

Tom 58(72), Fascicola 2, 2013

Intersection between two surfaces with AutoCad- the descriptive geometry method

Gheorghe BELEA¹ Cantemir KISS¹

Abstract: AutoCAD has opened new possibilities to solve the descriptive geometry problems. The three dimensional representation of the objects with the help of computers facilitates the simultaneous projection in axonometric system and in the orthogonal system on all the six faces of the projection cube.

All the elements in space can be represented in AutoCAD in three ways: lines (wire) plane (surfaces) or bodies. The paper presents a method to solve the intersection of two plane surfaces by wire representation.

Keywords: triangular surface, intersection, covering line, intersection line, visibility.

1. INTRODUCTION

Descriptive geometry is the first subject in the curricula which sets the methods for the geometric representation of elements in space.

ACAD opened new possibilities to solve descriptive geometry problems, since until the geometric representations on computer, these were an exclusive creation of the project designer. The designer imagines the space element and draws it on paper in axonometric projection, in perspective or in orthogonal projection, on two or three projection plans.

The draft is transposed in drawings at the exact scale needed to build the constructions. It is worth mentioning that for all these designs the wire model is used, i.e.: straight or curve lines and texts.

It is obvious that the transformations from one projection to another is made by architects, design engineers, masons, which have to understand when reading the plans in horizontal or vertical projections how to make a wall; which is a tridimensional physical construction in space. We emphasize that the transformation from one projection to another can be made only if the operators have the ability to see in space, the engineers to design constructions by making drawings in two or three projection plans and the masons to make the wall which is a three dimensional object.

The computer is used to represent the three dimensional objects, in axonometry or perspective, which can be immediately changed into projections or can be sectioned in any direction. This new facility offered by Autocad opened new possibilities for the

use of descriptive geometry.

The author of the article underlines the fact that there are three types of representations within the representations of the constructions and in obtaining detailed geometric solutions with the help of descriptive geometry, sustained by the CAD programs.

Representation by wire construction

These designs can be made in the same way as the above mentioned paper representations. This is another case in which drawing with AutoCad is an extra facility, especially if these can be drawn in a three dimensional space, i.e. 3D. In this case the designer uses several windows, and has the possibility to see on the computer screen two or more projections of the same object simultaneously. For this type of representation the working methods belong to the classic descriptive geometry. By using option 3D the objects can be represented directly in axonometry and visualized later as projections on any of the six sides of the projection cube.

Representation by plane

The second representation type is the one through faces, plans respectively. This form is used to construct in axonometry the faces of the solids or the surfaces of the fields, i.e.: the marked projection. The elevated points in the field can be used to trace streets or delimit parcels. The program has the capacity to represent, at the desired dimensions and angles, the digging and the filling for a road. At the same time we can calculate the volume of the earth that need to be moved.

The classic representations of the AutoCad have mainly a graphic value of representations and less the capacity for geometric calculation. It is recommended that the description of these surfaces to be made on separate layers that can be opened or shut at a certain moment. It is obvious that the use of 3D drawings to represent surfaces have the highest possibility to render objects in space.

Representation by volume

The third form of representations is by volume. In this case the geometric bodies drawn in 3D are volumes. We cannot figure a point on any of the faces by editing commands. It is useless to draw the faces since they are part of the geometric body drawn.

This form of representation opens a new

¹ "Politehnica" University of Timisoara, Faculty of Civil Engineering, address: T. Lalescu street, 2A 300223 zip code, Timisoara, Romania, gheorghe.belea@ct.upt.ro; mariamagdalen.kiss@bluewin.ch

possibility to obtain fast geometric solutions. We have to mention here all the Boole operations. These types of geometric constructions are made only in 3D and have a perfect visualization of the elements rendered. Projections on the computer screen can be made in different perspectives, therefore visualization is very plastic and has the value that it can replace the models in miniature. The current tendency is to make drawings as fast and plastic as possible, and if necessary with fast possibilities to correct, alter or replace the elements in the drawings. That is why this type of representation is the fastest and the most used in modern design offices. Axonometry, perspective and shadow representation are obtained immediately in this representation form and do not require further work.

As far as the construction of the volumes and the surfaces are concerned, we have to mention the need to change the universal system of coordinates in user coordinates or in those of the plane in which the drawing is made. The representation shape of the volume objects has possibilities to process parametrically the bodies and of the geometric volumes.

2. INTERSECTION BETWEEN TWO TRIANGULAR BOARDS IN THE REPRESENTATION OF THE WIRE CONSTRUCTION TYPE

Traditional Method

In the traditional method, used by descriptive geometry, it is determined the intersection points between the two sides of a triangle with the surface of the other triangle.

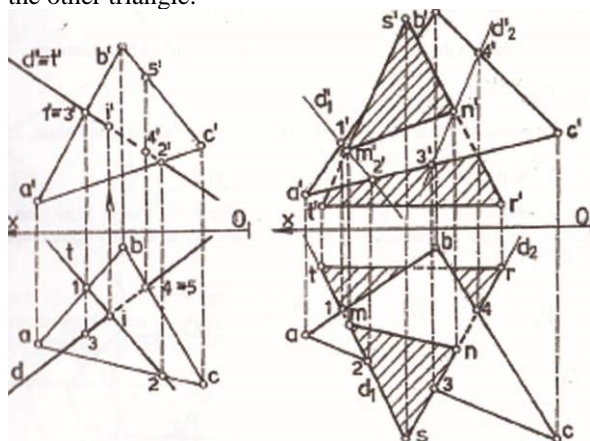


Fig. 1. Intersection between two triangular boards

The solution starts from the method of the intersection of a straight line with a plane surface by using a covering straight line contained in the plan. We consider line T in the plan of the triangle with vertical projection t' confounded with the vertical projection d' of the given line (Fig.1) The horizontal projection of the intersection point between the line and the plan results in the intersection between the horizontal projection of d with the horizontal projection t .

In the case of the intersection between two triangular boards we cover two sides of a triangle or a side of the triangle and a side of the other triangle

with two covering straight lines, D1 on side ST and D2 on side RS. We determine the vertical projections d_1' and d_2' which intersect the vertical projections of the two sides in m' and n' . The projections of the straight intersection line are obtained by connecting the same type of projections of the points M and N.

The problem is considered solved after obtaining the proper visibility of the triangles in the two projections. In horizontal plan we can see the sides with the highest quota and in the vertical plan we can see the sides which are the farthest. This problem is usually solved by the students of the Faculty of Constructions, and Figure 2 presents an example.

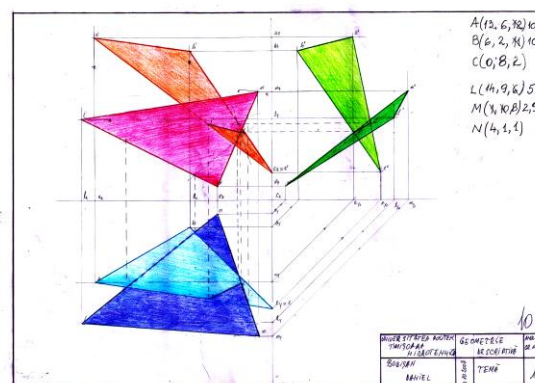


Fig. 2. Student paper

AutoCAD Method

To solve the same problem in Autocad, after the modification of the coordinates of the points of the triangles in order to obtain some lines in particular positions, it is needed a previous training to be able to see at the same time, on the monitor screen, all the three projections: horizontal H, vertical V and lateral L. They are similar to the triple orthogonal representation from the descriptive geometry, as well as a representation in axonometry.

The first step is to visualise on the monitor the tool bars for: **Visual Styles, Modeling, UCS, View and Orbit.**

Next, four windows have to be introduced with the commands: *View – Viewports – 4* and then the modification of the system of coordinates in each window:

- for plan H **View – 3Dview – Bottom;**
- for plan V **View – 3Dview – Back;**
- for plan L **View – 3Dview – Right;**
- for axonometry **View – 3D View – NE Isometric**

To visualise the solution stages different Layers are introduced for each stage.

The first two Layers are meant to represent the projections of the two triangles; with different colours. In the representation window in axonometry, we activate Layer for the first triangle which is drawn by marking the sides between the points introduced as points, through coordinates. We use a different colour to draw the next triangle after activating the Layer for this one. It would be easier if you represent the horizontal or the vertical projection of the two triangles in a different layer. At the end of these stages all these four projections of the triangle can be seen on the monitor screen as in Fig. 3.

To solve the problem, the next stage consists in

building the covering lines and in determining the intersection points of the two sides with the plan of the other triangle. Let us consider that the side of the first triangle crosses the plan of the second triangle, and a side of the second triangle crosses the plan of the first triangle, respectively.

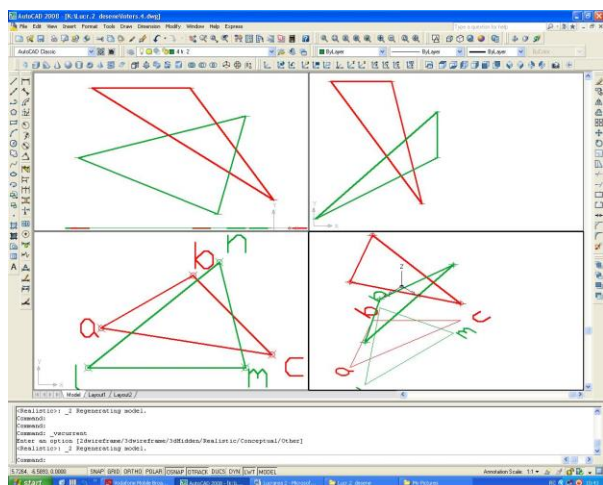


Fig. 3. Representation of triangles and horizontal projections in isometric representation

We introduce another Layer where we mark the intersection points of the sides of the triangles by horizontal projection, in the isometric window, through points of a certain size as to be able to be seen on the monitor.

In the next Layer introduced we draw vertical lines, still in the isometric window, until above the projections of the sides; then we materialize the intersection points with the sides of the other triangle, also using points. Next, we draw the covering lines by connecting the points determined previously. At the end of these stages it can be seen the image presented in Fig. 4.

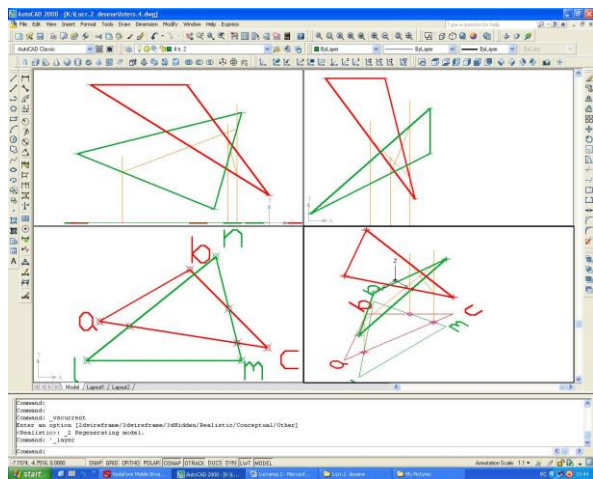


Fig. 4. Representaton of the covering lines

The intersection line will be marked in a different Layer, between the points determined by the intersection of the covering lines with the sides that they cover (Fig. 5).

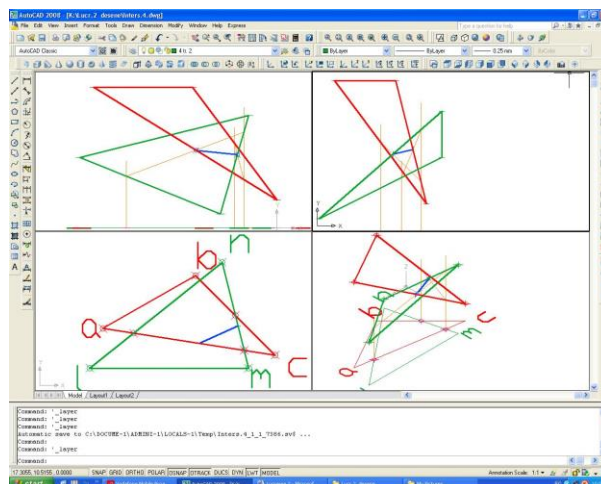


Fig. 5. Drawing the intersection line

To obtain a more suggestive representation of the two plans defined by the triangles, these are materialised by shading with command *Planar Surface* in the tool bar *Modelling* (Fig. 6).

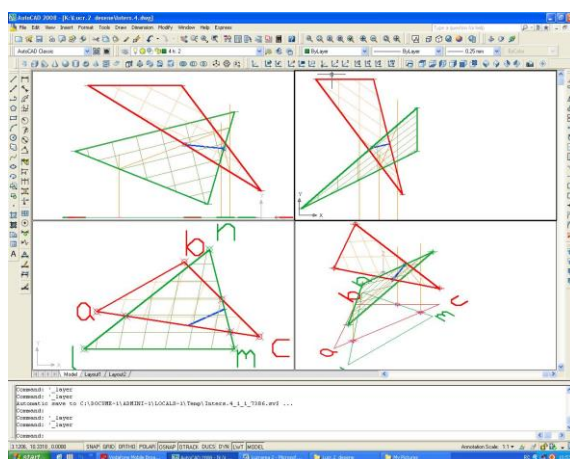


Fig. 6. Shading the plans of the triangles

For a better materialization of the plans of the triangles and of the intersection line, each viewport (projection) can be visualized with the following succession of commands: *View – Visual Styles – Realistic Visual Styles* (Fig. 7).

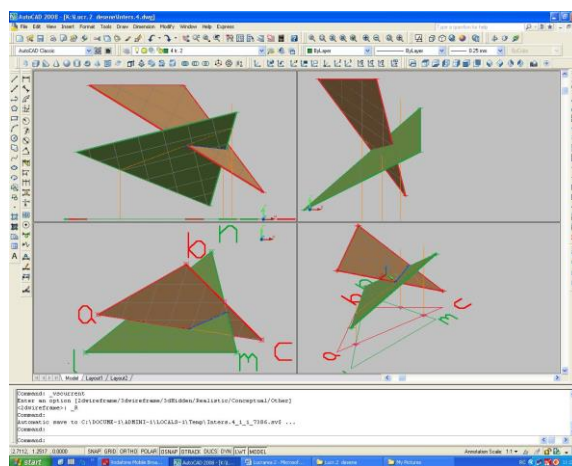


Fig. 7. Materialisation of triangle plans

The way in which the problem of the intersection of the two triangles is solved in the above situation,

follows the stages of the traditional way of drawing, i.e.: visualisation of the projections on all the projection plans. In Autocad it is enough to work just in axonometry, since with the help of command **View – Orbit – Free** the axonometric representation can be rotated in all the directions so that we can visualize the horizontal, vertical or side projection.

3. INTERSECTION OF TWO TRIANGULAR BOARDS IN REPRESENTATION BY PLANE

The problem is solved much easier in AutoCAD, through representation by plan, since there are fewer stages than in the previous method.

On a screen with three viewports, horizontal projection H, vertical projection D and isometric projection, the two triangles are represented in two Layers by marking the sides. On the screen it can be seen the representation in Fig. 8, similar to the one in Fig. 3.

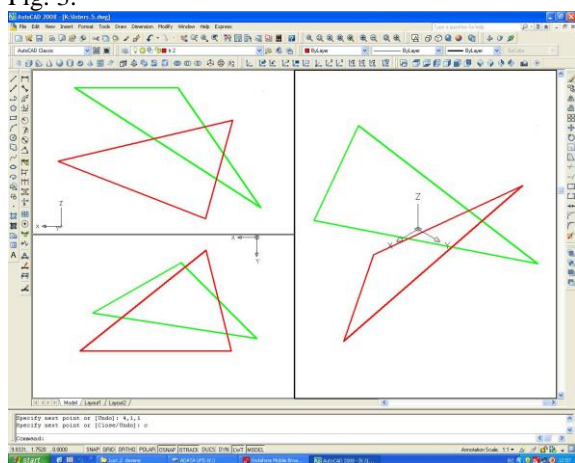


Fig. 8. Representation of triangular surfaces

The next step after the introduction of commands **Draw – Modeling – Planar Surface – Object**, where the objects are the sides of the triangles, plans are materialised by shading; the same as in Fig. 6 (Fig. 9).

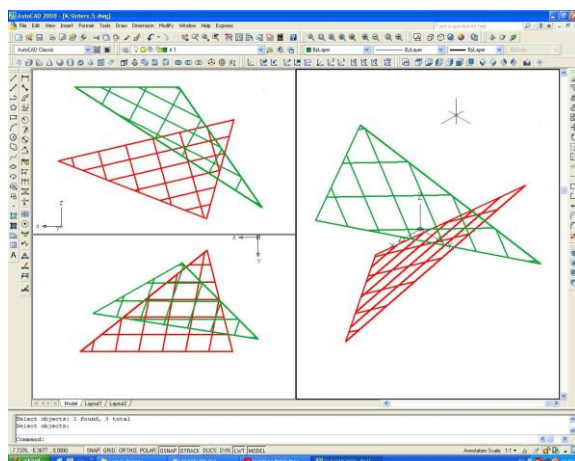


Fig. 9. Visualisation of plans

Since on this image the intersection is not visible, i.e. the intersection line and the visibility of the two triangular surfaces cannot be seen, we resort to visualising them by a succession of commands: **View – Visual Styles – Realistic Visual Styles** (Fig. 10), for

the projection on plan V and in isometric representation.

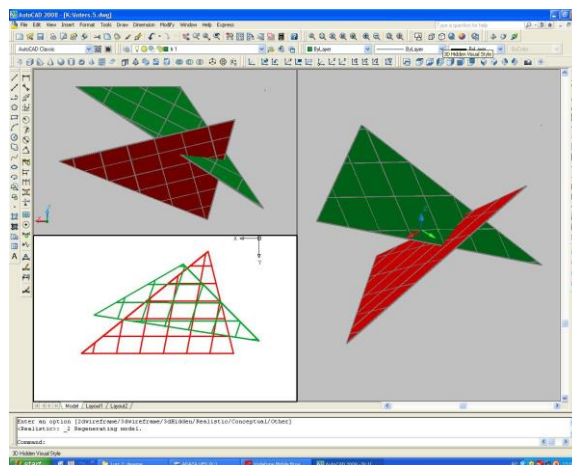


Fig. 10. Visualisation of triangular surfaces

In this case too, it is enough to work just in axonometry, since with the help of command **View – Orbit – Free Orbit** the axonometric representation can be rotated in all the directions so that we can visualize the horizontal projection, the vertical projection or the side projection.

The coordinates of the intersection points of the side parts with the surfaces can be read on the screen, but they are approximate and cannot be placed exactly.

4. CONCLUSIONS

Representation type wire

Disadvantages:

- it is vary laborious;
- it requires several stages.

Advantages:

- It is similar to the representation by the traditional method from the descriptive geometry;
- It ensures the visualization of the intersection line.

Representation by plan

Disadvantages:

- It does not ensure the materialization of the intersection line or its visualisation.

Advantages:

- It is very easy;
- It does not require intermediary stages.

Considering all the above each can decide which AutoCAD method to choose in order to solve the problem of the intersection.

REFERENCES

- [1] Gh. Belea, Geometrie descriptivă, Editura Politehnică, Timișoara, 2011
- [2] Gh. Belea, M. Mirea, GADT Aplicații, Grafică asistată de calculator și desen tehnic, Editura Politehnică, Timișoara, 2012.
- [3] C. CHIS, Geometrie descriptivă, Note de curs, predat la Facultatea de Construcții din Timișoara, în anul 2010.