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CONSIDERATIONS REGARDING THE APPLICATION OF THEORY IN PROBLEM SOLVING SPATIAL PROJECTION OF INTERSECTIONS OF SIMPLE OBJECTS

Abstract: *This paper presents how descriptive geometry contributes to the achievement of intersections of simple objects and isometric axonometric representation of these intersections. It also highlights the role of descriptive geometry on acquiring skills in Technical Drawing, in representation of objects intersection.*
All illustrations in this paper are made using Microsoft Office Word Drawing Toolbar and AutoCAD software.

Key words: *pyramid, cube, cylinders, planar representation, intersection, isometric axonometric representation*

1. INTRODUCTION

Graphical language is a natural and basic way to communicate the ideas and technical concepts based on norms and rules imposed by standards established approved by national and international organizations. Knowing the rules, regulations, principles and methods of graphical representation, the engineers and designers are able to provide solutions correlating their work with mathematical precision, having as results objects, parts, and high quality finished products (machine elements, mechanisms, installations, buildings etc.). Therefore, it does not matter if the graphical representation of an object is performed by conventional means, on the drawing format or computer aided. It is very important for the engineers and designers to master the graphical language for design underlying the preparation of technical documentation for the object execution.

The drawings shown in the figures 1, 2, 4, 6 and 8 are executed with the tools of Microsoft Word Drawing program (MWDT), simulating the traditional methods of working, and those from the figures 3, 5, 7 and 9 are executed with modern tools, using AutoCAD (ACAD).

The choosing of AutoCAD program as a specific program for graphical representation aided by computer is justified by the widespread of this technique in the engineering field, as well as, by the variety of solutions regarding the issues of technical landmarks design.

2. THEORETICAL CONSIDERATIONS

The theoretical basis of the technical representations is provided by studying of the descriptive geometry that develops the ability ñto see and think in spaceò of the future engineers.

The Descriptive Geometry forms and also develops the capacity for abstraction of the objects that will be represented, allowing the replacement by similarity of the complex components with basic geometric shapes and the application of the principles necessary of correct graphical representation of an object or set of objects.

The objects from space can be represented two-dimensional by plane projections or three-dimensional, in the perspective. The second case consist of careful observation of the plane projections by the designer, combinations of these, and intuiting the volume of that object. Axonometric representation is a graphical representation method that allows correct understanding of object from space through the fact that a single image shows all the forms and dimensions of that object.

3. PRACTICAL CONSIDERATIONS

In the figure 1 there are presented two projections of the intersection of a cube with 60 mm side, positioned the vertically inner diagonal and a right hexagonal pyramid with the height h = 120 mm, having the horizontal projection the same as of the cube [4].

The intersection is penetration type one because they are intersecting by two closed spatial polygonal lines formed by the set of common points of the surfaces of two bodies. In order to determine the intersection there are assumed the coplanar points and the auxiliary surfaces are used. These surfaces are chosen so that the intersection of the two surfaces to be clear and easy to build.

There are drawing a face of the cube (fig. 1), *abcd*, there are plotting the *ac* diagonal that is bended on the horizontal plane. From the resulted point, *e*, a vertical line is drawing. The *dc* side of the face of the cube is extended until it intersects the vertical from *e* and it notes with *f* the new point of intersection. There are bonding *a* and *f*, in this way finding the length of inner diagonal of the cube.

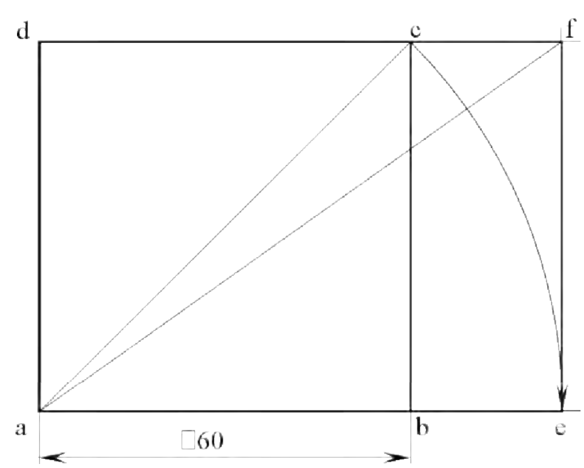

Fig. 1 Determining the size of the diagonal of the cube

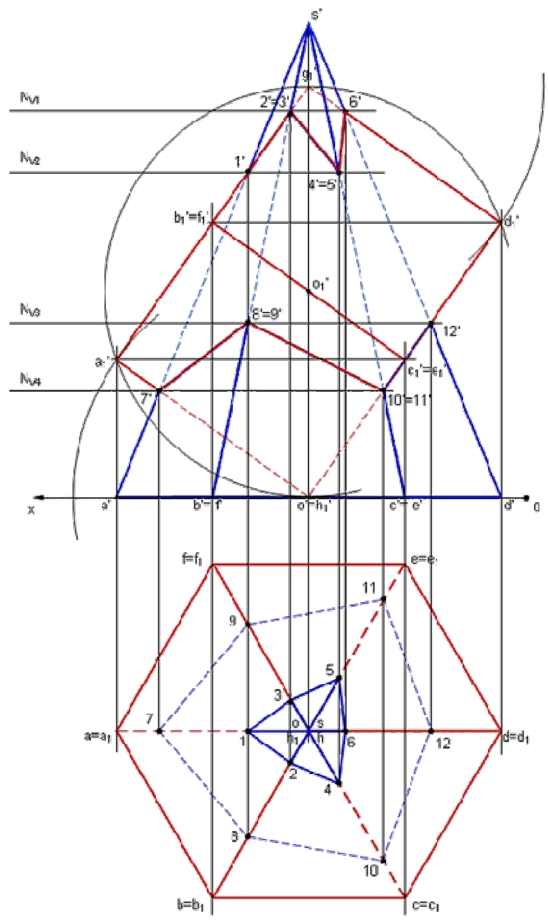

Fig. 2 The projections on the planes [V] and [H] of the intersection between the pyramid and cube (MWDT)

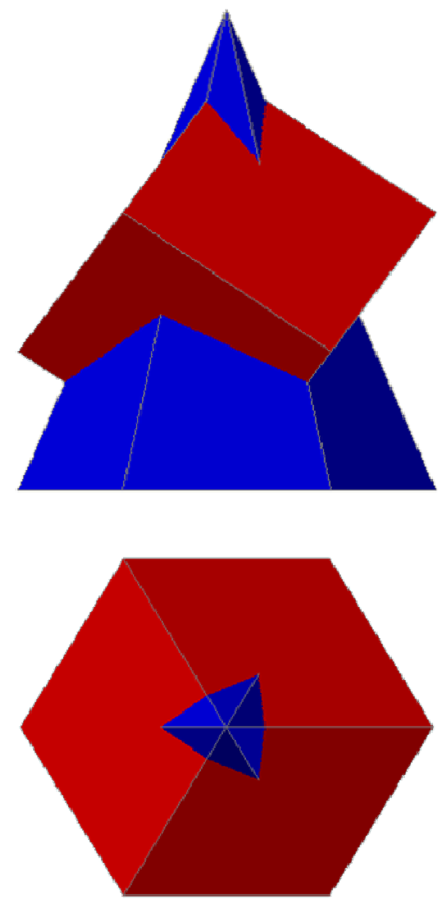

Fig. 3 The projections on the planes [V] and [H] of the intersection between the pyramid and cube (ACAD)

Due to the fact that there are working at 1: 1 scale, the inner diagonal of the cube can be measured directly from the drawing and it could be represented vertically on the plane [V] ($h_1'g_1'$, of figure 2). It is known that the rectangle formed falls into a circle that is centered on the diagonal, at the half them.

It is figured the circle with center in o_1' and radius $o_1'g_1' = o_1'h_1'$. With center in h_1', is drawn an arc of radius of 60 mm (side of cube), until the intersection with the circle of radius $o_1'h_1'$, resulting the point a_1' ($a_1'h_1' = 60$ *mm*). The procedure for obtaining the point d_1' is the same (the arc with the center in g_1' and radius of 60 mm).

It is tracing the sides of the rectangle ($h_1'a_1'$, $a_1'g_1'$, $g_1'd_1'$, $d_1'h_1'$), representing the vertical projection of the cube with the internal diagonal positioned perpendicular on the [H], at a point *H1* (fig. 4), which belongs to this plan. By o_1', is drawn a parallel line to the sides $h_1'a_1'$ and $g_1'd_1'$, representing the visible edge, B_1C_1 of the cube on the plane [V]. This edge of the cube overlaps over the F_1E_1 edge.

It is represented the pyramid knowing that: the base of the pyramid, on the plane [H], coincides with the horizontal projection of the cube, and the pyramid height is 120 mm and the diagonal of the cube are collinear [5].

It is predicted that the edges of the pyramid alternately comes in and comes out from cube as follows: one enters through an edge and exits through one face of the cube and the following reverse enters through a face of the cube and exits through an edge thereof. It notes the points of intersection between the two apparent contours, thus determining the projections 1ô, 7ô, 12ô and 6ô (fig. 2) i. e. the points from space 1, 7, 12 and 6 (fig. 4).

Further, the intersection is solved simply because all other points of the sought intersection are situated in the level planes that passing through the intersections of apparent contours of the two objects as follows (fig. 2): N_{V1} passes through 6ô and contains the projections 2ô and 3ô; N_{V2} passes through 1ô and contains the projections 4ô and5ô; N_{V3} passes through 12ô and contains the projections 8ô and 9ô; N_{V4} passes through 7ô and contains the projections 10ô and 11ô. For comparison, the figure 3 shows the plane representation performed by AutoCAD. For axonometric representation of the intersection of these simple bodies it applies axonometric principles. Figure 4 shows the intersection between cube and hexagonal pyramid classically executed with Microsoft Word Drawing Tools (MWDT) and in figure 5 it presents the same intersection that was performed with the aid AutoCAD (ACAD) [2], [3].

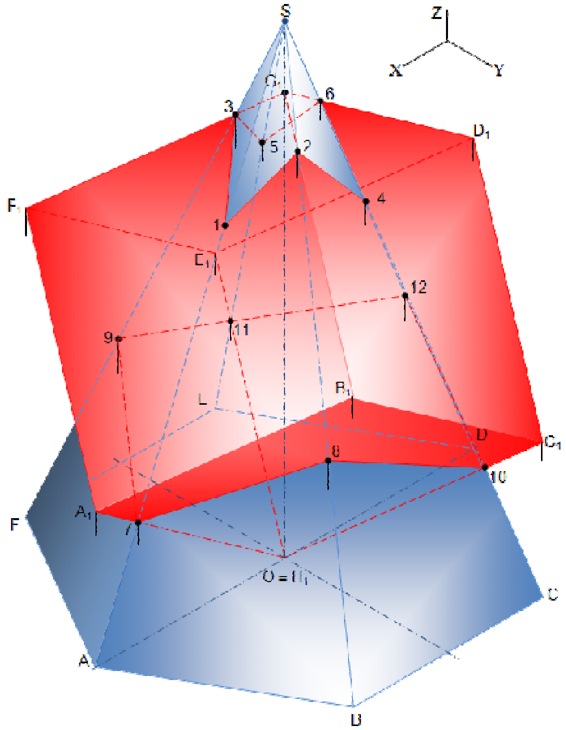

Fig. 4 Axonometric isometric representation of the intersection of bodies presented in figure 2 (MWDT)

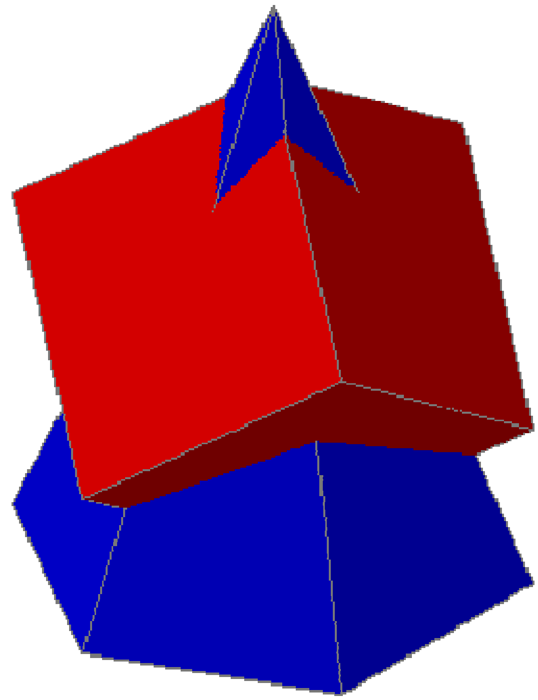

Fig. 5 Axonometric isometric representation of the intersection of bodies presented in figure 3 (ACAD)

The rest comes naturally! The horizontal projections of all these points are determined by drawing lines of order from the [V] plane in the [H] plane. (fig. 2).

Another example presented in the paper is the intersection of two cylinders with equal diameters and concurrent axes perpendicular. The figures 6 and 8 show the auxiliary spheres method [1] performed using classical instruments MWDT.

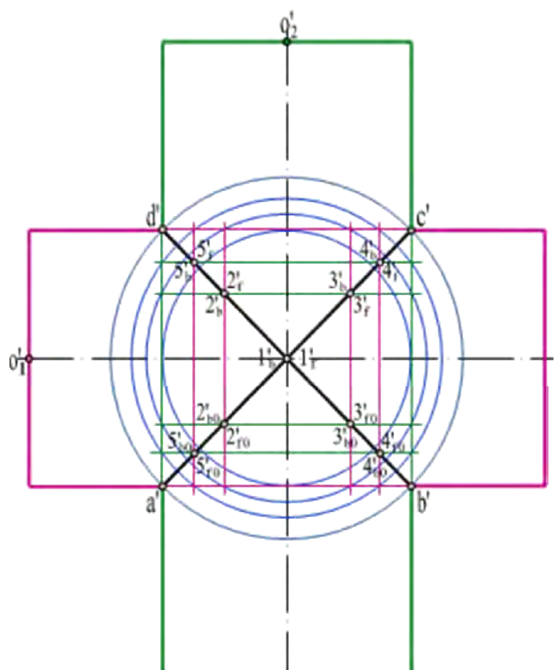

Fig. 6 Plane representing to the [V] plane of bitangential breaking intersection of two cylinders with diameters of equal and perpendicular axes, by auxiliary spheres method. (MWDT)

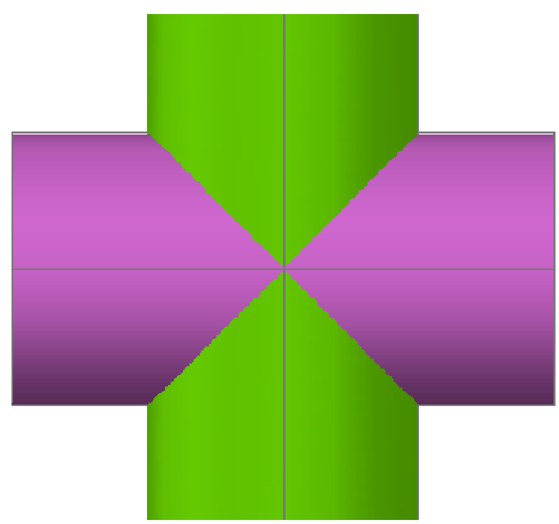

Fig. 7 Plane representing to the [V] plane of bitangential breaking intersection of two cylinders with diameters of equal and perpendicular axes, by auxiliary spheres method. (ACAD)

For comparison, the Figures 7 and 9 show the same intersection of cylinders with identical diameters and concurrent axis perpendicular in the plane projection and axonometric projection respectively, executed with the aid of ACAD.

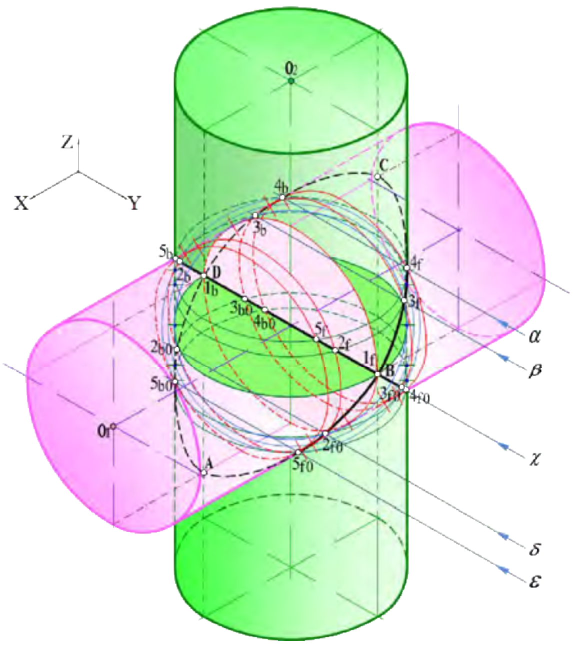

Fig. 8 Axonometric isometric representation of the intersection of bodies presented in figure 6 (MWDT)

In the figure 8, Ǖ, б, ɢ, ŭ and Ůrepresent the directions of intersection lines between the circles that come from intersection between the cylinders and the auxiliary spheres.

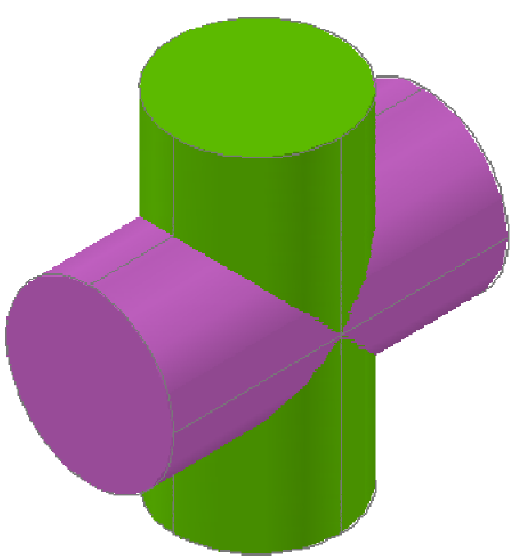

Fig. 9 Axonometric isometric representation of the intersection of bodies presented in figure 7 (ACAD)

4. CONCLUSIONS

It is noted the similarities and the differences between the two techniques of representation, meaning that the precision of execution is the same, if the rules of representation are respected.

In the classical representation case, can be highlighted the work steps, the elements auxiliary aids and covered edges of intersected objects.

In case of representation by using AutoCAD software, the objects are filled, the designer cannot see the covered edges, in turn, may rotate the set of objects according to any direction and sense such as to observe all the details of the intersection.

Another conclusion that can be deduced is the following: technique used for representation has a secondary importance, the drawing on standard paper or on the computer aided design. It is important that the engineer, the designer to know better the technical language underlying the preparation of technical documentation of the object.

REFERENCES

[1] Popescu, V., Manea, A., Cotrumba, M. (2011). *Descriptive Geometry*, Ovidius University Press, ISBN 978-973-614-642-8, ConstanŢa.

[2] Simion I. (2007). *Auto CAD 2008 for Engineers*, Editura Teora, ISBN 973-20-1135-5, Bucureкti.

[3] Pomazan V. (2005). *Parameterized Design in Mechanical Engineering*, Editura Ex Ponto, ISBN 973-644-459-7, ConstanŢa.

[4] TĿnĿsescu, A. (1975). *Descriptive Geometry. Perspective. Axonometry,* Editura DidacticĿ кi PedagogicĿ, Bucureкti.

[5] Pintilie, A., Cotrumba, M., RĿdoiu, B. (2015). *Graphics Assisted by Computer. Series II*, Ovidius University Press, ISBN 978-973-614-806-4, ConstanŢa.

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