Teaching Descriptive Geometry in the Process of Solving Engineering Problems it is One of the Forms of Interdisciplinary Integration in the Learning Process

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Abstract

Descriptive Geometry and Engineering Graphics is one of the fundamental disciplines, which is mandatory for all engineering education. Its methods can solve engineering problems in various fields of engineering. This discipline is taught to the first year students at the Technical University and, unfortunately, it is taught under the same program regardless the major of the student and interdisciplinary connections. At the Perm State Technical University at Oil and Mining faculty teaching is differentiated with orientation to the future profession, as well as the interdisciplinary integration in the learning process.

In this regard, firstly, we took into account that the objects of study for future professionals of mountain-geological profile are the bowels of the Earth, mines, oil wells and others. To work with these objects and solve engineering problems with them, it is necessary to teach students to simulate and replace the real objects of abstract geometric models.

Secondly, there were developed simple and complexed engineering problems that are needed to be solved by the future specialists of mining-geological profile and which have interaction and links with other special disciplines.

Solving these problems requires not only knowledge of classical descriptive geometry, ie projections of Monge, and projections of numeric grades, which were introduced in the teaching process further, but reading in parallel with the projections of Monge without increasing the teaching hours. This is an innovation in the teaching discipline.

A new method of teaching helps students to acquire the competencies needed professionals mining-geological profile of and increase their interest in learning and creativity.

1. Introduction

In recent years, in Russia there is an increase in the demand for specialists of the mining and oil and gas industry. One of the priority directions of development of the Perm State Technical University (now Perm has a status of a national research university) for the years 2009-2018 is the extraction and processing of oil, gas and minerals. In this regard, teaching of future professionals of mining-geological profile is particularly important. During training process they learn the fundamental, general and special subjects.

Discipline «Descriptive Geometry. Engineering Graphics» is a branch of mathematic science that is taught in all technical universities. The approach of teaching this discipline should be differentiated depending on the future profession of the student: mechanics, construction, design, and others. The teaching of descriptive geometry and engineering graphics to students of mining and geological profile also has its own specifics.

Therefore, the organization of the educational process should be built with regard to future specialty of students, interdisciplinary communication and integration in education.

2. Literature Review

In this chapter there is presented the literature review where the most actual aspects of the present research are described.

The Concept of modernization of Russian education until focuses on fundamental knowledge.

According to Rebrik B. M, Sirotkin H. B, Kalinichev V. N [1] without fundamental preparation «the young expert cannot independently put and solve scientific and applied problems, quickly and freely be guided in a stream of new information, cannot carry out a sweeping generalization and the analysis of continuously arising difficult industrial situations».

Students of the Oil and Mining faculty should be aware of engineering geological graphics, because it examines the theoretical foundations and methods of construction of geological objects in the drawing, forms the general engineering and general scientific thinking

Also for the specialists of mining and geological profile it is necessary to know the mining geometry. Fundamentals of mining geometry and methods of geometrization fields are described in [2]. Trofimov A. A who stresses the importance of developing of spatial thinking qualities to students, ability to model, that is to reproduce real-life objects. Also the author considers various projections which are applied to the solution of problems in mountain practice.

Base for exploring the engineering geological graphics and mining geometry is "Descriptive Geometry. Engineering Graphics", technology that is applied in various fields of engineering.

Some types of engineering problems for the future experts in mining are presented in [3]. Among them there are the direct and inverse problems, problems on the relative position of objects, and tasks for the geometrization of forms and conditions of occurrence of deposits and others.

3. Research Rationale

15 years ago at PSTU the students of mining and geological profile, as well as the students with major in other disciplines, studied only classical descriptive geometry: orthogonal projection on two or three mutually perpendicular planes of projection, axonometric projection, and studied how to work with engineering drawings. Thus, descriptive geometry almost did not fit into the overall context of the preparation of specific specialists of mining and geological profile and seemed to exist independently.

As a result, the contradiction arose: first-year students studying descriptive geometry and last-year students did not know how it can be applied in their own specialty, which was a result of not forming the necessary competence.

Thus, in recent years, traditional forms and methods of geometrical graphic preparation no longer correspond to modern requirements and have lost their effectiveness. There is a need to create another concept of teaching the discipline, based on the integrative approach in education [4].

Therefore, in the Perm State Technical University for the Oil and Mining faculty study was conducted on the development and introduction of new models of teaching descriptive geometry and engineering graphics. It includes a differentiated approach to teaching the discipline and the process of its integration with other disciplines. In our view, this model allows us to achieve a high level of systematization of technical expertise, saves training time and also gives training to professional orientation.

Methods of teaching the course have been revised so that there could be traced an interdisciplinary connection with the special subjects, and students know how knowledge of descriptive geometry can be applied in their future careers. The research urgency consists in it.

Mining engineers and geologists study bowels of the Earth. The various tectonic processes occurring in bowels of the Earth are more often inaccessible to direct observation, and mining-geological objects in overwhelming majority of cases have the most complicated spatial structure. It is impossible to display these objects precisely on the drawing with all their features. According to Trofimov A. A. [2], the engineer-geologist should not only imagine their position in space, but also to simplify them at display to a paper, to model, to adapt them into more or less simple regular solids, without bringing essential errors to the form and the size of represented object. Modeling of these processes and objects in practical activities allows receiving full enough data on laws of the studied phenomena in shorter terms with the least expenses, reduces designing terms, reduces expenses of mine building, and reduces production costs at mining operations.

In this regards, during the courses of descriptive geometry and engineering graphics students of the Oil and Mining faculty began to be involved in a graphic modeling of the Earth, i.e. the study of geometric properties of real material of geological objects.

These properties are reflected in such concepts as «form», «size», «position in space», relative position, «visible and invisible part», etc. This abstraction creates prerequisites for the widespread use of graphic methods not only in mining and geology, but also in other various fields of engineering activity.

Graphic modeling is based on geometric similarity and the various types of projections, which is an essential condition of scientific research of geological patterns, and graphic models of deposits are the basis for solving practical problems of exploration and mining. All drawings are considered as binary geometric models of objects and processes displayed on them. It needs to be mentioned that the future specialists of mining-geological profile in contrast to students major in mechanical specialties are required to have knowledge not only in classical orthogonal projections and axonometric, but also obtain knowledge of other methods of descriptive geometry — particularly of the projections with the numerical grades. Therefore, in the classroom, much attention is paid to problems of binary graphical models, performed in orthogonal projections on mutually perpendicular planes. This plan of mine manufacture, profiles of mine workings, vertical geological sections of the deposit, etc.

Geometrical modeling is supplemented with the evident projections received on one plane

(axonometrical, perspective, stereographic, affine, vector). These are various block-diagrammes.

The geometrization of mineral resources and drawing of the Earth surface topography on the plans can not do without the binary image models made by contour lines (isolines), based on the projection method with numerical grades. This method is particularly important for specialists of mining and geological profile. It is fully described in the [5]. Many surfaces are known as frame or picture, as they are only displayed a drawing: it is not possible to apply mathematical or geometric patterns. Families of lines obtained at the intersection of mental object beam parallel horizontal planes, form the skeleton of surfaces and planes. Frame surface provide the basis for the creation of universal methods of solving all the problems of position in relation to the arbitrary surface.

4. Contribution to Knowledge

Thus, students of mining and oil faculty study descriptive geometry and its methods for solving problems in with reference to their speciality.

However, the implementation of interdisciplinary links between descriptive geometry and professional disciplines has created a problem of combining classical and special courses within a restricted amount of lectures and seminars. This problem has illustrated the necessity of changing the methods of teaching the discipline.

As a result of innovative approach to teaching the lecture course was completely revised: there was introduced a special section of descriptive geometry — the projection of numeric grades. A recent innovation to the lecture course was a binary approach to the method of presentation, the essence of which lies in the fact that classical and special sections of descriptive geometry are not read sequentially as they are traditionally presented in educational publications, and at the same time, that is, each geometric object is considered at the same time at two or three graphic models.

Classes began to have the binary nature. This means that students review and analyze two parallel models of the same object (diagrams and drawings in the projections with numerical marks). This analogy is often found in the algorithms for solving problems. The process of reflection will be faster, since both models complement each other. Single-project model in projections with numerical grades often seems more understandable to students. Such a comparative analysis facilitates the process of learning and the development of abstract thinking among the students.

Thus, within the same classroom hours the volume of learnt material has increased.

Binary classes demanded a radical renewal of study equipment and methodical training of the course: they had to develop new teaching materials, options for jobs, etc.

For course maintenance methodical grants have been written [6] and [7], and individual graphic tasks are developed.

This article presents two assignments: «Structural map of oil deposits» is shown in Figure 1 and «Place of a deposit of iron ore red» is shown in Figure 2.

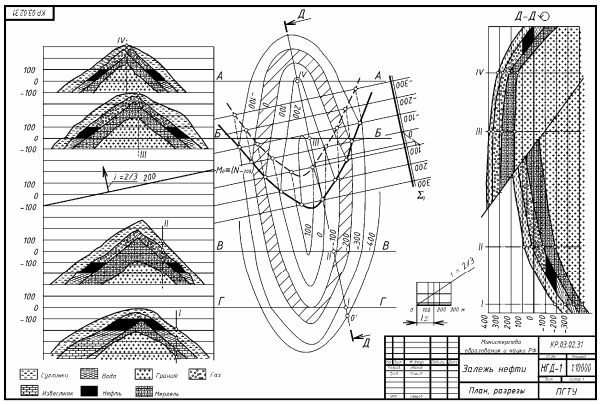

Figure 1. Structural map of oil deposits

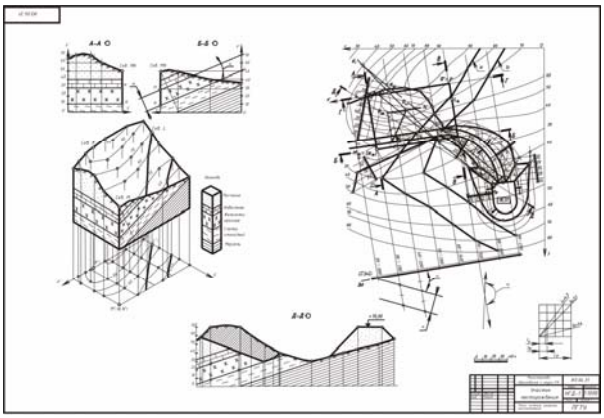

Figure 2. Place of a deposit of iron ore red

Simple and complex engineering problems with geological characteristics were developed as tasks for students. The problems reflect the interdisciplinary links and are given in the format of small studies. Students are divided into groups and learn how to work in teams, which is also an innovative approach to learning.

There was also an innovation made among teaching manuals — the express-summary [8] and the appendix to it [9] are the new effective teaching aids. This is a fundamentally new approach to the presentation of the material strictly and accurately structured express-

summary is a good reference point for the student in work with textbooks. It shows, to what sections in the educational literature it is necessary to address at occurrence of difficulties, to what points students need to pay special attention. Having in front of him such manual, the student does not summarise the material in his notebook, but otherwise pays more attention to the perception and understanding of material. This approach helps students to move directly to solving practical tasks, which is the best method of comprehending the basics of theory.

The time which was previously wasted on writing down the formulas and other information after the lecturer now can be spent on solving a large amount of tasks in order to improve practical skills. The latter, in turn, is very important because, for many students, even the knowledge of the theory does not help to succeed in solving the problems independently. Selection of problems in training manual by the number and complexity gives a possibility to practice on seminars, at home, and during preparation for the exam. Solving a big variety of problems and tasks on lectures leads to a better assimilation of educational material, increases the willingness of students to work independently on the decisions of individual graphic tasks. Work in class with the express-summary and the print material do not exclude the basics of traditional explanation of the key points of discipline on the board or using new learning technologies.

5. Conclusion

Thus, we managed to develop a course «Descriptive Geometry. Engineering Graphics» based on the integrated approach. The subject of study descriptive geometry and engineering graphics began to be considered in aggregate with mining-geological subjects, that is with reference to the decision of mining-geological problems. The special section of descriptive geometry — projections with numerical marks without change of class periods has been entered into studying. The big role in it belongs, undoubtedly, to the express summary as to logically built structure and presented in the tabular form.

Analogues of the express-summary in descriptive geometry are unknown to the author, so by a principle of a statement of a material it is original innovative educational work.

Studying of descriptive geometry in the process of solving engineering problems already at the first year training course acquaints students of Oil and Mining faculty with the future profession and provides an understanding why it is necessary to study this difficult discipline.

A scientific research has become a significant of an educational activity. All this has resulted in optimization of studying of the discipline: courses have become more productive and have given the training process a dynamical character that has raised creativity of students.

6. References

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