Journal of Fundamental and Applied Sciences

ISSN 1112-9867

Available online at http://www.jfas.info

Research Article

Special Issue

NEW EDUCATIONAL WEB RESOURCES FOR THE ENGINEERING COURSE "DESCRIPTIVE GEOMETRY"

M. A. Aygunyan*, D. V. Shevchenko

Department of Engineering Graphics & Computer Modeling, RUDN University, Russia

Published online: 24 November 2017

ABSTRACT

A new method of descriptive geometry teaching is proposed in the presented article. The method is based on video, imitating spatial geometric images and their connection with a complex drawing. The method allows to see a geometric image in space and all the constructions in the complex drawing simultaneously. Video is made in the 3ds Max software. The new technique successfully solves the spatial thinking development problem. Based on this course, the authors wrote a digital textbook. Each drawing in this tutorial has a link to the video that illustrates the drawing construction process. Practically, all the videos simulate the thinking process, which should occur in student's mind while solving the problem. The course has been tested for 4 years in the RUDN University. Students have increased their interest in descriptive geometry studying and faster spatial thinking development was noted.

Keywords: spatial thinking; geometric forms; complex drawing.

Author Correspondence, e-mail: maygun@yandex.ru

doi: http://dx.doi.org/10.4314/jfas.v9i7s.41

1. INTRODUCTION

Descriptive Geometry is a classic course that is studied by the future engineers, architects, designers. As is well known, the course serves for the spatial thinking development, and for the exploration of imaging laws. An engineer or an architect with no advanced spatial thinking is hardly imaginable. Spatial thinking is a natural ability. It's estimated that only 25% of all people have this natural ability. If one doesn't have such ability, it is possible to develop it up to a certain level. In this case, it is important to start this development at school age. The human brain loses the possibility of such development at later age.

The "Drawing" course, which contributes to the development of spatial thinking, has been taught in Russian schools for many years. However, recently "Drawing" course has been practically excluded from the Russian school course. As a result, students are not prepared for the study of Descriptive Geometry.

It has become an issue for technical universities to solve this problem. Not only this challenge is educational, but also it is psychological to a certain degree. There is a need to figure some new methods and forms of explanation for an adult's brain to get the spatial thinking related information. It's hard to learn the missed school course in addition within just the limits of time allowed for the Descriptive Geometry subject. The teachers of most of the Russian universities are facing this issue.

Many of them are willing to solve the problem by the means of traditional methods and also using modern ones based on Information Technology. The different authors' research in this field of exploration can be conventionally divided into two categories.

The first category is of those authors who talk about the importance of the Descriptive Geometry subject and try to bring its lost status and significance back. It's supposed to be done through going back to the amount of academic hours that used to be before. However, they forget that not only the amount of academic hours of Descriptive Geometry subject is being decreased, but also those of the whole educational process, as this is a tendency of a current educational process that is directed at a large amount of students' unsupervised work.

In addition, it is proposed to transfer descriptive geometry to the status of mathematical disciplines by introducing a clear mathematical evidence base and its rapprochement with analytic and differential geometry. The convergence of Descriptive Geometry as a science

with related branches of mathematical sciences can only be welcomed. However, Descriptive Geometry as an academic course should not be turned into a set of mathematical formulas and transformations. This is because this course is studied by future architects, designers, engineers, who do not need to know the deep mathematical foundations of descriptive geometry. It is the development of spatial thinking that is much more important for them. As you know, this is best conducted by geometric constructions, not mathematical calculations. At least, nothing better has been invented so far, which would contribute to the development of spatial thinking. This is the format the question is posed in the articles [6], [13].

Another category of authors is trying to find new ways of learning. Among them, we can note such ways as intensification of the learning process, application of information technology tools, convergence and merging of the courses of descriptive geometry with the course of computer modeling and computer graphics. In our opinion, this approach is much more productive.

It is suggested to accompany the educational process by demonstrating 3D images on the computer [8] and [10]. Of course, this contributes to a better students' vision of geometric images. However, this is the most elementary approach to the use of modern computer technologies, which does not require any additional efforts from the teacher and practically isn't any different from a simple demonstration of models of geometric bodies.

There are considered such things as: various methodological aspects of convergence or fusion of Computer Modeling and Computer Graphics courses; the creation of a synthetic Descriptive Geometry course; the development of a new methodological approach to these courses, taking into account the new generation educational standards in the works [1], [5], [9].

A new structure of the educational process is proposed in the work [7]: tasks, monitoring and evaluation. The authors of current article are close to the position of articles [11] and [12]. They set the main goal: the development of spatial thinking. There are various types of exercises that should contribute to this goal proposed. Besides, the mentioned authors introduce a classification of visibility concept and consider it from the point of view of all human senses effect. They consider Media products as one of the parts in this classification.

The development direction of Descriptive Geometry teaching with the help of media is

suggested by the author [2], [3], [4].

It is necessary to note the following when considering the state of the problem in general:

a) all authors recognize the existence of such a problem;

b) none of the authors has concrete ways of solving the problem of faster spatial thinking development.

2. MATERIALS AND METHODS OF RESEARCH

In connection with the above-mentioned, the authors proposed a Descriptive Geometry course teaching system, based on the course of lectures developed by them.

The course consists of a series of animated films created in the 3ds Max software. The authors have created about 140 videos, each of which demonstrates the solution of Descriptive Geometry course's essential tasks. The videos duration varies from a few seconds to 1-2 minutes.

The videos do not replace traditional Descriptive Geometry teaching, but are demonstrated in parallel with it, and precede the geometric constructions. The authors have tried to preserve the traditional course that has been worked out with great attention for many years, and to add new possibilities that have arisen with the advent of modern information technology.

Each video has roughly the same scenario: the initial state of the task is demonstrated both in the complex drawing and in space. This happens simultaneously, unlike a sheet of paper or a board, where we see only a complex drawing. This can be achieved by placing the projections perpendicularly to each other instead of developing them. The observer looks at them from a certain angle. Between the planes there is a spatial original.

If this is a static image, it is usually called a one-picture drawing. One-picture drawing earlier tried to realize in the form of static models, which can be viewed from different points of view. There is no process of geometrical construction in this case.

In our case, this model is combined with the construction process. Thus, a student can simultaneously see a geometric image in space, a complex drawing, the entire process of construction on an integrated drawing, and all the movements and transformations taking place in space in real time. This can also not be done on a regular drawing, unless you do it anew. There is also a possibility of returning to any previous stage of the construction, which

was unclear.

This is the novelty of the proposed work.

3. RESULTS AND DISCUSSION

Thus, the created videos are a virtual representation of what should happen in the student's mind. A student should mentally see the complex drawing and the spatial original at the same time.

This is what is called spatial thinking.

The frames from the video for solving the classical Descriptive Geometry tasks are presented below.

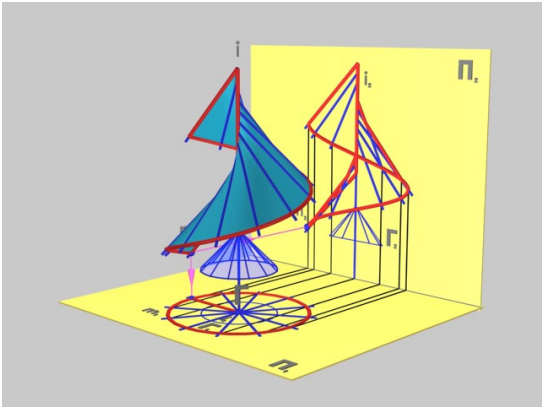

Fig.1. Inclined helicoids

Fig.1 shows the final frame of the video about the inclined helicoid surface formation. The kinematic formation of a surface is demonstrated. The only way to really see the motion of the generatric line and the resulting surface is the video.

Fig.2 shows the final frame of the video with the solution of the classical line-surface intersection problem, which is especially difficult for students to understand. The difficulty here is that they do not see the advantages of an additional mediator plane passing through the apex and intersecting the cone at the generatrices, which can be clearly seen in the video.

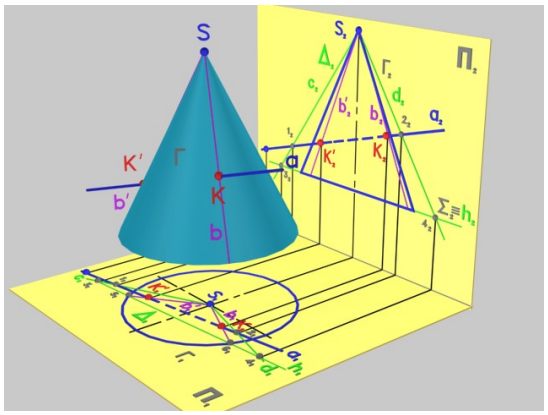

Fig.2. Intersection of a straight line and conical revolution surface

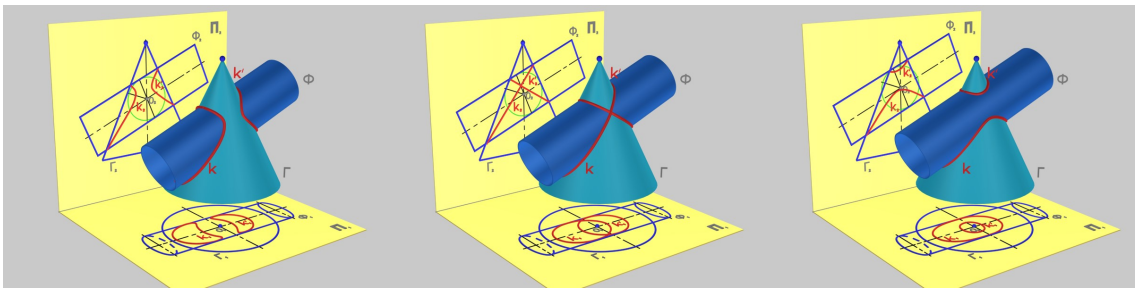

Fig.3. Intersection of conical and cylindrical revolution surfaces

Fig.3 shows three video frames with the conic and cylindrical revolutional surfaces' intersection problem solution by the method of concentric spheres. The conical and cylindrical revolution surfaces' intersection line character change with a slight movement of the cylindrical surface upwards can be clearly seen in the video. The mutual position of surfaces is especially interesting when the Monge theorem is applicable.

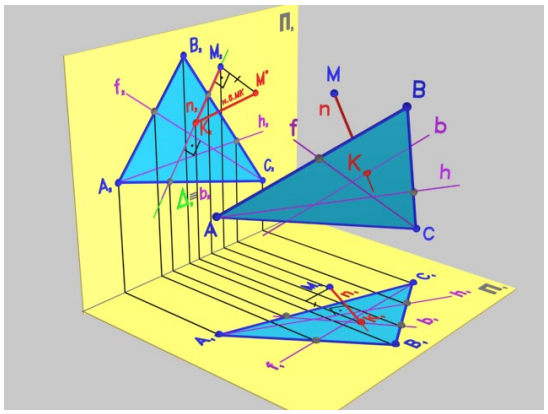

Fig.4. Finding the distance from a point to a plane

Fig. 4 shows the final video frame demonstrating the solution for classical problem of finding the distance from a point to a plane without complex drawing converting.

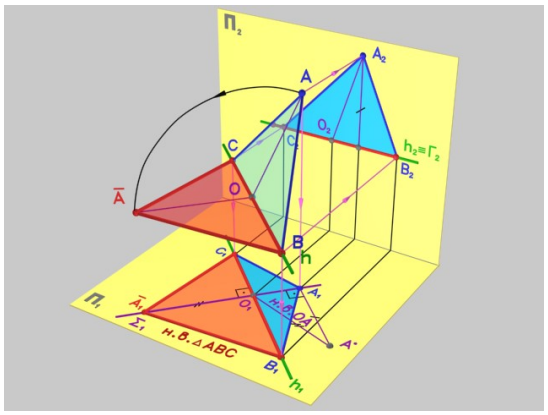

Fig.5. Determining the actual size of a triangle by rotation around the horizontal

Fig.5 shows the final frame of the video demonstrating the solution of the metric problem of finding the triangle's actual size by the method of rotation around the horizontal. Rotation around the horizontal is also a tough thing to understand for the students, so seeing this process on the video replaces a lot of words.

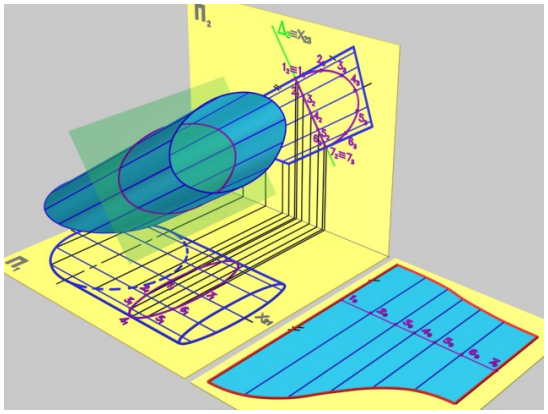

Fig.6. Construction of cylindrical surface developed views

Fig.6 shows the final frame for plotting of a cylindrical surface development by the normal section method. The video shows a gradual unfolding of the surface till aligning it with the plane.

Fig.7 shows the final video frame about the orthogonal isometric projection formation, its relation to the complex drawing, its scaling-up when transforming to reduced isometry and the transformation of circles into ellipses.

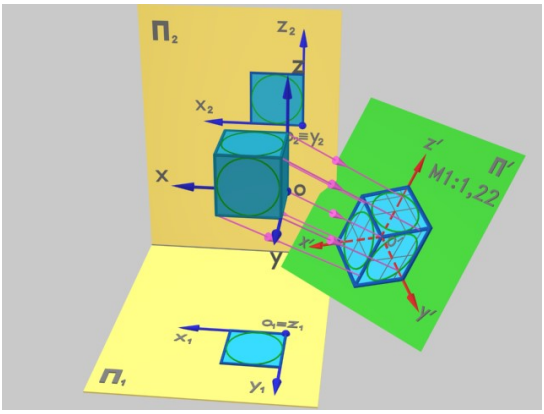

Fig.7. Formation of the reduced orthogonal isometric view

Authors wrote a digital textbook on descriptive geometry. The content of the textbook is a concise summary of the traditional classical course of descriptive geometry. Throughout the course, there are about 140 drawings with the solutions of the most important tasks of descriptive geometry. Each drawing is linked to a video that demonstrates the solution. All this takes place in real time. Why is it useful? Even a teacher can't explain better. A student can always go back and watch the video at any point. Student can see a geometric form in space and a complex drawing simultaneously.

A student can study this new-featured traditional course using any mobile device at anytime and anywhere. This interactive method increases student's interest in the study of Descriptive Geometry.

Currently, the authors are in the process of developing of the mobile app for Descriptive Geometry course study, based on the video course outlined.

4. CONCLUSIONS

For the last four years the authors have taught the Descriptive Geometry course at the RUDN University, using the proposed methodology. Thus, authors were able to run the course 4 times utilizing the new method, improving it and revealing its positive and negative sides. The over-years training has resulted in following conclusions:

a) students' interest in course "Descriptive Geometry" has increased: they almost did not miss lectures and even requested to repeat them;

b) a much better understanding of the subject has emerged in practical exercises;

c) the results of appraisals and examinations have attested the new methodology effectiveness.

5. REFERENCES

[1] Aleksandrova E.P., Nosov K.G., Stolbova I.D. Geometric Modeling as a Tool to Improve the Quality of Graphic Training of Students, Open Education, 2014, 5, 20-27. Available online at: https://elibrary.ru/item.asp?id=22316517

[2] Aygunyan M.A. Methodological aspects of the «Descriptive Geometry» subject teaching. Bulletin of the RUDN University: Engineering Research, 2015, 3, 157-160. Available online at: https://elibrary.ru/item.asp?id=24307502

[3] Aygunyan M.A. Development of spatial thinking by means of information technologies. Scientific Review, 2015, 6, 154-157. Available online at: https://elibrary.ru/item.asp?id=23831604

[4] In collection Aygunyan M.A. Development of spatial thinking by means of information technologies. In the collection: Proceedings of the VIII International Scientific and Practical Conference "Engineering Systems - 2015" RUDN University, 2015, 356-358. Available online at: https://elibrary.ru/item.asp?id=26268293

[5] Bogdanova E.E. Method of teaching descriptive geometry in technical high schools: some aspects of practical training of students. Actual problems of the humanities and natural sciences, 2016, 4-5, 26-28. Available online at: https://elibrary.ru/item.asp?id=26142004

[6] Kaygorodtseva N.V. The emergence, development and current state “graphics and geometry” education. Higher education in Russia, 2013, 4, 112-117. Available online at: https://elibrary.ru/item.asp?id=18968690

[7] Novik N.V. Information technology as a means to improve effectiveness of engineer's professional training (based on the materials of "Engineering graphics” discipline. Society: sociology, psychology, pedagogy, 2016, 8, 88-90. Available online at: https://elibrary.ru/item.asp?id=26538020

[8] Romanova V.A., Oskina G.N. Electronic didactic materials for subject «formation of canonical surfaces». Bulletin of the RUDN University: Engineering Research, 2013, 2, 19-24. Available online at: https://elibrary.ru/item.asp?id=19038334

[9] Stolbova I.D., Aleksandrova E.P., Nosov K.G. Functional information technology in geometry-graphic training of engineers. Open Education, 2017, 1, 59-67. Available online at: https://elibrary.ru/item.asp?id=28418648

[10] Tel'noy V.I., Rychkova A.V. Application of three-dimensional simulation at lecturing on descriptive geometry. Bulletin of the Moscow State University of Civil Engineering, 2014, 5, 176-183. Available online at: https://elibrary.ru/item.asp?id=21495104

[11] Tel'noy V.I., Rychkova A.V. Ensuring the principle of visibility when examining graphic disciplines. Bulletin of the Moscow State University of Civil Engineering, 2015, 11, 202-211. Available online at: https://elibrary.ru/item.asp?id=24871094

[12] Tel'noy V.I. Formation of spatial representation of students in the lessons of graphical disciplines. Bulletin of the Moscow State University of Civil Engineering, 2016, 8, 143-151. Available online at: https://elibrary.ru/item.asp?id=26533925

[13] Volkov V.Y., Kaygorodtseva N.V. On the possible way and problems of development of the discipline "Descriptive geometry". Bulletin of the Siberian State Automobile and Highway Academy, 2011, 20, 93-98. Available online at: https://elibrary.ru/item.asp?id=17882457

How to cite this article:
Aygunyan M A, Shevchenko D V. New Educational Web Resources for the Engineering Course "Descriptive Geometry". J. Fundam. Appl. Sci., 2017, *9(7S), 437-446.*