCLUSIONS

- Training in geometry and graphics in technical universities must continue throughout the whole period of studies replacing the courses in descriptive geometry and engineering graphics during the first year in the university; this criterion shall be taken into account when working out the curricula and practical programs.
- Students achieve better progress in studying engineering graphics if classes in descriptive geometry are directly coupled with the application of theoretical knowledge when solving practical tasks in applied graphics.
- Even the students with poorer achievements get interested in the creation of three-dimensional models and computer-aided construction of projections, which they understand quite well.
- Each student shall have free access to the electronic version of teaching materials.

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INFLUENCE OF E-LEARNING SYSTEM ON PROGRESS OF STUDENTS

Veronika Strozheva[1] Zoja Veide[2] Modris Dobelis[3]

1. ABSTRACT

In given article the efficiency of use of the Moodle Learning system by students is analyzed. The Moodle Learning System was used for accommodation of a teaching material for students of the Riga Technical University (RTU) for study of subjects at the Department of Computer Aided Engineering Graphics. The general structure of materials placed in environment of Moodle include: theoretical material, training exercises, and examples of the tests and individual graphical exercises. According to the analysis of statistical data, we can conclude that the direct dependence of activity in Moodle environment for progress of students is not revealed.

KEYWORDS: Engineering Graphics, e-Learning, Moodle Learning System

2. INTRODUCTION

The use of modern information technologies in training (network distance training; network distance courseware; virtual universities; etc.) opens new opportunities for development of the system of education [1]. However, the effective introduction of information technologies in training is connected both to adaptation of the participants of educational process to information technologies, and to adaptation of opportunities of computer engineering and program systems to the purposes, tasks and participants of educational process. Recently, a variety of distance learning schemes have arisen that use electronic ways of linking the learner and the source of instruction with increased interaction between them.

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E-learning is a process of education in electronic form through Internet network with the use of management system for education [3]. This process can be represented in the following model.

- Skill analysis. The learning manager analyses the learner's present skill and skill that is set as a learning goal, and obtains the necessary material information. The manager then searches for the related material.
- Material development. The developer creates exercise questions and the material structure (table of contents) linked with explanatory pages.
- Learning. The learner engages in learning that is suited to the need, that is, individual learning for knowledge acquisition.
- Evaluation. The learner carries out exercises and takes examinations using questions designed according to the learning goal. The learning manager makes the evaluation of each learner, using results of exercises and examinations.

Learning technology standards now use the learning management systems which include new functionalities and capabilities such as back-end connections to other information systems, complex tracking and reporting, centralized registration, on-line collaboration and adaptive content delivery. Moodle Learning System was used for improvement of education quality in Riga Technical University.

The word MOODLE, is an acronym for Modular Object-Oriented Dynamic Learning Environment [2]. It is handy for an online course that has students all over the world. Moodle has many capabilities including forums, journals (private between student and teacher), quizzes, resources, and a section for displaying assignments. Teachers have access to full user logging and tracking, and assignments are date-stamped when uploaded to the server, making class management in cyberspace more user-friendly.

3. ONLINE STUDENT COURSES

The learning material of Department of Computer Aided Engineering Graphics courses has been placed in Moodle at ORTUS portal of RTU to help students in mastering of topics of our subjects. The use of Moodle system was not obligatory for students. Use of Moodle environment was provided as an additional opportunity of study of a theoretical material, consultations with an instructor and performance of exercises with the purpose of better mastering of our subjects.

Teaching profession of our department created following courses: Descriptive Geometry and Engineering Graphics, Interactive Computer

Graphic, Computer Graphics (for civil engineering), Computer Graphics in Engineering Communications, Civil Engineering Computer Graphics. The teacher has the freedom to change the courses, but the other users do not have this possibility [4]. There are three different formats for the class (course) – Weekly, Topic, and Social. The weekly format organizes the class into weeks, with assignments, theoretical material, training exercises, etc, all residing in a week-by-week block. The Social format is built around a forum (bulletin board), which is good for announcements and discussions. The Topic format organizes everything by topics (or units), regardless of how long they take. Our courses are in topic and weekly formats. Theoretical material was presented in the form of chapters of textbooks, materials of lectures and examples of drawings performance step-by-step as PDF documents as well as video training materials.

Course management can be changed from lecture (teacher) and administrator. They have full control over all settings for a course, including restricting other teachers. All grades for course activities – Forums, Quizzes and Assignments – can be viewed on one page. Full user logging and tracking - activity reports for each student are available with graphs and details about each module (last access, number of times read) as well as a detailed "story" of each student involvement.

4. DISCUSSION AND RESULTS

In our investigation were reviewed 6 students groups which studied "Descriptive Geometry and Engineering Graphics" subject and 6 students groups of "Interactive computer graphic" subject. Active use of Moodle environment includes not only browse of information divisions, but also study of theoretical material, carrying out of the exercises and tests. That provides the development of skills in the performance of tasks in a subjects learned and more successful performance of tests.

Final assessments of students used Moodle system actively and used only information divisions such as timetable, description of course, results of tests etc, are shown on Fig. 1. The final assessment results show that progress of two groups of students is slightly different. Comparison of results of final assessments of the students gives possibility to make conclusions about sufficiently high level of knowledge of student who make nothing of e-learning opportunities or about use by them of traditional methods of training such as textbooks.

The students chose speed of studying of course materials independently. Intensity of the work in Moodle environment is shown on Fig. 2. It makes an opportunity to display the difference between a level of students' interest to

e-learning in a period of time. It is visible, that the greatest activity of the students has been shown at the beginning of semester.
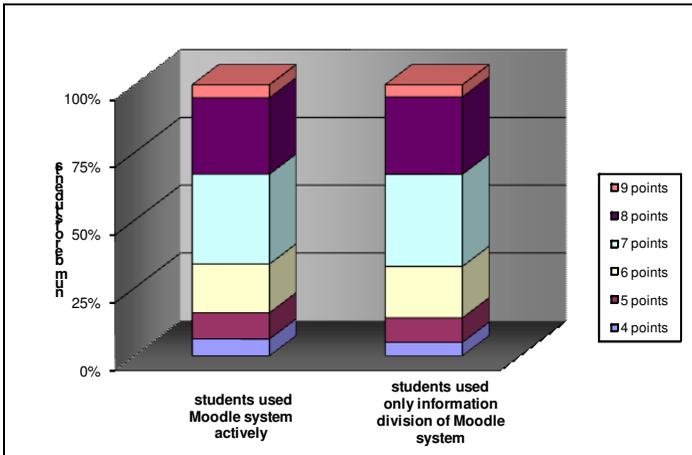
Fig. 1. Final assessments of students at Department of Computer Aided Engineering Graphics.
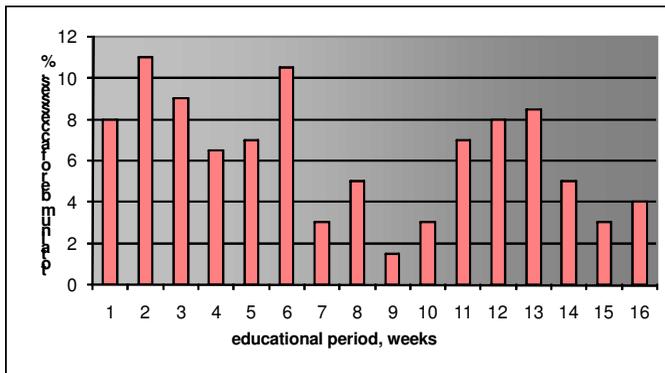
Fig. 2. Correlation between activity of the students in Moodle environment and duration of educational period.

Today's students represent the first generations to grow up with this new technology [5]. They have spent their entire lives surrounded by and using computers, videogames, digital music players, cell phones, and all the other toys and tools of the digital age. It is now clear that as a result of this ubiquitous environment and the sheer volume of their interaction with it,

today's students think and process information fundamentally differently from their predecessors. They would like to get necessary information quickly. They like to parallel process and multi-task. They prefer their graphics before their text rather than the opposite. They prefer random access. They prefer games to "serious" work. During processing of data related to materials placed in Moodle system, the active use of training video by all students of the course "Interactive Computer Graphics" was found. It speaks about necessity of expansion in the number of similar training materials in online courses.

5. CONCLUSIONS

- The experiences in using the Moodle system in actual teaching confirmed the potential of Moodle as a beneficial and usable system for teaching. The system enables the user to produce electronic course materials simply as a by-product of teaching. The Management System of Education allows better cooperation among the learners, the tutors and the students.
- Despite the advantages of using the system, the study found no dependence of student progress on the frequency of use of the system. To improve the training quality in Moodle system we propose to make performance of the tests obligatory for students.
- Students in the learning process more active use of video materials. Based on this, in our view, learning material which is placed in Moodle system must be supplemented by video tutorials. This will allow students to receive information more quickly and to make theoretical material more intuitive and understandable.

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THINKING "OUT OF THE BOX" IN COURSES OF ENGINEERING EDUCATION

Peeter Kukk[1] and Ly Sõõrd[2]

1. ABSTRACT

This paper concerns Engineering Graphics courses delivered to students at the Estonian National Defence College and the Institute of Physics at the University of Tartu. The main goal of these courses is to teach students the use of SolidWorks 3D (SW) engineering software for model-building and the generation of technical drawings according to ISO standards. In the following paper will be described how these courses are connected with other courses that students learn and what the essential outcomes are for their future careers.
KEYWORDS: Engineering Graphics, Outcomes, SolidWorks

2. INTRODUCTION

"Engineering graphics I and II" (EG I and EG II) are both 3 ETCP courses. The EG I course is an obligatory for all cadets of Estonian National Defence College and for students of physics, applied physics, information technology, material science and environmental technology in the University of Tartu [1]. The EG II course is an obligatory for students of physics, applied physics, and material science in the University of Tartu. An important point is that neither of these two higher educational institutions belongs to the community of technical colleges and universities. The objectives of the courses are to develop students´ practical drawing experience, their knowledge of understanding production drawings and their ability to visualise three-dimensional objects. An essential task of higher education is to develop student creativity, their ability to design, construct, compose, write, paint, etc., something new – for their own and everone else's benefit. In order to

create something new and interesting, first of all students have to learn to use the tools and common rules of presenting their ideas/data or, in other words, literacy specific to their area of activity.

The subject should be interesting for them and pique their interest in learning. The selected assignments for homework should be at a suitable level for first-year students, i.e., during the period when they need to build confidence in managing their assignments. To maintain student interest, assignments were ordered as follows:

- EG I – technical learning – creative work – technical learning;
- EG II – technical learning – creative work – technical learning– creative teamwork

The first technical/learning assignments were given in order to introduce students to the use of SW software for 3D model building and 2D drawings. They have to demonstrate the use of basic command sets of SW as sketches, extruded boss and cut, creating drawings, sections and inserting dimensions. Creative assignments were not overly specific, they contained some degree of freedom whereby students had to make their own decisions about how to find solutions for themselves [2]. During the introduction of the creative assignments, it was essential to stress that there were several correct solutions. To encourage students' creativity the best solutions from previous years were demonstrated and they were asked to make sure their homework was done to the same level, or even better!

3. DESCRIPTION OF ASSIGNMENTS

During the EG I course students have to present two creative assignments (demonstrating that they have learned the use of SW revolves, sweeps, lofts and sheet metal command sets). For example they were asked to design a coffee pot with a spout and handle, a pitcher or a cup and saucer which had different height-to-diameter ratios for different student groups. These assignments allow students to feel as if they are designers and to "play" with the model, reshaping, resizing and viewing from different angles. Sheet metal assignments with SW had different aspects: the economic use of the material (please model a sheet metal bracket to fix two matchboxes on a table at a distance of 20 mm from each other, the grade of this assignment was proportional to the number of brackets and inversely proportional to the amount of metal remaining from the large sheet of metal after stamping out the maximum available number of brackets) and whether the result fulfills a specific function (please construct a sheet metal bracket for fixing the

matchbox onto a table in a way that disabled people can take out and light a match with one hand).

For technical learning tasks, students were asked to construct a 3D model and 2D drawing files with sections and dimensions from three real metal or plastic details. The grading of these assignments took into account the choice and use of different SW tools for 3D model file construction and the adherence of the 2D drawing file to ISO standards.

The objective of the advanced level EG II course is to involve students in more detailed engineering knowledge such as material processing, design for manufacturing and assembly, and also to give them experience of real teamwork while solving engineering problems in three-member teams.

During this course students have to present for grading 12 SW parts and drawing files to display their knowledge of ISO standards for technical drawings and their skill in using SW.

As for creative individual work, students have to model an axe, or a kitchen or cheese knife in SW. Assignments with SW configurations command set were chosen in such a way that prior to working with SW students have to perform some data analysis or solve geometrical problems. These assignments gave students knowledge about the power of SW to generate completed models according to one specific parameter: constructing a set of ring spanners according to stated nut dimensions or a set of cog-wheels for a bicycle according to a specified number of cogs.

Three-member teams were formed on a voluntary basis for solving the last two problem-based and creative assignments. Example assignments: to design a small railway wagon for sand transportation with trailer hitches and discharge hatches (the width of the railway is 400 mm, the height and length of the wagon are 600 and 800 mm respectively) or to design a coasting wagon for children's toys with a cart volume of 40 litres. Students had to choose the overall design and all other dimensions themselves.

Each team had to present their design in the seminar and gave reasons why their solution was the best. For this task some groups created a separate PowerPoint file to promote their solution and SW animations and videos were used to demonstrate the working principles. During the presentation of the first teamwork assignment, students learned from each other and got the "feeling" for what was required to be successful; as a rule, the second teamwork presentation was more fluent and exciting, in some seminars so exciting that the lecturer had to restore calm. At the end of the seminar the groups graded each other's ideas/technical solutions and presentations. The lecturer summarized each group's grades to each other at the end of seminar. The best solution got maximum points for their presentation and others got

less points according to the group's rank of success. For the top performers the grades for the two seminar presentations constituted up to 16% of the final grade of the course.

4. COURSES OUTCOMES

After passing the course EG I students have basic knowledge of SW software and are able to use it for creating simple SW model and drawing files, and are able to make drawings consisting of all necessary views, sections and dimensions from real detail with 15 - 25 dimensions according to ISO standards. In addition to these outcomes, students recognize that technical creativity starts from the small simple things and is not something extraordinary. Open-ended feedback to the course showed student motivation and interest for futher learning: "I had a good experience with SW and I could do something interesting" or "What is the next course taught in the same way?"

After the IG II course students are able to compose assembly models and drawings, consisting of fits and tolerances with the help of SW software. In addition to these practical skills students understand the wide content of their learning – how different subjects are interconnected. Before working with SW they have to use mathematical modelling (how the diameter of the cog wheel depends on the number of cogs) or/and MS Excel for data analysis (how different dimensions of the ring spanners depend on the dimensions of the nuts). For their future career they got practical and creative problem-based learning experience in a team for solving engineering tasks. Presentation and defending ideas under competitive conditions is also the kind of experience and knowledge which is required in today's world. Open-ended feedback showed student satisfaction with the course:"I don't know or care about the time it took, it was an exciting task", "This was one of the most interesting courses I attended during my university studies" or "Teamwork and seminars were very interesting, this was a creative course".

Solidworks Comany performs certification of its software users at different levels. Certified SolidWorks Associate (CSWA) certification is intended for any industry professional or student with a minimum of six to nine months of SolidWorks experience and basic knowledge of engineering fundamentals and practices [3]. At the end of the Engineering Graphic II course students had a choice: to present their last individual work for grading or to sit the 3-hour CSWA certification online test. Out of 70 students 51 chose CSWA certification: 43 passed and 8 failed. This result may be viewed as an

independent evaluation of the students' knowledge and skills after passing two Engineering Graphics courses.

Students could print out Certification letters from the SW Certification Center web page and, if they so wished, their names could be posted on the Solidworks' Certification Center homepage. Having the CSWA certificate as an internationally recognised level and content certificate is something extra they can add to their CVs which deserves recognition among engineering employers of different levels.

5. CONCLUSIONS

Thinking "out of the box" in educating students who wish to maintain their interest in continuous purposeful learning, lecturers should pay attention to the following points:

- Ensuring the diversity and succession of technical learning and creative assignments
- Stressing that creative assignments have several correct solutions.
- Connecting the teaching/learning process of the particular subject with other subjects in the syllabuses and keeping in mind the wider content of the students' intellectual development.

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COMPUTER GRAPHICS (3D) AND STUDENTS' FEEDBACK

Rein MÄGI[1]
Külli MEISTER[2]

1. ABSTRACT

Computer graphics course for construction students consists of two parts – 2D-graphics and 3D-modeling. If 2D graphics reminds of painter's work then 3D-modeling resembles more the work of a sculptor. It makes the process more attractive because the real objects have also spatial (three-dimensional) shapes. Feedback from students at the end of the course showed that the exercises were very instructive for them.

KEYWORDS: Computer Graphics, 3D-modeling, Methodology, Feedback

2. INTRODUCTION

Our previous research on 2D-course [1] demonstrated that students' average rating to the 2D-course (4.74 of 5) was quite high. They were positively disposed and are looking forward to the following 3D CAD-course.

3D-course (32 academic hours) contains 13 practical exercises [2] – from the simplest to more complicated, step by step. To get feedback from students we gave 56 students a questionnaire (Fig.1).

Exercise	+ Positive opinion	- Negative opinion	Rating: 0…5

Figure 1. Questionnaire form for students

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3. STUDENTS' OPINIONS AND RATINGS FOR EXERCISES

The average rating for all 13 exercises (4.40) was quite high (from 3.67 to 4.80). It shows that students were satisfied with the course.

The first introductory exercise (Fig.2) is creating three-dimensional model of rotor using only *Thickness* as z-coordinate.
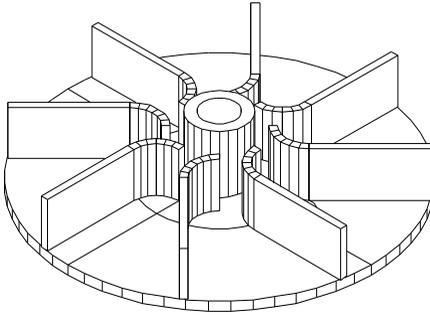
Figure 2. Rotor created using parameter *Thickness* for Polyline and Circle.

The average rating for this primitive exercise (4.70) was very high. +Opinions: very understandable, good transition from 2D to 3D. -Opinion: too simple (for students with previous cognition).

a)   b)
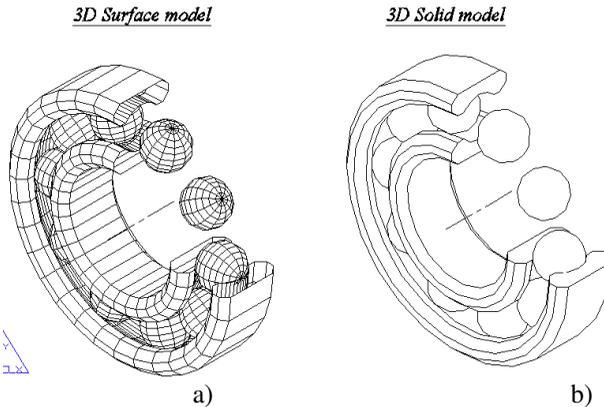
Figure 3. Ball-bearing created as 3D-surface model (a) and as 3D-Solid model (b).

Three-dimensional objects can be hollow (surface model) or volumetric (solid model). Next exercise (Fig.3) compared the difference of these variants on the same object - ball-bearing. The rating was also high (4.65).
+Opinions of students: good comparison of 3D-surface and 3D-solid model, real and practical object. –Opinions: quit hard for some students.

To form 3D solid object in *Model space* there is required to use *Solid editing* commands – *Union*, *Subtract*, *Slice* and others. But in *Paper space* we can create many *Viewports* with different view-directions. Students' rating to this exercise (Fig.4) was 4.15. +Opinions: introduce *Paper space*, presented the views placements by European and American system. -Opinions: too primitive and a little boring.
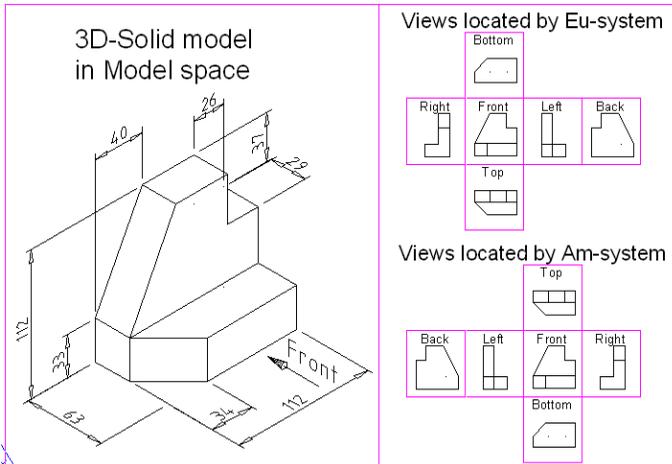
Figure 4. 3D-Solid model in *Model space* and 6 general views located by European and American system in *Paper space*.

The perfect task for future construction engineers is creating a little summerhouse with fir-trees and people (Fig.5). Average ratings for house was 4.53, for 3D-man – 4.00. Creation the fir-tree got the lowest rating (3.67) – too simple. Quite attractive for students was generation perspective views (rating 4.63) and rendering (4.67) – see Fig.6.

Figure 5. 3-D model of the summerhouse with fir-trees and people.
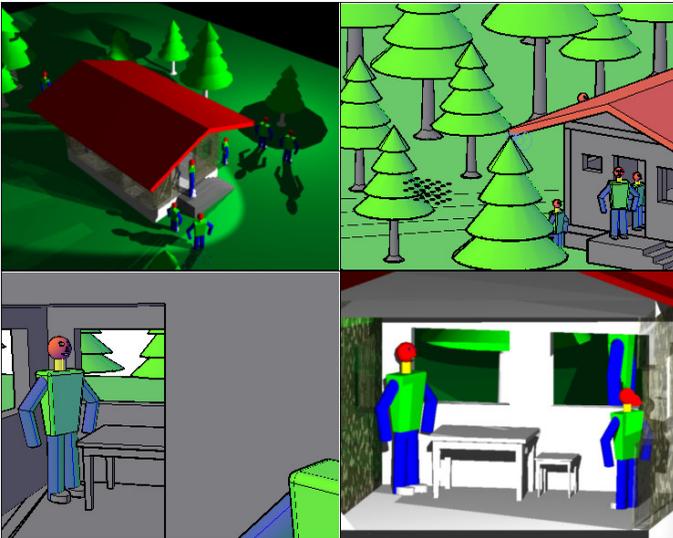
Figure 6. External and internal perspective views using rendering and clip planes.

The most interesting and developing was making 3D-solid model of the liquid tank and using it for diagram to determine the relationship between the liquid level and volume (Fig.7) – the rating 4.80. Analytical solution of this

task would be much more complicated. The 3D-solution of this task is shown in Fig.8
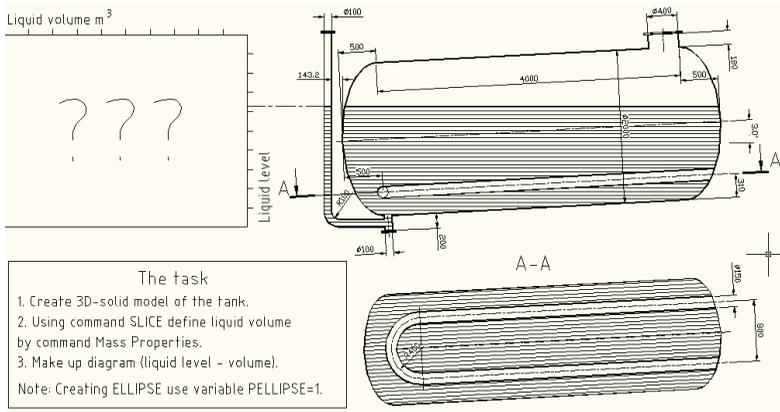
Figure 7. 3D-solid model of the liquid tank and using it for creating diagram to determine the relationship between the liquid level and volume.
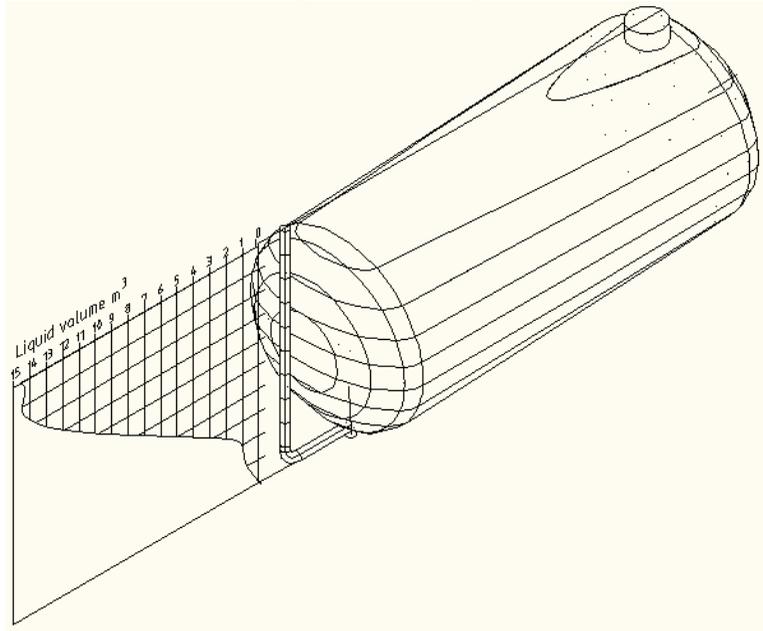
Figure 8. 3D-solution of the diagram determing the relationship between the liquid level and volume.

The final control task (Fig.9) was based on the previous exercises. For giving "sporting excitement" the working time was predicted from students and after then really measured. The average predicted time was 60 minutes (from 20 to 120) and average real time 49 min (21…75). Accordingly predicted by students time was 1.22 times longer than the real one. Students' average rating to this control-test was very high – 4.62. +Opinions: just enough difficult, controls major skills, very interesting to predict the time. -Opinions: a little too simple, took more time than predicted. Quite interesting is to compare correlation between predicted and real time (Fig.10).
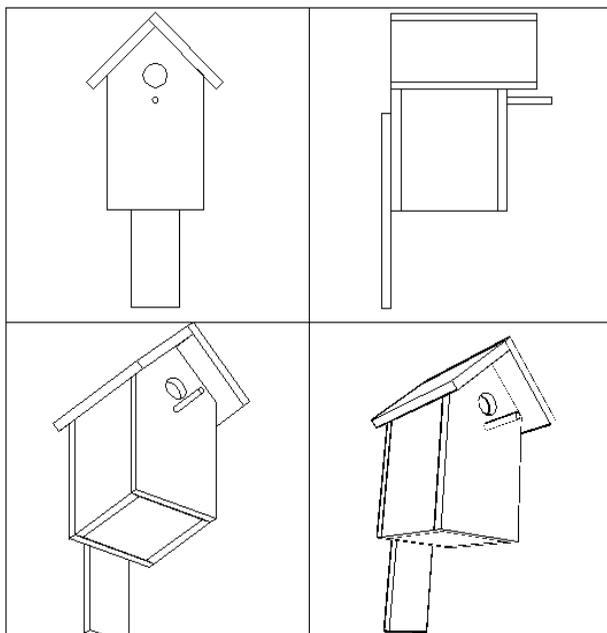
Figure 9. The control task. Create 3D-solid model of the nest box in *Model space* and make different Viewports (Front, left, isometric and perspective views) in *Paper space*.
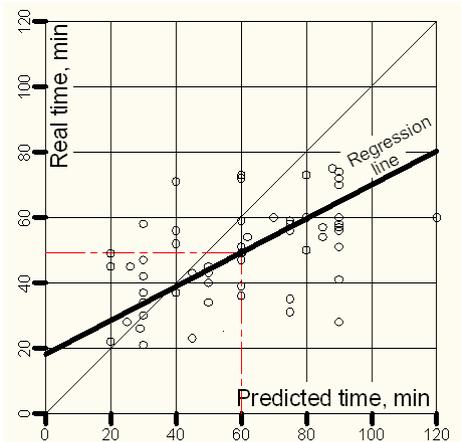
Figure 10. Comparing the predicted and real work time for creating the control-task (Fig.8). Correlation factor +0.52

4. CONCLUSIONS

- Since the modern trend is towards 3-D modeling, it is essential to future engineers.
- Students' average rating to this 3D-course (4.74 of 5) was quite high.
- The final questionnaire was a very good feedback to the lecturer but on the other hand also for the students as it enabled them to remember and analyze the learned subject.

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DESCRIPTIVE GEOMETRY

GEOMETRY AND ARTIFICIAL INTELLIGENCE

Algirdas Sokas[1]

1. ABSTRACT

This article deals with software agent technology, the potential of architecture. Methods based on fuzzy decision method are analyzed. The fuzzy techniques are presented in three parts: fuzzification, the logical decision engine and defuzzification. This technique uses geometric elements and their various characteristics. The author was very interested in how mathematics, graphics and programming create objects - agents, who carry out independent decisions.

KEYWORDS: Programming Agents, Fuzzy Technology, CAD

2. INTRODUCTION

Currently growing popularity of artificial intelligence technologies haves evolved agent technology to develop intelligence agents. The scope of agents' use is very broad. One of these technology areas is a smart home environment management system. Enhanced functionality can be achieved through intellectual software. Such system is able to continually analyze all incoming sensor data and tailor to respond in accordance with the rules, which reflect the needs of the inhabitants. This building can be called intelligent building. One of the main reasons why rapid growth in agent technology was seen in the eighties is certainly the ease of use of interface and powerful online infrastructure framework, which can be realized in various applications of agents. One of these technologies is in the areas of intellectual home management system. So multi-agents technologies use in this area is the new untapped area allowing covering artificial intelligence, computer training, and databases, mobile and multimedia technologies.

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3. AGENTS

The agent acts independently. It is not a called component; it is an active, monitoring its environment and responsive entity. The agent monitors its environment and is able to respond to changes in a manner to be able to continue to pursue the objectives of the task. The most common goals of one agent may be narrower, so then several interacting agents are needed in order to achieve the objectives of the interest to a person or place the necessary processes. Agents can cooperate in working towards a common goal, or simply interact with each other, each to its own objectives. Exclusive multi-agents system feature is a potential opportunity to provide its global objectives. Intelligent agent is a program that reacts to the sensations of certain actions [1]. Agent "feels" the environment and decides what actions are adequate to his senses and acts on them. Agents operate independently or nearly independently as a communication link between users and other software systems. Agents use following features: the continuity of time, autonomy, sociability, rationality, and ability to respond to the environment, adaptation. According to the architecture of agents are:

• Logic based agents. Such agents decide on action to be taken shall logical deduction method. Agent tries to make the need for action, using deductive proof. The agent is trying to prove process using deductive proof. If the formula is proved, the agent performs the act.

• Reactive based agents. These agents are simply responsive to the environment, but not reading mechanism.

• Belief-desire-intention agents. Such agents are within the beliefs, desires and intentions, and their decisions according to these three things impressions. Filtering function updates the agent's intention in accordance with its beliefs, desires and intentions of the current. Finally, the action selection function selects the most appropriate action according to the agent's intentions.

• Layers based agents. These agents take decisions during the software architectural layers. Each layer fulfil of the different levels of abstraction. There may be vertical and horizontal layers architecture. Behaviour of each layer can be treated as a single agent's behaviour.

4. FUZZY CONTROL SYSTEM

Fuzzy logic engine uses a rule-based expert system paradigm, in order to form fuzzy logic variables. The main objective of the fuzzy control engineering is to identify and apply the expert knowledge on how best to control the processes of designing efficient and precise control systems. Very

important is the fact that the fuzzy control system design does not require a mathematical model and control system can be used wherever there is a control system model is a particularly difficult or impossible because of the complexity of the problem [2]. Fuzzy logic rules into line with the method of choice are very important during system design. Study the conventional fuzzy control, which is also known as the creator of the first Mamdani fuzzy system on [3, 4]. Logical description of the decision engine IF - THEN a rule set of fuzzy expert system to provide connections between the fuzzy variables in order to obtain the changes that occur in the input sensor. Conclusions the process engine is composed of two steps: aggregation and composition. Aggregation - a process that calculates the values of IF rules, and the composition of the process - THEN estimate of the value of this policy. Mamdani minimum function method is used with the possibility of form the knowledge-based rules. Also, the minimum function approach allows the knowledge of the tables describe linguistic rules. The minimum function method is often used because it is easier to do the calculations [5]. Fuzzy control system inputs and outputs are described using linguistic variables. Linguistic variable is a word, a well-defined the term of fuzzy system input and output are described. Let's say the building entrance of the heating system can be described in a variable *Temperature* with linguistic values of "Cold," "Normal," "Hot" and evaluating the linguistic variable *Humidity* with values "Dry", "Average", "Wet" and summarizes the output variable to linguistic meanings *Comfort* with linguistic values of "Low", "Good", "High". These linguistic variables are mapped to digital values (Fig. 1).

Fuzzy controller consists of four main components:

• Knowledge Base - a set of rules (IF-THEN) - an expert knowledge based on logic, linguistics fuzzy description of how best to achieve good process control.

• Fuzzification unit - converts controller inputs to fuzzy values in order to activate the mechanism indifferent and adapt the rules for decision making.

• The decision engine - indifferent mechanism - to emulate an expert decision-making in interpreting and adapting a set of rules for information.

• Defuzzification unit - converts indifferent mechanism of the decisions taken in resolution process designed to manage signals.

Fuzzy system for decision-making on the basis of logical rules: IF premise THEN conclusion. Verbal rules describing the control system consists of two parts - conditions (between IF and THEN) and the effect of (after THEN). Depending on the type of system is not always necessary to define all possible input variations, because some of them occur very rarely or not at all happens. This allows the system to use fewer rule, the logic is simplified management and increased the total fuzzy logic operation of the system

performance. Fuzzy logic control based on the knowledge base of linguistic variables and logic control rules. Fuzzy rules base is a simple set of rules that describes the relationship between input and output sets fuzzy sets.
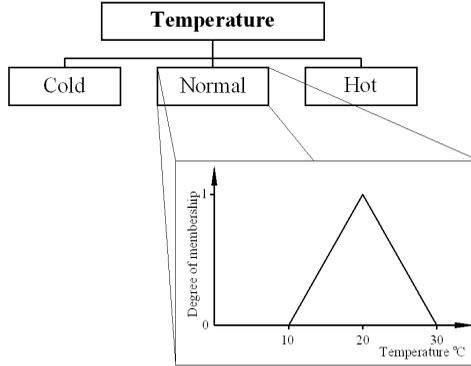

Fig. 1. The relationship between variables and fuzzy set.

For example, if we design the rules base for comfort control, input should be room for heat and humidity levels and the calculation of the output, the rules might be:
IF Temp IS Hot OR Humidity IS Wet THEN Comfort IS Low
IF Temp IS Normal OR Humidity IS Average THEN Comfort IS Good
Rules database indicates that the input variables are fuzzy output variables.

Fuzzification is the first stage of the logic of the system fuzzy calculation. During this stage of the real world variables are converted into fuzzy inputs. This process is used fuzzification for variable conversion or monitoring. Variables are used to convert the dependency function. Unlike the classic elements of sets, fuzzy sets are the elements of the set where elements may partly depend on the heap with a certain degree of dependence and at the same time hold more than one sets. The dependence function $\mu_f(x)$ for each element x of set X of attributes from the set F of fuzzy degree are membership between 0 and 1 [6]. Fuzzy set is fully characterized by the dependence functions. In practice, the four most commonly used features of dependence, which describes certain mathematical formulas: triangular, trapezoidal, Gaussian and bell-shaped dependence function. We will use triangular dependence function. In our case, we have the following two initial sequences of fuzzy graphs: temperature and humidity (Fig. 2). We have one output fuzzy set of comfort (Fig. 3).
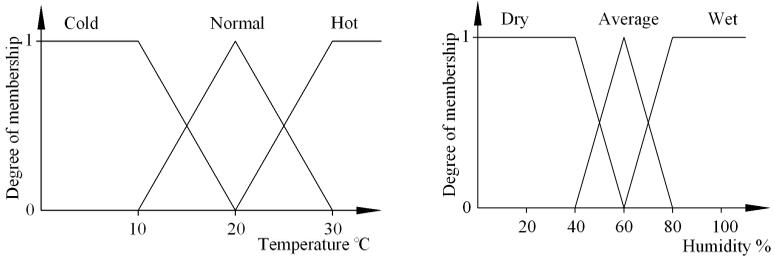
Fig. 2. Input fuzzy sets of Temperature and Humidity.
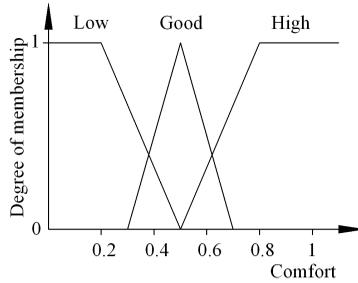
Fig. 3. Output fuzzy set of normalised Comfort.

Premises connected by an AND are combined by taking the degree of membership of the lesser of the two as the value of combination (Fig. 4). To combine rules, OR them together by taking the large of the two values as the value of combination at each point on the horizontal axis (Fig. 5).

The last phase of this methodology is defuzzification. Defuzzification a reverse action, when the answer comes from fuzzy set to traditional mathematics numerical value. Defuzzification procedure operates with existing rules vague conclusions sets to find the perfect expression of the output value. Simply put fuzzy forced expressive values [7, 8]. Centre of gravity defuzzification method calculates the significance of the expression as follows:

$$y_c = \frac{\sum y_i A_i}{\sum A_i} \qquad (1)$$

Here y_i is the centre of dependence functions and A_i - space is limited function dependency (hatch areas in the Figures 4, 5). Using a method previously received fuzzy set we get the expression of the control output value.
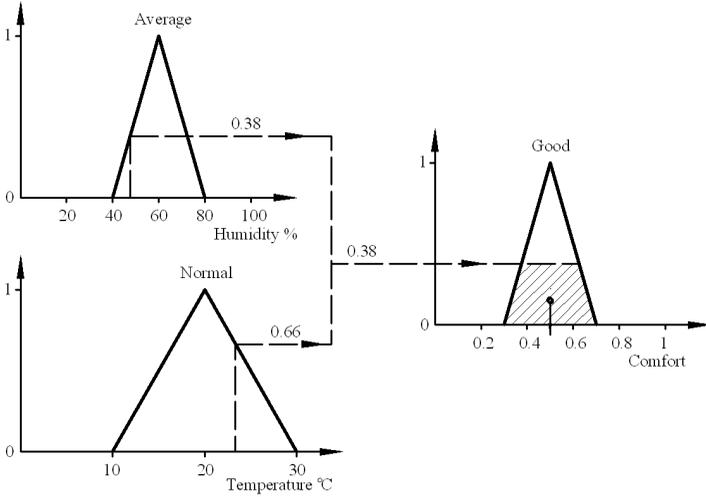
Fig. 4. Two inputs and one output, case AND.
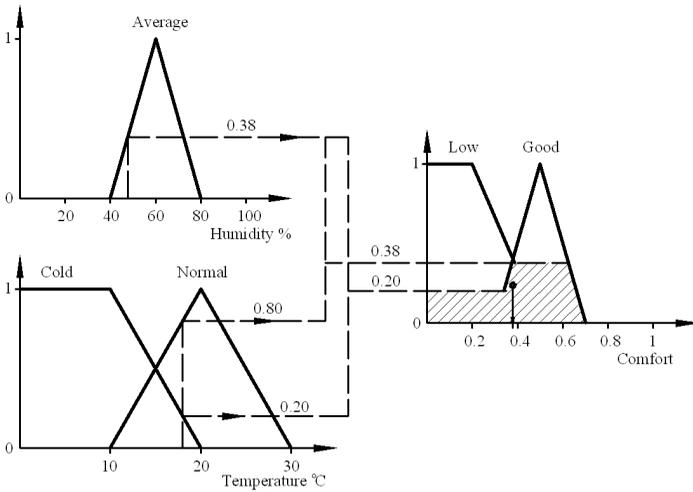
Fig. 5. Two inputs and one output, case OR.

5. CONCLUSIONS

- Artificial intelligence is the essence of acting independently of the program, known as agents. They are different levels of intelligence from reactive to trying to express feelings.
- The logic is expressed in support of intelligence agents in the use of fuzzy technology, which consists of four parts.
- Fuzzification and defuzzification expressed dependence features which describe certain mathematical formulas and geometrical features: triangular, trapezoidal, Gaussian and bell-shaped dependence function.
- When programming artificial intelligence systems is important graphics programming which can be easily managed by the geometrical features and to obtain other geometric characteristics.

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ANALYSIS OF DIFFERENT STUDY AIDS AT THE DESCRIPTIVE GEOMETRY LESSONS

Olafs Vronskis[1]

1. ABSTRACT

This investigation analyses the present situation of the use of various teaching/learning aids in the studies of descriptive geometry at the Latvia University of Agriculture. Students of the Faculty of Engineering, the Faculty of Rural Engineering, and the Forest Faculty participated in this research determining the frequency and efficiency of study aids used in the study process. The choice of study aids and grades at the secondary educational establishment influence the students' progress at the university course of descriptive geometry. Also, e-learning opportunities, as one of the study aids, and their use in this discipline are determined.

KEYWORDS: Study Aids, Descriptive Geometry, e-Learning

2. INTRODUCTION

The former generation used study aids different from those our students use today. New information technologies are developed and implemented in the study process too, so without them students' lives are unreal. Old study aids need to be upgraded, and information technologies introduced also in such a study course as descriptive geometry to make it closer to the student's life.
This paper examines such new teaching methods and study aids as presentations, handouts with blanks and e-learning environment.

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3. STUDY AIDS USED IN THE STUDY PROCESS

Study process is a system that contains such components as a teacher, students and the content and organization of study course, teaching methods, aim and results. Study process is a didactic system that contains an organization of student's work, and study aids are mutually connected with all components of the system [4].

At the Latvia University of Agriculture, teachers organize the descriptive geometry training courses and use a variety of teaching techniques and study aids at their lessons. The general use of study aids is shown in Figure 1.
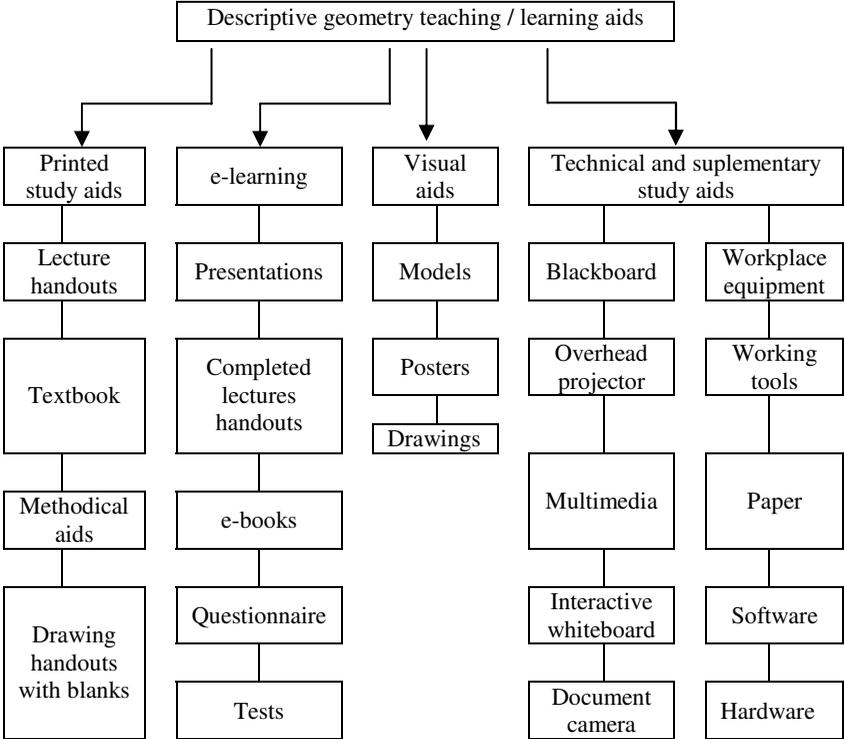

Figure 1. Descriptive geometry teaching/learning aids

4. STUDY PROCESS

The study process of descriptive geometry at the Latvia University of Agriculture can be organized in the following parts: lectures, practical

training, consultations, and independent work, e-learning as a supplementary aid. Teachers use different technical study aids at lectures: blackboard, overhead projector, multimedia and multimedia with special handouts with blanks. E-learning environment is used for different purposes: the environment for study materials, the environment of interactive study materials. E-learning is the learning process created by interaction with digitally delivered content, services and support [1].

Salmon G. stresses that delivery of "content" or study materials is not as important as a well-designed study process, the use of appropriate pedagogical techniques and learning support. Learner support must complement study materials and other resources used in the course. The most appropriate technology tools and methods have to be selected for a particular course and learner group in terms of usefulness for reaching learning objectives, availability (hardware, software, network, etc.), and affordability (cost, time, skills, experience, etc.), for both learners and tutors [2,3].

The author of the article uses multimedia with special lecture handouts with blank spaces. He uses Auto CAD and PowerPoint software for lecture development. Materials are also published in the e-learning environment. Materials should be logically structured and easy to use. The structure of every theme should have a similar arrangement and interactivity within the study course. The author has worked out a combined descriptive geometry study course with interactive e-learning elements. Each theme in the e-learning environment has the following structure, for example:

Theme 2 – Line projections

Lecture 2 handouts with blanks, PDF document.

Lecture 2 presentation movie file, SWF document.

Completed lecture handout 2.

Theme questionnaire 2.

The work management is as follows:

1. Before the lecture, students go to the e-learning environment and print out file „ Lecture 2 - handout with blanks, PDF document". Students complete the drawings and definitions during the lecture time. Handouts with blanks are made in the technical writing font to better memorize the style of this writing and can be used in the practical work (Figure 2).

In order to determine the true length of the oblique line and angles α,β and γ, ... – .... is constructed at the following ....:
The angle α is defined by a .... (plane Π₁);
The angle β is defined by a .... (plane Π₂);
The angle γ is defined by a .... (plane Π₃).
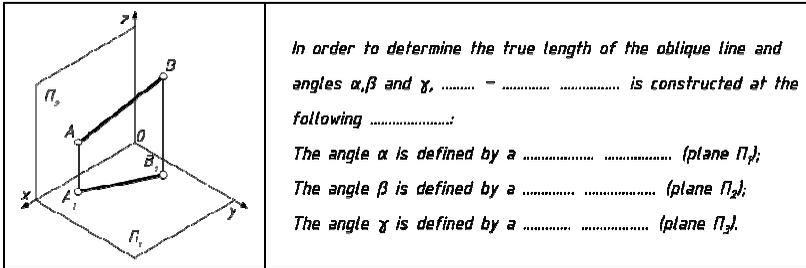
Figure 2. Part of a lecture handout with blanks

2. After the lecture students can watch a presentation of the drawing construction process in the e-learning environment and can complete the lecture handout with blanks.
3. Students can see the completed lecture handout with blanks and write down definitions in the section „Lecture 2 - completed handout with blanks" (Figure 3.).

In order to determine the true length of the oblique line and angles α,β and γ, right – angled triangle is constructed at the following projections:
The angle α is defined by a horizontal projection (plane Π₁);
The angle β is defined by a frontal projection (plane Π₂);
The angle γ is defined by a profile projection (plane Π₃).
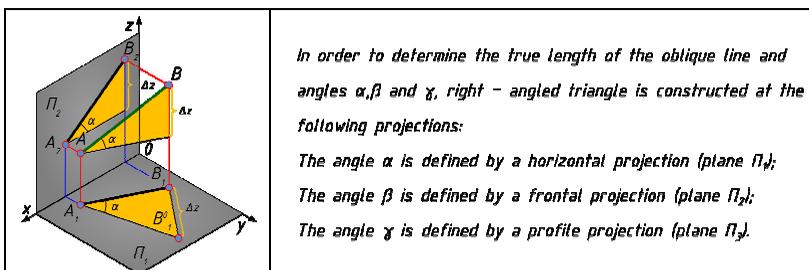
Figure 3. Part of completed lecture handout with blanks

4. Students get a drawing handout with blanks at the practical training and with completed lecture blank, textbook, teacher or other person assists complete drawing handout.
5. Students complete a questionnaire at section „Theme questionnaire 2" after presentation and discussion about their practical work.
6. In the e-learning environment teacher can see a summary of the students' questionnaire about each theme.

A questionnaire was prepared to obtain data about the time spent and study aids used to prepare for a test notes and textbooks.

Totally, 131 students from the Faculty of Engineering, the Faculty of Rural Engineering and the Forest Faculty participated in this research. Their secondary school grades were similar.

Figure 4 shows the differences of their knowledge assessment by different teachers – teacher 1, 2 and 3 when comparing test 1 and test 2.

Teacher 1 uses a blackboard and overhead projector to demonstrate a drawing and theory. The theoretical part he also explains orally and then makes the drawing on the board. Students take notes and draw in their notebooks. At the practical classes, teacher helps students to perform the tasks. They may use textbooks and other reference sources as well.

Teacher 2 uses multimedia; animated drawings are prepared for each lecture by using CAD and PowerPoint software. Theory is presented orally. Students take notes and draw in their notebooks. At the practical classes, teacher helps students to perform the tasks. They may use textbooks and other reference sources as well.

Teacher 3 uses multimedia; animated drawings are prepared for each lecture by using CAD and PowerPoint software. For practical training, all the necessary materials are available in the e-learning environment. Material should be logically structured and easy to use. The structure of every theme should have a similar arrangement and interactivity within the study course. Students fill in the lecture handouts and draw in their notebooks. At the practical classes, teacher helps students to perform the tasks. They may use textbooks and other reference sources as well

With teacher 1, who delivers lectures using blackboard and overhead projector, students have the average grade 2.9 points at test 1, and 3.6 points at test 2. The progress of students' success is rather slow.

Students use 0,4h notes and 0,8h textbooks when teachers use blackboard or overhead projector at their lessons.

With teacher 2, who delivers lectures using only multimedia, the progress of students' success increases more rapidly: the average grade at test 1 is 2.2 points, and at test 2 the average grade is 4.5 points.

Students use 0,2h notes and 0,6h textbooks when teachers use multimedia, at their lessons.

With lecturer 3, who uses multimedia and handouts and lecture materials are placed in the e-learning environment (a combined technique), the progress of students' success increases at the same speed as with teacher 2, who uses only multimedia, but the average grades are higher: at test 1 the average grade is 3.9 points, but at test 2 the average grade is 6.7 points. Students use 1,1h notes and 0,7h textbooks when teachers use combined technique, at their lessons.

The lecture delivering style and students average grades at the Latvia University of Agriculture are compared and are shown in Figures 4, 5 and 6.
Figure 4 shows that the highest average grade at tests have students of teacher 3, who uses a combined technique, then follows teacher 1, who uses blackboard and overhead projector, and finally – teacher 2, who delivers lectures using only multimedia.
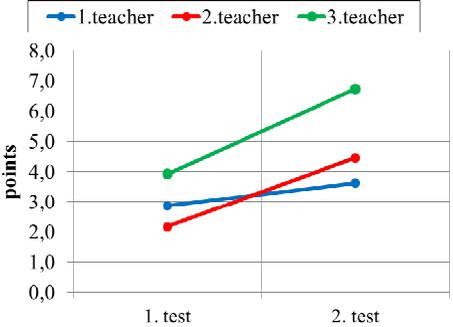
Figure 4. Dynamics of respondents' test assessment

Figure 5 shows that students of teacher 1 use mostly textbooks to prepare for the test, students of teacher 2 use textbooks, but less than those of teacher 1, students of teacher 3 mostly use completed lecture handouts.
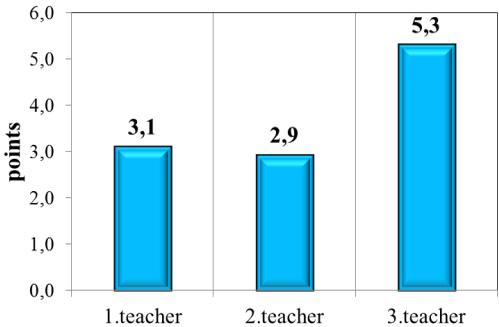

Figure 5. The average assessment of respondents' tests

Figure 6 presents the type of study aid students have used either notes or textbooks to prepare for the test.
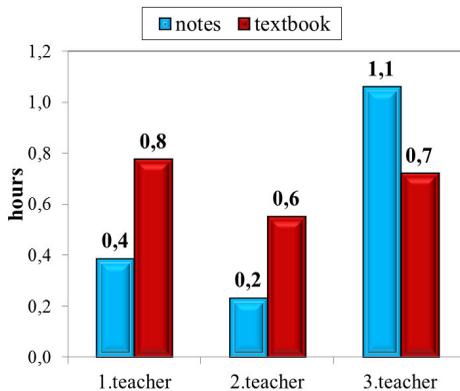
Figure 6. Study aids used by respondents

5. CONCLUSIONS

1. The students' success assessment level is higher when a combined technique is used at the lessons of descriptive geometry.
2. The progress of students' success increases at the same speed by using either only multimedia or a combined technique.
3. The progress of students' success is not so rapid when a blackboard and overhead projector are used at the lessons, but it increases when a combined technique is used.
4. Students use mostly textbooks during the study process when teachers use multimedia, blackboard or overhead projector at their lessons.
5. Students use mostly their lecture notes to prepare for the test in cases when a combined technique is used at the lessons.

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ANALYSIS OF E-LEARNING MATERIALS FOR THE COURSE OF DESCRIPTIVE GEOMETRY AND ENGINEERING GRAPHICS

Ella Leja[1], Ieva Jurane[2], Galina Veide[3]

1. ABSTRACT

The authors analyzed study materials placed in e-learning environment of Riga Technical University for the study course titled Descriptive Geometry and Engineering Graphics. The aim of this analysis is to evaluate the quality and effectiveness of the existing study materials for the course. The authors examined the following issues: is the amount of materials sufficient, do students actually use the materials, which of the materials are used by students more intensively, which materials are not used by students or are used rarely, is there any correlation between the use of environment and study outcomes. Results of this research constitute suggestions for improvements in organizing and managing e-learning materials for the Descriptive Geometry and Engineering Graphics course. The materials of analysis are log-files of the e-learning environment ORTUS of Riga Technical University.

KEYWORDS: Engineering Graphics, Descriptive Geometry, Education, e-Learning Environment, e-Learning Materials

2. INTRODUCTION

Along with the development of information technologies e-learning rapidly entered into study resource systems. Traditional teaching of study material

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and e-learning requires serious analysis and comparing; both ways of presenting the subject have their benefits and weaknesses. Therefore interaction of these basically different ways of learning should be examined. Many publications look at the benefits of e-learning and inconveniences in its use for teaching various disciplines [2]. Along with placing materials in e-learning environment, every lecturer hopes that this will increase interest among his or her students and they will have better success in acquiring the subject under consideration. Therefore, the amount and quality of materials in e-learning environment must be well-based and well-considered. Surveys carried out among university staff members reveal that results of e-learning are still viewed as the "great unknown" [1].

IT Centre of Riga Technical University has established a study course management system where all students have guaranteed access to e-learning courses and may exchange information with subject lecturers. The task of lecturers is to fill the study resource site of course management system with materials interesting for students and make them actively participate in the study process. Therefore one should develop substantial tests, attractive exercises, animated task solutions and short video materials [3]. In the starting stage of our research we carried out analysis of the use of methodical study material, developed by lecturers and inserted into e-learning environment, among full-time students.

## 3. LOCATION OF MATERIALS IN ORTUS ENVIRONMENT
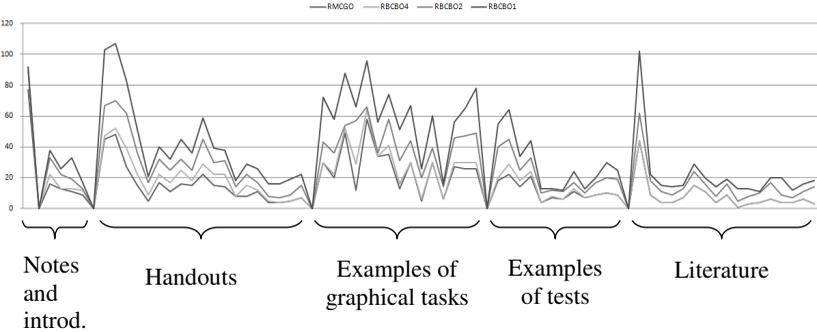
Fig. 1. Location of materials in ORTUS environment

Course materials are grouped as follows (Fig.1): introductory part contains general information on the course, calendar plan, learning scheme of the

subject and recommended tools for doing graphical work, as well as office hours of lecturers. The next part contains lecture handouts.

The next group includes tasks of graphic work, ready examples and assessment description. Tasks are usually handed out by the lecturer in the class, however, students who have missed a class, may print a respective option from ORTUS.

This is followed by a section containing examples of tasks for tests with some solved variants. The last part contains sections from a textbook filed according to course themes.

4. FINDINGS OF LOG-FILES

In order to assess materials placed by our department in RTU Course Management System ORTUS we analyzed log-files. The analysis contains data on each student's activities during semester. It was counted how many times each student viewed each material. Results were summarised according to student groups and reflected in a single diagram. Because the common diagram is very long, in this article it is divided according to sections in order to fit into a page format. The first diagram (Fig. 2) shows student's interest in the introductory part of the course and also grades (1st column). We see that information on grades have gained most popularity among students and is followed by a general course description.

1. Notes
2. General information on the course
3. Learning scheme of the subject
4. Calendar plan
5. Recommended tools for drawing
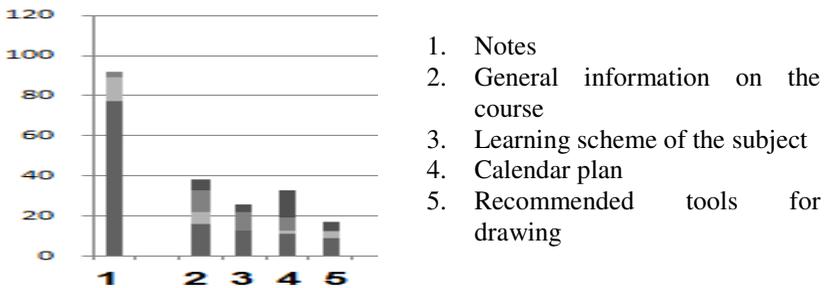
Fig. 2. Diagram showing the rate of hits for introductory part of the course

The next diagram (Fig. 3) shows students' interest in lecture handouts. Most viewed materials are first week handouts, and then interest drops. In semester's end part interest drops to the minimum, and for one group of students, even to zero level. The third diagram (Fig. 4) shows examples of

finished works and each work's assessment criteria. We see that examples of works have been viewed several times while interest in assessment is considerably lower.
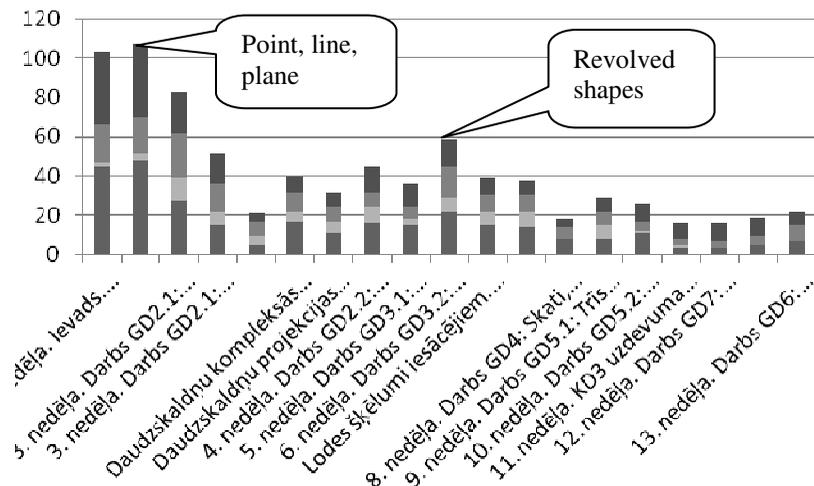
Fig. 3. Rate of hits for the second part of study course – handouts
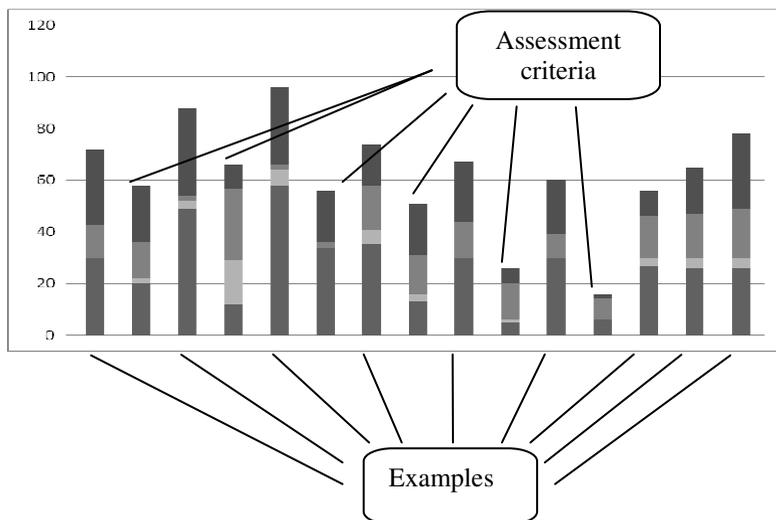
Fig. 4. Rate of hits for the section containing examples of finished works and assessment criteria

Fourth diagram (Fig. 5) tells of the students' interest in the part containing examples of test paper tasks and some solved tasks. Again, one may observe higher interest in test papers from semester's beginning, and then the interest goes down or does not exist at all. The last part contains sections from a textbook (Fig.6). Unfortunately, only one of the groups viewed this part, and also the rest of students did not show any major interest. It might be explained with the traditional habit of reading paper books. The stock of books in the library is sufficient. Interest in materials pertaining of the beginning of semester may be explained with the fact that all students have not yet received study books from the library, therefore they first use ORTUS.
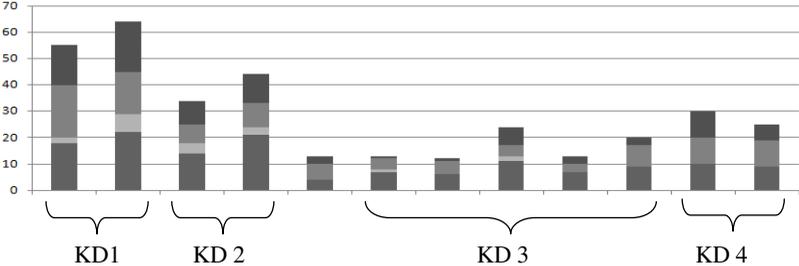
Fig.5. Examples of test paper tasks and their solutions
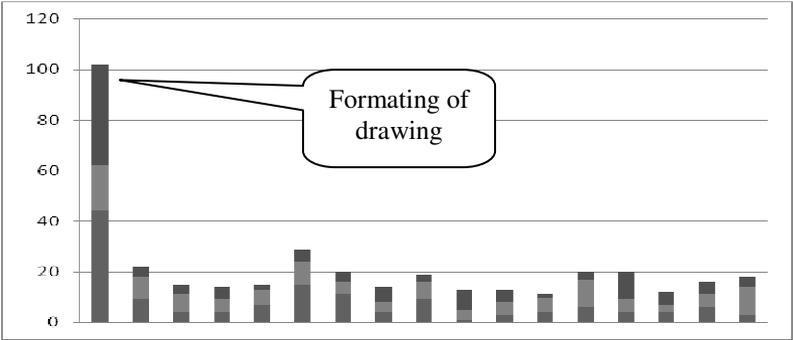
Fig.6. Sections of text book

Sixth diagram (Fig. 7) combines all sections in order to show relation between separate parts. From this diagram we see that the most popular

section is the one containing examples of solved tasks as well lecture handouts in the beginning of semester.
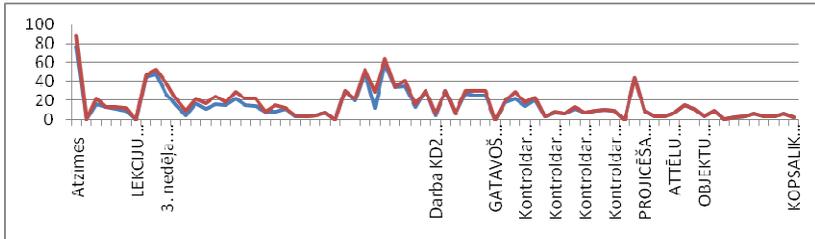
Fig.7. Common diagram combining all sections
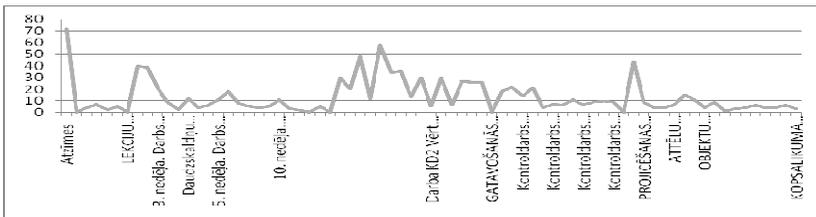
Fig.8. Diagram reflecting multiple hits only

Little interest was shown in work assessment. An unexpectedly low interest was in the section dedicated to test papers (Fig. 4). We had prognosticated higher interest in examples of tasks in order to train for test papers; we believe that ORTUS should contain them. We assume that test questions of test papers are important only in the case of very diligent students. Most of other students are not interested in them, because test papers consist of practical drawing tasks and do not address theoretical issues.

Revising activities of each particular student in e-learning environment it was found out that some students examine the whole course in the beginning of semester and later do not view the materials anymore. Mostly, those are students with good preliminary knowledge, and some of them finish the course in advance.

Viewing activities by themes, it was concluded that some themes had been opened only once while others had been viewed repeatedly. However, excluding all single hits from the diagram (Fig. 8), it does not differ from the

diagram with total results (Fig. 7). It means that practically all themes have been viewed at least once.

5. ANALYSIS OF RESULTS

Analysis of obtained data leads to a conclusion that original materials, i.e. examples of solved tasks and lecture materials, are of most interest. This part asks for refinement and development. More examples of solved tests might be included. Lecture materials might be supplemented by additional examples. Work assessment criteria might be retained, however they do not play a major role, because each lecturer carries out assessment in a slightly individualised manner.

The comparatively low interest in test questions only looks this way in the diagram. Actually, each of the four test papers includes several materials. Summing up all materials from each test paper, one obtains results reflecting high student interest rate. Curiously, the only interactive test caused very low student interest – maybe because it was not compulsory and, respectively, required no assessment. Analyzing the general student activity, we see significant difference between groups. We have a group with the average activity of 50 hits per student (Fig. 9), and another group with 10 hits per student. Besides, comparing with study results, we see that the most inactive group has a higher average grade (7.5) than the most active one (7.04). The most inactive group submitted all works earlier and finished the semester before time. We conclude that students with better preliminary knowledge and better study discipline use less auxiliary tools and have better results in using contact hours. Carrying out a survey of students an opinion came up that students with good previous knowledge have nothing new or interesting in this course. Consequently, e-learning environment might be structured according to difficulty levels corresponding to the amount of knowledge. This would provide good students with sufficiently interesting material, too.

On the contrary, students with weaker knowledge do need support from e-learning environment, and they actually make use of it. This finding is also supported by the fact that materials inserted with a remark "for students with weak preliminary knowledge" are viewed very intensively. This might be an area where number of materials needs to be increased.
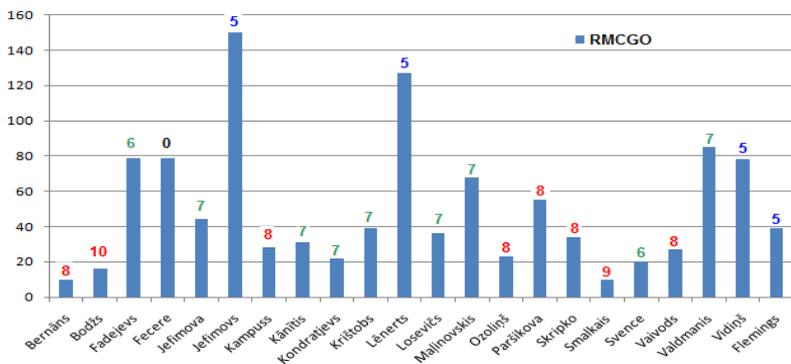
Fig. 9. Activity of students in e-learning enviroment in relation to their final grade.

6. CONCLUSIONS

- Students with good preliminary knowledge make less use of our materials.
- Students with weak knowledge use e-learning environment very intensively.
- E-learning environment needs to be structured not only according to types of materials, but also according to the level of difficulty.
- More material for students with weak preliminary knowledge should be included.
- Tasks with higher level of difficulty for students with good preliminary knowledge should be included.

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PANORAMA-MANIPULATING PERSPECTIVE OR PERSPECTIVE MANIPULATING OF IMAGINARY

Jolanta Dzwierzynska[1]

1. ABSTRACT

The paper deals with "panorama phenomenon." The term panorama was coined by the Irish painter Robert Barker to describe his semi-circular painting of Edinburgh. This form of presentation was destined to become the great mass medium of the early 19th century. The main part of the panorama was a cylindrical painting hung around inside walls of the cylindrical-shaped building. Techniques of panorama painting differed from those used in pictures viewed in more traditional way and they were regarded as very precise ones. It inspired the author to check geometrical aspects of the panoramic paintings, especially the geometrical correctness and accuracy of them. The most appropriate panoramas for such studying were panoramas displaying architectural sight. Due to this fact the author took into consideration a few architectural panoramas available in Internet in unrolled form. There were: *Panorama of Mesdag*, *Cyclorama of Early Melbourne in 1841, A view of Edinburgh from Calton Hill), 101 in Ranch Oklahoma.*
For testing panoramic images Mathcad program was used. The author transformed analytical algorithms for drawing panoramas of model objects presented in previous work, what enabled simple and quick checking accuracy of paintings. Received results proved perfect accuracy of panoramas. That permitted to state that the effect of great illusion one experiences watching panorama is not the result of manipulating perspective in the painting, but the result of manipulating one's imaginary by applying special effects and form. These issue is also analysed in the paper.

KEYWORDS: Engineering Graphics, Descriptive Geometry, CAD

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2. INTRODUCTION

The word "panorama" comes from <u>Greek</u> *pan* ("all") *horama* ("view"). However, the origin of the panorama can be traced to 1787 when the Irish "portrait-painter" Robert Barker patented a new form of representing an entire surround landscape through painting[1],[2],[3]. Barcer''s first semi-circular painting was a view of Edinburgh from Calton Hill. He called panorama as "La Nature a Coup d'Oeil, for the purpose of displaying views of Nature at large by Oil Painting, Fresco, Water Colours, Crayons, or any other mode of painting or drawing." It was complete novelty at that time, kind of entertainment, the early nineteenth century mass medium, which enjoyed considerable popularity. Nowadays that idea still intrigues public and is continued. A panoramic painting as each painting is a creation which depends on an artist's expression and ability to create a new, artificial space, as well as a spectator's skill of imagination. Sometimes, artists do not submit their paintings to geometrical rules to achieve better effects and impression. They regard manipulating perspective as the merit and advantage. However, in case of panorama "information booklets vouched for the accuracy of the depicted scene (as did panorama advertisements) informing potential spectators that the panorama was painted from sketches taken by the artist "on the spot." Claims of accuracy and mathematical precision in copying techniques were typical of the promotional writing around panoramas. It often accompanied by tales of personal risk, expense and hardship in procuring sketches. That statement inspired the author to check geometrical aspects of the panoramic paintings especially the geometrical correctness and accuracy of them.

3. BASIC INFORMATION

Perspective precision is the most competent factor evaluating geometrical correctness of the painting. Panoramic paintings should be submitted to geometrical rules regarding cylindrical perspective. Due to this fact straight lines should be sine curves on the unrolled panoramic mapping. These curves should intersect the horizon line in two vanishing points. The distance between them equals $\pi \cdot r$ (half of the length of the canvas). The images of the parallel lines should intersects themselves in the same vanishing points. However, the distance between the vanishing points for perpendicular straight lines equals $1/2 \cdot \pi \cdot r$. Before any testing of panoramas can be done some prior knowledge about geometrical properties, parallelism, or shape of the shown object is necessary. Next Mathcad program can be used.

4. PRESENTATION

In [4] analytical algorithms for drawing panoramas of simple objects were presented. They allowed to draw panorama image when the edge model of the figure was given.

After some transformations computed algorithm enables to draw the panorama image of any straight line passing through two points given in the unrolled panorama background. The points can be establish directly in the unrolled background of the panorama. The program displays their coordinates and after putting them as the variables of the created function, it draws the line as a plot (fig.1), (fig.2). The figure1 shows the example of drawing the line passing through two given points with following coordinates: (80,3), (110,9). Whereas the figure 2 shows the example of making up the line going through two corners of the model building.
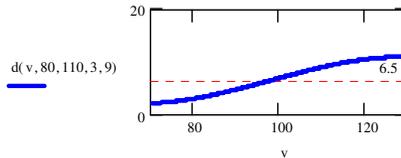
Fig.1. The panoramic mapping of the straight line in Mathcad program.
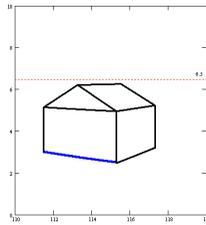
Fig.2. The example of making up missing line of the panoramic image.

A painting is a creation which depends on an artist's expression and ability to create a new, artificial space, as well as a spectator's skill of imagination. Consequently, before any geometric testing of the panorama paintings and assessment of their "geometric content" can be done some prior knowledge about geometrical properties, parallelism, or shape of the shown object is necessary. Then the presented algorithm can be apply. In this purpose it is first necessary to establish the h height of the horizon line as well as the r length of the base circle radius. In case of the historical panorama painting the r length can be calculated by the program on the base of the length of the

canvas, whereas the *h* height of the horizon line is established on the base of the vanishing point for images of any pair of parallel straight lines of the objects (fig.3).

Fig.3. Finding the *h* height of the horizon line of the panoramic image[5] .

Next, our algorithm can be used to draw a draft of lines of the panorama (fig.4,5). In case of the lines which are not straight lines in reality, it is recommend to divide them into some segments of lines, which can be approximated by the straight lines.

Fig.4. Testing geometrical accuracy of the panorama of Mesdag [5].

The algorithm was computed in Mathcad program but it can be implemented in any graphical package to make drawing panoramas more efficient. After some tests of the architectural panorama paintings (four different panoramas have been tested) and evaluation of their geometrical aspects we can state, that they were created precisely.

Perhaps that was due to the fact that the glass cylinder had been used for sketching panoramas. The artist standing at the station point and looking through it, had sketched the panorama on the paper wrapped on it. It gave good geometrical accuracy of the draft. Moreover, in case of the panorama representation, the effect of total immersion in the depicted scene was

achieved not by skillful manipulation of perspective, but by applying different devices.

There were as follows.

The cylindrical painting - cylindrical form of the canvas let admiring it in the full range of 360 degrees. Surrounding the spectator from every side with colorful image it enabled the elimination of comparing effects of the artist's work with reality (fig.6).

The platform (belvedere) - the round shaped platform usually surrounded with fence reducing the freedom of moving of the audience admiring the painting. It stood at the center of the room on the precisely calculated height and the distance from the linen, which gave character to the picture when viewed from an appropriate distance (fig.6).

Fig.6. Panorama platform in Prague.

Faux-terrain - a specially arranged ring between the platform and the canvas. It was a continuation of the space shown in a picture. Stage and theater setting techniques were employed there. The objects of appropriate size, so-called,, attrapes '' (hoaxes), being connected directly with a plot of the image were put there, in order to eliminate the border between their three-dimensionality and the two-dimensionality of the canvas (fig.7).

a)   b)

Fig.7. Faux-terrain: a) panorama in Prague, b) panorama in Altötting.

Velum - conical or umbrella shaped roof extended beyond the deck below, effectively shielding both the light sources and the painting's top edge from view (fig.8).

Fig.8. Velum- panorama in Insbruck.

Lighting- natural, daily lighting getting to the rotunda through the roof fitted with glass. White linen screens additionally deflected the light aiming it at appropriate fragments of the canvas (fig.9).

Fig.9.Lighting- panorama in Altötting.

Initial corridor - dimly lit, almost dark corridor leading to the platform and preparing the spectator for the proper, effective interpreting of the painting (fig.10).

Fig.10.Initial corridor- a) panorama in Prague,b) panorama in Wroclaw.

Above things caused overall disorientation. Panoramas were created with the intentions of illusion and, meant to cut off spectators from the outside world and fully engulfed them in the scene before their eyes, so they could not compare the image with reality.

5. CONCLUSIONS

- Panorama was one of the most influential form of visual entertainment.
- It was created with the great precision without manipulating rules of perspective.
- Amazing effect of panorama was achieved by applying special devices and manipulating one's imaginary

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REMARKS ON FLEXIBLE QUAD MESHES

Hellmuth Stachel[1]

1. ABSTRACT

A *quad mesh* is a discrete surface consisting of planar quadrangles. There are some examples where this polyhedral structure consisting of rigid faces, but variable dihedral angles, is continuously flexible, e.g., Miura-ori, Voss surfaces or Kokotsakis' example which starts from a regular tiling of the plane by congruent convex quadrangles. The classification of all flexible quadrangular meshes is an open problem. However, the determination of all flexible meshes of 3×3 quadrangles, the socalled *Kokotsakis meshes*, is close to be solved. The goal of this paper is to bring insight into the geometry behind some flexible examples and to analyze their flexions. The treated problems are also related to paper folding.

KEYWORDS: Paper Folding, Miura-Ori, Kokotsakis Mesh, Quadrangular Surface, Descriptive Geometry.

2. INTRODUCTION

In discrete differential geometry, but also in architecture there is an interest in polyhedral structures composed from quadrilaterals, i.e., in *quadrilateral surfaces* or - by short - *quad meshes*. When all quadrilaterals are planar, the edges form a *discrete conjugate net* (see, e.g., [1]). When each quadrilateral is seen as a rigid body and only the dihedral angles can vary, the question arises under which conditions such structures are *flexible*. In the flexible case we call the process of continuous isometric deformation *folding* and the obtained polyhedral structures *flexions* of the initial quad mesh.

A complete classification of all continuously flexible quad meshes is an open problem. In [1, p. 75] the following theorem can be found: A discrete conjugate net in general position is continuously flexible if and only if all its 3×3-complexes, the so-called *Kokotsakis meshes*, are continuously flexible.

In [4] an updated list of known examples of flexible Kokotsakis meshes is presented.

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In the following the geometric properties of flexions of some well-known flexible quad meshes are analyzed.

3. MIURA-ORI

Miura-ori is a Japanese folding technique named after Prof. Koryo Miura, The University of Tokyo. It is used for solar panels because it can be unfolded into its stretched flat shape by pulling on one corner only. On the other hand it is used as kernel to stiffen sandwich structures. Let us analyze the process of folding the sheet of paper depicted in Fig. 1 with given valley and mountain folds, thus proving that it is really continuously flexible.

We start with two coplanar parallelograms with aligned upper and lower sides (Fig. 2). Then we rotate the right parallelogram against the left one about the common side through the angle $2\delta \neq 0^0, \pm 180^0$.
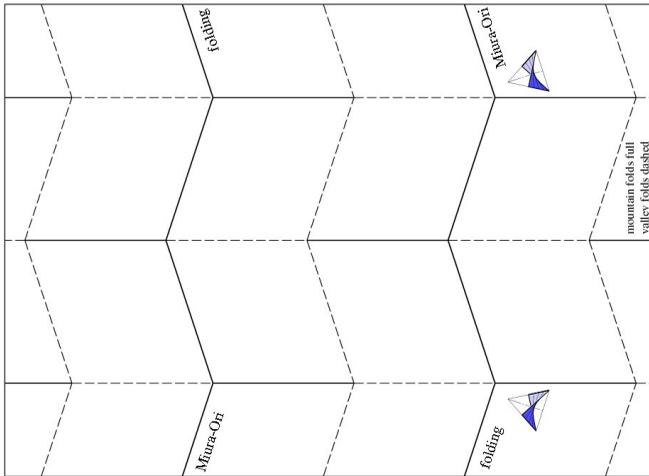
Fig. 1. The map of Miura-ori unfolded; dashs are valley folds,
full lines are mountain folds

Then the lower sides span a plane ε_1 and the upper sides span a plane ε_2 parallel to ε_1. Now we extend the two parallelograms to a zig-zag strip by adding alternately parallelograms translatory congruent to the left or to the right initial parallelogram. After this the complete strip has its upper zig-zag boundary still placed in ε_1 and the lower one in ε_2 (see Fig. 2). This remains valid when we fix the plane ε_1 but vary the bending angle 2δ.

After iterated reflection in planes ε_i parallel to ε_1 or after translation orthogonal to ε_1 the complete miura-ori flexion is obtained as depicted in Fig. 3. The edges can be subdivided into two kinds of foldings. The horizontal ones are copies of the zig-zig line in ε_1 and placed in horizontal planes. Due to the iterated reflections or translations, the others are located in mutually parallel vertical planes.

The complete flexion can also be generated by iterated horizontal translations and reflections in horizontal planes from the hexagonal compound of two non-coplanar parallelograms as depicted in the top-right illustration of Fig. 2. Miura-ori admits two flat poses, one for $\delta = 0^0$, one for $2\delta = 180^0$.
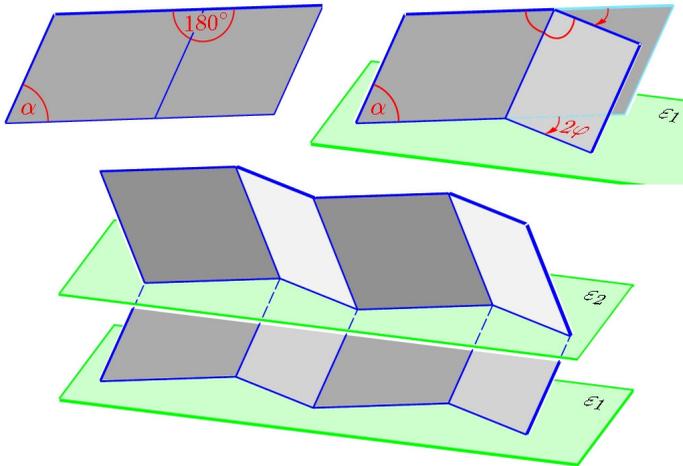
Fig. 2. Zig-zag strips of Miura-ori

Remarks: 1) In [4], the eqs. (1) and (2) together with Figure 5 show how the bending angle 2δ is related to the angle 2φ of the horizontal fold in ε_1 (see Fig. 2) and that of the vertical folds, in dependance of the interior angle α at the given parallelograms.

2) The mentioned one-parameter flexion of Miura-ori is not the only one. Trivial flexions arise, e.g., when in the stretched position we fold about the aligned horizontal folds. Or we fold adjacent horizontal strips one behind the other and treat them like one single strip.

3) There are several generations of Miura-ori, among them the impressive freeform-like versions presented in the recent paper of Tomihiro Tachi [7].
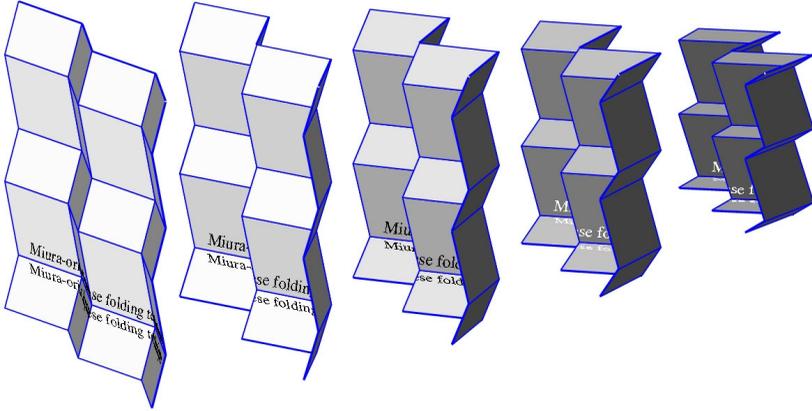
Fig. 3. Snapshots of the folding procedure

4. KOKOTSAKIS' FLEXIBLE TESSELLATION

There is one remarkable continuously flexible quad mesh which also starts from a flat initial pose. This example displayed in Fig. 4 dates back zu Antonios Kokotsakis (1899-1964) [2, p. 647]. He proved its flexibility, but did not present any geometric property of the obtained flexions:
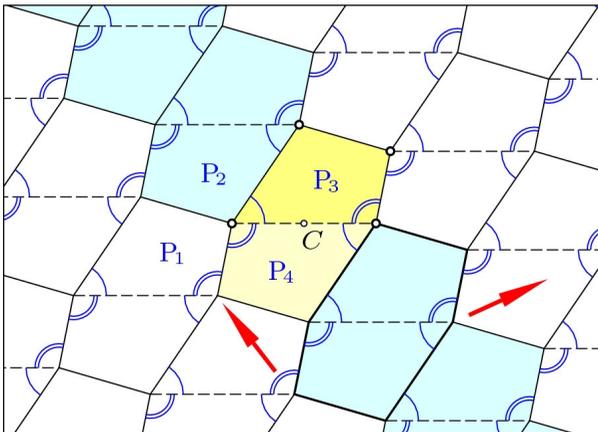
Fig. 4. Kokotsakis' flexible mesh unfolded

Take any arbitrary plane quadrangle like the yellow P_3 in Fig. 4. By iterated 180^0-rotations about the midpoints of the sides we obtain a wellknown regular tessellation of the plane. The same tessellation arises when the two adjacent quadrangles P_3 and P_4 are glued together thus forming a hexagon symmetric with respect to the center C and when this hexagon undergoes iterated translations indicated in Fig. 4 by the red arrows.

When the quadrangles are convex and seen as planar faces of a polyhedral structure with variable dihedral angles, then this structure is flexible (Kokotsakis [2], p. 647).

Proof: First we extract four pairwise congruent faces $P_1, ..., P_4$ adjacent to the vertex V_1 from our tessellation (note the shaded area in Fig. 5). These faces form a four-sided pyramid with apex V_1; it is flexible, provided the fundamental quadrangle is convex. We start with any nonplanar flexion.

According to the labelling in Fig. 5, for any pair $(P_1, P_2), ..., (P_4, P_1)$ of neighbouring faces there is a respective 180^0-rotation ρ_1, ..., ρ_4 which swaps the two faces. So, e.g., $P_2 = \rho_1(P_1)$ and $P_1 = \rho_1(P_2)$. The axis of ρ_1 (see Fig. 5) is perpendicular to the common edge $V_1 V_2$, and it is located in a plane which bisects the dihedral angle between P_1 and P_2.
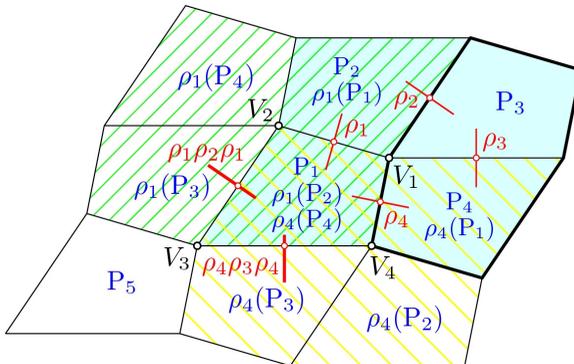
Fig. 5. The flexion is generated by iterated coaxial helical motions $\rho_1 \rho_2$ and $\rho_1 \rho_4$

After applying all four 180^0-rotations (= reflections in lines) ρ_1, ..., ρ_4 consecutively to the quadrangle P_1, this is mapped via P_2, P_3, P_4 onto itself, hence $\rho_4\,\rho_3\,\rho_2\,\rho_1 = \text{id}$. (We indicate the composition of mappings by left multiplication.) Because of $\rho_i^{-1} = \rho_i$ we obtain

$$\rho_4\,\rho_3 = \rho_1\,\rho_2 \,. \tag{1}$$

After that we extend this flexion of the pyramid stepwise by adding congruent copies of the initial pyramid without restricting the flexibility: The rotation ρ_1 exchanges not only P_1 with P_2 but transforms the pyramid with apex V_1 onto a congruent copy with apex V_2 sharing two faces with its preimage. This is the area hatched in green in Fig. 5. Analogously, ρ_4 generates a pyramid (hatched in yellow) with apex V_4 sharing the faces P_1 and P_4 with the initial pyramid.

Finally there are two ways to generate a pyramid with apex V_3. Either, we transform ρ_2 by ρ_1 and use

- $\rho_1\,\rho_2\,\rho_1$, which exchanges $\rho_1(P_2) = P_1$ with $\rho_1(P_3)$ and swaps V_2 and V_3.

Or we proceed with

- $\rho_4\,\rho_3\,\rho_4$, which exchanges $\rho_4(P_4) = P_1$ with $\rho_4(P_3)$ and swaps V_4 and V_3.

Thus we obtain mappings $(\rho_1\,\rho_2\,\rho_1)\rho_1 = \rho_1\,\rho_2$ and $(\rho_4\,\rho_3\,\rho_4)\rho_4 = \rho_4\,\rho_3$ with $V_1 \mapsto V_3$ and $P_1 \mapsto P_5$. Both displacements are equal by (1), and we notice

$$\rho_1\,\rho_2 = \rho_4\,\rho_3 : \; P_1 \mapsto P_5, \; P_2 \mapsto \rho_1(P_3), \; P_3 \mapsto P_1, \; P_4 \mapsto \rho_4(P_3) \,. \tag{2}$$

Hence each flexion of the initial pyramid with apex V_1 is compatible with a flexion of the compound of 3×3 quadrangles like that schematically displayed in Fig. 5, and this can be extended to the complete tessellation. Hence this is continuously flexible.   □

On the other hand, $\rho_1\,\rho_4 = \rho_2\,\rho_3$ maps the pyramide with apex V_4 onto that with apex V_2 and

$$\rho_1\,\rho_4 : \; P_1 \mapsto \rho_1(P_4), \; P_4 \mapsto P_2, \; \rho_4(P_2) \mapsto P_1, \; \rho_4(P_3) \mapsto \rho_1(P_3) \,. \tag{3}$$

The product of two reflections in lines is a *helical motion*. Its axis is the common perpendicular of the two axes of reflections. The angle of rotation and the length of translation is twice the angle and distance, respectively, between the two axes. When the pyramid with apex V_1 is not flat, then the axes of the line-reflections ρ_1, ..., ρ_4 are pairwise skew; the common perpendicular for any two of these axes is unique. Hence (1) implies that the axes of the four line-reflections have a common perpendicular n. The motions $\rho_1 \rho_2 = \rho_4 \rho_3$ and $\rho_1 \rho_4 = \rho_2 \rho_3$ are *helical motions with the common axis n*.

When P_3 and P_4 are glued together, we obtain a line-symmetric skew hexagon, one half of our initial pyramid with apex V_1. The line-reflection ρ_4 maps this hexagon onto itself. By (2), the helical motion $\rho_1 \rho_2$ maps this hexagon onto the compound of P_1 and $\rho_4(P_3)$, and furthermore P_1 onto P_5. The inverse $\rho_2\rho_1$ is the spatial analogon of the translation indicated in Fig. 4 by the red arrow pointing upwards to the right. On the other hand, $\rho_4\rho_1$ maps the compound of P_1 and $\rho_4(P_3)$ onto $\rho_1(P_4)$ and $\rho_1(P_3)$. This is the spatial analogon of the second generating translation of the flat tessellation.

Theorem: *Any flexion of the Kokotsakis' mesh is obtained from the line-symmetric hexagon consisting of the two planar quadrangles P_3 and P_4 by applying the discrete group of coaxial helical motions generated by $\rho_1 \rho_2$ and $\rho_1 \rho_4$. In the flat pose these generating motions are the translations applied to a centrally symmetric hexagon thus generating the regular tessellation of the plane.*

Remark: The flat initial pose of the pyramid with apex V_1 admits a bifurcation between two differentiable constraint motions of the pyramid. Hence the complete mesh admits two differentiable floldings when starting from the planar tessellation. In the case of a trapezoid P_1 one type of folding results in prismatic flexions and is therefore trivial.

5. AN EXAMPLE DUE TO SAUER AND GRAF

In order to obtain the flexible *T*-flat (German: *T*-Flach) detected 1931 by Sauer and Graf [3], we start with a non-closed prism Φ with horizontal generators e_0, ..., e_n as depicted in Fig. 6 in top view and side view (on the

left hand side). This prism is terminated by two vertical planes ε_1 and ε_2, hence its faces are trapezoids. Let α_1, ..., α_n denote the angles of inclination of the faces $e_{i-1}e_i$ for $i = 0,...,n$ under $0 < \alpha_i < 90^0$.
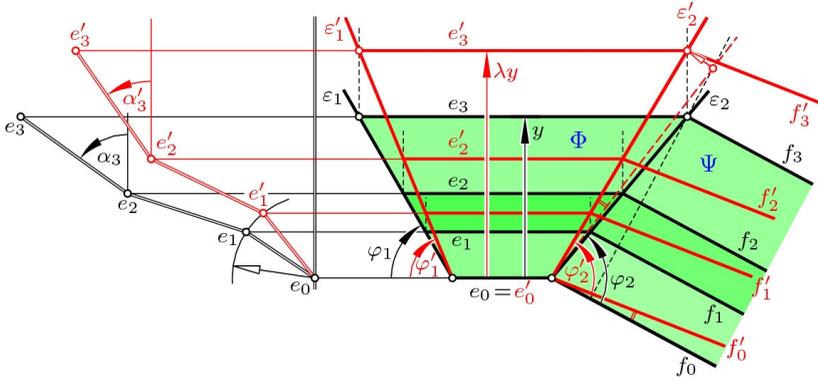
Fig. 6. *T*-flat together with a flexion (in red)

Now we apply a folding $e_i \mapsto e_i'$, $i = 0,...,n$, to Φ such that the generators remain horizontal and the top view undergoes an axial dilatation perpendicular to the generators with a factor λ close to 1. In order to transform all faces isometrically, the angles α_i of inclinations of the faces must be replaced by α_i' obeying

$$\cos \alpha_i' = \lambda \cos \alpha_i, \qquad (4)$$

provided $0 \le \lambda \cos \alpha_i \le 1$ for all i. The vertical planes ε_j remain vertical as the top view undergoes an affine transformation. The angle φ_1 between e_0 and ε_1, e.g., is replaced by φ_1' obeying

$$\tan \varphi_1' = \lambda \tan \varphi_1. \qquad (5)$$

For the polygonal sections $\Phi \cap \varepsilon_1$ each side length is preserved. The aligned top view of these polygons undergoes a scaling with factor $\cos \varphi_1 / \cos \varphi_1'$; therefore all ratios are preserved.

Suppose, $\Phi \cap \varepsilon_2$ is a section of another prism Ψ with horizontal generators f_0, ..., f_n (see Fig. 6). Then the folding of Φ implies a folding of Ψ under which in the top view the generators again are transformed by an axial

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dilation with a certain factor. Iteration gives a flexible quad mesh called *T-flat* with trapezoidal faces only.

Remark: In [5] the flexibility of T-flats is proved by checking the spherical image of the included 3×3 -meshes (see [5], Fig. 7).

6. CONCLUSIONS

This paper focuses on three well-known examples of continuously flexible quad meshes and analyzes their geometric background. These examples are
   Miura-ori (Fig. 1),
   Kokotsakis' flexible quad meshes [2] starting from plane tessellations by
      congruent convex quadrangles (Fig. 4), and
   T-flats due to Sauer and Graf [3] displayed in Fig. 6 with horizontal and
      vertical folds and trapezoidal faces only.

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TECHNICAL DRAWING HANDLING

PRINCIPLES OF PRODUCT DEVELOPMENT

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1. ABSTRACT

In the present work the main problem in the design of an engineering product is formulated. Basic principles of design and technological development (DTD) of products are suggested and discussed. Classification of these principles is proposed. The classification based upon _ambiguity_ of the development process, its stages, intermediate results, and _unambiguity_ of the set-up characteristics and parameters of the product under development.

KEYWORDS: Principle, Geometry, Graphics, Design, Product, CAD

2. INTRODUCTION

2.1 Statement of the problem
Design and technological development (DTD) of an engineering product is a complicated iterative multi-variant _ambiguous_ process [1-4]. It is carried out by a group of engineers (designers, technologists). In such a process, an engineer is an open nonlinear self-organized system [5]. He creates a product, which is an open system of certain structure with forecasted development.

In the course of product creation, its two-dimensional parametrical model [6, 7], three-dimensional parametrical model [8, 9], design documentation [4], technological documentation [9], solid parametrical model [9, 10], experimental setup and pre-production prototype [11-14] are developed. All these components and their parameters should correspond to each other. Therefore, the components and their parameters here comply _unequivocally_ with the technical requirements to the product.

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Thus, the essence of the problem in DTD consists in the contradiction between the *ambiguity of development processes and intermediate results* of product creation and the *unequivocally set-up characteristics and parameters* of the product under development. Schematically, the problem is illustrated in Figure 1.

Requirements to the quality, reliability and sustainability of a product are steadily getting tougher. In addition the market dictates reduction of cost and time for the development. Due to that, the *contradiction* between ambiguity of DTD processes and their intermediate results of specialists' activity and necessity of unambiguity of parameters of an end-product especially aggravates and becomes of prime concern. This concern and correlated problems occur due to mismatch between the resources, allocated for the DTD stage, and the total amount of work, that has to be done to accomplish the project.
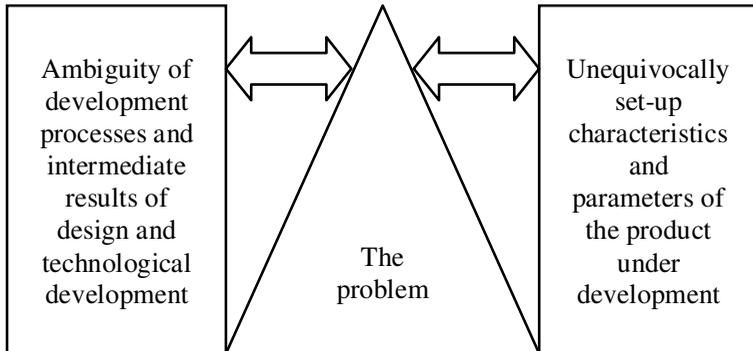
Figure 1: Graphical representation of the problem.

When such problem reaches a certain threshold, the DTD process is compromised so that the achieving the intended end result of the project becomes virtually impossible. No matter how high qualification of the engineering team, working on the project possesses, or how well the project is managed, using the most modern management technologies and business models. At achievement of critical mismatch, there is a rupture in DTD process and reception of economically defensible end result is impossible.

To solve the stated problem and thus to straightforward the DTD process, modern CAD systems and models, including information technologies, are utilized [15]. Although these modern technologies improve the whole DTD process, the stated problem is not resolved yet. It is remaining a serious problem for scientists, mathematicians, designers, technologists, programmers and managers and officials at developing, manufacturing, operating and recycling stages of product life.

Because experts in various areas participate in the development of a complex engineering product, it is especially important to define major fundamental principles as guidelines to achieve the desired end result. These various principles help to resolve the contradiction between the ambiguity of DTD process and the unambiguity of requirements to the end product. Therefore, the definition of such principles is necessary for further development of the theory of creation of a complex engineering product as well as for practical needs.

2.2 The analysis of publications. Professor Vanin and his research team have begun a new modern scientific direction in the development of applied geometry and engineering drawing. This direction has received the name of "structural parametrical modeling" [2, 16-18].

In their work [2] the general principles of structural parametrical geometrical methodology (SPGM) are formulated: principle of the system approach, alternativeness principle, optimality principle, openness and development principle, principle of the complex approach. These principles relate to the modeling on the basis of geometrical models.

A study of the created integral geometrical model does not require transformation of the components and elements of this model. Consequently, there is no need in the development of special mathematical procedures for transformations of model elements. As well as there is no need in mathematical procedures for mapping the essence and character of interrelations amongst these elements.

The features of interactions of a specialist with the already developed geometrical model, according to the set program, do not have any effect on the research results. Therefore, the character of such interaction is not taken into account.

Although it is true, in general, in certain situations foregoing principles of SPGM can be applied in DTD of the product as well.

2.3 Problem statement. The objective of the present work is to define principles of the design and technological development process of a complex engineering product, and to provide classification of these principles on the basis of *ambiguity* of processes and their intermediate results and

unambiguity of the set-up characteristics and parameters of the product under development.

3. BASIC INFORMATION

As geometrical modeling accompanies all the stages of life cycle of an engineering product, therefore the principles of structural parametrical geometrical modeling can also be used for realization of the design and technological development of this product. For realization of DTD process of a product, principles of structural parametrical geometrical modeling are modified. In this research modification of the basic SPGM principles is offered for another kind of activity (DTD) and another kind of object (product).

Principles of DTD of a product are formulated as follows:

1. *Principle of the system approach.* The developed product is set of the interconnected components and simultaneously a component of a product of higher hierarchical level or environment. Moreover, the product as a set of components possesses new properties and functions concerning its components.

2. *Principle of alternativeness.* In any DTD process, experts develop such structural and parametrical versions of the component, which allow the end user flexibly, effectively, and conveniently to determine the final version of the product, which satisfies the user's needs and requirements.

3. *Principle of optimality.* In any DTD process, the specialists develop the components of the final product, which allow determining and fixing the optimal ranges of the end parameters and characteristics of the product.

4. *Principle of openness and development.* DTD process provides possibility and flexibility of modification and updating of all components of the developed product during its lifecycle as needed or dictated by changing operation conditions and application of the end product.

5. *Principle of complex approach.* In DTD process of product components, special interfaces and internal connections should be developed to assure coherence of various components and their coordination, to achieve the desired final properties and characteristics of the developed product.

To increase efficiency of such coordination in a DTD process, two additional principles are used: the principle of transformation and the principle of the adaptive organization (Fig. 2).

Figure 2: Biunique transformations of models of a product.

6. *Principle of transformation* [4]. Non-surjective and biunique metrics of mapping of sets of parameters of components are obtained in the entire cycle of DTD process (Fig. 2).

7. *Principle of adaptive organization.* A specialist, responsible for the product development, adapting to the problems, organizes DTD process to find out a balance (conciliatory proposals) between inconsistent

requirements to the product and the processes of its functioning. For example, such inconsistent requirements as completeness and simplicity, unambiguity and multi-variant approach, accuracy and the comprehensible (acceptable) admission, flexibility and convenience in use, easy updating of components and complexity of a multipurpose (multifunctional) design of a product, etc. force professionals to define correctly the purposes and to find conciliatory proposals.

Efficiency of a compromise solution depends on the ability of a specialist to adapt *quickly* in a difficult inconsistent situation.

Classification of principles of a product creation is presented in Table 1.

4. CONCLUSIONS

4.1. In the present research, a classification of principles of DTD process of a product is offered. Three general principles are formulated: *the system approach, alternativeness, optimality*, as well as four particular principles: *openness and development, the complex approach, transformation, adaptive organization*.

4.2. The executed classification allows revealing three principles, resolving the contradiction between ambiguity of processes and intermediate results of engineering activity and unequivocally set-up characteristics and parameters of the product under development. It is a general scientific principle *of the system approach*, and also particular principles *of transformation* and *adaptive organization*.

4.3. All seven principles reflect ambiguity of processes and intermediate results of engineering activity.

4.4. The application of the developed principles allows realizing a product as a consolidated system with complex interactions among its components. Such product keeps integrity at overloads, damages and natural ageing.

4.5. Two of seven principles, namely, *transformation* and *adaptive organization*, are formulated for the first time for DTD process used in the product development. Today, the adaptation rate of specialists, involved in the development of products, in complex inconsistent situations is one of the important criteria of efficiency of DTD process as a whole.

Table 1: Classification of principles of product development.

№ , Generality	SPGM Principles Professor Vanin V.V. [2]	Principles of DTD Professor Brailov A.Yu. [3, 4]	Ambiguity	Unambiguity
1	2	3	4	5
1. General	The principle of the system approach, which consists "in consideration of investigated object simultaneously and as sets of the certain interconnected elements, and as potential component of a geometrical figure of higher hierarchical level"	*Principle of the system approach.* Specialists develop a product as a system of components. This product is also a component of the system of higher hierarchy level or environment. The developed system possesses new qualities and functions with respect to its components and with optimized interaction to the higher level system.	+	+
2. General	The alternativeness principle consists "in the requirement of maintenance with geometrical model of the creation of parametrical and structural versions of the given object flexible, effective, predicted and convenient for the end user or process".	*Principle of alternativeness.* In any DTD process, specialists develop structural and parametrical versions of the component which allow the end user flexible, effective, and convenient determining the final version of the product that satisfies the user's needs and requirements.	+	–

Table 1 continue

1	2	3	4	5
3. General	The optimality principle consists in "presence in model of means for definition of rational values of parameters and characteristics of a created subject or the phenomenon".	*Principle of optimality.* In any DTD process, the specialists develop the components of the final product that allow determining the optimal ranges of the end parameters and characteristics of the product under development.	+	–
4. Particular	The openness and development principle "is reduced to possibility of easy updating and expansion of components of structural parametrical geometrical model".	*Principle of openness and development.* DTD process provides possibility and flexibility of modification and updating of all components of the product under development during its lifecycle as needed or dictated by changing operation conditions and application of the end product.	+	–
5. Particular	The principle of the complex approach consists "in the adaptation of geometrical model to the coordinated account of various requirements of other mathematical descriptions of investigated object or process".	*Principle of complex approach.* In DTD process of product components, special interfaces and internal connections should be developed to assure coherence of various components and their coordination to achieve the desired final properties and characteristics of the developed product.	+	–

Table 1 continue

1	2	3	4	5
6. Particular	Not defined	*Principle of transformation* [4]. Non-surjective and biunique metrics of sets of parameters of mapping of parameters of the object are obtained in the DTD process.	+	+

Table 1 continue

1	2	3	4	5
7. Particular	Not defined	*Principle of adaptive organization.* A specialist responsible for the product development, adapting to the problems, organizes DTD process to find out a balance between inconsistent requirements to the product and the processes of its functioning.	+	+

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ENGINEERING DRAWINGS AS A SYSTEM OF VISUAL SIGNS FOR DEPICTING THE DESIGN OBJECT

Harri Lille[1], Aime Ruus[2] and Cornelie Leopold[3]

1. ABSTRACT

Within the course of Engineering Graphics students learn to perform the engineering drawing, which is the reflection of an existing object or geometrical structure of a future object, i.e. the design object. According to Bense, the design object is a special type of sign in that it realizes a combination of particular characteristics from three dimensions [1]. The sign may be the engineering drawing, the model or the prototype. Semiosis is a process that involves signs. The aspects of semiosis are communication and representation. In Engineering Graphics drawings with alphanumerical data are arranged aiming at better communication. Signification occurs in the encoding and decoding process within the framework of the communication model [2, 3]. Engineering Graphics involves design standards or codes that can be seen as conventions for communication in which signs make sense, i.e. conventional connections between the object and the means are established. Engineering Graphics is presented as a formal language using visual signs (semiotic tools) for transferring the data of the design object through Bense's triadic model [3].

KEYWORDS: Engineering Graphics, Engineering Drawing, Semiosis, Communication, Signification, Encoding, Decoding

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2. INTRODUCTION

The activity of the profession of design engineering is aimed at creating a suitable, rational and feasible variant of a future object, i.e. the design object. The principles of designing are semiotic by nature, which means placing signs in relation and conveying the information to be represented. The sign may be presented as the engineering drawing (graphic model), the model or the prototype. Semiosis is a process that involves signs. The aspects of semiosis are communication and representation. The design process can be interpreted as the process of encoding properties into an object. At the same time, it is also the process of decoding these properties from the viewpoint of the design team member or the user. It means that signification occurs in the encoding and decoding process within the framework of the communication model [2, 3]. The signs of the graphic model are visual signs (semiotics tools) created according to the requirements of design standards or codes. In other words, Engineering Graphics is presented as formal language using visual signs. The signs are explained with the help of Bense´s triadic model of signs [4]. The ability to decode and understand signification is based on competence in the sign system [5] with which one gets familiarized through performing engineering drawings within the course of Engineering Graphics.

3. COMMUNICATION MODEL

When the physician completes medical histories and the lawyer establishes rules of societal life or laws using terms and notions of an ordinary language developed over centuries, then the designer operates with different (individual, specific) visual signs and design specifications or codes, which are distinguished by people through sensory perceptions. The designer creates communication in which the object is not news (in the sense of ordinary communication) but represents a transferred model. This model may depend on the stage of the design, i.e. the engineering drawing (graphic model), the prototype or the model. Here we consider engineering drawing. In semiotics the model is an analogue of the object and replaces the object in the cognition process. According to J. Lotman, the basic questions in semiotics are the following. What did the author want to convey? Did you understand it [6]? For this kind of representation there are developed signs (icons, index and symbols), which can be observed as some kind of an ´´alphabet``. Signs are provided with rules for use in graphics – in the engineering drawing. The engineering drawing is an expressive reflection in the design process and a visual presentation on surface (canvas, paper, computer screen, etc.) aimed to create a two-dimensional record of a three-

dimensional object. The designer is not independent in presenting models of future objects but is severely restricted by economics, laws of nature, as well as by the requirements of design specifications or codes. On the other hand, all other members of the design team should also comply with certain requirements.

The aspects of semiosis are communication and representation. The designer visualizes his initial technical ideas and images of the objects as information, which is forwarded by using a communication model, see Fig. 1 [2] and [3]. In the communication model the image of the created object is forwarded by the sender (designer) using engineering drawings as the medium like and visual perception as the channel. The information is inducted by the receiver (member of the design team, user) but not in the full amount.
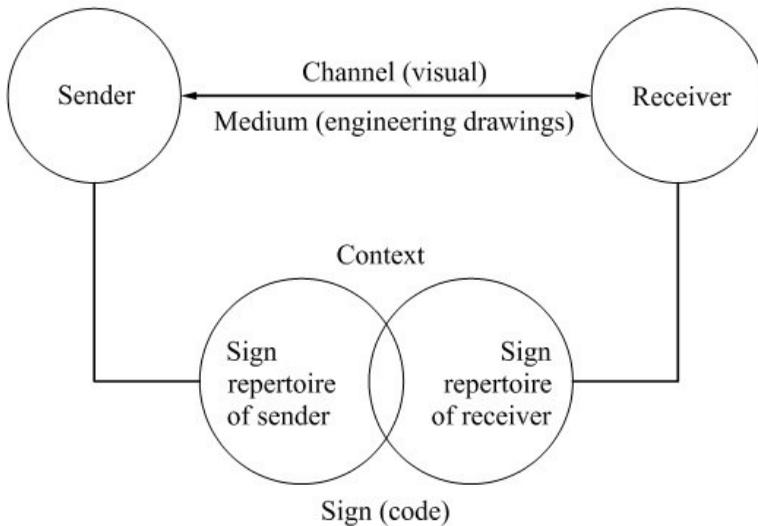

Fig. 1. A communication model.

When in a common communication model the sign repertoire of the sender and that of the receiver partly coincide, then the engineering drawing can be seen as a monomodel in which visual representation is provided in a highly conventional way, expressing the meaning exactly and systematically, with the written text playing a very limited role, and assuming an adequate understanding of parties. The visual signs (semiotics tools) of the graphic model include various images created according to the design standard (sometimes also standardized instructions) [7] or, in other words, according to the design standard or code as the repertoire of a semiotic structure in

which signs make sense. The design process can be seen as a process of encoding properties into an object; from the point of view of the user, it is a process of decoding these properties. A design code is thus a whole system of icons, indices, symbols each of which is made up of means of expressions and the impressions correlated with it. Decoding involves not merely basic recognition and the comprehension of what the engineering drawing as the result of three conceptual fields, geometry, semiotics and technology, conveys but also the interpretation and evaluation of its meaning with a reference to relevant codes. Decoding is closer to the 'construction' of the object than to the passive process suggested by the term 'reception' [8]. In the frames of the communication process there occurs transfer of information between the members of the design team as direct contact according to the stage of design process. However, through the information presented on drawings it is possible to create the object without direct contact between the sender and the receiver.

4. THE TRIADIC MODEL OF REPRESENTATION

Engineering Graphics may be seen as having the meaning of a formal language using visual signs for transferring the data of the design object through Bense's triadic model [4] Fig. 2.
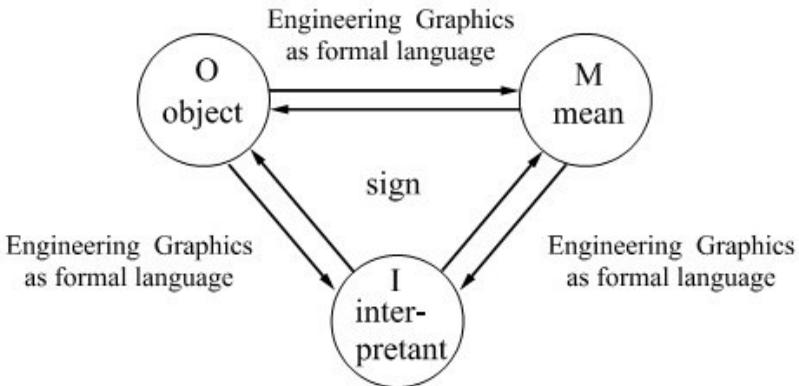
Fig. 2. Engineering Graphics - a formal language for transferring the data of the design object through the Bense triadic model.

The visual sign as a triadic relation of M (mean), in our case the 2-D drawing; may also be the model or the prototype, hence the 3-D geometric object, O (object – technical or design object) and I (interpretant –description of a geometric structure), according to Bense. Signs acquire meaning namely

in the context of codes and in case they are associated with the object. However, interpretation of Engineering Graphics is only possible in a limited design sphere.

Design standards or codes form also a semiotic structure on which the sender's and receiver's knowledge of signs is based. Design standards and codes are taught in engineering education which comprises mathematics, physics and chemistry, solid and structural mechanics, as well as the formal language of engineering graphics. The code and standardized instructions used in engineering drawing for the representation of a design object are sometimes quite distant from the actual graphic mode. An example of using in a system is presented in Fig. 3. Note, for example, that the presented graphic symbol, i.e. the circle, is an automatic actuating element which acquires meaning according to the referred standard.
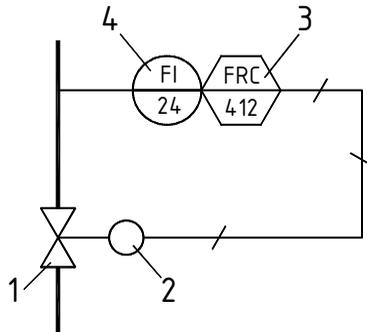

Fig. 3. Flow recording and control by computer, flow indication in the control room: 1-valve, 2-automatic actuating element, 3-flow recording to computer, 4-panel mounted instrument (ISO 3511/4-1985(E)) [7].

Drawings and alphanumerical data make it possible to adequately communicate initial techniques ideas to others. In other words, a data transfer and record system is created between an object and its own signs through visual tools [9, 10].

5. CONCLUSIONS

- In engineering graphics one learns to complete drawings, which forwards information by visual signs. By means of drawings communication is established between the object designer and the producer who manufactures the design object. This process is presented in the light of semiotics as semiosis, i.e. a process that involves signs.

- The communication model by C. Leopold, based on Shannon's communication model [3], is presented, in the frames of which the forwarding of information occurs by visual signs (engineering drawings) encoded by the sender and decoded by the receiver, where conventional relations between the object and means are established according to design standards or code.
- Engineering graphics is presented as a formal language, using visual signs (semiotic tools). Signs are explained with the help of Bense´s triadic model of signs.

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APPLICATION OF DOCUMENT MANAGEMENT TECHNOLOGY INSTEAD OF MANUAL APPROACHES IN STRAIGHTFORWARD CAD APPLICATIONS

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1. ABSTRACT

For years, small and mediums sized enterprises (the main users of AutoCAD LT) have relied on manual approaches and inefficient document processes to manage their important CAD drawings. Manual approaches in document management can lead to frequent "breakdowns" and absorb time on an ongoing basis.
The possible solution to this problem is application of technology that provided automated documents control for straightforward CAD applications (such as AutoCAD LT) and can be used as integrated part of Window Explore as well as Microsoft Office. In this work, the example of *Kinnosa* product family is described that includes property, metadata and relationship management along with external reference management. It also involved auditing and traceability, documents access control and automated releases.

KEYWORDS: Engineering Document Management, Drawing Property Management, External Reference Management.

2. INTRODUCTION

The main purpose of this work is to reduce a project development time and costs in building design and construction industry that are using straightforward CAD applications (such as AutoCAD LT). In small and mediums sized enterprises, users of AutoCAD LT have relied on manual approaches to manage their CAD drawings and associated documents. Manual approaches in document management can lead to frequent "breakdowns" and misplacement or lost of relationships between CAD drawing and associated documents. For these small and medium sized enterprises, the usual solutions for engineering document management (EDM) system [1] are too complex, extensive and costly. Such enterprises do

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not need many expansive and time-consuming features, such as an automation of manual processes, task collaboration, and data access control, integration with security systems, workflow management and data vault management. That is why the new technology has to be applied to provide management of documents and their properties.

The reduction of project development time and costs in building design and construction industry is performed by managing project technical documentation and digital data, which involves the complete life cycle of design documentation and design-related data inside CAD applications [2]. Such development is presented in this work with an emphasis on management of projects document properties. The document properties play an important role, as they represent an instrument for performing any manipulations with a document (such as submission, distribution, search, modification and so on). Thus, any document has to be accompanied by document properties. This issue is addressed because the straightforward attachment of properties directly to a document introduces a lot of mistakes. This may lead to misplacement of document in archive system. Instead of this, in a proposed approach the properties were attached to the project structure. Later these project properties were applied when filling the stamp by using AutoCAD LT, which is mandatory feature of any technical drawing [3].

The previous developments in management of electronic archive were focused on the automatization of data gathering, processing and submitting [4]. It allows storing the technical documentation according to the rules, which were based on the flow of documentation in a building design company. It was insured by additional models enclosed into the system. However, the growing requirements of engineers, and internal collaboration required across engineering departments, lead to the constant modification of the additional models. This introduces delays in engineering product design processes and requires an implementation of trainings and instructions. Therefore, it was fundamentally restructured and the objective of this work is to propose and implement a new development that offers a management of project document properties.

3. THE MAIN FEATURES OF ENGINEERING DOCUMENT MANAGEMENT FOR AUTOCAD LT USERS

The management of CAD documents involves a much higher degree of sophistication over traditional content management. CAD files often have complex designs, and compose a part of a larger package of documents. It usually called "release packages" or "product releases". The inter-

relationships between files are one of the core differences between typical "Office" content management and engineering content management. An effective CAD management process must maintain CAD file relationships, provide interoperability with the CAD tool, and allow for error-free transition between different groups, departments and companies.

AutoCAD LT is an abridged version, but engineering companies can use AutoCAD LT to build a strategic design process. However the lack of an interoperable EDM solution has left a major gap in a comprehensive CAD strategy. Without an interoperable EDM solution, determining the proper version of a CAD document, collaborating, and accurately distributing files to other groups can be very cumbersome and prone to errors.

The new technology (implement in EDM system) provides direct access and management of AutoCAD LT files directly through the AutoCAD LT interface. With proposed system engineers can automatically check files in and out within AutoCAD LT using standard file open and save functions for total version control. Document management functions are executed behind the scenes, without requiring the user intervention or disrupting the users normal work routine. The main features of the new technology is that users do not have to even leave AutoCAD LT to open another application or worry about additional work to properly manage files. The dialog box where user can directly access to version-controlled files within AutoCAD LT is presented in Fig.1.
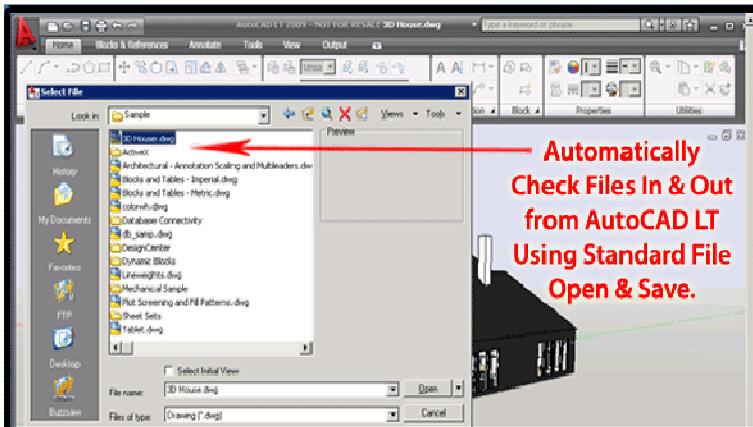

Fig.1. Direct access to version-controlled files

Another method how engineers can manage AutoCAD LT files through EDM system is extended Windows Explorer interface. Windows Explorer is the most familiar document organization tool in the world, but it is much too

cumbersome to be used by itself in an Engineering setting. The developed EDM system is directly integrated into the common file/folder environment for rapid adoption by end user. The EDM system is embedded into Windows Explorer system (Fig.2).
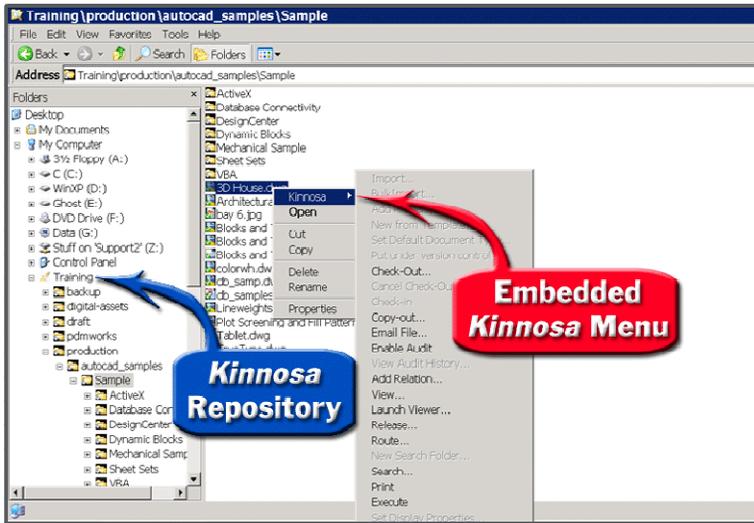

Fig.2. Integration with Windows Explorer

Using AutoCAD LT file open and save functions or functions embedded into Windows Explorer, EDM system provides:

- Version Control;
- Property Management;
- Relationship;
- Management (xrefs);
- Change Management.

Engineers, using this EDM system (the name of EDM system is *Kinnosa*) can have three additional tabs added to Windows Explorer properties: *Kinnosa* Properties (System Properties); *Kinnosa* Custom Properties (Document Properties); *Kinnosa* Security Properties (User Properties). These document properties can be entered or modified by opening dialog box showed in Fig. 3.
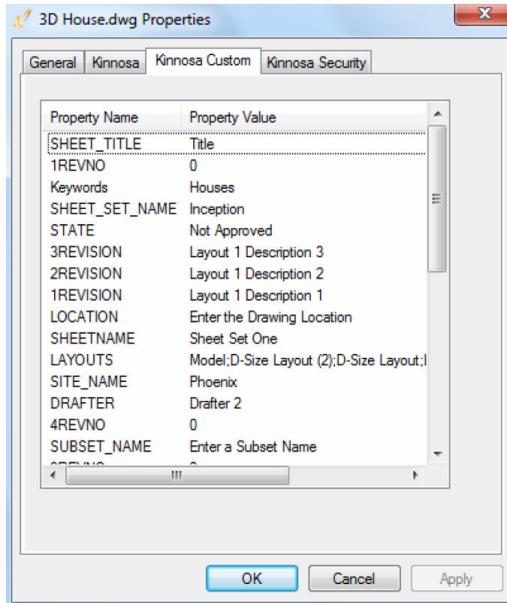
Fig.3. Document properties dialog box

The document management solution can significantly improve the overall document management process. However, the unique aspects of the construction industry make it a requirement that relationships between documents and the construction process be explicitly defined.

4. THE SPECIAL ADJUSTMENT OF DOCUMENT MANAGEMENT FOR AUTOCAD LT

CAD files are a treasure trove of information that includes objects, shapes, design data and metadata that describe the contents of the file. Various parts of this rich data set are needed by other enterprise systems as projects progress from concept to completion. The problem has always been on how to get the critical data out of the proprietary CAD files, distribute it effectively and keep design files in sync across the enterprise. Until now the solution for most manufactures has been to manually re-enter the data, which is costly and slow; or to integrate a limited amount of data using a "batch processing" strategy that unfortunately fails to keep data current and in sync. Both approaches tend to require enormous amounts of human intervention to cope with numerous manual workarounds that are characteristic of both approaches.

In new technology (implement in EDM system) a new feature called CAD Attribute Linking (CAL) is implemented. CAL consists of services that can access file objects, their design data and the metadata stored in a CAD file. With CAL, object attributes can be created, modified, queried and managed as needs arise. Once closed to the enterprise, object attributes can now be used to do things like helping a designer find a layout or extracting design data and loading it into another software system.

Many companies using AutoCAD have avoided using the powerful layout feature because of difficulties finding and retrieving the right layout within a drawing. Additionally, it is difficult to provide indexing and ability to modify CAD objects outside of the CAD environment for the individual layout objects. CAL makes using layouts easier by automatically managing and tracking CAD file revisions as well as providing access to the metadata of the layout objects within the CAD file. During the file check-in process, a CAL service extracts layout attributes and links them to *Kinnosa* properties where they can be searched and queried to find a specific layout.

A unique feature of the CAL between object attributes and *Kinnosa* Properties is that data movement can be "bi-directional". Users can update a *Kinnosa* Property and CAL will also cause the update to link back to its mapped object attribute. This permits users to update CAD file attributes without requiring them to have CAD software installed on their machines. It also provides external programs a way to update and create attributes in the CAD file.

5. CONCLUSIONS

The new technology provides following capabilities for AutoCAD LT users:
- Search for specific CAD file objects (i.e. layouts) using attribute and revision data.
- Non-CAD users can update CAD properties using inexpensive tools provided by *Kinnosa*.
- Changes in CAD attributes can be driven to other systems in real time.
- Design attributes can be extracted, transformed using metadata, and loaded into other systems to meet integration requirements.
- Important business attributes not associated with the CAD tool can be linked to objects for process control or formatting output (i.e. plotting parameters).
- External applications can access, update and create attributes in the CAD file keeping data in synchronize with other systems.

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UNCOMFORTABLE SETTINGS

Rein Mägi[1]
Heino Möldre[2]

1. ABSTRACT

The main task of the designer is to create well-functioning constructions rationally and as fast as possible. Using CAD programs could raise the designing productivity but not disturb it. Widespread program AutoCAD contains about 600 variables/settings that can change the designing more comfortable or uncomfortable. Knowing the impact of all these variables is not possible. Using different settings depends on particular situation and also on the subjective preferences. Our practical analysis shows that part of the settings is favorable, but some of them are unfavorable for designing process. Knowing uncomfortable settings allows to avoid them and facilitate designer's work.

KEYWORDS: Computer Aided Design, AutoCAD, Settings

2. INTRODUCTION

As our prior analysis [1] showed some problems appear from time to time when using Computer Aided Design (CAD). But in the work of the designer should not be unsolvable problems. Otherwise, it would be impossible to complete this work. Quite important is to use comfortable settings not contrariwise, uncomfortable settings.

3. PROBLEMS AND RECOMMENDATIONS

At first about display set-up (Fig.1).

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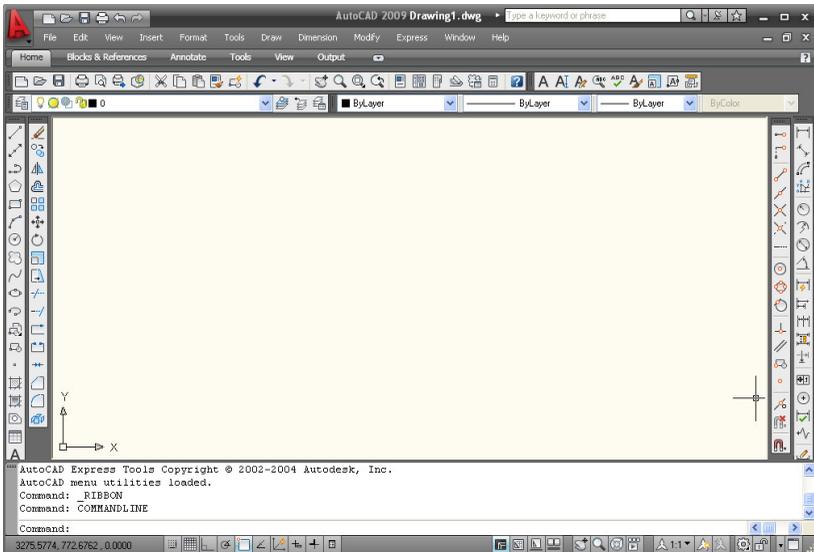
Fig. 1. The normal set-up of display in AutoCAD.

The most important is the drawing area - the bigger the better. Too indispensable is existence of *Menubars* (Command: *Menubar* = 1) and *Commandline* (Press *CTRL+9* to restore *Commandline* ; 4-5 lines is optimal to observe the computer-user dialog).

How many *Toolbars* is rational? Maybe all potential 40 ones? Not of course! The less the better, but only general *Toolbars*. Ordinarily for 2D-drawing – *Standard* on the top side, *Draw* and *Modify* on the left side, *Osnap* and *Dimension* on the right side. For 3D-modeling we can add *Modeling*, *Solid Editing* and something more. But all desirable commands are available from menubars.

Quite uncomfortable is to use *Ribbons* that diminishes the drawing area nearly 20% (Fig.2). But there is also subjective factor – what is convenient for one person may be uncomfortable for another.
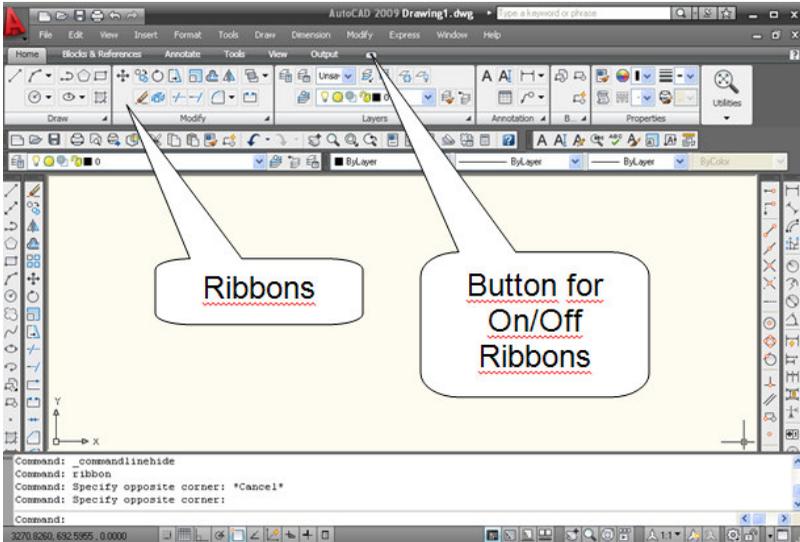
Fig. 2. The *Ribbons* diminish the drawing area nearly 20%.

Fig. 3. *Object Snap* settings for automatic selection.

Now about fixation of points with mathematical precision – Object Snap (OSNAP). Using *Osnap Settings* dialog (Fig.3) can change the Object-snapping automatic and quite comfortable. There are 2 alternative choices –

Select All or *Clear All*. It should choose only frequently used variants. For example – *Endpoint*, *Intersection*, *Center*. Quite undesirable and even dangerous is *Nearest* point – the nearest incidental point is selected. The *OSNAP*-button can be switched ON or OFF as needed.
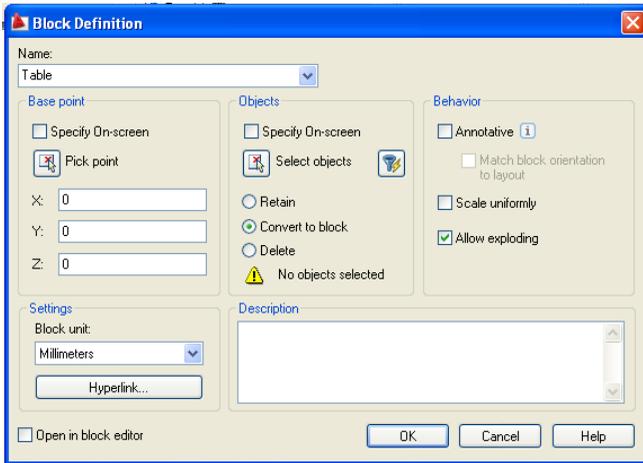
Fig. 4. Making *Block* by *Block Definition* dialog.

Specialities of Blocks, Layers and Styles are analyzed in the paper [2]. But making *Blocks* by Block Definition dialog (Fig.4) there are possible some uncomfortable settings. The *Base point* for Block should be selected by *Pick point* efficiently related to the object, not retain the point with x=0, y=0, z=0. Switching *Allow exploding* ON and *Scale uniformly* OFF enables to transform the created block. In otherwise this operation is impossible.

Quite illogical and inconvenient situation will appear if mode *Use Shift to add to selection* is turned ON (Fig.5). Also too small *Pickbox size* complicates selection objects.

Very promising possibility to change various parameters (Color, Linetype, Lineweight …) is command *Modify> Properties*. But the selection order is important. At first, we should choose the object(s) and after that change property. Otherwise (*No selection*), this feature is attributed to all new objects created. The last variant is usually not desirable. Quite comfortable is command *Match Properties* to transfer parameters of the source object to destination object(s).
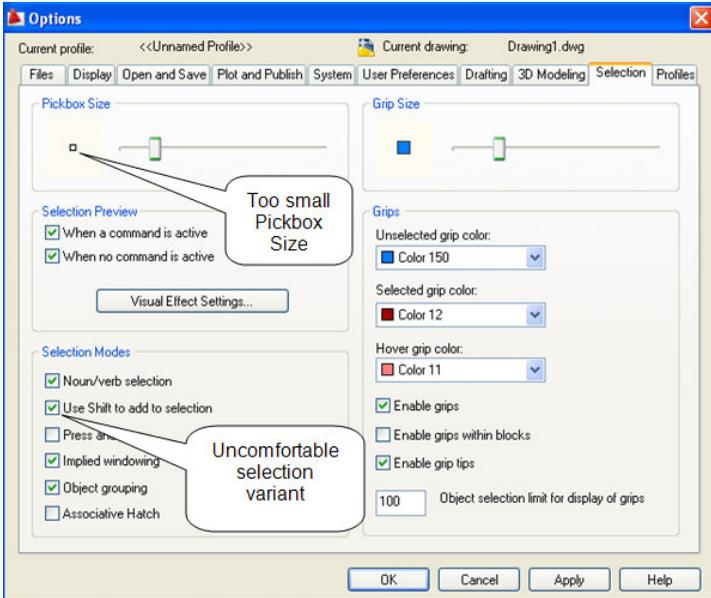
Fig. 5. Uncomfortable settings for selection objects.

Quite often, especially in 3D-modeling, it is necessary to change the User Coordinate System (UCS). For example, creating dimensions or hatching in the new plane (Fig.6). The dialog text in modern AutoCAD versions is:

Command: UCS
Current ucs name: *WORLD*
Specify origin of UCS or
[Face/NAmed/OBject/Previous/View/World/X/Y/Z/ZAxis] <World>:
Unfortunately there is failed very workable variant New, as it was in previous AutoCAD versions. But after selection N (New) this variant still works:

[Face/NAmed/OBject/Previous/View/World/X/Y/Z/ZAxis] <World>: N
Specify origin of new UCS or [ZAxis/3point/OBject/Face/View/X/Y/Z] <0,0,0>: 3
Specify new origin point <0,0,0>:
Specify point on positive portion of X-axis <-74.5651,222.6926,0.0000>:
Specify point on positive-Y portion of the UCS XY plane
<-74.5651,222.6926,0.0000>:

The most universal and comfortable is to define new UCS by 3 points (origin point, X-direction, Y-direction). For multiple use created UCS could be saved with suitable name.
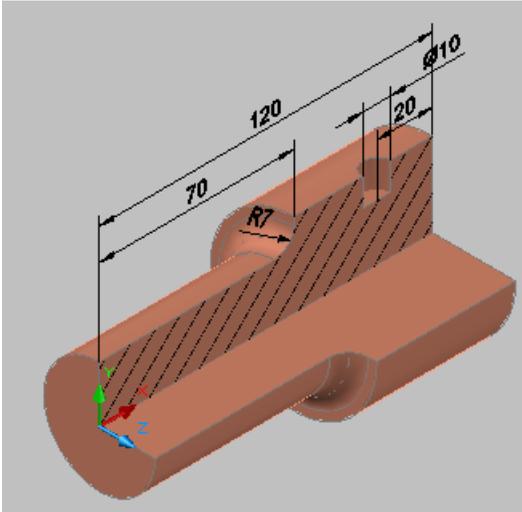
Fig. 6. Using suitable coordinate system in 3D-modeling

4. CONCLUSIONS

- Using comfortable settings and avoiding uncomfortable settings of CAD can raise effectiveness of designer's work.
- Uncomfortable settings could be avoided also in Computer Graphics classrooms.
- But knowing undesirable settings enables to avoid them in future.

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DESIGN AND AUTOMATIC CALCULATIONS OF MACHINE ELEMENTS

Mart Tiidemann[1], Ahto Kalja[2], Tiit Tiidemann[3]

1. ABSTRACT

Mechanical engineering design often includes drawings coming from designer thoughts by visualization that should use as much as possible standard elements and standard parameters. The thinking stage is often accompanied by freehand sketches. The following step - modelling in 3D and 2D – requires quick calculations. During recent years the authors have developed some experimental AI CAD packages for automatic calculations of machine elements such as gear drive, shafts, bearings, belt drive, that includes finding standard parameters from tables. The packages are especially designed to be used at conceptual design stage.

KEYWORDS: CAD, AI, Conceptual Design, ExpertPRIZ

2. VISUALIZATION WITH QUICK CALCULATION FOR DECISION MAKING FOR DRAWING

Design problems have more than one answer. In each field of design, the designer evolves a philosophy befitting the nature of the work he is doing. Computed results only provide evidence for eventual decisions. Other considerations are involved. The actual practice of designing is applying a combination of scientific principles and knowing judgment based on experience. Very often the result of mechanical engineering design will be evaluated by visualisation. "What is nice for eye is usually constructively right" – a known Estonian engineer and designer of bridges Prof. Ottomar Maddison has said. This applies to contemporary design process as well – many elements and parts of drawings are made not according to exact calculations but using estimation by sight.

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We have analysed the design and drawing process [1, 2]. The design process begins with recognition of a need and decision to do something about it. After several iterations, the process ends with presentation of the plans that satisfy the need. Having defined the problem and obtained a set of specifications the next step is the synthesis of a new optimum solution. The very first stage could be best described as the scheming, or "pencil –thinking" stage. This thinking stage often results in freehand sketches not drawn to any particular size or scale. It is the idea generation. It is form synthesis because the objective is to obtain the basic configuration. The modelling in 3D or drawing in 2D is the next step, when dimensional synthesis is necessary. Then calculations of machine elements become necessary. After that follows detailed determination of sizes to assure reasonable values of the stresses appearing in various components. At this point we are concerned with material selection, and with factors of safety and reliability. The final phase of dimensional synthesis concerns manufacturing and should encounter assembly problems. Thus tolerances and fits between mating parts must be specified. Along the way engineering practice usually requires compromises.

We shall do so again and again - design is an iterative process where we proceed through several steps, evaluate the results, and then return to an earlier phase of procedure. Evaluation is the final proof of successful design. Here we wish to discover if it really satisfies the needs, is reliable.

3. NEW IN CALCULATIONS IN EXPERTPRIZ ENVIRONMENT

Developing and using problem solvers has been a long time scientific activity in Institute of Cybernetics at Tallinn University of Technology. Our research in the field dates back over thirty five years and a lot of solver based software environments have been developed since [2-4]. The last system CoCoViLa has been under improvement and used at the Institute of Cybernetics for the last five years. An older but the simplest system ExpertPRIZ does not need programmers for using different domains and is still alive. There are a lot of engineers, ExpertPRIZ users in their everyday work that have no experience in programming and still capable of making their own specific programs.
We have described elements of such programs earlier, e.g. that calculates all parameters of a gear drive (fig.1) [3, 4]. Now we can do it together with selecting standard parameters from standard tables, and selecting materials for it. Automatically. And it takes very little time, half a minute.
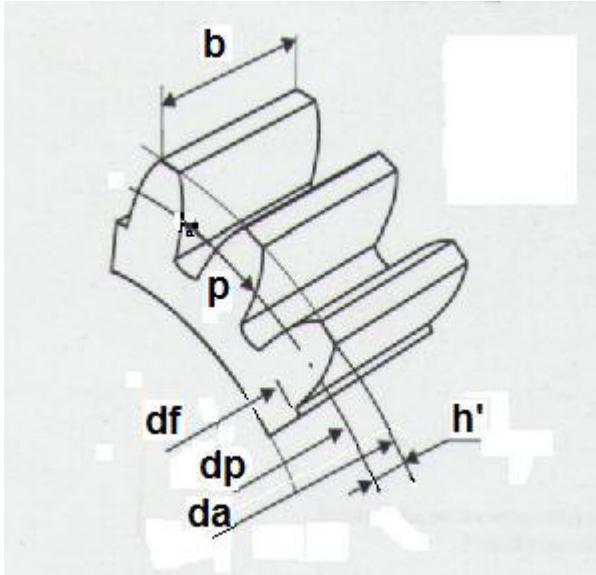
Fig. 1. Elements of a gear drive
that can be calculated automatically and find standard values.

When solving the design problem in AI methods the designer must only enter a minimum amount of input parameters and the system uses methods to automatically compose the algorithm and calculates the results. If we have necessary formulas in the concept base of a system the system can calculate everything we ask and select automatically the nearest standard parameters.

If the drawing results are not satisfactory, new backward calculations can be performed, based on a new selection of initial and some calculated parameters.

It will be possible to calculate the extreme, medium and optimal values for the parameters and after that decide on the design direction.

The software environments from the PRIZ family, which have been developed in the Institute of Cybernetics, mainly include the problem solver based on principles of deductive program synthesis. Such synthesis method is based on Prof. E. Tyugu's theory in intuitional logic.

4. EXAMPLE OF CALCULATING VALUES FOR CONCEPTUAL DESIGN

Let us take a simple problem to find the approximate gear parameters (Fig. 1), if we have initial modulus m=3 mm, and diameter of gear d=140 mm. The calculus is shown on three ExpertPRIZ windows – left to right (Fig. 2).

```
!clear y
d=m*z
da=d+2*m
df=d-2.5*m
m=3
d=140
?z            -> z=45.67
```

```
!clear y
d=m*z/cos(beta)
da=d+2*m
df=d-2.5*m
m=3
d=140
?                    -> m=3
                     -> d=140
                     -> z=46
                     -> df=132.5
                     -> da=146
                     -> beta=9.7
```

```
!clear y
d=m*z
da=d+2*m
df=d-2.5*m
m=3
*d=140
z=46
?            -> m=3
             -> z=46
             -> d=138
             -> df=130.5
             -> da=144
```
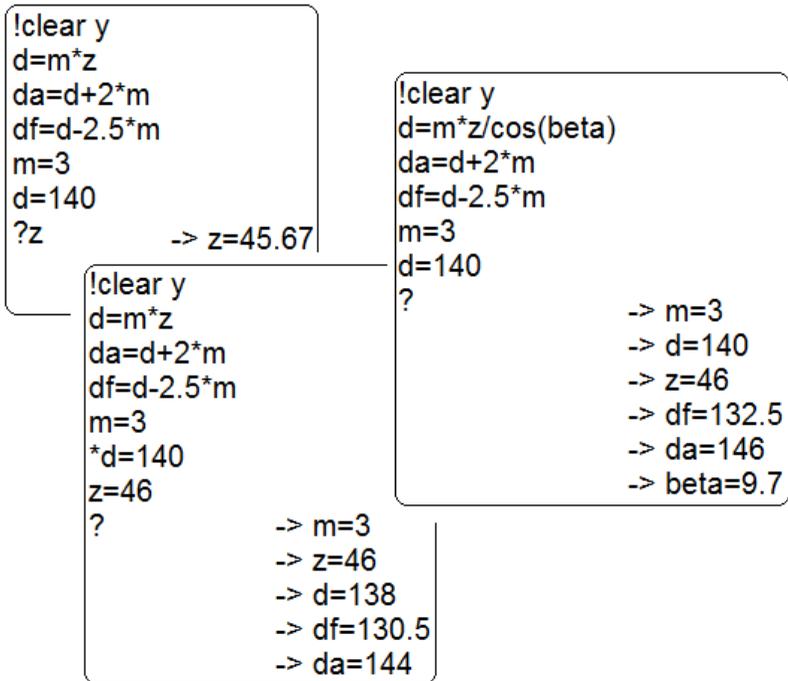
Fig.2. Example of using ExpertPRIZ
for calculating approximate gear parameters

ExpertPRIZ assumes every row in the workplace to be a formula. If we enter the command „!clear y", then program clears the model from previous actions. After writing down all formulas and initial parameters, in free order, we can ask for the number of teeth "?z". The answer appears immediately: "z=45,67".

As such calculated number of teeth (with fraction) is not realistic, we pick a nearest more suitable one "z=46". In next calculation (shown on next window) we eliminate the initial value for d (by adding * to the beginning of the row – the program assumes it then to be a comment). Now we can get all values calculated by typing "?".

If there is necessary to take already initial d=140, we can calculate helical gear with helix angel beta (shown in the last window). We will get immediately the necessary parameters for conceptual design.
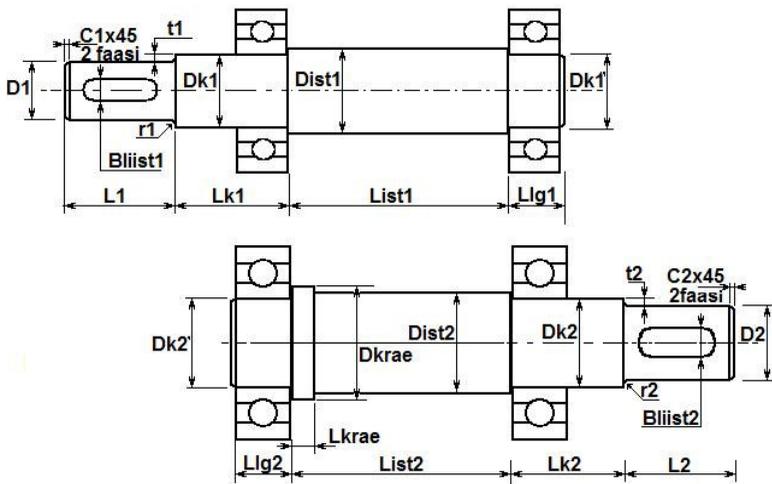
Fig. 3. Shaft elements and bearings
that can be calculated beforehand for a detailed design.

That was the simplest example. We have not shown here the automate finding of standard parameters from standard tables, but it is easy to use. We have CAD programs for finding materials and complete automatic solving all elements of gear drive, belt drive, bearings, and shafts (Fig. 3). Parameters that will be calculated according to stress and endurance limits are shown.

Usually the designer must draw the shaft, find distances between bearings and diameters of different parts of shaft elements, and after that the designer can find forces, moments actuated to bearings and get access to the calculus of strength. Now from the beginning of any initial parameter we will find all others, calculated for conceptual design. If necessary, the final checking in next design stage must be done [7].

The routine design work as finding tolerances and fits is also available by our AI software [5, 6]. Correct tolerances play a key role in machinery activities and become a critical link between designing and manufacturing.

We have discussed the useful experience of AI (artificial intelligence) software in design earlier, including latest variants CoCoViLa (Compiler Compiler for Visual Languages) [2-5]. The simplest one from the PRIZ family ExpertPRIZ is still alive and can be used by every engineer to make his own program packages. We have used them for checking student home works and projects in machine elements. It is more effective then Excel or other calculation software, because not necessary to show the exact order of formulas for calculations, we can ask value of different components we are interested in. We can check variants step by step on the same collection of formulas.

5. CONCLUSIONS

- The thinking stage of creative design is often accompanied by freehand sketches.
- Quick calculations are useful in every stage of drawing, 3D and 2D modelling in conceptual design.
- AI software ExpertPRIZ is simple to use in everyday engineering calculations.
- Experimental programs in machine elements are useful by freeing designers from routine calculations in order to leave more time for drawing on the creative way.

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HOW TO REDUCE *.DWG* FILE

Konstantinas Stanislovas Danaitis[1], Juozas Grabys[2]

1. ABSTRACT

The article deals about the problem how to reduce the volume of *.dwg* files creating automatic model projections. Authors describe the example and demonstrate the technology how to change the drawing to significantly reduce the volume of *.dwg* files. It is stated that at the *.dwg* file volume reduction algorithm is useful for drawings are sent by limited-scale e-mail.

KEYWORDS: Computer Graphics, *.dwg* Files, CAD, Automatic Projections

2. INTRODUCTION

Design and seen how much memory has the model in .dwg file is shown in Figure 1. It is 46.7 KB.
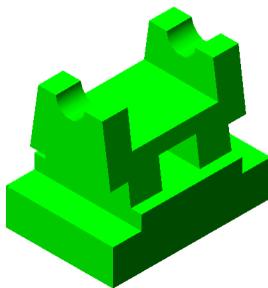
Fig. 1. Model as the object of the experiment

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3. FILE PROCESSING

Now, mount the two automatic model projections, the profile section and isometric projection. At the working we recorded the file volume creating automatic projections. With the formation of the horizontal projection (Fig. 2.) file volumes increased 13.2 KB, then a frontal view (Fig. 2b) – the file increased by 7.2 KB, creating the profile section (Fig. 2c) - file increased 13.7 KB and after formation of the isometric projection the file volume increased 19.2 KB (Fig. 2d)

a) 13.2 KB   b) 20.4 KB   c) 34.1 KB

d) 53.3 KB
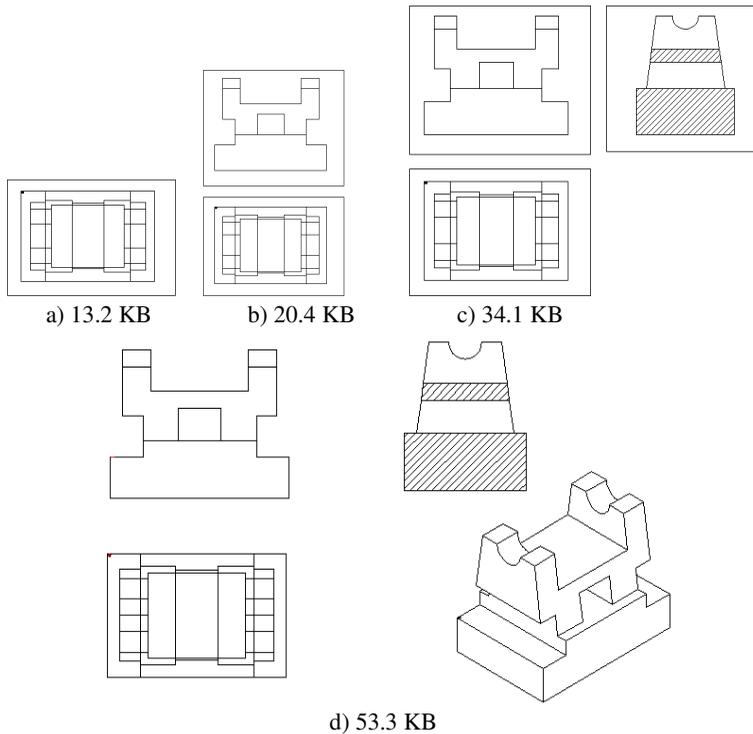
Fig. 2. Automated projections in paper space
a) - horizontal, b) - horizontal, frontal view, c) - the profile, front view, profile section, d) - the profile, front view, profile section, isometric view.

To finish the drawing need to edit the result that it complies with the standards, put the axis, the dimensions, the frame and load the records table.

But this does not exhibit, because it does not affect the contents of the experiment.

It is known that AutoCAD program creating automated projections forms them in model space and yet the model is repeated as many times as we do the windows with model images or its fragments in paper space. It is understood that the *.dwg* file volume highly increase depending on the model volume and images in the paper space being made to the drawing.

If move the obtained automatic projections to a *.dwg* file paper space and delete all images data source, then will significantly reduce the *.dwg* file. But we will get the same result, for example if you are printing. And if you do not want to delete a model, then we can move the automatic projection in a new *.dwg* file of paper space. How to do it, see below.

a) Transfer to paper space over the operational of memory

o   Activate the window in paper space, from which we want to move the projection lines. For this click the model space tab [1,2].

o   We have seen that the activated window coordinates **UCS** xy plane parallel to the plane of the screen (**UCS V**), Command **UCS** $\Rightarrow$ **V** $\Rightarrow$ **E** (Enter).

o   Copy projection lines in the window, command **COPYCLIP** $\Rightarrow$ select projection by frame $\Rightarrow$ **E**. The projection copied to the operational memory.

o   Entering a new sheet of paper and set the format for what the format sheet with the projections, Command **PASTECLIP** $\Rightarrow$ The projection traces comes. They are seeking the mouse cursor and you specify the insertion point of the projection.

In this way, the projection moved to a new page. Projection transfer through the operational memory is simple, but unreliable option. Sometimes, instead of the projection appears a straight line, i.e. projection transferred perpendicular screen surface. Then, the projection can move through the block.

b) Transfer to paper space by using a block

o   Activate the paper space window, from which we want to move the projection lines. For this click the model space tab, Command **Draw** $\Rightarrow$ **Block** $\Rightarrow$ **Make** $\Rightarrow$ block creating and name of block input, **Select Objects** $\Rightarrow$ select projection by frame, **Pick Point** $\Rightarrow$ select the insertion point, chose the mode **Retain** (save) $\Rightarrow$ **E**. Such we created a new block and keep the original object.

  o Entering a new sheet of paper and set the format for what the format sheet with the projections. Command **Insert** $\Rightarrow$ **Block** $\Rightarrow$ select a block by name $\Rightarrow$ **OK** $\Rightarrow$ select the insertion point on the screen.

In this way, the projection moved to a new page. If you want by using block to move the projection to another *.dwg* file, then used the command **Wblock** instead of the command **Block**. The next steps will be similar to transfer command **Block** [3]. In this way, move all the desired automated projections, sections and slices.

Our *.dwg* file, transfer automatic projections to the new sheet is 53.3 KB and the original file with the model is 79.3 KB. In this way, by presented manipulation our DWG file reduced 1.5-fold.

If such experiment carried out to the larger DWG file, for example. building model (Figure 3), then we will get a greater effect. "Building" model *.dwg* file occupies 3:36 MB.
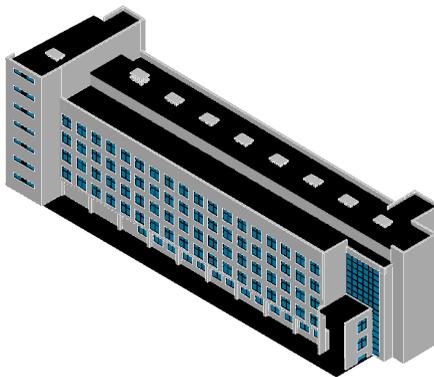
Fig. 3. Larger experimental model "building"

Creating horizontal and frontal view, the profile section and isometric view in the paper space *.dwg* file increased to 8.25 MB. Transfer projections and section by using block in a separate sheet of paper and then deleting everything that is located in model space *.dwg* file volume was 3.31 MB.

In this way *.dwg* file has decreased from 25.8 MB to 31.3 MB, i.e., 2.5-fold. It is important for making large volume *.dwg* files on automatic projections, sections or individual units' projection footnotes. Limited-scale e-mail will not be able to store transmissions these drawings. One solution proposed - to move all of the projections formed by automatic and cuts in a separate sheet

of paper of another *.dwg* file. This file volume will reduced by a few times. The original will remain. It needn't to delete the model space.

4. CONCLUSIONS

- Where drawings using automatic projection capabilities, *.dwg* file volume is increasing rapidly, depending on model complexity and projections and images number. Drawing volume compared to the original version may be increased many times. A real opportunity to significantly reduce the extent of the *.dwg* file transfer of all the projections and cuts from the model space to paper space of the next file. This will provide the opportunity to save computer memory, or more effective use e-mail by sending drawings.

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HUMAN DIMENSION IN ENGINEERING GRAPHICS

Rein Mägi[1]

1. ABSTRACT

Engineering Graphics objects can be from very small to quite large. Object's real size is expressed by dimension values. According to overall dimensions the scale should be selected for the drawing sheet. But in real life a man compares himself as an etalon to the size of objects. Using human figure can more attractively sense the actual sizes of several constructions. Creation of a virtual human 3D-figure is demonstrated.

KEYWORDS: Engineering Graphics, Human Dimension, 3D-modeling.

2. INTRODUCTION

In 1970s Computer Aided Design (CAD) began as 2D-graphics but since 1985 started 3D-modeling [1]. 3D computer graphics nowadays is very fast-growing trend in modern designing due to many attractive possibilities [2]. It enables better to understand buildings and plans for people without special graphic imagination.
Comparison with human real dimension allows to sense better people among constructions or nature (Fig.1). But some attractions are made contrariwise to feel an adult like small children (Fig.2). Designing buildings and furniture it is rational to use full 3D human figure for sense visually the real situation (Fig.3).

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Fig. 1. The beautiful nature object Suur Taevaskoda (Great Sky Chamber)
 in the South Estonia. By comparison, human groups.
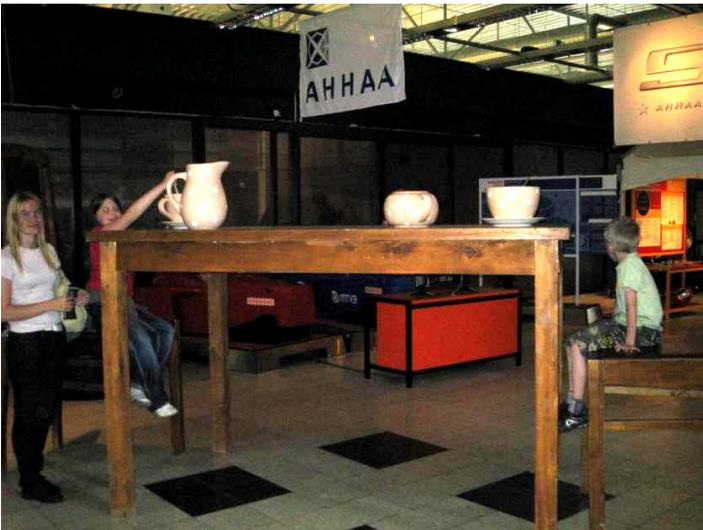
Fig. 2. The attraction in the Ahhaa-Centre to feel an adult like small children.
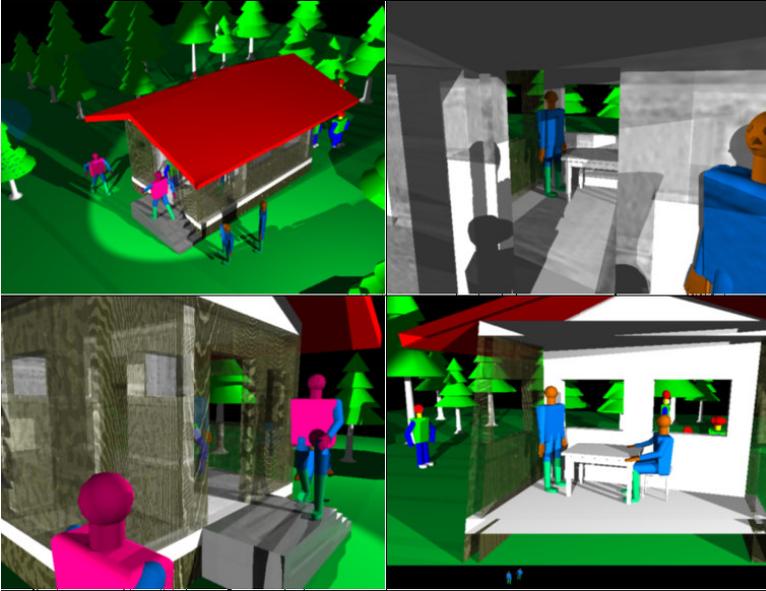
Fig. 3. Human 3D-figure in exterior and interior of the house.

Creating 3D-solid model is not very hard. The starting point should be that the height of an average person is nearly 180 cm. But the proportions are quite different for adults and children (Fig.4). For example the head of adult includes nearly 13% of the total length, for child about 23%. Creating process of the 3D-solid model of the man is demonstrated on the Fig.5. Typical Solid-modelling commands (Sphere, Cylinder, Revolve, Extrude etc) are used for creating part of human body. For the further rotation of these parts is rational to use spherical ends as suitable base points (snap by *Center*-point). Not use *Union* command for solid elements! Making *Blocks* not prohibit *Exploding* them - otherwise we cannot edit blocks' primary elements. There is more interesting than to create different figures – standing, walking and sitting persons (Fig.6). Certainly the human head has also the face with eyes, nose and mouth (Fig.7). Colors of these elements should be determined before *Solid editing* commands *Union*, *Subtract*. Afterward it is impossible to change colors of individual parts. This human model can be used for reasons of ergonomics for example for designing tram controller (Fig.8).
Students' average rating (4 of 5) after creating this figure showed their interest and creativity [3]. It was like the "Lord God's human creation".

Fig. 4. The father and the son – the work of Estonian sculptor Ülo Õun.

Fig. 5. Creating process of the 3D-solid model of the man.

Fig. 6. Getting various forms the figure as result of rotation of body-joints.
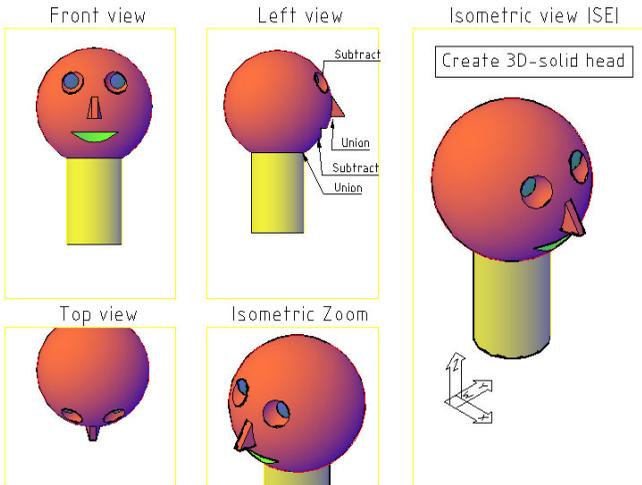
Fig. 7. Creating 3D-solid model of the human head.
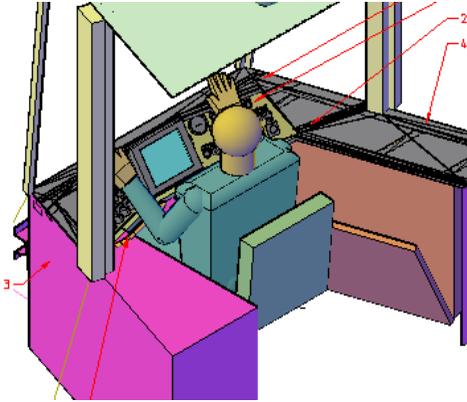
Fig. 8. Using 3D human model for designing tram controller.

3. CONCLUSIONS

- Comparing objects with human figure allows more visually interpret building's and furniture's dimensions.
- Using flexible virtual 3D-model of man enables design quite human-friendly constructions.
- Creating human model was interesting alternation for technical students.

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CAD METHODS

CONTEMPORARY DESIGN METHODS AND SYSTEMS

Nomeda Puodziuniene[1] Vidmantas Nenorta[2]

1. ABSTRACT

Today the effective employment of Computer-aided technologies is the main reason of successfully product development and it's swimmingly competing in the world market. Computer-aided technologies tools participates in many stages of product lifecycle management (PLM), including computer aided design (CAD), finite element analysis (FEA), digital product development (DPD) and direct digital manufacturing (DDM), product testing using virtual prototyping and visualization with photo realistic rendering, product documentation management, product data management (PDM), product support management (PSP) and etc. Suitable employment of CAD tools increases product reliabilities and decrease product development costs and a greatly shortened design cycle. The list of contemporary design systems is very dynamic: old companies go out of business, new companies appear and some companies split and merge.
The aim of this paper is to overlook some news of automated design systems, its prospect and developmental trends.

KEYWORDS: KEYWORDS: Automated Design Systems, CAD/CAM/CAE, Digital Product Development (DPD), Product Lifecycle Management (PLM).

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2. INTRODUCTION

PLM concepts were first introduced where safety and control have been extremely important, notably in the aerospace, medical device, military and nuclear industries. Today many major companies employed design systems with tools witch maintain Product lifecycle management (PLM). Its tools managing all data that covers the product's lifecycle relating to the design, production and service. Extremely important is assuring the communication process between engineering, manufacturing, marketing and product service. The PLM system is the place where all information about product from marketing and design comes together. Companies depending on the situation in the market promptly can do required variations in product life cycle for suitable competitive product in the today markets witch is overflowing of analogous products. With the PLM tools engineers can neglect about data transferring to the manufacturing, filling documentations or communications with emails between different work teams or other correspondence. So engineers with all assiduity can direct develop the new features of product.

Product Data Management (PDM) is an integral part of PLM. PDM maintenance covers: engineering data management (EDM), document management, product information management (PIM), technical data management (TDM), technical information management (TIM); handling: stream of works and process, data and documentations, structure of product. PDM systems working not only with text documentations, but with geometrical model and its data, witch are necessary for automatic line functioning with computer numeric control (CNC) machine-tool. One of the goal of PDM - maintenance working between different teams with project that is revising at the moment and operating general information source of company. Without PDM, PLM have another four main areas: Systems Engineering (SE), Product Management (PM), Product Design, Manufacturing Data Management (MPM) [1, 2].

The main tool used for product design and development is CAD. This can be simple 2D Drawing/Drafting or 3D Parametric Feature Based Solid/Surface Modeling. These software includes technology such as Hybrid Modeling, Reverse Engineering, Knowledge-Based Engineering, Nondestructive testing, Assembly construction.

Design systems use different design methods for product development during design process. Concurrent engineering (simultaneous engineering) is a workflow that, involves product planning which includes all departments within an organization. Feature-based CAD systems have the simultaneous work flow on 3D solid model and the 2D drawing by means of two separate files. When the model changes, the drawing will associatively update. Some

CAD softwares also allow associative copying of geometry between files. It is the copying of a part design into the different files used by the tooling designer. The manufacturing engineer can then start work on tools before the final design is not finished. And when a designer changes size or shape, the tool geometry will update. Concurrent engineering maintain more immediate communication between departments.

Bottom-up design (CAD Centric) when the product design starts with the construction of individual components. This method designs some sub-assemblies until the full product is digitally created. This is, sometimes, known as the review structure, showing how the product will look like. Bottom-up design tends to focus on the capabilities of available real-world physical technology.

Engineering traditionally develops the product structure from the top-down. Top-Down design starts with a layout model, often with a simple 2D sketch defining basic sizes and some major parameters. Geometry from this is associatively copied down to the next level, which represents different sub-systems of the product. A number of levels of the assembly are created until the basic definition of components can be identified, such as position and principal dimensions of separate parts. A top level is decomposed into lower level structures and specifications, until the physical implementation layer is reached.

Both-Ends-Against-The-Middle (BEATM) design is a design process that endeavors to combine the best features of Top-Down design, and Bottom-Up design into one process. BEATM design methodology is to immediately focus at both ends of the design process flow: a top-down view of the solution requirements, and a bottom-up view of the available technology which may offer promise of an efficient solution.

Design in context. Individual components cannot be constructed in isolation. CAD models of components are designed within the context of part or all of the product being developed. This is achieved by using assembly modeling techniques. Other components' geometry can be referenced within the CAD tool being used. The other components within the sub-assembly, may or may not have been constructed in the same system, their geometry being translated from other collaborative product development formats.

3. DESIGN SYSTEMS AND ITS FEATURES

Computer Aided technologies (CAx) software has been produced since 1970s though the present for a variety of computer platforms [3]. In today's industry the list of this software often change some companies disappear, some companies appear or merge.

Fom 1989, SolidWorks, Pro/DESKTOP, ADAMS, ANSYS-DesignSpace, Unigraphics, Solid Edge, Mastercam, MicroStation Modeler have the same geometrical modelling kernel – Parasolid of UGS Corporation (Unigraphics Solutions). In 2007, UGS was acquired by the Automation & Drives Division of Siemens AG. UGS company was renamed to Siemens PLM Software on October 1, 2007 [3]. Today there are some CAD systems from different companies in the world, which are very popular in industry and naturally in education process.

Autodesk company started with AutoCAD in 1982. Now Autodesk company has about 9 millions users all over the world. First versions of AutoCAD operate with elementary objects such as line, circle, arc and etc, from witch was created more complicated objects. Since 2010, AutoCAD has the parametric drawing support. Users can attach geometric and dimensional dependences to the object. This guarantee that if user did some changes in the project, early determined relations between objects will be keeped. AutoCAD software environment data can be saved in different versions of DWG format. For the efficient and save distribution and communication of design data to anyone who needs to review, or print design files, DWF file format is used [4].

On November 15, 2010 was released first version AutoCAD for Mac OS. DWG files produced in the Mac software can be exchanged with Windows users, and vice versa. The suite also supports AutoCAD WS - on online workspace where editing and sharing can be accomplished via the web or the iPhone/iPad app [5].

Autodesk Inventor is also product of Autodesk company. It is parametric modeling design software for creating 3D digital prototypes used for the design, visualization and simulation of products. This CAD system can integrate all design data into a single digital model; create a virtual representation of the final product to market before it's built; digitally simulate product's real world performance. With Autodesk Inventor software, users can easily integrate AutoCAD and 3D data into a single digital model to create a virtual representation of the final product. Inventor software helps users realize the benefits of digital prototyping by providing direct read and write of native DWG files, so there is no risk of inaccurate translations [4].

Inventor iLogic technology is fully integrated into Inventor 2011. Inventor iLogic technology simplifies rules-based design for any Inventor user—even those with little or no programming experience. iLogic technology allows designers and engineers to capture and embed engineering and product knowledge directly into virtual models. With Inventor iLogic, rules are created graphically from native Inventor parameters and embedded directly into the Inventor data model. By making rules-based design intuitive and

accessible, iLogic technology can help all Inventor users define complex product configurations, increase engineering productivity, and optimize designs to meet their required design goals [4, 6].

SolidWorks system is developed by Dassault Systèmes SolidWorks Corp., a subsidiary of Dassault Systèmes. SolidWorks is currently used by over 1.3 million engineers and designers at more than 130000 companies worldwide. Now in SolidWorks is easy-to toolsets, clear communication of design information, virtual prototyping, and quick generation of manufacturing-ready drawings and data. Large Design Review – enables users to work with massively large assemblies. The true beauty of modelling with SolidWorks 3D CAD is the ability to visualize and demonstrate how a product will operate. With powerful visualization and collaboration tools, users can create brochure-ready product renderings selecting from a range of options for materials, textures, and backdrops. Unlike traditional rendering tools, SolidWorks PhotoView 360 requires no photographic experience and renders dynamically, achieving high-quality results faster than traditional rendering tools. SolidWorks eDrawings Viewer lets users share the 3D models, drawings, animations, and simulations via email, no CAD software required [7, 8].

CATIA is Dassault Systèmes Pioneer Brand. CATIA V1 was announced in 1981. In 1993 was announced CATIA V4 for UNIX OPERATING system and in 1998 was announced CATIA V5 for Microsoft Windows. At the beginning this systems was not popular in the market. Then Dassault Systèmes proposed PLM. In 2008 Dassault Systèmes delivered to market CATIA V6. It has few systems: CATIA for automated design, ENOVIA for or engineering data and team work, SIMULIA for engineering analysis, DELMIA for Digital Manufacturing Solutions allow manufacturers in any industry to virtually define, plan, create, monitor and control all production processes. CATIA provides industrial designers and mechanical engineers with a full suite of surfacing, reverse engineering, and visualization solutions to create, modify, and validate any type of complex innovative shapes, 3D parts and assemblies and help streamline the transition and collaboration between engineer's teams. CATIA equipment provides an integrated environment that enables the collaborative detailed design of electronic, electrical, and fluidic systems in context of a virtual product [8].

NX of Siemens PLM Software and Pro/ENGONEER of Parametric Technology Corporation are the main rivals of CATIA.

Now Pro/ENGINEER of PTC's is CreoElements/Pro. Today's, fully integrated CAD and PLM solutions to the system allow users to develop optimal and competitive product. Creo is being designed as a scalable suite of interoperable, open, and easy-to-use product design programs. Creo is being specifically created to solve the big problems remaining in the mechanical CAD market: usability, interoperability, assembly management and technology lock-in. Company will offer customers the right tool, for the right user at the right time, enabling everyone in the organization to participate in the product development process. The result: new ideas, creativity, and personal efficiency are unlocked. The users will enable to incorporate data from any CAD system. PTC expects Creo1.0 to be available during mid-year 2011 [9].

4. CONCLUSIONS

- Popularity of the CAD system in the region depends on dealers' activity. 3D design possibilities for the all most popular CAD systems practically are similar.
- Analysis shoved, that new trends in CAD systems evolution are declared by CreoElements/Pro corporation and should be delivered to the market in 2012.

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AUTOLISP ROUTINES FOR DESIGN ACCELERATION

Vidmantas Nenorta [1], Tilmutė Pilkaitė [2],

1. ABSTRACT

The paper deals with AutoLISP routines creation in order to accelerate design works. It is very important to create precise drawings with a constant, required line width. These and other technical problems, examples for its solution are presented and described in the paper. All solutions are adapted and applied to educational process.

KEYWORDS: AutoCAD, AutoLISP.

2. INTRODUCTION

AutoCAD computer-aided design system has an open architecture and provides for user development platform for specialized design and drafting applications. Working with AutoCAD software all the users have possibility to extend and personalize menu and toolbars, to accelerate design process by creating AutoLISP routines that minimizes drafting time and shows the power of parametric programming. Hundreds of AutoCAD uses extend productivity of software by creating new AutoLISP routines, solving typical every day problems. There are a lot of Web pages with AutoLISP routines assigned for design works acceleration [1, 2]. Useful suggestions and ideas for an appropriate technical decision, task solving can be obtained from Autodesk forum pages [3]. On Web sites we can found advertisements like "we make LISP programs for CAD thru online. Pay thru PayPal" [3].
Frequently we can use express tools inside AutoCAD. Express tools inside AutoCAD contain library of productivity tools designed to help you extend the power of AutoCAD. They are easy to use, easily integrated in your manus and toolbars, and cover a wide range of AutoCAD functions (including dimensioning, drawing, object selection and object modification) [4].
However in spite of large amount of routines adapted to AutoCAD system not always we can found proper for ourselves, a lot off these routines are

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cost money (fee-paying). In any case any new routine extends functionality of the main system, fastens design works.

3. DESIGN WORKS ACCELERATION BY AUTOLISP ROUTINES

We can state, that AutoCAD system one of the most suitable CAD systems for two-dimensional (2D) technical drawings, schemes, diagrams creation. It is contemporary tool for graphical information preparation in the text books, scientific papers, conference proceedings etc. However we attached with a problem how to prepare DWG file in order to get the best drawing quality for the print jobs. Basically drawings quality depends on separate graphical object intensity, equability, uniformity. Inside drawing graphical objects (lines, circles, arcs etc.) are drawn with different line width. Starting from AutoCAD 13 version designer can attach for graphical object property lineweight that accelerates drawing's finishing works. Lineweight values can be BYLAYER, BYBLOCK, DEFAULT and set up by user. The DEFAULT value is set by the LWDEFAULT system variable, which has an initial value of 0.01 inches or 0.25 mm. All new layers use the default setting. The lineweight value of 0 plots at the thinnest lineweight available on the specified plotting device and is displayed at one pixel wide in model space [5]. Lineweight values are seen in the „Lineweight Settings" dialog box (Fig. 1).
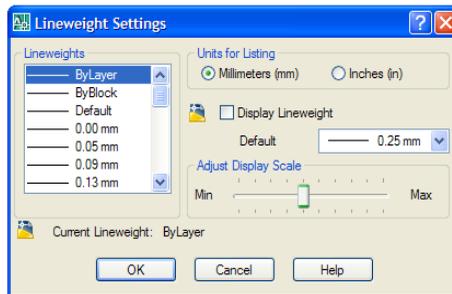
Fig. 1 Dialog box „Lineweight Settings"

Lineweight has a few problems and advantages:
- When LWT option is on, the graphical object width on a screen depends on zooming scale and looks sometimes unduly.
- It is difficult exported drawings move into other application without losing line's width stability (its intensity, equability, uniformity).

- Lineweights are listed in millimetres by default. This is because lineweights were originally designed for use with carousel pen plotters, and the width of plotter pens is generally measured in millimetres.
- If you turn off the display of lineweights (the LWT button on the status bar), you lose the thickness [6].

The other way to make objects have a heavier lineweight uses a polyline. You can draw polylines of various widths by using the width or halfwidth options. The width and halfwidth options set the width of the polyline segments you draw. Zero (0) width produces a thin line. Width is greater than zero produce wide lines, which are filled by colour (if fill mode is on) and outlined (if fill mode is off). The Halfwidth option sets width by specifying the distance from the centre of the wide polyline to an outside edge [5]. There is problem to create a circle with a natural width. For this aim can be used OFFSET or DONUT commands. Nice results for circle with a constant width creation can be obtained by using PEDIT command's subcommand Fit (can be used for polygons). All these actions can be executed by using AutoCAD standard commands. However it is much time required work and an appropriate AutoLISP routine is useful for these jobs acceleration. The solution achieved by geometrical data extraction from DWG drawing. DWG files graphical objects geometrical data handling performed with DXF (drawing exchange format) code analysis.

We create AutoLISP routine "LP" which can help to change the width of the graphical entities drawn in the DWG files. Routine "LP" adapted to learning process, has practical engineering application [7].

Full text of routine "LP" presented below:

```
 (defun *error* (msg)
   (princ "error: ")
    (princ msg)
    (terpri))
(defun  C:LP  ()
   (setq kint1 (getvar "cmdecho"))
   (setq w (getdist "\n Specify polyline width w:"))
   (setq LL (entsel))
   (setq L1 (nth 0 LL))
     (while (/= nil L1)
     (setq en (entget L1))
     (setq ent (assoc 0 en))
     (setq tip (cdr ent))
        (while (= tip "CIRCLE")
        (setq w1 (/ w 2.0))
```

```
      (setq ent1 (assoc 10 en))
      (setq ent2 (assoc 40 en))
      (setq RC (cdr ent1))
      (setq AS (cdr ent2))
      (setq RV (* (- AS w1) 2.0))
      (setq RI (* (+ AS w1) 2.0))
      (command "donut" RV RI RC ""))
      (setq tip nil))
  (if (= tip "POLYLINE") (command "Pedit" LL    "w" w ""))
  (if (= tip "LINE")        (command "Pedit" LL "" "w"  w ""))
  (if (= tip "ARC")         (command "Pedit" LL "" "w"  w ""))
  (setvar "cmdecho" kint1)
  (setq LL (entsel))
  (setq L1 (nth 0 LL))
  (setvar "cmdecho" 0))
  (command))
```

We are frequently confronted with graph creation. AutoCAD system creates a spline (smooth) curve, using points you specify by applying NURBS (nonuniform rotational B-splines) mathematics. This way is perfect for irregular curves creation when the points located on a curve are known and its number not great. Inside AutoCAD system by using programming way we can create a graph much faster and with more accuracy (by using unlimited number of points).

The GR.lsp routine allows for user create a graph for mathematical equations with unlimited number of points, with required width of irregular curve, by means of a polyline. For this aim expression, supplemented by quote function ('), should be assigned to the variable Y1. AutoLISP function quote returns an expression without evaluating it. For expression evaluation with new $(x+\Delta x)$ value AutoLISP function Eval is used. As an example for equation $y = sin\ x$ graph creation AutoLISP expression will be:

$$(setq\ y1\ '(sin\ x))$$

Following prompts displayed in a command line appears: "Specify origin point of UCS", "Specify function's alteration value"; "Specify scale factor", "Specify polyline width", "Max value of argument", "Min value of argument" (see routine), all the initial data for graph creation are specified. Further all intermediate values are calculated with require accuracy (alteration value).

```
(defun  C:GR  ()
  (setq pp (getpoint "\n Specify origin point of UCS:"))
  (setq ppo (list (* -1.0 (car pp)) (* -1.0 (cadr pp))))
  (setq pok (getdist "\n Specify unction's alteration value:"))
```

```
(setq m (getdist "\n Specify scale factor:"))
(setq w (getdist "\n Specify polyline width w:"))
(command "ucs" "O" pp)
(setq y nil x nil p0 nil p1 nil PL1 nil PL2 nil)
(setq x (getdist "\n Max value of argument:"))
(setq n (getdist "\n Min value of argument:"))
   (while (> x n) ;
     (setq y y1)
     (setq y (eval y)) ;
     (setq p1 (list (* m x) (* m y))) ; point's location on a graph
                                    ; determination
     (setq x (- x pok))  ; x value after alteration applying
     (if (null p0) (setq p0 p1))        ;
     (command "PLINE" p0 p1 "")
     (setq PL1 (entlast))
     (if (null PL2) (setq PL2 PL1))
     (command "PEDIT" PL1 "J" PL1 PL2 "" "")
     (setq PL2 (entlast))
    (setq p0 (getvar "lastpoint"))))
 (setq pl1 (entlast))
 (command "pedit" pl1 "s" "w" w "" "")
 (command "ucs" "O" ppo))
```

Practical application of presented routine showed in Fig. 2. One of the graphs
presented with a grips (calculated points on a curve).
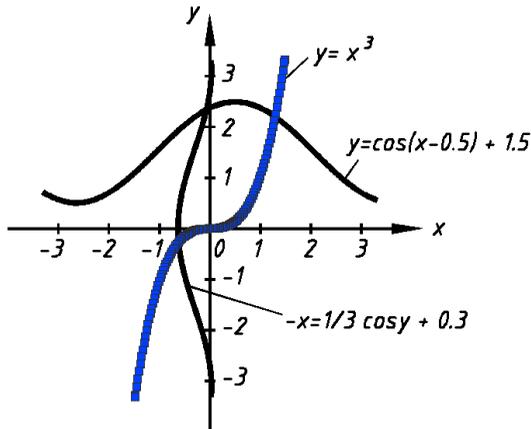
Fig. 2 Example of graph drawn with AutoCAD system

Presented routines are widely used for design works, text books preparation. They show advantage of AutoLISP for creating graphical applications, the application of theory to practice.

There a lot of problems that can be solved by AutoLISP routine. Particularly we interested in special task (more complicated) solving, which are related with tree-dimensional modelling (design) and two-dimensional drawing recognition. So the future plans are to investigate above mentioned and other problems related with engineering design process.

4. CONCLUSIONS

- Such kind of solution saves drawing creation time, increases accuracy of a graph drawing;
- Their can be widely used in studies and in learning process for practical aims and to solidify theoretical skills.

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GEOMETRICAL MODELLING OF 3D FITTINGS IN ENGINEERING SYSTEMS

Irena Gabrielaitienė[1], Linas Gabrielaitis

1. ABSTRACT

Geometrical modelling of 3D fittings was performed in an engineering system of a pipe network. This work considers 3D representation of a pipe network of a district heating system, which enables application of detailed numerical models (i.e., two-equation turbulent models). For this, the strategy for geometrical modelling was developed that included the subdivision of 3D fitting elements in logical and structural elements, so that numerical mesh could distinctly be applied. Such geometry decomposition enables effective numerical investigations with repetitive number of test runs that includes meshing (i.e., applying grid points) the same geometry numerous numbers of times.

KEYWORDS: Engineering Graphics, 3D Modelling of Pipe Fittings, Geometry Decomposition, District Heating Systems

2. INTRODUCTION

The geometrical and numerical modelling has been performed for a pipe-network fragment of a district heating system. Modelling considers fluid flow and heat transfer conditions including transient temperature distribution. Temperature propagation in district heating networks is usually predicted by simplified approaches, where the fluid flow assumed to be one dimensional. The heat transfer coefficient is based on equations developed for steady-state conditions [1]. This provides a good approximation of the time delay in a system. However, it requires careful consideration when attempting to predict the actual temperature value at a specific time during the emergence of the temperature change [2]. Therefore, more detailed modelling approaches have to be applied, which requires 3D representation of a pipe network in district heating systems.
In previous studies, a pipe supply network was presented as a one-dimensional network [3], while this work considers 3D representation of a

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pipe network including bends and junctions. The main emphasis of this work is placed on development the strategy for geometry decompositions and effective meshing of 3D fittings, required for numerical modelling. The 3D representation of pipe network enables to examine whether or not the general prediction of the transient temperature profiles will be improved by applying turbulence models. For assessment of the turbulence models, the experimental data obtained from the Madumvej (Denmark) district heating system were used [4]. The data set involves temperature data at the inlet and outlet of the network fragment, which has geometry with bends and junctions.

3. 3D MODELLIGN OF NETWORK WITH BENDS AND JUNCTIONS

The 3D dimensional modelling was performed of a pipe-network fragment presented in Fig. 1. The 3D representation of the engineering system including bends and junctions is shown in the Fig.2.

The main aim of this work was to develop the strategy for effective meshing the 3D elements of pipe fittings and elbows with distinct mesh. In this case the hexahedral mesh was applied, because it is more regular than easy-to implement tetrahedral mesh.

For tetrahedral meshes, the user can generate meshes without performing geometry decomposition. The mesh generation process is fast, robust and automatic [5]. However, for hexahedral meshes, the geometry decomposition task is the bottleneck of process. It could be required to decompose geometry into simpler sub-volumes. To generate a hexahedral mesh, one has to manually decompose the geometry into simpler sub-volumes. This process is repeated until each sub-volume can be meshed with existent automatic hexahedral mesh generators. There are two main decomposition strategies: the divide and conquer approach, and the multi-block approach [5].

In this work, first approach was selected and the initial geometry is decomposed until each sub-volume can be meshed with existent automatic hexahedral mesh generators. The decomposition is mainly a geometrical and interactive process, where the engineer has to decide how to divide a given domain. The operations allow performing the decomposition by cutting existing entities with: planar and cylindrical surfaces, extensions of surfaces, surfaces filling holes between curves, and extrusions of curves. This possess is described hereafter.

Geometry of pipe network was divided in logical and structural elements and the consequent 3D elements were divided into smaller elements that were suitable for hexahedral quadrilateral meshing. The main advantage of subdivision is that extra edges were created enabling to control the

hexahedral mesh by the applying of different number of grid points directly on these edges. If the subdivision is neglected, then the mesh applies chaotically with no consideration to the most difficult parts, such as bends and junctions. The subdivision also ensures easy and quick changes in number of grid points. In the numerical modelling it is important to make many tests runs with different number of numerical grid cells. So, it becomes easy to change the number of points in all 3D directions.
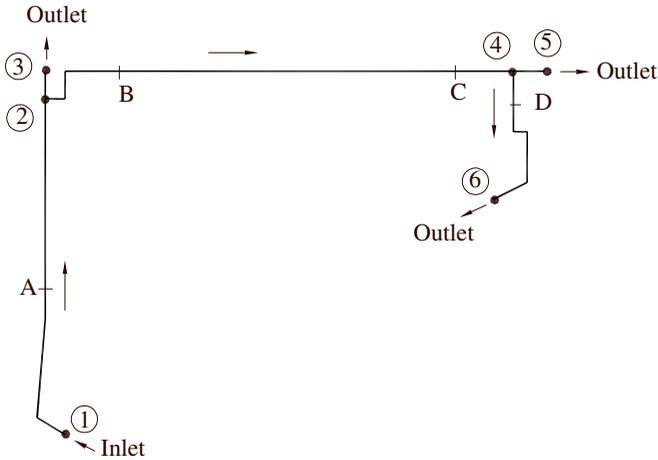

Fig. 1. A pipe-network fragment of the Madumvej district heating system (Denmark).

a)   b)
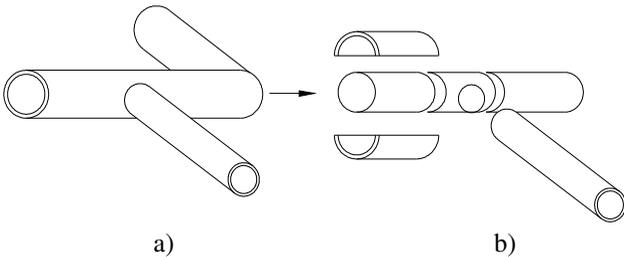
Fig. 2. a) 3D representation of a pipe network fragment;
b) Subdivision of the pipe network into elements.

The strategy for effective meshing the 3D element of pipe fittings and elbows is described herein. The pipe network was divided in longitudinal direction into straight pipe segments, and into segments with bend and junctions, as shown in Fig.2 b). It was also divided according to different media – fluid flow and metal pipe. This way different mesh can be applied in the different parts of the pipe network.
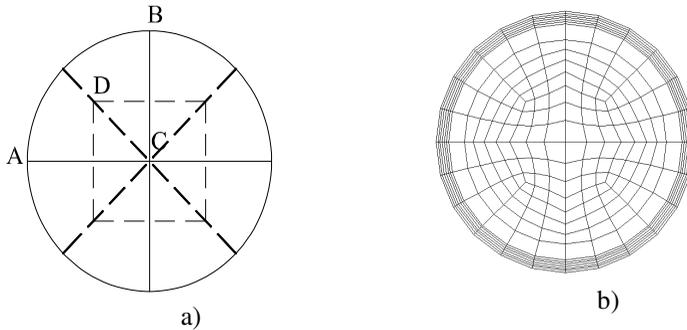
Fig. 3. a) Subdivision of a pipe cross-section into quarters; b) The example of a cross-sectional grid.

The main elements of a pipe network were following:

1. A straight pipe segment, where hexahedral elements should be implemented in a pipe cross-section. The pipe cross-section was divided into geometrical elements: quarters, one quarter is denoted with A-B-C (as shown in Fig. 3a). The edges of this element AC and BC are required for specifying the gird point, while meshing. The additional edge DC is an extra precaution, to ensure hexahedral mesh. The grid points are also specified on this edge. The messing of other quarters of the pipe was done in a similar way. If it is not divided the tetrahedral mesh will be applied, which should be avoided due to less reliable numerical results. This strategy allows changing easily different numbers of grid point on all edges directly. The example of a cross-sectional grid is displayed in Fig. 3 (b).

2. The bend of a pipe was represented by a sphere which was divided into 8 elements and 1/8th of a sphere was used to build up a bend. This element is shown in Fig. 4.Two such elements are required to describe the bend element. The mesh in the bend has to be connected to the mesh in the pipe cross-section (shown in Fig.3). That is, the element ABC in the pipe cross-section in Fig. 3 should have the same mesh as element ABC of the bend in Fig.4. The same number of grid points was applied to the edges in the pipe cross-section and in bend, otherwise meshing technique is incorrect.

3. The network junction was divided in the way shown in Fig. 2b. First, the smaller branch and its cross-section should be meshed. Then the cross-sectional mesh is imprinted on the pipe surface of the main network branch, and the rest of pipe surface should be meshed. For network junctions (*nodes 2, 4*), cross-sectional and longitudinal computational cells were also adjusted.
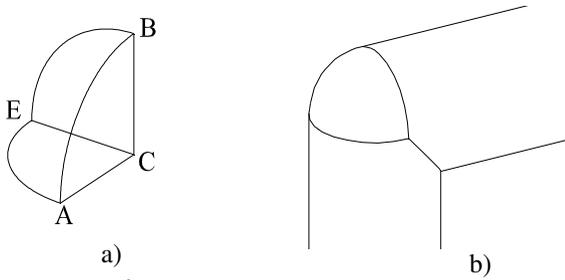
Fig. 4. a) 1/8th of the sphere describing the elements in the bend; b) a bend element.

The grids displayed in Fig. 5 produced a solution that showed negligible influenced to greater grid densities
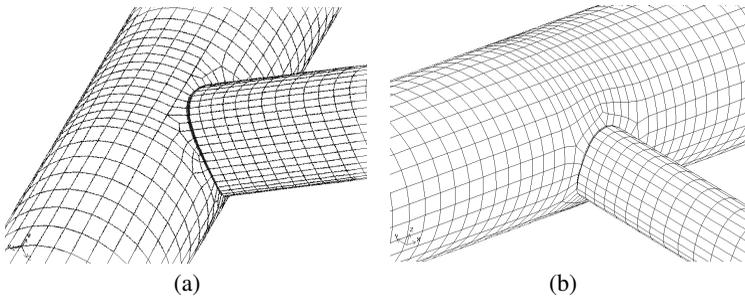

Fig. 5. Computational mesh in node 2 (a) and node 4 (b). The nodes are denoted in Fig.1

The solution domain was discretized by an unstructured grid. For finding out the required spatial resolution, a grid dependence assessment was carried out. In the several test runs, the impact of the grid refinement on the flow and heat transfer in a computational domain was established.

The computational grid was generated with the pre-processor GAMBIT [6] which integrates with the commercial CFD code, FLUENT [7]. Only a structured mesh was used for these studies. Prior to each study a number of grids with varying mesh density were examined in order to establish grid independency.

4. RESULTS OF GEOMETRICAL AND NUMERICAL MODELING

Prediction of transient temperatures in the pipe-network fragment is presented in Fig. 6. It was performed by turbulence models and a simplified approach, and assessed against the experimental data. The predictions obtained from the turbulence model (namely standard k-epsilon model)

showed the distinct advantage over the prediction obtained by the simplified approach. This is especially true when predicting relatively large impulse-like temperature changes. The peak temperature value, even though under predicted, is closer to measured value than the value obtained by the simplified approach. The general trend of the predicted temperature profile also correlates well with measured data.
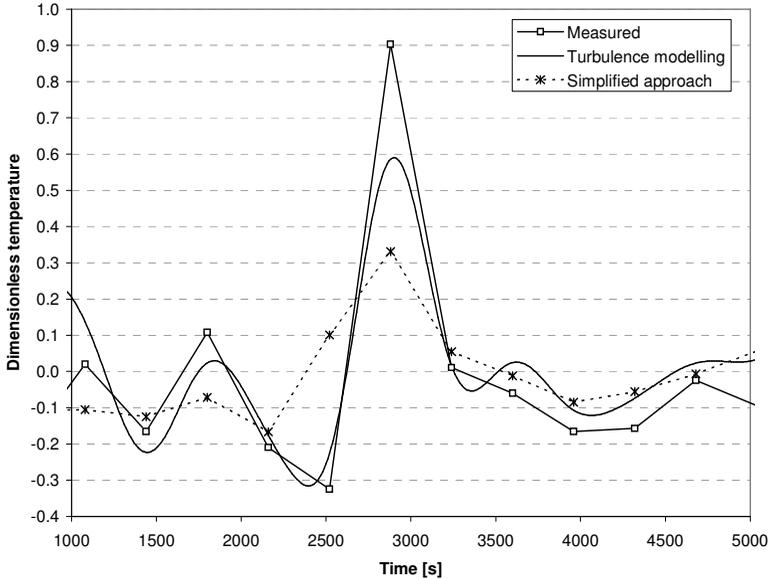

Fig 6. Predicted temperature at node 6

5. CONCLUSIONS

- A strategy was developed that ensured the subdivision of 3D fitting elements in logical and structural elements, and the consequent 3D elements were divided into smaller elements that were suitable for hexahedral quadrilateral meshing
- Geometrical and numerical modelling was performed on a pipe-network fragment of Madumvej district heating system in Denmark. The results show that the general trend of the predicted temperature profiles correlate well with measured data. It was found that turbulence model improved the transient temperature prediction compared to simplified approaches.

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APPLIED GRAPHICS SKILLS USING FOR SELECTION A WALL ELEMENT

Birutė Juodagalvienė[1], Ana Usovaitė [2], Lina Sakauskiene [3]

1. ABSTRACT

In AutoCAD system developed program to calculate the thermal resistance of the wall structure. Also this program selects the lintels by the hole. In the paper describes the practical benefits of this work and the advisability for the students of the constructions engineering.

KEYWORDS: Engineering Graphics Course, CAD, Thermal Resistance, Lintels, Elements Contribute in Buildings

2. INTRODUCTION

So that computer technology and software are improving rapidly, has increasingly adapted to new realities and to new surroundings. This requires a strong base preparation. Students of Faculty of Civil Engineering in general engineering graphics course gain the employment skills in AutoCAD graphics package and in special graphics course - the beginning programming skills in AutoLISP. It is true that the programming skills are not considered to mandatory works, but in the education community are always curious students, who are acquiring knowledge is not too much; especially if it is known that it will be applied to subsequent courses in student work. For example, a students don't mastered AutoLISP programming (due to lack of time or talent), but they will be able totransform other created *. *LSP* files

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and used for increase of his drawings performance quality and speed. At higher course graphic part of coursework volume is large, so even fully mastered AutoCAD graphic system, the work has for a long time. A student would be more valuable time to study a new discipline. As such, the building construction course content not every student is quickly absorbed, most of them is difficult, because for the first time most of students hear some name of the structural elements (foot foundation, rafters, lintel, etc.). Students must aware not only these elements contribute in buildings, but also how these elements are represented in sections of the building, in the plans or nodes.

The graphic part of coursework is the area where the students apples the knowledge and skills acquired in Applied Graphics course. This will not only save your time but also improve the engineering graphics performance using.

3. THE GOAL OF WORK

The main purpose of this work – create a program that helps to calculate the thermal resistance of the wall structure in the building [1] and represent its section fragment; study basic AutoLISP functions and commands, learn to use them as needed, to improve the AutoLISP graphics system, integrated into AutoCAD knowledges.

4. ENERGY EFFICIENCY REQUIREMENTS FOR BUILDINGS

Since 2018 the public purpose and, since 2020 in general all newly constructed buildings will be a "near-zero energy buildings". Maximally strengthen energy efficiency requirements for buildings the European ministers agreed in December 2009 in 2983-th the European Council meeting.

Approach to the "near-zero energy buildings" means that the plank for builders raised even higher than in the case so far, even the debate about passive house technology. According to statistics, currently in the EU's buildings consume about 40 percent of all consumed energy. The insulation materials manufacturers association "Eurima" scientists say that by taking simple measures such as wall and roof insulation, new and existing buildings for energy consumption can be reduced by half and 20 % reduce energy consumption in Europe. This would save 3.3 million barrels of oil per day [2,3]. Currently, under the current Lithuania Construction Technical Regulation (CTR, *STR – in Lithuanian*) [4], the energy certification mandatory for all newly constructed and in a capital renovated buildings.

5. WALL STRUCTURE SELECTION

Of the five known structural systems of buildings (wall, frame, volume-precast, ticking and stem), students further study the wall and frame. At beginning of the study differences of the wall structures resolved, learn to calculate the resistance of partitioning envelope.

In design of structural wall systems of buildings used the walls of the three types of structures: plaster two-layered wall (type 1), three-layered wall with air space and brick finish (Type 2) and three-layered wall with air space and sheeting to finish (Type 3) (Figure 1.).
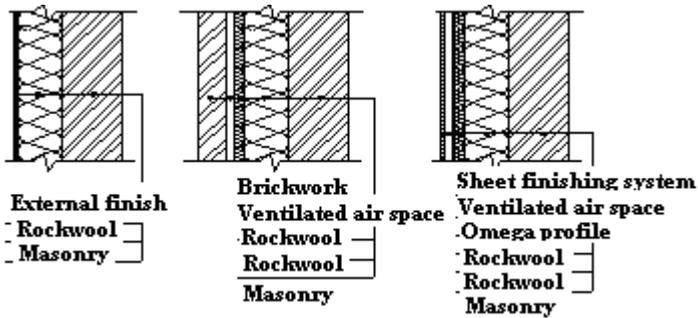

Fig. 1. Three types of wall structure

First type of wall structure of the options is low, bet second and third type structures of the wall are several options (2 and 3 figure).
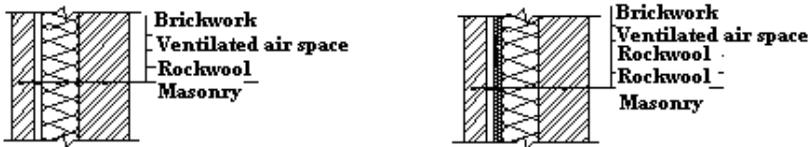

Fig. 2. Second type structures of the wall options
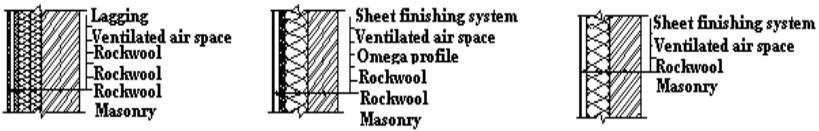
Fig. 3. Third type structures of the wall options

This is appropriate to provide all of these proposed options for the wall structure in development of resistance calculation program.

6. WALL IMPEDANCE CALCULATION

In construction design the thermal resistance calculated for the newly designed and renovated the building partitions.

In Lithuania according the Soviet rules resistance rates were about 1 (0.8 to 1.3) m² K/W. Since 1993 in Lithuania established building technical regulations, and according to them has been the requirement that the wall resistance is equal to approximately 3 m² K/W. In 2005 was once again changed the wording of the rules [1], and increased resistance of walls up to 5 m² K/W (currently at the passive building design the resistance is calculated as 10 m²), etc. wall heat transfer coefficient U-value must be equal to or greater than at the $U_N = 0.20$.

It would seem that by the arithmetic sense, this is a very simple task - the wall thickness divided by the wall material thermal conductivity coefficient and then summed up the resistance of wall forming layers. But today is a huge variety of walls and, consequently, a lot of confusion in the calculation of resistance (when viewed through the eyes of students), ambiguities and exceptions.

At the beginning of work (during the conceptual design), this simple arithmetic does not seem easy for students, because first of all need to understand information about the object, etc. to understand how designed a multi-layered wall. In the program structure of the wall meet Paroc Isover, Rockwool and other firms proposed wall design solutions. It is clearly that the program duplicates the information about units presented by firms, thereby facilitating the student's initial conceptual search and impedance calculation.

7. SELECTION OF WALL ELEMENTS

At workflow, students learn the elements of the walls: basement, ground and plinth. One of the most difficult to understand wall elements is a lintel. The information about the lintels in the Internet or educational literature is a lot.

Online materials are for commercial purposes, etc. for construction participants, who do not have to interpret what is lintel. For example, some manufacturers offer their own products, but (as a general rule) only in small print informs that their lintels suitable for filling holes up to 2 meters. The student still fails to focus on in those commercial publications, and often prefer the lintels with carrying capacity are too small for the projected work.

But, there is not literature, which would explain how to select lintels for diffident walls. There are lectures and exercises, during which the teacher provides students with information about the lintels, but experience has shown that many students received the information (even to explain to each person). Students are beginning to understand only after a certain period of time. There is a great variety of lintels (Figure 4, Figure 5). Teacher must help to understand for students this information flow. It was therefore looking for ways to help students quickly and with the lowest possible labor and time costs to assimilate the information provided. Reference material, of course, it is necessary to study. The authors developed AutoLISP program is only teaching aids. The program also includes rational (according to the authors) and are generally used variations to selection the lintels under and the wall outlet structure.
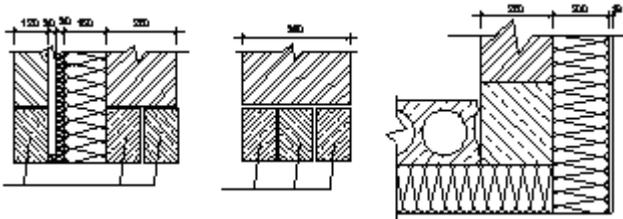

Fig. 4. Different lintels constructions
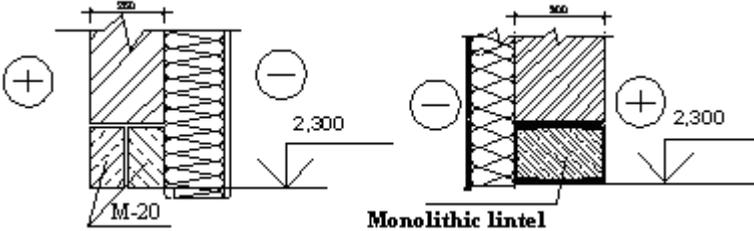
Fig. 5. Lintels type (depending on the thickness of the wall bearing)

8. PROGRAMING IN AutoLISP

One of the AutoCAD system advantages is that the system's graphical user interface can continuously improve, expand and adapt to their needs. AutoLISP allows to users and AutoCAD developers to write programs, and macro functions [5], adapted to specific needs.

The program algorithm is presented in Figure 6. It was implemented in the AutoLISP surroundings by using standard AutoLISP functions and calls the appropriate commands from the AutoCAD program.

In this way, created a small program in which the wall material components and their coefficients of thermal conductivity can be changed depending on the manufacturer, CTR and other factors that influence the calculation of the resistance of the wall. Calculated the resistance of the wall, the work can be completed or to continue: under structure of the walls and the aperture select bearing lintels.
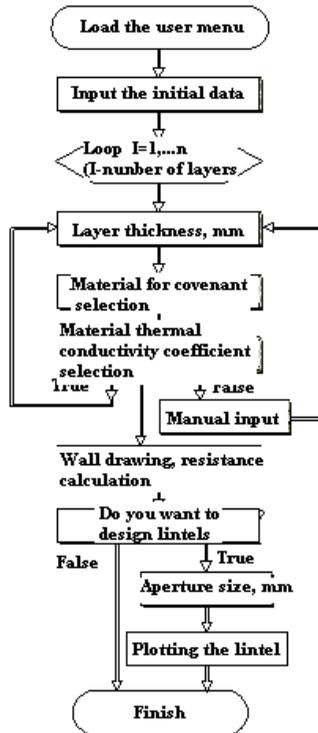

Fig. 6. Wall drawing, resistance calculating and the lintel selection algorithm

9. CONCLUSIONS

- Because AutoCAD is an open system, it promotes its ability to use individual, so depending on the needs, you can create small programs.
- Created *. LSP file calculates the resistance of the wall and draws the wall fragments, according to the aperture chosen bearing lintels.
- Created file and functions can be used for other course works graphical parts: where is necessary control of layers, hate, shade and so on.

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CAD SYSTEMS APPLICATION FOR MODELLING LANDSCAPE AND ITS ELEMENTS

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1. ABSTRACT

Graphical visualization is an extremely powerful communication tool for better understanding landscape processes, functions and features. The graphics systems significantly improved designer work on hand. The rapid development of graphics objects and their visual presentation – that is the main thing in the contemporary design development process. This work reviews the design peculiarities of an individual landscape with AutoCAD system. Modelling landscape consists of several stages. All of them are important and require intensive work. Topographical land surface is formed using TIN method. The individual components, such as vegetation, small buildings, parametric objects (stairs, etc.), fencing and irrigation systems, can be simulated using CAD systems. By the way, CAD systems allow simulating the lighting plot, which gives a true picture of the total. On the first stage of design the landscape is divided into separate areas which depend on future or existing buildings, plantings, utilities and others. Only after that the development of a specific area is started, eventually all zones are combined together using visualization drawing tools.

KEYWORDS: Graphical Visualization, CAD, Parametrical Objects, Landscape Modelling, Computer Window

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2. INTRODUCTION

An environment is constantly changing world created by human and nature. Colours, flowers and forms varieties are becoming a vital and harmony picture. Many people buying plots of land want to create their dream garden, which must be not only beautiful but also easy to use. This requires knowledge and ingenuity.

Time is one of the most important factors in land plot project works. Thus, even the most knowledgeable in various fields of design professionals faced with a dilemma - how and which software tools must be taken to realize their ideas for the best result.

Analyzing the design process, including an individual plot's landscape creating, we can clearly see design tools modernization. Ten years ago a pencil and a piece of paper or other materials for visually ideas interpretation were the main design tools of major organizations and individual designers. However, designers faced with some problems because of low drawings precision, small working speed, low-copying capability, errors and etc. The emergence of computer equipment entered a new stage - the objects creation by graphical editors. A plot landscape design can be divided into the following steps:

- Plot formation: its division into different functional areas and covers, terraces and walk place determination in the plot;
- Flowers, shrubs and trees and other elements loading;
- Irrigation system design;
- Plot lighting setting design;
- Plot fencing and fence elements design.

All these steps are important and it must be given special attention to them. It is very important for architects or designers to present their ideas to the customer, the general public or the authorities. Often professional drawings are not easy to understand for the average consumer. In addition, they are not visual. Project visualization helps to understand the drawings.

Before starting visualization it is necessary to create an object model. Model formation is quite complicated and this process requires a lot of work and skills. The object formation techniques and methods depend on the object features.

3. PLOT SURFACE FORMATION

The authors propose a scheme of work as shown in Figure 1.
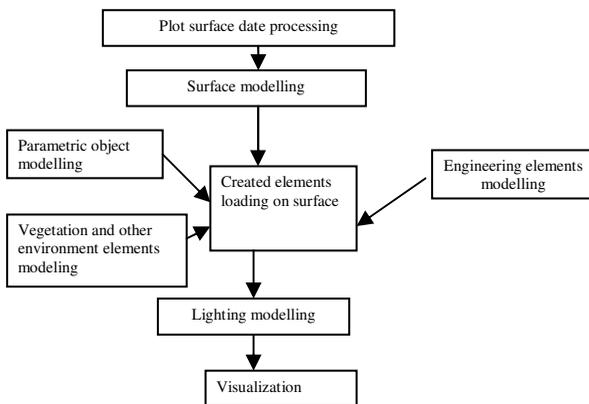
Fig. 1. Landscape modelling algorithm

As you can see in the scheme, a surface model is being created first, after that the necessary objects (environmental elements, parametric objects, and engineering communications elements) are being loaded into it and finally designers can create lighting and develop visualization.

The landscape landform (or terrain) is its principal element in nature, an undulating, sometimes roughly broken surface of varying slopes and convexities, landform may also be geometrically simple, composed of tilted planes and simple curved forms. This is particularly characteristic of the surfaces created by landscape architects and sculptors.

The surface is covered with varies simple repetitive surfaces such as grass, asphalt, brick or sand, trees or randomly sized boulders in glacial fields.

The landform usually requires large digital data sets, so the surface areas modelling historically associated with GIS, rather than CAD. Therefore, this kind of modelling requires more powerful computers, faster processors with bigger memory [1, 2].

The main tasks of surface modelling are the checkpoints creation and rendering. Frequently two methods for reducing the sheer number of points required for terrain models are used. This is the algorithm of irregular triangle (TIN) and reverse fractals. TIN method reduces the number of points necessary for marking specific high spots, low spots, ridges, etc. Reverse fractals create an appropriately roughened surface upon a small number of control points. Despite both these techniques which help to form the terrain model we can notice some advantages and disadvantages [1, 3].

The model surface is created using triangular irregular network (TIN) method. Surface modelling with TIN is widely used. The main advantage of a

TIN is the possibility to upload data directly to the surface and generate required part. We can describe the surface at different level of resolution. We can use not only altitudes but areas with contour line (isolines) for surface modelling too. Flat triangles are frequently generated along contours when the sample points occur along the contour at a distance that is less than the distance between contours [1, 4].

Vilnius Gediminas Technical University area surface was created by TIN method using the Google SketchUp program. Main factors of chosen this program is the initial data source - topographical photo image and the ultimate objective of the vision (Fig. 2).
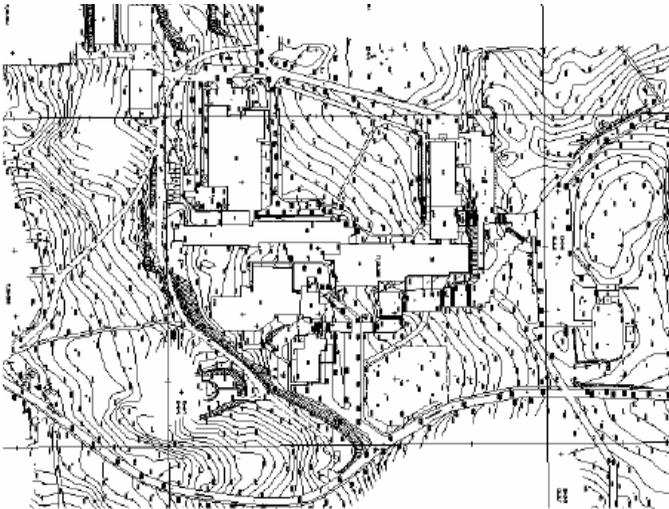

Fig. 2. Topographical picture of the landscape surface in ACAD system (*.dwg file format)

Modelled urban area's size: length - 410 m, width - 350 m, difference of altitudes - 22 meters. According to the territorial size and the available data, the altitude range is one meter (Fig. 3).
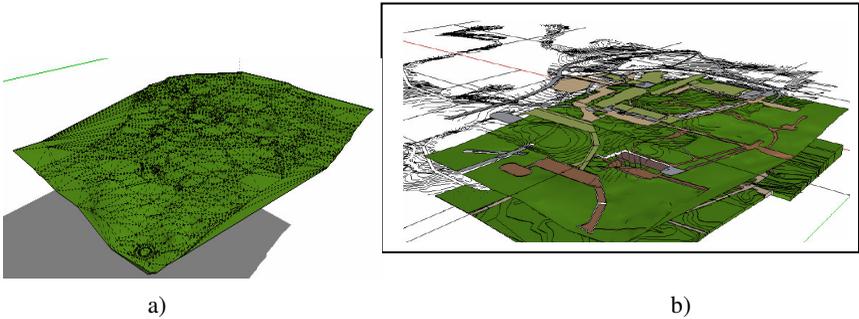
Fig. 3. Surface contours formed by topographic map isolines (a) and surface contour
map raised above the surface model (b)

4 ELEMENTS OF THE ENVIRONMENTS MODELLING

4.1 Flowerbeds, shrubs and trees modelling

It is necessary to transfer the drawing from two-dimensional space to three-dimensional for the relief modelling in order to render vegetation (trees, shrubs, grasses) more realistic.

Three-dimensional object model can be described in different compound forms. A simple building can be constructed using simple geometric figures. But the individual parts of the plant are not flat and consist of square or even cylindrical shape objects. Million polygons (and sometimes more) are initial data to create a simple tree [5]. The most common method for vegetation modelling uses photographic textures applied to flat billboards or cut-outs. This method makes tree image more realistic, but in such a case 3D model faces with various difficulties and limitations.

Creation of a 3D model is quite a difficult task [6]. It could be solved using computer programs which generate tree-type structures by algorithms (Fig. 4).

Fig. 4. The tree formed by computer

Often in landscape and garden design plants are placed in order by creating a geometric lines or clumps. In addition, they are used to define space, for example, paths and rooms, or simply as a visual organizing technique.

Most 3D modelling programs have tools that allow evenly spaced objects, for example, in accordance with sections or rectangular and circular arrays, where the distances and dimensions are known.

When repetitive elements are used, some techniques for introducing some amount of variation, found in nature, should be employed. Usage of two or three slightly different, but similar tree images is a good technique; these should be randomly allocated to the array. Also, mirror flipping of a photographic image, or very slight stretching, horizontally or vertically, can be used to introduce some minor variation in repetitive groups. But it may be a problem with the resulting lighting model. It is not incongruous; images with a strong directional lighting and shadows in them should not be flipped horizontally and used together [7].

4.2 Parametric 3D models

Taken in a view of parametric objects forms, complexity and its elements repeat patterns; it's far more effective to use computer technologies which generate 3D models, for example, small sculptures, stairs and other parametric objects.

This paper presents stairs models as parametric elements. AutoCAD package AutoLISP programming language is used for stair modelling. Usually areas have a lot of stairs and other parametric object, so a new created program helps to save a time. Stairs have been integrated on TIN surface. The program which creates stairs of different sizes can be used many times. You can enter a stairs length, width, height, distance and height between the steps (Fig. 5). By the way, you can simulate other parametric objects using this program.


<div align="center">a)   b)</div>
Fig. 5. Photo of stairs (a) and visualization of stairs model (b)

5. DESIGN FEATURES OF INDIVIDUAL SITE PARTS IN AUTOCAD GRAPHICS SYSTEMS

5.1. Site fencing design

Nowadays fence does not lose relevance. It protects against noise, wind, dust, strange eyes or saves children from the disaster in busy places. The fence as a homestead architectural element that connects all the buildings into a coherent whole, marks boundaries of a site, creates background for homestead yard plants and allows you to feel cosy in the only place where you can relax. However, the fence as elements of the site must satisfy the requirements for construction projects [8].

a)
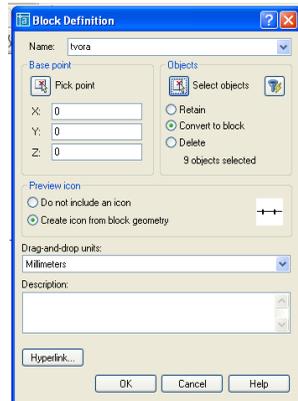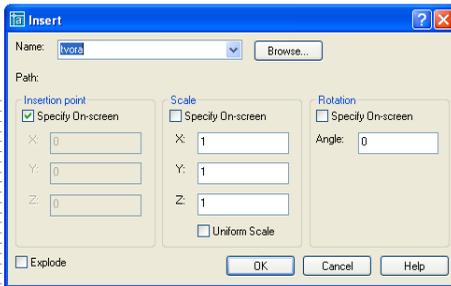
b)

Figs. 6. Fence symbol (a) and computer windows for block creation (b)

Investigating the usage of graphics package in the site design process, it is essential to pay attention to fence symbols, governed by standards. It is sufficient to mark fences with emphasizing symbols (Fig. 6 a) which could be simply drawn and inserted into a drawing at any time using the building blocks as one of the many AutoCAD tools [9] (Fig. 6 b). On the next stage of the development of the site fencing areas, we use the Block Insertion command, which is easily done with one mouse-click on the default location.

If the project involves the preliminary site fencing it is easy to create a block indicating the selected plant symbol. One of the most effective ways for saving time is to use CAD internet library, which offers a variety of symbols that can easily be inserted into a drawing downloading special program or using the i-drop technology [10].

The site owner is most interested in the final result - a real image of the plot and fencing. Then the visualization can be done in two ways – inserting three-dimensional symbols or creating surface models.

Let us examine a number of different fences surface creations.

3D can be created as 3D solids or surfaces. Fence elements can be represented as basic solid shapes called solid primitives or objects made using extrude and revolve commands (Fig. 7). In this case we create a solid or surface adding thickness to a common profile of an object.
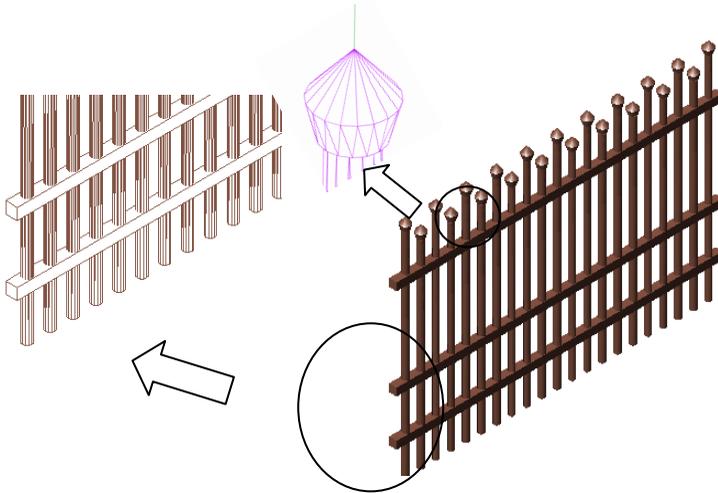

Fig. 7. Examples of created fence elements

The object is drawn with the colour assigned to him not always seems realistic. Fences, as well as all objects are made of concrete materials, which create different effects to render a realistic image of a model. We can import a predefined material from a materials library file (render.mli). We can use a material selected in the Current Library list or Current Drawing list or modify it, then use the list to specify whether the sample is applied to a sphere or a cube and preview it (Fig. 8).
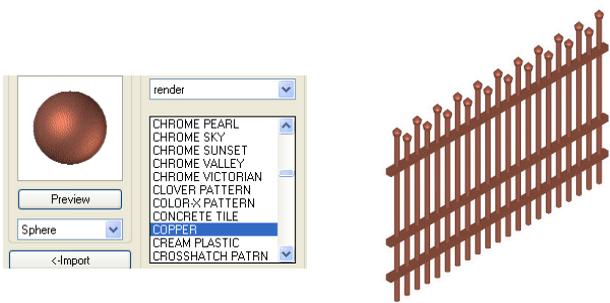
Fig. 8. Selection of available materials from the materials library in AutoCAD

If we can not find any proper material it is possible to perform new material as AutoCAD provides opportunities to create the required materials yourself. The computer window allows us first of all to name or rename the material because it must be unique to the drawing, then we specify the material attributes to change (colour, ambient, reflection, roughness, transparency, refraction and other characteristics) (Fig. 9).
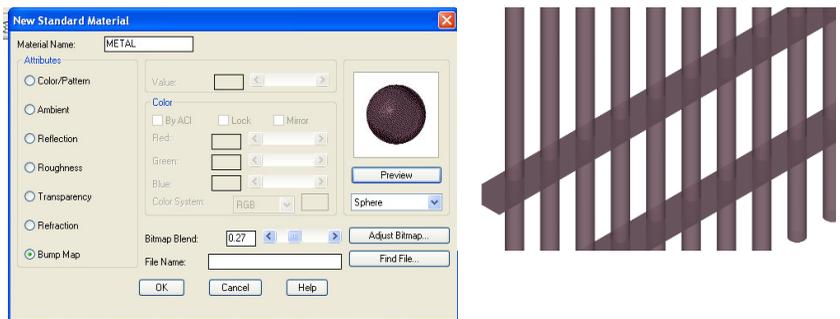
Fig. 9. Specifying a new material

AutoCAD provides the opportunity to download the standard elements of a true picture of the sketch, also known as decorations. If we find suitable hedges elements in AutoCAD file *render.lli* holding the considerable variety of scenery, only the one key press of computer window will allow us to move the decoration into proper position of the drawing. First, we insert the decoration symbol into the display (Fig. 10), which is parallel to the screen plane and the location is not hard to replace. Realistic scenery in our uploaded image will appear after Render command.

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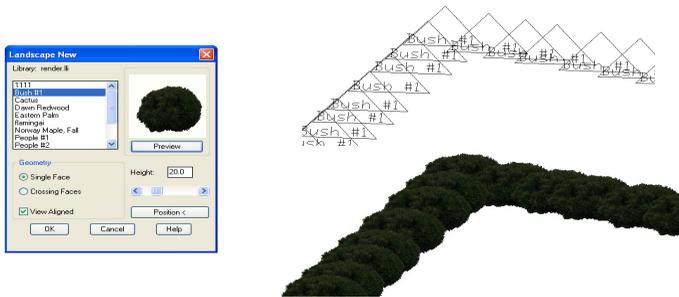
Fig. 10. An example of the decoration inserted into a drawing

If the current landscape library doesn't offer necessary decorations then we can create new or use suitable images downloaded from the online libraries [7].

5.2. Irrigation Systems Modelling

Suitable irrigation is one of the main conditions of beautiful environment. Development of the irrigation system begins with a clear and accurate project preparation. In preparing the project is detailed and takes into account the territory of the buildings, paths, and any existing or future plant location, height, type, etc. In order that the irrigation system to operate effectively, it is very important to determine the water debit and pressure measurement. Irrigation system lines and nozzle types are obtained according to the data. Water manholes are installed in places where water is usually required.
Irrigation systems have a lot of options. So we will build blocks for different types of jets (Fig. 11).

a)   b)
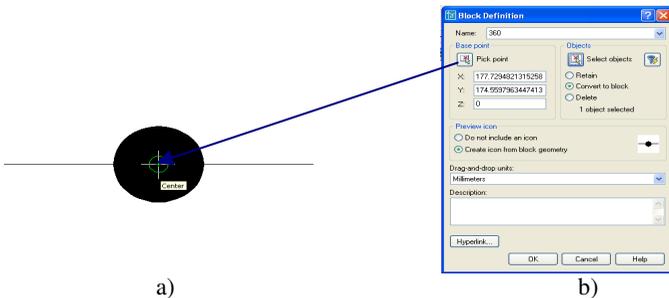
Fig. 11. Symbols of different jets (a) and computer window for jets block definition

It is easy to insert the symbol (block) selected in the list of symbols created by the required nozzle elect title according to a reference to the water spray angle by drop-down menu bar.

Sometimes the design drawings are easier to read when all the irrigation nozzles conventionally labelled the same, but they must be indicated with the type of irrigation, and even the angle of beam. In this situation it is necessary to develop not a simple previously described block, but the block with the attributes. Attributes are often used when loading a lot of drawing in the same block with a different text string, which is inserted with the block together.

We specify the attribute name and its value (by default) which is offered to upload the sketch in the Attribute Definition dialog box. The block can have several attributes. For example, spray marking of the drawing will use a block with two attributes specifying the location near the attribute (Fig. 12).

The attribute will be assigned a value of default or it is possible to write it in the text command line.
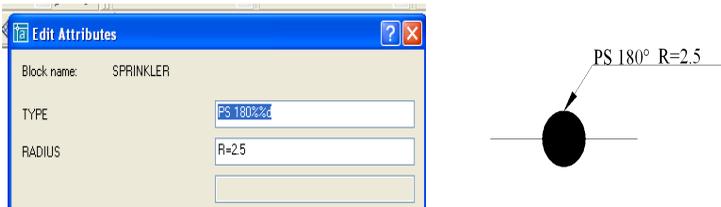
Fig. 12. Definition of jet block attributes

The main drown irrigation system symbols can be quickly inserted into any place of the drawing with indicated different values (Fig. 13).
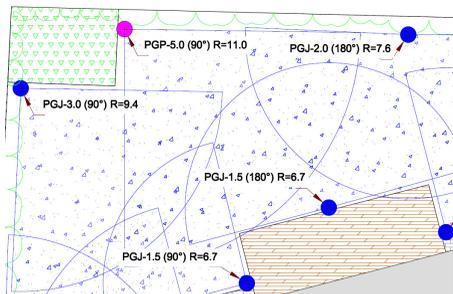
Fig. 13. Jets in the drawing

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5.3 Site Lighting

Installation of the lighting plot is organized according to two main things: it must be practical and aesthetic. It should be designed so that even at night in the site you could feel like in the daytime. The safety and good view are most important. Modern lighting systems can present unlimited imagination. There are many types of light projectors: they could be mounted into the ground, they can be low, high and etc. According to the selected light the site view at night can be very different. Everything depends on the choice of lighting variants. Optimal lighting plot option is selected in the final step of creation when the plants, trails or water bodies are already designed.

It is recommended to start lighting system design with marking the site lighting plan in the two-dimensional drawing.

Any luminary symbol has to comply with the applicable standards of Lithuania [11]. We draw a circle (radius is chosen according to the size of the site plan drawing) with a narrow crosswise intersecting lines (Fig. 14). However, if it is important to indicate the illuminator class in the drawing (they are classified according to the choice of insulation), then it may be worthwhile to create different blocks (Fig. 15), as it was carried out in the development of irrigation symbols.
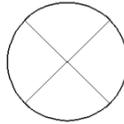
Fig. 14. General symbol for luminary
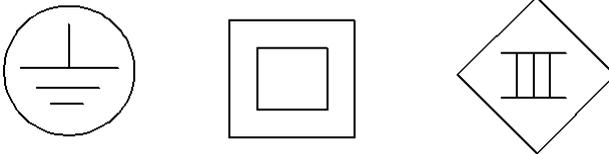
Fig. 15. Symbols for different classes of luminary

The all lighting and irrigation system symbol elements could be included in a file of separate blocks from which at any moment of editing process it is easy and fast to insert the required characters into the drawing.

On the last design step it is appropriate to visualize the full three-dimensional drawing. For this purpose, AutoCAD computer program provides the Render dialog box [12]. According to presentation quality AutoCAD offers three rendering types: Render (the basic AutoCAD rendering option for best performance), Photo Real (the photorealistic scanline renderer, which can

display bitmapped and transparent materials and generate volumetric and mapped shadows), Photo Raytrace (the photorealistic raytraced renderer, which uses ray tracing to generate reflections, refraction, and more precise shadows). Rendering often requires the most computer time in a 3D project, which generally involves three steps: preparing models, illuminating and adding colour.

The most important step is illuminating, which includes creating and placing lights and creating shadows. First, the light sources must be selected. AutoCAD provides three types of lighting (point light, distant light and spotlight) with a different lighting angle. In the Lights dialog box we specify the name of the light, set the intensity or brightness of the light, the intensity attenuation and determine the location in the drawing (Fig. 16).
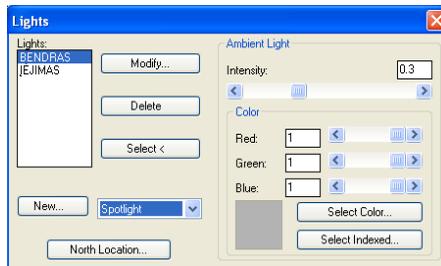
Fig. 16. Computer window for specifying light

The light source gives a realistic image in the drawing [13]. It is easy to imagine the aesthetic characteristics of the designed site changing the intensity or location in the drawing. Submission of final project outcome depends on the designer or the client's purposes and the means to achieve it.

6. CONCLUSIONS
- Computer-aided design systems can be adapted to modelling and designing the elements of site and landscape. This significantly accelerates and facilitates the work of designers. In addition, it helps designers to present the final results to customers.
- The visual presentation of landscape design helps the developer to get to know the plan of the projected site and value of aesthetic, financial and other characteristics.
- Irregular triangles (TIN) method is offered for site modelling. It allows modelling and displaying the desired surface fast, precisely and without large computing resources.

- Parametric objects are often chosen for landscape modelling. They can be simulated with AutoLISP programming package, which saves time and labour resources.
- 3D computer models created by CAD systems become basic blocks which can be used in various landscape projects at any time.

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DESIGN OF GEAR WHEELS IN 3D CAD

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1. ABSTRACT

Nowadays 3D CAD systems such as SolidWorks, SolidEdge, Inventor and others, allows you to create models that accurately reflect the real parts. Can be seen all the elements of the part their shape and position. But complications arise when the following detailed drawings of the model should be established to meet the standards. Since the rules for the drawings generated from the time when drafted only with a pencil, a lot of things were simplified, for example, regardless of the number of teeth, teeth in the section view aren't hatched. Creating drawings from 3D models or electronic prototype, in the section view of gear wheels the teeth, which are located in the section plane, will be hatched. This article describes calculation of geometric parameters, and selection of surface texture and tolerances values and 3D CAD design of gear wheels for correct drawings.

KEYWORDS: Gear Wheels, Design, 3D CAD

2. INTRODUCTION

The mechanical power transmission from the motor to the actuating element is carried out through different driving gears, including: gearings, worm gearings, belt drives, chain drives, and friction gears. Gears are applied in order to obtain the required power, and kinematics parameters of the actuating element. By selecting a gears take into account gear ratio, transmission power, dimensions, and economical parameters. If the driving gears of relatively small dimensions, mass and synchronous movement of the drive shaft and the driven shaft is necessary, the gearings is recommended [1, 2]. The gearings also has high efficiency – 0.97…0.98, high load-carrying capacity and safety. It is applicable over a wide force range (circumferential forces from 0.01 N in instrumental devices to 1000 kN in rolling mill drives) and wide velocity range (circumferential velocity from about $0 \ \mathrm{m \ s^{-1}}$ in systems for telescope displacement to $250 \ \mathrm{m \ s^{-1}}$ in the drive of helicopter rotors). It has comparatively small loads on the shafts and bearings and

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persistence of the average value of the gear ratio. Easy maintenance also is important factor [1].

Disadvantages of gearings are: the necessity for high accuracy in manufacture and mounting; noise when operating gearings with high rotational frequencies, which results from varying tooth rigidity and imprecision of step and teeth profiles; high stiffness which does not compensate dynamic loads [1, 3]. However, despite the fact gearings are applied in a wide range of fields and working conditions, for example, in watches and measuring instruments, transmissions of cars, tractors, other vehicles, and road-building machines, lifting and steering crane devices, machine gearboxes, drives of rolling mills, carriers, etc. [1, 3].

Nowadays 3D CAD systems such as SolidWorks, SolidEdge, Inventor and others, allows you to create models that accurately reflect the real parts. Can be seen all the elements of the part their shape and position. But complications arise when the following detailed drawings of the model should be established to meet the standards. Since the rules for the drawings generated from the time when drafted only with a pencil, a lot of things were simplified, for example, regardless of the number of teeth, teeth in the section aren't hatched. Creating drawings from 3D models or electronic prototype, in the section view of gear wheels the teeth, which are located in the section plane, will be hatched. This article describes calculation of geometric parameters, and selection of surface texture and tolerances values and 3D CAD design of gear wheels for correct drawings.

This subject is topical for students of study program Machine design and manufacturing who designs the models of the gear wheels in 3D CAD and creates the drawings.

3. MATERIALS AND METHODS

Students, geometric parameters of the gear wheels, determine from the relationships given in first table (look also Fig. 1). Each student has his own variant of input data: module, tooth number, shaft diameter.

To make a correct drawing of the gear wheel it is recommended to build the assembly of two components – hub and teeth crown (Fig. 2a). A similar effect can be achieved when in a part document multibody model is made. Hub and teeth crown with two features "Revolved" should be formed. By creating a second feature "Revolved", the tick by "Marge result" haven't be selected, then the feature creates a distinct solid body (Fig. 2a and 3).

Table 1. Gear wheel parameters

No. in Fig. 1	Parameter	Designation and calculation
Nr. 1	Shaft diameter	d_v
Nr. 2	Addendum	$h_a=m$
Nr. 3	Dedendum	$h_f=1.25m$
Nr. 4	Whole depth	$h=h_a+h_f=2.25m$
Nr. 5	Pitch diameter	$d=mz$
Nr. 6	Outside diameter	$d_a=d+2h_a$
Nr. 7	Root diameter	$d_f=d-2h_f$
Nr. 8	Hub length	$L_r=1.5d_v$
Nr. 9	Hub diameter	$d_r=1.6d_v$
Nr. 10	Width of the gear wheel	$b=7m$
Nr. 11	Chamfer	$n=0.5m$
Nr. 12	Location diameter of the holes	$D_{urb}=0.5(d_a-4.5m-2\delta_1+d_r)$
Nr. 13	Diameter of the holes	$d_{urb}=(0.35...0.4)(d_a-4.5m-2\delta_1-d_r)$
Nr. 14	Width of the gear ring	$\delta_1=2.25m$
Nr. 15	Disk thickness	$\delta_2=1/3\ b$
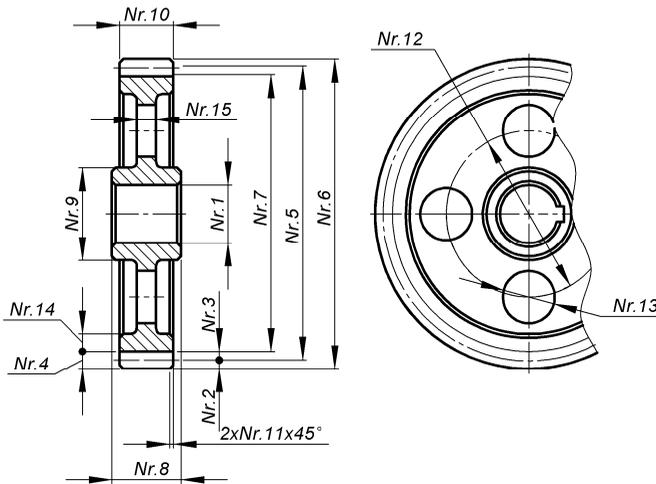
Fig. 1. Geometric parameters of gear wheel

a)   b)
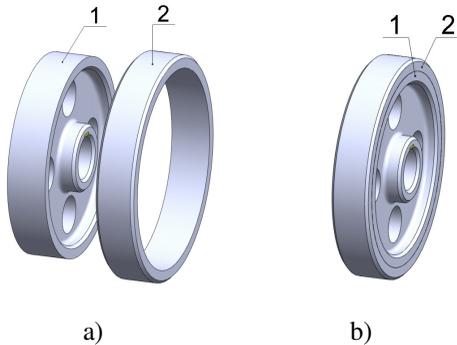
Fig. 2. Prototype of 3D gear wheel: Fig.3. Property
1 – hub; 2 – teeth crown   "Merge result"
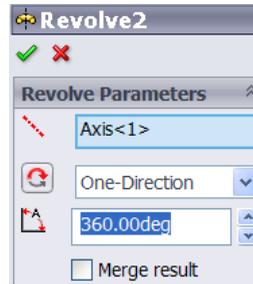
The working capacity of gearings depends considerably on the production accuracy of the gear wheels. Production errors are unavoidable due to: deviation in pitch, profile, tooth direction; radial run-out of the gear ring; deviation from parallelism and misalignment of the gear wheel axes; center distance variation; etc. These errors result in increased noise, loss of rotational accuracy of the driven wheel, failure of precision and smooth toothing, torsional vibration, dynamic increase and decrease of distribution evenness along the contact line acting in the load toothing, and other detrimental effects.[1, 3]

Standards regulate the accuracy of gear wheels as well as cylindrical and bevel gearings. Twelve degrees of accuracy are specified and are designated in decreasing accuracy order by the numbers from 1 to 12. Most often, degrees 6, 7, and 8 are applied, where degree 6 corresponds to high-accuracy speed gears, degree 7 corresponds to gears with a normal grade of accuracy that operate with high speed and moderate load, or with moderate speed and large load, and degree 8 corresponds to low-accuracy gears. For each degree of accuracy there are three standards of tolerances: the standard for kinematics accuracy; the standard for smooth operation; the standard for teeth contact [1, 3].

Table 2. Radial run-out of the gear ring [4]

Degree of accuracy	Radial run-out (µm) of the outside diameter d_a (mm)						
	≤ 50	≤ 80	≤ 120	≤ 200	≤ 320	≤ 500	≤ 800
6	12	16	20	22	26	32	40
7	20	25	32	36	42	50	60
8	32	40	50	55	65	80	100

Radial run-out, axial run-out, and surface texture of the gear ring depending on the degree of accuracy can be selected in the tables 2, 3 and 4.

Table 3. Axial run-out of the gear ring and hub [4]

Degree of accuracy	Axial run-out (µm)				
	Gear ring $d = 100$ mm* Width of the gear wheel b, mm		Hub ($L_r/d_v \leq 1$) ** Shaft diameter d_v, mm		
	< 55	55…100	≤ 50	≤ 80	> 80
6	17	9	20	30	40
7	21	11	20	30	40
8	26	14	30	40	50

* If $d \neq 100$ mm, multiply the axial run-out with $d/100$;
** If $L_r/d_v > 1$, increase axial run-out by 40…50%.

Table 4. Surface texture [4]

Surface	Degree of accuracy		
	6	7	8
Working surface of the tooth	Ra 0.8	Ra 0.8…1.6	Ra 1.6…3.2
The diameter of the tooth tops	Ra 1.6	Ra 1.6…3.2	Ra 3.2…6.3
Gear ring side faces	Ra 1.6	Ra 1.6	Ra 3.2
Gear hub side faces	Ra 1.6	Ra 3.2	Ra 3.2
Gear hub face (mated with shaft)	$d_v \leq 80$ mm – Ra 1.6…3.2 $d_v > 80$ mm – Ra 3.2…6.3		
Other, not marked surfaces	Ra 12.5		

4. RESULTS AND DISCUSION

Modelling the gear wheel and creating the working drawing, student understands the meaning of presented parameters and selection procedures of values. The working drawing of the gear wheel is shown in Fig. 4. The gear wheel model was build as assembly from two components – hub and ring and it is possible to specify not to hatch gear wheel teeth crown in the section view.

The local view of hub internal contour is possible to create as projected view and after that hide the unnecessary lines.
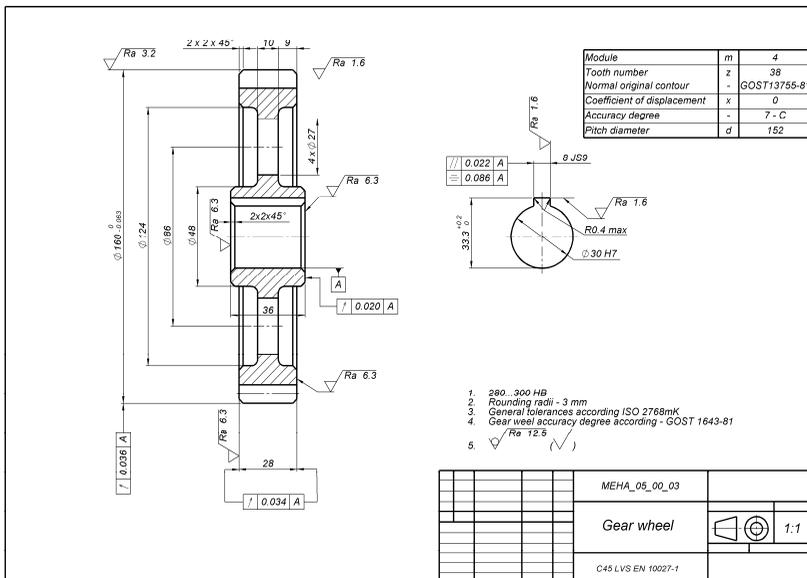
Fig. 4. Execution example of the working drawing of a gear wheel

5. CONCLUSIONS

- For working drawings, creating assembly or multibody part of a gear wheel is recommendable.
- Modelling the gear wheel and creating the working drawing, students understand the meaning of presented parameters and selection procedures of values.

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AUTOMATED TOOLS FOR CREATION COLOUR HARMONY AS A MEANS OF OPTIMIZATION: A FIRST YEAR COURSE ON «COLOUR STUDY»

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1. ABSTRACT

The article discusses the experience of using automated tools for creation colour harmony in the learning process on the example of teaching the subject «Colour Study».

KEYWORDS: Education, Traditional and Innovation, CAD, Colour Study.

2. INTRODUCTION

Contemporary information technologies are widely applied in teaching various subjects in the Design Faculty of Euroacademy. The intensive use of the computer-assisted facilities in the study process corresponds also to the recommendations of the EU educational commission.

3. BASIC INFORMATION

Traditional means from the set of Microsoft Office are of great help in preparing specialists. Not only the text editor Word but also Power Point, which is for compiling and implementing presentations, expand the possibilities of the education process. As the named facilities belong to the «typical computer pieces», and do not need the installation of specific programmes, it is rational to guide students to those when carrying out their home- and independent works. Graphic editors Adobe Photoshop, Corel

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Draw, Google SketchUp, AutoCad and ArchiCad, which are effective in teaching the main subjects, have also enjoyed wide use in the teaching process. Alongside with the use of well-known specific programmes, there are also available the programmes, which are not so widely spread, and are intended for implementation of more specific tasks. For example, NCS Navigator, ACC Colour Map are successfully used in teaching the subject «Colour Study».

In particular, we would like to dwell on innovative approaches and peculiarities of teaching the profiling subject «Colour Study». According to the study programme this subject is taught in Euroacademy in the specialities of «Interior Design» and «Fashion Design». The motivation for studying this subject is connected with the possibilities of applying the acquired knowledge and skills not only in the field of design, but also in other related areas.

In connection with the general intensification of the teaching process, the number of auditoria lessons has been reduced. This, in turn, stimulates to search for new methods to solve the tasks the teacher is confronted with. For this reason, a special attention is paid to the organization of the independent work of the students. Broad teaching experience allows to work out and introduce numerous tasks and the methods of realising them. But the traditional «manual» way of carrying out the exercises and course projects using paints and brushes does not allow to acquire the material on the required level because of the time limit. Thus, the former methods, ways and technology of teaching the issues of colour are enlarged on account of the use of new possibilities – computer programmes. Today is the tradition supplemented by innovation, and essential part of the subject «Colour study» is occupied by interactive computer programmes, which make possible not only the shorter teaching period but also enlarge the boundaries of the subject.

In case of «Colour study», it is of importance to pay attention to the programme facilities, which provide the opportunity to study not only the theoretical basics of colour study but also acquire practical skills in applying them. The main advantage of those programmes lies in the fact that the change in the main characteristics of the colours: hue, saturation and lightness is taking place in real time. The learning of the traditional colour theory is visual and takes less time. This applies in particular to the realization of the three-dimensional virtual colour model of the body (Fig.1).

The optimizing of the creative process simplifies the performing tasks in composing harmonious colour combinations.
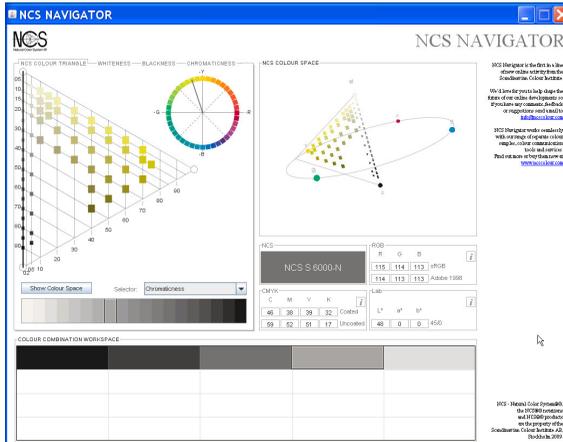

Fig.1. Virtual color model of NCS system [1]

All specific programmes can be divided into 2 groups. The first one, comprising, for example, NCS Navigator, ACC Colour Map, have both theoretical and practical character. The second group, more numerous, includes, as a rule, websites of the manufacturers of the paints with colour visualizations both for the professionals and for product users. Most of the manufacturers adapt and suggest to load their palettes for using in such widespread programmes as AutoCad, Archicad and Photoshop.

But we cannot ignore the fact that the use of colour harmony options implemented by those programmes are, however, of assisting nature. The colours on the computer display are not exact copies of the real ones, so the modelled colour combinations are, rather, spatial conceptions of colours than factual characteristics of a particulate colour. Virtual colours cannot substitute the real ones, since there are many factors affecting perception, e.g. surface qualities (texture, smooth, rough, gloss area of perception, etc.). The most genuine results are achieved painting the surface either by paints, or comparing the selected samples with those in the catalogues, or colour swatches.

NCS Navigator [1] is a new product of the Scandinavian Institute of Colour. It gives freedom for creative option for colour harmonies and does not limit the choice of colour combinations by standards of colour harmonies. Conformity not only to the colour codes of NCS systems but also to SMYK and RGB models, make this programme indispensable for a designer.

Colour Wheel Pro is the programme, which allows to speed up the search for harmonious colour combinations. Changing the hue, saturation and lightness of a particular colour, the user can immediately see the altered result, which enables within a short period of time to look through a big amount of possible variants. The programme comprises all standard colour harmonies: monochromatic, primary, primary-contrasting, contrasting built on the basis of geometrical forms, etc.

ACC Colour Map [2] is a virtual colour map, which allows to have ACC codes and RGB and SMYK systems of colour transmission. Colour cards comprise the main characteristics of colours: colour hue, saturation and lightness. The programme includes interactive teaching course, consisting of 14 exercises. These tasks enable within a short period of time not only to get familiar with the theoretical basis of colours but also study them thoroughly. The users are also provided with the possibility of creating a personal collection of colours from the virtual colour card (Fig.2).
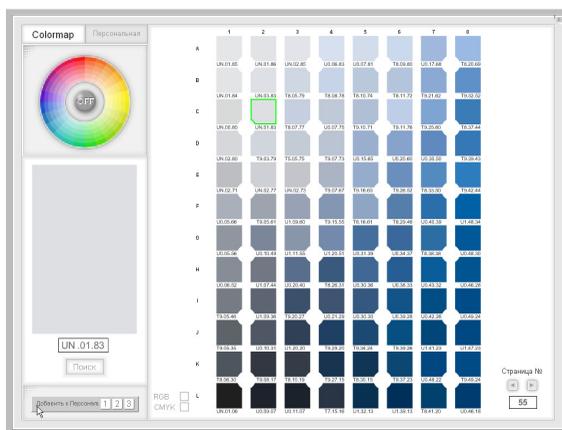

Fig.2. Virtual color card ACC

The colours of the personal collection, as well as their combinations can be exported to the programme Colour Painter (Fig.3).
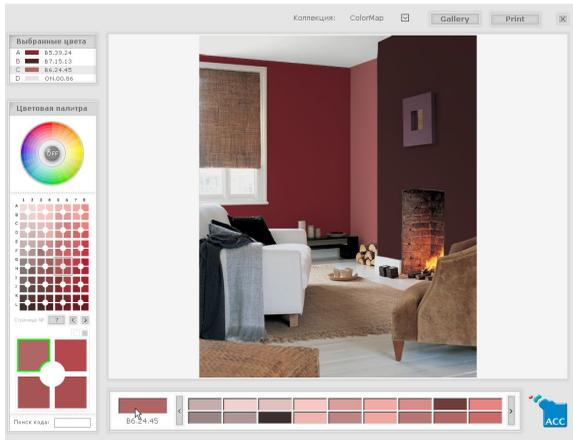
Fig.3. Creation interiors colour harmony with ACC Colour Painter

Colour Visualizer provides the possibility of changing colour hue, saturation and lightness of form modelling the objects of interior design. The advantage and difference from other similar programmes lies in the possibility of creating masks for virtually painted surfaces of whatever form (Fig.4).
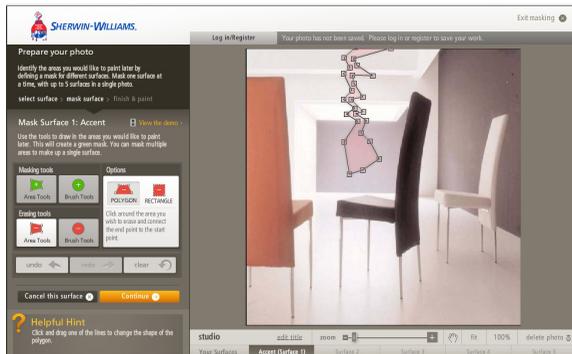
Fig.4. Creation of masks for virtually painted surfaces in Color Visualizer programme

The analysis of the painting produced by a famous artist with regard to colour and composition occupies an important place in the teaching of colour, contributing to the understanding of mutual relations between form and colour of the composition. The exercises are carried out by the traditional materials and tools – brushes and paints. The analyzed palette of the author will be applied in a new form of composition. The composition of the colours will be changed, as well as the area taken by them and the conceptual location of the colour, which, in turn, results in changes in emotional perception of the colour [3]. Additional use of virtual Colour Schemes, palette generators, and Colour Blenders enables to optimize the study process and to enlarge the possibilities of searching for new colour solutions.

We cannot ignore the fact that the options for colour harmonies created by the application of the named programmes is of assisting character. In creative professions the main importance is attributed both to the professional competence and the creative potential of the future specialist. At the same time great emphasis is laid on the responsibility of the specialist for the option of colours, particularly in the case of public interiors.

Despite the fact that the information technologies have been applied in the study process for a long time, we can still speak about their innovative character in the process of education for the following reasons:
- the process of the development and innovation of most of the used programmes of information technologies is permanent;
- the developing and innovative hardware technology;
- continually developing and expanded (also in case of more specific areas) areas and spheres of application of these media;
- stimulates in turn the introduction of new teaching methods due to the development of information technologies;
- the changing element of the learners;
- the higher starting level of the informative- innovative preparation of the learners.

The strategy of teaching and application of particular means of computer-assisted technologies in educational process are determined by the following factors:
- the general strategy of the educational institution, orientation to the European educational standards;
- possibilities of acquiring licensed software;
- individual educational needs of the learners;

- peculiar properties of learning material;
- positive motivation to learning and creative self-development of the students.

The analysis of the results of application of the named programmes in teaching of the subject «Colour Study» reveals that not only the possibilities of modelling colour conceptions are increasing but also the time spent on covering the main areas of the subject is decreased on the average of 30% (Table 1).

Table 1.

A comparison of training hours to complete learning tasks traditional way (handmade) and using of software: a first year course on «Colour Study»

Topic	Handmade (hours)			Handmade + using software* (hours)		
	Contact hours	independent work	Total	Contact hours	independent work	Total
Colour harmony I	2	2	4	2	2	4
Colour harmony II	2	2	4	2	2	4
Colour harmony III	2	2	4	2	2	4
Colour harmony IV	2	2	4	2	2	4
Colour harmony V	4	4	8	4	4	8
Colour harmony VI	4	4	8	2*	2*	4*
Colour harmony VII	4	4	8	2*	2*	4*
Colour harmony VIII	4	4	8	2*	2*	4*
Colour analysis	6	6	12	2*	2*	4*
	30	30	**60**	20	20	**40**

4. CONCLUSIONS

- The experience of introducing information technologies in educational process has proved that the application of innovative methods contributes to the profound and more qualified acquisition the material;

- increases the positive motivations of the learners to expand the borders of studying the subject;
- stimulates the activity of the creative process and, finally, increases the efficiency of the teaching process.

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CAD-INTEGRATED MEASURING TECHNOLOGIES FOR CAPTURING BUILT ENVIRONMENTS BALTGRAF-11

Urmas Jüriorg, MSc [1]

1. ABSTRACT

CAD-integrated point to point laser measuring has proven to be a promising technology in capturing the Built Environment for design and assembly checking purposes in construction industry. A survey has taken to outline the state of art technologies in this field.

KEYWORDS: CAD, Point-to-Point Laser Measurement, Built Environment

2. INTRODUCTION

It is estimated that the world wide construction industry is $4.6 trillion dollars a year. However, up to 80% of that construction is performed in the built environment. Adaptive reuse, tenant improvements, renovations have importance especially in older cities and especially in Europe. The challenge is how to take advantage of all the benefits of CAD/CAM and BIM in respect of the quality of input data. The need for digitizing the built environment in an efficient and accurate way becomes crucial. [1] There are different technologies at use that are more complimentary than competitive. Traditional low-tech ones (measuring tape, paper-pencil), laser based point-to-point devices and laser scanners. While low-tech aids lack the efficiency and precision, the laser scanning although time-efficient is often too expensive and too complicated for practical use not mentioning that so far there is no good automated solution for deciphering point clouds into geometrical model. Therefore point-to-point solutions with real time CAD-integration seem to provide most practical and time/cost efficient solution for capturing built environments.

3. BASIC INFORMATION

The idea of integrating point-to-point measuring devices with CAD software was born out of the need to capture existing building information quickly and accurately, reduce the amount of steps in modelling and drastically reduce

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rework and translation time by measuring and building directly inside a BIM or CAD enabled workstation. Point-to-point devices refers to a technology that enables a user or surveyor to survey or capture a building's geometry in real time or while on site by translating laser range finder data directly into a Computer Aided Design (CAD) or Building Information Models (BIM) work station. [2]

By its principal construction a point-to-point device can be a tachymeter that determines, mechanically (e. Prodim Proliner, wire based [4]), electronically or electro-optically, the distance to target. In order to utilize CAD integration it must be motorized, computer controlled and is highly automated in its operations

Few different systems has been developed and become market ready over the last decade. Some of those have built in microcomputers with CAD software (Prodim), others are split hardware-software solutions (Flexijet, TheoCAD, SL ProCollector [6]), some solutions are hardware independent (Kubit [3], Vitas by Vitruvius [7]) and made to work with geodetic survey tachymeters or total stations from known manufacturers.

Major advantage of CAD-integrated systems is that projects are completed with little to no need for editing or post-processing, resulting in less time on-site and less time in the office. Additionally, onsite user errors are eliminated. This means no more multiple trips to the field saving users time and money. [3]
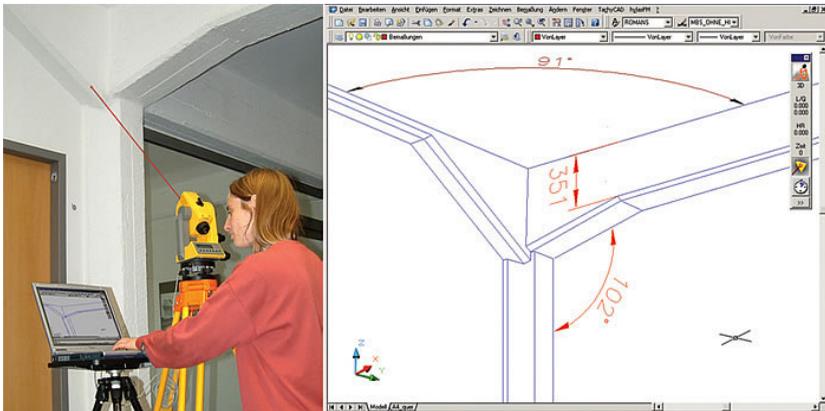

Illustration. 1. Measuring and simultaneously drawing the resulting CAD drawing [3]

There are several other benefits from the point of view of practical user in construction industry:

- User-friendly operator interface
- Professional CAD functions
- Project data (buildings, floors, room, parts) management
- Import and export formats such as DWG, DXF, JPG, XML
- Direct interfaces for other CAD software
- Integration/development options through API (Application Programming Interface)
- Optimal interface for direct CNC machining

4. PRESENTATION

In my presentation the practical work process of CAD-integrated measuring will be demonstrated using a Flexijet 3D by TechniSoft [5]. Several automated measurement and stake options will be explained as an example of highly efficient and construction-aware methods for capturing the built environment into a digital model.

5. CONCLUSIONS

- CAD-integrated point-to-point measuring technologies have been evolving rapidly over past decade originated from the need for efficient yet simple solution for digitizing built environment.
- Elimination of post processing, instantaneous on-site graphic feedback industry-specialized automated functions and relatively simple handling would make portable PPTL systems a favourable choice for construction applications like stonemasonry, stairways- or furniture design, carpentry, land or building surveying etc.
- PPLT systems are cost-efficient and show several other if compared to laser scanner, specially where selective and in construction-aware capturing is important

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