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METHOD FOR TEACHING GRAPHICAL REPRESENTATION OF PARTS IN TECHNICAL DRAWING

Abstract: *The paper presents applications meant to develop and improve the spatial ability of the students and to enable and develop their spatial perception of the objects. These applications are oriented on the definition of the spatial shape of the parts and the representation of their axonometric projections, given the minimum number of orthogonal projections necessary for completely defining the respective parts.*

Keywords: *Orthogonal projection, axonometric projection, technical drawing, spatial ability, projection.*

1. INTRODUCTION

The proposed paper presents applications designed such as to enable, gradually, the development of the graphical perception of the students. Also, the purpose of the applications presented is to help students understand the representation of the orthogonal projections of different types of parts, as well as their connection with the appropriate spatial shapes of the parts, enabling the construction of their axonometric projections. The purpose of these applications is represented by the development and improvement of the spatial ability of the students and, at the same time, the development of the skills needed for associating fast the given orthogonal projection(s) for a part with its appropriate spatial representation and then, with its axonometric projection.

Graphical representation of parts is very important in teaching technical drawing and the applications developed should reveal to the best advantage the spatial shape of the part taken into account; on this purpose, the spatial representation of the parts, which is used by the teacher when presenting the necessary issues for the appropriate class/laboratory, was achieved based on the facilities of 3D Studio MAX program [1] – the rendering, mapping and animation techniques and by using the AutoCAD program. The applications presented in the paper are focused on the connection between the given orthogonal projections of a part - the minimum number of projections needed for defining the respective part, and the appropriate spatial representation/axonometric projection of the part considered. In the considered applications, important issues taught in the descriptive geometry course are presented in a more practical manner, such as to connect them with the elements to be taught in technical drawing. At the same time, the applications presented use the experience of the author in teaching graphical subjects.

The applications which are presented in this paper come to continue and complete other applications designed on the same purpose - development and improvement of the spatial ability of the students, applications which have been developed for teaching technical drawing, [2], [3], [6], [7], [8], but they can all be very easily applied in teaching both technical drawing and any other subject involving graphical representations.

2. GRAPHICAL REPRESENTATION OF THE PARTS

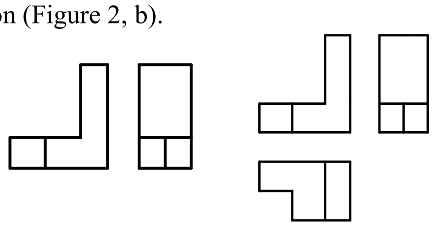
In teaching technical drawing, the first chapter to start with is the one concerning the drawing standards. The following chapter is the one dealing with the graphical representation of parts, orthogonal projections, projections arrangement and axonometric projections [4], [5]. Students learn how to construct and arrange the orthogonal projections of a certain part, by placing the part inside the projection cube. In order to construct the orthogonal projections of a part, students are taught that they should place the part such as most of the faces of the part are parallel to the planes of projection; in this way, the surfaces of the part parallel to the planes of projection will be projected in true size on the appropriate plane of projection. Also, students are taught that a part should be represented using the minimum number of orthogonal projections needed for completely defining the part in terms of shape and dimensions, according to the standards prescriptions.

When teaching graphical representation of parts, there are two directions to consider; the first one deals with the connection of a given 3D shape of a part with its appropriate orthogonal projections, which need to be constructed; the second direction deals with the connection of a minimum number of given orthogonal projections of a certain part with its spatial representation/axonometric projection, which needs to be constructed. 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 [2].

In the classical method, the laboratories are developed in the following way: the teacher presents the fact that the goal to be reached is to draw the 3D shape of a part/the axonometric projection, given two orthogonal projections of the respective part (usually, prismatic parts are considered). Also, it is required to be constructed the third orthogonal projection of the part, as well. An example is performed by the teacher and then, students have to solve similar problems individually. With all the explanations/examples given, this laboratory appears to be one of the most difficult to lead, due to the low level of the spatial ability of the students and their lack of experience in the graphical domain. The background of the students, related to the graphical representation of the parts, is limited to that achieved during the descriptive geometry course. A problem to deal with appears in case the descriptive geometry subject is taught in parallel with the technical drawing subject, because, in this case, students do not have the necessary background to start with in technical drawing. The present paper proposes as a solution to solve partially the problem presented above, to reconsider, in more practical examples, important issues learned or about to be learned in the descriptive geometry classes and to connect them with the elements needed for accomplishing the goal set for the technical drawing laboratory. Usually, in the descriptive geometry course, the elements to be taught - points, lines, plane shapes, are presented in most cases in orthogonal projections, they are not represented in space; in most cases, it is assumed that students can imagine the way the respective item is placed in space, in a 3D system of projection. In the applications presented in the paper, the plane shapes in which the surface of a part can be decomposed are drawn in space and projected on the three planes of projection.

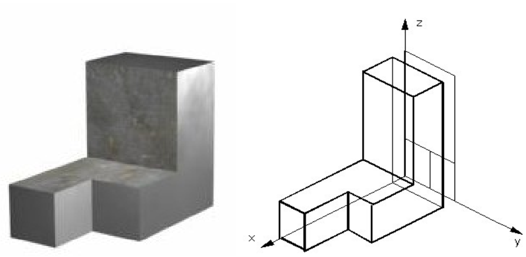
The first application considers two orthogonal projections of a prismatic part having all the surfaces parallel to the planes of projection (Figure 1). As long as the given orthogonal projections contain lines/surfaces parallel to the planes of projection, there are no major problems with the construction of the third projection of the part and the axonometric projection of the part.

Figure 1, a presents two orthogonal projections given for a part – front view and left-hand view. Students are asked that, starting from these two given projections, to determine the third projection of the part – the top view (Figure 1, b) and then, to sketch the 3D shape of the part (Figure 2, a) and to construct the axonometric isometric projection (Figure 2, b).



a b

Fig. 1 Orthogonal projections for a part.



a b

Fig. 2 The 3D shape and the axonometric projection of the part.

In constructing the third projection of a part – top view, one can consider the projections of a rectangle parallel to the horizontal plane of projection [H] (Fig. 3).

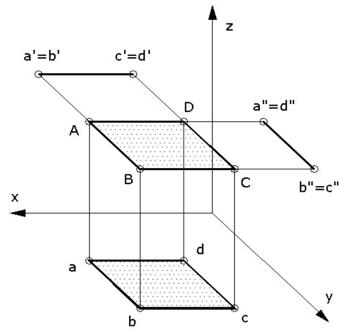


Fig. 3 Orthogonal projections of a rectangle parallel to the horizontal plane of projection.

The next application consideres two orthogonal projections of a part containing intersecting surfaces, inclined to the planes of projection: two symmetrical faces perpendicular to plane [V] and a face perpendicular to plane [L] (Figure 4).

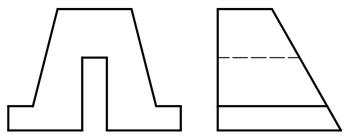


Fig. 4 Orthogonal projections for a part.

The construction of the third projection of the part is difficult to achieve for most of the students, so that they need some explanations to help them manage the problem. The method which gave the best results is described as follows:

- one considers a surface, a rectangular trapezoidal shape [ABCD], perpendicular to plane [V], being contained in a vertical projecting plane (Figure 5). The horizontal and profile projections are partially deformed, they preserve the shape of the surface, while the vertical projection is totally deformed (line segment);

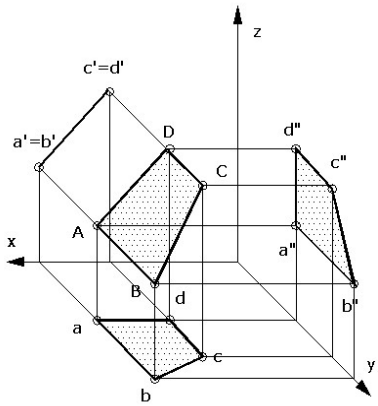


Fig. 5 Projections of a rectangular trapezoidal surface perpendicular to plane [V].

- one considers a surface, a rectangular trapezoidal shape [ABCD], perpendicular to plane [L], being contained in a profile projecting plane (Figure 6). The vertical and horizontal projections are partially deformed, they preserve the shape of the surface, while the profile projection is totally deformed (line segment);

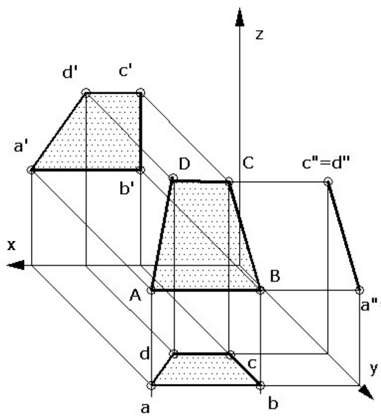


Fig. 6 Projections of a rectangular trapezoidal surface perpendicular to plane [L].

- one considers a part containing a rectangular trapezoidal shape [AFED], perpendicular to plane [V] and a rectangular trapezoidal shape [ABCD], perpendicular to plane [L] (Figure 7). The horizontal projection of the part contains the horizontal projections, partially deformed, of both surfaces. The part is presented in Figure 8.

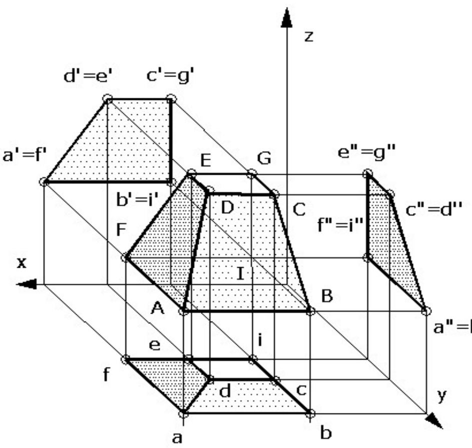


Fig. 7 Projections of a rectangular trapezoidal surface perpendicular to plane [L].

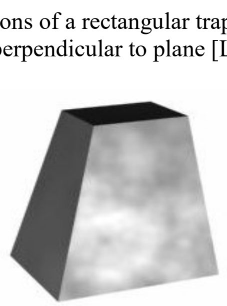


Fig. 8 Part with intersecting inclined surfaces.

By performing the example presented above, the construction of the horizontal projection of the part described in Figure 4 is more simplified. When constructing the top view of the part, besides considering surfaces in the shape of rectangles parallel to plane [H], surfaces which are projected in true size on plane [H], one constructs the projections on plane [H] of the partially deformed shapes of the surfaces of the part which are perpendicular to plane [V] and [L] respectively. Figure 9 presents the three views obtained for the part considered, shown in Figure 10.

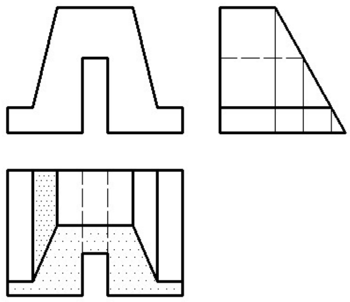


Fig. 9 Orthogonal projections for the part in Figure 10.

Fig. 10 The 3D shape of the part.

A very important issue in the graphical representation and modelling of the parts is represented by the construction of the axonometric projection of the part which describes the 3D shape of the considered object. Figure 9 presents the given orthogonal projections of the object. The axonometric projection of the part can be achieved by using the method of extrusion, as described in [2], [7]. By extruding along a certain direction, on a certain length, a closed outline described by one of the given orthogonal projection, one obtains a solid which can be modified such as to obtain the part.

Figure 11, a, b, c, d presents the necessary steps for accomplishing the axonometric projection of the part in Figure 10. Students are offered an example such as to enable them to understand gradually the construction of the axonometric projection of the part. At first, one starts from the two given orthogonal projection – front view and left-hand view, drawn by respecting the full size scale, using the axes of the axonometric system (Figure 11, a). Then, one can construct the axonometric projection of each rectangle parallel to plane [H], defined by the appropriate projections (Figure 11, b). By joining the appropriate points of the rectangles, as in Figure 11, c, one obtains the axonometric projection of the part (Figure 11, d).

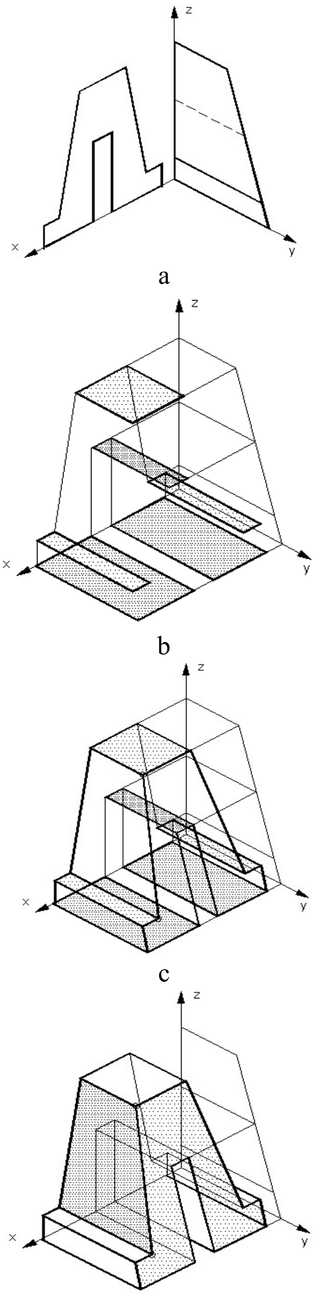


Fig. 11 Steps for drawing the axonometric projection.

The axonometric projection of the part reveals the shape of the inclined surfaces of the part, so that students can verify and associate both the axonometric projection with the top view of the part, verifying the shapes of the projections of these surfaces.

The applications presented can be extended for parts for which the two orthogonal projections given are the front view and top view and students need to construct the left-hand view, case in which one should consider to project at first, the surfaces parallel to plane [L].

3. CONCLUSIONS

The paper presents applications focused on the construction of a third projection of a part, once two projections of the considered part are given, and, on the construction of the axonometric projection of the part, by using an appropriate method. The applications help students develop and improve their spatial skills such as to understand the shape of any part represented in orthogonal projections on a technical drawing, in the minimum number of orthogonal projections needed for completely defining it, and also to associate the projections of the part with its appropriate axonometric projection which describes the spatial shape of the part.

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