The Need (?) for Descriptive Geometry in a World of 3D Modeling

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ABSTRACT

Traditionally, descriptive geometry has consisted of the projection of three-dimensional figures on a two-dimensional plane of paper using successive auxiliary views. Through this method quantitative measures of length, angles, shapes and other geometric information were obtained. The technology required a systematic approach to problem solving with accuracy in projections and transfer of distances from previous views. The layout and position of the successive auxiliary views were essential in the solution of the problem.

Modern CAD methods that may be used to solve descriptive geometry problems no longer require that the auxiliary views be positioned in the standard layout of auxiliary views. Often the CAD system will allow for a direct solution of the problem without an intermediate auxiliary view as would be required by the traditional two-dimensional successive auxiliary view approach. Using traditional two-dimensional successive auxiliary views with CAD is cumbersome and antiquated. With the advent of CAD, the concepts of descriptive geometry have not changed; however, the process through which we obtain the results has changed.

Introduction

For many years, the technology used to solve descriptive geometry problems has been through projection of three-dimensional figures on a two-dimensional plane of paper using successive auxiliary views. These solutions are achieved through a series of geometric manipulations of two-dimensional views to determine lengths, angles, shapes, and other geometric information (Earle, 1994). Today, a three-dimensional CAD system with solid modeling is the state-of-the-art technology used to create many engineering designs which often include some form of descriptive geometry for complete presentation. The CAD system facilitates the creation of the three-dimensional model and then from this model the orthographic views can be extracted for the final engineering design drawings. What happens when the geometry of the design is such that an auxiliary view is required that shows the true shape of an oblique surface? Should this powerful CAD system be simply used as an electronic pencil with the screen being the paper and thus generate the two-dimensional views as has been done for years using pencil and paper graphics? Ritter (1990) used this concept in the computer layout of the true size of oblique surface. CADKEY 1.4E, a three-dimensional CAD package, is used to layout a series of two-dimensional views with reference lines as you would expect to see using pencil and paper. Knoblock and Jensen (1997) report that "modern texts", both comprehensive and specialized, continue to treat descriptive geometry as solely a two-dimensional subject. They further report that even texts that embellish titles with CAD/CAE only use CAD to emulate manual methods. The concepts and geometric rules have not changed regarding descriptive geometry solutions; however, the tool has changed. The purpose of this paper is to introduce a more modern approach to CAD solutions to descriptive geometry problems.

Descriptive Geometry with CAD - Not a New Concept

Many professionals in the field of graphics have a hard time with new technologies and find it very difficult to forget the "old" way in favor of the new way. For example, in determining the true size of an oblique surface, the basic concept is to view the surface normally. The only way this can be accomplished using two-dimensional auxiliary view technology is to first get an auxiliary view that shows the surface as an edge, then get another auxiliary view off the edge view that shows the surface in true size. Figure 1 shows this solution. Since the horizontal view shows AB as a true length line, a point view of AB can be obtained through an auxiliary view H-1. Since AB is a line contained in the oblique plane ABC, then ABC must be an edge view where AB is a point view. View 1-2 is a successive auxiliary view that shows a normal view of ABC which is the true size view.

The same problem solved using a three-dimensional CAD system is really no different. The technology allows us to create a true size view of the oblique surface directly without the intermediate step of getting an edge view. Therefore, instead of having two auxiliary views to create the true size view, there is only one auxiliary view. How can this view be documented on the drawing? One simple method is to place it on the drawing with a note of explanation. See *Figure* 2. In this case, the three-dimensional data base is manipulated to create a new view with line CB being the new X axis and point A depicting the direction of the new Y axis relative to the X axis. Note that the true size view is not in projection with any other view. This type of layout may bother some

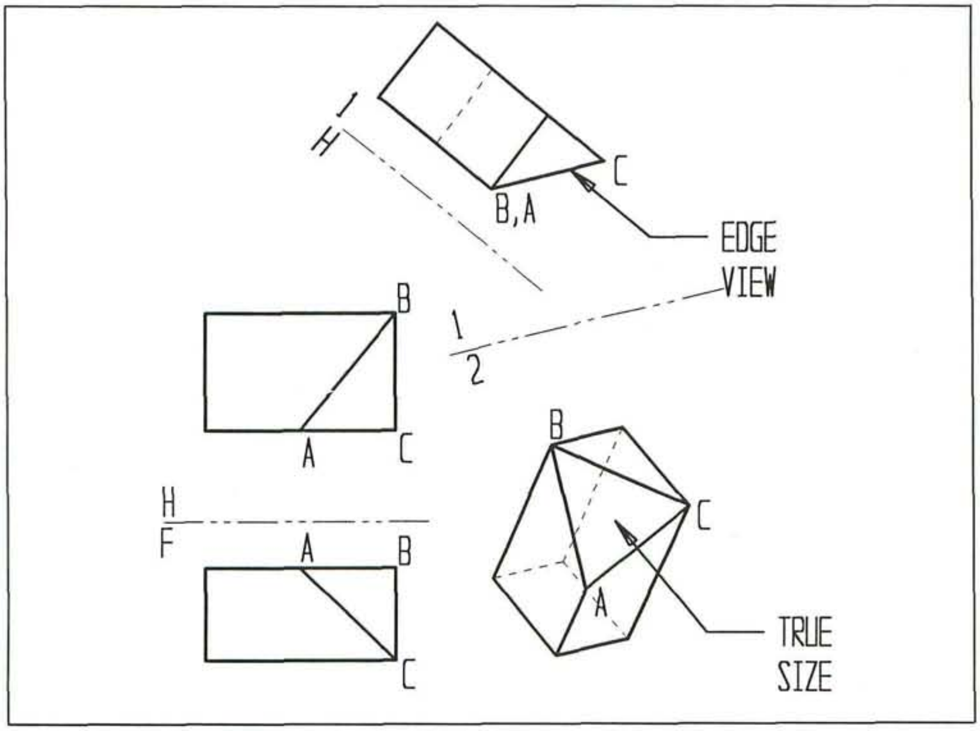

***Figure 1** - True size of an oblique plane - successive auxiliary view technique.*

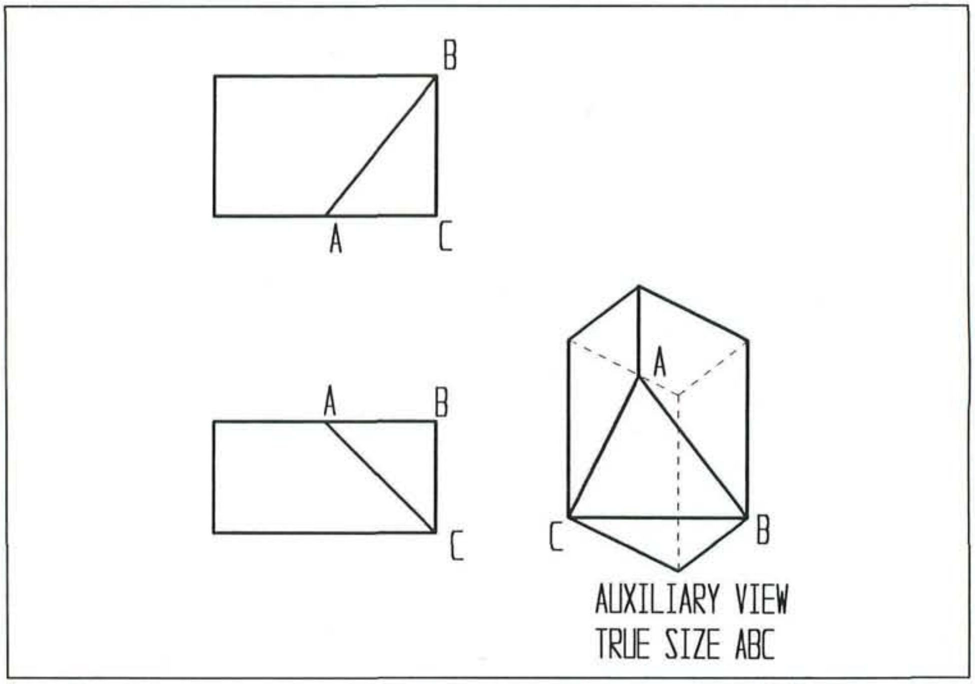

Figure 2 *- True size of an oblique plane - CAD technique.*

since it "breaks tradition"; however, in this format, there is no view appropriate from which to project the true size view. It simply is obtained through CAD manipulation of the three-dimensional model.

Kelso (1995) recognized the fact that computer geometric modeling need not use orthodirectional projection. He offers three alternatives in the presentation of traditional multiviews which consist of a series of phantom lines connecting the geometric elements of the model in each view and a double line depicting the "fold line". Why is it necessary to show phantom projectors and fold lines when the CAD system manipulates the geometry to obtain the desired results and these results can be verified through a query of the system? The procedure described above and shown in *Figure 2* simplifies the presentation and fully utilizes the power of the CAD system.

For the purist, there is an alternative. After obtaining the true size view of the oblique surface, another auxiliary view showing the edge view can be created. Then in the two-dimensional layout mode that most CAD systems offer, the auxiliary views can be shown in their "traditional locations". This type of layout is shown in *Figure 3*. The layout shown in *Figure 3* is similar to what Kelso (1995) suggest except that there are no phantom lines connecting geometric elements and there are no fold lines. It should be emphasized that the true size view is determined first and then from the true size view an edge view is created. Unlike traditional descriptive geometry techniques, the edge view is not necessary to determine the true size in the CAD technique.

In the Winter 1997 issue of the *EDGD Journal*, Kelso (1997) shows a another method by which one can facilitate the drawing of auxiliary views using CAD. The premise of his presentation is simply to ensure that "glass box" theory is not violated and that the distance from the fold-line to the auxiliary view matches the distance from two fold lines back (two 90 degree turns in space). This approach is fine when two-dimensional graphics is being used; however, with three-dimensional CAD, it is cumbersome and really serves no useful purpose. In the problem illustrated all that was needed was the true angle between the protruding angle jig and the base. *Figure 4* shows a similar problem. The angle between the protruding angle jig and the base is determined from an auxiliary view taken in the direction of A-B. The geometric information is determined once the view is shown. It does not matter how this auxiliary view is placed on the drawing; however it is shown in its projected position in *Figure 4*.

Conclusion

Before CAD (BC?), descriptive geometry problems were solved using successive auxiliary views. Precise projections and precise transfer of measurements had to be made in order to get the desired results. With the advent of CAD, the concepts of descriptive geometry have not changed; however, the process through which we obtain the results has changed making the successive auxiliary view format cumbersome and antiquated. CAD often times allows us to get the desired result directly from the three-dimensional data base without having to create a preliminary auxiliary view first as was described in the true size of an oblique surface problem. It only makes good sense to use the power of the CAD system for what it was intended; to help us solve our design problems efficiently and to increase productivity.

Is there a need for descriptive geometry in the world of three-dimensional modeling? The answer to this question should be a resounding YES!! The technology has changed and the challenge is to determine how to make the best use of this technology as was done decades ago when traditional projective geometry was the state-of-the-art. Descriptive geometry using CAD techniques requires an even greater command of spatial relationships than what is required for traditional projective geometry. CAD enables us

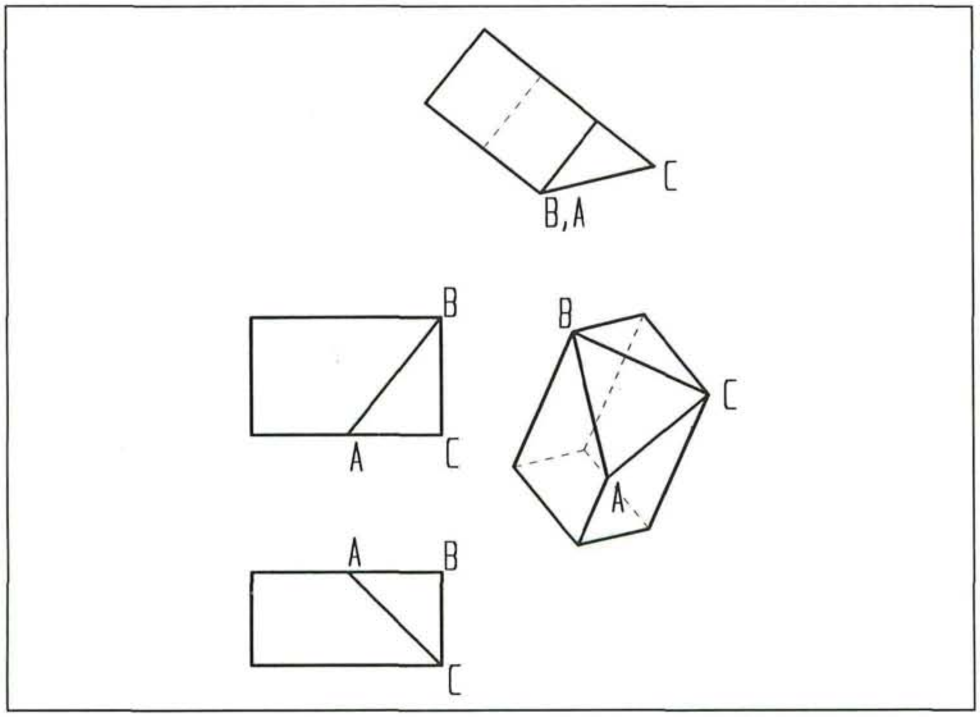

Figure 3 *- True size of an oblique surface - CAD technique with traditional views.*

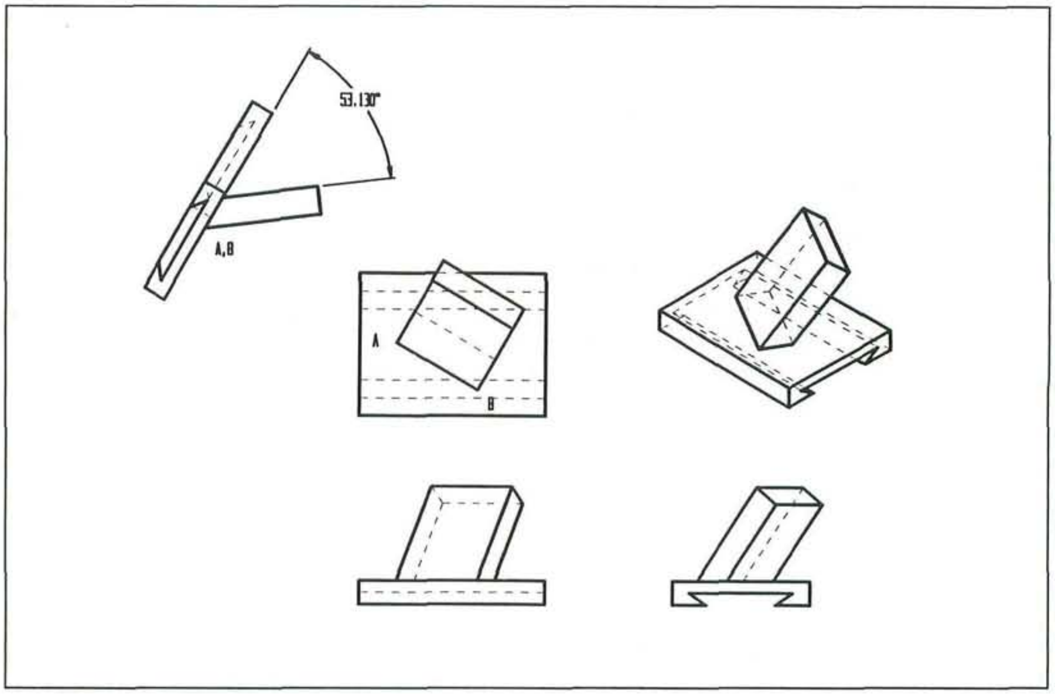

Figure 4 - Measurement of dihedral angle - CAD technique.

to use a variety of methods to solve the same problem, and it is essential that the user have a sound foundation in spatial relationships and visualization so that the solutions that are developed are the most efficient.

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