ENGINEERING DESIGN GRAPHICS JOURNAL

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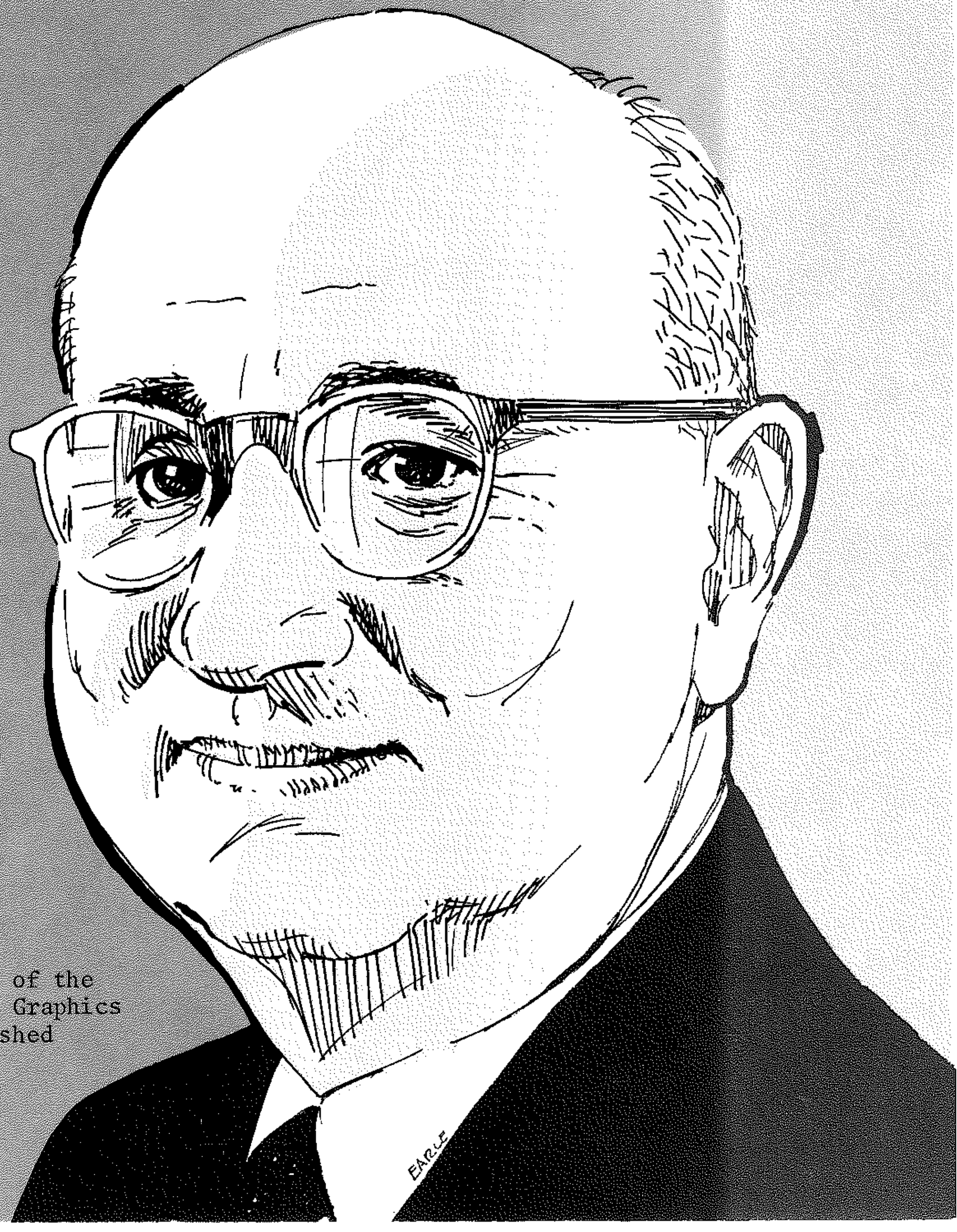

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ENGINEERING DESIGN GRAPHICS JOURNAL

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ENGINEERING DESIGN GRAPHICS JOURNAL OBJECTIVES:

The objectives of the JOURNAL are:

1. To publish articles of interest to teachers of Engineering Graphics, Computer Graphics and allied subjects.
2. To stimulate the preparation of articles and papers on the following topics (but not limited to them):
3. To encourage teachers of Graphics to innovate on, experiment with, and test appropriate techniques and topics to further improve quality of and modernize instruction and courses.

CALENDAR OF MID-YEAR MEETINGS

1973-74 -- New Orleans, Louisiana
1974-75 -- Williamsburg, Virginia

STYLE GUIDE FOR JOURNAL AUTHORS

The Editor welcomes articles submitted for publication in the JOURNAL. The following is an author style guide for the benefit of anyone wishing to contribute material to Engineering Design Graphics Journal. In order to save time, expedite the mechanics of publication, and avoid confusion, please adhere to these guidelines.

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3. Two copies of each manuscript are required.
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CALENDAR OF ASEE MEETINGS

1974 -- Rensselaer Polytechnic Institute
1975 -- Colorado State University
1976 -- University of Tennessee

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EDITOR'S PAGE

The school year 1973-74 has been a good year for the Division of Engineering Design Graphics. We can look back with pride at the accomplishments made by our Division; and those of you who made these accomplishments happen, can enjoy a great deal of satisfaction for your efforts.

This year has seen an intensive study of the Division's By-Laws in an attempt to develop a new set of guide lines by which our Division will be governed. Many are to be congratulated for the fine work that they performed: Borah Kreimer, Bob Hammond, Claude Westfall, Bill Rogers, Ed Mochel, Ron Pare', and Ken Botkin. Those working on these by-laws have received extensive input from the members of our Division at-large, and they have had a considerable task in refining these ideals into a workable set of rules.

Another outstanding activity participated in by our Division was the Midyear Meeting held in New Orleans, Louisiana under the sponsorship of Louisiana State University. We are particularly grateful to the Engineering Graphic STaff of L.S.U. at Baton Rouge and L.S.U. at New Orleans. The major burden for making the excellent arrangements was carried by Clarence Hall and Boris Boguslavsky, both of L.S.U. The program and facilities were outstanding for this meeting which was attended by our members from throughout the nation.

We, the Editorial Committee of the *Engineering Design Graphics Journal*, are appreciative of the support that we have received from contributing authors and from our readers who have shown an interest in our publication. Special efforts have been made by associate editors Bob Foster and Garland Hilliard in presenting news of the Division. Clarence Hall has been an effective Advertising Manager, and Clyde Kearns has been instrumental in maintaining a current and active subscriber list.

We have tried to change the format of the *Journal* somewhat to make it both more attractive and more effective in transmitting current news of our Division. The slate of officers was published in the Fall issue to assist the subscribers and members of the Division in selecting the candidates for whom they would vote. The preliminary draft of By-Laws that will be approved this summer were published in this issue to insure that membership was aware of the changes that were being proposed. A complete outline of the Midyear Meeting was advertised by the *Journal* in advance of the meeting as a means of making our members aware of the plans of the program meeting. A brief resume of the Annual Meeting is covered in this issue to entice more of our members to attend this excellent meeting.

We will continue to encourage members of the E.D.G. Division to submit news items, formal papers, and informal announcements that would be of interest to our readership.

We look forward to an active year in 1974-75.

JIM
EARLE

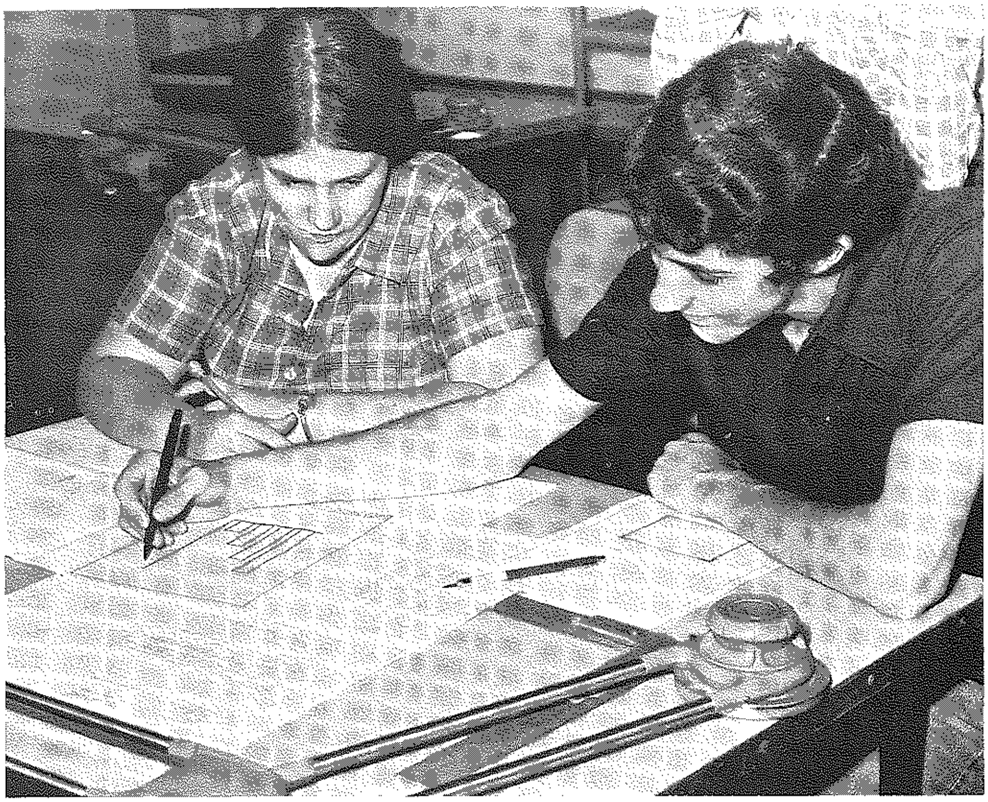


Figure 1: After obtaining the computer printout, students hand plot the results. This procedure is valuable in locating errors before Gerber or Calcomp plots are made.

COMPUTER GRAPHICS FOR EDG

BACKGROUND:

Computers are an important tool in the engineer's bag of problem solving techniques. More and more engineering offices and departments have their own terminals. It is only natural that many of these organizations would like to have graphical, rather than numerical output. Plotters, cathode-ray tubes, graphical tablets, and mini-computers have improved in reliability, and in general, have become less expensive than the prototypes of the late sixties. Graphical output from computers is no longer an experimental toy. This means that the engineering student should have at least an introduction to computer graphics, and the best place for this introduction is in engineering freshmen graphics courses.

CLASS MAKE UP

During the fall of 1973, computer graphics was introduced to three classes of approximately 40 engineering students each at Texas A&M University. The students in these classes were primarily first semester freshmen. Some students had no background, some had toured the computer center, some had six weeks of instruction, and some were completing a basic programing course. By the end of the first semester only one out of six students felt they were somewhat proficient in computer programing. Needless to say, with the varied experiences of the students the instructor had to assume that the students had no knowledge of computers.

J. Timothy Coppinger
Texas A&M University

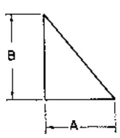
```
X=3.
Y=4.
SUM=X+Y
PRINT,X,Y,SUM
STOP
END

   //$DATA
0.3000000E 01    0.4000000E 01    0.7000000E 01
```

Figure 2: The first assignment was a program that adds two numbers and prints their values along with their sum. This procedure allows the students to become familiar with the input-output procedures of the computer center.

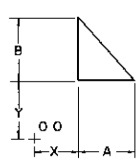
INTRODUCTION TO COMPUTER GRAPHICS

Subroutine TRI (A,B) will draw a right triangle, A, wide and, B, high with the orgin at 0,0.




```
SUBROUTINE TRI (A,B)
CALL PLOT (0.,0.,3)
CALL PLOT (A,0.,2)
CALL PLOT (0.,B,2)
CALL PLOT (0.,0.,2)
CALL PLOT (0.,0.,3)
RETURN
END
```

Subroutine TRIANG (X,Y,A,B) will draw a triangle that can be shifted an amount X and Y from the orgin. A and B is the width and height respectfully.




```
SUBROUTINE TRIANG (X,Y,A,B)
CALL PLOT (X,Y,3)
XX=X+A
YY=Y+B
CALL PLOT (XX,Y,2)
CALL PLOT (X,YY,2)
CALL PLOT (X,Y,2)
CALL PLOT (X,Y,3)
RETURN
END
```

Subroutine PLOT (X,Y,IPEN) normally causes a line to be drawn, however during check out the following subroutine PLOT should be used. It causes the value of X,Y, and IPEN to be printed.

```
    SUBROUTINE PLOT (X,Y,IPEN)
    WRITE (6,101) X,Y,IPEN
101 FORMAT (' ',5X,'X=',F10.3,5X,'Y=',F10.3,5X,'IPEN=',I2)
    RETURN
    END
```

ASSIGNMENT Write a subroutine that will draw a rectangle "W" wide and "H" high, with the lower left corner having coordinate X,Y.

Write a main program that reads the values of X,Y,W, and H from data cards and calls subroutine RECT (X,Y,W,H). The student may select his own values for X,Y,W, and H.

Punch the necessary cards, run the program, and hand plot the results. This assignment is due at the end of the class period.

BASIC DECISIONS

Several basic decisions were made which affected the material to be presented. The first decision reached was that three, two hour class periods would be scheduled. Of this time, approximately half would be in the classroom and half in the computer center. A team approach was used for two reasons. At least one of the six- to eight-man team members should have a knowledge of the computer language and key punch procedures. Secondly, there was a limited number of key punch machines available to the students during class time.

PROCEDURE

The introduction to computer graphics took place in three steps, one step each class period. The first period was devoted to a history of computer graphics, a slide presentation of the computer graphic facilities, and an introduction to Fortran. Only the Fortran necessary to understand the programs to be used was covered. The proper control cards were supplied and discussed. This lecture took approximately 75 minutes of the two-hour period. After making the assignment to write a program that adds two numbers the instructor accompanied the class to the computer center where the programs were processed. The assignment was turned in to the instructor before the end of the class period (Figure 2).

During the second class period, additional Fortran fundamentals were discussed and the concept of Subroutine Plot, which draws a line, was introduced. Most computer graphics programs use either Subroutine Plot or something very similar. For example, in CALL PLOT (X,Y, IPEN), the X and Y are the coordinates of the point to which the line will be drawn, and the IPEN will control whether the PEN is up or down. A dummy, or check out subroutine, Subroutine Plot, which would write (numerically) the values for X, Y, and IPEN was supplied prepunched. The students could then use this information and hand plot the numeric output to obtain their plot.

It is important to realize that even if a school does not have plotting facilities, the procedure of using hand plots can be used to intoduce computer graphics. Due to the large amount of time needed to obtain an actual computer plot they were not used. This time lag is a local problem and actual computer plots would be preferred. A subroutine that would draw a triangle anywhere on the page was given to the students (Figure 3). After class discussion, the students were assigned the problem of writing a program which would draw a rectangle. (It is the same as Subroutine Triangle with the addition of one card). Again, the instructor accompanied the students to the computer center and accepted their hand plots of the data generated by the computer before the end of the class period (Figure 4).

Figure 3: During the second class meeting, a subroutine that would draw a triangle was given to the students and discussed. The students were then asked to write a subroutine that would draw a rectangle.

```
C    THIS PROGRAM SHOULD DRAW A RECTANGLE 3 INCHES HIGH AND
C    2 INCHES WIDE WITH LOWER LEFT CORNER AT X=2, Y=1.
       READ,X,Y,W,H
       PRINT, X,Y,W,H
       CALL RECT (X,Y,W,H)
       STOP
       END

       SUBROUTINE RECT (X,Y,W,H)
C    THIS SUBROUTINE DRAWS A RECTANGLE WITH LOWER LEFT CORNER AT
C    COORDINATE X,Y.      W, WIDE AND H, HIGH
       CALL PLOT (X,Y,3)
       XX=X+W
       YY=Y+H
       CALL PLOT(XX,Y,2)
       CALL PLOT(XX,YY,2)
       CALL PLOT(X,YY,2)
       CALL PLOT(X,Y,2)
       CALL PLOT(X,Y,3)
       RETURN
       END

       SUBROUTINE PLOT (X,Y,IPEN)
C    X AND Y ARE THE COORDINATES TO WHICH THE LINE IS BEING
C    DRAWN, IPEN=3 MEANS PEN UP AND IPEN=2 MEANS PEN DOWN
       WRITE (6,101) X,Y,IPEN
  101 FORMAT (' ',5X,'X=',F10.3,5X,'Y=',F10.3,5X,'IPEN=',I2)
       RETURN
       END

    //$DATA
0.2000000E 01    0.1000000E 01    0.2000000E 01    0.3000000E 01
  X=    2.000     Y=    1.000     IPEN= 3
  X=    4.000     Y=    1.000     IPEN= 2
  X=    4.000     Y=    4.000     IPEN= 2
  X=    2.000     Y=    4.000     IPEN= 2
  X=    2.000     Y=    1.000     IPEN= 2
  X=    2.000     Y=    1.000     IPEN= 3
```

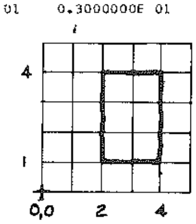


Figure 4: The completed student assignment for the second class period shows a program that draws a rectangle and a hand plot of the results.

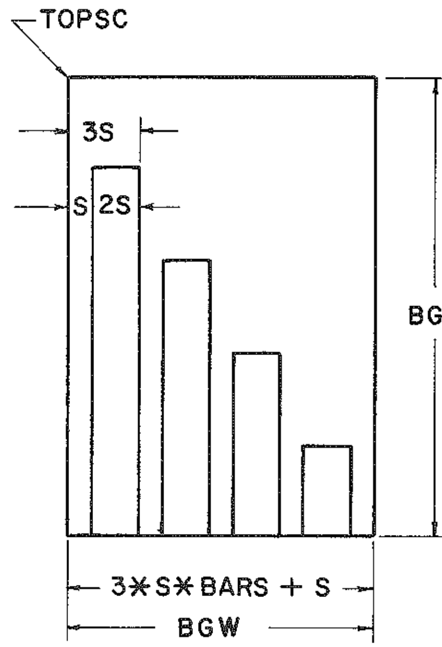


Figure 5: Transparencies are used to speed the presentation to the students. The one illustrated aids the student understanding of the variable names and development of the subroutine that draws a bar graph.

The third class period was devoted to the discussion of a subroutine which would utilize the students Subroutine Rectangle to draw a bar graph. After considerable discussion this subroutine was supplied to the students prepunched. The assignment was to supply the appropriate data, main program, and hand plot the results (Figure 6).

FUTURE

During the spring of this year this same approach to the introduction of computer graphics will be used in all freshmen drawing courses at Texas A&M University. Since there are approximately 950 students, it is anticipated that all programs will be supplied to the students prepunched. There will also be several meetings to further coordinate the activities of the faculty in this area. Possible expansion of the program will be considered for the Fall semester. Several topics that might be included are broken line graphs, polygons with any number of sides, hex head bolts around a bolt circle, orthographic views of an object, oblique and isometric drawings. If more time is allotted, either plots from the Gerber or Calcomp Plotters will be used.

CONCLUSION

It should be remembered that this approach is an introduction. The students are not expected to be computer programers after three hours of instruction and three hours of practice. The students felt that the instruction was very worthwhile, and that more of the course should be devoted to it. A separate course in computer graphics is offered for those students who desire to delve into computer graphics in detail. It may be concluded that an introduction to computer graphics can be included in existing engineering freshmen graphics courses with a minimum of disruption to the existing course curriculum. It is also important to remember that actual plotting capabilities are not necessary when the hand plot technique is used.

Figure 6: At the end of the third class period the students submitted to the instructor a program that draws a bar graph along with a hand plot of the numerical output.

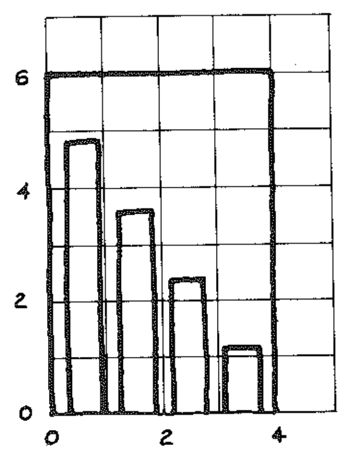
```
      TOPSC=125.
      BARS=4.
      BGW=4.
      BGH=6.
      CALL BRGRAF(TOPSC,BARS,BGW,BGH)
      STOP
      END

      SUBROUTINE PLOT (X,Y,IPEN)
C   X AND Y ARE THE COORDINATES TO WHICH THE LINE IS BEING
C   DRAWN. IPEN=3 MEANS PEN UP AND IPEN=2 MEANS PEN DOWN
      WRITE (6,101) X,Y,IPEN
  101 FORMAT (' ',5X,'X=',F10.3,5X,'Y=',F10.3,5X,'IPEN=',I2)
      RETURN
      END

      SUBROUTINE RECT (X,Y,W,H)
C   THIS SUBROUTINE DRAWS A RECTANGLE WITH LOWER LEFT CORNER AT
C   COORDINATE X,Y.      W, WIDE AND H, HIGH
      CALL PLOT (X,Y,3)
      XX=X+W
      YY=Y+H
      CALL PLOT(XX,Y,2)
      CALL PLOT(XX,YY,2)
      CALL PLOT(X,YY,2)
      CALL PLOT(X,Y,2)
      CALL PLOT(X,Y,3)
      RETURN
      END

      SUBROUTINE BRGRAF ( TOPSC, BARS, BGW, BGH)
C   THIS SUBROUTINE DRAWS A BAR GRAPH. TOPSC IS THE TOP MOST SCALE
C   VALUE. BARS IS THE NUMBER OF BARS THAT THE GRAPH WILL
C   CONTAIN.  BGW IS THE BAR GRAPH WIDTH.  BGH IS THE BAR GRAPH HEIGHT
C   THE FOLLOWING EXPRESSION CALCULATES THE SCALE FACTOR SF FOR
C   THE VERTICLE AXIS.
      SF= BGH/TOPSC
C   THE FOLLOWING EXPRESSION CALCULATES THE SPACE BETWEEN THE BARS,S.
C   THIS IS BASED ON THE BAR WIDTH, BW, BEING TWICE THE SPACE WIDTH.
      S=BGW/(3.*BARS+1.)
      BW=2.*S
C   NOBARS IS THE INTEGER VALUE OF THE NUMBER OF BARS
      NOBARS=BARS
C   XINC INCREAMENTS THE X VALUE IN THE RECTANGLE FOR THE BARS
      XINC=S
      DO 10 I=1,NOBARS
      READ,DATA
      PRINT, DATA
C   BH CALCULATES THE BAR HEIGHT
      BH=DATA*SF
C   THIS RECT IS THE BARS
      CALL RECT (XINC, 0., BW, BH )
C   THIS EXPRESSION CHANGES THE VALUE OF XINC IN ORDER TO DRAW
C   THE NEXT BAR
      XINC= XINC + 3. * S
   10 CONTINUE
C   THIS DRAWS THE RECTANGLE FOR THE BARS TO FIT INSIDE
      CALL RECT (0.,0.,BGW,BGH)
      RETURN
      END
```

```
    //$DATA
0.1000000E 03
  X=      0.308      Y=      0.000      IPEN= 3
  X=      0.923      Y=      0.000      IPEN= 2
  X=      0.923      Y=      4.800      IPEN= 2
  X=      0.308      Y=      4.800      IPEN= 2
  X=      0.308      Y=      0.000      IPEN= 2
  X=      0.308      Y=      0.000      IPEN= 3
0.7500000E 02
  X=      1.231      Y=      0.000      IPEN= 3
  X=      1.846      Y=      0.000      IPEN= 2
  X=      1.846      Y=      3.600      IPEN= 2
  X=      1.231      Y=      3.600      IPEN= 2
  X=      1.231      Y=      0.000      IPEN= 2
  X=      1.231      Y=      0.000      IPEN= 3
0.5000000E 02
  X=      2.154      Y=      0.000      IPEN= 3
  X=      2.769      Y=      0.000      IPEN= 2
  X=      2.769      Y=      2.400      IPEN= 2
  X=      2.154      Y=      2.400      IPEN= 2
  X=      2.154      Y=      0.000      IPEN= 2
  X=      2.154      Y=      0.000      IPEN= 3
0.2500000E 02
  X=      3.077      Y=      0.000      IPEN= 3
  X=      3.692      Y=      0.000      IPEN= 2
  X=      3.692      Y=      1.200      IPEN= 2
  X=      3.077      Y=      1.200      IPEN= 2
  X=      3.077      Y=      0.000      IPEN= 2
  X=      3.077      Y=      0.000      IPEN= 3
  X=      0.000      Y=      0.000      IPEN= 3
  X=      4.000      Y=      0.000      IPEN= 2
  X=      4.000      Y=      6.000      IPEN= 2
  X=      0.000      Y=      6.000      IPEN= 2
  X=      0.000      Y=      0.000      IPEN= 2
  X=      0.000      Y=      0.000      IPEN= 3
```



Student's hand plot

Isometric Views of Circles on a Sphere

Jack Arwas

Technion, Israel Institute of Technology

GENERAL CONSIDERATIONS

It is common practice in many books on cosmography, geography, and physics, to show the main circles on a sphere, namely the equator and the zero longtitude circle as shown in Fig. 1, with disregard to the rules of axonometry. The main reason might be the belief that there could be no point north of the North Pole, nor south of the South Pole, and that these points should be so indicated in the drawing.

Another reason might be the difficulty in determining the length and direction of the ellipses axes, and especially, the location of the tangent points on the contour circle. It is therefore important to establish a simple method to find the length of these axes and the points of tangency for all latitude and longtitude circles, assuming the axis North - South as being vertical.

LATITUDE CIRCLES

Latitude circles are the horizontal circles of the sphere, relative to the isometric direction and as projected on the horizontal and vertical planes shown in Fig. 2. The isometric drawing of the sphere is the circle shown in Fig. 3, its radius $R = \frac{3}{2} r$; γ being the actual radius of the sphere. The usual construction to find R is shown in Fig. 2.

(a) Visibility: The highest point A in the isometric drawing is obtained by the "shade" construction shown in Fig. 2. The height H of the horizontal circle passing through point A is that of the ellipse fully visible in the isometric of the sphere and tangent at point A. All circles above H will be represented by ellipses fully visible. Between the zero level and H, the ellipses will be partly hidden - between the two tangent points on the contour circle.

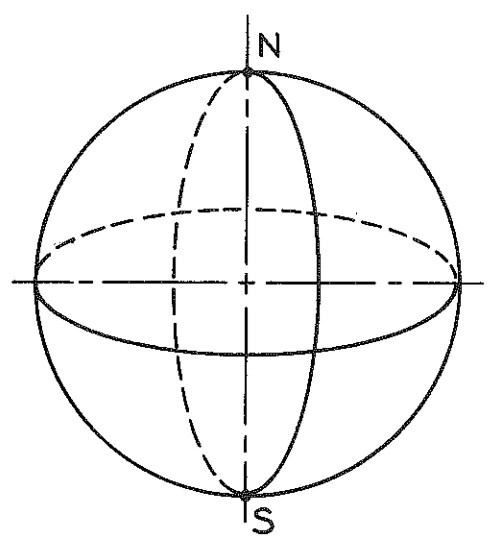


Figure 1: The equator and the zero longitude circles are conventionally drawn with disregard to rules of axonometry.

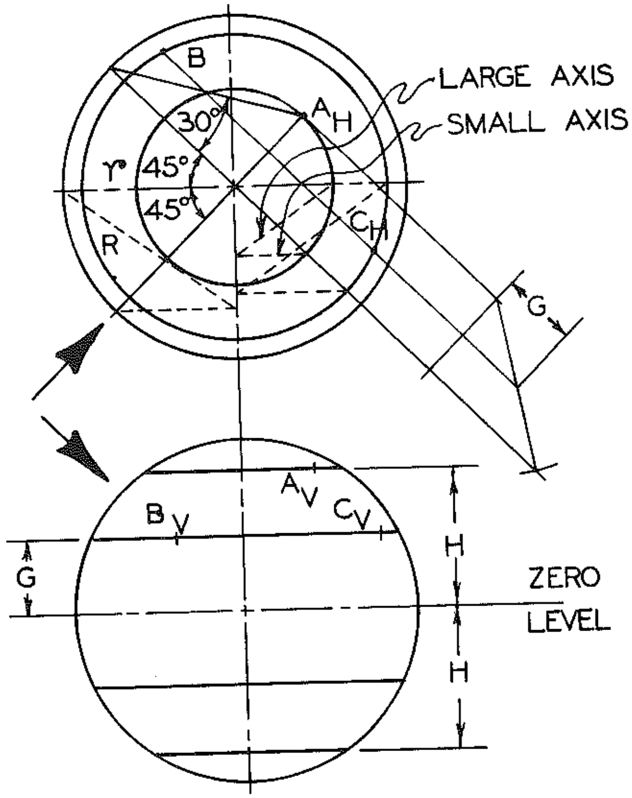


Figure 2: Determination of the latitude circles on a sphere.

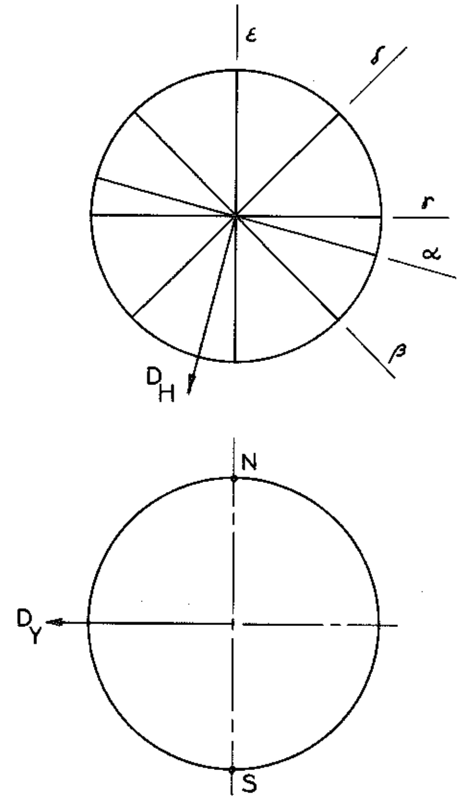


Figure 4: The location of the ellipse axis.

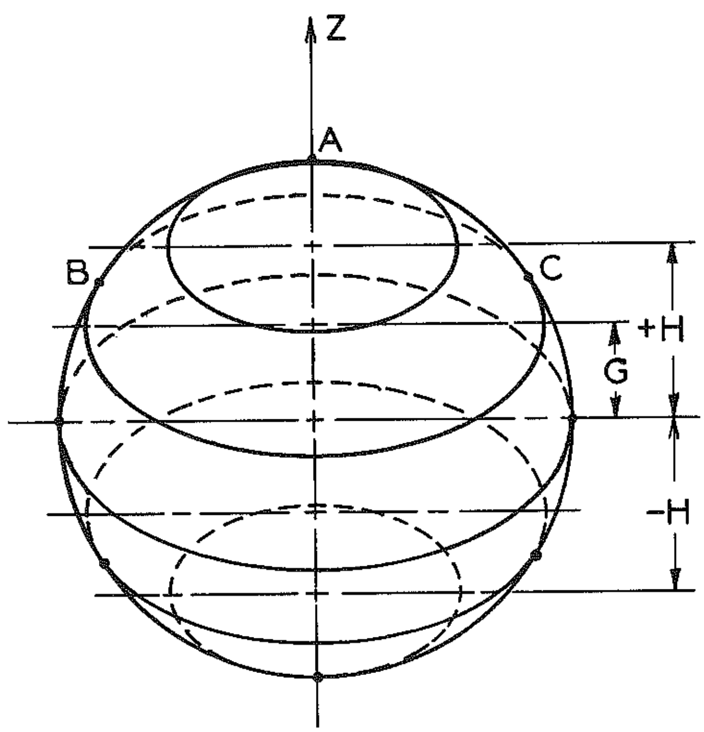


Figure 3: Location of the tangency points on an isometric projection of a sphere.

At zero level half the ellipse will be visible. At levels between zero and H only part of the ellipses will be visible and at H and below, the ellipses will be fully hidden.

(b) Ellipses axis: The large and the small axis of the various ellipses are obtained through the usual construction shown in Fig. 2. In the isometric drawing, the direction of the small axis and that of the large axis perpendicular to it is Z.

(c) Tangents: For the circle at height G in Fig. 2, the construction shown in the horizontal plane based on the projection on a side plane and reversed direction - helps to find the tangent points B and C, and the subsequent isometric location of these two points situates them on the contour circle of the sphere, as shown in Fig. 3. These points are important as they constitute the transfer points of visibility.

LONGITUDE CIRCLES

These circles have in common the N and S points shown in Fig. 5, representing the North and South poles.

(a) Visibility: The ellipses representing the various circles are all half-visible in the upper part between the two tangent points.

(b) Ellipses axis: To find the direction of the small axis we assume the circle to be represented, as being in the plane α. The perpendicular line to plane α through the center of the sphere is shown as D_H and D_V in Fig. 4.

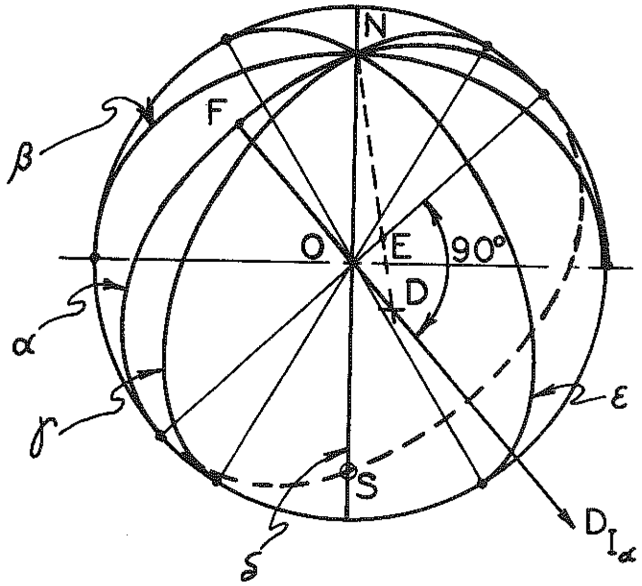


Figure 5: Construction of longitude circles.

In the isometric drawing shown in Fig. 5, the perpendicularity between $D_{I\alpha}$ and the large axis, remains for the reason that the large axis is parallel to the isometric projection plane, and we can therefore determine the direction of both the large and the small axis, which coincides with $D_{I\alpha}$.

The length of the large axis of the α ellipse is equal to the diameter of the sphere and the length of the small axis is obtained through the construction shown in Fig. 5, where ND = R and NE = OF.

It should be noted that circle δ is seen in Fig. 5 as a straight line.

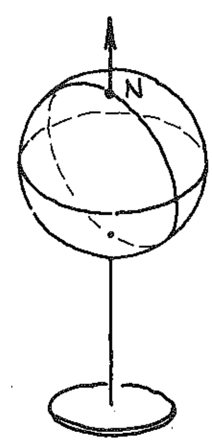
(c) <u>Tangents</u>: The two tangent points of the various ellipses on the contour circle are located at the ends of the large axis and constitute the transfer points of visibility.

CONCLUSION

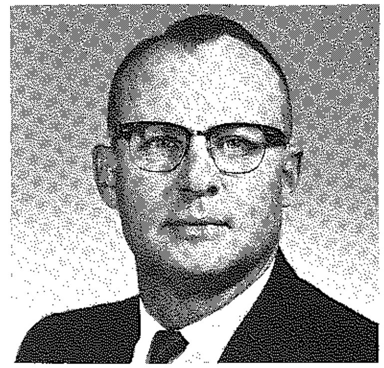
It can be seen in this example that graphical methods can be effectively used to determine axonometric views of longitudes and latitudes on a sphere. This is a basic and necessary step in solving problems in cosmography, geography, and physics.

Isometric Drawing	Visibility	axis direction	axis length	Tangents
Sphere circle	Contour	Figure : 2 radius : R		
Latitude ellipse	<u>Figure 2</u> above H : all below -H : none between $\pm$H between tangents	small axis z	Figure 2	Figure 2 B,C,....
Longtitude ellipses	upper half between Tg. points	small axis d_I	Figure 5	large axis ends

Figure 6: Summarizing table of values.



NOTE: This paper was chosen as the best presentation given at the Midyear Meeting in New Orleans, January 1974, and was awarded the Frank Oppenheimer Award.



Metric Integration for Basic Engineering Courses

By W. George Devens

Virginia Polytechnic Institute and State University

The editorial in the first issue of the new "American Metric Journal", (Mr. Robert A. Hopkins, Editor) is entitled, "Look Out for the Metric Expert". Mr. Hopkins' premise is that there is no such thing as a "metric expert". I assure you that I fully agree with him. Mr. Hopkins also states that "metric speakers should concentrate on that area of metrology that deals only with their own specialty or profession". Following that sound advice, let me share with you a few thoughts confined to our field of engineering education, specifically, "Metric Integration for Basic Engineering Courses".

When most of us were young high school students pursuing a first course in Chemistry, we were intrigued by our initial exposure to grams, cubic centimeters, liters, and meters. This "foreign" system of weights and measures lent additional aura to the experiments and calculations, making us feel a great deal more "scientific" than had we used the familiar inches and pounds. We were somewhat aware that the system stemmed from France, though we probably didn't know that a French monk, Gavriel Mouton, initially conceived the basic meter as early as 1670 and that the metric system was adopted by France in 1795. We were, however, impressed with the powers of ten relationship of units of the system, could see why scientists would prefer such a system, and no doubt wondered why the system couldn't be applied to all. Of course, the answer was obvious. We had "our" system, "they" had "theirs", and we weren't going to change even if their system might be better. Continuing through our engineering education, we were, unhappily perhaps, required to use the "centimeter-gram-second" system in science courses, but relieved to get back to the old familiar "foot-pound-second" system in most of our engineering courses.

Fortunately, though some will disagree, there have been changes for the better in the 1st thirty years. More and more Americans have found themselves intimately involved in every nook and cranny of the world. Though our planet is still approximately 40,000,000 meters in circumference, the world is a much smaller place in which to live. As members of the world community, it is high time that we subscribe to a universal standard as basic as the International System of Units (SI).

American military men have long used the meter as a basic unit of linear measure. Military maps contain metric grids; artillerymen compute range in meters; and kilometers, as familiar as miles, are called "clicks" in military jargon. American golfers in Europe have found it easy to translate the metric lengths of each hole into yards by simply adding 10% to the metric distance for a close approximation - good enough for most people's game! The metric system has unobtrusively worked its way into our daily life in many areas. We purchase 8, 16, and 35 millimeter film, electricity in kilowatt hours, and pharmaceuticals by grams and cubic centimeters. Industry has taken the lead in adopting metric units. Such giants as General Motors, International Harvester, Caterpillar, and Ford have integrated the system into engineering design and production. Automobile mechanics have long used metric tool sets to work on imported vehicles and equipment. Some of out state highway departments are now including kilometers on their interstate road signs as well as adopting the highly graphic European style traffic control signs. Like it or not, the metric system is here, has been here for a long time, and should be legally adopted as our standard. Perhaps the next session of the U.S. Congress will move us more rapidly in that direction.

THE ROANOKE TIMES, Sunday, December 9, 1973 A—9

U.S. More Aware Of Metric System

By GEORGE GALLUP

PRINCETON, N.J. — In every major nation of the world, except the United States, the metric system is the standard system of weights and measures. In this country—still on the traditional system of pounds, yards and gallons—only slightly more than half of the public indicate awareness of the metric system and only three in 10 can accurately describe it.

At the same time, however, awareness of the metric system among the U.S. public has grown since a 1965 Gallup survey on the subject—from 29 per cent in 1965 to 44 per cent in 1971, to 54 per cent in the latest nationwide survey.

The present survey, however, shows that while more than half of Americans say they have heard or read about the metric system, only about three persons in 10 of the total sample are able to correctly describe this system.

Among the three in 10 who give a correct description of the system, opinion divides about 3-to-2 in favor of adoption.

While the bill to convert to metric has still not passed, some industries have already gone metric. The textile industry for example, has adopted the new system, while the American wine industry is planning to do so. Recently the California Division of Oil and Gas converted—the first state agency in the United States, it is believed, to make the change.

In addition, signs showing distances in kilometers as well as in miles are beginning to appear on the nation's highways.

Gallup Poll

To obtain a measurement of awareness, all persons in the current survey were first asked this question:

"Do you know what the metric system is?"

Following is the trend in awareness:

Trend in Awareness of Metric System

1965	29%
1971	44

All persons who indicated awareness were then asked:

"Would you please tell me what the term 'metric system' means to you?"

Here are the responses based on the aware group:

Definition of Metric System

Correct	29%
Incorrect	25
Not Aware of Term	46

Those who are aware of the metric system and can give a correct description of it, were then asked this question:

"Would you like to see the U.S. adopt the metric system?

Here are the results based on the aware group and those who give a correct description, with the trend:

Favor or Oppose Adoption?

Favor	16%
Oppose	10
No Opinion	3
Those Unaware or Incorrect	71

The results reported are based on in-person interviews with 1,502 adults, 18 and older, interviewed in more than 300 scientifically selected localities in the nation during the period Sept. 7-10.

WHAT IS THE METRIC SYSTEM?

1. The metric system was devised in France in 1795, and has since been adopted by most nations of the world. It is legally recognized in the United States, but has never been officially adopted.

2. A distinctive feature of the metric system is that it is based on factors of 10, like our coinage system, that is, numbered or proceeding by tens.

3. It is a system of weights and measures in which the gram is the basic unit of weight, the meter is the unit of length and the liter is the measure of capacity or volume.

However, it is generally used by scientists, and certain industries in this country use it for the sake of precision. For example, the metric system is used in pharmacy and in the optical industry; the medical profession uses it for prescriptions.

The Army and Marine Corps adopted it for many purposes in 1957. The major part of activities of the National Aeronautics and Space Administration have been converted to the metric system to reduce errors from mixed usage.

The

The table below gives some equivalents:

Inch	2.54 centimeters
Foot	0.3048 meter
Mile	1.609 kilometers
QUANTITY	
Fluid Ounce	29.573 milliliters
Quart	0.946 liter
Gallon	3.785 liters
WEIGHT	
Grain	64.799 milligrams
Ounce	28.35 grams
Pound	453.592 grams

Figure 1: A news item showing public opinion concerning the metric system.

Our problem as engineering educators is to determine how and when to best integrate this world standard of units into our classroom instruction and laboratories. In a recent article, Dr. Henry Kroeze, Chairman, Engineering Department, University of Wisconsin submits that "educating engineers and scientists to think and design in metric should not pose a problem. One U.S. concern that converted voluntarily a few years ago reported: 'We gave them a two-hour pep talk and that was all there was to it. Within two months they all preferred working and designing in the metric system'." Dr. Kroeze was speaking primarily of engineers in industry. Obviously, these engineers have a real incentive to convert when their employers decide to make the move. I wonder if we are as ready in higher education.

Reviewing current text material and instruction for basic engineering courses at my own institution, I find a range of metric usage from nil to exclusive. Maximum metric usage occurs in the "pure" science areas of Chemistry and Physics. Chemistry uses the c.g.s. system exclusively. Physics used the m.k.s. system except in those areas devoted to "mechanics", where there is a reversion to the f.p.s. system. Mathematics, dealing mainly in the abstract, involves few units but when they do occur, the f.p.s. system prevails.

The "applied" science courses basic to engineering include Engineering Graphics, Surveying, Statics, Dynamics, Strength of Materials, Thermodynamics, and Electrical Theory. Our current course material in Statics, Dynamics,

Metric System On Way

Committee hearings on the adoption by this country of the metric system have been held and the U. S. Senate has enacted such legislation. Some years will be allowed to put the metric system into operation. It will put other measurements on more or less the same footing as our monetary decimal system now operates. It will be strange and difficult at first to shift from yards to meters, from gallons to liters, from miles to kilometers, but once the strangeness is overcome, it will be much simpler.

Jonathan T. Utin, sixth grade science teacher at Gilbert Linkous Elementary School in Blacksburg, makes an excellent suggestion toward the adult population getting used "to thinking" in the metric system. Here's his excellent idea as described in a letter sent to the local media (newspapers, radio, and television stations):

"Sometime in the next few years, our country is going to change from its present measurement system to the metric system. Also, we are going to change from the Fahrenheit scale to the centrigrade scale.

"In our schools we are teaching children to use these methods of measuring, hoping that the children will gradually get 'the feel' of them. But we must also educate those Americans who are not in school. Thus I write to you, the news media.

"My request is simple. I ask that you ADD to your readings, reports, and forecasts of the weather, the temperature in degrees centigrade. By doing this along with the temperature in Fahrenheit, a feel for 'new' system can happen; a learning by doing method. It will make our lessons in school more relevant and functional.

"I hope that you will support this idea. I really do not think that it is 'jumping the gun'; and I know it will work–they did it this way when they changed over in Great Britain."

For many years, American scientists have been using the metric system of measurements in their work. Manufacturers, especially those with large foreign markets, have advocated changing to metric measurements which is to a great extent world-wide. It's coming to this country and steps to prepare for using the metric system must be taken now before Congress makes use of the metric system mandatory.

Figure 2: An editorial from the Montgomery County newspaper, News Messenger.

attention authors!

Beginning with the October 1974 issue, articles published in *Engineering Education* will present units of measure in both English and metric (SI) terms. Papers submitted to the journal after January 1, 1974, should use both units where it is reasonable to do so. Papers that do not conform to this requirement shall be returned to the authors.

Figure 4: A typical use of metrics in the Research Trendletter.

UNEQUALED PICTURES OF THE EARTH for weather forecasting are produced by the newest of the Air Force's satellites. Visual and infrared (IR) sensors built by Westinghouse Electric Corp., Pittsburgh, bring back highly defined pictures with resolutions from 3.2 km (2 miles) to 0.5 km (0.3 mile). IR sensors produce imagery representing temperature. Combining the visual and IR images, the type and contour of clouds as small as 600 m (2,000 ft) can be determined.

SOVIETS ARE GETTING CLOSER TO FUSION with a hot plasma device that produces a stable plasma column at 1-million C. Developed by nuclear physicist Peter Kapitsa, several hours of life are ascribed to the 20-cm plasma arc. This is a long step toward fusion reactor stability, even though the temperature is still far too low to permit a continuous reaction.

Figure 3: Recommended standards for authors in Engineering Education.

Strength of Materials, Thermodynamics, and Surveying in completely dominated by the English system of units. Electrical Theory finds itself with somewhat of a mix of units, while in Engineering Graphics we have barely scratched the surface of introducing the metric scale. Inches, feet, and pounds prevail.

So, what is being done to hasten acceptance and usage of SI? Certainly the various metric oriented organizations, governmental, educational, and industrial, are now taking the lead in publishing and distributing an ever increasing flow of information. Newspapers will play a major role in bringing the metric message before the general public. The Gallup Poll article from the Roanoke Times (Figure 1) and interest such as expressed in a recent editorial from a small local newspaper, The Montgomery County, Virginia, News Messenger (Figure 2) are examples. Education and Industrial Journals have begun to use, and some require the metric system in printed matter. Note the use of SI in a recent "Industrial Research" Trendletter (Figure 3) and the note to authors (Figure 4) published in the "Journal of Engineering Education". These are all steps in the right direction, but of limited value to us as engineering educators in our classrooms.

Most of our engineering courses are built around a particular text. I believe our most pressing need in engineering education is basic text material with all text, illustrations, problems, and experiments utilizing the metric system exclusively. The problems and costs associated with the preparation of such text material are enormous, but not insurmountable. Texts will need revision, new editions proving both boon and bane for publishers and authors. Instruments for metric measurement must be acquired, or existing English system instruments recalibrated. Visual aids and conversion tables must be prepared and utilized. Dual usage of the English and metric systems should be avoided since this tends to foster reversion to the old system. We, ourselves, and our students will not become adequately familiar with the metric system unless we are, in effect, "forced" to use it on a daily basis.

We will be required to learn and to teach the prescribed norms for dimensioning in SI. While dual dimensioning may be necessary in industry for some years to come, it is not at all necessary in our engineering classrooms. Graphic students will think in millimeters instead of inches; surveying students in meters rather than feet. Students in engineering design courses should be encourages or, better yet, required to compute and design in the metric system. Why not - it's easier!

We recently ran into a small problem in illustrating the meaning of the figures at the left of metric scales. A number such as .025 is associated with a ratio of 1:40. We could find no accepted "names" in any literature, so we have decided to call the decimal number the "scale factor" and the ratio the "scale ratio". Obviously, the scale factor is merely the decimal equivalent of the scale ratio.

In the final analysis, it's going to be the individual engineering teachers who will, or will not, provide the stimulus and impetus to implement SI in engineering education. As you well know, change comes rather slowly in colleges and universities. Teachers of fundamental subjects such as Engineering Graphics, however, are in a position to initiate and hasten the change over to SI. If you teach metric at the basic level, higher level instruction must follow suit.

Seven short years ago, in my own college, there were very few members of our one hundred sixty man engineering faculty with experience in computer programming - and more than a few lacked interest. At that time, we developed and implemented our Engineering Fundamentals Program for first year students. Included in the program is a course in computer programming. Believe me, we had to hustle that first year to stay one step ahead as selected faculty learned the subject with the students. The effect of the freshman course was immediate! Since rising sophomores were going to have a basic knowledge of programming (and would clamor for more), the degree granting departmental faculty were forced to get into the game, which to their credit, they have done. Today, it is a rare engineering professor who is not at least somewhat adept at computer programming. Why not use the same type of gambit to go metric? - and the time is now! I quote from a recent issue of "The Military Engineer": "You better start practicing metric and thinking metric or it may hit you like 1,000 kilograms of brick!" You'd better believe it.

References:

1. Hopkins, Robert A., "Look Out for the Metric Expert", American Metric Journal, September 1973.
2. "Think Metric", Martin Instrument Company, 1973.
3. Kroeze, Henry, "Training Your Work Force to Think Metric", American Metric Journal, September 1973.
4. "Brief History of Measurement Systems", U.S. Department of Commerce, October 1972.
5. Davies, Neville C., "SI is Simple", Canadian Consumer, Jan./Feb. 1973.

Midyear Meeting
Jan. 24-26

The annual midyear meeting of the Engineering Design Graphics Division was held January 24-26, 1974, in New Orleans. Headquarters for this meeting was the Fountainbleu Motor Hotel located near downtown New Orleans. Sponsor for this meeting was Engineering Graphics Department of Louisiana State University with Professor Clarence Hall and Boris W. Boguslavsky, both of L.S.U. serving as hosts.

Registration was Thursday afternoon January 24th with the Executive Meeting at 6:15 that night. The Executive Meeting discussed old and new business of the Division with primary emphasis on refinement of the rough draft of the new By-Laws of the Division of Engineering Design Graphics. These By-Laws will be submitted for approval during the annual meeting in New York this summer. Chairman Ken Botkin presided over the Executive Meeting and received reports from all standing committees.

Dean Roger W. Richardson greeted the attendees at the general session held at 9:00 Friday morning. Dr. Richardson is Dean of the College Of Engineering at Louisiana State University.

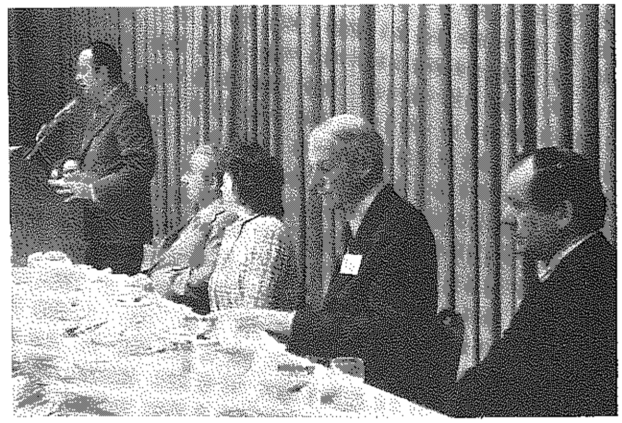
Excellent papers were given following the general session by Professor Klauss E. Kroner, University of Massachusetts; Bob R. LaRue, Ohio State University; George Devens, Virginia Polytechnic Institute; and Ms Naomi J. McAfee, Westinghouse Electric Corporation. During the noon luncheon, an excellent movie depicting the planning, development, and construction of the Superdome being built in New Orleans was presented by a staff member of the construction company.

Papers were presented Friday afternoon by Robert J. Foster, Pennsylvania State University; Wilfred J. Tolman, Brigham Young University; Don Beattie, Queen's University; and Thomas R. Long, West Virginia University.

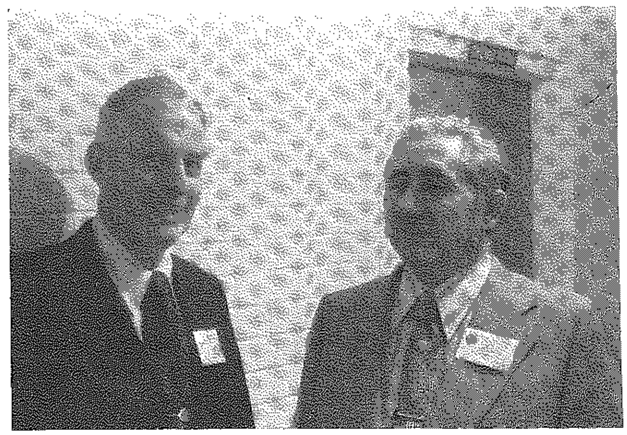
The Honorable Mrs. Hale Boggs, U.S. House of Representatives, gave an after dinner speech following the annual banquet held Friday night. Her topic was the legislature status of the metric system of measurement.

A ladies tour was organized for wives of the attendees that included visits to famous landmarks in the old New Orleans area. Ample time was provided for sightseeing and visits to the many historical spots available in the area.

The meeting was both informative and enjoyable, providing academic stimulation and relaxation. The facilities and conveniences provided by the Fountainbleu Motel contributed greatly to this well-organized meeting. The meeting adjourned with the conclusion of the annual banquet.

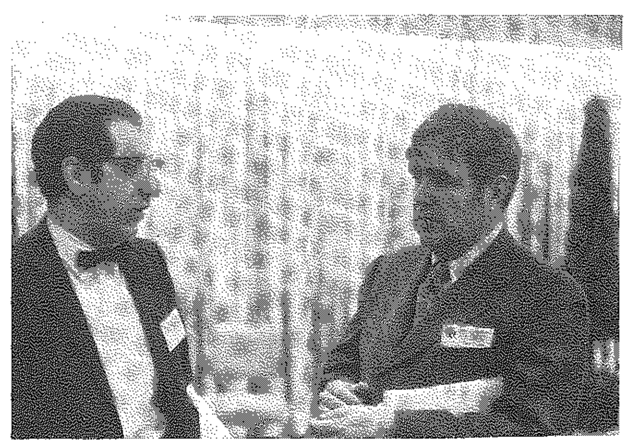


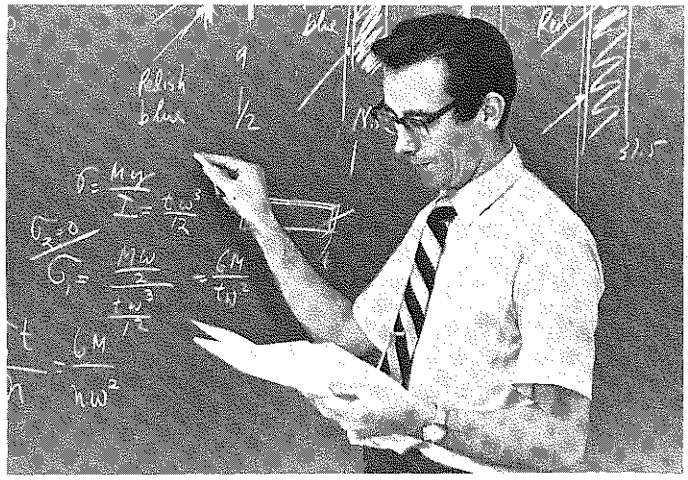
The "Superdome" was the topic of the noon luncheon and was presented by Mr. Charles F. Cronin. (L to R: Mr. Cronin, Ken Botkin, Ms. Laner, Dean Richardson and Vice Chairman Claude Westfall).



Dean Roger W. Richardson, Louisiana State University and Chairman Ken Botkin, Purdue University.

Francis Mosillo, Chicago Circle, discusses a topic with Bob LaRue, Ohio State University.





Application of Graphics to Mechanical Design

APPLICATION OF GRAPHICS TO MECHANICAL DESIGN

By George Raczkowski
Texas A&M University

Graphical methods are used extensively in solving problems in all areas of mechanical design. In general, graphical methods are simple, practical, and easy to learn; they provide immense visual effect and aid in the understanding of the principles involved. Therefore, they are powerful tools that should be used whenever possible in both education and application. By showing examples of problems facing the student or designer in practice, some of the advantages of graphical methods over analytical will be pointed out.

The engineering student is exposed to graphics from the beginning in ENGINEERING GRAPHICS courses and these principles are used in later courses. Reduction of a system of forces in STATICS, finding the resultant by force polygon, and determining equilibrium conditions are performed by graphical methods. The same applies to DYNAMICS where one should use graphical methods whenever applicable, even as a supplementary method. It helps in understanding the theory involved when operations on vectors and motions are under consideration. Unfortunately, some textbooks do not cover graphical methods, but rely only on analytical methods. When studying kinematics and dynamics of rigid bodies, determining velocities, accelerations, and forces, problems could often be solved much faster by using graphical methods rather than analytical methods.

Let us examine a slider crank-mechanism as shown in Fig. 1 as an example that lends itself to solution by use of graphics. Given is the angular velocity of the crank equal to 1 rad/sec (clockwise), and the mechanism's dimensions as drawn to scale. Required: Find the acceleration of the slider point B.

Similar problems are assigned and solved in mechanics and mechanisms courses. To solve the problem, the analytical solution is shown in Fig. 2 with some of the arithmetic ommitted. Yet, it is a lengthy solution as compared with the graphical solution shown on Fig. 3 and Fig. 4. Only seven lines needed to be drawn with one simple calculation to work the problem with approximately 1% of error as compared with the three-decimal-point accuracy of the analytical solution. It is apparent that the graphical solution is far better and faster in this case. The graphical error is a result of inaccuracies of drafting. It accumulates in laying out angles, drawing perpendicular or parallel lines, transferring dimensions, or using scales (often too small).

Yet another approach in solving the same slider-crank mechanism is shown on Figs. 5 & 5a. The mechanism is drawn for a number of successful crank positions with 30° crank intervals in Fig. 5. Fig. 5a shows the displacement, velocity, and acceleration curves for the slider obtained

VELOCITY:

$$\vec{V}_A = \vec{\omega}_A \times \vec{r}_A = -\vec{k} \times (\vec{i} + 1.732\vec{j}) = 1.732\vec{i} - \vec{j}$$

$$\vec{V}_B = \vec{V}_A + \vec{V}_{B/A} = 1.732\vec{i} - \vec{j} + \vec{\omega}_{B/A}\vec{k} \times$$

$$\times (+3\vec{i} - 1.732\vec{j})$$

$$V_B\vec{i} = 1.732\vec{i} - \vec{j} + 3\omega_{B/A}\vec{j} + 1.732\omega_{B/A}\vec{i}$$

$$0 = -1 + 3\omega_{B/A} \quad \therefore \omega_{B/A} = +\tfrac{1}{3} \text{ RAD/SEC}$$

$$V_B = 1.732 + 1/3(1.732) = \underline{2.310 \text{ ips}}$$

ACCELERATION:

$$\vec{A}_B = \vec{A}_A + \vec{A}_{B/A}$$

$$A_B\vec{i} = \vec{\omega}_A \times \vec{V}_A + \vec{\omega}_{B/A} \times \vec{V}_{B/A} + \vec{\alpha}_{B/A} \times \vec{r}_{B/A}$$

$$\vec{\omega}_A \times (\vec{\omega}_A \times \vec{r}_A) = -\vec{k} \times \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 0 & 0 & -1 \\ 1 & 1.732 & 0 \end{vmatrix} =$$

$$= -\vec{i} - 1.732\vec{j}$$

$$\vec{\omega}_{B/A} \times (\vec{\omega}_{B/A} \times \vec{r}_{B/A}) = +1/3\,\vec{k} \times \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 0 & 0 & +1/3 \\ +3 & -1.732 & 0 \end{vmatrix} =$$

$$= -1/3\,\vec{i} + .192\vec{j}$$

$$A_B\vec{i} = -\vec{i} - 1.732\vec{j} - 1/3\,\vec{i} + .192\vec{j} -$$

$$+ 3\alpha_{B/A}\vec{j} + 1.732\vec{i}$$

$$0 = -1.732 + .192 + 3\alpha_{B/A}$$

$$\therefore \alpha_{B/A} = +.51$$

$$\vec{A}^t_{B/A} = 1.53\vec{i} + .883\vec{j}$$

$$\vec{A}_B = -1 - 1/3 + (1.732)(+.51) = \underline{-.444 \text{ ips}^2}$$

Figure 2: Analytical solution of slider-crank solved graphically in Fig. 1, Fig. 2 and Fig. 3.

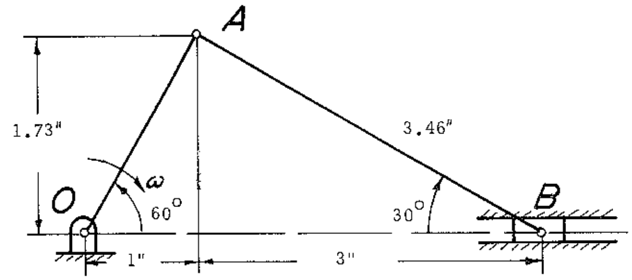


Figure 1: Given: Slider crank mechanism as shown. Angular velocity of crank = 1 Rad/sec CW. Find: Velocity and acceleration of slider at pt. B.

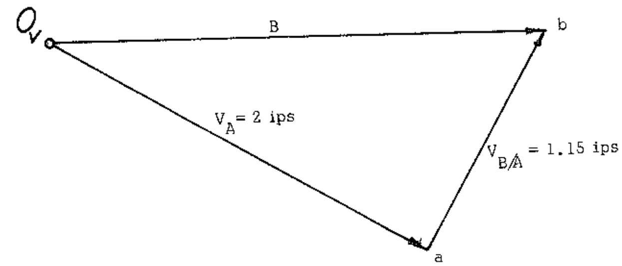


Figure 3: Step 1: Draw given velocity of A from any point O_V to scale. Draw directions of V_B and $V_{B/A}$ perpendicular to AB. Point of intersection is the solution to equation:

$V^B = V^A + V^{B/A}$

V = 2.3 ips

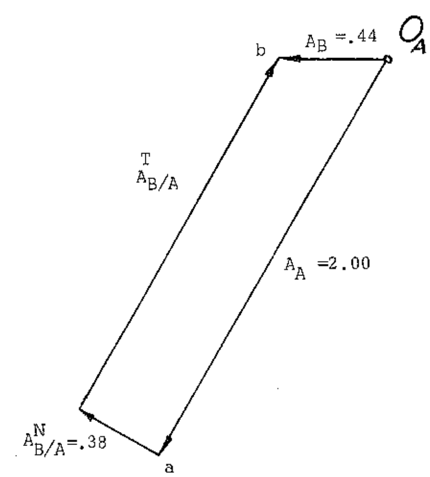


Figure 4: Step II: Draw accelerations from O_A by solving the Eq. given below:

$A_B = A_A + A_{B/A}^N + A_{B/A}^T$. Calculate $A_A = V^2_{A/R} = 2.00$ ips^2

and $A^N_{B/A} = V^2_{B/A}/AB = 1.15^2/3.46 = .38$ ips^2.

Next draw a line perpendicular to A^N_B/A and find point b.

A_B is the answer.

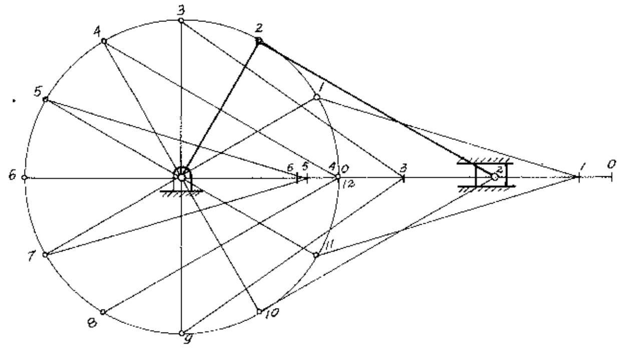


Figure 5: Different crank positions of a slider-crank mechanism.

by laying off the displacements of the slider and next differentiating graphically (5) the displacement and velocity curves. The analysis is complete for every position of the slider, whereas in the previous methods only one position was analyzed. Although the previous two methods give velocities and accelerations for different points of only one position, there are advantages and disadvantages of the methods considered and should be chosen depending upon needs of the designer. The subject of MACHINE DESIGN could be divided into Analysis and Synthesis of Mechanisms and Dimensioning, or Strength of Materials sections. Analysis means studying a given mechanism. To perform the task, graphical methods are used for finding positions, instantaneous methods, drawing velocity and acceleration polygons, determining forces, differentiating and integrating functions and laying out cam profiles, etc.

Synthesis means designing the best mechanism and its dimension for a given motion. Examples of application of graphics are: guiding a point along a specified curve, correlating angular positions of two or three cranks, guiding a body through a number of distinct positions, developing function generators, and other uses. Descriptive geometry(by consecutive auxiliary views) is used in solving for displacements, velocities and accelerations of spatial mechanisms, which in many cases significantly simplifies the solution of the more difficult cases (2 & 4) as compared with those of planar mechanisms.

To show how powerful, yet simple the graphical method could be, let us design a mechanism which will guide a rigid body shown on Fig. 6 from position AB to A'B'. A four-bar mechanism is one of the simplest and most suitable for such a job. As shown in Fig. 6a-c it is solved by arbitrarily selecting centers O_1 and O_2 on the perpendicular bisectors of AA' and BB'. One can choose any suitable system of four links as a solution.

Another example shows the advantage of using the graphical method to design a function generator $y = \log x$; $1 \leq x \leq 2$ with three accuracy

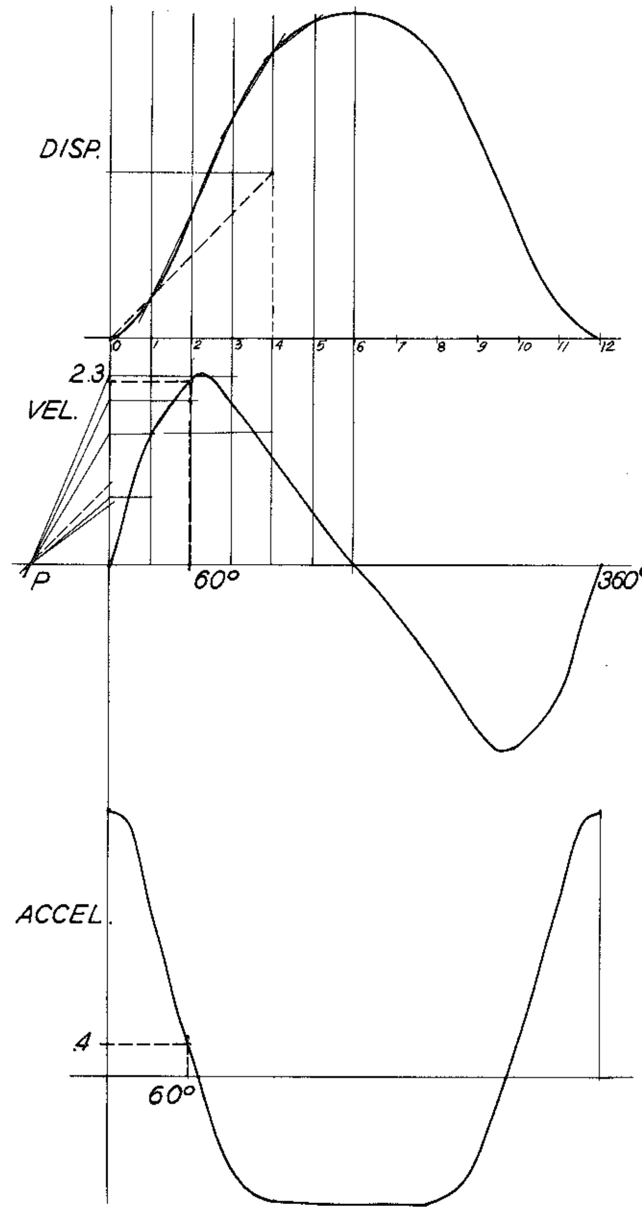


Figure 5-a: Displacement, vocity and acceleration curves for a slider-crank obtained graphically.

points. Figure 7 shows such a function generator linkage in which the motion of rocker R_2 corresponds to x and the motion of rocker R_4 to the function $y = F(x)$. The starting position of $\phi = 45°$, the total swing of 60° of the input rocker, and the starting position of $x = 0°$, and the total sweep of the output rocker of 60° are found by transforming the linear values of x and y into degrees. The analytical solution requires setting up and simultaneously solving a system of three equations for the three unknown values of link ratios. The equations are given below as follows:

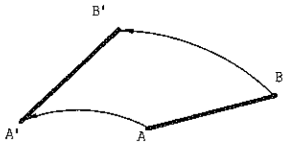


FIG.6

Given: A rigid body of length AB, and its position.
Find: A mechanism which will guide body AB from position as shown to postion A'B'.

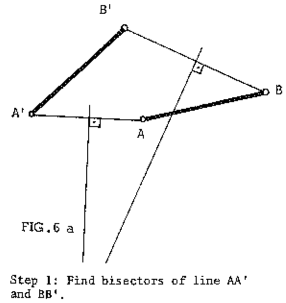


FIG.6 a

Step 1: Find bisectors of line AA' and BB'.

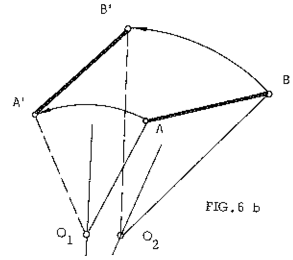


FIG.6 b

Step 2: Choose any point O_1 along the line which is the bisector. Repeat for O_2. A particular case is when O_1 coincides with O_2.

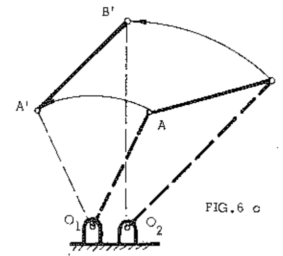


FIG.6 c

Step 3: Connect O_1 with A and O_2 with B to obtain a four-bar-mechanism which will satisfy the required condition of guiding body AB to A'B'.

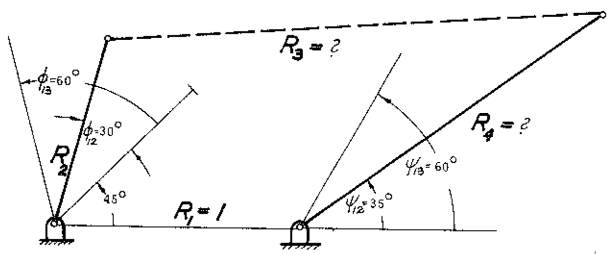


Figure 7: Given: Starting position ϕ=45°; total swing of input link 60°; total swing of output link 60°; ϕ_{13}=60°; ϕ_{12}=30°; Ψ_{13}=60°; Ψ_{12}=35°; R_1= 1 in., and assumed R_2 as equal 0.79 in.
Find: A four-bar mechanism(R_3;R_4) which will satisfy the required conditions.

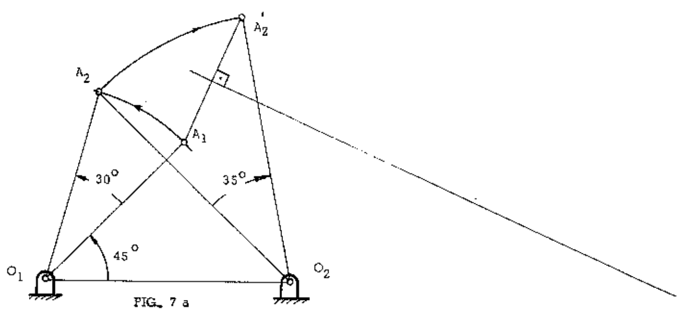


FIG. 7 a

Figure 7A: Step 1: Draw line O_1O_2 equal 1 in. to scale, and line O_1A_1 as equal R_2. Draw an angle of 30° to obtain line O_1A_2. Connect points A_2O_2 and draw angle 35° as shown. Find bisector of A_1A_2 by geometric construction. To find point A'_2 swing an arc of O_2A_2.

$K_1 \cos 49.020 + K_2 \cos 5.614 + K_3 = \cos (49.020 - 5.614)$
$K_1 \cos 75 + K_2 \cos 35.10 + K_3 = \cos (75 - 35.10)$
$K_1 \cos 100.98 + K_2 \cos 57.056 + K_3 = \cos (100.98 - 57.056)$

Solving for K_1, K_2 and K_3 yields:
$K_1 = -0.6629$; $K_2 = 1.2566$ and $K_3 = -0.0894$.
The relationship between the constants K_1, K_2, K_3 and the link lengths $R_1, \ldots R_4$ is given by the following formulas:

$K = (R_3^2 - R_1^2 - R_2^2 - R_4^2)/\ 2 R_2R_4;\ /\ K_2 = R_1/R_4$ and $K_3 = R_1/R_2$.

Let us assume R_1=1.600 in. and substituting it into the above values for K_1, K_2, and K_3 we obtain:
R_2=0.7936 in.; R_3=2.034 in. and R_4=1.515 in.
A four bar-linkage with such dimensions will generate the log function as required.

Quite a number of mathematical operations were omitted in solving this problem analytically, particularly in setting up the system of equations. The graphical solution is shown in Fig. 7 a-c. This method is also called the inverse method. Briefly it follows: first a line O_1O_2 is assumed of any length (in our case R_1 = 1 in.) and drawn to a suitable scale, and another line is drawn as the input link R_2. To check the analytical solution with the graphical solution R_2 was chosen to be equal 7.7936 in. as obtained before from solving the three equations.

Next, angles ϕ 12 and ϕ13 were constructed and points A_2 and A_3 found. Joining points A_2, A_3 with point O_2 and drawing angles ψ 12, ψ 13 in the directions as shown on Fig. 7a and 7b gives points A_2' and A_3'. The intersection of the erected perpendicular bisectors of A_1A_2' and A_1A_3' determines the fourth point B_1 and the required links R_3 and R_4.

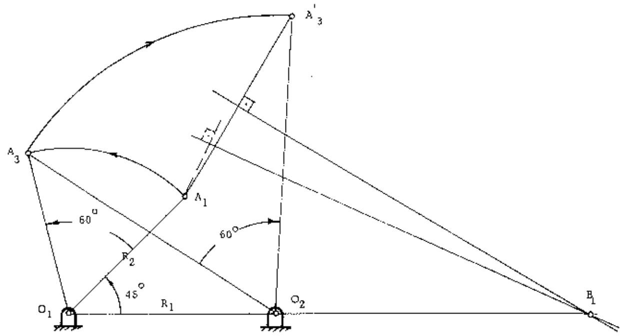


Figure 7 B; Repeat construction as described in step 1 for point A_3. Point B_1 is the point of intersection of the two bisectors obtained from steps 1 and 2. This point determines the length of line R_3 and R_4.

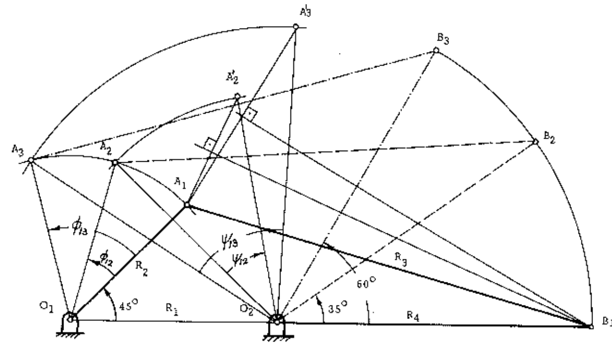


Figure 7C: Step 3: By connecting O_2 with B_1 and A_1 with B_1 the mechanism is completed. From point B_1 by swinging an arc other positions were shown.

By comparing the two methods one can appreciate the simplicity of the graphical method. When checking the results R_3 and R_4 as obtained by graphics with the calculated values by solving the three equations analytically, one observes that they are the same, which proves the correctness of both methods.

DIMENSIONING AND DATA ANALYSIS

Dimensioning machine elements is also simplified by using graphical methods.
Some examples are:
1) Mohr's Circle for finding stresses, strains, and moments of inertia
2) Shear and bending diagrams of forces and moments, deformations of beams
3) Fatigue diagrams; etc.

Also, as could be seen from the assignment sheet 80 for engineering design graphics students included (Fig. 8), some data must be plotted before being analyzed. Without drawing the curves first, it would be impossible to determine the yield stress which is one of the most important characteristics of materials. The method used to determine the yield stress is commonly known as the offset method and is strictly a graphical method. The same applies to the other questions, that could not be answered without drawing the curves first.

SUMMARY

As could be observed from the brief description of different solutions of problems, graphics plays a dominant role in mechanical design. With the rapid developments and improvements of computer graphics this will remain as such for a long time to come. When combined with analytical methods, graphical methods are of great importance and hundreds of new applications are published in original works. Even handbooks of graphical methods are available (3) giving quick solutions to typical design problems. Today's students equipped with electronic pocket calculators seem to forget about the great opportunities in simplifing their solutions by a simple sketch or drawing. Therefore, it is the instructors responsibility to point them out whenever possible. Such was the intention and purpose of this article. Every other area such as civil engineering, electrical, or any of the long list of specialities could point out numerous examples of applications of graphics to their problems.

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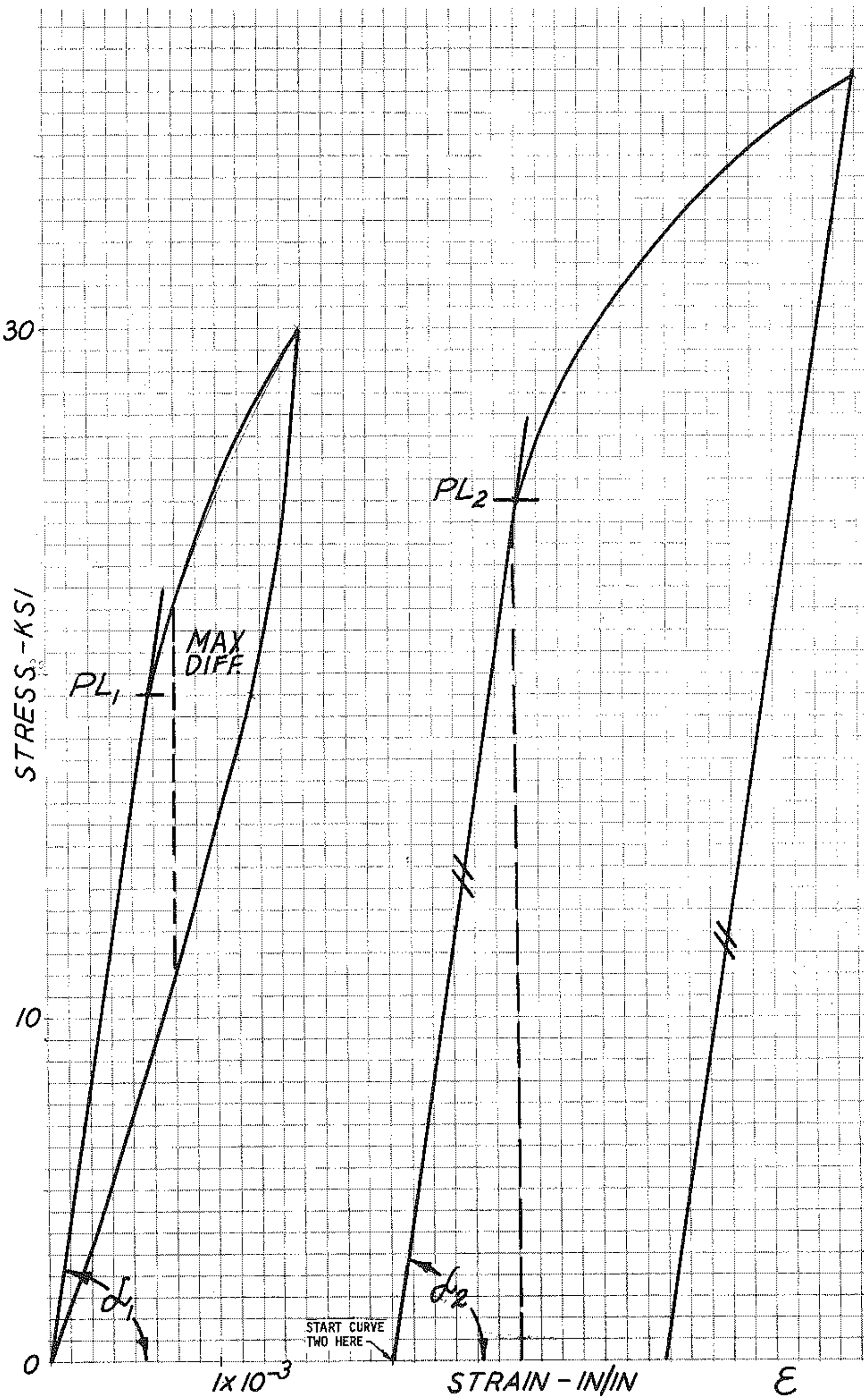
1. Hartenberger, R.S., Kinematic Synthesis of Linkages, McGraw-Hill Book Company, 1964.
2. Shigley, J.E., Theory of Machines, McGraw-Hill Book Company, 1961.
3. Tao, D.C., Applied Linkage Synthesis, Addison-Wesley Publishing Company, 1964.
4. Beggs, J.S., Advanced Mechanisms, The Macmillan Company, 1966.
5. Earle, J.H., Engineering Design Graphics, Addison-Wesley Publishing Company, 1973.

DATA ANALYSIS

MOST DATA MUST BE PLOTTED GRAPHICALLY BEFORE IT CAN BE ANALYZED. THE DATA IN THE TABLE BELOW WAS TAKEN FROM A TWO RUN COMPRESSION TEST OF A STEEL SPECIMEN. PLOT THIS DATA AS STRESS-STRAIN CURVES FOR EACH RUN SEPARATELY IN THE SPACE BELOW. FROM THE CURVES, DETERMINE FOR EACH RUN:

1. YOUNG'S MODULUS "E" USING A FORMULA $E = \frac{\Delta\sigma}{\Delta\varepsilon}$ $E_1 \approx 32(10^6)$ $E_2 \approx 32(10^6)$ PSI
2. PROPORTIONAL LIMIT OR STRESS AT WHICH THE CURVE BEGINS TO DEVIATE FROM A STRAIGHT LINE PORTION OF THE GRAPH.
   $PL_1 \approx 19.4$ KSI $PL_2 \approx 25$ KSI



3. MAXIMUM DIFFERENCE IN STRESS WHILE LOADING AND UNLOADING FOR THE SAME VALUE OF STRAIN.
   MAX DIFF. 11.6 KSI

ALSO, ANSWER THE FOLLOWING QUESTIONS:

1. DID THE YOUNG'S MODULUS CHANGE IN RUN TWO AS COMPARED WITH RUN ONE? NO
2. DID THE PROPORTIONAL LIMIT INCREASE IN RUN TWO? YES

STRESS (KSI)	STRAIN (10^{-3} IN/IN)			
	RUN 1		RUN 2	
	Up	Down	Up	Down
0	0	0.05	0	1.50
2.5	0.07	0.20		
5.0	0.16	0.35	0.15	1.65
10.0	0.32	0.67	0.30	1.80
15.0	0.45	0.92	0.45	1.95
20.0	0.65	1.20	0.60	2.10
22.5	0.75	1.30		
25.0	0.95	1.40	0.76	2.26
27.5	1.25	1.45	0.89	2.34
29.0	1.50	1.50		
30.0			1.07	2.42
32.5			1.35	2.49
35.0			1.75	2.52
37.5			2.65	2.65

COURTESY TO MTS SYSTEMS CORP.

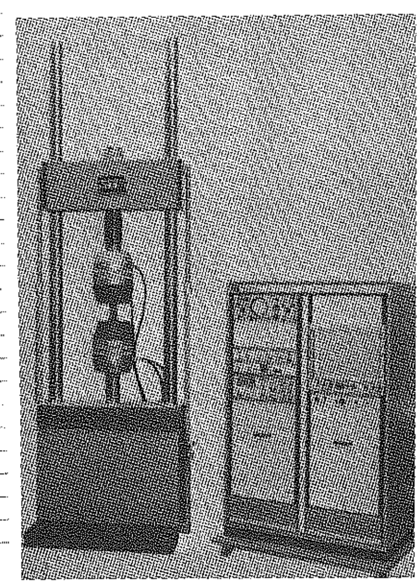


Figure 8: Data analysis of stress-strain curves.

Let's Get Involved For 1974-75

Claude Z. Westfall
Vice Chairman
Engineering Design Graphics Division

The Engineering Design Graphics Division has changed considerably since its inception in 1928. Through the efforts of its first chairman Thomas E. French and those that followed... Harry M. McCully, John M. Russ, Carl L. Svensen, Clair V. Mann, Randolph P. Hoelscher, Walter E. Farnham, Justus Rising, and more recently... James H. Earle, Percy H. Hill, and William B. Rogers, the Division has prospered and grown. Many changes have occurred in the last forty-six years. There have been several changes in the emphasis of graphics, new areas of involvement have been entered into, and two changes in name have occurred. More recently a Self-Study Committee and a Journal Study Committee proposed several long range recommendations related to the operation and organization of the Division. New By-Laws have also gone into effect since the Annual Conference at Iowa State in 1973.

For the year 1974-75 the Division will continue to promote the interests and activities that pertain to graphics and design. The focal point for carrying out activities will be the Mid-Year Conference to be held at Williamsburg, Virginia, and the Annual Conference to be held at Colorado State. Individuals in charge of institutional graphics programs are urged to find ways to get their younger members involved in the work of the Division. An opportunity to attend either or both of the Conferences would be a good way to introduce these people to the Division.

A concern frequently expressed by individuals of the Division is that there is a need for more member participation. The membership is now urged more than ever to take part in its programs, to share their new innovations in graphics, and to take an active role in committees that are vital to its operations. Several committees that have been inactive will be abolished for the year 1974-75. Others will undoubtedly be added. Your concerns and interests will help the new chairman to develop those committees required to carry out the work of the Division. Current operating committees are:

Liason Committees

Public Relations

Educational Relations

Industrial Relations

Technical & Professional Committees

Graphics Technology

Computer Graphics

Theoretical Graphics

Engineering Design Education

Teaching Techniques

Human Factors in Design

Claude Z. Westfall
General Engineering
University of Maine

Programs Committees

ASEE Annual Conference

Mid-Year Conference

Exhibits

Creative Design Displays

Zones Activities Committees

Zone I

Zone II

Zone III

Zone IV

Responsible for planning geographical activities

Publications Committees

Engineering Design Graphics Division Journal

Additional committees in other areas of interest as expressed by the members will also be formed. You are invited to respond to the following questions.

1. Areas of interest that you would like to see developed.
2. Committees that you have an interest in or would be willing to work on.
3. Program suggestions for the Mid-Year and Annual Conferences, 1974-75.

There will always be a need for a place and time to exchange ideas. Issues will always confront us, and problems will need to be resolved. In the final analysis, the future of the Division will depend on the determination of each member to do his or her part.

Comments should be sent to:

Claude Z. Westfall
Department of General Engineering
202 East Annex
University of Maine
Orono, Maine 04473

book review

INTRODUCTION TO DIGITAL COMPUTER PLOTTING

by T. C. Smith and Y. C. Pao
Gordon and Breach Science Publishers, New York

This book is quite well done. It is illustrated with many plotter-drawn graphs and drawings that give ample evidence of the power and scope of computer plotter graphics. The book includes listings of the programs and subprograms that generated the plots, with comment cards and accompanying explanatory text. Calcomp and Complot subroutines as well as some Job Control Language statements are explained, compared, used and the resulting pictures shown.

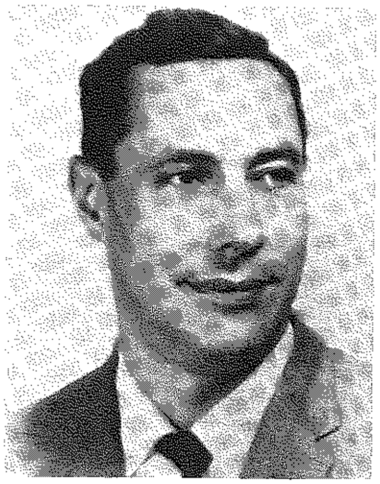
I especially liked the illustrations of the transformations of letters, figures, and objects --the scaleing, translating and rotating; these operations help the reader to think of the digital computer as containing a collection of an almost infinite number of templates, each with a choice of hundreds of sizes and attitudes.

Other illustrations in this book include bar, solid and broken-line graphs; curve fitting, two- and three-dimensional views with visibility shown, Mohr's circle, contour drawings, gears, Moire's pattern, a floor plan and an electrical schematic diagram.

Photos of plotters and computers are inculded, plus a plotter-drawn example of pen and paper movements. To help locate information in the exact columns of control cards, a scaled photo of a numbered computer card is placed below card listings. Although a knowledge of Fortran is assumed, a motivated novice should catch on by careful and thoughtful reading, with occasional reference to a Fortran text. Subroutine arguments (the variables shared by different program components) are commented upon and explained. I think that if this or a similar text could be made available in advance to those attending computer graphics conferences, all would benefit.

Overall, this is a worthwhile textbook that will help students understand, appreciate, and use plotting hardware and software.

Reviewed by Professor Norman Buchanan
General Engineering
Pennsylvania State University



Scales and Alignment Charts Using a Digital Plotter

Part One

Prof. Clair M. Hulley
University of Cincinnati

Frequently scales for non linear functions must be created and the time to lay them out by hand can be very large if the functions are complex and highly non linear.

While there are many linear and special logarithmic scale routines available on a digital plotter none are flexible enough to be generalized.

To satisfy this obvious a curved scale routine(CRVSC) and a program to annotate it called (LBL) was written. These programs were written for a 16 K, 1130 I.B.M. computer driving a 4-1/2 X 6 foot Calcomp 718 plotter on line with a step size of 0.001 inch. A print out of the program is given in Table 1.

To convert to a 360 or 370 computer would only require control card changes and a removal of the cards requiring the data switch two(CALL DATSW). The NUMB, PLOT, and SYMB are the standard Calcomp number, plot, and symbol routines.

Subroutine LBL is automatically fed proper information from the CRVSC routine. It will center the value above or below the tick mark for values from 0.001 to 10000.0(positive or negative). Values outside this range require the usual procedure to factor out ten to the nth power and place this in the scale title. Also, LBL routine will place the value to the right or left of the tick mark, and move it as close as possible as well as suppress the value.

You will note the card following LBL00040 and also following CRV00040 is the card to obtain a listing. If this is the last card with an asterisk in column one, and if C is placed in column 80, the card can be left in the deck and reversed end for end to get a listing as you desire. The same technique can be used in debug write statements by placing a C in column 80 and turning the card end for end to place the deck back in de-bug status.

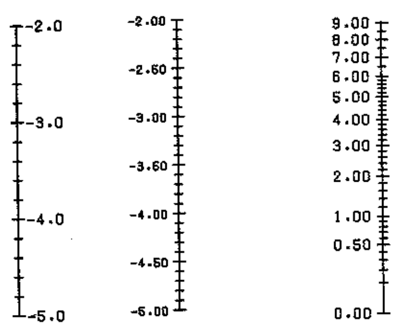
The customary subroutine argument list is shown on card CRV00060. The last two arguments are external x and y scale functions. This is useful in making alignment charts where several scales and functions are involved. If only one scale is to be drawn, the card following CRV00060 should be used and the functions stored on disk as FXFZ and FYFZ.

```
// DUP
*DELETE             LBL
// FOR
*ONEWORDINTEGERS
                                                  MARGORP ECRUOS TSIL*
C
      SUBROUTINE LBL(X,Y,I,Z,N,SIZE)
      DIMENSION IL(5)
      DATA IL/'D','U','N','R','L'/
      CALL DATSW(2,ISW2)
      GOTO(10,30),ISW2
   10 WRITE(3,20)X,Y,I,Z,N,SIZE
   20    FORMAT(2F10.4,A10,F20.8,I10,F10.2,'''')
   30 IF (ABS(Z) - 1.0) 40,50,50
   40 NN = 1
      GOTO 60
   50 NN = ALOG(ABS(Z)) / 2.302585 + 1.001
   60 DO 70 JI=1,5
      JJI = JI
      IF (I - IL(JI)) 70,80,70
   70 CONTINUE
      JJI = 1
   80 GOTO(90,140,190,200,210),JJI
   90 IF (Z) 100,130,130
  100 IF (Z + 1.) 120,120,110
  110 NN = NN + 2
      GOTO 130
  120 NN = NN + 1
  130 CALL NUMB(X - ( (NN + N) / 2.) * .1 * SIZE,Y - .19 * SIZE,.1 *
     1SIZE,Z,0.,N)
C     DOWN 116  UP 117  RIGHT 19 LEFT 22
      RETURN
  140 IF (Z) 150,180,180
  150 IF (Z + 1.) 170,170,160
  160 NN = NN + 2
      GOTO 180
  170 NN = NN + 1
  180 CALL NUMB(X - ( (NN + N) / 2.) * .1 * SIZE,Y + .09 * SIZE,.1 *
     1SIZE,Z,0.,N)
  190 RETURN
  200 CALL NUMB(X + .1,Y - .05,.10 * SIZE,Z,0.,N)
      RETURN
  210 IF (Z) 220,240,240
  220 NN = 2
      IF (ABS(Z) - 9.99) 240,240,230
  230 NN = NN + ALOG(ABS(Z)) / 2.302585 + 0.001
  240 CALL NUMB(X - .1 - (NN + N + 1) * .10 * SIZE,Y - .05,.10 * SIZE,Z,
     10.,N)
      RETURN
      END
// DUP
*STORE        WS  UA  LBL
// JOB
// DUP
*DELETE             CRVSC
// FOR
*ONEWORDINTEGERS
*LIST SOURCE PROGRAM
                                                                    C
      SUBROUTINE CRVSC(ZMIN,ZMAX,XINC,YINC,FXFZ,FYFZ)
C                                 )CNIY,CNIX,XAMZ,NIMZ(CSVRC ENITUORBUS
      INTEGER BLANK
      DIMENSION IMAJ(10),ZDEL(10),LBLRL(10),ZCHNG(10),IACC(10)
      DIMENSION SIZE(10)
      DATA BLANK,L,ZERO,ONE/' ',    'L',0.,1./
      IPN = 3
      ZDE = .0001
      DX2 = 0.
      Z = ZMIN
   10 X = FXFZ(Z) / XINC
      Y = FYFZ(Z) / YINC
      Z = Z + ZDE
      CALL PLOT(X,Y,IPN)
      IPN = 2
      XX = FXFZ(Z) / XINC
      YY = FYFZ(Z) / YINC
      CALL PLOT(X,Y,2)
      D = SQRT( (X - XX) * * 2 + (Y - YY) * * 2)
      IF (D - .01) 12,12,14
   12 IF (D - .005) 16,16,18
   14 ZDE = ZDE / 1.5
      GOTO 20
```

```
16 ZDE = ZDE * 1.5
18 IF (Z - ZMAX) 20,20,22
20 Z = Z + ZDE
   GOTO 10
22 Z = ZMIN
   READ(2,50)N,(ZCHNG(J),ZDEL(J),IMAJ(J),LBLRL(J),IACC(J),SIZE(J),J=
  11,N)
   CALL DATSW(2,ISW2)
   GOTO(24,26),ISW2
24 WRITE(3,50)N,(ZCHNG(J),ZDEL(J),IMAJ(J),LBLRL(J),IACC(J),SIZE(J),J=
  11,N)
26 IF (LBLRL(1) - BLANK) 30,28,30
28 LBLRL(1) = L
30 IF (SIZE(1) - ZERO) 34,32,34
32 SIZE(1) = ONE
34 NMIN1 = N - 1
   DO 46 KJ=1,NMIN1
   IF (LBLRL(KJ + 1) - BLANK) 38,36,38
36 LBLRL(KJ + 1) = LBLRL(KJ)
38 IF (IACC(KJ + 1) - IFIX(ZERO)) 42,40,42
40 IACC(KJ + 1) = IACC(KJ)
42 IF (SIZE(KJ + 1) - ZERO) 46,44,46
44 SIZE(KJ + 1) = SIZE(KJ)
46 CONTINUE
   GOTO(48,52),ISW2
48 WRITE(3,50)N,(ZCHNG(J),ZDEL(J),IMAJ(J),LBLRL(J),IACC(J),SIZE(J),J=
  11,N)
50 FORMAT(I10/(2F10.2,I10,9X,A1,I10,F10.2))
52 ZCHNG(N) = ZCHNG(N) * 1.001
   ICNT = 1
   J = 1
54 X = FXFZ(Z) / XINC
   XXX = X
   Y = FYFZ(Z) / YINC
   YYY = Y
   IML = IMAJ(J)
   DO 86 I=1,IML
   Z = Z + ZDEL(J)
   XX = FXFZ(Z) / XINC
   YY = FYFZ(Z) / YINC
   DX = XX - XXX
   IF (ABS(DX) - .1E - 5) 56,56,58
56 DX = SIGN(.001,DX)
58 AN = ATAN( (YY - YYY) / DX)
   ANG = AN * 180. / 3.14159
   DXSAV = DX2
   Z2 = Z + ZDEL(J)
   X2 = FXFZ(Z2) / XINC
   DX2 = X2 - XX
   Y2 = FYFZ(Z2) / YINC
   IF (ABS(DX2) - .1E - 5) 60,60,62
60 DX2 = SIGN(.001,DX2)
62 AN2 = ATAN( (Y2 - YY) / DX2)
   ANGNU = AN2 * 180. / 3.14159
   ANGAV = (ANG + ANGNU) / 2.
   IF (DX * DX2) 64,66,66
64 ANGAV = ANGAV + 90.
66 CONTINUE
   LBLR = LBLRL(J)
   IF (I - 1) 84,68,84
68 IF (I + J - 2) 72,70,72
70 SAVAN = ANG
   DXSAV = DX
72 AVANG = (SAVAN + ANG) / 2.
   IF (DXSAV * DX) 74,76,76
74 AVANG = AVANG + 90.
76 CALL SYMB(X,Y,.12,13,AVANG, - 1)
   CALL SYMB(X,Y,.02,0,AVANG, - 1)
   IF (ICNT - 1) 80,78,80
78 CALL LBL(X,Y,LBLR,ZMIN,IACC(J),SIZE(J))
   GOTO 82
80 CALL LBL(X,Y,LBLR,Z - ZDEL(J),IACC(J),SIZE(J))
82 IF (1.001 * Z - ZMAX) 84,98,98
84 CALL SYMB(XX,YY,.08,13,ANGAV, - 1)
   XXX = XX
   YYY = YY
   SAVAN = ANGNU
86 CONTINUE
   Z = Z + ZDEL(J)
   IF (ABS(ZCHNG(J)) - 1.) 88,88,90
```

```
88 IF (ABS(Z - ZCHNG(J)) - .1E - 4) 96,96,94                          CRV01090
90 IF (ABS(Z - ZCHNG(N)) - .1E - 4 * (ABS(ZCHNG(N)))) 54,54,92        CRV01100
92 IF (ABS(Z - ZCHNG(J)) - .1E - 4 * (ABS(ZCHNG(J)))) 96,96,94        CRV01110
94 ICNT = 2                                                           CRV01120
   GOTO 54                                                            CRV01130
96 Z = ZCHNG(J)                                                       CRV01140
   J = J + 1                                                          CRV01150
   ICNT = 2                                                           CRV01160
   GOTO 54                                                            CRV01170
98 RETURN                                                             CRV01180
   END                                                                CRV01190
// DUP                                                                CRV01200
*STORE      WS  UA  CRVSC                                             CRV01210
```

```
THE SCALE ON THE RIGHT...
THE TWO FUNCTIONS WERE....
      FXFZ=0.
      FYFZ=SQRT(Z)
      CALL CRVSC(0.,9.,1.,1.)
DATA CARDS WERE....
        3
       1.          .1          4          L          2
       6.          .2          4          L
    9.00           .5          1          L
```



EXAMPLE 1

```
THE CENTER SCALE...
THE TWO FUNCTIONS WERE....
      FXFZ=0.
      FYFZ=Z
      CALL CRVSC(-5.,-2.,1.,1.)
DATA CARDS WERE....
       1
     -2.          .1          4          L          2          .8

LEFT HAND SCALE...
THE TWO FUNCTIONS WERE....
      FXFZ=0.
      FYFZ=Z
      CALL CRVSC(-5.,-2.,1.,1.)
DATA CARDS WERE....
       1
     -2.          .2          4          R          1
```

Example 1: The calibration of an alignment scale.

The use of the routines are best illustrated by examples. In example 1, the functions are FXFZ=0 and FYFZ=SQRT(Z) creating the vertical scale on the right. The arguments in the call statement are ZMIN (starting value=0.), ZMAX (terminating value=9.), XSCALE and YSCALE, which are the scale factors in units per inch. These correspond to the constants used to multiply the columns of the alignment chart design matrix.

The first data card indicates in an I 10 format the number of data cards to follow. (Three in this example)

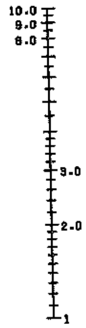
Each card then contains in order the value at which the present tick mark spacing changes, the increment between tick marks, the number of ticks between major(longer)ticks, where to place the value (L to left, R to right, U above, D down or N no label), the number of digits after the decimal point (no decimal point if -1) and the reduction factor in the number size if other than 0.1 inch high numbers are desirable.

In this example, the increment is to be every 0.1 until 1.0 is reached on the scale. Other annotations are four graduations between major tick marks, label on the left and label with two digits after the decimal point; and since the last field is blank, standard size labels.

If no instruction is given on the first card, the label will appear below and full size. If no instruction is given as to size, position of the number, or the number of digits after the decimal point on succeeding cards, the previous card option is carried forward.

These time-saving options have not been fully used in these examples to prevent confusion.

The second data card indicates that the increment is to change to 0.2 for values between one and six, label left with four minor tick marks between labels, carry forward the size and accuracy as on the first card.



EXAMPLE 1 Continued

```
FUNCTIONS ARE
      FXFZ=0.
      FYFZ=ALOG(Z)/2.302585
      CALL CRVSC(1.,10.,1.,1./3.)
DATA IS
     4                                              -1        .8
    2.        .1        9         R                 1         .7
    4.        .2        4                           1
    8.        .5        1         N                 1         .7
   10.        .5        1         L
```

Example 1: (continued) Calibrated and located alignment scales.

By utilizing this program non linear functional scales may be graduated with a minimum of programming effort. To satisfy the needs of a user not too familiar with programming built in defaults were introduced. For the user with a very involved function and a need for complete flexibility of increment selection and numbering a simple one card input over-ride is provided when he desires a change.

Part 1 should serve as the only background needed to easily construct any functional scale along a straight line.

Part 2 will show how this can easily be expanded to curved axis nomographs with a very large saving of time and effort.

CREATIVE ENGINEERING DESIGN DISPLAY

WANTED: YOUR PARTICIPATION

You and your students are invited to participate in the Seventh Creative Engineering Design Display to be held during the 1974 ASEE Annual Conference at Renssalaer Polytechnic Institute. This display is sponsored by the Engineering Design Graphics Division and needs your support to maintain its role as an important part of the conference. RPI officials are very enthusiastic about the display and have arranged to locate the 1974 display in a wide corridor surrounded by meeting rooms, where projects will receive maximum exposure. Be sure you are represented.

If you have not seen previous Design Displays, you should know that entries have ranged from sets of design and working drawings to a complete design report with models or prototypes. Each school may enter up to seven projects, two freshman and one each from sophomore, junior, senior and graduate levels and one from a cooperative program. Team projects are limited to eight students. Display space limitations are such that each project should be set up for display on a table measuring 30" deep and 36" and 48" wide.

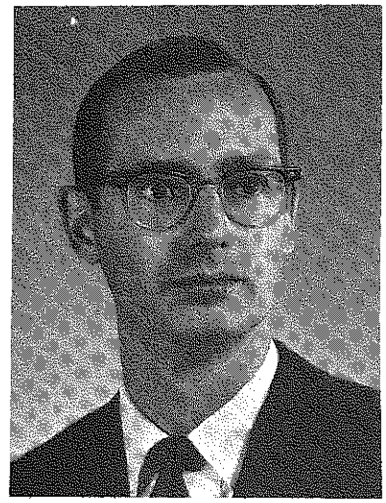
Support for the display has grown greatly and is very encouraging. The James S. Rising award, a cash award, has been established to encourage outstanding designs. Industrial support and cooperation has provided for recognition of schools and individuals winning in each category. Schools will receive plaques for first place winners and all individual winners will receive certificates. These awards, it is hoped, will encourage more students toward creative design, both in the classroom and in their professional careers.

Judging of the display will again be done by individuals from industry, ASEE Division chairman and distinguished educators from various disciplines. This diversity, in the judges background assures objective evaluation of the projects; which involve many different disciplines.

If you have further questions, please write or call Paul DeJong(address below) for additional information or applications. This does not commit you to display but will provide the committee with the information needed to estimate space requirements at Renssalaer.

Paul S. DeJong
Coordinator
Creative Engineering Design Display
Engineering Graphics Department
403 Marston Hall
Iowa State University
Ames, Iowa 50010
Phone: (515) 294-6524

The Committee
Ralph Blanchard, Co-chairman
Borah Kreimer, Co-chairman
Paul DeJong, Display coordinator
Dr. George Sandor, Local arrangements



Robert J. Foster
Pennsylvania State University

They Who Start in Engineering

By Robert J. Foster

Introduction

The American Society for Engineering Education (ASEE) is conducting an Engineering Student Retention Study, now in its second year. One may recall that this study seeks to determine why students remain in or leave engineering. Funded by the IBM Corporation and the General Electric Company, and directed by Dr. Edward Kraybill of the Pennsylvania State University, the study has three major facets.

The focus of this paper deals with one facet which is to utilize data of the American Council on Education (ACE) for 52,000 students tracked during four consecutive college years (1).

A second aspect, still in progress, is the analysis of data from engineering freshmen via a questionnaire developed specifically for this study. It is hoped that responses during the first year, correlated with academic status the second year, will yield differing patterns useful to engineering educators. Results for 3500 freshmen of spring 1973 should be available by summer 1974. A replication study should be completed within a year.

A final facet of the ASEE study is the compilation of information on specific freshman programs which have proved successful in retaining engineering students. An expected output is a booklet to be available to interested persons describing constructive efforts in retention at various engineering schools.

Background for ACE study

In 1966, ACE collected data from the entire freshman class of 217 institutions. A 150-item questionnaire covered demographic information and items concerning aspirations and self-concepts of the students. In 1967, ACE followed up with a random sample of 250 students from each school (or all students when fewer than 300 freshmen were enrolled). For these 51,721 students in all majors, dropout status was provided ACE by the schools, as well as college ability test scores and high school grades.

The same students were again traced in 1970-71 as to academic status. From this, several measures of retention were developed, including:

1. Student returned for a second year.
2. Student received a bachelor's degree in four years.
3. Student received a bachelor's degree in four years <u>or</u> was still enrolled.

With their data ACE produced tables including those relating the effect of high school grades and Scholastic Aptitude Test (SAT) scores on persistence in college. Also developed were regression equations which related demographic and personal characteristics to persistence.

It occurred to those persons in the ASEE study that much valuable information on students starting in engineering lay buried within the ACE data. None of their results were broken down by major. It appeared appropriate to tap this rich source and see in what ways students starting in engineering were like or unlike students in general in terms of academic persistence (2).

Dr. Alexander Astin of ACE kindly made available raw data for the subset of 4025 students who had started in engineering. To make data comparable to Dr. Astin's, his weighting procedure was used according to the following equation:

$$\text{Weight} = \frac{\text{N, school's freshman class 1966}}{\text{N, school's students sampled 1970}} \times \frac{\text{1966 freshmen for all N, schools in that cell}}{\text{N, 1966 freshmen in schools sampled in that cell}}$$

A cell represents a particular sampling stratification, for example, men in a public four-year college within a specific high school grade and SAT range.

Certain procedures are employed by the writer to highlight and clarify trends:

1. Cells must have 25 or more students to be used.
2. Percentages are rounded to the nearest whole number
3. High schools grades are grouped as A,B,C, rather than A, A-: B+,B,B-; C+,C. Similarly, SAT scores are sometimes grouped.
4. Data involving SAT scores under 770 verbal plus math and over 1469 are deleted due to few students in these cells.
5. Women and black students are included in the overall data, but are not presented separately due to few numbers.

Results

Table 1 shows that students who start in engineering persist as well as students overall. They do take longer to receive a bachelor's degree in some field, not necessarily engineering. The data indicate that while students may be lost to engineering due to transfer, they do stay in higher education. In fact, more students starting in engineering return a second year than students in general.

Figures 1 and 2 dramatize the effect of high school (HS) grades and SAT scores or persistence. By any measure, excellent HS grades and high SAT's help a student to persist. HS grades and SAT scores seem approximately equal in their ability to relate to persistence. One does note, however, that for starters in engineering, low HS grades and low SAT's appear to have a more adverse effect on returning to college a second year than for students overall. Also, as in Table 1, it is evident that considerably fewer starters in engineering receive a degree in four years.

Table 1

PERSISTENCE RATE FOR STUDENTS

Students who:	Percentage: Starting in Engineering	All Students
Returned second year	80	78
Received degree in four years	38	47
Received degree in four years or were still enrolled	62	59

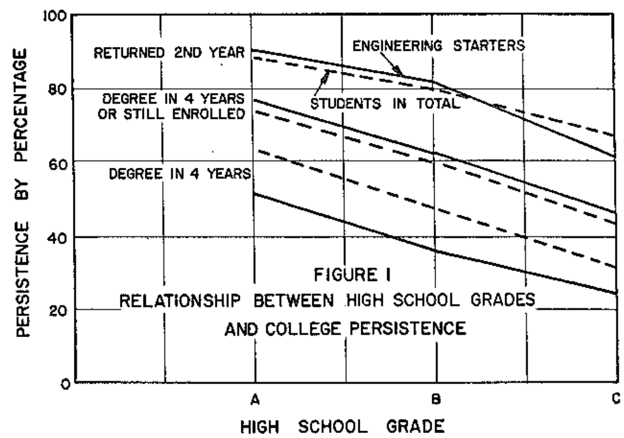


FIGURE I
RELATIONSHIP BETWEEN HIGH SCHOOL GRADES AND COLLEGE PERSISTENCE

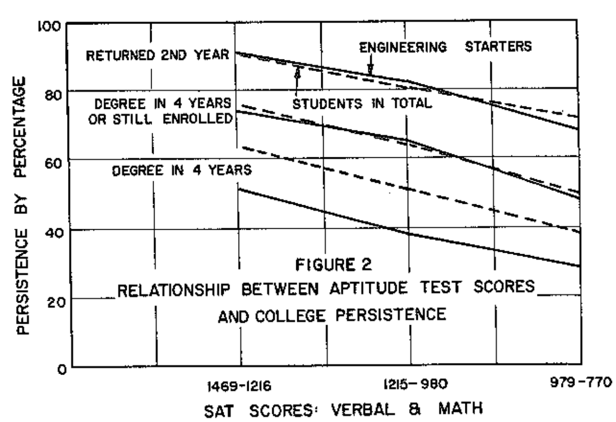


FIGURE 2
RELATIONSHIP BETWEEN APTITUDE TEST SCORES AND COLLEGE PERSISTENCE

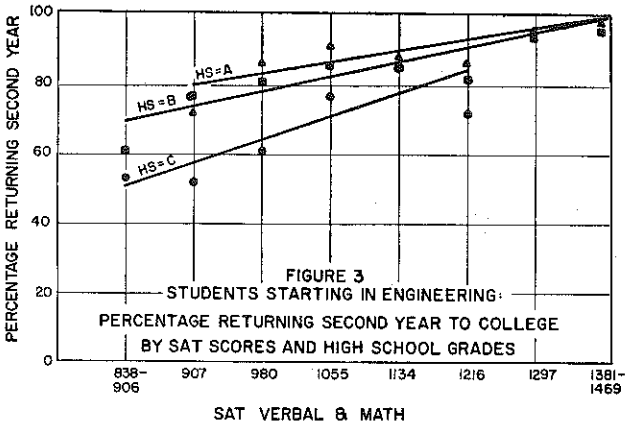


FIGURE 3
STUDENTS STARTING IN ENGINEERING:
PERCENTAGE RETURNING SECOND YEAR TO COLLEGE
BY SAT SCORES AND HIGH SCHOOL GRADES

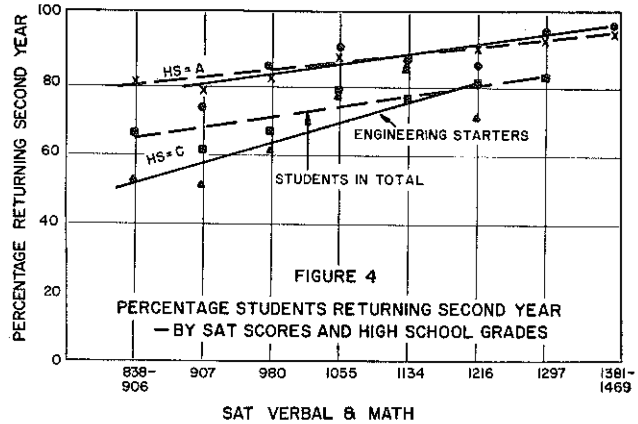


FIGURE 4
PERCENTAGE STUDENTS RETURNING SECOND YEAR
— BY SAT SCORES AND HIGH SCHOOL GRADES

Figure 3 and 4 give the interrelationship of HS grades and SAT scores, when observing return rates for the second year. One sees the tendency for high SAT scores to negate the effect of low HS grades. Conversely, the effect of low HS grades and low SAT's seems even more pronounced.

Figure 4 indicates that starters in engineering having low HS grades and low SAT's have less chance of returning a second year to any field than students in general. This may imply that freshman engineering programs are indeed tougher academically than other programs, and that dropout is a greater risk in engineering than elsewhere when a student has a weak academic background. However, since engineering programs often have high admission requirements, students who transfer out tend to do well in another major. Table 1 shows that these two effects tend to cancel one another, giving on the average equal persistence into the second year for both groups.

Persistence in receiving a degree in four years is provided in Figures 5 and 6. Figure 5 suggests that engineering starters having high HS grades and high SAT scores graduate in four years with considerably less difficulty than those with less impressive credentials. Perhaps those students who do transfer from engineering can proceed at an accelerated rate to make up non-transferrable credits. That they do not quite catch up is seen in Figure 6. On the other hand, low SAT's seem to be a handicap even with good HS grades.

Comparing Figures 3 and 5 shows that HS grades converge toward high SAT scores when measuring persistence into the second year. However, HS grades diverge when measuring ability to graduate in four years. For starters in engineering, ability to enter the second year is strongly HS grades dependent if SAT scores are low, but ability to graduate in four years is dependent on HS grades when SAT's are high. Overall, the combination of high HS grades and high SAT scores is sufficiently powerful to enable starters in engineering to have an excellent probability of entering a second year in some field, and a reasonably probability of graduating in four years.

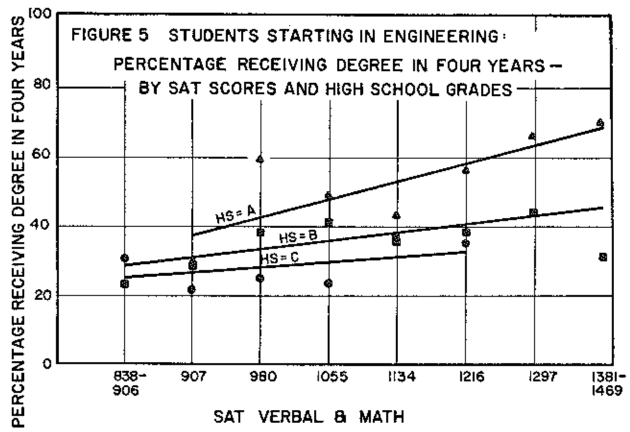


FIGURE 5 STUDENTS STARTING IN ENGINEERING:
PERCENTAGE RECEIVING DEGREE IN FOUR YEARS —
BY SAT SCORES AND HIGH SCHOOL GRADES

One realizes that merely measuring ability to graduate in four years would be an incomplete measure of persistence. Many students get "off schedule" as they pursue their academic careers. Recent writings even suggest that breaking a lock-step cycle of scheduling is helpful to many students.

Figures 7 and 8 certainly indicate that starters in engineering do tend to prolong their baccalaureate education, as do students in general. The persistence percentage in these two figures are well above those of Figures 5 and 6. (Table 1 also notes this effect). Again strong HS grades and SAT scores help a student to persist.

Figure 8 shows that engineering freshmen with HS grades of A persist better than "A" students in general. This may suggest that academically strong students who transfer from engineering are actually strong persisters. HS grades of C more adversely affect starters in engineering when SAT's are low. This is probably due to the increased difficulty (or reluctance?) of such students to continue education.

Multiple regression analysis led to the development of Tables 2, 3, and 4. Sixth-one items of the ACE questionnaire were selected as being

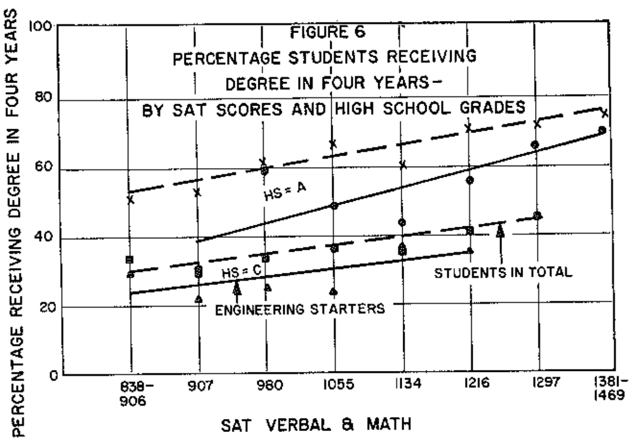


FIGURE 6
PERCENTAGE STUDENTS RECEIVING DEGREE IN FOUR YEARS - BY SAT SCORES AND HIGH SCHOOL GRADES

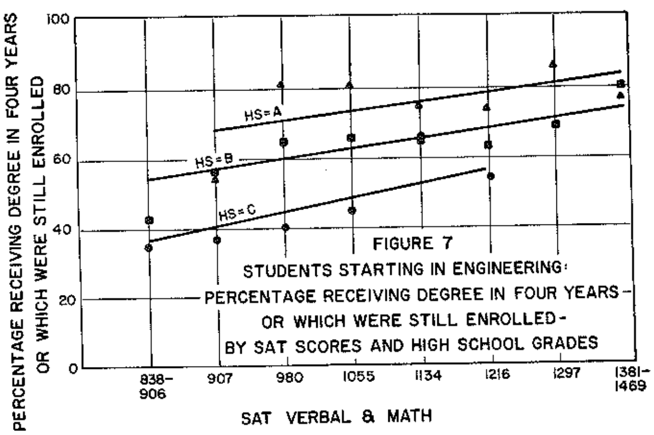


FIGURE 7
STUDENTS STARTING IN ENGINEERING: PERCENTAGE RECEIVING DEGREE IN FOUR YEARS - OR WHICH WERE STILL ENROLLED - BY SAT SCORES AND HIGH SCHOOL GRADES

of possible interest in the study of engineering students. Approximately one half of these were statistically significant in reducing unaccounted error. The top six items for each measure of retention are given in the three tables.

The regression weights are such that they satisfy the equation:

Probability of X = b_1 a + b_2b +...+b_6f

where X = event of a retention measure
b_1, b_2,...b_6 = regression weights
a,b,...f = variables

Items which are consistently positive in their contribution are high school grades, ability test score (SAT), and financing of schooling aided by parents. Negative factors vary somewhat by measure predicted. Present in a negative manner were smoking cigarettes, stubbornness, turning in a paper late, and planning to marry in college. Planning to be an engineer was a detriment to graduating in four years.

It must be realized that regression equations applied to human beings do not constitute prediction equations of high accuracy. They are helpful when applied to large groups of persons, but are very risky when used to predict the ac-

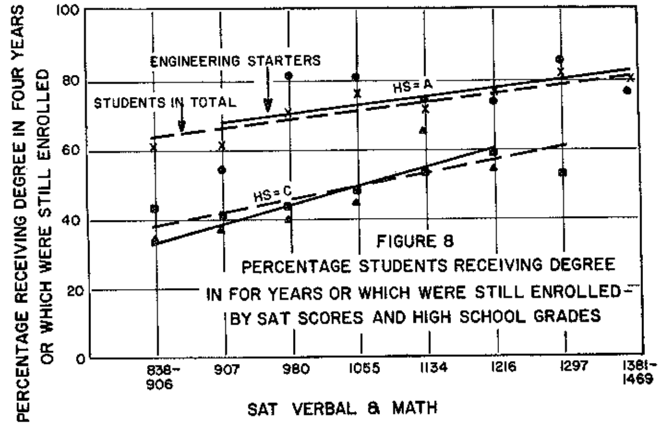


FIGURE 8
PERCENTAGE STUDENTS RECEIVING DEGREE IN FOR YEARS OR WHICH WERE STILL ENROLLED - BY SAT SCORES AND HIGH SCHOOL GRADES

Table 2

REGRESSION VARIABLES FOR STARTERS IN ENGINEERING RETURNING A SECOND YEAR

Variable	Regression Weight
High school grades	.167
Smoked cigarettes	-.094
Ability test scores	.087
Parents financing	.075
Intellectual confidence	-.044
Stubbornness	-.043

Table 3

REGRESSION VARIABLES FOR STARTING IN ENGINEERING GRADUATING IN FOUR YEARS

Variable	Regression Weight
High school grades	.156
Ability test score	.103
Turned in paper late	-.090
Smoked cigarettes	-.064
Plan to marry in college	-.060
Future career = engineer	-.059

Table 4

REGRESSION VARIABLES FOR STARTERS IN ENGINEERING GRADUATING IN FOUR YEARS OR STILL ENROLLED

Variable	Regression Weight
High school grades	.179
Smoked cigarettes	-.095
Ability test scores	.079
Turned in paper late	-.076
Parents financing	.065
Stubbornness	-.059

tions of an individual. In this study, the regression equations improve by some ten percent the prediction of an event by chance alone.

Conclusion

One can conclude that students starting in engineering persist in college as well as any students when both groups have strong high school grades and high SAT's. However, if a student is weak in his academic preparation, starting in engineering would tend to decrease chances of entering a second year in any field.

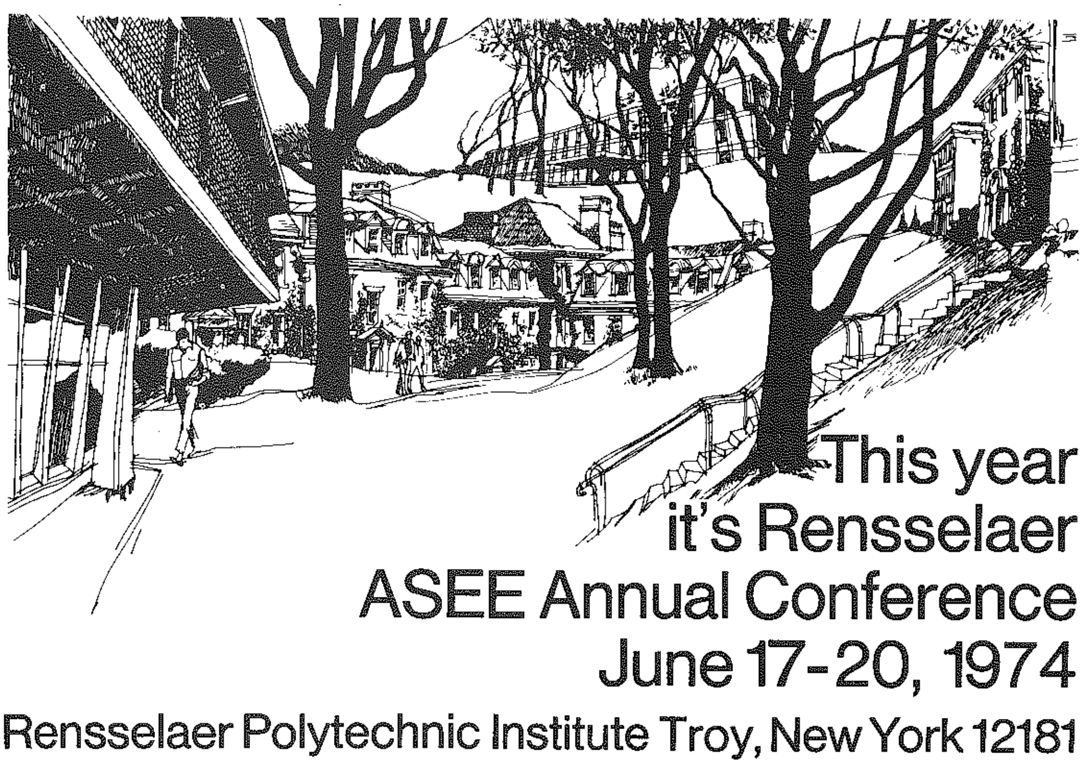
In other respects, students who start in engineering have patterns of academic persistence much like students overall. Freshmen engineers do not appear to be a "unique breed" in terms of their success or failure in completing their academic careers.

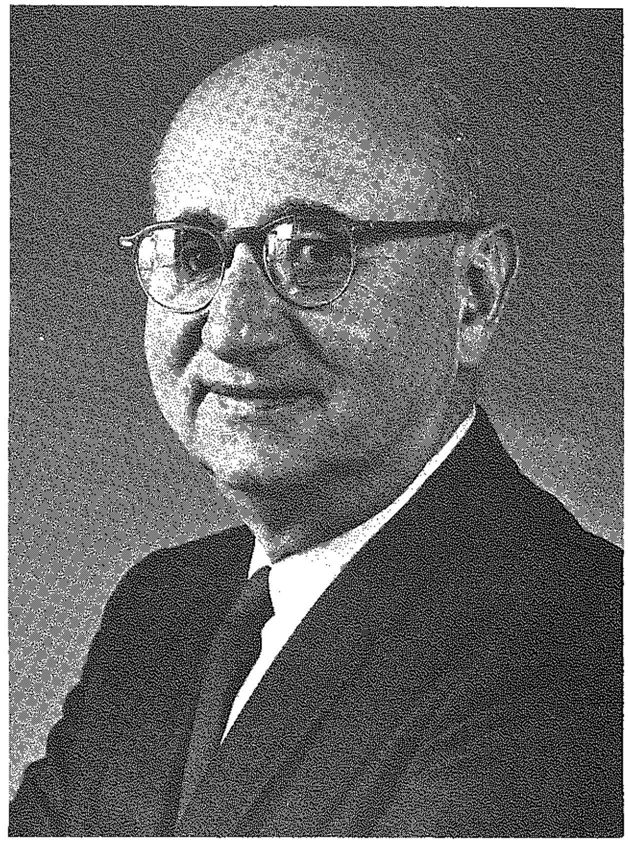
Nevertheless, the freshman year is one of considerable risk for many who begin in engineering. It would appear that careful academic counseling and monitoring would be a minimum service needed by engineering freshmen. The weaker ones may need extra assistance. For the strong ones who leave engineering to do well elsewhere, the question remains: why?

References:

(1) Astin, Alexander W. College Dropouts: A National Profile, ACE Research Reports, Vol. 7, No. 1, February 1972.

(2) Grateful acknowledgment is made to Dennis M. Freeman for programming ACE data into the Penn State Computer.





Distinguished Service Award

IRWIN WLADAVER

Irwin Wladaver has been named recipient of the 1974 Distinguished Service Award given by the Engineering Design Graphics Division. This award is the highest award that can be given to a member of the American Society for Engineering Education. The presentation of this honor will be made at the EDG Annual Banquet in Troy, New York, June 19, 1974.

Associate Professor Emeritus Irwin Wladaver recently retired from New York University where he had served many years in their Engineering College both as a teacher and as an administrator.

Professor Wladaver first became a member of ASEE in 1946. He first appeared on a Division program in 1951 at Lansing, Michigan when he presented a paper based on his Doctor's Dissertation earned in 1950. He presented other papers in 1953 at Gainesville, Florida; in 1956 at the summer school at Ames, Iowa; in 1958 at Wichita, Kansas; and in 1965 at Washington State University.

He was editor of the T-Square Page of the Engineering Education Journal from 1954-1955. Professor Wladaver served three years as editor of the Engineering Design Graphics Journal from 1956-58.

In 1958 he was elected secretary of the Division by the membership, vice-chairman in 1959, and chairman in 1960. After completion of his duties as chairman, he was a member of the Special Awards Committee from 1961 through 1964.

In addition to his many contributions to the Division, he co-authored four problem books in engineering graphics with Professor L. O. Johnson and authored two textbooks in mechanical drawing that were prepared for the United States Armed Services Institute which were published by McGraw-Hill Publishing Company. He authored a slide rule manual for a German manufacturer.

The index of the first twenty-five years of the Engineering Design Graphics Journal was prepared for publication by Professor Wladaver. He was also instrumental in the preparation of the twenty-fifth anniversary issue edition of the Journal of Engineering Design Graphics which traced the development and history of our Division.

Professor and Mrs. Wladaver are now residing at Apartment 305, 1615 West Avenue, Miami Beach, Florida. Their phone number is 305-673-0581.

The Division of Engineering Design Graphics is deeply indebted to the many contributions made to it since 1946 by Irwin Wladaver.

The Use of Determinants in the Construction of Nomographs

Clarence Hall
Louisiana State University

The purpose of this paper is to show the application of third order determinants in the construction of a workable chart for equations containing two or more variables. It is assumed that the reader has a working knowledge of third order determinants as applied to first year college mathematics.

In Figure 1, it is assumed the straight line intersects three vertical lines (scales) P, Q, and R. Let the coordinate points, with reference to the O-X and O-Y axes, be labeled (XpYp), (XqYq), and (XrYr) where the straight line intersects each vertical line. From the figure the following is derived:

$$\frac{Yq-Yp}{Xq-Xp} = \frac{Yr-Yp}{Xr-Xp} \qquad (1)$$

$$YpXq + XqXr + YrXp - YrXq - YqXp - YpXr = 0 \quad (2)$$

Equation (2) is the expansion of a third order determinant for the equation,

$$P + Q = R$$

when the value of each variable is expressed in terms of its coordinate points. The determinant is shown below.

$$\begin{vmatrix} Yp & Xp & 1 \\ Yq & Xq & 1 \\ Yr & Xr & 1 \end{vmatrix} = YpXq+YqXr+YrXp-YrXq-YqXp-YpXr = 0$$

If Xp and Yp are functions of the variable P, the P scale may be graduated according to values assumed by that variable. In a like manner, scales Q and R may be graduated according to values assumed by those variables.

In examining the above determinant it is found that:

1. The elements of one column are all ones.
2. The elements of any row contain only variables not found in the other two rows.
3. At least one of the coordinates in each row of the determinant may be constant.

Any equation which can be expressed in a form identical with that above, subject to the three statements, can be represented by a nomographic chart.

Seeing that at least one column will have to be made to contain only ones, the original determinant may have to be transformed. This is accomplished by multiplying the original determinant, which equaled zero, by another that does not equal zero. The determinant, that is to be used as a multiplier, consists of constant elements which are determined by:

1. The length of the scales for the independent variables.
2. The distance between the scales of the independent variables.
3. The distance along a scale where a given value of the variable will be plotted. (its coordinate points).

These conditions will be determined by the one making the nomograph. There have been some general forms of matrices developed for transforming different determinants. These will be discussed later.

The following rules for the transformation of determinants are given here without proof:

1. A column may be interchanged with another column or a row with another row, without altering the values of the determinant.
2. A column may be added to another column, or a row to another row, without altering the value of the determinant.
3. A column or a row may be multiplied by any quantity without altering the value of the determinant.

In analytical geometry, if three points are on a straight line, the determinant used to express the area enclosed by lines connecting these points is equal to zero. The reason for making all nomographic determinants equal to zero, when a straight line is drawn through the

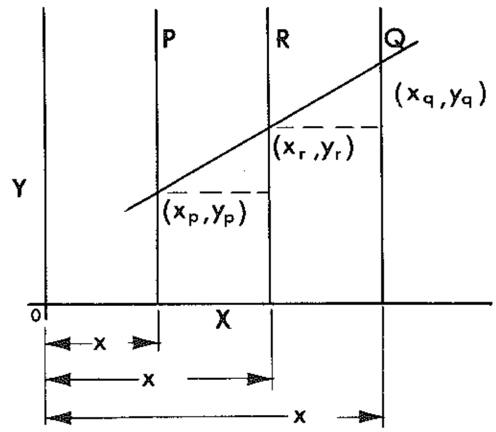


Figure 1: Positioning of the vertical scales.

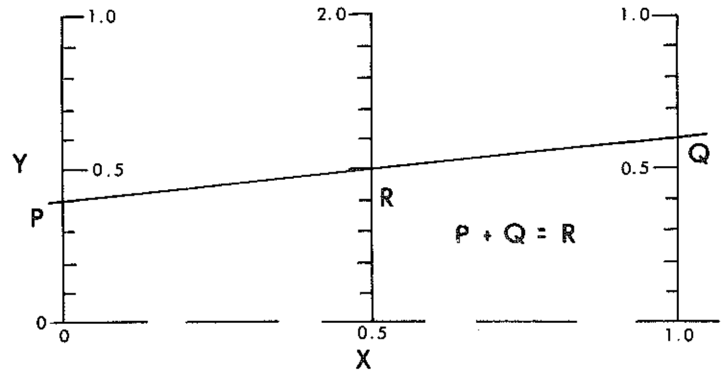


Figure 2: The graph of the equation: P + Q = R

three scales, is that values for each variable can be located that will satisfy the given equation.

Now consider the equation:

$P + Q = R$

where P varies between limits (0 to 1)

Q varies between limits (0 to 1)

R varies accordingly (0 to 2)

The desired scale is to be one unit in length.

Using the conventional method of constructing a nomograph, the scale modulus for each variable is:

$$Mp = \frac{1}{1-0} = 1$$

$$Mq = \frac{1}{1-0} = 1$$

$$Mr = \frac{1.1}{1+1} = 1/2$$

$$Xp = 1(P)$$

$$Xq = 1(Q)$$

$$Xr = \frac{R}{2}$$

The graph for this equation is shown in Figure 2.

The determinant for the equation in terms of the variables is developed as follows:

$$\begin{vmatrix} P & 0 & 1 \\ Q & 1 & 0 \\ R & 1 & 1 \end{vmatrix} = P + Q - R = 0$$

Each row contains only variables not found in the other two rows, but it is not in nomographic form because there is not a column consisting of ones.

By observing the rules for transformation it is possible to change the determinant into nomographic form. This is done by adding the elements in the second column to those of the third column and then dividing each row, by the value in the third column.

$$\begin{vmatrix} P & 0 & 1 \\ Q & 1 & 0 \\ R & 1 & 1 \end{vmatrix} = \begin{vmatrix} P & 0 & 1+0 \\ Q & 1 & 0+1 \\ R & 1 & 1+1 \end{vmatrix} = \begin{vmatrix} P & 0 & 1 \\ Q & 1 & 1 \\ \frac{R}{2} & \frac{1}{2} & 1 \end{vmatrix} = 0$$

This last expression is in nomographic form with Y coordinates values for each variable in the first column, and the X coordinate values in the second column. The coordinates for the variables are,

$Xp = 0$ $\quad Xq = 1$ $\quad Xr = 1/2$

$Yp = P$ $\quad Yq = Q$ $\quad Yr = \frac{R}{2}$

This means that the P scale will coincide with the Y axis and will be graduated in the positive direction. The Q scale will be on unit to the right of the origin and graduated in the same direction. The R scale will be halfway between the two, and parallel to both. The R scale will be graduated in the same direction as the other two. The modulus for each scale is obtained from the determinant when in nomographic form. The scale is the coefficient of that variable in the determinant. The algebraic sign of the elements of the determinant has the same meaning here as when making a graph of a straight line using Cartesian coordinates.

In the above nomograph, if it is considered that the P scale is coinciding with the Y axis, and a line drawn through the zero value of the three scales considered as the X axis, the chart will be identical with one made from the determinant developed.

To express, in determinant form, an equation with two or more variables frequently requires several tries. After some experience, one soon learns that a given form of equation will fit a general determinant form. After some additional study one develops a feel for what type of nomograph to use for given equations. Knowing this and having a general idea of how and where the scales of the independent variables will appear, the determinant becomes easier to develop.

All equations are not as easy to express in determinant form and to graph as the one above. The limits of the independent variables may have various ranges. For example, one variable may vary from zero to ten while the other may vary from zero to a thousand. To be able to construct a uniform chart with scales about the same length, it will be necessary to have different moduli for different scales. This involves transformation of the original determinant. As mentioned above, the elements of the matrix of transformation depends upon:

1. The desired length of the scales for the independent variables
2. The distance between the two scales in (1)
3. The location of one or two particular values of the two variables along their respective scales

The position of the dependent scale and its graduation will be determined when the conditions above have been determined.

Consider the same equation as above but for different limits of the variables.

$$P + Q = R$$

where P varies from 10 to 60

where Q varies from 30 to 40

where R varies from 40 to 100

The desired scale length of both P and Q is 10 inches. The P scale shall conincide with the Y axis, and the Q scale shall be <u>seven</u> units from the origin. The solution of the problem is as follows:

$$\begin{vmatrix} P & 0 & 1 \\ Q & 1 & 0 \\ R & 1 & 1 \end{vmatrix} = 0 \qquad \begin{vmatrix} P & 0 & 1 \\ Q & 1 & 1 \\ \frac{R}{2} & \frac{1}{2} & 1 \end{vmatrix} = 0$$

This last form is in nomographic form and is the same as shown previously. It must to be transformed before a uniform chart can be made in accord with the new criteria governing the nomograph. Most, if not all, equations capable of nomographic solution can be expressed in the following form:

$$\begin{vmatrix} Yp & 0 & 1 \\ Yq & Xq & 1 \\ Yr & Xr & 1 \end{vmatrix} = 0$$

where the P scale coincides with the Y axis, and the Q and R scales are parallel with it, and placed a given distance from the origin. As previously mentioned there are some general forms of matrices of transformation for certain forms of determinants. The matrix shown here will usually effect a suitable transformation for a equation involving the sum of two variables. The matrix is:

$$\begin{vmatrix} 1 & 0 & 0 \\ A_2 & B_2 & C_2 \\ A_3 & 0 & C_3 \end{vmatrix} \neq 0$$

Before multiplying the original determinant by the matrix of transformation it might be well to show how one determinant is multiplied by another.

$$\begin{vmatrix} X_1 & Y_1 & Z_1 \\ X_2 & Y_2 & Z_2 \\ X_3 & Y_3 & Z_3 \end{vmatrix} \times \begin{vmatrix} A_1 & B_1 & C_1 \\ A_2 & B_2 & C_2 \\ A_3 & B_3 & C_3 \end{vmatrix} =$$

$$\begin{vmatrix} (A_1X_1+A_2Y_1+A_3Z_1) & (B_1X_1+B_2Y_1+B_3Z_1) & (C_1X_1+C_2Y_1+C_3Z_1) \\ (A_1X_2+A_2Y_2+A_3Z_2) & (B_1X_2+B_2Y_2+B_3Z_2) & (C_1X_2+C_2Y_2+C_3Z_2) \\ (A_1X_3+A_2Y_3+A_3Z_3) & (B_1X_3+B_2Y_3+B_3Z_3) & (C_1X_3+C_2Y_3+C_3Z_3) \end{vmatrix}$$

The transformation of the original determinant is as follows:

$$\begin{vmatrix} P & 0 & 1 \\ Q & 1 & 0 \\ R & 1 & 1 \end{vmatrix} \times \begin{vmatrix} 1 & 0 & 0 \\ A_2 & B_2 & C_2 \\ A_3 & 0 & C_3 \end{vmatrix} = \begin{vmatrix} (P+A_3) & 0 & C_3 \\ (Q+A_2) & B_2 & C_2 \\ (R+A_2+A_3) & B_2 & (C_2+C_3) \end{vmatrix} = 0$$

Now change the last expression into nomographic form.

$$\begin{vmatrix} \frac{P+A_3}{C_3} & 0 & 1 \\ \frac{Q+A_2}{C_2} & \frac{B_2}{C_2} & 1 \\ \frac{R+A_2+A_3}{C_2+C_3} & \frac{B_2}{C_2+C_3} & 1 \end{vmatrix} = 0$$

The reason for the elements that appeared in the first row of the matrix is that the P scale did not change during the transformation.

The coordinate points of each variable in the nomograph according to the determinant are:

$$Yp = \frac{P+A_3}{C_3} \qquad Xp = 0$$

$$Yq = \frac{Q+A_2}{C_2} \qquad Xq = \frac{B_2}{C_2}$$

$$Yr = \frac{R+A_2+A_3}{C_2+C_3} \qquad Xr = \frac{B_2}{C_2+C_3}$$

It must now be decided where certain values of the variables will occur on each scale. The value of the constants in the above expressions depend upon the choice of the position of certain values of the variables. The value P = 10 shall be plotted at the orgin of the coordinate system. The value Q = 40 shall be plotted at the point Xq = 7, Yq =10.

Solve for the value of the constants by substituting in known quantities.

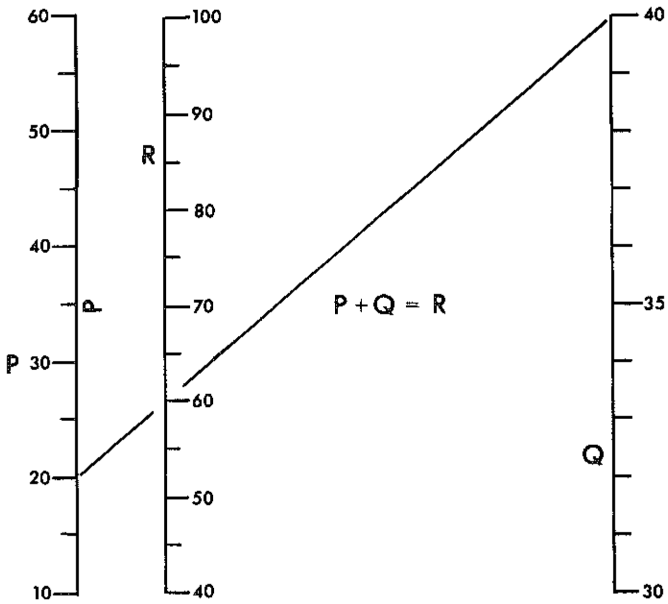


Figure 3: The nomograph of the determinant.

$$Yp(60) - Up(10) = \frac{60 - 10}{C_3} = 10 \qquad C_3 = 5$$

$$Yp(10) = \frac{10 + A_3}{5} = 0 \qquad A_3 = -10$$

$$Yp(40) - Yq(30) = \frac{40 - 30}{C_2} = 10 \qquad C_2 = 1$$

$$Yq(40) = \frac{Y + A_2}{1} = 10 \qquad A_2 = -30$$

$$Xq(40) = \frac{B_2}{C_2} = 7 = \frac{B_2}{1} = 7 \qquad B_2 = 7$$

$$Yr = \frac{R - 40}{6}$$

$$Xr = \frac{7}{6}$$

The design of the completed nomograph can be readily observed substituting the values of the constants into the determinant;

$$\begin{vmatrix} \frac{P-10}{5} & 0 & 1 \\ \frac{Q-30}{1} & \frac{7}{1} & 1 \\ \frac{R-40}{6} & \frac{7}{6} & 1 \end{vmatrix} = 0$$

The nomograph for this determinant is shown in Figure 3.

NOTE: The values Yr and Xr were entirely dependent upon the location and limits of the other two scales. The modulus for each scale is the coefficient of the Y coordinate of the variable.

journal AUXILIARY bits and pieces

WHAT'S GOING ON?

What's going on in this big U.S. of A. in engineering design graphics education. We would like to know and EDGJ readers would like to know. The Journal needs YOU and YOUR contributions if it is to be effective in reporting the current activities of its membership. From the four corners of the USA and foreign nations, the Journal reflects, keeps current, disseminates and unifies individual effort toward common goals.

If you have a short announcement: a promotion, a unique course, a new technique, a question, a bit of humor, "toot your horn" under this column. We will All listen. Mail all news items to Garland Hilliard, Associate Editor, at the address shown on the inside front cover.

SELF-PACED GRAPHICS AT NCSU

Garland K. Hilliard, John L. Crow, John F. Freeman, and Dr. William J. Vander Wall of North Carolina State University were instructors/proctors at the ASEE Institute on Effective Teaching held at the Velvet Cloak Inn in Raleigh, North Carolina on November 5 and 6 of 1973.

The Institute was conducted in a workshop fashion on the strategy, preparation and management of self-paced instruction. Dr. Lee Harrisberger, Dean of Science and Engineering at the University of Texas at the Permian Basin was the principal lecturer.

All of the Basic Engineering Graphics courses in NCSU's School of Engineering are being taught by the self-paced method. The graphics faculty have been experimenting with self-paced instruction for over two and one-half years, and have gradually developed both the content and the method to the point that they feel they have one of the best self-paced courses in the nation. Hilliard presented a talk on NCSU's experiences with self-paced graphics instruction.

E. D. G. PROGRAMS
OF THE FUTURE!

Contact Gordon Sanders, Director of Programs, Engineering Design Graphics Division of ASEE, NOW! NOW, meaning NOW NOW or FUTURE NOW if you have:

Good subjects and substance for PAPERS. (Include a concise, meaningful abstract and a comprehensive description of the subject.) State your preference for when and where...

Good suggestions for:

- Panel Discussions
- RAP Sessions
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Good ideas for:

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- Agenda for Luncheon Meetings and Awards Banquets
- Banquet Speakers
- Etc.

Give us excellent MATERIAL, and we will give you excellent PROGRAMS.

DEVENS AWARDED FOA

The winner of the Frank Oppenheimer Award at the Engineering Design Graphics Division Mid-Winter Conference was Professor W. George Devens.

Frank Oppenheimer established the award to encourage and reward excellence in the presentation of papers at Engineering Design Graphics Division Meetings. The award of $100 and a certificate is given twice yearly; at the Division Mid-Winter Conference and the American Society for Engineering Education Annual Summer Conference.

Professor Devens is Chairman of the Engineering Fundamentals Department at Virginia Polytechnic Institute and State University, Blacksburg, Virginia. He presented an informative and refreshingly novel talk entitled "Metric Integration for Basic Engineering Courses" at a paper session of the Division Mid-Year Conference held January 24-26, 1974 in New Orleans, Louisiana.

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DEC. 1974

DECEMBER

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22	23	24	25	26	27	28
29	30	31				

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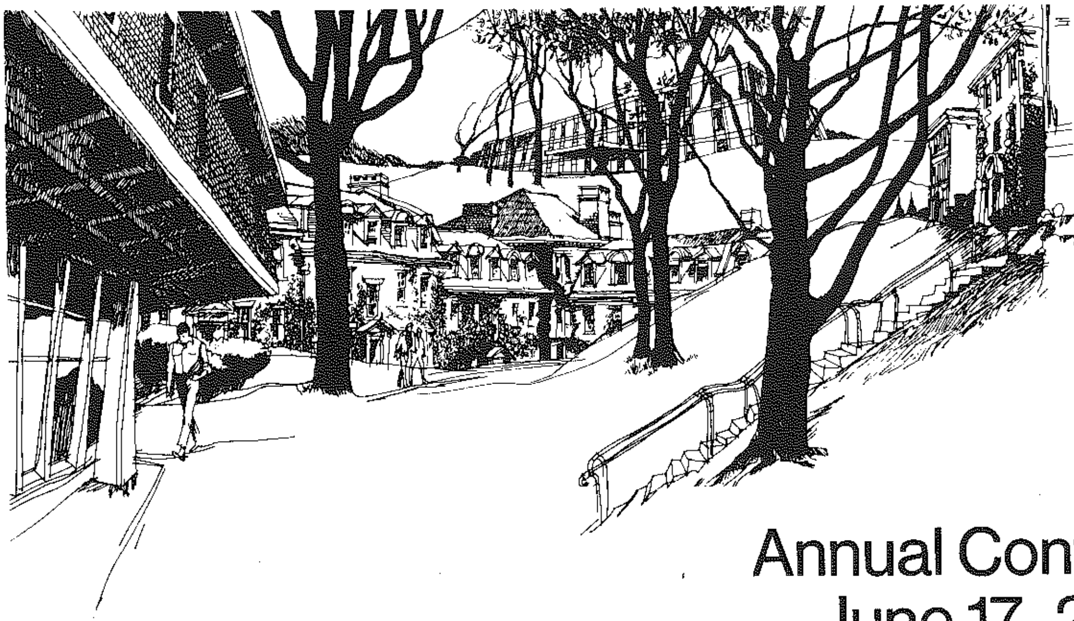
ENGINEERING DESIGN GRAPHICS DIVISION

THE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

Colonial Williamsburg
Williamsburg, Virginia



ASEE
Annual Conference June 17-20, 1974

1974 ANNUAL CONFERENCE

Rensselaer Polytechnic Institute will host this year's 82nd ASEE Annual Conference. RPI in Troy, New York will be the hub of activities from June 17 through June 20. A full week of exchanging the latest in engineering education ideas, exhibits, presentations, and entertainment awaits all those who attend.

You are invited to double your pleasure and double your fun by combining the conference with a New York state vacation. A side trip to Niagara Falls, the Adirondack and the Catskill Forest Preserve, Howe Caverns, the Atlantic surf, Lake George and the skyscrapers of New York City offer but a few of the attractions within convenient access along the state's 100,000 mile network of modern highways. RPI is the Hub!

Rensselaer will celebrate its founding 150 years ago as the first school of engineering and applied science in North America. Stephen Van Rensselaer founded the school in 1824 for the unique purpose of "instructing persons, who may choose to apply themsleves, in the application of science to the common purposes of life." The preceding quote very closely resembles this year's conference theme: "Resources and the Quality of Life."

Today, RPI is the oldest engineering school in continuous operation in any English-speaking country. The academic community is made up of approximately 3,600 undergraduate students, 1,200 graduate students, and 320 faculty members together representing 50 states and 65 foreign countries.

The faculty and staff at Rensselaer invite you to attend and hope you will leave with memories of a pleasant time and information on the latest innovations in engineering education.

FINGER LAKES

COOPERSTOWN

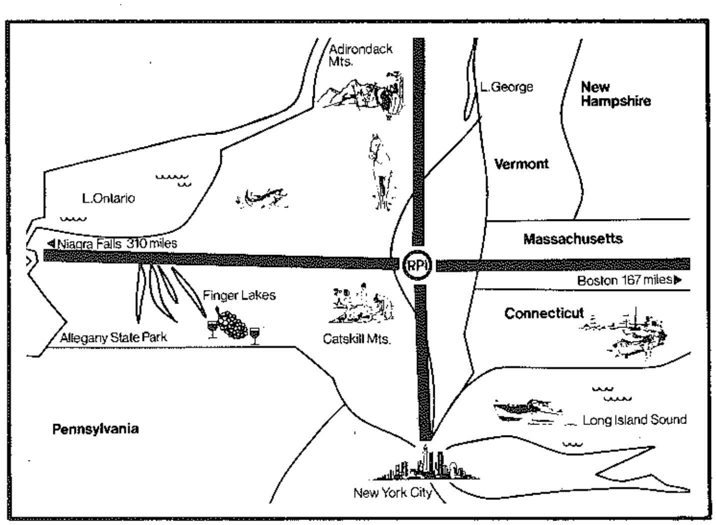
HOWE CAVERNS

RPI is the Hub!

NIAGARA FALLS

ADIRONDACK-CHAMPLAIN AREA

This year it's Rensselaer



EDG Annual Conference Program

The Engineering Design Graphics Division of ASEE has gone all out to follow the expressed wishes of ASEE headquarters. To this end this year's Annual Conference will feature fewer events, better events and cross division lines more frequently with co-sponsored events.

All technical paper sessions involving the Engineering Design Graphics Division will be jointly sponsored with other ASEE Divisions at RPI. For example, on Monday from 3:45 until 5:30 p.m. and from 9:00 to midnight, the Engineering Design Graphics Division and the Engineering Design Division will jointly sponsor a paper session and "rap" session. Engineering Design will be in charge of the two sessions. Similarly, the sessions on Tuesday and Wednesday will be jointly sponsored. Our Division, EDG, will be in charge of the Wednesday session.

In order to fairly test this plan for broadening our horizons and strengthening our program, why not attend these four jointly sponsored sessions and decide on an informed basis the relative merits of jointly sponsored events!

It might be noted that fewer events and joint events almost certainly cut down the number of participants from a given division. The other side of the coin presents the possibility of having better quality technical sessions through selectivity. Either route to successful program planning requires enthusiastic and positive response to the "call for papers" for both the mid-year and the Annual Meetings. Generally speaking, selecting a few from several will assure better quality than by selecting(?) the "only ones we get!" R.S.V.P.

MONDAY

7:30 a.m.
EXECUTIVE COMMITTEE BREAKFAST - BUSINESS MEETING (By Invitation)
Kenneth E. Botkin, Chairman
Engineering Design Graphics Division

8:00 - 9:45 a.m.
CREATIVE DESIGN DISPLAY - COMMITTEE MEETING (Closed)
Ralph Blanchard, Chairman
Northeastern University

12:00 Noon - 1:30 p.m.
CREATIVE DESIGN JUDGES LUNCHEON (By Invitation)
Ralph Blanchard, Chairman
Northeastern University

3:45 p.m. - 5:30 p.m.
JOINT PAPER SESSION
Sponsored jointly by Engineering Design and Engineering Design Graphics with Engineering Design in charge.

9:00 p.m.
JOINT "RAP" SESSION
Sponsored jointly by Engineering Design and Engineering Design Graphics with Engineering Design in charge.

TUESDAY

12:00 Noon - 1:30 p.m.
ENGINEERING DESIGN GRAPHICS BUSINESS LUNCHEON
A business luncheon meeting for membership participation in Division affairs
Kenneth E. Botkin, Division Chairman
Purdue University

3:45 - 5:30 p.m.
JOINT PAPER SESSION
Sponsored jointly by Educational Research and Methods and Engineering Design Graphics with E.R.M. in charge.

Dinner
ANNUAL AWARDS BANQUET
Recognition and Awards for outstanding Division members
Change of leadership ceremonies
Creative Design Awards
Recognition of Creative Design contest judges
Featured speaker and/or other entertainment
Kenneth E. Botkin, Division Chairman

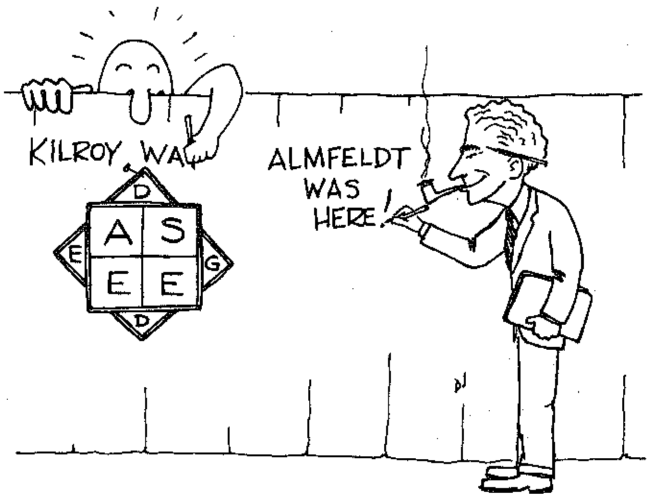
WEDNESDAY

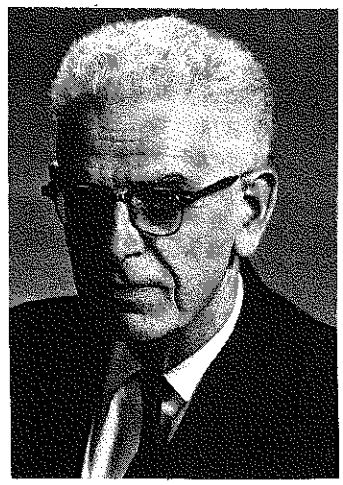
8:00 - 9:45 a.m.
THE COMPUTER IN EDUCATION - MATHEMATICS AND COMPUTER GRAPHICS
Sponsored jointly by Engineering Design Graphics and Computers in Education and Mathematics with EDG in charge.

Presiding: Byard Houck, Jr.
North Carolina State University

A Computer Graphics Course
Wayne C. Dowling
Iowa State University

Freshmen Engineering Students - How We Add Their Interests - via Graphics, Computers and Design
Richard T. Delorm & Thomas C. Smith
University of Nebraska





Maurice Amfeldt
Iowa State Univer.

AL ALMFELDT RETIRING

Remember when "Kilroy was here!" showed up in both likely and not-so-likely places?

It seems appropriate for members of the E.D.G. Division of ASEE to, at this time, express their collective appreciation to Al Almfeldt of Iowa State University for "being here" (a faithful member of the division) for the past twenty-two years.

Al will retire from active teaching on June 1 this year. We appreciate his past performance and want him to remain active in the Division present and future.

Professor Almfeldt started his long and illustrious teaching career as an Instructor at Rhode Island State College in 1935. He became an Assistant Professor at Syracuse University in 1946 then went to Iowa State as an Associate Professor in 1951 and was appointed Professor in 1960...Almost forty years of teaching.

He was elected Engineering Professor of the year at Iowa State University in 1966 by the students in the College of Engineering.

He has co-authored many editions of Engineering Graphics texts and Problem books.

Al has been Secretary, a member of the Board of Directors, a member of the Executive Committee and various other committees of the E.D.G. Division of ASEE and has attended meetings on a regular basis.

Yes, Almfeldt was here--and we appreciate his being "Al" and a loyal member of the division for 22 years. Keep up the good work, Al Almfeldt!

DESIGN PROBLEMS

By James H. Earle

One of the strongest aspects of current engineering graphics programs throughout the nation is the exposure of engineering students to the development and representation of design ideas. This ability to deal with creative ideas and their implementation is essential to the engineer since this is basically the engineer's function.

The engineer is a designer who must develop his ideas through many preliminary freehand sketches. In turn, these sketches must be refined and modified and developed into instrument, scale drawings. From these scale drawings the geometry of the designs is defined and established, the product is then analyzed, and finally engineering graphics is used extensively in representing the details of its construction.

Many excellent problems can be found in current magazines such as Design News. A typical situation that lends itself to classroom implementation is the manually propelled boat shown at the right.

This page could be reproduced and given to a class of students with the requirement that they take the idea from this point through a complete set of working drawings. The first assignment could be to establish the geometry and dimensions that would encompass human factors necessary for its operation. Next, they should be concerned with materials, methods of assembly, hardware, and method of installation in a standard boat.

You may even wish to require that they conduct a market survey, build a working model or prototype, and inventigate methods of obtaining a patent on this design. Hopefully, this approach would stimulate additional creative ideas that might also perform the same function. No other single course can as effectively cover the developmental and executional aspects of a design as an up-to-date course in engineering design graphics.

We are hopeful that this example will suggest how design concepts can be introduced to your students.

Feet flip fin, free fingers for fishing

(Reprinted with permission from DESIGN NEWS, March 4, 1974)

Oscillating motion of flexible fin propels, steers small boat

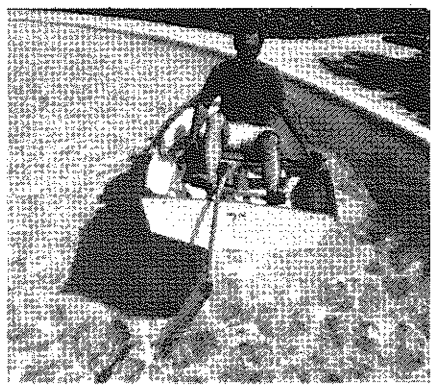
R. F. Stengel, Senior Editor

Let's say you have a small boat, and you like to go trolling for whatever bites. Motors are noisy, eat fuel and may spook the fish. Rowing is a good alternative, but you can't grab a pair of oars and a fishing pole at the same time.

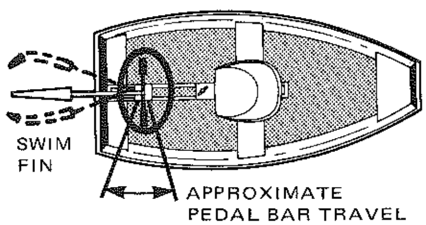
Inventors have proposed all conceivable (and some hard-to-believe) schemes connecting human feet to propellers, paddlewheels or fins by power trains that range from chain drives upward to Rube Goldbergs.

William Gross, an engineer living in Rancho Palos Verdes, CA, discloses a propulsion scheme of such classic simplicity that one is reminded either of the sketchbooks of Leonardo, or Oog the Neanderthal straddling a log and dipping a leafy branch in lieu of a paddle.

The sketches show how it's done. This development (patent applied for) makes one almost wonder about the wisdom of building solid-state-instrumented water tunnels and studying the propulsive efficiency of *tursiops truncatus*.

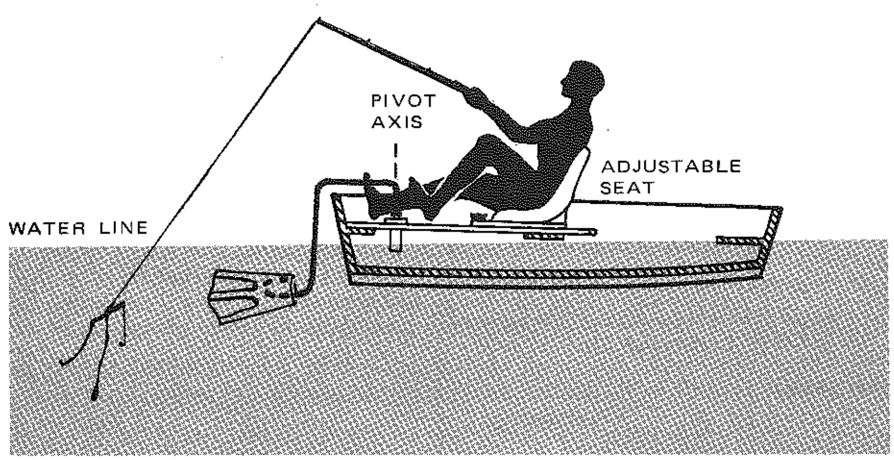


Prototype (demonstrated by inventor's son) reaches 4 knots in calm seas (or swimming pool, as shown).



How to operate it: attach crossbar (color) to tubular member. Provide pedals at each end of crossbar. Assume seated position, facing aft. Place feet on pedals and actuate pedal bar. As fin oscillates, flexing shape results in propulsion. If midpoint of oscillatory arc is offset, e.g. to starboard, boat will execute starboard turn.

How to build it: Install board lengthwise between transom and seat. Provide vertical pivot point where indicated. Bend tubular member (color) as shown. Insert one end into pivot. Push flexible fin (procurable from sporting goods section) over other end of tube. Fish at end of trolling line is not essential component of construction.



METRIC SCALES

By James H. Earle

Metric units are being used with more frequency in the United States, and it is apparent that this system will replace the English system within the next few years. This switch-over will be encouraged both by legislation and by the large industries who influence national standards and specifications.

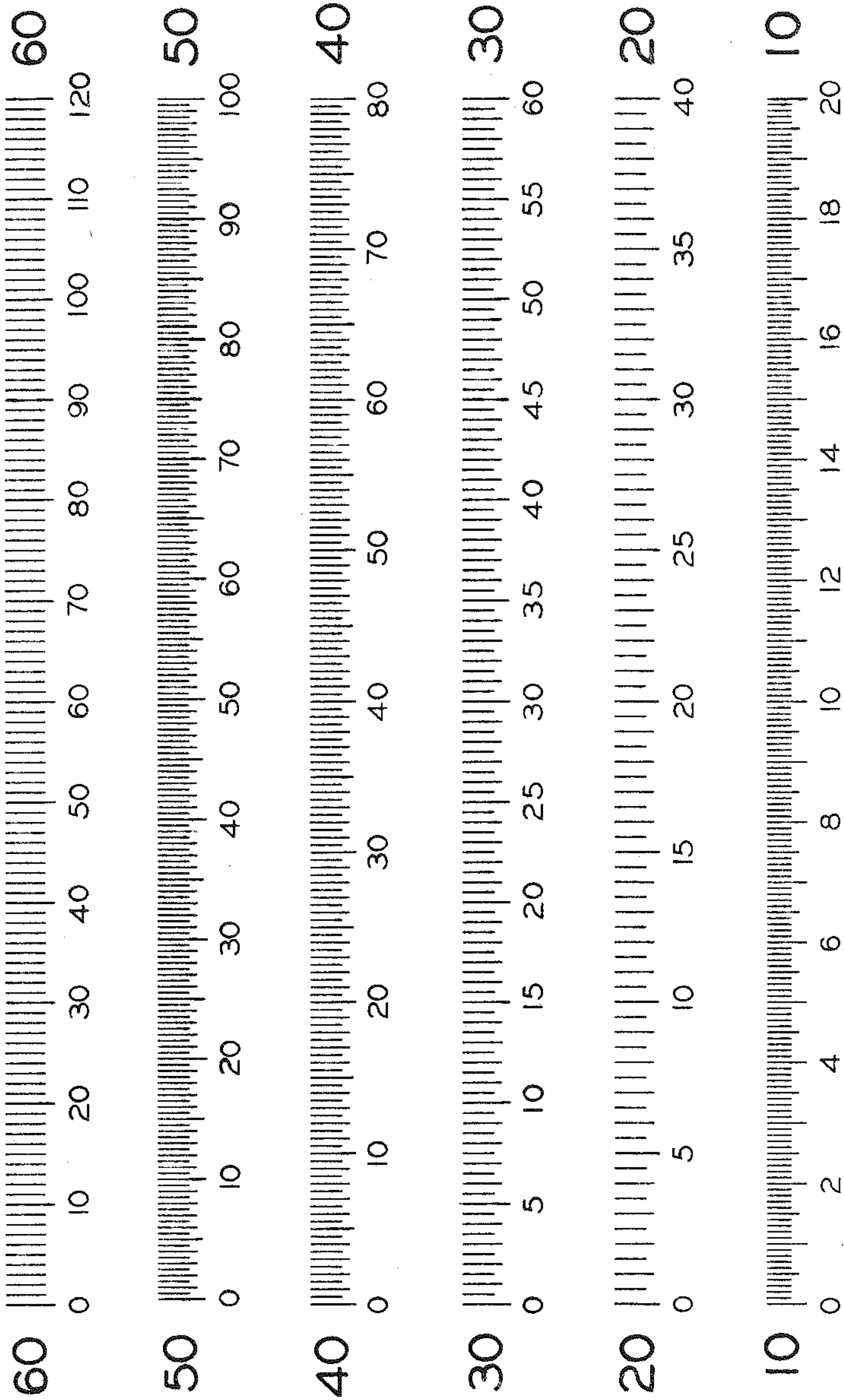
Students should receive a reinforcement of the metric system from their classes in engineering design graphics. This will serve to strengthen the introductions that they have received in physics and chemistry.

An immediate problem encountered in switching over to the metric system is the specification of scales that students should have available to use. Probably most instructors would prefer that the students use both the English system and the metric system from time to time in different types of problems. In order to be equipped to handle both systems, the students would be required to have an engineers' scale and architects' scale in addition to metric scales.

A temporary method of providing scales for your students are the printed scales shown on the opposite page. These scales will be reproduced on 8 1/2" X 11" sheets and given to all the students at Texas A&M University in order for them to begin using metric units in a routine fashion as they use engineers' scale at the present in the English system. These scales were developed by Dr. George Raczkowski of Texas A&M and were drawn by a computer plotter to insure a high degree of accuracy (Note: there may be a slight error in these scales due to the reproduction process in printing).

This page may be removed from your Journal and reproductions made from it in quantities sufficient to provide each of your students with a copy. It is intended that these sheets be folded along each scale in order for the calibrations to extend to the edge of the fold, thereby making it a more functional device with which to measure. The scale is calibrated with 10--60 divisions meaning that each centimeter is divided into ten units, twenty units, thirty, and etc.

Eventually, when your students have made a complete switch from the English system to the metric system, they will wish to acquire permanent metric scales to serve their purposes. In the meanwhile, these scales will provide you with a means of introducing metrics at no cost to your students.



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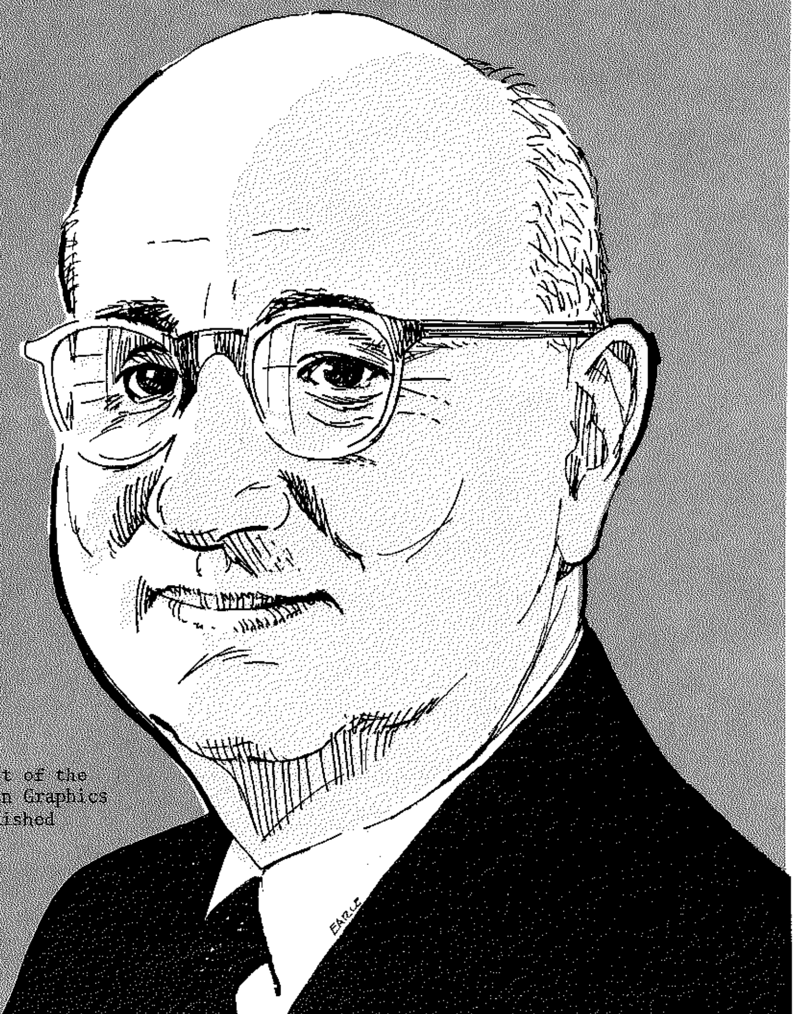

IRWIN WLADAVER

The 1974 recipient of the Engineering Design Graphics Division Distinguished Service Award

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