

**THE PROBLEM OF FORMATION THE PROFESSIONAL
COMPETENCES OF BACHELORS OF EQUIPMENT AND
TECHNOLOGY THROUGH THE INTEGRATED USE OF
GRAPHIC PACKAGES AND THE STUDY OF CLASSICAL
DESCRIPTIVE GEOMETRY**

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Abstract: *The requirements for the specialists' training in higher professional education are increasingly oriented towards the computerization of the educational process. The undeniable advantage of computer graphics makes it possible to simplify the process of creating drawings, and accordingly in the educational process the use of graphic programs justifies itself completely. At the same time, the development of spatial imagination and the mental representation of space objects through a complex drawing is perhaps one of the fundamental conditions for educating an engineer as a high skilled specialist. Thus, the teacher, having a good geometrical and graphic training, could transfer to students this invaluable experience of perception of space and its reflection on the plane according to certain laws of projection.*

Keywords: information space, quality of education, graphic editors, development of spatial imagination.

Modern scientific literature allows considering the phenomenon of legal personality in several planes. Thus, there is an analysis of a person that acts in legal framework as the subject of interaction with state possessing peculiar legal properties and qualities; as the subject of legal socialization, which is expressed in the process of legal values digestion by the person; and as subject of legal activity. By the criterion of predominance of legal provision within society such personality is considered a person being a conscious and authorized citizen of legal state, and therefore the category of "legal personality" matches the category of "personality" in general.

The information space has become an integral part of modern society in general, and particularly all levels of education. It implies the possession of a truly huge amount of information, its processing, accumulation, transfer and use, carried out with the help of computer technology. This applies to classroom activities, and organization of independent work¹.

¹ T.I. Shukshina, Z.A. Movsesyan, L.A. Serikova, "Approbation of pedagogical conditions for the formation of didactic competence of teachers' college students in the process of independent work", in *Astra Salvensis*, 2018, vol. 6, p. 551-559.

Huge opportunities to obtain information through the Internet network assume the possession of virtually unlimited volume of various kinds of information resources: text, graphics, audio and video files and even virtual reality space². As a result, students who do not master this or that topic offered by the teacher can use the multimedia equivalents of theory, practice, and, sometimes, the whole process. Thus, the quality of self-training significantly increases and really rises to a new level. The possibility of training in "home" conditions, less tight time frames and personal distribution of priorities in the process of obtaining, repeating, consolidating knowledge and skills and should compensate for the rapidly shrinking auditory hours allocated in the educational program to study a particular discipline.

Materials and methods

In fact, the result is the opposite: the decline in academic performance and, as a consequence, the quality of education. We believe that the intensification of the educational process and the replacement of the development of logical thinking by the skill obtained through training deprive the specialist of universality. This is the main problem of basic disciplines in the graduates training of engineering profiles and specialties. We analyzed the state of the disciplines "Descriptive Geometry", "Engineering and Computer Graphics" when teaching students in technical areas.

Competences of educational programs for training specialists – engineers prescribe to own:

- 1) the ability to determine the spatial and geometric position of objects, process and interpret the results of geodetic and surveying measurements;
- 2) development the necessary technical and regulatory documentation, monitoring the compliance with standards;
- 3) working with software products of general and special purpose for simulation the mineral deposits.

The second and third positions fully justify the use of computer technologies in the process of education in acquiring the work experience, for example, with State Standards, which unambiguously regulate the

² A.M. Lamminpiya, O.V. Zashirinskaia, Y.E. Shelepin, "Psychophysiological analysis of the reading and text understanding", in *Fiziologija cheloveka*, 2015, vol. 41, no. 2, p. 23-28; A.M. Lamminpiya, O.V. Zashirinskaia, Y.E. Shelepin, "Psychophysiological analysis of text reading and understanding", in *Human Physiology*, 2015, vol. 41, no. 2, p. 130-134.

creation and execution of technical documentation. The biggest advantage of such training is the ability to deal directly with the objects of construction that is to learn the proper drawing of the necessary images of a particular part, the creation of hatching, the placement of dimensions and the inscription. The use of graphical editors greatly reduces the time of drawing execution by using various libraries of standard elements, as well as technical execution moments, such as observing types and thickness of lines, writing letters, etc. This undeniable advantage of computer graphics allows you to simplify the process of creating drawings, and accordingly in the educational process, the use of graphic programs justifies itself completely.

It is impossible to overestimate the importance of the discipline "Descriptive Geometry" for specialists in engineering education profiles. The development of spatial imagination and the mental representation of space objects through a complex drawing is perhaps one of the fundamental conditions for educating an engineer as a high-skilled specialist. Difficulties arise in the studying of Descriptive Geometry that studies spatial figures, as well as methods for solving and investigating spatial problems using their images on a plane. The attempt to replace creative and logical thinking with ordinary skill and simple memorization often leads to the fact that changing the conditions of the task makes either its solution impossible or leads to an error solution.

Many years of debate among scientists on the question of replacing the Descriptive Geometry by Computer Modeling in the training of future engineers is one of the pedagogical problems. The analysis of the labor functions of workers in various areas of production activity shows that the level of geometric and graphic training of a specialist is determined not by the quality of his possession of the technique of performing the graphic images (the ability to draw), but by how much he is able to visualize the problem, by readiness for the mental transformation of the object, development and mobility imaginative thinking as well as the presence of formed spatial representations³. Scientists have substantiated the positions asserting that the ability to create spatial images, operate with them, visualize the problem are in many respects the basis for success in graphic and constructive-technical activity⁴. The owners of developed spatial

³ S.A. Kryukova, "Understanding of visual thinking", in *Analytics of Cultural Studies*, 2012, no. 22. Available at: <http://cyberleninka.ru/article/n/ponimanie-vizualnogo-myshleniya>.

⁴ E.P. Alexandrova, K.G. Nosov, I.D. "Stolbova, Practical implementation of project-oriented activities of students in the course of graphic training", in *Open Education*, 2015,

thinking successfully develop a professional career not only in the engineering or artistic field, but also in management, pedagogy and social activities^{5,6}. We will not be mistaken if we conclude that spatial thinking not only contributes to the process of obtaining knowledge, internalization and objectification, the self-creation. It is also a solid foundation for the development of personal and professionally significant qualities of a personality.

Thus, the formation of this kind of thinking should be included in the educational goals of the training and implemented in those disciplines where it is used to a greater extent and, consequently, is formed and develops. Scientists believe that the most important place among such objects belongs to Descriptive Geometry, since in the most developed forms spatial thinking is formed on a graphic basis (A.V. Zaporozhets, B.F. Lomov, V.P. Zinchenko, I.Ya Kaplunovich, E.I. Rogov, I.S. Yakimanskaya and others)⁷. In drawing, the subject content of images is combined with the extensive use of symbolic models, conditionally replacing the subject of the image and having lost any visual and logic with it⁸. A fairly complex discipline that shapes engineering thinking, spatial perception, ability to mentally rotate and scale objects requires also special methods and techniques for organizing the process for its study.

Results and discussion

Scientists and psychologists were engaged in this problem in different periods of time. Teaching means for drawing in their work in detail examined A.A. Abrikosov, V.O. Gordon and V.I. Kuzmenko. They have developed such programs and textbooks for secondary schools, which are still in demand for self-preparation at the drafting course. Development of methodical manuals for teachers of drafting was studied

vol. 112, no. 5, p. 55-62; N.V. Mishina, "Methods of development of graphic skills of adolescents in the process of artistic and project activity", in *Modern Problems of Science and Education: Electronic Scientific Journal*, 2014. Available at: <https://science-education.ru/en/article/view?id=14397>.

⁵ T.V. Shtal, Y.O. Polyakova, E.L. Hasanov, G.S. Ukubassova, S.A. Kozhabaeva, "Formalization of the enterprise international economic activity efficiency management", in *Utopia y Praxis Latinoamericana*, 2018, vol. 23, no. 82, p. 64-82.

⁶ V. Afanasiev, M. Vrazhnova, M. Nechaev, S. Frolova, L. Shypovskaia, "Directions of increasing the effectiveness of career guidance system for students in Russia", in *Astra Salvensis*, 2018, vol. 6, no. 12, p. 193-209.

⁷ V.Yu. Shcherbakova, *Formation of spatial thinking of schoolchildren in drawing lessons*, Kursk State University, Kursk, 2005.

⁸ I.A. Roitman, *Methods of teaching drafting*, VLADOS, Moscow, 2002.

by A.D. Botvinnikov. A group of scientists under his leadership developed a set of methodological recommendations for the selection of effective methods and techniques for improving the graphic preparation of students. D.M. Borisov, Yu.F. Kathanova, V.I. Kuzmenko, I.H. Makarova, L.A. Pavlova, N.N. Rostovtsev, S.A. Soloviev and others developed fruitfully educational programs and manuals for pedagogical universities, in which teachers of drafting were specially trained (and often these were merged with the mathematics directions)⁹. Thus, the teacher, having a good geometrical and graphic training, could transfer to students this invaluable experience of perception of space and its reflection on the plane according to certain laws of projection. Questions of continuity in the graphic preparation of schoolchildren and university students were reflected in the publications of V.N. Vinogradov. Essential experience in the development of manuals for teaching¹⁰ drafting and graphics was published in the papers of N.S. Vyshnepolsky, A.V. Gerver and N.S. Nikolaev.

The use of computer graphics in Descriptive Geometry seems to us useful in studying the specific topics, for example, "Surfaces" and "Surface intersection". So, a visual image of typical surfaces and the corresponding complex drawings executed in a graphic editor help the learner to facilitate

⁹ "Facets. Handbook of Drafting", 2018. Available at: http://www.granitvtd.ru/index.php?option=com_content&task=view&id=3&Itemid=4; "Methodological Recommendations on the Introduction of the Federal State Educational Standard of Basic General Education", 2016. Available at: http://minobr.gov-murman.ru/files/Kontrol/FGKK/Letter_08-1228.pdf; N.N. Vyborova, M. Yu. Permyakova, "Formation of functional-graphic literacy as a necessary component of vocational training for students of technical specialties", in *Pedagogical Education in Russia*, 2016, no. 6, p. 40-43

¹⁰ S.N. Devyatkina, A.F. Amirov, "The results of experimental work on the formation of professional competencies of future technology teachers", in *Siberian Pedagogical Journal*, 2016, no. 1, p. 41-49; B.F. Lomov, *Formation of graphic knowledge and skills by students*, Izdatel'stvo Akademii Pedagogicheskikh Nauk of the RSFSR, Moscow, 1959; A.A. Pavlova, "Methods of teaching drawing and graphics: manual for teachers", in *Humanite*, Ed. Center VLADOS, Moscow, 2004; A.A. Pavlova, E.N. Korzinova, "Problems of formation and development of the initial graphic literacy of a schoolboy and a freshman student", in *Teacher XXI Century*, 2012, no. 2, p. 131-135; O.N. Shevchenko, "Grapho-geometric training of schoolchildren as a pedagogical problem. University complex as a regional center of education, science and culture", in *Materials of the All-Russian Scientific and Methodological Conference*, 25 May, Orenburg, 2018, p. 1089-1091; O.N. Shevchenko, "Pre-university geometrical and graphic education of the entrant in the strategy for the preparation of bachelors of engineering directions", in *Bulletin of the Orenburg State University*, 2017, vol. 205, no. 5, p. 33-38.

the perception of information and to learn the principles of surface formation¹¹.

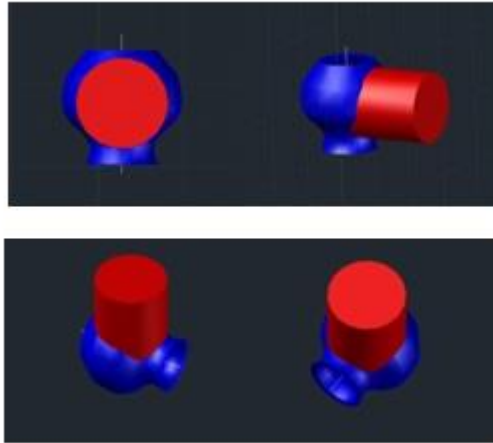


Figure 1: Computer models are in the intersection of projecting elements of space

The intersection of surfaces is of the greatest interest, since the result is, most often, unpredictable for students. It is advisable to use here also computer models in the intersection of projecting elements of space, since orthogonal projections are completely deprived in this particular case of clarity (Figure 1). The horizontal and frontal projections coincide with the trace, that is, the projection of each of the intersecting surfaces, and it is very difficult to represent the general spatial line. The possibility of dynamic movement allows us to view the result from all sides in real time. The definition of the line of surfaces intersection, with only one projecting objects is more clearly, but also involves some difficulties of mental representation (Figure 2).

Demonstration of the process of creating objects, their mutual intersection and resulting in a three-dimensional common object demonstrates to students not only the possibilities of graphic modeling, but also the connection and the relationship of computer graphics with the Descriptive Geometry.

¹¹ A.L. Kheifets, A.N. Loginovsky, I.V. Butorina, V.N. Vasilyeva, *Engineering 3D-computer graphics: a textbook for bachelors: for students of engineering and technical universities when studying the course "Engineering and Computer Graphics"*, National Research South Ural State University, Moscow, 2013; O.N. Malikova, "Fundamentals of descriptive geometry: Tutorial. IUT: Tyumen; I.V. Robert, *Modern information technologies in education: didactic problems; perspectives of use*, ИО RAO, Moscow, 2010; O.V. Shishov, *Modern technologies and technical means of information: a textbook for university students studying in the direction of "Service"*, INFRA-M, Moscow, 2014

The question arises about the advisability of using the graphic packages in the process of learning the projecting geometry. On the one hand, this is a real relief of the "manual labor" and visualization of the studied elements of space.

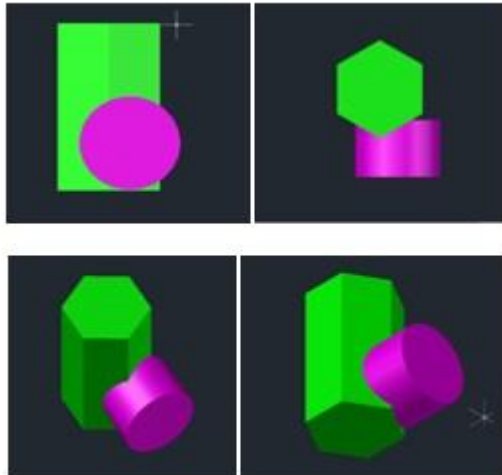


Figure 2: There is a definition of the line of surfaces intersection, with only one projecting objects

On the other hand, it is a ready-made result that excludes the search for an independent solution of volumetric problems in a complex drawing and, as a consequence, a limitation of the possibility of developing a spatial imagination, a decrease in the creative potential of a future engineer. For successful training in the technical areas of training bachelors of engineering and technology.

The following conditions are necessary that form the professional competencies of the future engineer through the integrated use of graphic packages and the study of classical Descriptive Geometry:

- 1) development of the positive motivation of the student for the formation of general engineering competence related to geometrical and graphical training;
- 2) actualization of the subject position of the learner in the process of forming a life plan related to future professional activity;
- 3) differentiation of learners into groups, depending on the level of development of spatial representations and knowledge of information technologies, with the construction of an individual route for studying the drafting and graphics;
- 4) methodological support of the formation of spatial representations, a progressive advance from simple to complex;

5) use of scientifically based educational and methodological recommendations taking into account the requirements of educational standards.