

## DETERMINING THE INTERSECTION LINE OF TWO PLANES BY THE COMPUTER HELP

### DETERMINAREA DREPTEI DE INTERSECȚIE A DOUĂ PLANE CU AJUTORUL CALCULATORULUI

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**Abstract.** *In study of the descriptive geometry, from the point of view of understanding and assimilation by students, the issue of determining the intersection line of two planes, always was found to be difficult. Starting from this, the authors present a strategy, elaborated by themselves, and an original computer program, which gives to the students the possibility to easily understand the way in which the planes that intersect can be represented in draught or in space, and, also the way of determining the intersection line of the two planes.*

**Key words:** Descriptive Geometry, Intersection line, AutoCAD

**Rezumat.** *În studierea geometriei descriptive, din punctul de vedere al înțelegerii și asimilării de către studenți, problema determinării dreptei de intersecție dintre două plane s-a dovedit, din todeauna, a fi una dificilă. Pornind de aici, autorii prezintă o strategie, elaborată de ei înșiși, și un program de calculator original care oferă studenților posibilitatea de a înțelege cu ușurință modul în care sunt reprezentate planele care participă la intersecție, în epură sau în spațiu și, de asemenea, modul în care se determină dreapta de intersecție dintre cele două plane.*

**Cuvinte cheie:** Geometrie Descriptivă, dreaptă de intersecție, AutoCAD

## INTRODUCTION

One of the first topics of Descriptive Geometry discipline that raises students' understanding, solving and assimilation issues, is the determination of the line of intersection of two planes (Prună *et al.*, 2002). This difficulty arises from the following reasons:

1. most times, during the course and seminar, the representation of planes is achieved only in double orthogonal projection; this does not allow students to easily grasp the planes' position in three-dimensional space;

2. the determining way, in draught, of the line of intersection between certain categories of planes is difficult to achieve;

3. many students do not have a good view into space, thing which would have been of great help in understanding of the position of the planes, in three-dimensional space but and, of the determining way of the intersection line between them.

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Based on these shortcomings the authors, have designed and built a software that allows viewing, in 3D model and in draught, of the planes and of the line of intersection between them.

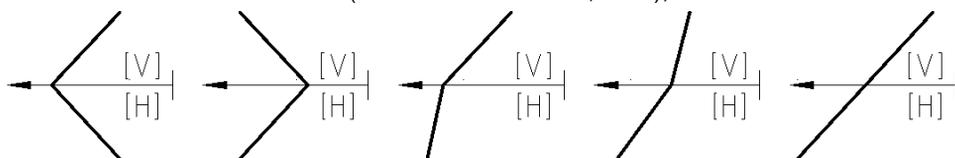
## MATERIAL AND METHOD

For the start, the authors were faced with the problem of establishing all types of planes that can participate in the intersection. It is known that the number of types of plans is eight (general position plane, level plane, frontal plane, profile plane, vertical plane, ending plane, parallel to OX axis and containing OX axis plane).

If intersects, by turn, first plan with all others, then the second plane with the following, and so on, and finally, the last two planes, are obtained 28 variants.

But the total number of combinations is much greater, and this is given by the distinct positions of the point Px and by the traces of each plan. Therefore:

1. In the general position plan's case, the minimum number of positions of the traces of the plane is 5 (fig. 1). By changing positions of the traces, the intersection of the same types of planes, but and different planes, the minimum number of combinations that results is 15 (Slonovschi and Prună, 2006);



**Fig. 1** Distinct positions for the general position plane

2. In the case of the vertical plan, the minimum number of combinations, regarding to the intersection of two planes, is 5 (fig. 2) (Prună *et al*, 2006);



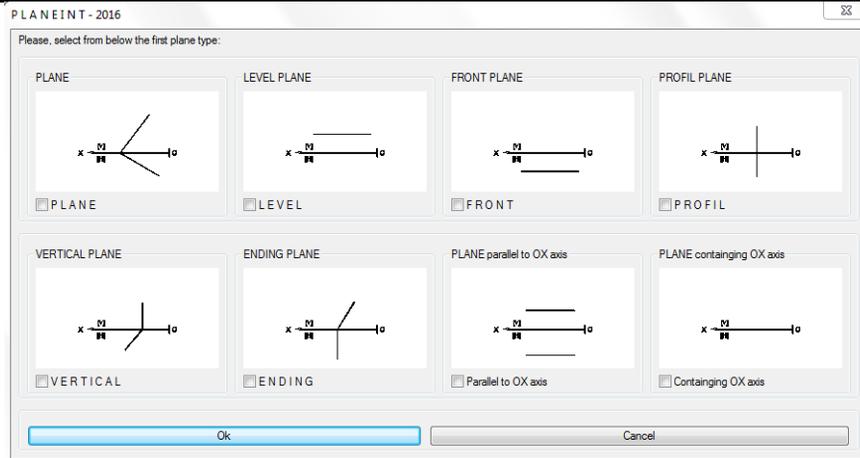
**Fig. 2** The combinations that emerge when two vertical planes are intersecting

A quick evaluation, revealed the fact that the minimum number of combinations, that can be obtained by intersecting the eight types of planes listed above, is 100.

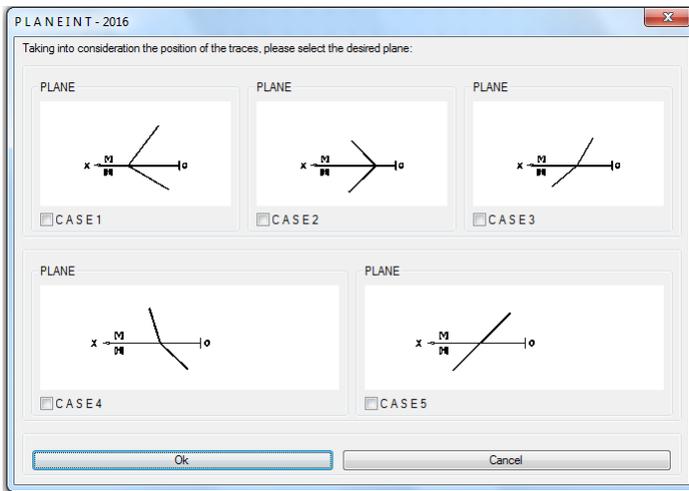
In order to facilitate the assimilation of the problem regarding the determining the intersection line of two planes, the authors built a software named PLANEINT, which run under graphical interface of the AutoCAD.

By inserting, in the command line, of the word, PLANEINT, and by pressing ENTER<E>, the program displays the dialog box presented in figure 3, in which the user has the possibility to choose the first type of plane which take part to the intersection.

If the user chooses the type PLANE, by pressing the OK button, the software displays the dialog box, presented in figure 4, through which the user is invited to select the general position plane desired.



**Fig. 3** The dialog box which allows to choose the type of plane

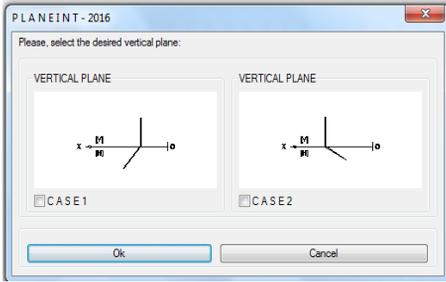


**Fig. 4** The dialog box which allows to choose the variant of general position plane

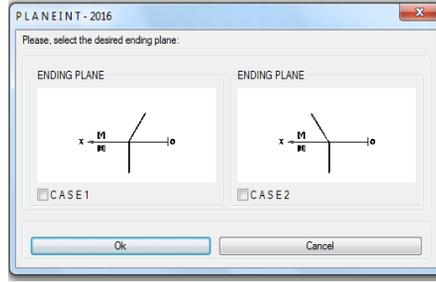
By pressing the OK button, the software displays once again the dialog box from figure 3 and the user is invited to choose se second plane which takes part to intersection.

In case that the user selects, from dialog box presented in figure 3, *VERTICAL PLANE* and presses the OK button, the program displays the dialog box presented in figure 5, which allows the choosing of the variant of vertical plane.

In case that the user selects, from dialog box presented in figure 3, *ENDING PLANE* and presses the OK button, the program displays the dialog box presented in figure 6, which allows the choosing of the variant of ending plane.



**Fig. 5** The dialog box which allows the choosing of the vertical plane



**Fig. 6** The dialog box which allows the choosing of the ending plane

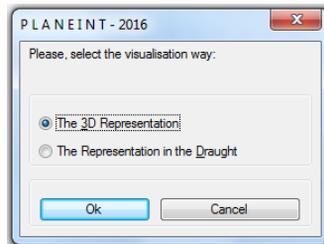
After the planes selection, which take part to intersection, the user has the possibility of choosing, from a database created by authors, the coordinates which permit the planes representation (fig. 7).

Px			Ph			Pv			Qx			Qh			Qv		
X	Y	Z	X	Y	Z	X	Y	Z	X	Y	Z	X	Y	Z	X	Y	Z
Plan de pozitie generala / Plan de pozitie generala																	
79	0	0	38	45	0	14	0	45	58	0	0	45	47	0	21	0	48
.....																	
65	0	0	25	45	0	8	0	40	41	0	0	94	37	0	10	0	22
Plan de pozitie generala / Plan orizontal																	
65	0	0	25	45	0	8	0	40	82	45	14	82	0	14	22	45	14
.....																	

**Fig. 7** The database created by the authors (fragment)

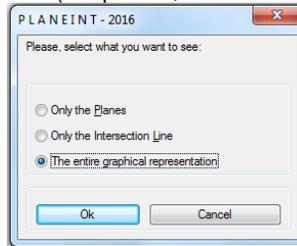
In case that the planes which take part to intersection are similar (e.g. both planes are of the type ENDING PLANE CASE 1) according to the chosen coordinates, may arise three situations:

1. the chosen coordinates for both planes are identical; the user must change the coordinates for one plane or must choose another plane;
2. the chosen coordinates for both planes determines parallel planes; the user must change the coordinates for one plane or must choose another plane;
3. the chosen coordinates for both planes makes them to intersect; the software displays the dialog box shown in figure 8 and, the user, is invited to choose the representation type (representation in volume model or in draught);



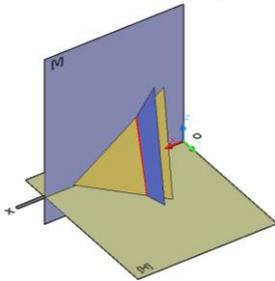
**Fig. 8** Message for selecting the mode of representation (in model volume or in draught)

Next, by pressing the OK button, the software invites the user to choose the elements which will be represented (the planes, the intersection line or both) (fig. 9);

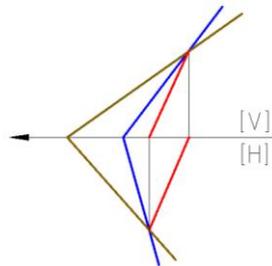


**Fig. 9** Message for the specification of the elements which will be represented

Analysing the database, the user has the possibility to choose, by selecting the desired row, of any set of coordinates. Thus, by choosing the coordinates placed on the first row (fig. 7), the representation of the planes and of the intersection line are given in volume model in figure 10 and in draught in figure 11.



**Fig. 10** The planes and the intersection line (presented in volume model)



**Fig. 11** The planes and the intersection line (presented in draught)

## RESULTS AND DISCUSSIONS

To analyzing the utility of this software, the authors have tested him on a sample from 30 students that previously have covered that issue in classical manner.

Their have been presented, using the PLANINT software, the way to determine the intersection line between next planes:

- ✓ two general position planes, with the angle between traces smaller than  $90^\circ$ ;
- ✓ a general position plane and level plane;
- ✓ a level plane and plane parallel with the OX axis;
- ✓ two ending planes;
- ✓ a level plane and a front plane;
- ✓ a front plane and a profil plane;
- ✓ two general position planes, with the angle between traces bigger than  $90^\circ$ ;
- ✓ two general position planes which have the traces in extension;
- ✓ a vertical plane and a general position plane with the traces in extension;

- ✓ a general position plane with the traces in extensio and an ending plane.

At the end of the last class hour the students received a multiple choice test, in which each question and variant of answer had or not, associated an image. It has been found that:

- 26 students (86,67%) answered correctly at all questions;
- 4 students (13,33%) answered correctly only to the first six questions.

At the end of this test students had to answer to the next question: *How useful is this software?* Thus:

- 24 (80%) have answered *Very useful*;
- 5 (16.67%) have answered *Useful*;
- 1 (3.33%) have answered *Useless*.

## CONCLUSIONS

Because of the great number of planes, which can be intersected and combinations which can be obtained (minimum 100), it can be observed that the issue regarding of determining of the intersection line between two planes is not that simple as it seemed at first.

Starting from above ideas the original software named PLANEINT, created by the authors, was built with the aim to improve the assimilation level by the students of the knowledge referring to the planes representation and to the determining way of the intersection line between two planes (by practicing the visual-spatial intelligence).

The test's efficiency was evaluated by the help of a group made from 30 students. Their have been presented, via PLANEINT software, a number of issues having various level of difficulty. At the end, students have had to answer to a number of questions. The answers of these questions have proved the efficiency and the utility of the software.

As a further direction of research, the software created by authors, can be developed, in sense that the user could had the possibility to introduce own coordinates, with checking of them by the program, because otherwise errors can arise, like case when are given three collinear points which cannot determine a plane, or when the given points lead to overcome of some dimensions, resulting a too big construction.

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