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Correction to Chastain (1989)

In the article "Axonometric Projections" by Lemuel J. Chastain (*Engineering Design Graphics Journal,* 1989, Vol. 53, No. 2, pp. 19 – 25—see http://edgj.org/index.php/EDGJ/issue/view/237), three types of errata have been found:

1. typographical errors were introduced after the final proof-reading (by the compositor?);
2. usage of the variables A, B, and C, on page 25 which is inconsistent with the preceding development;
3. and, a thoughtless sentence by the author (being all of the next-to-last paragraph on page 25) overstates the findings.

The simple typographical errors on pages 19-23 will be corrected in page order, followed by the inconsistency, and then the factual error (this being in the reverse order of importance).

1a - On p.19, col.1, para.2, l.6, "It" should be replaced by "If".
1b - On p.20, col.2, l.17, a square root symbol should be added just before the "6".
1c - On p.22, col.1, para.1, ll.1-2, "basis" should be replaced by "basic" (i.e. lower-case).
1d - On p.23, col.1, l.7, "vary" should be replaced by "very".
1e - On p.23, col.1, l.24 "independent" should be replaced by "dependent".

2 - Beginning on p.25, col.1, paras. 1&2 (paragraph 2 continuing in column 2) suddenly introduce an analysis of the many solutions obtained by running several sequential iterations of the program shown in Figure 3. The result of the first iteration of the program, shown in Figure 4, quickly reveals that, for relatively prime solutions, the single even-valued variable occurs freely as any one of A, B, or C (for a given solution set).

Contrary to that, the new treatment summarized in Figure 7, compels C to always be the single even-valued variable. Unfortunately, the conciseness of these four parametric equations ignores the ascending order imposed on A, B, and C, by the program in Figure 3: thus, the inconsistency.

There is no need to extend the current program to rearrange the variables to correspond with Figure 7. It has served its purpose, and is obsolete. Any new program in a better language (e.g. Python) should be based on the Figure 7 results; with the programmer given the option of switching the expressions for A and C.

3a – On p.25, col.2, ll.1-2, "(in BASIC)" should be deleted.
3b – On p.25, col.2, l.4, the word "all" (made more egregious being underlined) should be deleted: integer triplets for the parameters f, g, and h, will always yield a real solution for the four variables. However, it is clear that those triplets will not always result in a perfect square in the discriminant. [Contrast Solution 1 from (f, g, h) = (1, 1, 1), with the irrational results from (5, 5, 5).] This was a thoughtless generalization by the author from the parametric equations used for the 2-D 'Pythagorean Triplet' case which do not require a square root symbol.

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While the original objective was to find Axonometric Projections with rational projections for a unit-cube, the final results shown in Figure 7, go well beyond that: non-negative real values of the parameters will result in real values for the 4 variables. (Caution prevents the use again of "all" in the prior sentence.)

Lastly, the use of the 'plus or minus' sign before the discriminant is standard for a quadratic solution. Use of the minus alternative, however, while preserving equality, will result in some negative values in the variable quadruples. Such solutions do not apply to 3-D Axonometric Projections.

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ENGINEERING DESIGN GRAPHICS DIVISION

AMERICAN SOCIETY FOR ENGINEERING EDUCATION

The Transfer of Data Between Dissimilar Computer-Aided Design Systems

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The transfer of geometric modeling data between dissimilar CAD systems is an important capability in an integrated engineering or manufacturing environment and can be accomplished by two means: direct conversion of data or the use of a standardized intermediate file format. The Initial Graphics Exchange Specification (IGES), a part of ANSI Standard Y14.26: Digital Representation of Product Definition Data, is the standard neutral file format for the exchange of CAD modeling data in the United States. While IGES is supported by all major CAD vendors, the standard has three serious problems. First, most IGES translators are incomplete in their implementation. Second, translation of certain types of entities is often incomplete or inaccurate. Third, the IGES standard lags behind state-of-the-art geometric modeling techniques. These problems can be handled effectively if they are identified and if procedural and systems tools are developed and implemented to minimize their impact. The IGES standard, procedural tools, and computer-based tools are described.

Introduction

As Computer-Aided Design (CAD) and Computer-Aided Engineering (CAE) systems have become more widespread in their use, the problem of transferring design data between different computer-aided design systems must be addressed. Each individual CAD system uses a unique internal representation scheme for storing and manipulating the binary data which defines a CAD model. As a result, design data created on one CAD system is not directly usable by another CAD system without some form of processing. In any environment where several different CAD or CAE systems are used, such as education, mechanisms must be implemented to facilitate transfer of model data between dissimilar CAD systems.

Two basic approaches are available for transferring data between dissimilar CAD systems. The first approach is to develop a program which translates the data structures used to define the CAD model on the source machine directly into the data structures required by the target machine. The second approach is to translate the data structures used to define the CAD model on the source machine into a standardized intermediate neutral format which can then be translated by the target machine.

Each of these approaches is represented schematically in

Figs. 1 and 2. Both translation methods have advantages and disadvantages when compared to each other.

Direct translation, the first approach, is best suited to large-scale data conversion or frequent data transfer between two systems. The software used in direct translation must either be purchased, if available, or developed. The development, testing, and implementation of a translator requires a sophisticated and extensive knowledge of programming and database techniques. Additionally, specific information on data structures used by the commercial CAD package is required to write the translator and this information is often proprietary. A separate dedicated translator is required for each system to which data will be transferred. This means that an increase in the number of systems requires a geometrical increase in the number of translators, i.e., for four systems, twelve translators would be required; for five systems, twenty translators, etc.

The use of an intermediate neutral file format in the translation of CAD data, the second approach, is a general purpose approach to the problem. These translators, usually available for standard file formats, are available from vendors and only one translator is required for the system. However, problems can develop in data translation because two translations of the data are required. The data structures defined by the source systems may not directly convert to the data structures defined by the intermediate neutral file format. Further, the neutral format data may not directly convert to the data structure used by the target system. If this conversion problem is not considered, incomplete or inaccurate CAD models may be produced on the target system.

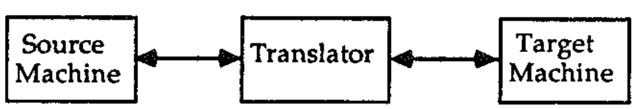

Fig. 1 Direct Translation

Intermediate Neutral File Formats

Worldwide, there exists a number of neutral file formats for the exchange of CAD modeling data. Many of these interchange formats are specific to a particular industry, vendor, or national group. The most common interchange format standards in use worldwide are:

IGES - The Initial Graphics Exchange Specification (IGES), is part of ANSI Standard Y14.26: Digital Representation of Product

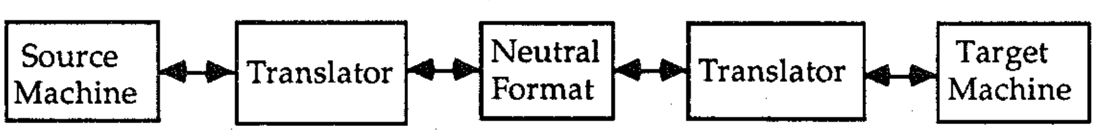

Fig. 2 Intermediate Neutral Format

Definition Data[1,2] and is designed to function as a standard intermediate neutral file format for the exchange of data between CAD systems. IGES has been approved by ANSI as an American National Standard. IGES is being presented to the International Standards Organization (ISO) for acceptance as a worldwide standard.

PDES - The Product Data Exchange Standard (PDES) is being developed by the IGES committee and will supercede IGES. PDES will incorporate information relevant to the entire development and manufacturing life cycle of the product.

STEP - The Standard for the Exchange of Product Definition (STEP) is currently under development by ISO. It is anticipated that STEP and PDES will be similar, if not directly compatible. PDES will precede STEP, which is not anticipated before 1990.

SET - (Standard D'Exchange et Transfer) is a compact format for data transfer. SET was released by Aerospatial in 1984 and is now French National Standard Z68300.

VDA-FS - The German National Standard, DIN 66301, was developed by the automotive industry for the exchange of complex surface data. VDA-FS/IGES translators are available.

EDIF - Electronic Design Interchange Format has been developed by the electronics industry for the exchange of VLSI (Very Large Scale Integration) and PCB (Printed Circuit Board) design and manufacturing data. This interchange format is the de facto standard in the electronics field worldwide.

DXF - Drawing Interchange File is a standard developed by Autodesk for the transfer of data (usually 2-D) in the microcomputer based CAD environment. This standard may actually be superior to IGES in the transfer of production drawings.

Each of these data interchange formats fulfills specific needs from an industry or national viewpoint. However, the formats are merging into a limited number of international standards. Principal among those standards gaining international acceptance are EDIF for electronics industries and IGES/PDES for nonelectronics inductries.

The Initial Graphics Exchange Specification

IGES was developed under the Air Force Integrated Computer-Aided Manufacturing (ICAM) program and coordinated by the National Bureau of Standards (NBS). This technical committee produced a report in 1980 that is known as IGES Version 1.0. This report covers models constructed in two and three dimensions as wire frame representations with planar or curved surfaces. This version also supports annotated entities and structure entities, such as groups. The format structure utilizes ASCII files in 80 character records. IGES Version 1.0 was adopted as part of ANSI Standard Y14.26M in 1981.

IGES Version 2.0 was published in 1982 and is an extension and refinement of Version 1.0. The major additions to IGES in Version 2.0 include rational B-spline surfaces and curves, additional surface entities, FEM (Finite Element Modeling) support, and provision for a binary file format. IGES Version 3.0 was published in 1983 and corrected errors in IGES 2.0. Version 3.0 provides additional and component libraries by providing for external file reference and introduced a compressed ASCII file format. Offset curves and surfaces, provision for representing flow, direction, and connectivity, and extension to the Macro facility were included in Version 3.0. IGES Version 4.0 is an extension to IGES for the representation of solid modeling entities and was published in 1987. Version 4.0 addresses only constructive solid geometry (CSG).

A number of extensions to address problems in specific applications areas have been adopted or are being considered by various subcommittees of IGES. Several of the major CAD vendors (IBM, CV [since purchased by Prime], CALMA [since purchased by Prime], and Prime) have cooperated in developing or recommending extensions in certain areas, such as in manufacturing and plant design.

A Description of IGES

IGES is a data format for describing product design and manufacturing information produced on a CAD/CAM system. It was designed to function as an intermediate neutral file format for the interchange of CAD/CAM data between dissimilar systems. An IGES file has at least five sections:

Start Section
Global Section
Directory Entry Section
Parameter Data Section
Terminate Section

Additionally, a Binary Information Section is prefaced to a file created under IGES Version 2.0 or 3.0 when a binary format is produced, rather than an ASCII file.

An IGES file is created when an IGES preprocessor software package on the source machine translates the entities from the source machine's CAD database into the neutral format file defined by the IGES standard. An IGES postprocessor software package is required to translate the IGES file into data structures the target machine is required to reconstruct (Fig. 3). The IGES file transfers information of the following types:

Geometric Information
Nongeometric Information (dimensions, text, etc.)
Drawing and Display Information (drawing size, fonts, etc.)
Relationship Information (connectivity, flow, etc.)
General or Global Information

Each entity is initially classified as geometric or nongeometric with nongeometric entities having primary classifications of annotation or structure. The IGES representation of each entity is divided into two parts: directory entry and parameter entry. The directory entry is identical for each entity of the

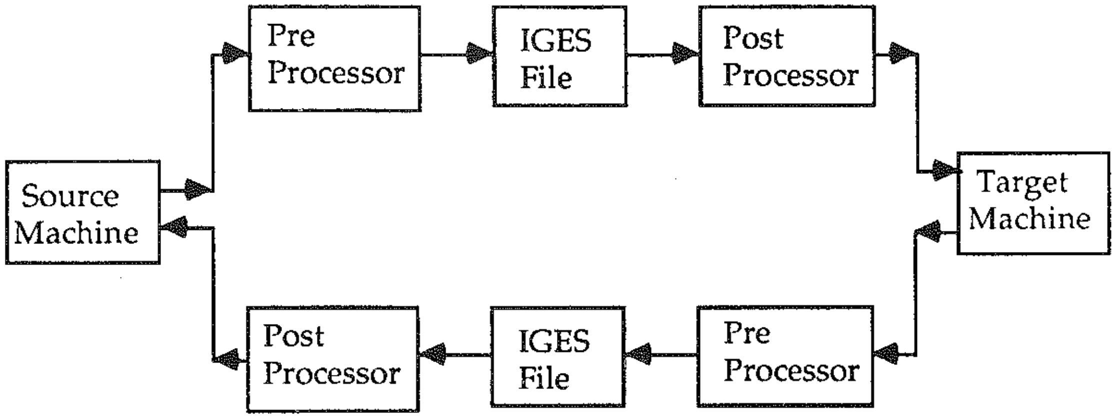

Fig. 3 IGES File Translation

same type but the parameter section is unique to each entity. Each entity type is classified as an IGES entity number which may be further subclassified by an IGES form number. In the example IGES file (Table 1), the next to last column indicates with the letters listed below the section being presented:

S - Start Section
G - Global Section
D - Directory Section
P - Parameter Section
T - Terminate Section

Table 1 represents a short IGES file which describes a drawing of a flat plate with three holes and centerlines on an A-size sheet. The sample IGES file is 119 lines long and is used to describe a part consisting of 16 separate entities (Fig. 4).

IGES Data Conversion

The primary function of the IGES postprocessors and preprocessors is to map the entity types of the source CAD file into a description which uses the available IGES entity types. This conversion can be accomplished to varying degrees of accuracy and completeness depending on the implementation of the IGES preprocessor and limited by the inherent constraints of the IGES file types available. Fig. 5 indicates the types of conversions which can take place[2,3,4]. These possible modifications to the original data file must be understood to successfully utilize the IGES file format. These modifications can occur while translating the original file to the IGES file format and from the IGES

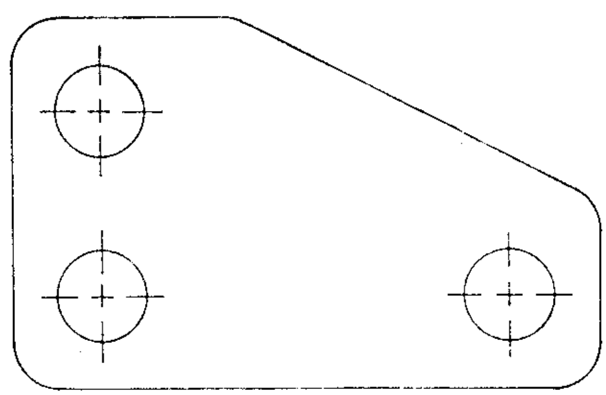

Fig. 4 A 16-entity part.

```
EXAMPLE OF SIMPLE IGES CONVERSION                                       S      1
,,3HDWG,9HIGES.TEST,46HCOMPUTERVISION CADDS4X REV 5.0 GRAPHIC SYSTEM ,  G      1
16HIGES VERSION 3.0,16,8,24,8,56,3HDWG,1.0,1,4HINCH,32767,32.767,13H8810G      2
17.140917,0.000001,,14HDENNIS R SHORT,17HPURDUE UNIVERSITY,4,3;         G      3
     124       1       1       0       0       0       0       0       1D      1
     124       0       0       1       0                                D      2
     124       2       1       0       0       0       0       0       1D      3
     124       0       0       1       0                                D      4
     124       3       1       0       0       0       0       0       1D      5
     124       0       0       1       0                                D      6
     124       4       1       0       0       0       0       0       1D      7
     124       0       0       1       0                                D      8
     124       5       1       0       0       0       0       0       1D      9
     124       0       0       1       0                                D     10
     124       6       1       0       0       0       0       0       1D     11
     124       0       0       1       0                                D     12
      .
      .
      .
      .
     106      35       1       1       0       0       0       0   10101D     61
     106       0       0       2      20                                D     62
     106      37       1       1       0       0       0       0   10101D     63
     106       0       0       2      20                                D     64
     406      39       1       0       0       0       0       0   10201D     65
     406       0       0       1      15                                D     66
     406      40       1       0       0       0       0       0   10201D     67
     406       0       0       1      17                                D     68
     406      41       1       0       0       0       0       0   10201D     69
     406       0       0       1      16                                D     70
     404      42       1       0       0       0       0       0     201D     71
     404       0       0       1       0                                D     72
124,1.0,0.0,0.0,0.0,0.0,1.0,0.0,0.0,0.0,0.0,1.0,0.0;                   1P      1
124,1.0,0.0,0.0,0.0,0.0,0.0,-1.0,0.0,0.0,1.0,0.0,0.0;                  3P      2
124,0.0,0.0,1.0,0.0,1.0,0.0,0.0,0.0,0.0,1.0,0.0,0.0;                   5P      3
124,1.0,0.0,0.0,0.0,0.0,-1.0,0.0,0.0,0.0,0.0,-1.0,0.0;                 7P      4
124,0.0,0.0,-1.0,0.0,-1.0,0.0,0.0,0.0,0.0,1.0,0.0,0.0;                 9P      5
124,-1.0,0.0,0.0,0.0,0.0,0.0,1.0,0.0,0.0,1.0,0.0,0.0;                 11P      6
    .
    .
    .
    .
106,1,6,0.0,5.86811,3.25,5.625,3.25,5.5625,3.25,5.4375,3.25,          61P     35
5.375,3.25,5.13189,3.25;                                              61P     36
106,1,6,0.0,5.5,3.61811,5.5,3.375,5.5,3.3125,5.5,3.1875,5.5,          63P     37
3.125,5.5,2.88189;                                                    63P     38
406,1,3HDWG;                                                          65P     39
406,1,1;                                                              67P     40
406,2,11.0,8.5;                                                       69P     41
404,1,25,0.0,0.0,6,53,55,57,59,61,63,0,3,65,67,69;                    71P     42
S      1G      3D      72P      42                                      T      1
```

Table 1 Example IGES File

Source	Target
single entity	single entity
multiple entity	single entity (grouping)
single entity	multiple entities (cross hatching)
single entity	modified entity (line and text fonts)
single entity	approximated entity
single entity	not translated

Fig. 5 Types of conversions which can take place

file format to the target system. Entities can be altered twice in the process of conversion. On some systems, such as IBM's CATIA[3] (Fig. 6), the use of an internal intermediate file format called IIF places an additional layer of conversion between the original file and the intended destination. This additional translation further contrains that which can be translated and transferred by an IGES file. Many commercial CAD systems are better at translating IGES files than at generating IGES files.

Procedural Tools

The first requirement in working with an IGES translation is to know the converting capabilities of the preprocessor

Fig. 6 IBM CATIA IGES Translation

and postprocessor implementations[5,6,7,8]. The capabilities of an IGES translator are usually indicated in the system's IGES documentation. The capabilities of the processors are indicated in the documentation in tabular form showing the system entities which can be mapped to IGES entity and form types. Also shown are special considerations required in translation.

When developing any model for IGES translation, the model should be constructed using only those system entity types which are known to be translatable without modification or approximation. Particular attention should be directed toward special text fonts and related symbols, line fonts of any type including centerlines, dimensioning, and datums or related constructs. Foreign systems frequently involved in IGES transfers should be evaluated. IGES entity types which are most suitable for conversion and entity types to avoid should be determined.

IGES transfers between microcomputer-based CAD systems and larger, more robust CAD systems, can represent a particularly difficult problem. Implementation of IGES preprocessors and postprocessors on microcomputer based CADD are often woefully inadequate for the task and suffer from a series of problems. The types of problems encountered include:

1. Floating point accuracy due to 32-bit to 16-bit conversion which can result in such problems as loss of tangency or disconnected line segments. This can cause severe problems when transferring tool path information.

2. The ability to translate only a very limited subset of the available IGES entity types and forms.

3. Poor error recovery and exception reporting during the translation process.

4. Inadequate documentation of processors and their cababilities.

5. Inadequate validation and testing of IGES processors. Many IGES processors will fail a self-translation test.

These problems cannot easily be corrected by the user. Corrections rests with the vendors.

Computer Based Tools

Since IGES files are in ASCII text format, it is possible to develop a set of tools to aid in the translation, verification, and validation of IGES files. These IGES utility programs can be programmed using any higher level language, such as C or Pascal, which permits easy manipulation of text files. The IGES utility programs are also available from commercial software companies.

The most common type of IGES utility programs are filter programs. These programs scan an IGES file prior to conversion on the system. Most frequently the programs scan for entity or form types which cannot be converted properly by the host system. Filter programs can also check for file integrity, illegal characters in file names, length of file names, missing file references for library parts, or out-of-range values. Filter programs can also be developed which evaluate database integrity by checking for stacked, overlapped, concatenated, or out-of-range entities.

Modifications of IGES files can also be accomplished by the use of text file editors or special IGES file editors. The editing of IGES files prior to translation can permit use of otherwise valueless files. The editing of IGES files must be approached with caution since an intimate knowledge of IGES and its file structure is required. An intelligent IGES editor linked with IGES filter programs can permit the successful translation of the majority of IGES files. These utility programs can also generate considerable savings in translation time.

Conclusion

IGES represents the best currently available standard for the transfer of 3-D modeling data between dissimilar systems. While the restrictions present in any standards applied to a rapidly evolving field are unfortunate, IGES is widely supported and is an evolving and improving standard. Unfortunately, the quality and robustness of the implementation of IGES translators varies considerably between vendor implementations. However, the pressures of the market place and the increasingly common requirements for CAD data transfer are resulting in better tools and support.

The development of PDES and adoption of IGES/PDES as a worldwide standard indicate the acceptance of IGES. Using the standard is not yet a turn-key operation and an understanding of the problems and limitations of the standard are required to implement IGES file transfers successfully. A proper set of procedural and systems based tools for IGES are essential for any successful implementation.

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[3]"Reference Manual VM, CATIA-IGES and IGES-CATIA Interfaces", IBM Publication, 1988.

[4]"IGES User Guide, CADDS 4X Revision 5.0/2.00G", Computervision Corporation, Bedford, MA, 1986.

[5]Bloor, M. S., Dodsworth, J. R., Owen, J., Stewart, P. F., "Computer Aided Design of Interchange Data: Guidelines for the Use of IGES in the Transfer of Two Dimensional Drawings, Test, and Additional Data Between Different CAD Systems, Using Magnetic Tape", CAD-CAM Data Exchange Technical Centre, University of Leeds, England, July, 1986.

[6]Grabowski, M., Glatz, R., "IGES Model Comparison System, A Tool for Testing and Validating IGES Processors", *IEEE Computer Graphics and Applications*, December, 1987.

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[8]Owen, J., Bloor, M. S., "Neutral Formats for Product Data Exchange: the Current Situation", *Computer-Aided Design*, Vol. 19, No. 8, October, 1987.

A Technique for Drawing Auxiliary Views Using 2-D CAD (CADKEY)

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A technique for creating auxiliary views of three-dimensional objects using 2-D CADKEY is demonstrated.

The problem: Using 2-D CAD, create an auxiliary view of a three-dimensional object showing the true shape image of an inclined surface. For the object of Fig. 1, show the true shape image of the surface appearing in edge view in the front view.

The solution:

A. Draw two lines parallel to the designated edge view - one to serve as a "backstop line" for the projection lines constructed perpendicular to the edge view and the other to serve as the auxiliary folding line (Fig. 2).

B. Construct projection lines perpendicular to the backstop line and passing through the end-points of each line of the front view image (Fig. 3).

C. Copy the top (or side) view, including the folding line, to a position such that the end-point of the copied folding line coincides with the endpoint of the auxiliary folding line (Fig. 4). (Change the lines to phantom lines to create a phantom view.) If overlapping of principal views occurs, transfer the phantom view to a different LEVEL (a pseudo-transparent overlay with on/off visibility capabilities).

D. Determine the angle between the phantom folding line and the auxiliary folding line (Fig. 5).

E. ROTATE the phantom view such that (1) it lies on the same side of the auxiliary folding line as the desired auxiliary view and (2) the folding line is collinear with the auxiliary folding line (Fig. 6).

F. From the end points of each line in the phantom view, draw projection lines parallel to the auxiliary folding line into the area of the desired auxiliary view (Fig. 7).

G. The intersection of the projection lines which are (1) parallel and (2) perpendicular to the auxiliary folding line determines the points of the final auxiliary image (Fig. 8).

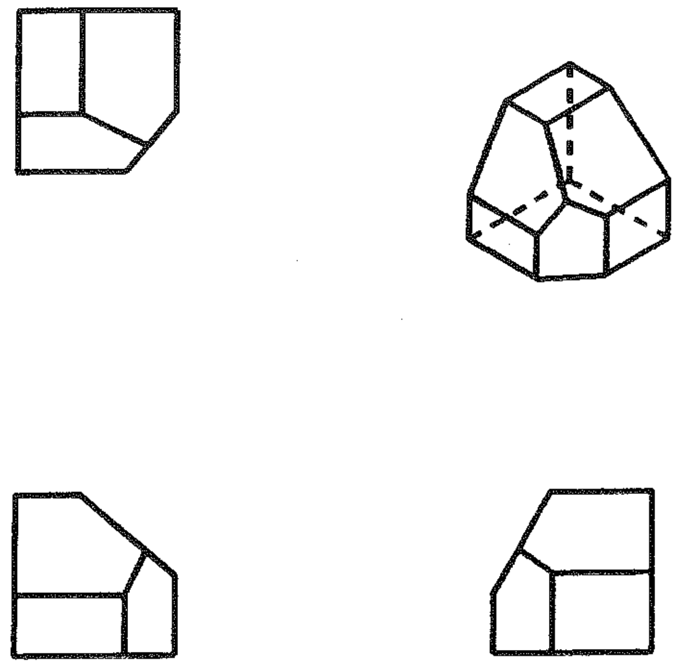

Figure 1

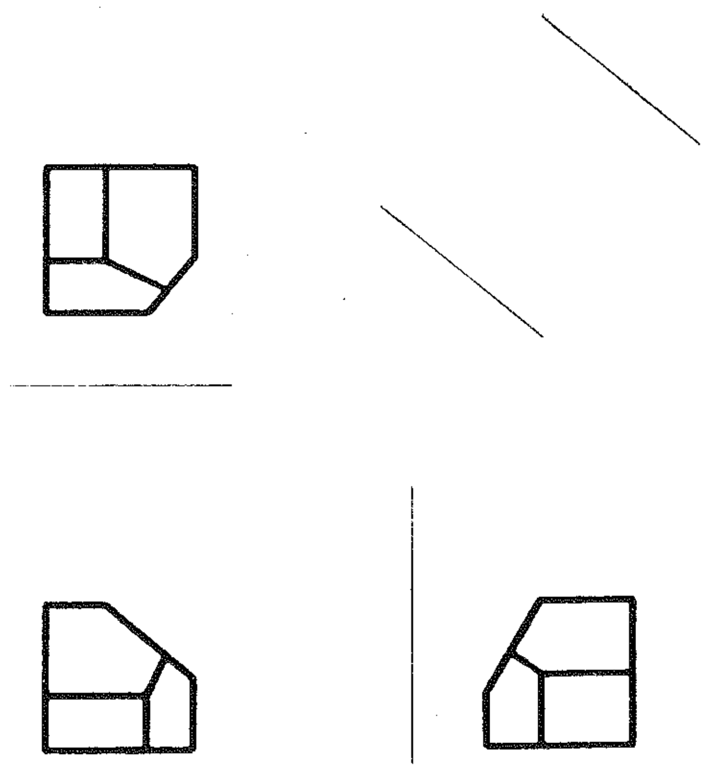

Figure 2

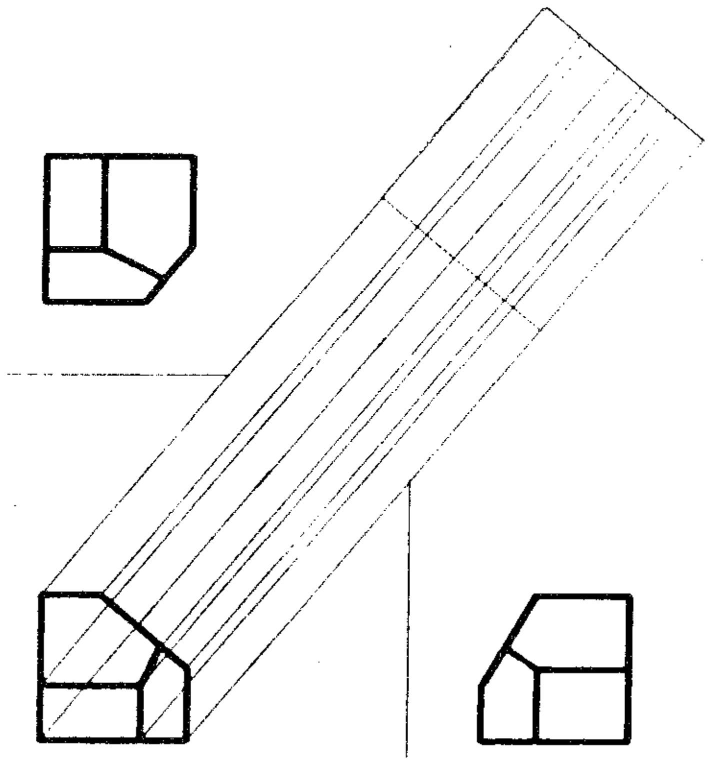

Figure 3

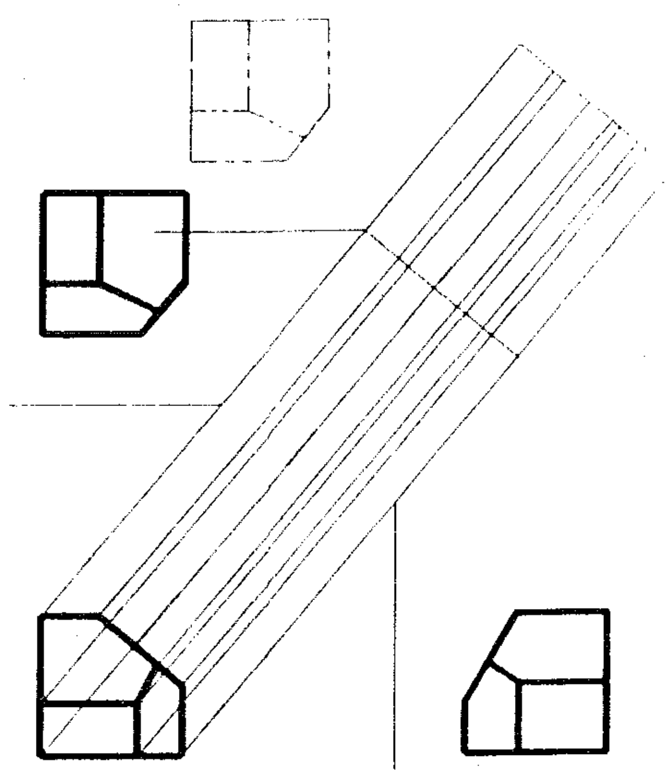

Figure 4

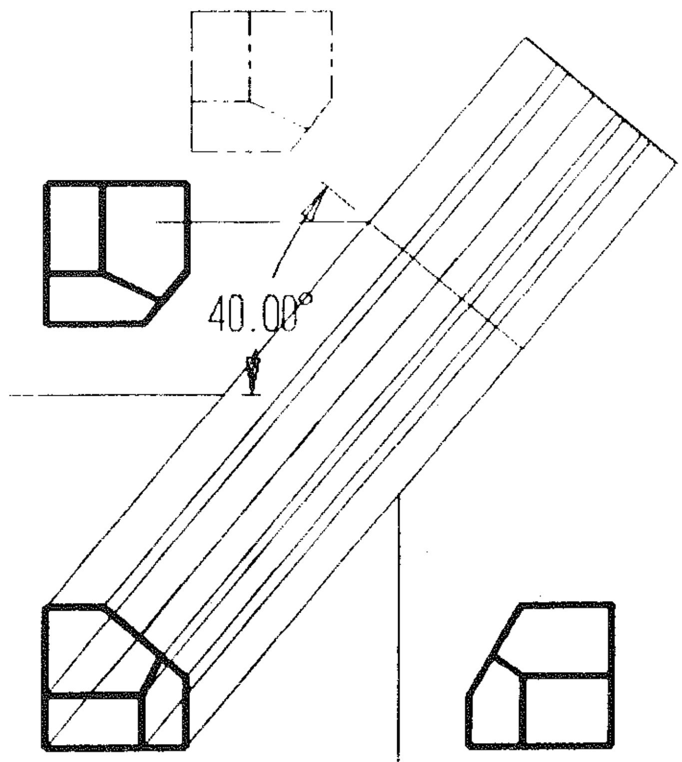

Figure 5

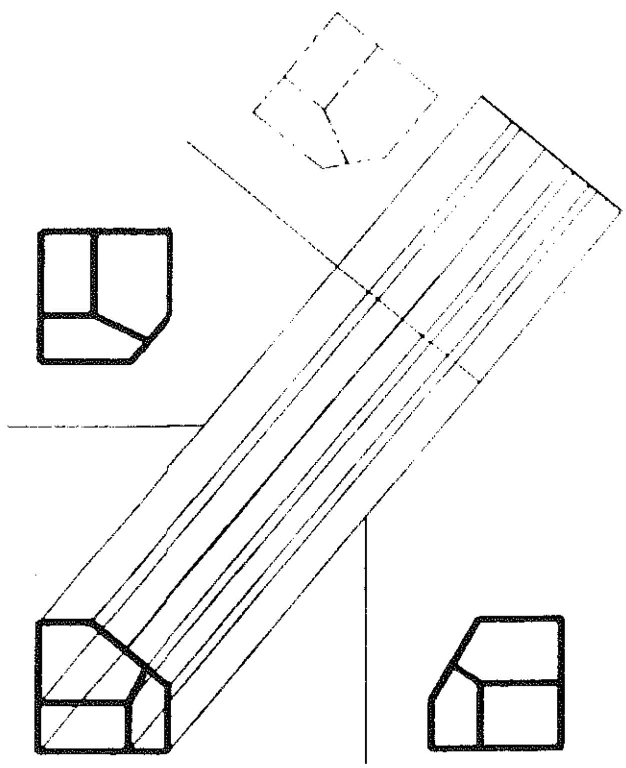

Figure 6

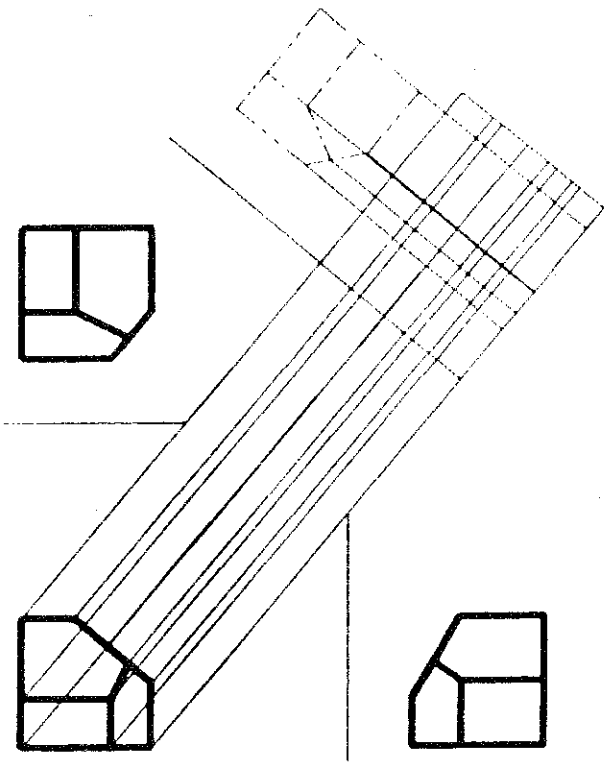

Figure 7

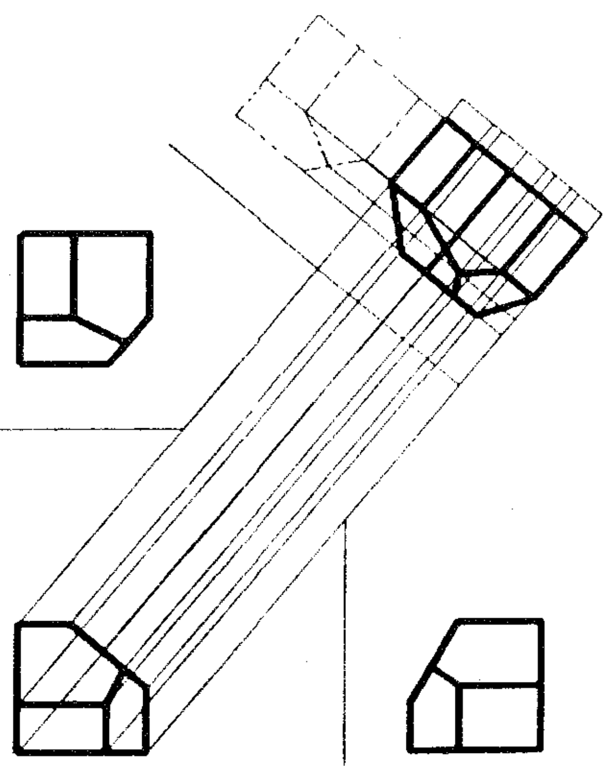

Figure 8

Formulas for Quickly Determining the Area of Regular Polygons

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Formulas for the area of regular polygons are developed using the properties that all regular polygons can be inscribed in or circumscribed about a circle and that each regular polygon can be decomposed into a set of congruent isosceles triangles. Basic geometric and trigonometric properties are used to determine the area when given the three most common parameters used by drafters: distance across corners, distance across flats, or length of a side. A summary of formulas for the area of the most common regular polygons is given.

A general method for finding the area of a regular polygon is helpful to mathematicians, drafters, and engineers. Any regular polygon of n sides can be decomposed into a set of n congruent isosceles triangles (Fig. 1), each of which has its vertex at the center of an inscribed or circumscribed circle. Hence, finding the area of one of the triangles and multiplying by the number of sides will give the area of the polygon.

The available parameters are the radius of the circumscribed circle (R), the radius of the inscribed circle (r), and the length of a side of the polygon (s) (Fig. 1).

Case 1. The radius (R) of the circumscribed circle is known. This is the situation which occurs when the "distance across corners (vertices)", twice the radius, is given for a polygon with an even number of sides (Fig. 2).

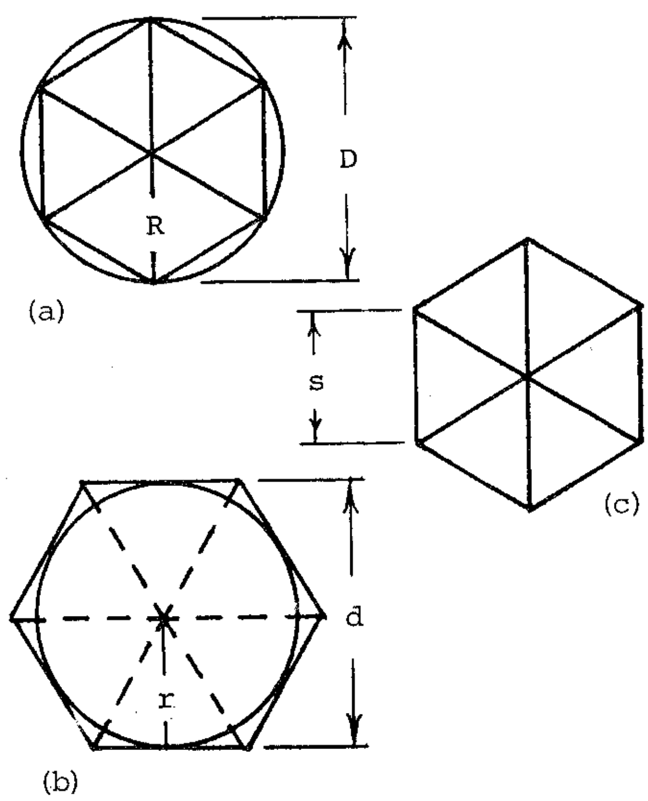

Fig. 1 Regular hexagons with (a) a circumscribed circle of radius R, (b) an inscribed circle of radius r, and (c) a side length s.

In this case the formula for the area of a triangle given two sides and the included angle is utilized, namely

$$A = 0.5\ a\ b\ \sin\alpha$$

For

$$a = b = R$$

and

$$\alpha = 360° / n$$

then

$$A = 0.5\ R^2 \sin(360° / n)$$

and K, the area of the polygon, is given by

$$K = n A$$
$$= 0.5\ n\ R^2 \sin(360° / n)$$

Example: A bolthead is in the shape of a regular hexagon and the distance across corners is 20 mm. What is its area?

$$D = 20 \text{ mm}$$

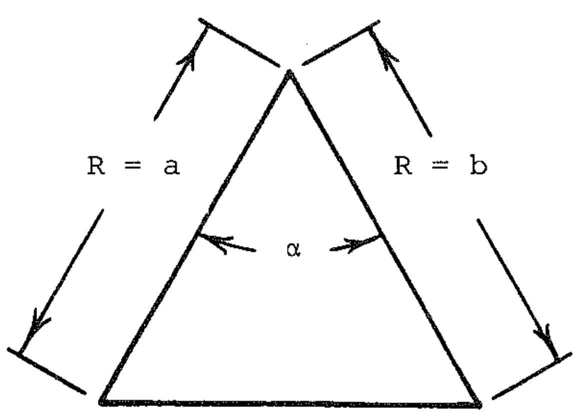

Fig. 2 Reference triangle for a polygon circumscribed by a circle. R = radius of the circle = length of triangle side.

Thus

$$R = 10 \text{ mm}$$

For a conventional bolthead, $n = 6$ and $\alpha = 60°$.

Thus, the area of the polygon is

$$K = 0.5\ (6)\ 10^2 \sin 60°$$
$$= 300\ (0.866)$$
$$= 259.8 \text{ mm}^2$$

Case 2. The radius of the inscribed circle (r) is known (Fig. 3). This is the situation where the "distance across flats", 2r, is given.

In this case, the area of the triangle is 0.5 b r. Since

$$\tan(\alpha / 2) = (b / 2) / r$$

then

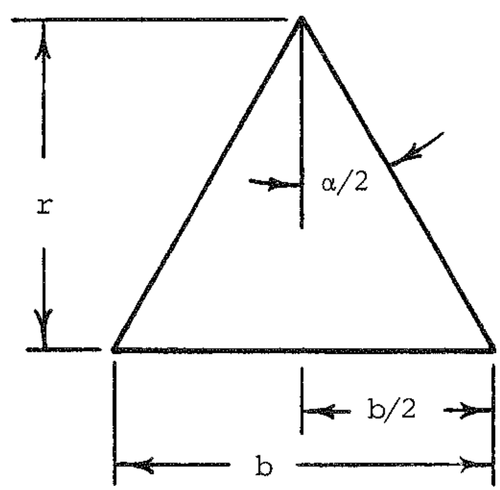

Fig 3 Reference triangle for a polygon with an inscribed circle. Radius of the circle = r = altitude of the triangle.

$$b / 2 = r \tan(\alpha / 2)$$

And since

$$\alpha = 360^\circ / n$$

then

$$\alpha / 2 = 180^\circ / n$$

Therefore, the area of the triangle is

$$A = r^2 \tan(180^\circ / n)$$

Thus, the area of the polygon is given by the formula

$$K = n r^2 \tan(180^\circ / n)$$

Example: A customized octagonal bolthead has a distance of 16 mm across flats. What is its cross sectional area?

$$n = 8$$

$$d = 2 r = 16 \text{ mm}$$

Thus

$$r = 8 \text{ mm}$$

and

$$180^\circ / 8 = 22.5^\circ$$

The area of the bolthead is therefore

$$K = 8^2 \tan(22.5^\circ)$$

$$= 64 (0.414)$$

$$= 26.50 \text{ mm}^2$$

Case 3. The side of a regular polygon is given (Fig. 4). The side (s) of the polygon is the base of the isosceles triangle. Since the area of the triangle is

$$A = h s / 2$$

and

$$\cot(\alpha / 2) = h / (s / 2)$$

then

$$(h s) / 2 = 0.25 s^2 \cdot \cot(\alpha / 2)$$

Since

$$\alpha = 360^\circ / n$$

then

$$\alpha / 2 = 180^\circ / n$$

Thus, the area of the triangle is

$$A = 0.25 s^2 \cot(180^\circ / n)$$

The area of the polygon is therefore

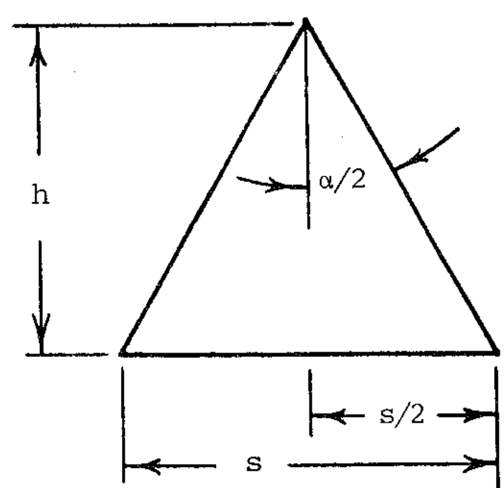

Fig. 4 Reference triangle for polygon with side length given. Side length = s = length of triangle base.

$$K = 0.25\ n\ s^2 \cot(\ 180° \ /\ n\ )$$

Example: Find the area of a regular pentagon which is 20 cm on a side.

$n = 5$

$s = 20$ cm

Therefore,

$$K = .25\ (5)\ 20^2 \cot(\ 180° \ /\ 5\ )$$

$$= 500 \cot(\ 36°\ )$$

$$= 500\ (1.376)$$

$$= 688\ \text{cm}^2$$

Table 1 summarizes the formulas for each case and gives approximations for the most common configurations.

Given \ Number of sides	n	4	6	8
R	$0.5nR^2\sin(360°/n)$	$2R^2$	$2.598R^2$	$2.808R^2$
r	$nr^2\tan(180°/n)$	$4r^2$	$3.964r^2$	$1.657r^2$
s	$0.25ns^2\cot(180°/n)$	s^2	$2.598s^2$	$4.818s^2$

Table 1 Summary of Area Formulas for Regular Polygons

Axonometric Projections

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An alternative to the method of double-rotational transformation is described for the generation of dimetric and trimetric projections which avoids any explicit statement of angular measure.

In *Technical Drawing*, Sixth Edition[1], there are descriptions of axonometric projections and dimetric drawings. This article will extend that coverage. Correct constructions for dimetric and trimetric projections will be given. If dimetric drawings are required, they can easily follow from dimetric projections.

A "primary auxiliary view" of an object may be obtained by a single rotational transformation from a regular multiview projection by explicitly stating an angular value of rotation. It this angle is one of the acute angles of a Pythagorean triangle, then lengths along both foreshortened axes will appear as rational fractions of their true length. Using the 3-4-5 right triangle, for example, dimensions parallel to the three axes would be 60%, 80%, and 100% of their true lengths. This avoids the irrational values inherent in rotations, such as with thirty or forty-five degrees. The values of the acute angles in Pythagorean triangles, such as the 3-4-5 triangle, cannot be stated exactly, nor need those values be known.

An objection to the isometric projection is that it requires dimensions parallel to the three axes to be multiplied by an irrational fraction ($\sqrt{6}$ / 3) to obtain their projected lengths. If all points are given by three coordinates, then this little inconvenience applies to all lines. The isometric drawing avoids this problem, but adds its own, in that it is not in correct proportion to multiview projections which it might accompany. The challenge was to determine if there were points in space from which to view an object in an orthogonal three-dimensional coordinate system for which unit lengths along each of the axes would all project as rational fractions. Obviously, it can not be the same fraction for all three directions, as this case is taken by the isometric projection. The work that follows, while being a satisfying cerebral exercise, may be too late given the ability of graphic generators to easily rotate and display solids dynamically. It is also possible to calculate static projections by use of a double rotational transformation, but this is hardly a convenient alternative; it adds computational difficulties and still involves irrational values.

There is a fundamental mathematical relationship governing axonometric projections that is not in the readily available literature. It is most easily illustrated by reference to a cube with an edge of length D. Let the three mutually perpendicular edges be parallel to the X, Y, and Z axes. For any view of the cube, let A be the projection onto the projection plane of the edge in the X direction, let B be the projection of the edge in the Y direction, and let C be the projection of the edge in the Z direction. Assume that D is positive, and that all three of A, B, and C are nonnegative. The relationship then is:

$$A^2 + B^2 + C^2 = 2D^2 \qquad (1)$$

If all three edges could appear at once as true lengths, the left side of Eq. (1) would exceed the right side; thus, this case is impossible. The three regular multiview projections result when two of the edges appear in the projection as true lengths, forcing the third to have a magnitude of zero. A "primary auxiliary view" results when only one of the projected edges appears as a true length, such as a view showing just the front and side of the cube. Only the cube height appears at its full value. (Since one of the terms on the left of Eq. (1) is equal to D^2, the other two terms must sum to the remaining D^2 on the right of Eq. (1) - implying involvement of the Pythagorean Theorem.)

The final possibility is that none of the cube's edges project in their true length and this, involving axonometric projections, is the most interesting. (The term "secondary auxiliary views" also refers to axonometric projections.) The sum of A, B, and C appears to have a minimum value of 2 in the multiview projections, and a maximum value equalling 6 for the isometric projection. The following constraint may be added to avoid trivial cases:

$$A \leq B \leq C < D$$

The isometric view may also be avoided by the further requirement:

$$A < C$$

which is justified, as finding an alternative to the isometric projection was the first motivation. Also note how Eq. (1), without the above constraints, unifies all the various views.

What began as a search for sets of four integers that satisfy Eq. (1) yielded many such sets. The first solution (A=7,B=7,C=8,D=9), illustrated in Fig. 1, was found using a calculator. Many other solutions were then found using a program written in BASIC run on a Commodore 64 computer. A few of these projections were actually executed with compass and straight edge. The program did not distinguish between dimetric and trimetric cases, nor did it

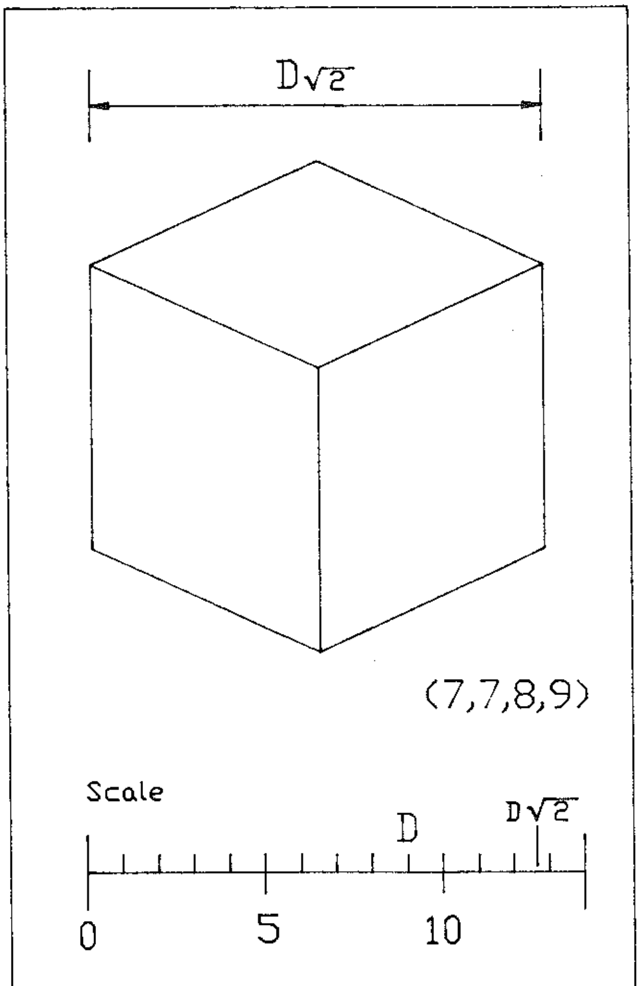


Fig. 1

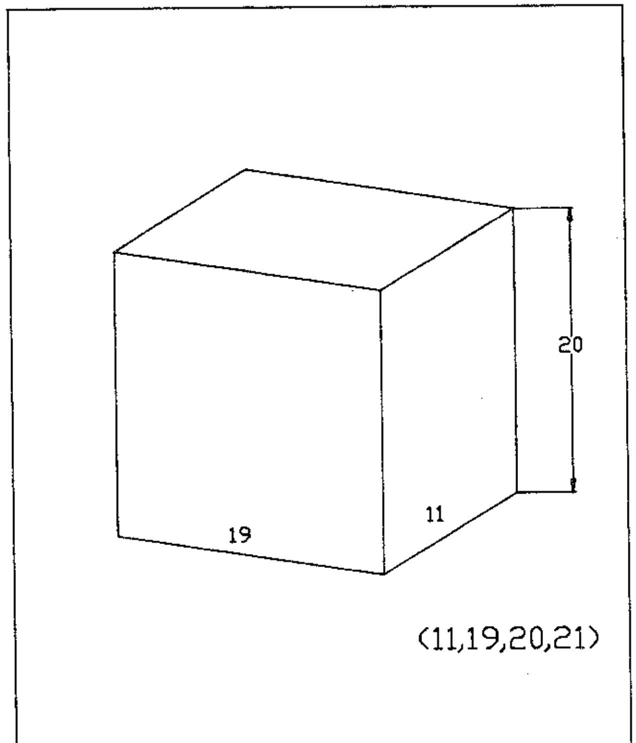


Fig. 2

weed out selections that were linearly dependent with previously calculated solutions. The first solution, above, is dimetric, as is (12,17,17,19). The first trimetric solution, illustrated in Fig. 2, is (11,19,20,21). (The actual ordering of solutions depends on how the computer program is written.)

Fig. 3 illustrates an IBM PC program; however, development was done almost exclusively on a Commodore 64. (Programming instructors may object to the liberal use of the GOTO statements.) Fig. 4 indicates a typical IBM PC output.

Redundant solutions do satisfy Eq. (1) and are not difficult to isolate when only a few solutions are being considered. This problem was partially avoided by selecting the upper and lower bounds of D for a given execution of the program. Since even values of D are not considered, the double of a previously occurring solution can not appear. For example, the first multiple of (7,7,8,9) will be (21,21,24,27), and not (14,14,16,18). This suggests that D be considered in a given run from D = X to D = 3X-1. This is not totally adequate, as other odd multiples of unique solutions will appear: a program with D ranging from 25 to 74 would yield (21,21,24,27),

```
20 INPUT "START WITH  D ODD INTEGER > 1 ";S
21 IF S < 3 GOTO 631
22 IF NOT S/2 = INT(S/2) + 1/2  GOTO 640
30 INPUT "MAXIMUM FOR D = ";E
40 INPUT "PRIOR TALLY(OF D-1)= ";T: D=S-2
55 LPRINT: LPRINT
60 LPRINT "D FROM ";S;" TO "; E : LPRINT
70 LS = TIMER: GOTO 115
114 REM LPRINT TAB(20) (TIMER -LS)/60;"MIN.":LPRINT
115 D=D+2: IF D>E GOTO 600
130 A=1: B=A: C=B+1: GOTO 410
210 A=A+1: IF A>D*.8165 GOTO 114
220 IF A*A < 6*D - 6 GOTO 210
240 IF A/2 = INT (A/2) GOTO 260
250 B = A: GOTO 270
260 B = A + 1
270 C = A + 1: GOTO 410
310 IF A/2 = INT (A/2) GOTO 360
320 B=B+1:C=B+1:IF A*A<6*B+7 GOTO 210
350 GOTO 372
360 B=B+2:C=B: IF A*A<4*B+2 GOTO 210
372 IF B=> D GOTO 210
380 IF A*A+B*B+2<D*D+2*D GOTO 310
384 GOTO 410
405 C = C + 2
410 IF C < D*.81649 GOTO 405
420 IF A*A+B*B < C*C+4*C GOTO 310
422 IF C=> D GOTO 310
425 K = (A+B+C)/D: IF K < 2 GOTO 405
426 IF K > 2.45 GOTO 320
428 R = A*A+B*B+C*C-D*D*2
430 IF ABS(R) < .00004 GOTO 509
435 C = C+2 :  GOTO 420
509 T = T+1
510 LPRINT"SOLUTION";T;" (";A;B;C;D;" )"
520 GOTO 310
600 LPRINT
610 LPRINT "DONE D =";S;" TO";E: LPRINT
611 LPRINT "BEGIN NEXT TIME WITH D=";E+1
612 LPRINT "AND WITH TALLY(D-1) =";T;"."
625 LPRINT :  GOTO 645
631 PRINT "ERR; D TO SMALL": GOTO 645
640 PRINT "ERROR LINE 20, MAKE D ODD."
645 REM LPRINT "DEM36D/IBM:88": LPRINT:LPRINT
660 END
```

Fig. 3

(35,35,40,45), and (49,49,56,63) - all representing (7,7,8,9).

Eq. (1) was derived from a basis result in linear algebra: "The sum of the squares of the direction cosines (of a line with respect to a set of orthogonal axes in an n-dimensional space) is equal to one." Only three-dimensional space will be considered, requiring three angles: α , β , and γ .

Then,

$$\cos^2 \alpha + \cos^2 \beta + \cos^2 \gamma = 1 \tag{2}$$

```
D FROM  3  TO  44

SOLUTION 1   ( 7   7   8   9  )
SOLUTION 2   ( 12  17  17  19  )
SOLUTION 3   ( 11  19  20  21  )
SOLUTION 4   ( 16  19  21  23  )
SOLUTION 5   ( 20  23  23  27  )
SOLUTION 6   ( 21  21  24  27  )
SOLUTION 7   ( 13  27  28  29  )
SOLUTION 8   ( 16  31  31  33  )
SOLUTION 9   ( 23  25  32  33  )
SOLUTION 10  ( 20  31  33  35  )
SOLUTION 11  ( 25  32  33  37  )
SOLUTION 12  ( 27  28  35  37  )
SOLUTION 13  ( 29  35  36  41  )
SOLUTION 14  ( 27  37  40  43  )

DONE D = 3  TO 44

BEGIN NEXT TIME WITH D= 45
AND WITH TALLY(D-1) = 14 .
```

Fig. 4

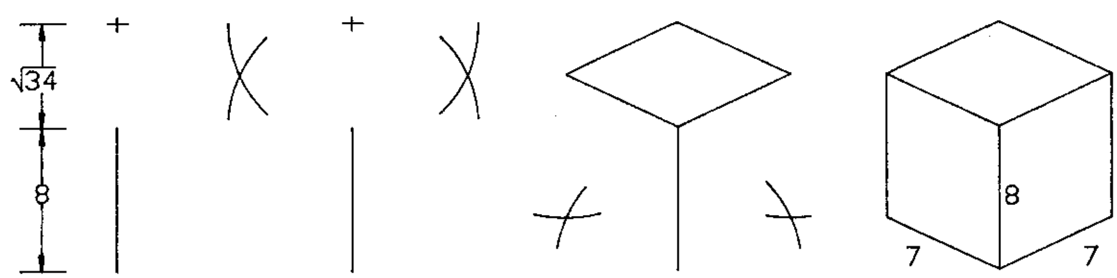
Each $\cos^2$ term is then replaced by $1 - \sin^2$ (of the respective angle), for which $\sin \alpha = A/D$, $\sin \beta = B/D$, and $\sin \gamma = C/D$. To avoid round-off errors for fractions in the computer, D^2 appears on the right side of Eq. (1). This equation was designed to determine integer solutions, but it works equally well for irrational values. Eq (2) can be generalized for n-dimensional space by having "n" terms on the left for "n" different direction cosines. (For two dimensions, it is equivalent to the Pythagorean Formula.)

There is not yet a term "direction sines" - perhaps because it would yield two angular values in the range of zero to one hundred eighty degrees, for any input in the domain from zero to one. The nature of these projections is such, however, that no angle greater than ninety degrees will be required, so a term such as "projection sines" might be justified. Since projection sines would have a more restricted range and domain than direction cosines, one would have to be vary careful not to be confused by the two. This alone might rule against introducing such a new term.

Given the restraints, Eq. (1) allows for three independent variables, which determine the fourth. As such, the dimetric drawing on page 517 of *Technical Drawing*[1] can become dimetric projections with the proper choices for the edge lengths for the three cubes, which are: $\sqrt{82}/ 8$, $\sqrt{17}/ 4$, and $\sqrt{18}/ 4$, respectively, for I, II, and III of Fig. 16.42. Obviously, not D alone, but any one of the variables may be the independent variable.

Consider the dimetric projection, as it is easier to construct than the trimetric projection. Assume that the one nonequal projection is the height, for the sake of the construction in Fig. 5. Then the top face is a rhombus with edges composed of the two projections that are equal. Its major diagonal is horizontal on the page and appears as a true length (i.e., $D\sqrt{2}$). In this dimetric view, the top rear corner appears directly above the top front corner. [For (7,7,8,9) the (vertical) minor diagonal projects as: $\sqrt{2}\cdot(9^2 - 8^2)^{0.5} = \sqrt{34}$, which may be constructed as the hypotenuse of a right triangle with leg lengths of three units and five units.]

This allows the rhombus to be completed and subsequently, the rest of this dimetric projection. This construction does not re-



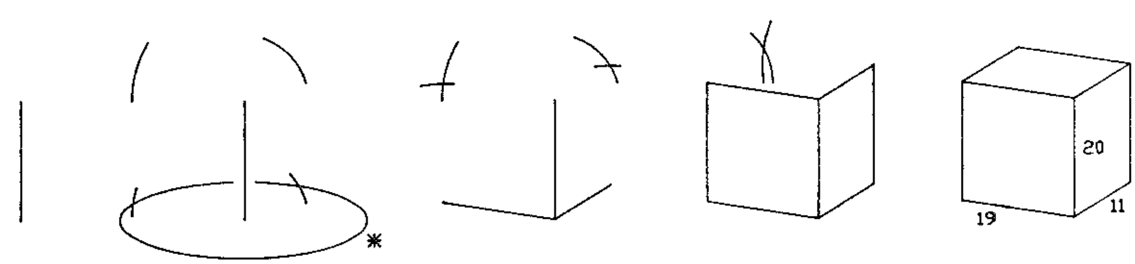
Construction Series 1 - Dimetric projection (7,7,8,9)

Fig. 5

quire the equation given by Giesecke, et al., on page 516.

Construction of a trimetric projection requires a bit more mathematics. Consider the projection that yields the solution (11,19,20,21). Construct the first edge as a segment of the vertical axis, with endpoint coordinates of (0,0) and (0,20) (Fig. 6). Plan to construct the eleven-unit edge projections off to the right of the vertical axis and the nineteen-unit edge projections to the left. The other endpoints of these four edges will lie on two circles of radius nineteen and two circles of radius eleven, and also on ellipses that intersect these circles. (One of each sized circle, and one ellipse, will be centered at each end of the edge just constructed on the vertical axis.) The intersections of these curves will provide, at most, four orientations of the cube. Since the eleven-unit edge projections are to be on the right, only two choices remain: looking down on the cube or looking up at the cube. Assume the view from above.

The height of this cube is tilted away from the plane of projection at an angle, the sine of which is (20/21). Allow the cube to rotate around this edge (height), the projection of which was just constructed. This axis of rotation does not lie in the plane of projection, so that all points not on the axis of rotation project ellipses on the plane of projection as the cube is rotated. Of concern are the four nearby vertices. When the edges connecting them to the axis of rotation are parallel to the plane of projection, these ellipses have a semimajor axis (of their own) of twenty-one units, horizontally, to the left and to the right. When the cube is rotated ninety degrees from this position, the ellipses have a vertical semiminor axis that equals $\sqrt{41}$. Note that eleven and nineteen lie between these two values, guaranteeing inter-



Construction Series 2 - Trimetric Projection (11,19,20,21)

* Ellipse $\left(\frac{x}{21}\right)^2 + \left(\frac{y}{\sqrt{41}}\right)^2 = 1$

Fig. 6

sections between the circles and the concentric ellipse. The same sized ellipse is used with all of the circles. The end points of the bottom nineteen-unit edge projection are (0,0) and $(-\sqrt{352.8}, \sqrt{8.2})$. The endpoints of the lower eleven-unit projection are (0,0) and $(\sqrt{88.2}, \sqrt{32.8})$. All other edges are parallel to one of the three lines that are now determined. Those endpoints that were just found should fall exactly on the circular arcs with radii of eleven and nineteen units that were previously indicated. This is a bit complicated to do by hand, but a few simple programs should allow a modern plotter to do this quite quickly. In actuality, the coordinates of the points given above are found algebraically, since it is not possible to construct an ellipse using just a compass and straight edge.

Only by first organizing numerous Pythagorean triplets into an orderly two-dimensional array was an approach developed which could be adapted to a three-dimensional array of the axonometric quadruples. This led to the equations of Fig. 7 for A, B, C, and D in terms of three new variables f, g, and h.

These equations, in turn, allow programs to be developed (in BASIC) for finding integer solutions for A, B, C, and D, in terms of <u>all</u> f, g, and h.

While dimetric solutions abound and are not too difficult to execute, they are only slightly more dramatic than the isometric. Consider illustrating a house. Who would suggest that the roof and a side should get the same emphasis as the facade - as with the isometric projection? A well chosen trimetric projection rivals a good perspective for such applications.

References

[1]Giesecke, F. E., Mitchell, A., Spencer, H. C., and Hill, I. L., *Technical Drawing*, Sixth Edition, Macmillan, New York, NY, 1974.

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I would like to thank Professor H. Martyn Cundy for his encouragement over many years. My thanks also to Professor James H. Earle for suggesting the EDG Journal as an appropriate publication. William Merron executed all drawings with a CAD package. Daniel W. Barto, Ph.D., persevered with the editing tasks.

$$A = 2g + (2h - 1) \pm 2\sqrt{2fg + 2gh + 2hf - f - g} \quad (3a)$$

$$B = 2f + (2h - 1) \pm 2\sqrt{2fg + 2gh + 2hf - f - g} \quad (3b)$$

$$C = 2f + 2g \pm 2\sqrt{2fg + 2gh + 2hf - f - g} \quad (3c)$$

$$D = 2f + 2g + (2h - 1) \pm 2\sqrt{2fg + 2gh + 2hf - f - g} \quad (3d)$$

Fig. 7

2-D and 3-D Graphics Software for Lower Division Graphics Courses

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A description of the 2-D graphics package, EDRAW, and the 3-D graphics package, GEOM3D, both developed by the Freshman Engineering Department at Iowa State University, is given. Integration of this software usage into a course covering fundamentals of graphics, computer graphics, and engineering design is outlined.

Introduction

Incorporation of the computer in the lower and upper division graphics courses is a necessity. Students must become familiar with the potential of the computer to be adequately prepared for industry. Industrial (commercial) software packages are powerful and impressive tools but can become cumbersome and impractical to use in a lower division program that handles hundreds to thousands of engineering students each year. When using an industrial package, the course tends to be centered on that particular package instead of on the appropriate fundamental course coverage. A suitable balance must be maintained between the course fundamentals and the computer usage.

The Department of Freshman Engineering at Iowa State University developed and has been using 2-D and 3-D software packages capable of handling multiple users on moderately priced computer graphics hardware. The 2-D drawing package was developed as an introduction to computer-aided drafting. Graphic elements are available to create 2-D drawings by using a locator, absolute coordinates, or relative coordinates. The software is menu-driven and has a very short learning curve. The 3-D modeling and analysis package is also menu driven. It allows the user to enter and manipulate a 3-D database comprised of simple geometries with plane surfaces. Analysis of the object allows the user to visualize a particular property of an object or determine the magnitude of geometric properties, including true shape, dihedral angle, and many others. Incorporation of these packages into our freshman engineering graphics course has successfully enhanced our course objectives.

Engineering Graphics at Iowa State

At Iowa State the engineering

graphics course integrates fundamentals graphics, computer graphics, and engineering design. Each of these components comprises approximately one-third of the one semester course. The fundamental graphic portion consists of 2-D and 3-D freehand sketching, lettering, instrument drawing, engineer's and metric scales, orthographic systems, solid object drawings, and dimensioning. The computer graphics portion covers usage of 2-D computer drawing, computer drawing using BASIC programming, and 3-D modeling and analysis. Finally, engineering design ties together the skills developed in the fundamental and computer graphics sections of the course to expose the freshman to open-ended design problems[1].

The course objectives for the engineering graphics course are as follows:

1. To develop an ability to communicate in the graphic language.

2. To develop an ability to visualize in three dimensions.

3. To introduce the student to techniques for describing geometries in two and three dimensions.

4. To use computer graphics to enhance the understanding of fundamental graphic principles and to assist in the visualization and solution of problems.

5. To involve the student in a design experience in the following ways:

a. Introduction to the design process.

b. Experience with the iterative nature of design.

c. Preparation of reports and presentations for design reviews.

d. Production of design documentation, such as design drawings and geometric databases.

Approximately 600 students take the engineering course each semester. This course is a required class for all the engineering students at Iowa State. It is part of the "Basic Program" of courses and must be completed before the student can progress more than one semester into his "Professional Program."

The students have access to 108 DEC VT241 color graphics terminals, which are in classrooms and student labs. These terminals are connected on a DEC Ethernet and then are carried to a VAX cluster across a fiber optic link. The VAX cluster consists of three 11/785's and a VAX 8200.

Utilizing EDRAW, a 2-D Drawing Package

An interactive two-dimensional drawing package (EDRAW) was developed for the engineering graphics course by the Freshman Engineering Department at Iowa State University. EDRAW was designed by faculty and programmed by undergraduates student programmers, thus allowing the program to correspond to the objectives intended for the engineering graphics course. This software package was specifically designed to be an introduction to computer-aided drafting. EDRAW was developed to work on Digital VT241's and VT 341's.

EDRAW was written as a menu-driven system, making the learning curve very short. At startup, the main menu appears in the upper right-hand corner of the screen and the scale appears in the upper left-hand corner. A menu option can be selected by positioning the block cursor on the desired option with the cursor keys on the keyboard or by pressing the number associated with the desire option and then pressing the <return> key. The scale is the ratio of the window coordinates to the world coordinates. The world space is a two-dimensional Cartesian coordinate system with the starting origin at (0,0).

Several submenus branch from the main menu. Some of the submenus are shown in Fig. 1. The "create" submenu can be used to develop several graphic elements, including boxes, curves (circles, ellipses, and irregular curves), lines, markers (arrows and cross hairs), and polygons (Fig. 2). Other create options include selection of a color, line pattern, locator mode, and grid options (pictorial or rectangular). Location features can be specified with absolute coordinates, relative coordinates, or with a locator. The other submenus (Fig. 1) allow the user to add text to the drawing, dimension the drawing, modify existing graphics elements or text, change display options, such as the scale, and manipulate files.

EDRAW is introduced early in the semester to help the students become familiar with the computer system. Approximately 15-20 minutes are spent by the instructor demonstrating to the class how to use EDRAW, after which the students begin working on their assignments in class. Since EDRAW is menu-driven, little assistance is required once the students begin. Assignments range from reproducing a multiview drawing to creating the pictorial or isometric drawing of an object. EDRAW can also be used during the dimensioning section of the course and during the design drawing portion of the course. Fig. 3 illustrates an example drawing made using EDRAW.

Utilizing GEOM3D, a 3-D Modeling Package

Many vendors of 2-D CAD packages are adding 3-D capabilities to their products. There are many advantages to 3-D, especially in engineering applications. "When a drawing is created from a 3-D model", explains Joel Orr, principal consultant with Orr Associates, Inc., "consistency in views is assured." After the time is spent creating a 3-D model, the drawing comes "free." For a package to be true 3-D, it must contain x, y, and z coordinates.

GEOM3D is an interactive 3-D geometric modeling package designed by Freshman Engineering faculty and programmed by undergraduate student programmers. This package, like EDRAW, is also menu driven, thus making this package very easy to learn and use. The database is made up of the x, y, and z coordinates (as defined in a right-handed Carte-

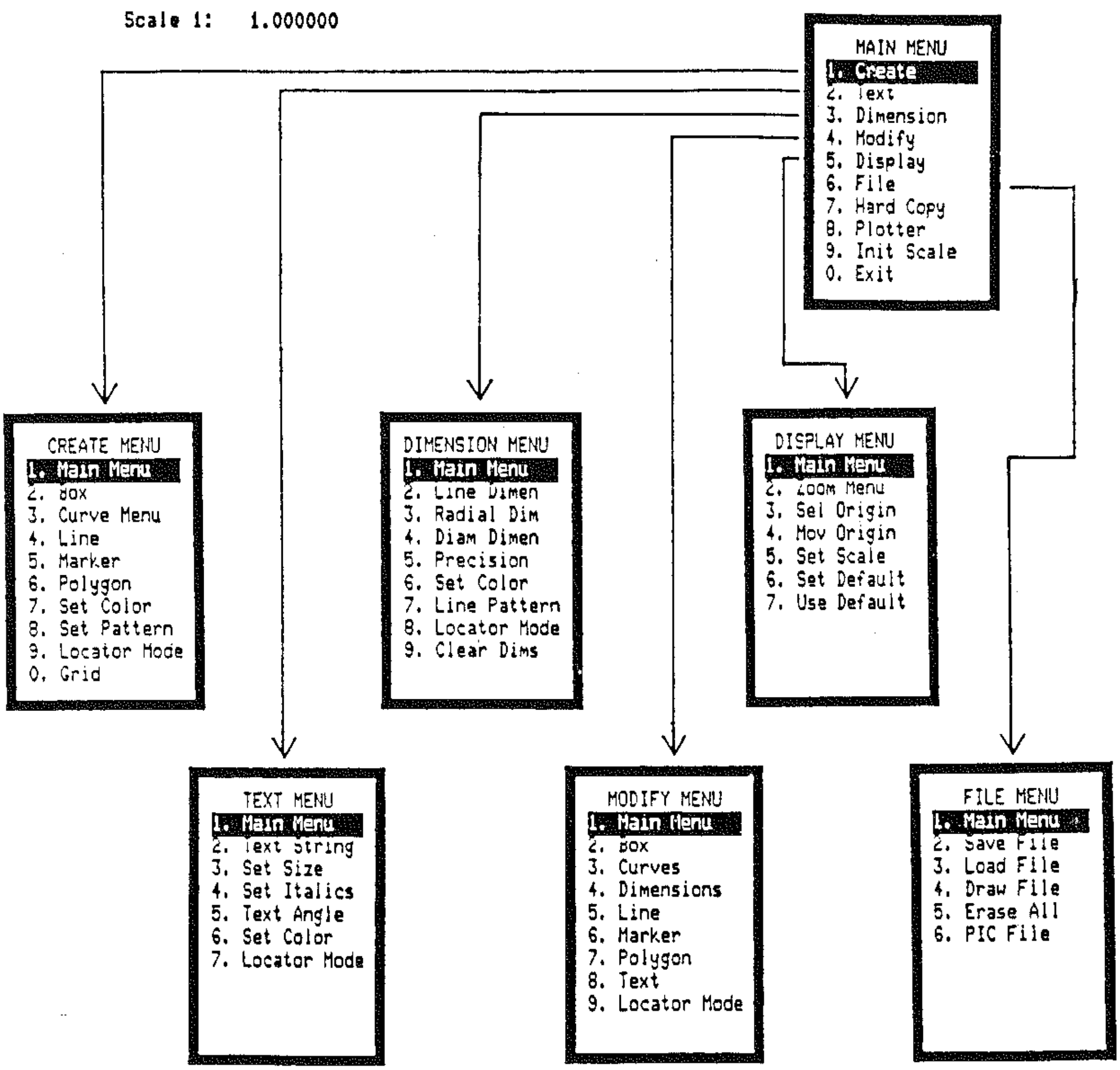
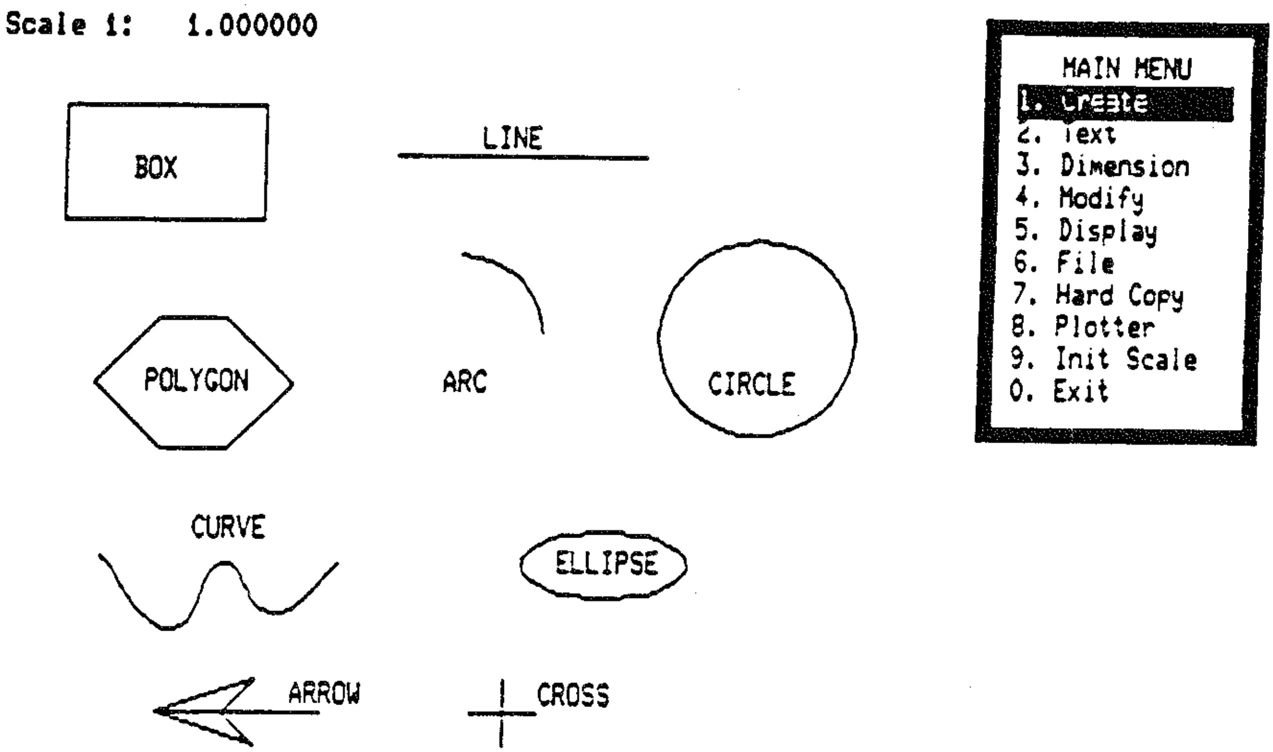


Fig. 1

sian coordinate system) of each node of the object and the connectivity of all nodes, the order in which the points are connected in order to form the surfaces of the object. An input database is shown in Fig. 4.

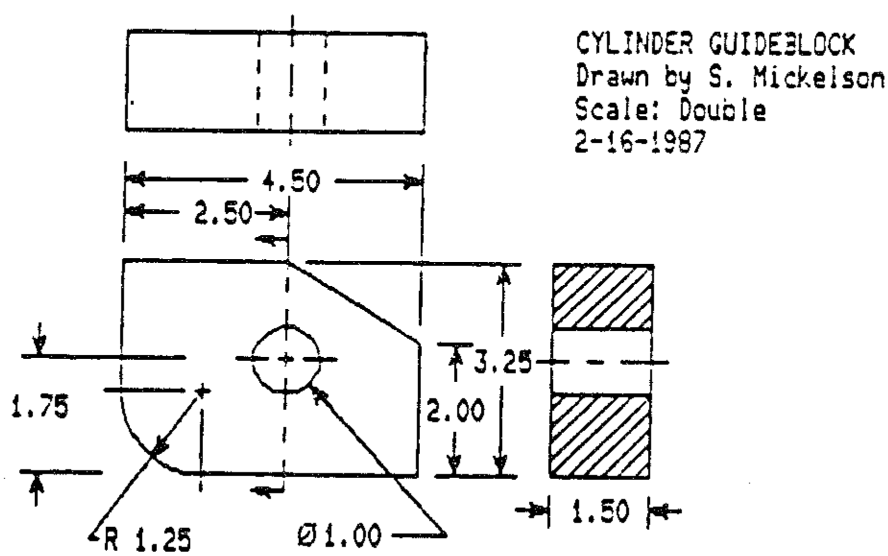
Once the database is input, different views of the object can be displayed on the left or right half of the monitor simultaneously (Fig. 5) or the object may be displayed on the full screen or in orthographic views (Fig. 6).

GEOM3D also has an analysis option. Analysis of the object allows the user to see a particular property of a polyhedra, and to determine the magnitude of geometric properties. Analysis options include finding the true length of a line, the angle between a chosen line and the x, y,



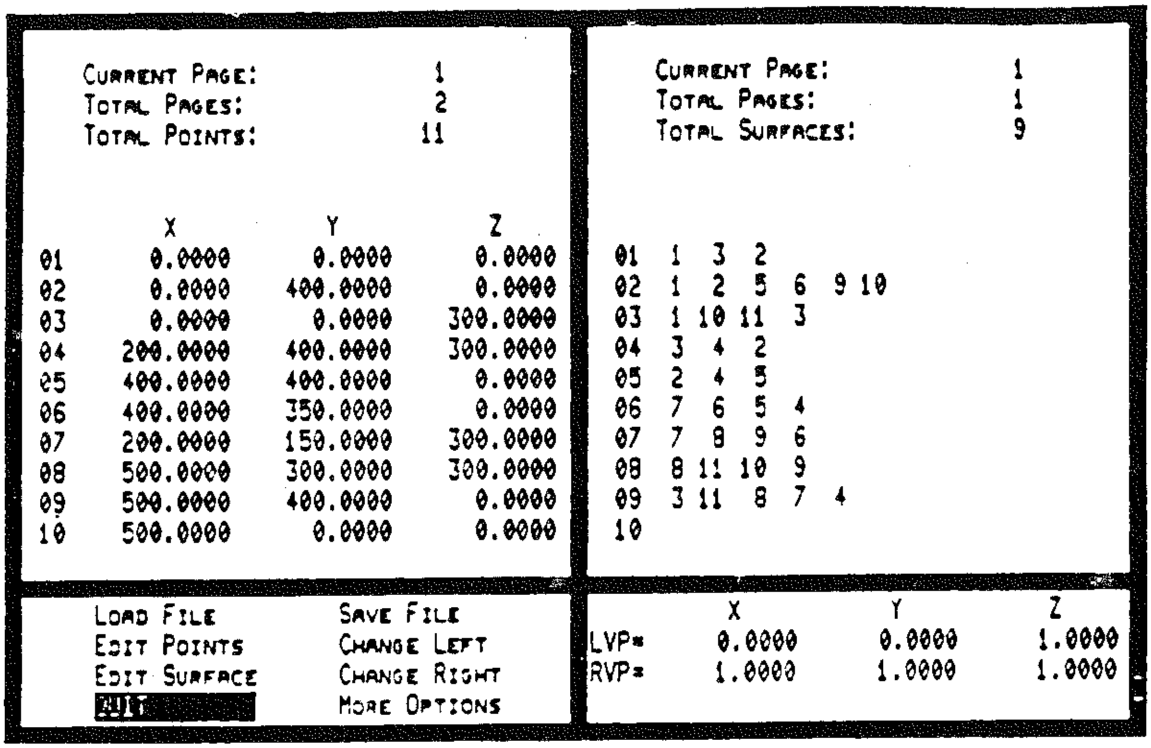
Scale 1: 1.000000
BOX
LINE
POLYGON
ARC
CIRCLE
CURVE
ELLIPSE
ARROW
CROSS
MAIN MENU
1. Create
2. Text
3. Dimension
4. Modify
5. Display
6. File
7. Hard Copy
8. Plotter
9. Init Scale
0. Exit

Fig. 2



CYLINDER GUIDEBLOCK
Drawn by S. Mickelson
Scale: Double
2-16-1987
4.50
2.50
3.25
1.75
2.00
1.50
R 1.25
Ø1.00

Fig. 3


CURRENT PAGE: 1
TOTAL PAGES: 2
TOTAL POINTS: 11
X Y Z
01 0.0000 0.0000 0.0000
02 0.0000 400.0000 0.0000
03 0.0000 0.0000 300.0000
04 200.0000 400.0000 300.0000
05 400.0000 400.0000 0.0000
06 400.0000 350.0000 0.0000
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09 500.0000 400.0000 0.0000
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CURRENT PAGE: 1
TOTAL PAGES: 1
TOTAL SURFACES: 9
01 1 3 2
02 1 2 5 6 9 10
03 1 10 11 3
04 3 4 2
05 2 4 5
06 7 6 5 4
07 7 8 9 6
08 8 11 10 9
09 3 11 8 7 4
10
LOAD FILE
EDIT POINTS
EDIT SURFACE
QUIT
SAVE FILE
CHANGE LEFT
CHANGE RIGHT
MORE OPTIONS
X Y Z
LVP= 0.0000 0.0000 1.0000
RVP= 1.0000 1.0000 1.0000

Fig. 4

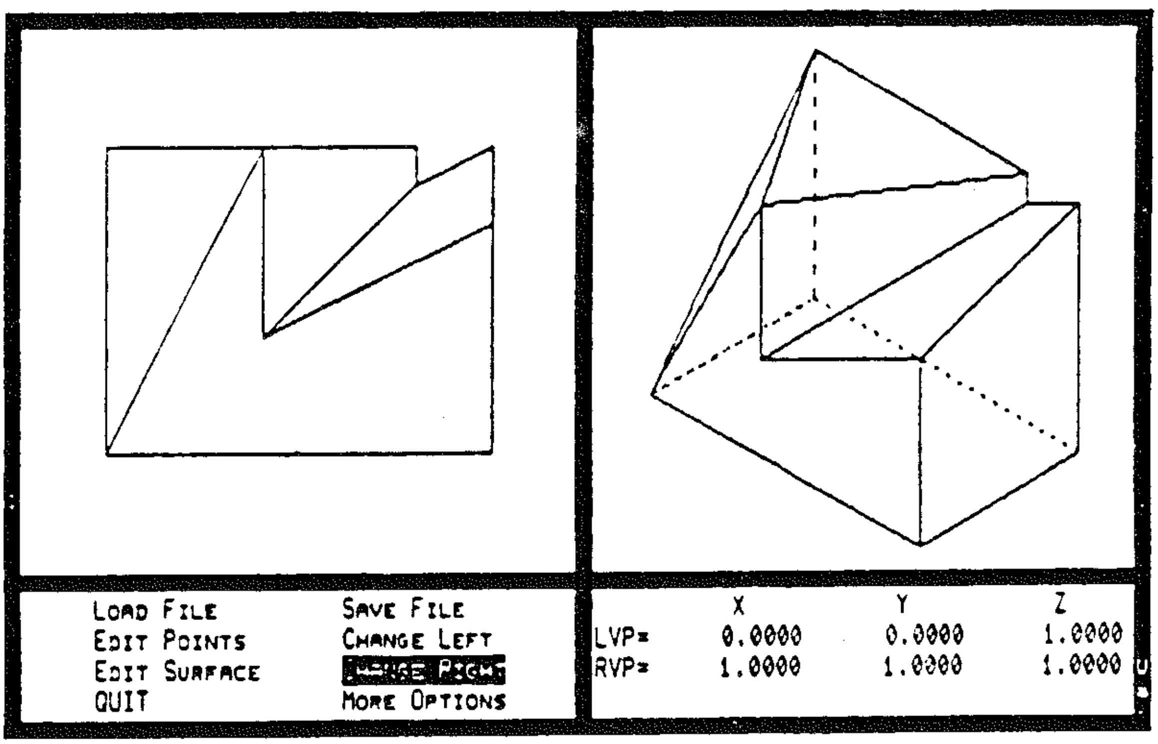

LOAD FILE
EDIT POINTS
EDIT SURFACE
QUIT
SAVE FILE
CHANGE LEFT
MORE OPTIONS
X Y Z
LVP= 0.0000 0.0000 1.0000
RVP= 1.0000 1.0000 1.0000

Fig. 5

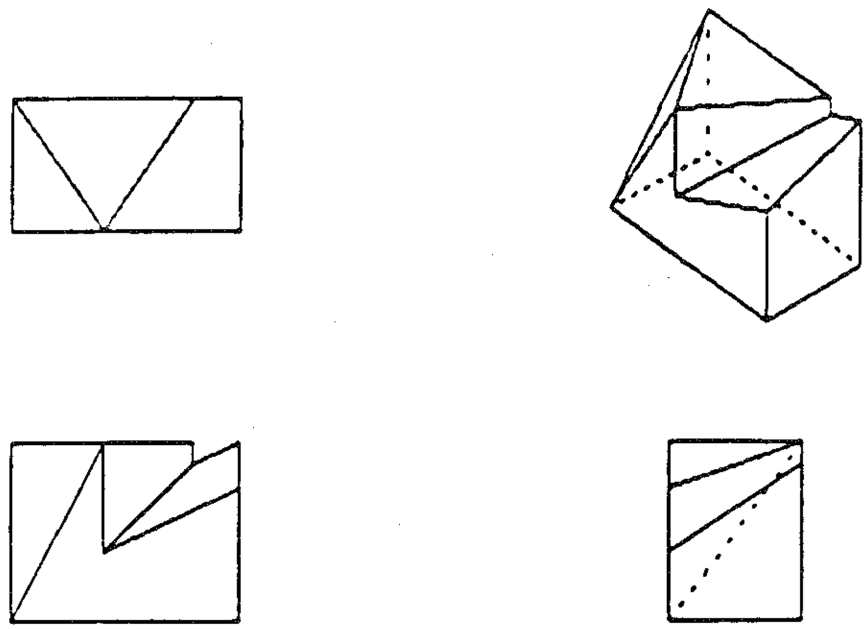


Fig. 6

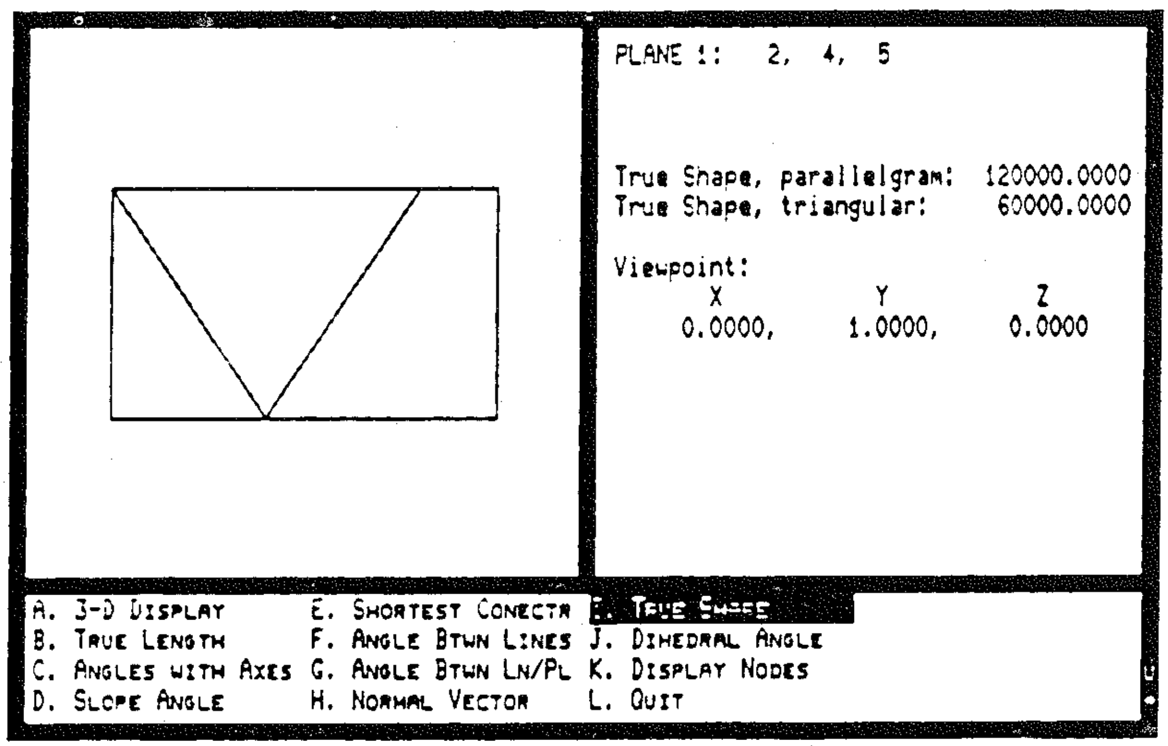

PLANE 1: 2, 4, 5
True Shape, parallelgram: 120000.0000
True Shape, triangular: 60000.0000
Viewpoint:
X Y Z
0.0000, 1.0000, 0.0000
A. 3-D DISPLAY
B. TRUE LENGTH
C. ANGLES WITH AXES
D. SLOPE ANGLE
E. SHORTEST CONECTR
F. ANGLE BTWN LINES
G. ANGLE BTWN LN/PL
H. NORMAL VECTOR
TRUE SHAPE
J. DIHEDRAL ANGLE
K. DISPLAY NODES
L. QUIT

Fig. 7

or z axis, the shortest connector or shortest perpendicular distance, the angle between two lines, the angle between a line and a plane, the normal vector to a specified plane, the true shape of a plane, and the dihedral angle. An example of finding the true shape of the plane defined by nodes 2, 4, and 5 is shown in Fig. 7. Notice how the magnitude of the triangular area of plane 2-4-5 has been calculated. The viewpoint necessary to see the true shape is given, and the true shape view is shown in the right window.

Before students are allowed to use the GEOM3D modeling package, they spend approximately three periods (six class hours) using vector techniques in order to learn how to work with 3-D databases. Given a simple geometric object with plane surfaces, the students are required to calculate various viewpoints and magnitudes of specific geometric properties. The vector analysis used has been covered in a previous paper by Helmlinger and Northup[2] and in Eide, et al[3]. After making the necessary calculations using vector analysis, the students are allowed to use GEOM3D in order to verify their answers. GEOM3D, a very useful tool in helping the students to visualize, also allows students to consider such problems as the total area for an object, as well as many other analysis-type problems.

Conclusion

The Department of Freshman Engineering at Iowa State University has developed 2-D and 3-D graphics software that supports the course objectives established by the department. EDRAW, the 2-D package, serves as an appropriate introduction to computer graphics. The 3-D program, GEOM3D, helps students in understanding how to work with a 3-D database and is an effective tool in helping the students to visualize in three dimensions. Continuing modifications to both packages is taking place in order to stay abreast of the changing field of engineering computer graphics.

References

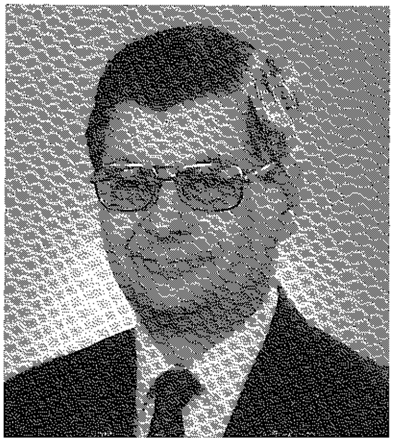
[1]Mickelson, S. K., "Utilizing the Computer in Freshman Design", paper presented at the EDGD Midyear Conference, Austin, TX, January, 1987.

[2]Helmlinger, K. R. and Northup, L. L., "Interactive 3-D Geometric Modelling with Vectors and Viewpoints", *The Engineering Design Graphics Journal*, Vol. 50, No. 2, 1986.

[3]Eide, A. R., Jenison, R. D., Mashaw, L. H., Northup, L. L., and Sanders, C. G., *Engineering Graphics Fundamentals*, McGraw-Hill, Inc., New York, NY, 1985.

Chairman's Message

by
Merwin Weed



It is hard for me to believe that my tenure as Chairman of the Division is almost over. Since this is my last opportunity to write you in the Journal as Chairman, I want to take this opportunity to thank all of the officers for their many hours of dedicated service to the Division. I also want to thank the Division membership for the loyal support that they have given to the Division through committee work, article production, conference activities, and the like. This broad-based support is what makes the EDGD so special.

This brings me to the next topic - "membership". We have a good thing going, so let's not hide it! In fact, let's broadcast it. If you have a friend, a colleague, or just an acquaintance interested in any facet of engineering design graphics, would you please introduce that individual to the activities of the Division. The EDGD is strong and healthy, and there is no reason why it can't be more so with a little effort. If you would like to have an application form or a supply of forms, please call or write:

Merwin L. Weed
Penn State McKeesport
University Drive
McKeesport, PA 15132
(412) 675-9497

The next meeting of the EDGD will be held at the annual ASEE Conference in Lincoln, Nebraska, June 25-29, 1989. I hope to see you there.

1989 ASEE Annual Conference

by
Moustafa R. Moustafa
(EDGD Program Chairman)

Sessions to be held at the Annual ASEE Conference sponsored by the EDGD include:

1138* - Mon., June 26, 7-8:15
Creative Engineering Design Competition and Display Judges' Breakfast
Thomas R. Baker, Villanova
Orientation procedures will be presented to the judges of this competition.

1237 - Mon., June 26, 8:30-10:15
Theoretical and Computational Graphics Research
Walter E. Rodriquez, Ga. Tech
Edward Galbraith, Cal. Poly.
This session will describe current graphics research efforts and innovative project ideas in theoretical and computational

graphics. It will focus on the impact these projects have on the engineering graphics curriculum and on the educational activities it generates.

1238 - Mon., June 26, 8:30-4:15
Creative Engineering Design Competition and Display
Thomas R. Baker, Villanova
Engineering student design projects from the United States and Canada will be presented in an ongoing display of creativity and ingenuity. Projects will be judged and winners presented awards at the annual EDGD banquet.

1638 - Mon., June 26, 4:30-6
EDGD Executive Committee Meeting
Merwin L. Weed, Penn State
Business Meeting

2237 - Tues., June 27, 8:30-10:15
Graphics in Capstone Design Courses
Rollie Jenison, Iowa State
Ileana Costea, Cal. State
Speakers will discuss the utilization of engineering graphics in their capstone design course for engineers and technologists. Graphical prerequisites for their senior students will be outlined. Suggestions will be offered for improving introductory graphics courses, particularly in the areas of computer usage and definition of geometry.

2238 - Tues., June 27, 8:30-4:15
(see session 1238)

2438* - Tues., June 27, 12:30-2
EDG Curriculum Modernization Committee Luncheon and Meeting
Ronald E. Barr, Univ. of Texas
A luncheon and business meeting of the EDG Curriculum Modernization Committee. All committee members are urged to attend the meeting.

2537 - Tues., June 27, 2:30-4:15
Computer Graphics Projects in Engineering Education - Part I
Davor Juricic, Univ. of Texas
Ronald Barr, Univ. of Texas
Presentation of computer graphics projects initiated last summer at a 2-week NSF-sponsored workshop on computer graphics in engineering.

2637 - Tues., June 27, 4:30-6
Computer Graphics Projects in Engineering Education - Part II
(see session 2537 - Part I)

2738* - Tues., June 27, 6:30-10
EDGD Annual Awards Banquet
Merwin Weed, Penn State
Presentation of the Creative Engineering Design Competition and Display awards and the Division Distinguished Service Award. Social hour with cash bar will precede the meal.

3238 - Wed., June 28, 8:30-12
(see session 1238)

3438* - Wed., June 28, 12:30-2
EDGD Annual Business Luncheon
Merwin Weed, Penn State
Open business meeting.

Session locations were not available at the time of publication. ASEE will publish this information in the final conference program.

* Denotes meal event

New ASEE Requirements Placed on Divisions

Recently, three write-ups were distributed to all ASEE Division officers by W. D. Turner, ASEE Vice-President and PIC I Chairman. Please direct any comments to:

Merwin Weed
Chairman, EDGD
Penn State University
McKeesport Campus
University Drive
McKeesport, PA 15132
(412)-675-9497

Important Changes Facing ASEE Divisions/Committees

There are several important issues facing the ASEE membership. Some are cost-driven; others are driven by our quest for quality within our organization, quality in our leadership, our program, and our publications. Let us take several of these issues and discuss both the problem and some solutions.

First, the annual conference proceedings. The number of volumes has steadily increased, resulting in a five-fold increase in the number of pages. The proceedings are expensive (adding nearly $50 to the cost of registration for the annual conference), contain papers of little interest to many of the readers, and quality control on most papers is poor. Some are excellent, while others are poorly written and are not deserving of publication.

To study the problem a special task force was appointed. Representatives from the Professional Interest Councils (PIC's), the Annual Conference Committee, and the Publications Committee were included. The task force met in Lincoln during the Fall Planning Conference and made recommendations to the ASEE Board, which were approved at the November Board meeting. The summary recommendations are as follows:

All papers which will appear in the proceedings must go through a peer-review process, beginning <u>with the 1990 Proceedings</u>. The divisions/committees will need to establish their review procedures and have them approved by the Publications Committee, who will have oversight responsibility. This policy does not preclude divisions/committees from having poster sessions, "shirt-sleeve" discussion sessions, panel sessions, or even technical sessions where papers are formally delivered. It simply means these papers will not appear in a bound volume, unless they have gone through a peer-review process. The names of the paper reviewers for each session/division will also appear in the proceedings.

For many of the divisions /committees this change is going to have a considerable impact. It will mean establishing and following a peer-review process, and meeting deadlines much earlier than we have been used to, which will require having the program chairperson identified at least two years prior to a given annual conference. Before you say it cannot be done, I would like to point out that a few of the divisions are already reviewing papers for presentation at the annual conference and for

publication in the conference proceedings. The M.E. Division, for instance, has been following this procedure for the past five years. And it works!

Having peer-reviewed papers will, hopefully, address one of the other issues, that of improving the quality of papers presented at the annual conference. Our summer meeting is our "flagship" conference, and we should strive to make it even better.

Another critical issue is the need to develop better continuity of leadership within the divisions/committees. Officers need to be elected for succeeding offices, have proper orientation and training and they need to attend the ASEE leadership and training sessions at the annual conference. Again, some divisions/committees do a good job in training, but others do not. One extreme case is a division which elects the entire slate of officers at the annual conference, and they serve for only one year. There is no continuity of leadership, no "apprentice" training, and little opportunity for advance planning. The latter item, advance planning, is going to be even more important with the new schedule for the advance conference program, and for the peer-review process. <u>It is essential that divisions which require by-laws changes prepare the changes this spring</u> for consideration and vote at the 1989 Annual Conference in Lincoln.

These two issues alone, peer-review of proceedings' papers and possible by-laws changes for some, are going to require a great deal of effort to get accomplished by 1990. I hope you will agree that the end result will be worth the effort required, and that our annual conference, our conference proceedings, and the society as a whole will be improved.

Suggested Model for Peer-Review of Papers for Proceedings

This discussion assumes all divisions will have an executive committee consisting of officers which have been elected to a succession of offices within the division, and that the program chairman for a given meeting is known two years in advance of the meeting.

Example for 1990 Annual Conference in Toronto

The dates herein assume the incoming program chairman will have met with the planning committee and laid out plans for the 1990 conference (i. e., session topics have been agreed upon).

February, 1989 - Incoming program chairman prepares "Call for Papers" for 1990 Conference in ASEE publications for March publication. Request abstracts of potential papers be sent to Program Chair by June 1, 1989. If a division does not have a program chair identified, I would suggest the current program chair and executive committee perform this function for this year.

Note: Divisions may resist the idea of a two-step paper submittal, i.e., abstracts followed by full papers. Let me argue in favor of abstracts because they help in planning. Once a division decides on a session topic or theme, the call for papers is sent out. At this point there is a great deal of uncertainty on the response. You may get three abstracts - you may get 15. Having the abstracts in-hand at the annual conference will enable the planning committee to change program directions, if necessary, develop a plan to solicit papers if needed, and allow for more abstracts to be submitted very soon after the annual conference. It is simply easier to work with one-page abstracts than full papers. If your division does call for abstracts as a first stage, please ask for a 300-word (or longer) abstract. It is almost impossible to judge the potential quality of a paper from a two-or-three sentence abstract.

June, 1989 - At the annual conference, review abstracts submitted, and firm up the session topics. Use the annual conference to solicit additional papers ("fillers") or add a possible new session based on input of attendees. Name moderators or session organizers of each session. Organize mini-plenary to be proposed.

July, 1989 - Notify authors of the acceptance of the abstract and request the full paper by October 1, 1989. Note: The papers can either be returned to the Program Chair or to the moderator (session chair) of that session, depending on the division's preference. The invitation to authors should include space for preparing/laying out the paper - the draft form should emulate the final layout form to be distributed with author kit once the paper is accepted.

July, 1989 - Send out "Call for Papers" for those sessions which <u>will not include peer-reviewed papers, papers which will not appear in the conference proceedings</u>. These could be poster sessions, laboratory demonstration projects, panels, or non-reviewed paper sessions. The deadline date for abstract/long abstract/paper submittal, depending on your preference, should be September 1, 1989.

September, 1989 - Submit preliminary program form to ASEE in preparation of Fall Planning Conference, including proposed mini-plenaries.

October, 1989 - Fall Planning Conference in Toronto. Sessions should be fairly well laid out. Mini-plenaries should be as complete as possible.

October 1 - November 10, 1989 - Review process for peer-review papers. At least three reviewers are suggested for each paper. The session moderator should probably review all papers proposed in his/her session to avoid overlap and to make sure that there is consistent quality. The other reviewers should come from different universities to ensure a diversity of reviewers. Over time, each division should establish a list of potential paper reviewers, and not use the same people each year.

The names of all reviewers will appear in the section of the proceedings where the papers are published.

Mid-November, 1989 - Final program completed, including session titles, authors, paper titles, etc., and submitted to ASEE headquarters. (Changes could probably be made up to around December 1, 1989).

Late-Winter, 1990 - Author's kits distributed to authors of peer-reviewed papers for the proceedings.

Spring, 1990 (Probably around mid-April) - Papers due back to publisher on mats.

Those divisions having their own publications will have different internal deadline dates to meet. The dates suggested herein are certainly not absolute, but they appear to be workable. All division program chairmen should feel free to modify them to suit their own division activities. Certain dates, however, are set and should be kept in mind, i.e., annual conference in June, fall planning conference in October, and final program submission to ASEE in November.

Models for Division Officer Elections and Executive Committee

There is an urgent need throughout all the Divisions for better continuity of leadership and better training. The officers, to a large extent, determine the quality of the annual program and the quality of the papers appearing in the proceedings. The ASEE reputation and our professional reputation as educators are partially at stake here. With the new peer review process required in 1990 for the proceedings' papers, and with the emphasis on better officer training, it is important that all divisions have a workable officer election process in place by 1990. If your division already has a workable model, please read anyway just in case improvements can be made. Division by-laws changes may be required.

The goal of these changes is to have all divisions with an election scheme which (1) allows for a succession of officers and (2) has the officers identified in time for them to attend the Leadership Training session on Thursday morning at the annual conference.

Possible Models

Have an entry level office such as "Elected Member of Executive Committee" which would give a person a year of apprenticeship serving on the Executive Committee and learning the division organization. This officer would then start through the successive ranks of Secretary/Treasurer, Vice-Chairman and Program Chair, Division Chairman, and Past

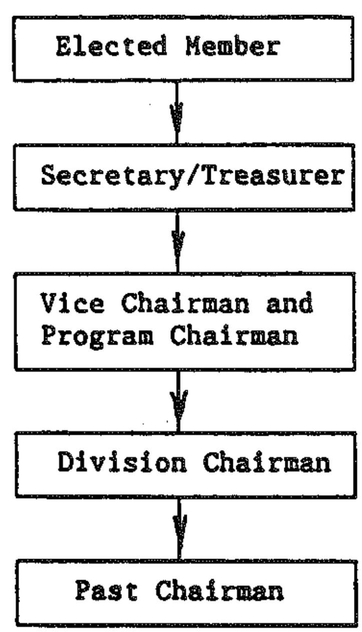


Fig. 1 Possible Model for Officer Succession

Chairman (Fig. 1).

Another model would be start out as Secretary, and then go through successive offices of Treasurer, Vice-Chairman and Program Chairman, Division Chairman, and Past Chairman (Fig. 2).

The models, as proposed, would require a five-year commitment on the part of an officer. Two important facts should be pointed out with these models. First, the incoming program chairman is identified two years in advance and has the opportunity to work with one program prior to having the responsibility for the annual conference program. Second, the past chairman is retained as an executive committee member to provide additional leadership and guidance to the division. Several divisions have the Past Chairman head up the nominating committee for the next year. This makes sense because he/she will have worked closely with many different persons throughout the previous four years and will be able to evaluate potential officer material.

If your division is planning to adopt an officer selection model similar to one of the above models and by-laws changes are required, please initiate this process as soon as possible. Check your division by-laws to determine the procedures required. The goal would be to have all changes in place by 1990.

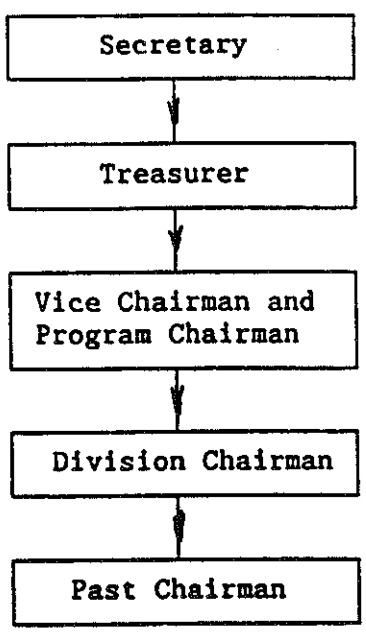


Fig. 2 Possible Model for Officer Succession

Highlights of the Activities of the Liaison Committees

by
Jim Leach
Director, Liaison Committees

There are six liaison committees available for EDGD member activities:

Membership Activities Committee
Educational Relations Committee
Industrial Relations Committee
International Relations Committee
Freshman Programs Committee
Metrication Committee

A project for the recruitment of new members to the EDGD from community, technical, and junior colleges is continuing. Recruitment packets are sent prior to the midyear conference and the annual ASEE conference to engineering department chairmen in the proximity of the conference.

This past October, 106 packets were mailed to colleges in Illinois, Indiana, Iowa, Kentucky, Michigan, Missouri, Ohio, Pennsylvania, and Tennessee. The packet contents were compiled and sent by Director of Zones Billy Wood preceding the midyear meeting in New Harmony, Indiana.

Membership Activities Committee
- William VanderWall, Chairman

The tradition of sending letters of invitation for membership along with the EDGD brochure, a copy of the EDG Journal, and an ASEE membership application form continues. Thirty-nine percent of the persons previously contacted (16 of 41) are now Division members. The success of this recruitment program is due largely to the efforts of Bill VanderWall and to Division members who submitted names of potential members.

The ASEE membership promotional DEAN'S PROGRAM has been continued indefinitely. Spread the word that the ASEE membership fee is FREE (excluding Division dues) for the first two years for new members if they have been employed for five years by a participating institution. Applicants need only complete the standard membership form and write DEAN'S PROGRAM in the top right corner. Half of the fees are paid by the institution and half by ASEE.

Educational Relations Committee
- Robert Matthews, Chairman

Bob will be concentrating on establishing liaison with related divisions within the ASEE as well as with educational organizations outside of ASEE having related interests.

Industrial Relations Committee
- Gary Bertoline, Chairman

A project to establish on-going relations with CAD/CADD software vendors and textbook publishers is underway. More about this project will be presented at the ASEE Annual Conference in Lincoln.

International Relations Committee
- Vera B. Anand, Chairman

The current schedule of international conferences on computer graphics and related topics of interest is now published in the EDG Journal, in addition to being presented at EDGD meetings.

Freshman Programs Committee
- Hugh Keedy, Chairman

No recent activities have occurred.

Metrication Committee
- Edward V. Mochel, Chairman

No recent activities have occurred.

Book Review

by
Bob Chin

Architectural Graphic Standards (Student Edition) by Robert T. Packard and Stephen A. Klimet (editors), John Wiley & Sons, New York, NY 1989.

In response to the special needs of design students, John Wiley & Sons has produced an abridged edition of the architect's "bible", the venerable *Architectural Graphic Standards*. As the cover of the student edition notes, it is an abridgement of the seventh edition rather than the unabridged eighth. According to Mr. Stephen A. Klimet, one of the editors, the seventh edition was more appropriate for editing. It should be noted also that the eighth edition was not available at the time research began for production of the student edition.

It is apparent from the finished product that, to keep production costs down, the editors made a conscious decision to pare down the seventh edition by discarding selected topics and portions of selected topics on a page-by-page basis, rather than editing on a line-by-line, paragraph-by-paragraph, or illustration-by-illustration basis. This they apparently felt would achieve their goal of providing "vital information, at a price students could afford." Fortunately for the editors, the original text does not "wrap around" from one page to another, nor is the content of one page necessarily dependent on the content of adjacent pages. This made editing so much easier: topics and selected pages retained and discarded by simply cutting and pasting page numbers. More importantly, the finished product does not exhibit the abrupt transitions which so often accompanies abridgements.

Close examination of the student edition reveals that the choice of topics and pages to be retained or discarded was a function of thorough research. Editing decisions were based on data gathered over a one year period through interviews and surveys of three groups of users. Students, faculty, and members of an advisory board were invited to provide input and to make specific recommendations. In keeping with the publisher's goal to minimize production costs and the cost to students, no new or updated materials were added.

The 17-chapter, 499-page student edition is organized along the same lines as the 17-chapter, 785-page seventh edition. However, the appendices and index, orginally a part of chapter seventeen in the seventh edition, stand alone in the abridged edition.

A chapter-by-chapter analysis revealed the following changes. The four original topics in chapter one, <u>General Planning and Design Data</u>, were retained. Editing, however, took the first chapter from 116 pages to 82 pages. In chapter two, <u>Sitework</u>, the topics Site Drainage, Soil Treatment, Site Utilies, Site Furnishings, and Earth Work were edited out. Furthermore, Site Development, Paving and Surfacing, Site Improvements, Playground Equipment, Landscaping, and Walls and Fences were abbreviated, taking it from 64 pages to 30. Chapter three, Concrete, was left intact. Adobe, Rammed Earth, and Glass Block were edited out of chapter four, Masonry. In addition, the topics Unit Masonry and Fireplaces were edited, reducing the chapter from 48 pages to 30.

In chapter five, Metals, the topics Ornamental Metal, Fasteners and Supports, and Metal Finishes were edited out, and General Information and Metal Fabrication were abbreviated, taking it from 38 to 15 pages. General Information, Design Load Tables, Plywood, and Table of Wood Species were edited out of chapter six, Wood, and the topic Architectural Woodwork was edited, reducing it from 66 pages to 35. In chapter seven, Thermal and Moisture Protection, the topics General Information and Composite Building Panels were deleted, shortening it from 53 pages to 44. Environmental Factors and Security were omitted from chapter eight, Doors and Windows, and the topics Glazing, Hardware, Metal Doors, Metal Windows, and Special Doors were edited, taking it from 60 to 40 pages. Except for editing the topics Tile, Wood Flooring, and Wall Covering, reducing it from 28 to 23 pages, the ninth chapter, Finishes, was left intact.

In chapter ten, Specialties, the topics Chalkboards and Tackboards, Fireplaces and Stoves, and Wall and Corner Guards were edited out. Furthermore, Compartments and Cubicles, Partitions, Storage Shelving, Louvers, and Wardrobe Specialties were edited, taking it from 32 to 17 pages. Chapter eleven, Equipment, went from 34 pages to 10 with the deletion of Bank Vault Equipment, Dark Room Equipment, Education Equipment, Food Service Equipment, Laboratory Equipment, Music Room Equipment, and Waste Handling Equipment, and with the editing of Athletic Equipment and Residential Equipment. None of the topics were discarded from chapter twelve, Furnishings. The topics Building Accessories and Furniture, however, were edited, taking it from 24 to 20 pages. Radiation Protection and Sound and Vibration Control were deleted from chapter thirteen, Special Construction, and the topic Special Purpose Rooms was edited, reducing it from 22 to 18 pages. Chapter fourteen went from 18 pages to 8 with the deletion of Material-Handling Systems, Pneumatic Tube Systems, and People Movers and the editing of the topic on Elevators.

The topics Materials and Methods, Vibration Control, Insulation, and Controls were deleted from chapter fifteen, Mechanical. In addition, Plumbing, Plumbing Fixtures, Fire Protection, and HVAC were abbreviated, taking chapter fifteen from 58 pages to 27. Chapter sixteen, Electrical, went from 36 to 27 pages as a result of Materials and Methods, Service Distribution, Communications, and Special Systems being edited. Chapter seventeen, Metric (SI) Units in Design and Construction, was left intact. The appendices, orginally a part of chapter seventeen, went from 30 to 25 pages with the deletion of Data Sources and the editing of Drafting Techniques. The index, of course, was reduced in size accordingly.

The student edition was reproduced to the same very high standards as its unabridged counterpart, and the graphics and text retain the same high qualities exhibited by its predecessors. To keep costs down though, the student edition was bound with a soft rather than a hard cover.

The editors seemed to have achieved their goals with the introduction of an abridged edition of *Architectural Graphic Standards*. Furthermore, it is quite apparent that they gave very careful consideration to potential user's needs during the editing process. As a result, the publisher has provided a great service to students seeking relief from the ever-increasing financial burden of funding an education. Forty-nine dollars and ninety-five cents for a high quality reference is well within any student's budget. The seventh edition, which is no longer in print, retailed for $130.00; the eighth retails for $150.00.

The student edition contains most, if not all, of the essential information design students need. It is a high quality product as it is not choppy like so many edited works, and it is reasonably priced. It will be welcomed and well received by both faculty and students.

Calendar of Events

by
Josann Duane

1989 Annual ASEE Conference
June 25-29, 1989
Lincoln, NE

1989-90 EDGD Mid-year Conf.
November 5-7, 1989
Tuscaloosa, AL

1990 4th International Conference on Engineering Graphics and Descriptive Geometry
June 11-15, 1990
Miami, FL

1990 Annual ASEE Conference
June 24-28, 1990
Toronto, Canada

1990-91 EDGD Mid-year Conf.
Tempe, AZ

1991 Annual ASEE Conference
New Orleans, LA

1991-92 EDGD Mid-year Conf.
Norfolk, VA (tentative)

1992 Annual ASEE Conference
Toledo, OH

1992 5th International Conference on Engineering Graphics and Descriptive Geometry
August 17-21, 1992
Melbourne, Australia

1992-93 EDGD Mid-year Conf.
San Francisco, CA (tentative)

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by Ernest R. Weidhaas, Pennsylvania State University

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Fourth International Conference on Engineering/Computer Graphics and Descriptive Geometry

by

Steve Slaby

Sponsored by ASEE's Engineering Design Graphics Division and the Florida International University, Miami, Florida.

Date: June 11-15, 1990.

Topics: Descriptive geometry, theoretical graphics, computer graphics, kinematic geometry and other applications of geometry, engineering computer graphics, computer-aided design, computer-aided geometric design, computerized descriptive geometry, graphics and computer graphics teaching techniques, graphics exercises and computers in engineering graphics education.

Deadlines: October 15, 1989 for 500-word abstracts. Full papers will be due March 15, 1990.

Contacts: Steve M. Slaby, Civil Engineering & Operations Research Department, Princeton University, Princeton, NJ 08544, (609) 452-4654 and/or Luis A. Prieto-Portar, Department of Civil & Environmental Engineering, Florida International University, University Park, Florida 33199, (305) 554-2824.

International Computer Graphics Calendar

by

Vera Anand

June 19 - 23, 1989
Graphics Interface '89 - 15th Canadian conference devoted to computer graphics and interactive techniques
London, Ontario, Canada

June 27 - 30, 1989
Computer Graphics International '89 - 7th conference of the Computer Graphics Society
Leeds, United Kingdom

July 18 - 20, 1989
3rd International Conference on Image Processing and its Applications
Coventry, United Kingdom

July 23 - 26, 1989
UPCAEDM '89 - 7th Annual Conference on University Programs in CAE/CAD/CAM
Laramie, WY

July 31 - Aug 4, 1989
SIGGRAPH '89 - 16th Annual Conference on Computer Graphics and Interactive Techniques
Boston, MA

Sep 4 - 8, 1989
Eurographics '89
Hamburg, West Germany

Sep 12 - 15, 1989
Engineering Education '89 - 18th International Symposium on Engineering Education
Munich, West Germany

Sep 18 - 22, 1989
HCI International '89 - 3rd International Conference on Human-Computer Interaction
Boston, MA

Oct 23-27, 1989
Second International Conference on Computer-Aided Drafting, Design, and Manufacturing Technology
Hangzhou, China

For further information, contact Vera Anand, 302 Lowrey Hall, Clemson Univ., Clemson, SC, (803)-656-5755.

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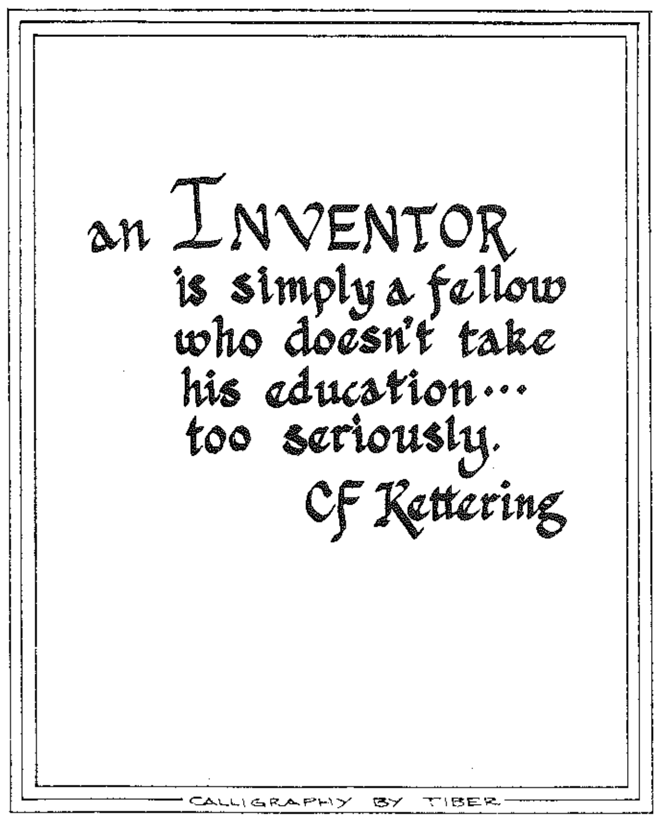
Editor's Comments

by
Barry Crittenden

The proposals (page 36), or demands - I'm not quite certain which they are - set forth by ASEE Vice-President and PIC I Chairman W. D. Turner have their good points and those which are questionable. The requirement to review papers to be published in the proceedings of the ASEE conference is a good one for the Society. The models of progressive positions assumed by division officers leave a bit to be desired.

Review of papers is always desirable for either a first-class publication or conference. Our present organization of the EDG Journal Review Board under the direction of the Technical Editor would allow, with little trouble if begun sufficiently early, review of all papers to be presented at the annual ASEE conference and at the EDGD midyear conference, However, as editor of the Journal, I would prefer that papers accepted by the Review Board for presentation at any conference be published in the EDG Journal, rather than in the ASEE proceedings. ASEE would be happy - their proceedings would be thinner and less costly to print - and the EDGD membership might be happier - more papers published in each issue of the Journal.

The models for officer succession might be acceptable, if our division didn't already have a smoothly functioning system. The five-year commitment proposed in the models certainly offers the continuity of leadership desired by ASEE. But, what if a "loser" made his way into the five-year pipeline? A totally incompetent person could certainly be removed from office, but the division might be inclined to let "sleeping dogs lie" if an only slightly incompetent individual assumed an initial leadership position. Which would be better, or worse, the continuity of leadership or the lack of leadership for five years? My gosh, the President of the United States is elected for four years only!



ENGINEERING DESIGN GRAPHICS JOURNAL

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Scope

This Journal is devoted to the advancement of engineering design graphics technology and education. The Journal publishes qualified papers of interest to educators and practitioners of engineering graphics, computer graphics, and subjects related to engineering design graphics in an effort to (1) encourage research, development, and refinement of theory and application of engineering design graphics for understanding and practice, (2) encourage teachers of engineering design graphics to experiment with and test appropriate teaching techniques and topics to further improve the quality and modernization of instruction and courses, and (3) stimulate the preparation of articles and papers on topics of interest to the membership. Acceptance of submitted papers will depend upon the results of a review process and upon the judgement of the editors as to the importance of the papers to the membership. Papers must be written in a style appropriate for archival purposes.

Submission of Papers and Articles

Submit complete papers, including an abstract of no more than 200 words, as well as figures, tables, etc. in quadruplicate (four copies) with a covering letter to J. B. Crittenden, Editor, Engineering Design Graphics Journal, EF - VPI&SU, Blacksburg, VA 24061. All copy must be in English, typed double-spaced on one side of each page. Use standard 8 1/2 x 11 inch paper only, with pages numbered consecutively. Clearly identify all figures, graphs, tables, etc. All figures, graphs, tables, etc. must be accompanied by a caption. Illustrations will not be redrawn. Therefore, ensure that all line work is black and sharply drawn and that all text is large enough to be legible if reduced to single or double column size. High quality photocopies of sharply drawn illustrations are acceptable. The editorial staff may edit manuscripts for publication after return from the Board of Review. Galley proofs may not be returned for author approval. Authors are therefore encouraged to seek editorial comments from their colleagues before submission of papers.

Publication

The Engineering Design Graphics Journal is published one volume per year, three numbers per volume, in winter, spring, and autumn by the Engineering Design Graphics Division of the American Society for Engineering Education. The views and opinions expressed by individual authors do not necessarily reflect the editorial policy of the Engineering Design Graphics Division. ASEE is not responsible for statements made or opinions expressed in this publication.

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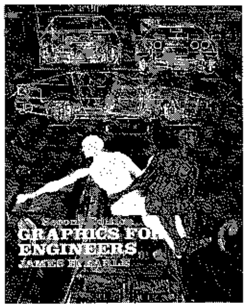

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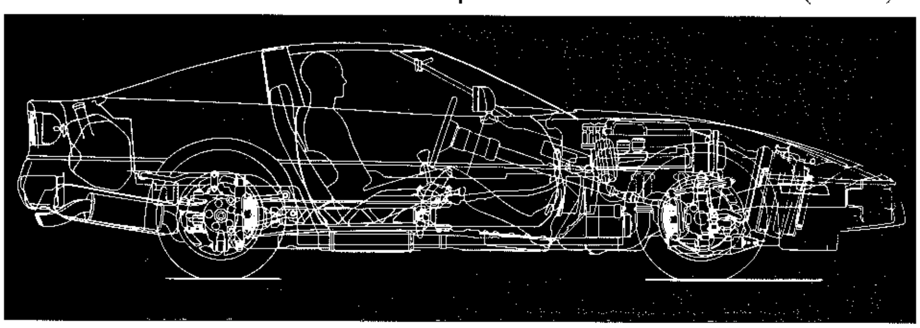

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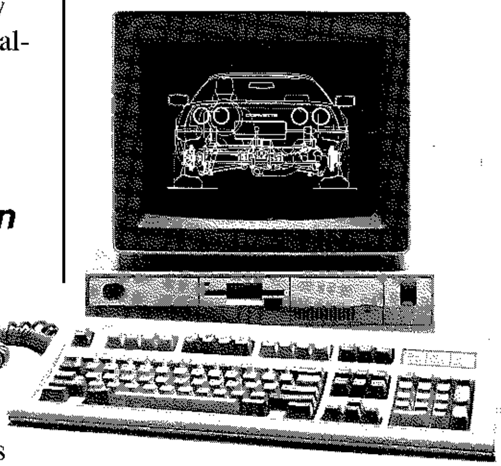

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