Ramona CLINCIU, Mihaela Rodica CLINCIU

APPLICATIONS USED IN TEACHING TECHNICAL DRAWING FOR DEVELOPING THE SPATIAL ABILITY OF THE STUDENTS

Abstract: *The paper presents applications developed for teaching technical drawing. The purpose of the applications presented is to develop and improve the spatial ability of the students and their spatial perception of the objects. These applications are focused on the definition of the shape of the parts and their graphical representation, by considering the elements taught in the descriptive geometry course.*

Key words: *Orthogonal projection, axonometric projection, technical drawing, plane, spatial perception.*

1. INTRODUCTION

The paper presents applications which may be used in teaching technical drawing, based on the elements taught in the descriptive geometry course. These applications are intended to link the elements already studied in the descriptive geometry course with the elements which are required for constructing the orthogonal projections of different type of objects. The aim of the applications developed is to help students improve their spatial ability and to develop their skills towards understanding the shapes of different types of objects and the way they are to be projected on the planes of projection.

The descriptive geometry course is taught usually in the first semester of the first year of the university studies. At the end of this course, the spatial abilities of the students, acquired due to this course, should offer them the capacity for understanding the connection of the spatial shape of simple objects and their orthogonal projections on the three planes of projection considered - the horizontal plane of projection [H], the vertical plane of projection [V] and the profile plane of projection [L].

Graphical representation of different types of parts is considered to be a very important issue in teaching technical drawing. Students need to learn how to construct and arrange the orthogonal projections of a certain part. They should learn how to represent a given part using a minimum number of orthogonal projections needed for completely defining the part in terms of shape and dimensions, according to the standards prescriptions. At the same time, they need to develop skills for associating fast the given orthogonal projection(s) for a part with its appropriate spatial representation, the axonometric projection.

The applications presented in the paper are intended to make the connection between the minimum numbers of orthogonal projections given, projections which are needed for defining the respective part, and the appropriate spatial representation/axonometric projection of the part considered. They use the experience of the author in teaching graphical subjects. and come to continue and complete other applications which have already been developed for teaching both descriptive geometry and technical drawing [1], [2], [6], [7], [8], applications which can be applied in teaching any other subject which considers graphical representations.

2. GRAPHICAL REPRESENTATIONS OF PARTS

In teaching technical drawing, one of the most important issues is the graphical representation of parts, with all the elements resulting from it: orthogonal projections, projections arrangement and axonometric projections [3], [4]. At the beginning, students learn to construct and arrange the orthogonal projections of a certain part, given its spatial shape and then, they learn to construct the spatial representation, by means of the axonometric projection of the part, given the minimum number of orthogonal projections needed for completely defining the part in terms of shape and dimensions. Then, by gaining enough experience, they need to construct the spatial representation/axonometric projection of the part, starting from a minimum number of orthogonal projections given for the respective part [4], [5].

A problem to be solved continuously is to connect the spatial representation of an object with its appropriate orthogonal projections (Figure 1). Direct observation of an object or its axonometric projection should enable the construction of the appropriate orthogonal projections. On the other side, the given orthogonal projections of an object should enable the imagination of the spatial shape of the object and then, if needed, the construction of its axonometric projection. A way to accomplish these elements is to observe the surfaces defining the outline of the considered part and to consider their position towards the planes of projection.

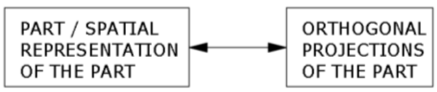

Figure 1 A problem to be solved in teaching technical drawing.

Since different types of planes were studied in the previous semester, the first thing to start with is a revision of all types of planes parallel or perpendicular to the planes of projection. Students are asked to consider a rectangle and to place it in parallel and then, in perpendicular positions to any of the three planes of projection. In order to simplify the revision and to produce a more important impact for the perception of the position and the projections of all these planes, students are asked to project the rectangle on the three planes of projection, for each case considered.

The projections of a rectangle parallel to the horizontal plane of projection [H] are presented in Figure 2, while Figure 3 presents the case of a rectangle parallel to the vertical plane of projection [V] and Figure 4 presents the case of a rectangle parallel to the profile plane of projection [L].

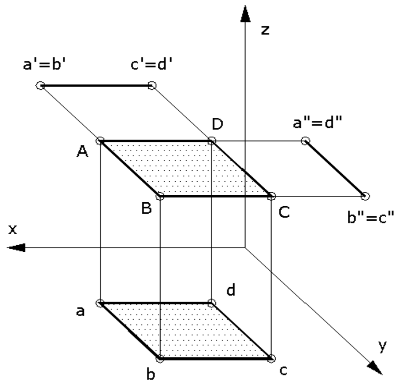

Figure 2 Case of a rectangle parallel to the horizontal plane of projection [H].

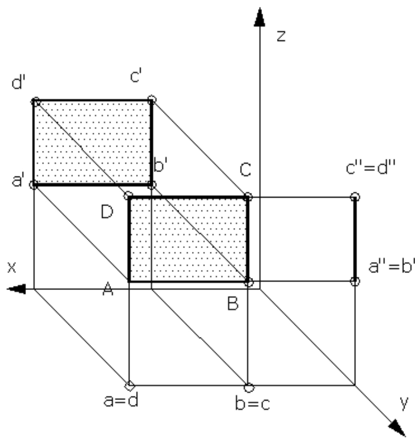

Figure 3 Case of a rectangle parallel to the vertical plane of projection [V].

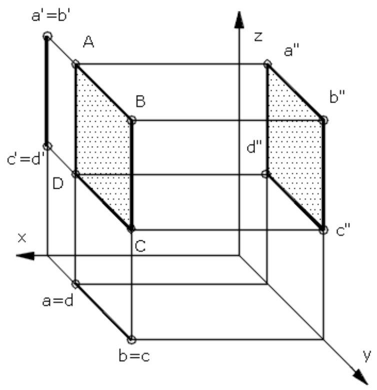

Figure 4 Case of a rectangle parallel to the profile plane of projection [L].

Figures 5, 6 and 7 present the cases of a rectangle perpendicular to the horizontal plane of projection [H], to the vertical plane of projection [V] and to the profile plane of projection [L], respectively.

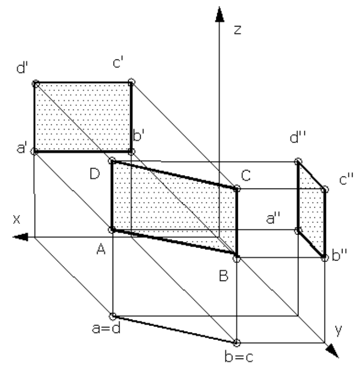

Figure 5 Case of a rectangle perpendicular to the horizontal plane of projection [H].

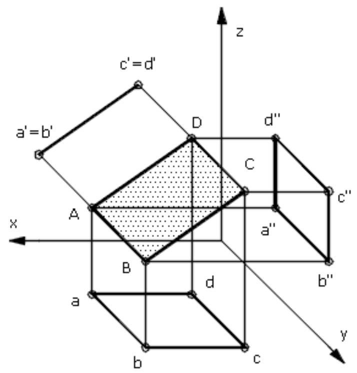

Figure 6 Case of a rectangle perpendicular to the vertical plane of projection [V].

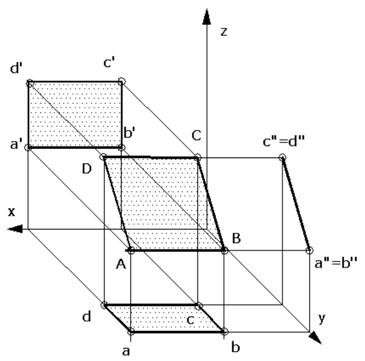

Figure 7 Case of a rectangle perpendicular to the profile plane of projection [L].

The next objective to be accomplished is to identify these different types of planes, parallel or perpendicular to the planes of projection, for a considered part (Figure 8).

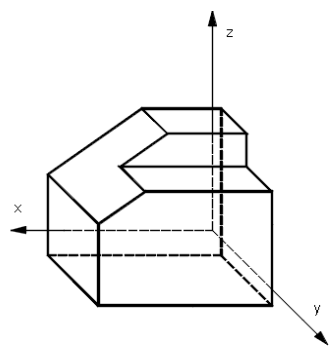

Figure 8 The part considered.

The surface of the considered part is decomposed into different types of planes with certain positions towards the planes of projection, parallel to the planes of projection [V], [H] and [L], respectively (Figures 9, 10 and 11), or perpendicular to plane [V] (Figure 12).

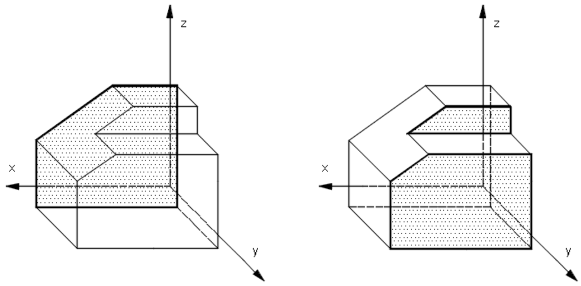

Figure 9 Surfaces parallel to the vertical plane of projection [V].

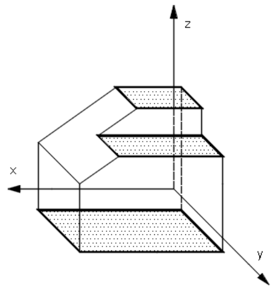

Figure 10 Surfaces parallel to the horizontal plane of projection [H].

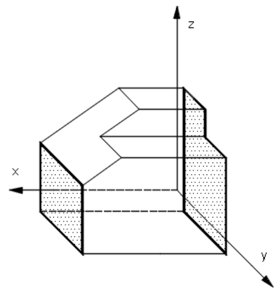

Figure 11 Surfaces parallel to the profile plane of projection [L].

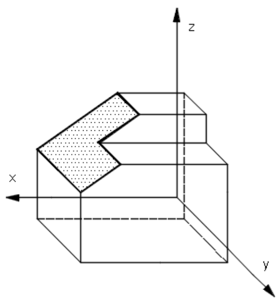

Figure 12 Surface perpendicular to the vertical plane of projection [V].

Students are asked to construct three orthogonal projections (Figure 13) for the part in Figure 8 and then to find the appropriate projections for all the surfaces presented in the drawings above. In this way, they learn how to recognize/identify different types of planes by considering a certain 3D projection. Also, they learn to make the connection between the spatial representation of an object and its appropriate orthogonal projections.

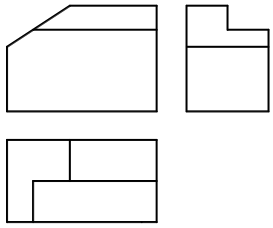

Figure 13 Orthogonal projections for the part in Figure 8.

In teaching technical drawing, the connection of a given 3D shape of a part with its appropriate orthogonal projections, which need to be constructed, seems to be much easier than the inverse connection, that one which links the orthogonal projections of a certain part with its spatial representation/axonometric projection, which needs to be constructed this time (Figure 1). It seems to be more difficult to imagine and to represent the 3D shape, the axonometric projection of a part by considering its orthogonal projections, in minimum number, as required by the standards. Students need to identify, in the given orthogonal projection, plane shapes parallel to the planes of projection, which are projected in true size, but also plane shapes perpendicular to the planes of projection, which are projected partially deformed on the other two planes of projection and totally deformed on the plane of projection to which they are perpendicular.

Students need to establish the solid in which the part is to inscribed and then, by considering different plane shapes, placed in parallel or perpendicular position towards the planes of projection, they can obtain the final 3D shape of the object. In this way, they learn how to recognize/identify different types of planes by considering a certain 3D projection. Also, they learn to make the connection between the spatial representation of an object and its appropriate orthogonal projections. The following examples present the cases of two parts defined by two orthogonal projections. Part 1 is defined by main view and top view (Figure 14).

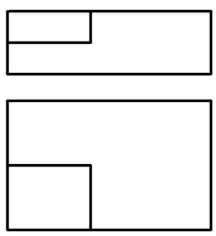

Figure 14 Orthogonal projections of part 1.

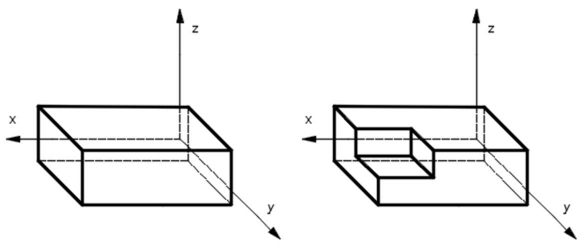

Figure 15 The solid in which part 1 is inscribed and the spatial representation of part 1.

The solid in which part 1 is inscribed and the spatial representation of part 1, the one that needs to be constructed by the students are presented in Figure 15. Figure 16 indicates the way one can identify the plane shapes which are parallel to the planes of projection [V] and [H], respectively, according to the orthogonal projections in Figure 14.

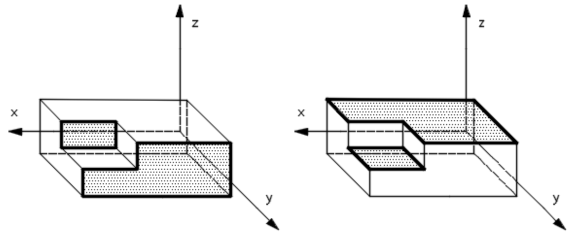

Figure 16 Identification of plane shapes parallel to the planes of projection [V] and [H], respectively.

Part 2 is defined by main view and left-hand view (Figure 17). Figure 18 presents the solid in which part 2 is inscribed and the spatial representation of part 2, the one that needs to be constructed by the students. Figure 19 help students to identify the plane shapes which are parallel to the planes of projection [V] and [L], respectively, or perpendicular to plane [V] according to the orthogonal projections in Figure 17.

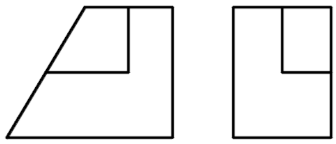

Figure 17 Orthogonal projections of part 2.

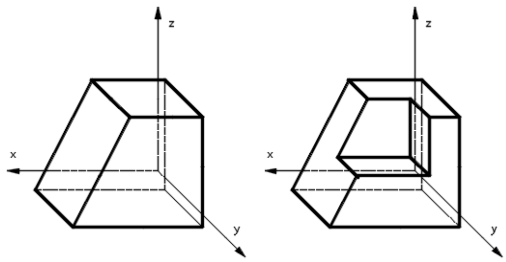

Figure 18 The solid in which part 2 is inscribed and the spatial representation of part 2.

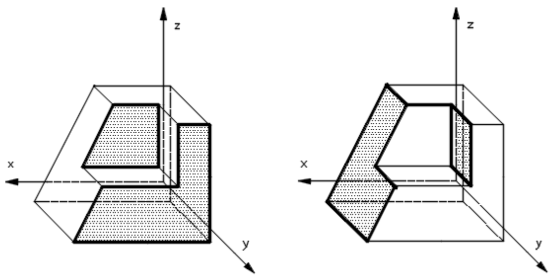

Figure 19 Identification of plane shapes parallel to the planes [V] and [L], and a plane perpendicular to [V].

The applications presented in the paper intend to present solutions for the problems connected with the case in which a minimum number of orthogonal projections of a part are given and the spatial representation/axonometric projection of the part needs to be constructed, by using an appropriate method [3].

3. CONCLUSIONS

The paper presents applications intended to help students make the connection between the orthogonal projections of a part and its spatial shape. It is a rather difficult problem to solve by most of the students and it needs to be considered in order to develop or improve the spatial perception of the students. The applications help students understand the shape of any part represented in orthogonal projections and they help them associate the projections of the part with its axonometric projection describing the spatial shape of the part.

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Authors:

Prof. Ramona CLINCIU, Transilvania University of Braşov, Department of Manufacturing Engineering, e-mail: r.clinciu@unitbv.ro

Lecturer Mihaela Rodica CLINCIU, Transilvania University of Braşov, Department of Manufacturing Engineering, e-mail: clinciumr@unitbv.ro