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COMPUTER GRAPHICAL REPRESENTATION, IN TREBLE ORTHOGONAL PROJECTION, OF A POINT

Abstract: *In the stages of understanding and study, by students, of descriptive geometry, the treble orthogonal projection of a point, creates problems in the situations in that one or more descriptive coordinates are zero. Starting from these considerations the authors have created an original computer program which offers to the students the possibility to easily understanding of the way in which a point is represented, in draught, in the treble orthogonal projection whatever which are its values of the descriptive coordinates.*

Keywords: *descriptive geometry, descriptive coordinates, point representation, AutoCAD, treble orthogonal representation of a point.*

1. INTRODUCTION

For the most students, the treble orthogonal representation, in draught, of a point, whatever of the trihedra in which it is situated, if its descriptive coordinates (X, Y, Z) are not null, did not creates any troubles.

On the contrary, if the point has a particular position, in that it is situated in one of the bisector planes B_1 ... B_4, projection planes *[H]*, *[V]*, *[L]*, on the *X*, *Y* or *Z* axes or it overlaps with the origin *O*, his representation, in draught, is difficult, because his projections *a*, *a'* and *a"*, on the projection planes *[H]*, *[V]*, *[L]* and the points that determine these projections, a_x, a_y, a_{y1}, a_z, may overlap each other or with the origin, which does not happen where the point is situated in one of the trihedron T_1 ... T_8.

Starting from these data, the authors had created an original computer program which help the students to understand, the way of representation of a point in a draught, both in the case in that the point has a general position (is situated in one of trihedron T_1 ... T_8), and in the case in that it has a particular position (is situated in bisector planes B_1... B_4, projection planes *[H]*, *[V]*, *[L]*, or in the origin O).

2. PRESENTATION OF THE SOFTWARE

The computer program, made by the authors, runs on the graphical interface of the AutoCAD. Before it launching in execution, is recommended the moving of the UCS in the center of the drawing space, bounded by the margins of the monitor and changing of the direction of the X, Y and Z axes, Fig. 1, in such way that, they respect the direction from the descriptive geometry, Fig. 2.

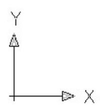

Fig. 1 The direction given to the X, Y and Z axes.

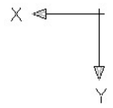

Fig. 2 The direction of the axes in descriptive geometry.

The launch in execution of the computer program is done by typing, in the command line, of its name, *reprpoint* and pressing then the *ENTER* key <*E*>.

For helping the user to pursue the software logic, to understand the projections which will be represented (*a*, *a'*, *a"*, a_x, a_y, a_{y1} and a_z), their names, the order and their position in relation with the origin *O*, the computer program specifies to the user these data by using a series of dialog boxes.

Thus, after which the values of the abscissa, distance and quota are specified, the computer program displays the dialog box from Fig. 3 in which it specify that:

- the projection that will be specified will be a_x;
- the a_x projection is situated in the left side of the origin (because the given value, by the user, for abscissa is positive);

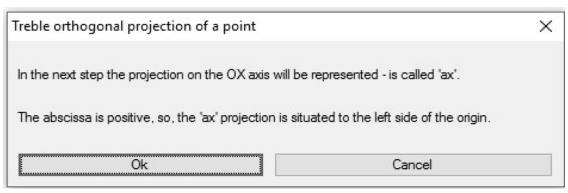

Fig. 3 The message displayed by the computer program after the values for abscissa, distance and quota were specified.

By pressing the *Ok* button the computer program specifies the position of the a_x projection (Figura 4).

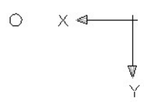

Fig. 4 The position of the a_x projection.

To the requirement of the software *Please select the point for annotation* (Figure 5), the user specify the place for the notation of the a_x, and the program writes this text (Figure 6).

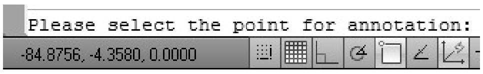

Fig. 5 The program asks the user the position of the annotation.

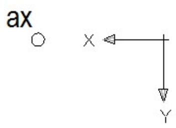

Fig. 6 The program has placed the specified a_x notation in the place indicated by the user.

By pressing the ENTER key <*E*> the computer program represents the line of recall, Figure 7, to the end of which is situated the horizontal projection *a*, of the point *A (a, a', a")*.

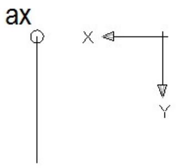

Fig. 7 The computer program represented the line of recall at the end of which is placed the horizontal projection *a*, of the point *A (a, a' a")*.

Then the computer program, by the message presented in Figure 8, announces the user that at the end of the line of recall, previously represented, will draw the horizontal projection *a*, which is situated under the *X* axis (on the positive *Y* axis), because the value of the distance, indicated by the user, is positive.

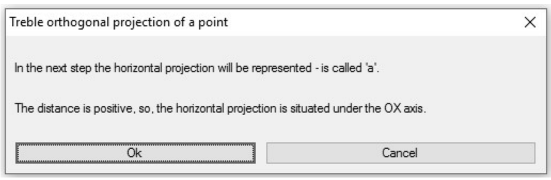

Fig. 8 The message displayed by the computer program, which specifies which projection will be represented.

By pressing the *Ok* button the computer program displays the place of the horizontal projection *a*, of the point A (a, a', a") and at the dialog *Please select the point for annotation* the user specifies the location of the *a* notation then, the software writes this text (Figure 9).

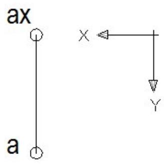

Fig. 9 The computer program displays both the location and the notation of the horizontal projection *a.*

By pressing the *ENTER* key <*E*> the computer program represents the line of recall (Figure 10) at the end of which is placed the vertical projection *a'*, of the point *A (a, a', a")*.

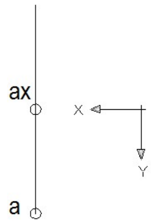

Fig. 10 The computer program represented the line of recall at the end of which is placed the horizontal projection *a'.*

After that, the computer program, through the message presented in Figure 11, announce the user that to the end of the line of recall, previously represented, will draw the vertical projection *a'* which is situated above the *X* axis (on the negative part of the *Y* axis) because the value of the quota specified by the user is positive.

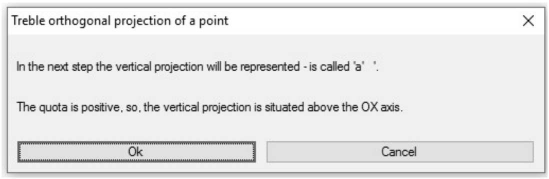

Fig. 11 The message displayed by the computer program that specifies which projection will be represented.

By pressing the *Ok* button the computer program displays the location of the vertical projection *a'*, of the point *A (a, a', a")* and at the dialog *Please select the point for annotation* the user specifies the location of the *a'* notation then, the software writes this text (Figure 12).

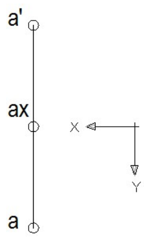

Fig. 12 The program displays both the location and the vertical projection notation *a'.*

By pressing the *ENTER* key <*E*> the computer program represents the line of recall (Figure 13) to the end of which is situated the projection a_y.

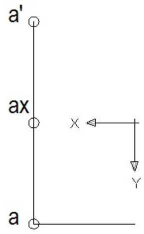

Fig. 13 The computer program represented the line of recall at the end of which is placed the horizontal projection a_y.

Then, the computer program, through the message presented in Figure 14, announces the user that to the end of the line of recall, previously represented, will draw the projection a_y.

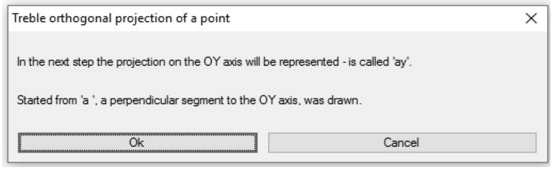

Fig. 14 The message displayed by the computer program that specifies which projection will be represented.

By pressing the *Ok* button the computer program displays the location of the projection a_y and to the dialog *Please select the point for annotation* the user specify the position of the a_y notation, then, the software writes this text (Figure 15).

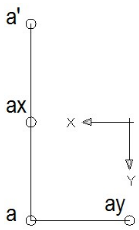

Fig. 15 The program displays both the location and the vertical projection notation a_y.

By pressing the ENTER key <*E*> the computer program represents the arc, counter clockwise drawn, which permits the determination of the a_{y1} projection (Figure 16).

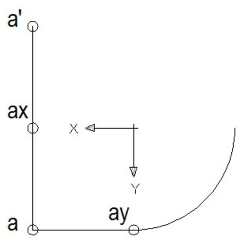

Fig. 16 The computer program represents the arc.

Then, the computer program, through the message presented in Figure 17, announces that to the end of the arc, previous represented, will draw the projection a_{y1}.

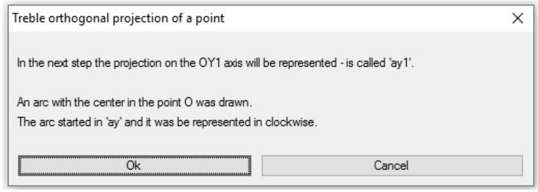

Fig. 17 The message displayed by the computer program that specifies which projection will be represented.

By pressing the *Ok* button the computer program displays the location of the projection a_{y1} and to the dialog *Please select the point for annotation* the user specify the position of the a_{y1} notation, then, the software writes this text (Figure 18).

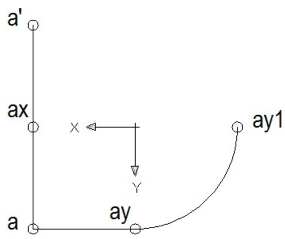

Fig. 18 The computer program displays both the location and the notation of the horizontal projection a_{y1}.

By pressing the *ENTER* key <*E*> the computer program represents the line of recall, (Figure 19), to the end of which is situated the a_z projection.

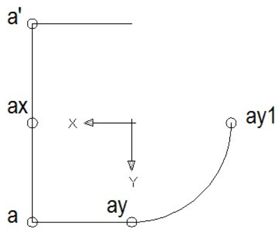

Fig. 19 The computer program represented the line of recall at the end of which is placed the a_z projection.

Then, the computer program, through the message presented in Figure 20, announces that to the end of the line of recall, previously represented, will draw the a_z projection.

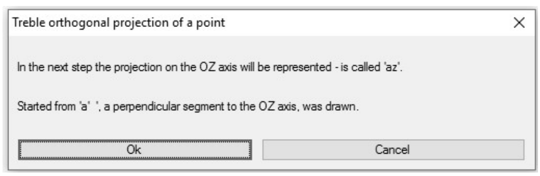

Fig. 20 The message displayed by the computer program that specifies which projection will be represented.

By pressing the *Ok* button the computer program displays the location of the a_z projection and to the dialog *Please select the point for annotation* the user specify the position of the a_z notation, then, the software writes this text (Figure 21).

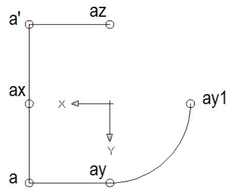

Fig. 21 The computer program displays the location and the notation of the a_z projection.

By pressing twice of the *ENTER* key <*E*>, the computer program represents the lines of recall which start from a_{y1} an a_z and determines the lateral projection *a"* (Figures 22 and 23).

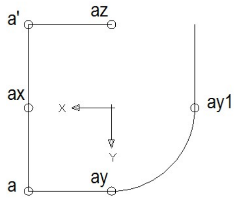

Fig. 22 The computer program represents the line of recall from a_{y1}.

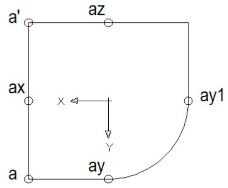

Fig. 23 The computer program represents the line of recall from a_z.

Further the computer program, through the message presented in figure 24 announce the user that, in the intersection point between the two lines of recall, will be represented the lateral projection *a"*.

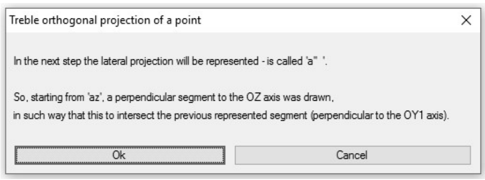

Fig. 24 The message displayed by the computer program that specifies which projection will be represented.

By pressing the *Ok* button the computer program displays the location of the *a"* projection and to the dialog *Please select the point for annotation* the user specify the position of the *a"*, then, the software writes this text (Figure 25).

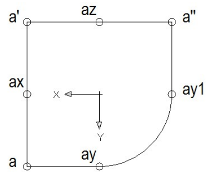

Fig. 25 The computer program displays the location and the notation of the projection *a"*.

In case that, one or more descriptive coordinates of a point are null, the computer program represents in draught, each of the projections a_x, a, a', a_y, a_{y1}, a_z, a'' taking account the inserted values by user.

Thus, in case in that the user chooses a point which has the distance equal with zero and the abscissa and quota are negative, the representation, step by step, in treble orthogonal projection of this point and the messages displayed by the computer program for understanding the mode of representation, are presented in figures 26 ... 40.

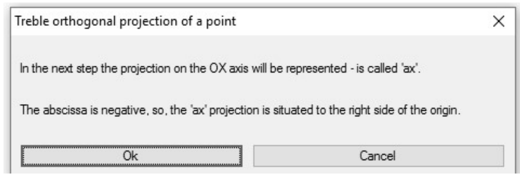

Fig. 26 The message displayed by the computer program through which specify what point will represent (a_x) and his location.

Fig. 27 The highlight of the location and of the text for the projection a_x.

From the figures 26 and 27 it can be observed that the a_x projection is situated to the right side of the origin *O* (on the negative part of the *X* axis) because the abscissa specified by the user was negative.

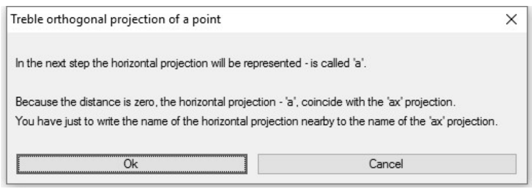

Fig. 28 The message displayed by the computer program through which specify what point will represent (the horizontal projection *a*) and his location.

Fig. 29 The highlight of the location and of the text for the horizontal projection *a*.

From the figures 28 and 29 it can be observed that the a and a_x projections coincide, because the distance specified by the user was zero.

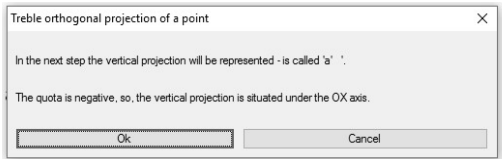

Fig. 30 The message displayed by the computer program through which specify what point will represent (vertical projection *a'*).

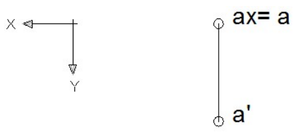

Fig. 31 The highlight of the location and of the text for the vertical projection *a'*.

From the figures 30 and 31 it can be observed that the vertical projection *a'* is situated under the origin *O* (on the positive part of the *Y* axis), because the quota specified by the user was negative.

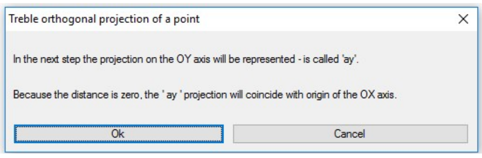

Fig. 32 The message displayed by the computer program through which specify what point will represent (a_y) and his location.

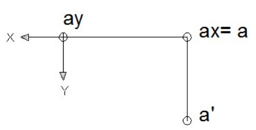

Fig. 33 The highlight of the location and of the text for the projection a_y.

From the figures 32 and 33 it can be observed that, the *O* point coincides with the a_y projection, because the distance specified by the user was zero.

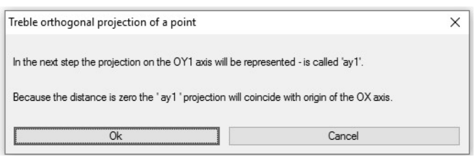

Fig. 34 The message displayed by the computer program through which specify what point will represent (the projection a_{y1}).

From the figures 34 and 35 it can be observed that the a_y and a_{y1} projections coincide, because the *O* point overlaps with the a_y projection.

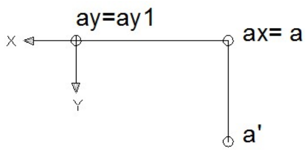

Fig. 35 The highlight of the location and of the text for the a_{y1} projection.

By pressing the *ENTER* key *<E>* the computer program represents from *a'* a line of recall which intersects the *Y* axis in a_z (Figures 36 and 37).

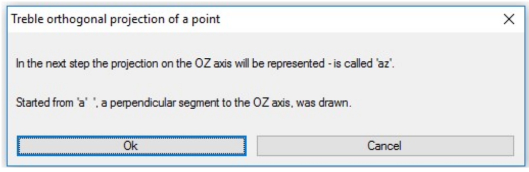

Fig. 36 The message displayed by the computer program through which specify what point will represent (a_z projection).

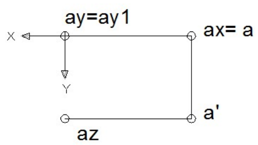

Fig. 37 The highlight of the location and of the text for the a_z projection.

By pressing the *ENTER* key *<E>*, the computer program represents from a_{y1} a line of recall parallel with the *Y* axis on which is situated the lateral projection *a"* (Figure 38).

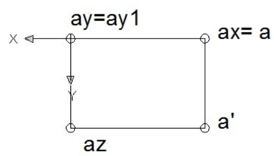

Fig. 38 The computer program represents from a_{y1} a line of recall on which is situated the lateral projection *a"*.

Further by pressing the *ENTER* key *<E>* the computer program represents from a_z, a line of recall, parallel with the *X* axis.

Whereas the a_z and a_{y1} projections are on the same vertical, result that the a_z projection coincide with the lateral projection *a"* of the point *A (a, a', a")* (Figure 39), information which is displayed by computer program through the message presented in figure 40.

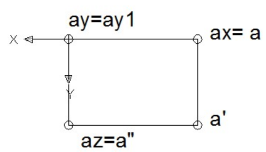

Fig. 39 The a_z and *a"* projections coincide.

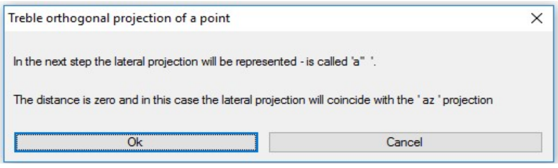

Fig. 40 The message displayed by the computer program through which specify what point will represent (a_y) and his location.

3. RESULT AND DISCUSSIONS

The advantages/disadvantages and the efficiency of the software was tested on a class with 32 students, that previously studied in the classical manner (using the books and the notes from seminars) the issue of representation, in treble orthogonal projection, in draught, of a point..

At the beginning, for students to understand the way of using of the computer program named *reprpoint*, the stages which permits to establish the projections (a, a', a*"*, a_x, a_y, a_{y1} and a_z), in draught, of a point situated in first trihedron *T1*, were made in both cases (in classical manner and using the computer program made by the authors).

After that, for the representation of points in the rest of the trihedra, T_2 ... T_8, the classical manner was abandoned. An analysis was made and her result showed that no student had no problem in correctly specifying the names of the projections represented by the program.

Then, it was passed, to the representation of draught for a point situated in the anterior horizontal half-plane, in the posterior horizontal half-plane, in the superior vertical half-plane, in the inferior vertical half-plane, on the *X, Y, Z* axis, confused with the *O*.

In the first four cases the students correctly specified the names of the projections represented by the program.

Nor in the following four cases (when the point was situated on the *X*, *Y* or *Z* axis or when the point was confused with the origin O*)* were not problems in correctly specifying the name of the projections specified by the program.

After the students resolved all the cases they had to respond to the next questions: "*Did you find this computer program useful/useless?", "Why?"*

Analyzing the students answers, it was observed that 6 students (18.75%) responded that they could have been represent the projections of the points, in draught, in the classical manner. In exchange 26 students (81,25%) consider him that is very efficient and much more useful comparative with the classical representations.

4. CONCLUSIONS

In this paper the authors present a computer program named *reprpoint*, made by them, in order to facilitate the understanding of the representation of the point, in draught, in the treble orthogonal projection. More than that, they present a study, which was made with the help of the students, with the goal to establish if this computer program is useful or not in teaching of the point representation in the descriptive geometry.

The computer program leads, step by step, the user in representing of the draught, constantly offering him, useful information about what is he doing in a certain moment or what is going to do in the next step. This dialog give to the user the possibility to learn or to verify himself if he correctly understood the bases of the point representation in descriptive geometry theory.

The study starts with simultaneous representation in classical manner and with *reprpoint* computer program, of the point, in treble orthogonal projection in first trihedron T_1. For the rest of trihedra it was used only the *reprpoint* computer program.

The study revealed the fact that the most of the students (81,25%) have found that this computer program is very useful and efficient in the study of treble orthogonal projection of a point.

Considering this, the authors consider that this software can be used with efficiency in the e-learning system.

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