Sergiu DINTU, Angela SULETEA

THE USE OF SOFTWARE IN DESCRIPTIVE GEOMETRY AND TECHNICAL DRAWING COURSES

Abstract: *The development of information technologies requires the use of software to solve engineering tasks. The study program should provide for the study of this software. According to the current program, it is studied as a separate discipline. We believe that it should be studied in core disciplines as a tool for solving engineering tasks.*
Our goal is to use a teaching methodology for graphic issues by including this software in Descriptive Geometry and Technical Drawing courses. The article presents a method of intercalating these topics that are studied in the first year of study with SolidWorks, AutoCAD and Inventor software.

Key words: *Descriptive Geometry, Technical Drawing, SolidWorks, AutoCAD, methodology*

1. INTRODUCTION

The graphic software is a necessary tool nowadays for any engineer. The study of this software holds a valuable place in the training of specialists in engineering. However, it is usually included in the study program as a separate subject. We consider that graphics applications need to be studied only as a tool for achieving concrete engineering tasks. So, it is necessary to study the various software by applying them to solve the concrete tasks proposed to students in the disciplines "Descriptive Geometry", "Technical Drawing", "Machine Elements", "Mechanisms and Machine Theory", etc. Thus the future specialists will be able to choose the best tool to perform their professional tasks.

2. DESCRIPTIVE GEOMETRY

The Descriptive Geometry is taught in engineering universities. Its role is indisputable in training specialists who will work with technical documentation. The spatial imagination is required for effective work with graphic technical documentation. The main task of Descriptive Geometry is to develop the spatial imagination, which allows them to mentally reproduce a spatial object from a two-dimensional drawing. Graphic software has an important role in this area. In addition, many problems that could be solved only by Descriptive Geometry methods can now be successfully transferred to graphical software [1], [2]. The software provides superior accuracy and reduces the effort and the time required to solve these tasks.

We have developed a curriculum that combines the study of Descriptive Geometry with the study and use of SolidWorks software. SolidWorks is being studied by mechanical students in the second and third year of study. The optimization of the Descriptive Geometry study program would allow the use of three-dimensional models to facilitate understanding of the orthographic projection, and the use of theoretical concepts of Descriptive Geometry to determine such elements like curves, lines, and curved surfaces in SolidWorks.

Thus we could reduce the time spent studying manual methods to solve complex graphical problems in favour of computerized methods [3], [4]. Traditional methods will only be used to solve elementary problems.

The use of the spatial model of the body (fig. 1) viewed on a computer, reduces the study time by combining "Orthogonal projections of lines" and "Projections of planes" in the lecture "Orthogonal projections of the body".

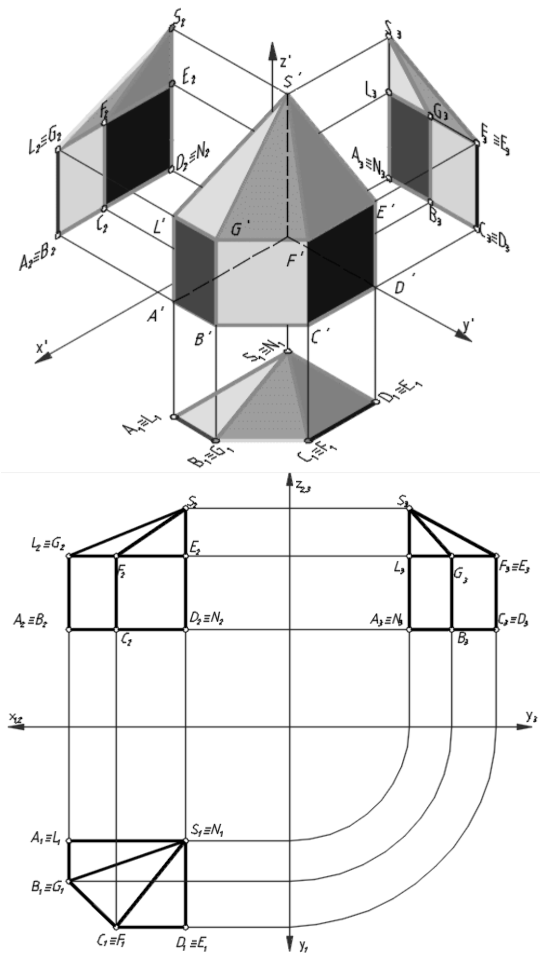

Fig. 1 Orthographic projection of the body.

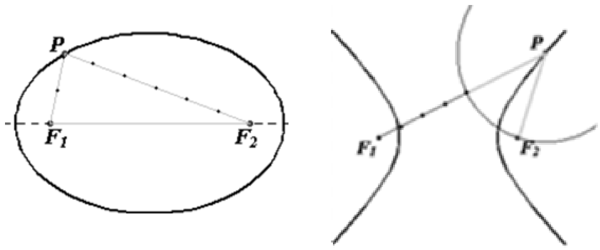

Fig. 2 Dynamic definition of curved lines.

We consider during the course planes (faces) and straight lines (edges) positioned differently, both general and particular.

The Descriptive Geometry methods for plane determination are the theoretical basis of the SolidWorks Reference Geometry compartment. The combination of these subjects in a single block allows both the conscious choice of the reference for the determination of the plans, as well as the space visualisation, and the designing of the chosen plans.

Particular attention will be provided to the study of curved lines. To facilitate their understanding, we rely on dynamic methods for defining curved lines (fig. 2). It is necessary to study deeply the types of flat and spatial curved lines and their properties.

The parameters that determine the shapes and dimensions of the 2D and 3D splines will be studied more detailed.

The curve surface definition mode studied in Descriptive Geometry will be applied when you create them in SolidWorks. In the laboratory works, various curved lines will be obtained as a result of flat sectioning of the curved surfaces (fig. 3).

Fig. 3 The flat section of the cone.

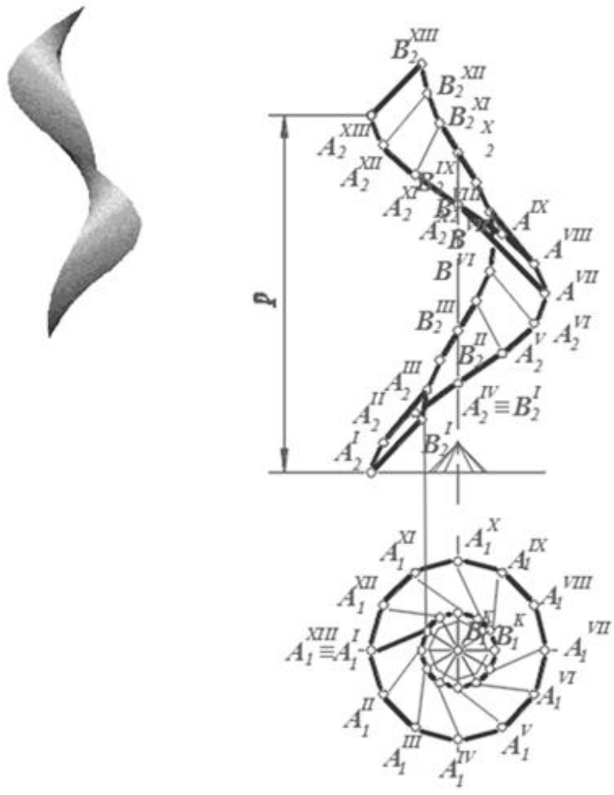

Fig. 4 Curved surfaces.

In the "Curved Surface" topic we analyse the dynamic methods of creating curved surfaces. These methods will apply to create surfaces in SolidWorks. We have created a 3D library to simplify the process of studying the formation and representation of curved surfaces. It contains the classification of curved surfaces and their representations in space and in orthographic projection (fig.4).

The interactive 3D models can be viewed in Acrobat Reader. The software allows such models to be rotated in space, cut, viewed as an image (including invisible lines) or as a carcase.

The topics “Flat sections” and “Surface intersection” will contain only general theoretical concepts, which will be illustrated with specific cases. To define the intersection lines manually, only the method of parallel auxiliary planes will be used. SolidWorks tools will be used for more complex tasks, which are specific cases and used to be solved in Descriptive Geometry by methods of concentric or eccentric spheres.

The theoretical material of the topic “Positional problems” and “Metric problems” can be significantly reduced by limiting it to general cases only.

Hence we will consider in the topic “Surface development” the calculation of the precise developments of simple bodies and the particularities of the developable and non-developable surface. The computer will solve other types of problems. The lines constructed by SolidWorks are definitely highly accurate, which is impossible to obtain using the traditional Descriptive Geometry methods.

3. TECHNICAL DRAWING

Besides we have created a new program by combining the disciplines "Technical Drawing" and "Infographics".

This program examines both the technical drawing rules and the tools necessary to perform graphical tasks [5]. The elaborated graphical tasks develop manual drawing skills, as well as the skills to use advanced graphics software tools. Practical lessons are divided into pencil-based seminars and laboratory work during which students work on computers.

Manual drawing skills are required for an engineer, for example, when drawing up sketches. Geometrical constructions - filleting, construction of tangents, division of circles, angles and segments cannot be omitted from the training of an engineer. The fillet made with the compass makes the students understand the essence of the notions as a centre and pairing point of fillet, the common tangent of two arcs, etc.

The manual construction of the lateral projection of a body from two given projections is aimed to familiarize with the projective connection between the projections, the transfer of coordinates from one projection to another. The algorithm for building the third projection using the coordinates is very important at the initial stage of studying the technical drawing, when students cannot rely on spatial imagery.

The drawing of the gasket is done both in pencil and computer. Drawing on a computer demonstrates the benefits of using graphical software. Students learn to use AutoCAD software as a tool for technical drawings. We teach them to use various 2D drawing and editing tools in laboratory sessions.

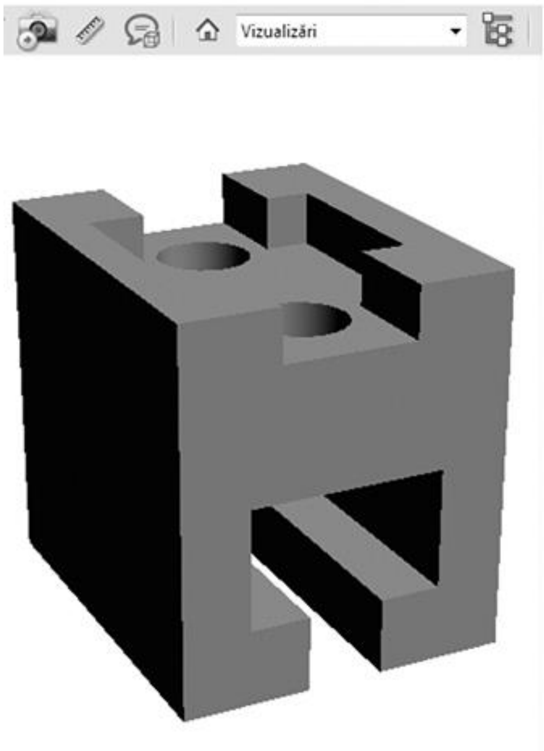

Fig. 5 Interactive 3D model.

Fig. 6 Cutting the interactive 3D model.

Drawings for "Views", "Sections", "Offset section" are performed in AutoCAD. Knowing about the possible lack of spatial imagination, tasks on these topics were supplemented with interactive 3D models in PDF format (fig. 5).

To create the 3D PDF files there was implemented three-dimensional models using the Inventor software. Inventor 2017 and 2018 include new features that allow direct 3DPDF spaceport export. Models created with Inventor can contain pre-set views that can be selected by the student in the 3DPDF file review process. For assemblies, it is possible to display or hide assembly components. PDF files are able to support fully interactive three-dimensional spatial and temporal content.

We've made 30 variants of 3D models for each of the topics "Views", "Sections", "Offset section" in the Inventor software and exported them to 3D PDF format [6]. This format, which can be opened with Acrobat Reader, allows students to cut and view the piece from different parts (fig. 6).

Besides of that the students learn in the lab a new way of working in AutoCAD called 2.5D drawing to make an axonometric projection of the body. We offer them a simple algorithm that allows getting an intuitive drawing. We also consider it useful for our students to study how to create parametric drawings and dynamic blocks. The gear drawing is executed as a parametric drawing in which the dimensions are expressed by the functions of the parameters m and z.

This type of design changes its aspect and dimension values when changing the value of the m and z parameters. In addition, we teach students how to create interactive tables that automatically calculate the other gears parameters. We use dynamic blocks as a tool for making drawings of standard parts. As a result, students create a library consisting of dynamic blocks of assembly parts, which we use in the laboratory work " Demountable Joints ".

The difficulty of these two topics is increased, so we allow them to perform the work ordinary without the use of blocks and parameterization. We have developed a grading scale that favors students who manage to use these drawing methods. We allow students to choose how to draw drawings - manually or in AutoCAD in individual works on the "Additional Sections" and "Permanent Connections " subjects.

We introduced into our course the principles of creating and editing three-dimensional models. We manage to teach only the general methods of creating and viewing parts. However, the studied methods can be applied by students to modelling simple parts in both AutoCAD and Inventor.

4. CONCLUSION

The purpose of the created courses is not only to teach students the rules for presenting machine parts in accordance with the standards but also to offer various tools for solving engineering tasks.

The proposed program will contribute to the development of students' spatial imagination and will allow them to resolve engineering problems. In addition, we propose students to use software to solve various problems with increased accuracy.

We consider the benefits and areas of using AutoCAD or Solid Works during class. The proposed program combines the theoretical knowledge gained in the Descriptive Geometry course with the possibilities offered by these programs in order to make the most complete and correct use of their tools. As mentioned earlier, we allow students to choose how to draw the latest drawings - manually or using computer.

The practice has shown that towards the end of the semester all students traditionally choose computer-executed drawings.

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Authors:

Sergiu DINTU, Head of Department, Technical University of Moldova, Department of Descriptive Geometry, Technical Drawing and Infographics, E-mail: sergiu.dintu@gddti.utm.md;

Angela SULETEA, university professor**,** Technical University of Moldova, Department of Descriptive Geometry, Technical Drawing and Infographics, E-mail: angela.suletea@gddti.utm.md.