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AUTOCAD AND E-LEARNING IN TEACHING DESCRIPTIVE GEOMETRY

AUTOCAD I E-LEARNING W NAUCZANIU GEOMETRII WYKREŚLNEJ

Abstract

The world is changing constantly and inexorably, and the new technologies enter all of the fields of our lives. The changes also affect the ways of teaching traditional subjects, such as descriptive geometry. Until recently, this subject, being the basic communication language for engineers all over the world, had only been taught with traditional methods – using paper, pencil, compasses and ruler. Currently, instruction on solving geometric problems begins to use computers with the AutoCAD software as well as e-learning platforms with a full range of possibilities. An essential issue in the course of instruction is to make the student realise that a computer can only do what it is told to do by its operator, and it is necessary to have theoretical knowledge to be able to use one in order to solve a given problem.

Keywords: descriptive geometry, AutoCAD, e-learning

Streszczenie

Świat się nieustannie, nieubłaganie zmienia, a nowe technologie wkraczają we wszelkie dziedziny naszego życia. Również sposoby nauczania klasycznych przedmiotów, takich chociażby jak geometria wykreślna, ulegają zmianie. Ten przedmiot, będący podstawowym językiem porozumienia inżynierów na całym świecie, do niedawna był nauczany wyłącznie klasycznymi metodami – przy użyciu papieru, ołówka, cyrkla i linijki. Obecnie do nauki rozwiązywania problemów geometrycznych zaczyna się wykorzystywać komputer z programem AutoCAD oraz platformę e-learningową z całym wachlarzem jej możliwości. Ważną rzeczą jest uświadomienie studentowi w trakcie nauki, iż możliwości komputera zależą wyłącznie od jego wiedzy teoretycznej i umiejętności rozwiązywania problemów.

Słowa kluczowe: geometria wykreślna, AutoCAD, e-learning

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The dynamic development of new technologies is changing the face of the contemporary world. All fields of life are affected by changes, including ways and methods of teaching young people at all stages of education. Subject to the process of changes are even the most traditional subjects, such as mathematics or descriptive geometry. Descriptive geometry was chosen an example illustrating the progress in teaching students of technical colleges. Until recently, this subject, being the basic communication language for engineers all over the world, had only been taught with traditional methods – using paper, pencil, compasses and a ruler. These instruments were used both at lectures and in classes, and the geometrical constructions were recorded in the form of drawings. Teaching aids for this type of tutorials comprised of textbooks and other academic manuals. Currently, computer technology is more and more frequently used in the teaching of descriptive geometry, along with relevant software. The computer is used by students as an advanced drawing board requiring them to master a suitable graphics program. Access to the Internet, and thereby to the e-learning platform, makes it possible to take advantage of the resources stored there. E-learning courses supplement classroom activities. Students can access the materials stored there at any time during the course. This enables them to repeatedly revise the topics covered during the lecture and to do the exercises provided there. The e-learning platform provides a close equivalent to the constant contact with the tutor.

At the Faculty of Electrical and Computer Engineering of the Technical University of Krakow, first-year courses include the subject of *Geometry and Engineering Graphics in AutoCAD*. The objective of the course is to shape the students' spatial imagination and instruct them in methods of representing a three-dimensional space in the drawing plane. The subject is accomplished according to the following timetable: 1 hour of lecture and 1 hour of laboratory classes (using mainly the AutoCAD computer program) - it has the value of as many as 5 ECDL credits. In its scope, it includes Monge projections, axonometric projection, affinity and collineation, technical drawing with dimensioning principles and AutoCAD basics for creating 2D drawings (technical documentations, assembly drawings) and shaping 3D objects (modelling of spatial objects).

Within the framework of the course, students must master the basics of descriptive geometry and technical drawing, and learn the computer program with the aid of which they perform all the tasks (AutoCAD). This forces both students and teachers to get significantly involved in the teaching process. Due to the relatively small number of classes, students have access to an internet service run by the course instructor as well as constant contact with him via email. This way, additional consultations and corrections are provided (outside of the time provided for in the consultation schedule). On the e-learning platform, they receive tutorials and drafts for each of the topics being covered. They also take advantage of animations and instruction films (performed in real time), the purpose of which is to show step-by-step the manner of action, especially when introducing new AutoCAD program commands. The e-learning course also includes quizzes that check and consolidate the knowledge concerning each of the issues. Furthermore, students use sets of descriptive geometry problems published by the Technical University of Krakow, such as: *Rudiments of Monge Projections in Exercises*, *Affinity and Collineation in Exercises*, or *Sphere and Solids of Revolution in Exercises*. These sets constitute a compendium of knowledge within the given scope of material, indispensable to students of technical faculties, as well as a sets of topics to be studied by students on their own (beside the problems themselves, they contain the solutions thereof along with a scheme of reaching correct solution to the problem posed). These textbooks provide students with

the possibility to reanalyse the patterns and constructions that they learnt during the lecture, and to use them for solving engineering problems, while at the same time, they enable them to prepare themselves properly for laboratory classes.

The basis for participation in the descriptive geometry course is knowledge acquired by students at the earlier stages of education, mainly in the scope of Euclidean geometry. Course instructors prepare tasks, the purpose of which is for students to recall and consolidate information concerning plane figures and their properties, tangents to circles, the intercept theorem, Thales' theorem, etc.

In the course of studying the subject, the student acquires the ability to work in the AutoCAD environment, both in the scope of 2D and 3D. He is able to make planar drawings of various mechanical objects, including their sections, dimensioning and creating assembly tables. He can build spatial models of these objects, selecting appropriate material indispensable for the visualisation thereof and saving in the form of raster images. Further skills relate to drawing, reading and supplementing technical documentations (collaboration between different sectors). Learners acquire the ability to combine vector images with raster images and to prepare materials for print. Towards the end of the semester, each student creates their own poster that presents a solution to a given geometric problem. The project consists of a problem solution with the use of descriptive geometry methods as well as images representing a spatial model of the existent situation.

Within the scope of descriptive geometry, students learn what geometry deals with and what are the basic ways of representing space. They learn the principles of orthographic projection (ambiguity of images from two projections) as well as the differences between the European first-angle projection and the American third-angle projection. Further on, they learn axonometric acquainting themselves with each of its kinds. They practice constructing military axonometric, cavalier axonometric, orthogonal isometry, orthogonal dimetry and orthogonal anisometric. Another method of representing three-dimensional objects in the form or two-dimensional drawings that the students learn is the method of Monge projection. Beginning from the general information, that is the way of representing points, straight lines and planes in this kind of projection as well as singular straight lines and planes, they proceed to the 5 basic constructions (affinity, common element, parallelism, orthogonality and metrical constructions, sections and rotations). The next stage is becoming familiar with the method of transformation that is the ability to deal with consecutive projection planes perpendicular to one of the previous ones[1].

After becoming familiar with the basic "alphabet" in the form of basic constructions and transformations, students proceed to three-dimensional objects, that is to say problems related to solids. They find out about regular and half-regular polyhedrons, pyramids, prisms, the sphere, cones and cylinders. They solve problems involving the topics of piercing points, sections, intersections and developments of solids. They learn about the relation of collineation and affinity with respect to some engineering problems. They construct conic sections: ellipse, parabola and hyperbola. At the end, they learn various engineering problems that are solved using geometric methods.

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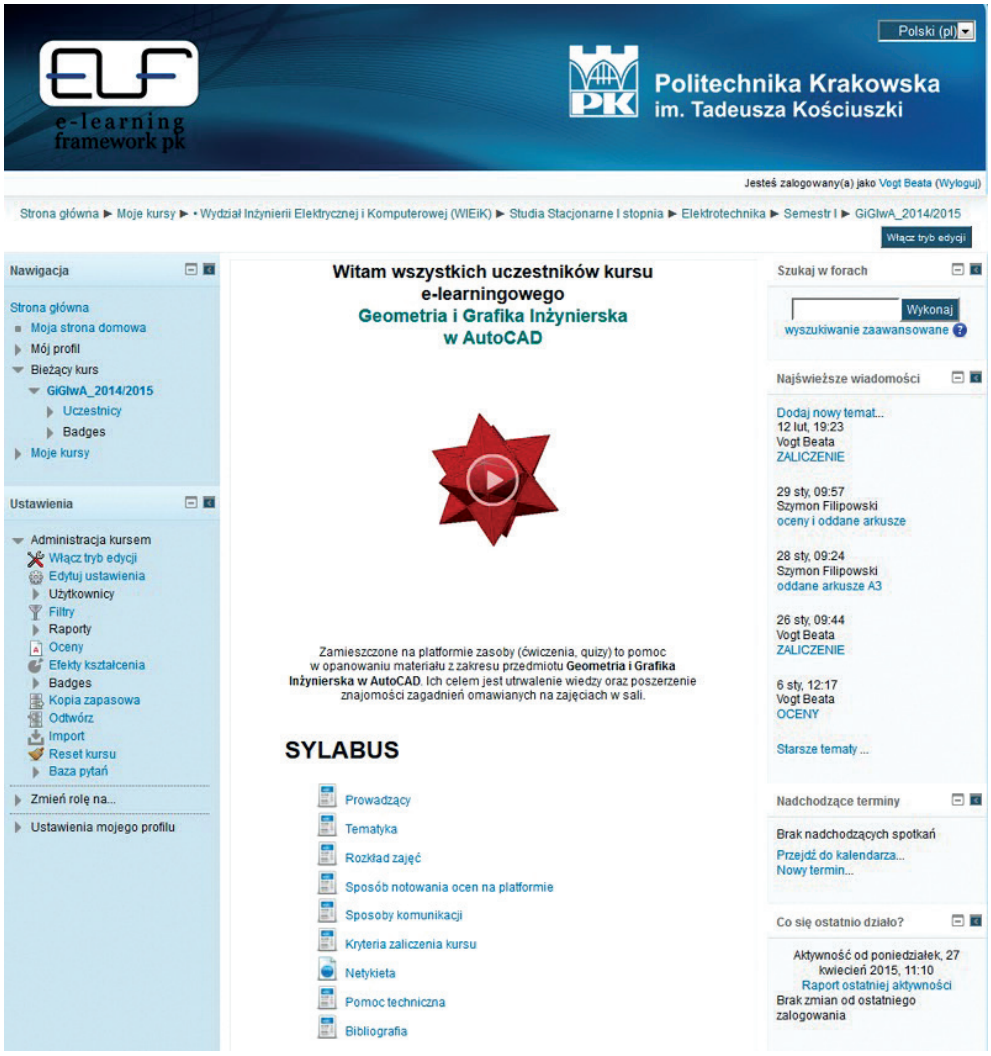
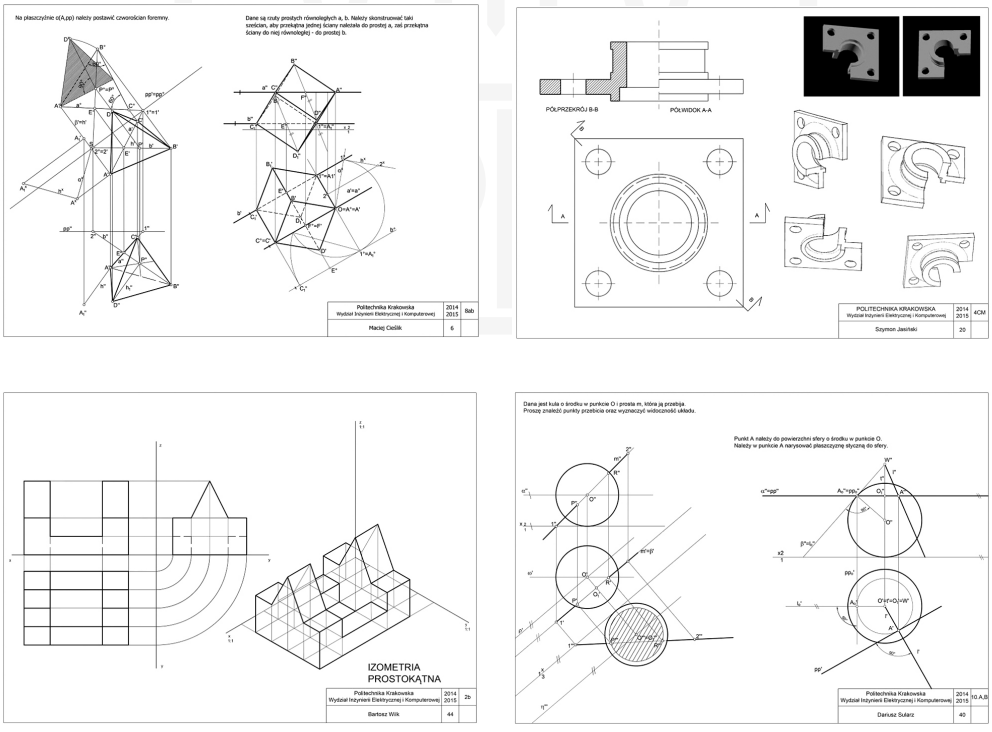
[1] When teaching descriptive geometry in the traditional way (with the aid of pencil, ruler and compasses), due to the decreasing number of classes of this subject, the tutors often depart from teaching the 5 basic constructions and proceed directly to the method of transformation. In the case of classes conducted with the use of a computer, students more frequently choose to solve a geometric problem using the basic constructions (section) than transformation. Moreover, they make fewer errors in these exercises.

The introduction of modern teaching techniques [computer programs and e-learning] was intended to streamline and improve the efficiency of teaching, and at the same time, to facilitate the direct contact between students and lecturers, which would enable an individual approach to the problems arising in the course of the teaching process. However, as in the saying "there are two sides to every coin", even here there is the other side, as these methods are more time-consuming, to both the students and the lecturers. It is also necessary to have access to broadband internet [which is still not so easy outside big cities] as well as computer hardware of sufficient parameters. Despite these disadvantages, it seems that this way of conducting classes is going to be more and more common.

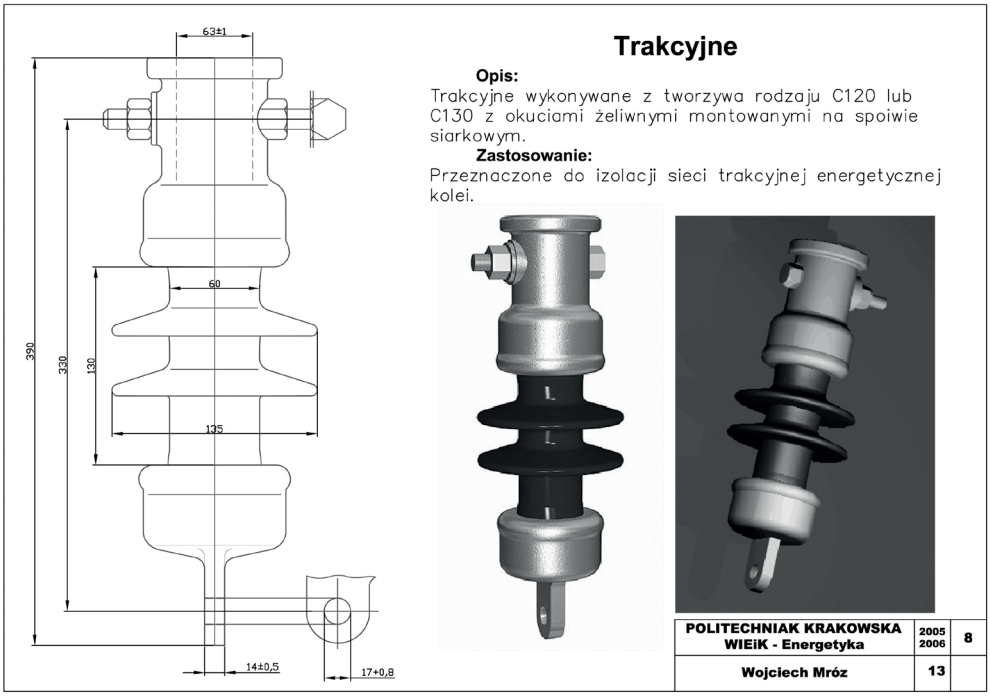


Ill. 1. View of the e-learning site of the course Geometry and Graphics in AutoCAD

Ill. 2. View of the e-learning site of the course Geometry and Graphics in AutoCAD

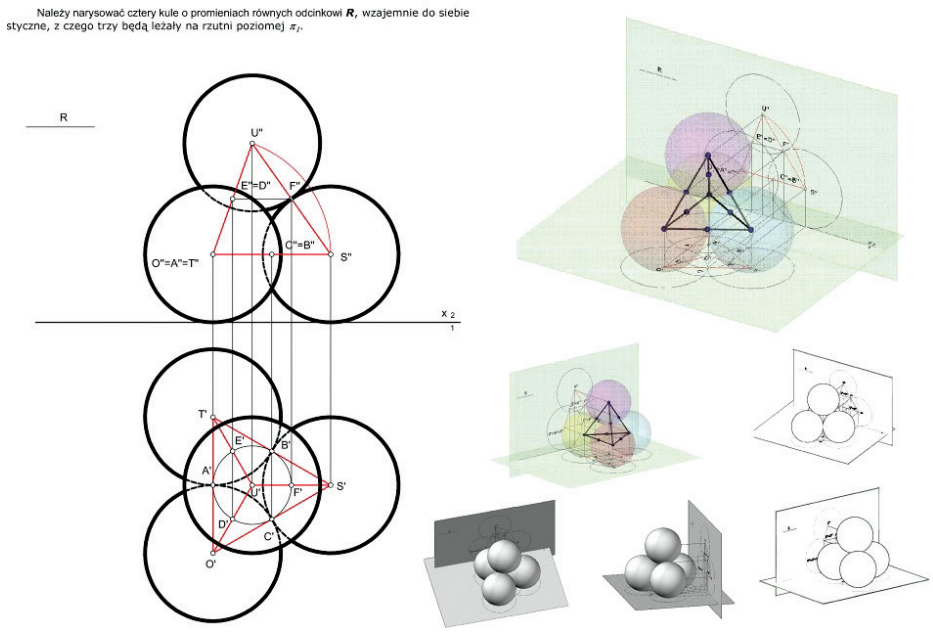


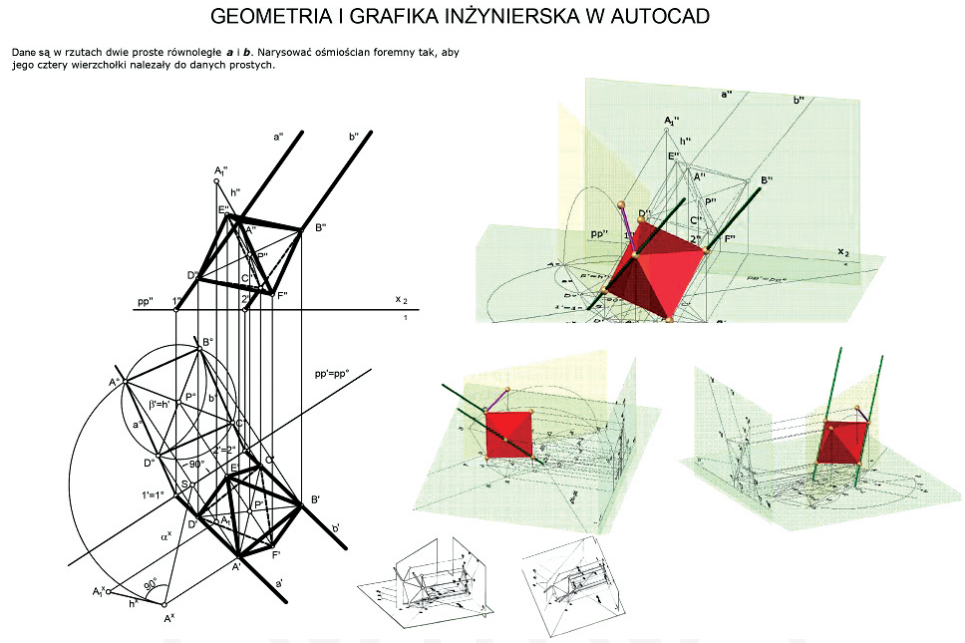
Ill. 3. Examples of various geometric-engineering problems solved during the classes



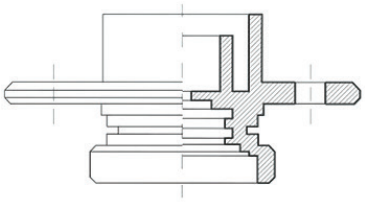
Ill. 4. Traction – a 2D drawing along with dimensioning and a raster image of a 3D model created by a student

GEOMETRIA I GRAFIKA INŻYNIERSKA W AUTOCAD





Ill. 5. Specimen posters made by students. Each one contains the topic of the problem, geometric solution as well as a representation of the 3D model showing the existent system



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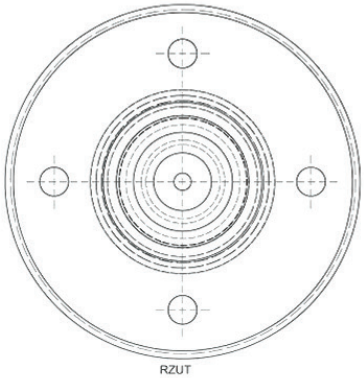

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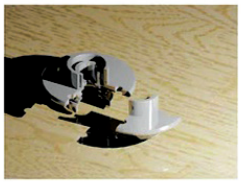

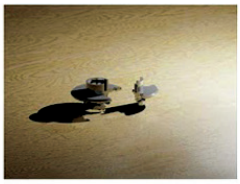

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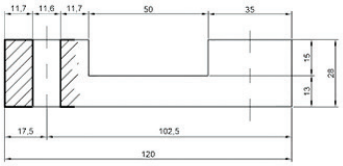

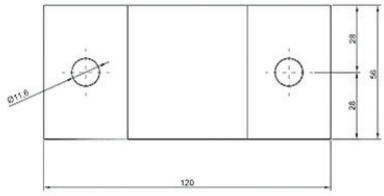

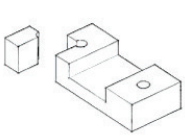

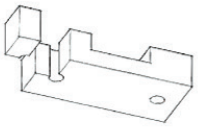

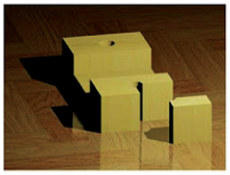

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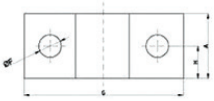

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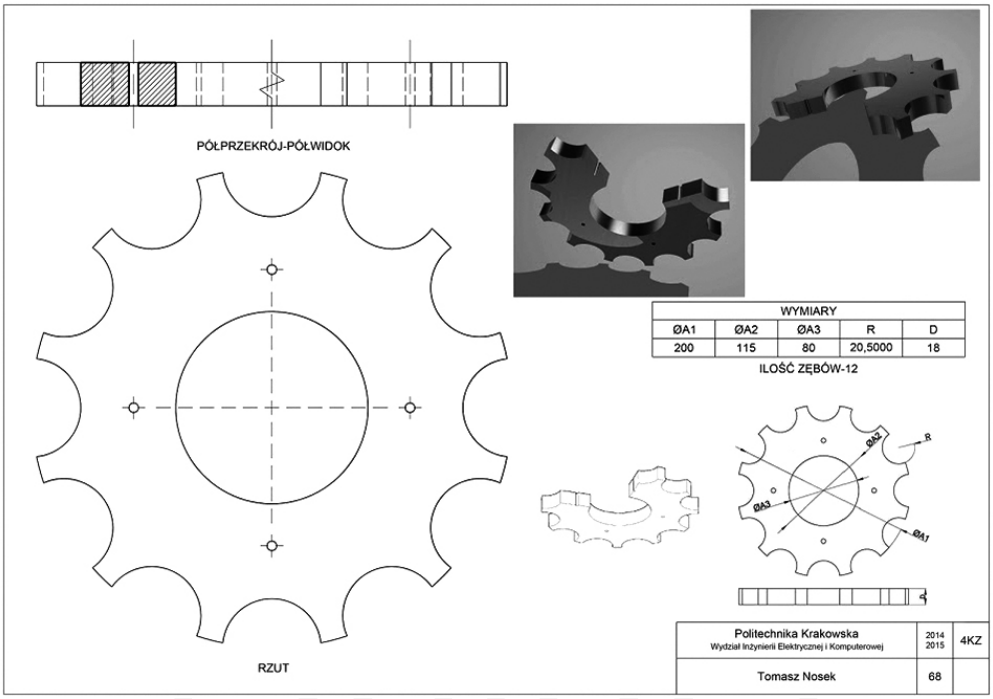
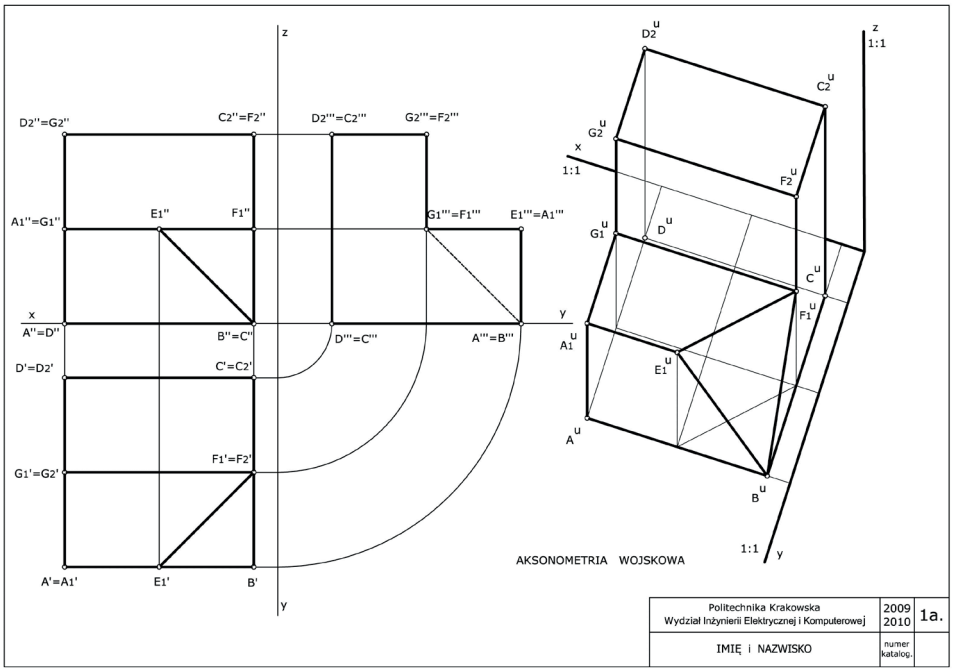
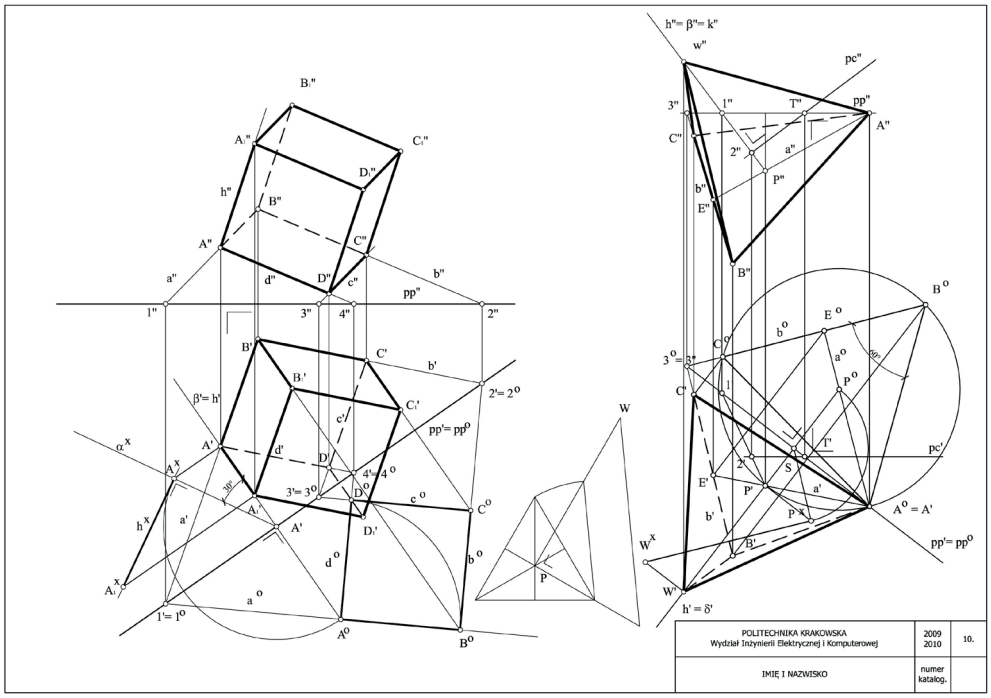


Ill. 6. Various mechanical part developed by the students



Ill. 7. Based on two existing projections students construct a third one, label appropriately all the vertices, and then draw the axonometry of the system (developed by Beata Vogt)



Ill. 8. Exercises with polyhedrons solved with the traditional methods (developed by Beata Vogt)

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[1] *Geometria i Grafika Inżynierska w AutoCAD* [Wydział Inżynierii Elektrycznej i Komputerowej > Studia Stacjonarne I Stopnia > Elektrotechnika > Semestr I]; http://elf2.pk.edu.pl/course/view.php?id=578 (online: 26.02.2015).

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