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THE PROJECTING AND CONSTRUCTING FORMATION OF THE FUTURE ENGINEERS' COMPETENCE IN THE PROCESS OF GENERAL ENGINEERING TRAINING

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Abstract: The article specifies the stages of formation of the projecting and constructing competence of the future engineer (initial, basic, fixing, forming, and creative), which provide an elementary literacy (an ability to read and to draw charts correctly); the graphic literacy (the conscious application of normatively defined graphic knowledge, which are obligatory for an educated engineer; they are characterized by its volume and depth, as well as the ability to navigate freely in the IT field); the graphic competence (an ability to apply effectively the obtained graphic knowledge and skills in the process of teaching special disciplines; an experience in the use of computer technologies in the professional activities); the professional graphic competence (an ability to predict and plan professional activities, and readiness to apply the obtained knowledge in the process of solving professional tasks; an ability to work in a team, to use communication skills and an own independent experience).

Keywords: general engineering training, projecting and constructing competence, graphic competence, graphic literacy, professional graphic competence, engineer

INTRODUCTION

The general engineering training of students occupies an important place in the learning process, because it is an integral part of higher education. Thus, Morkun, Bakum, and Tsvirkun (2014) believe that one of the areas of future engineers' professional training is fundamental training, the main task of which is to teach students to use the obtained knowledge in the process of

professional activity. It will contribute to a broad scientific outlook and motivation to the new knowledge acquisition. Therefore, the educational process should take place in unity, integrity and system during the teaching of general engineering and special disciplines, which will bring students closer to the future professional activity and the knowledge obtaining related to the real practice, promote personal potential, interdisciplinary analysis, synthesis and knowledge integration.

MATERIALS AND METHODS

Anisimova (1998) emphasizes that the level of graphic education of a student is determined not only by mastering the technique of performing graphic tasks, but also by his readiness for the future activity. Accordingly, the professional development of the student in the learning process should provide not the obtaining of individual knowledge and skills only, but mastering the basics of projecting and constructing activity that requires the project vision development, construction abilities, personal and professional qualities. The solution of the outlined problem requires clarification of the stages of the projecting and constructing competence formation of the future engineer (*Table 1*).

Table 1

**The projecting and constructing formation
of the future engineers' competence**

Training stages	The projecting and constructing formation of the future engineers' competence	
	Subjects	Graphic base
I initial	Drawings (secondary school)	Geometrical graphical fundamentals *(elementary graphic literacy)*
II basic	Descriptive geometry and engineering graphics	Graphic and normative base of application skills and abilities of traditional image construction methods and rules *(graphic literacy)*
III fixed	Systems of automatized projecting	Graphic and information base of skills and abilities of image construction with the help of computer technologies, using traditional algorithms of descriptive geometry and engineering graphics *(graphic literacy)*
IV forming	Disciplines of professional training	Formed graphic base of abilities and skills necessary for performance of the projecting and constructing works similar to the professional activity *(graphic competence)*
V creative	An application and enrichment of gained skills in the professional activity process *(professional graphic competence)*	

Source: created by authors

Based on the abovementioned, it can be stated that each of the stages (initial, basic, fixing, forming, and creative) provide:

- elementary literacy (an ability to read and draw charts correctly, without errors);

- graphic literacy (an application of normatively defined graphic knowledge necessary for an qualified engineer, characterized by its volume and depth, as well as an ability to navigate freely in the IT field);

- graphic competence (an ability to apply effectively the obtained graphic knowledge, and skills in the learning process of special disciplines; an experience in the use of computer technologies in professional activities);

- professional graphic competence (an ability to predict and to plan professional activity, readiness to apply the obtained knowledge in the process of solving professional tasks, an ability to work in a team, to use communication skills and own independent experience).

RESULTS

An important stage in the development of the projecting and constructing competence of future engineers is the formation of "graphic literacy" using traditional methods of descriptive geometry and engineering graphics (basic stage) by using computer technologies of automatized projecting (fixing stage). In the process of learning descriptive geometry, tasks are important and are a powerful stimulator of students' mental activity aimed at conscious and independent knowledge gain. Thus, Anisimova (1998) believes that graphic problems contribute to cognitive activity, because during the solution it is necessary to put forward different hypotheses that are elements of the creativity.

When solving a specific problem, the student must use techniques of a mental nature, such as analysis, synthesis, generalization, as well as find algorithms to follow and to predict the result that will meet the requirements of the graphic problem. To do this, the student must observe, be able to perceive educational information, analyze, hypothesize, compare facts and information that will help not only to understand and remember the graphic material, but also to enhance cognitive activity.

Thus, in the process of performing a complex calculation and graphic task "Planes Perpendicularity", the student has to capture the following competencies (*Figure 1*).

In the next stage, students learn to build images using computer technologies of automatized projecting by using traditional algorithms of descriptive geometry and engineering graphics. Let us consider finding the line of intersection of two surfaces using ICT (*Figure 2*).

- ability to draw the main lines of the plane (f – frontal, h – horizontal);

- creation knowledge of the perpendicularity of a line and a plane;

- ability to build a line perpendicular to the plane;

- knowledge and ability to find the intersection line for planes;

- ability to determine the point of intersection of a line with a plane;
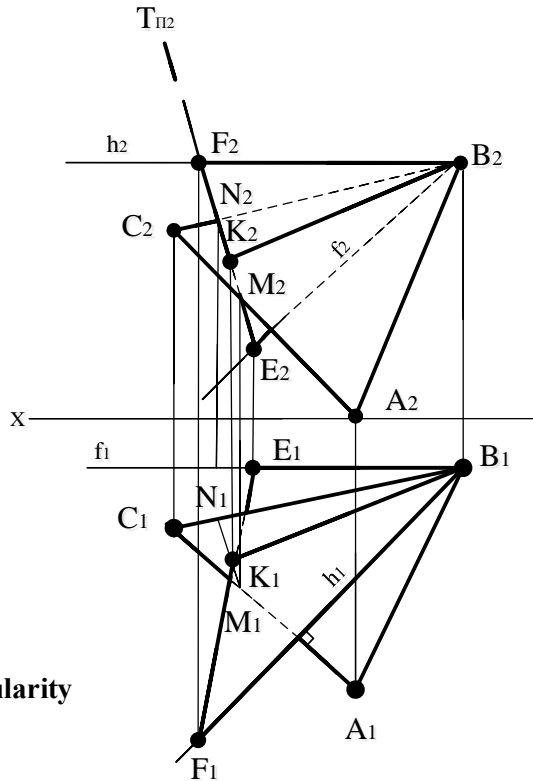
- ability to determine the planes visibility.

Figure 1: Planes Perpendicularity Task Example
Source: created by authors

The *first stage* (informational and analytical) involves the ability to explain, check, analyze, and predict the outcome. From the visual condition of the problem, it is seen that two bodies of rotation are drawn: a cone and a cylinder (*Figure 2*).

The *second stage* (graphically geometric) promotes the formation of skills and abilities to work with computer technologies of automatized projecting. Based on the received information students build a spatial model of a detail, which is more visualized and developed. The particular important is an opportunity to see it from all over that promotes understanding of a condition of a graphic task and the further actions have to be done (*Figure 2a*).

The *third stage* (engineering) provides the implementation of the obtained knowledge in the process of teaching descriptive geometry and engineering graphics. With the help of the cutting plane, students make a cut that allows seeing the internal structure of the detail, the line of intersection of the two surfaces (*Figure 2b*).
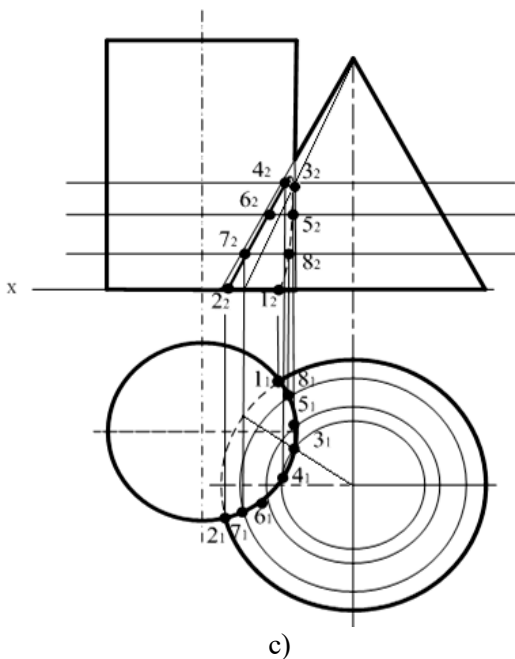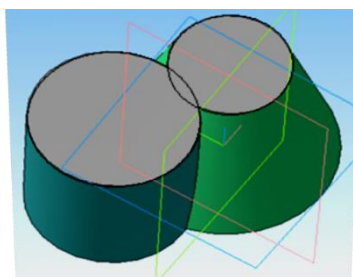
Figure 2: Cross section of surfaces
Source: created by authors
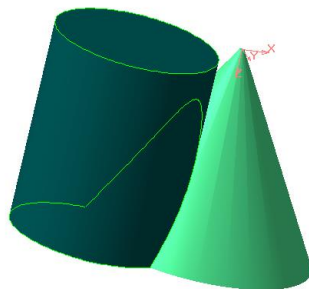
The *fourth stage* (projecting) is based on the 3D model. Students create three standard associative detail visions that are associated with a particular 3D model of detail. *Figure 2c* reflects two visions of detail (the main and the top view) with the resulting line of intersection.

The future engineer must be able to use complex knowledge in further projecting and constructing engineering activity by using algorithms of descriptive geometry and the capabilities of computer technologies for automatized projecting.

CONCLUSION

Based on the abovementioned, it can be argued that the projecting and constructing competence is a formed characteristic of the student's readiness for the future engineering activity, which is manifested in the gradual accumulation of normatively defined graphic knowledge and skills in the process of graphic training; it provides adaptive ICT possession and the ability to apply the obtained knowledge in the future professional activity.

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