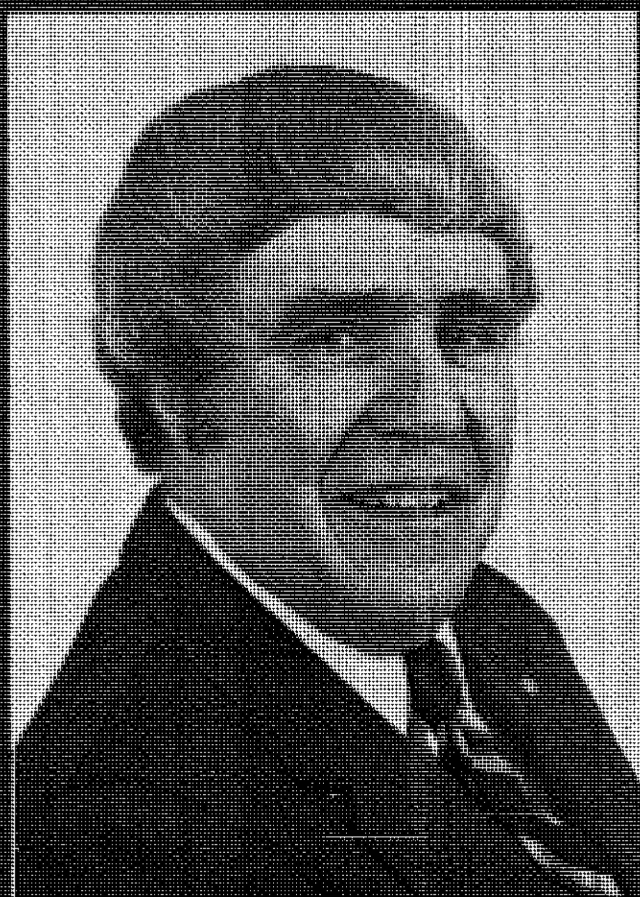
METRIC

ENGINEERING DESIGN GRAPHICS JOURNAL

FALL 1981 VOLUME 45 NUMBER 3



ROBERT D. LARUE
Distinguished Service Award

IN THIS ISSUE: Papers from ANNUAL MEETING– Creative Engineering Design Display– Design in Graphics -- AND MORE!!

ASEE ANNUAL CONFERENCE

A&M in '82

Texas A&M in '82—ASEE ANNUAL CONFERENCE, June 20-24, 1982
Sponsored by the American Society for Engineering Education

A&M in '82

THEME: "Productivity Through Engineering"

WHERE: Texas A&M University is at College Station, adjoining Bryan. The community population is 100,000 and is located 100 minutes from Houston, Austin, and Waco; and four hours from Dallas.

FACTS about Texas A&M University:
- Founded in 1876, Texas A&M is the oldest public university in Texas.
- With an enrollment of 33,000, it has been the fastest growing university in the nation.
- Its 11,000 engineering students make it the largest college of engineering in the nation.
- It has the largest campus in the nation with 5,200 acres.
- College Station was the fastest growing city in Texas during the 1970's with a 63% increase.
- Texas A&M has its own airport that is served by Rio Airways from Houston and Dallas.
- The famous Corps of Cadets has furnished more reserve officers than any other university.
- Texas A&M is fully coeducational with approximately 12,000 female students.

TOURS: Visits to Independence and Washington on the Brazos State Museum, Sam Houston Museum, Texas antiques in the neighboring towns, local wildcat oil rigs in operation, a cotton plantation, a cattle ranch, a horse breeding farm, and a Texas Instruments manufacturing plant.

PARTICIPATIONS: Texas dancing (with lessons), mechanical bull riding, tennis courts, swimming pools, crafts, hobbies, and more.

SHOWS: A fast-gun demonstration, a Texas Rodeo, Western music, and more.

PROGRAM: The majority of the program will be held in the Rudder Tower complex at the heart of the campus where an array of facilities and food services are available. Maximum walking distance to housing and other events will seldom exceed two blocks.

EXHIBITS: Commercial exhibits will be located in the Rudder Tower exhibition hall and the adjoining foyer, closely situated to the registration desk and all presentations.

DRIVING TOURS: Those wishing to make a driving vacation of the trip to the meeting will find many attractions in the nearby area. Waco—Baylor University and the Texas Ranger Museum; Houston—San Jacinto Battlefield, Astrodomain, shopping, oil industry, NASA, and museums. San Antonio—Alamo, Institute of Texas Cultures, river walk. Austin—State capitol, University of Texas, museums, Hill Country. Dallas/Fort Worth—shopping, museums, and art galleries. East Texas—the Big Thicket National Park, Indian Reservation, Old Nacogdoches, timber country, and oil fields.

TRANSPORTATION: Rio Airways can bring 300 passengers a day with its regularly scheduled flights from Houston and Dallas to the Texas A&M airport located five minutes from the conference center. The passenger capacity will be increased for the meeting. Motoring from the Houston International Airport will take less than two hours.

HOUSING: Airconditioned dormitory suites will be available for 2,500 visitors. Off campus motels are available for 2,400 occupants. A shuttle service will operate continuously to motels.

COST: Registration: less than $100. Campus housing: $10-$20 range; motel housing: $27-$45 range.

TEXAS A&M

For other information contact:
Jim Earle, General Chairman
ASEE Meeting, Texas A&M University
College Station, Texas 77843
Phone 713-845-1633 or 845-4451

ENGINEERING DESIGN GRAPHICS JOURNAL

ENGINEERING DESIGN GRAPHICS JOURNAL is published - one volume per year, three numbers per volume, in Winter, Spring, and Fall - by the Engineering Design Graphics Division of the American Society for Engineering Education, for teachers and industrial practicioners of Engineering Graphics, Computer Graphics, and Design Graphics, and Creative Design.

The views and opinions expressed by the individual authors do not necessarily reflect the editorial policy of the ENGINEERING DESIGN GRAPHICS JOURNAL or of the Engineering Design Graphics Division of the ASEE. The editors make a reasonable effort to verify the technical content of the material published; however, final responsibility for opinions and technical accuracy rests entirely upon the author.

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ASEE-EDG members	$1.50
ASEE but not EDG members	3.00
Non-members	5.00
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Subscription expiration date (last issue) is printed in upper right corner of mailing label, W79 for Winter 1979, S80 for Spring 1980, etc.

ENGINEERING DESIGN GRAPHICS JOURNAL OBJECTIVES:

The objectives of the JOURNAL are:
1. To publish articles of interest to teachers and practitioners of Engineering Graphics, Computer Graphics and subjects allied to fundamentals of engineering.
2. To stimulate the preparation of articles and papers on topics of interest to its membership.
3. To encourage teachers of Graphics to innovate on, experiment with, and test apprpriate techniques and topics to further improve quality of and modernize instruction and courses.
4. To encourage research, development, and refinement of theory and applications of engineering graphics for understanding and practice.

DEADLINES FOR AUTHORS AND ADVERTISERS

The following deadlines for the submission of articles, announcements, or advertising for the three issues of the JOURNAL are:
Fall . . . . September 15
Winter . . . . . . December 1
Spring . . . . . . February 15

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 the ENGINEERING DESIGN GRAPHICS JOURNAL. In order to save time, expedite the mechanics of publication, and avoid confusion, please adhere to these guidelines.

1. All copy is to be typed, double-spaced, on one side only, on white paper, using a black ribbon.

2. All pages of the manuscript are to be consecutively numbered.

3. Two copies of each manuscript are required.

4. Refer to all graphs, diagrams, photographs, or illustrations in your text as Figure 1, Figure 2, etc. Be sure to identify all material accordingly, either on the front or back of each.
Illustrations cannot be redrawn; they are reproduced directly from submitted material and will be reduced to fit the columnar page.

Accordingly, be sure all lines are sharply drawn, all notations are legible, reproduction black is used throughout, and that everything is clean and unfolded. Do not submit illustrations larger than 198 x 280 mm. If necessary, make 198 x 280 or smaller photocopies for submission.

5. Submit a recent photograph (head to chest) showing your natural pose. Make sure your name and address is on the reverse side. Photographs, along with other submitted material cannot be returned, unless postage is prepaid.

6. Please make all changes in your manuscript prior to submitting it. Check carefully spelling, structure, and clarify to avoid ambiguity and maximize continuity of thought. Proofreading will be done by the editorial staff. Galley proofs cannot be submitted to authors for review.

7. Enclose all material unfolded in a large size envelope. Use heavy cardboard to prevent bending.

8. All articles shall be written using Metric-SI units. Common measurements are permissible only at the discretion of the editorial staff.

9. Send all material, in one mailing to:
Mary A. Jasper, Editor
P.O. Drawer HT
Miss. State University
Miss. State, MS 39762

REVIEW OF ARTICLES

All articles submitted will be reviewed by several authorities in the field associated with the content of each paper before acceptance. Current newsworty items will not be reviewed in this manner, but will be accepted at the discretion of the editors.

NOTE: The editor, although responsible for copy as it is published, begs forgiveness for all typographical mistakes, mis-spelled words and any goofs in general. Typing is done mostly by non-professional word processors who either are still in high school or are not trained in professional word processing. Thank you for your patience.

CALENDAR

ASEE ANNUAL CONFERENCES

1982 - Texas A & M University
College Station, June 21 - 24

1983 -

EDGD MIDYEAR CONFERENCES

1981 - The University of Louisville
Louisville, KY

1982 - California Polytechnic Univ.
Pomona, CA

ENGINEERING DESIGN GRAPHICS JOURNAL

THE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

Volume 45 Number 3 Fall 1981

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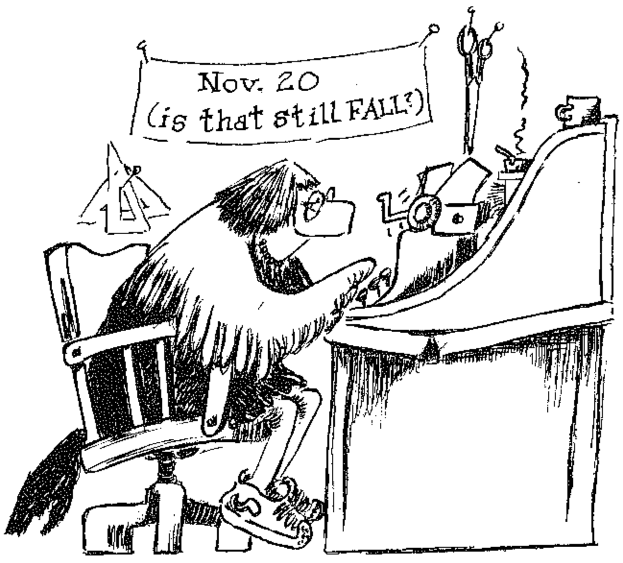


SHEE!
(with apologies to SHOE)

MARY A. JASPER
DEPARTMENT OF ENGRG. GRAPHICS
MISSISSIPPI STATE UNIVERSITY
MISS. STATE, MS 39762

Seems as though there's good news and bad news, in equal proportions, all across the U.S.A. this year.

ITEM (GOOD): Engineering enrollments are up, all over the country. More students than ever before are choosing the profession of engineering as a possible field of study. ITEM (BAD): With increased freshman enrollments also comes increased loads for teachers of freshman subjects (including Engineering Graphics). No longer can we give each student all of the individual attention that we feel that student deserves. It is almost impossible to provide prompt "feed-back" to the students by means of graded class-work and tests or quizzes. Some universities and colleges -- including 2-year technical schools -- find this problem to be more acute than do others.

ITEM (GOOD): The pendulum has finally begun to swing back for Engineering Graphics as a course or courses in engineering curricula across the country. Descriptive geometry is also being called "an invaluable aid for visualizing systems of forces in the Mechanics courses." (This quoted from a graduate student in electrical engineering at Miss. State.) ITEM (BAD): For those departments which somehow remained intact during the last 15 years -- departments which taught service courses in engineering graphics in the various colleges of engineering across the land -- this reverse of popular opinion (administrative) brings mixed emotions. On the one hand, we are glad -- as Bob LaRue puts it (see p.9 this issue) -- that WE STAYED AROUND UNTIL GRAPHICS WAS NO LONGER A DIRTY WORD. On the other hand, most of our staff is ready or almost ready to retire, and there seems to be a real lack of young graphics teachers out looking for employment, even at larger and more well-known universities.

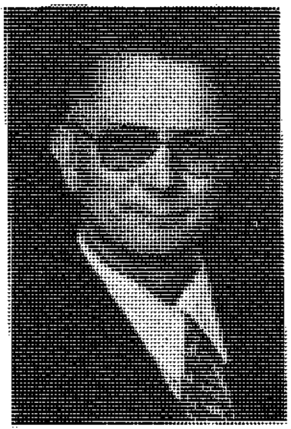
ITEM (GOOD): All the engineering disciplines want computer graphics included in existing graphics curricula; some disciplines even want the graphics staff to teach extra courses in computer graphics for their students. ITEM (BAD): Not only is there a need for more faculty to teach basic graphics courses; now, existing faculty must learn new techniques and skills in order to just keep afloat in this swirling sea of technological development. Furthermore, with the state of the economy being felt more severely by higher education, money for equipment (new or used) is just not there.

ITEM (GOOD): With the higher engineering enrollments also comes greater percentages of women and minorities who choose engineering as a course of study. ITEM (BAD): With these larger percentages of women and minorities studying engineering comes the fact that more of these (as well as the traditional white male engineering students) are even less well-prepared in high school for this study. More study on new ways to teach visualization to students who have never learned to "see" with their minds is needed. We cannot teach even basic graphics courses in the same old manner. New techniques must be developed and used -- and these techniques should be presented to the membership of the EDGD in the form of papers presented at Annual or Mid-Year conferences, or articles written for the Journal.

The good news and bad news presented above is just the tip of the iceberg, and we all know it. Problems such as money for travel to conferences, (or lack of it), learning to live with budget cut-backs in the areas of supplies, or university services, and the rising costs of computing services and equipment could be added to the list. These items must be studied, and when some of us arrive at some solutions, these solutions should be communicated to the membership.

It is apparent from what we all hear and know, that these are the times when we should become more active in the EDGD, and encourage our colleagues who are not members to join, but mostly to participate.

Mary A. Jasper



CHAIR'S PAGE

JACK C. BROWN
DEPT. OF ENGINEERING GRAPHICS
P.O. DRAWER EG
UNIVERSITY, AL 35486

ph. (205) 348-6320

The other day a friend remarked that "time passes so fast when you are having fun". I must agree, because it does not seem possible that I started teaching graphics twenty-six years ago. However, that is not long compared to 150 years that my instruction has beeen in existence, nor to the fifty-three years that the Engineering Design Graphics Division has been serving the needs of education and industry. History is usually measured in time, so it was natural for me to refer to one of the books on my shelf, <u>Proceedings of the Summer School for Drawing Teachers</u> June 18 to 28, 1946, McGraw-Hill Company.

Flipping through the pages I stopped at the section by Frederic G. Higbee. He gave a very interesting historical account of the "Development of Graphical Representation." A plea is given in the next section by A. A. Potter to advance the teaching of Graphics. He states "Drawing is a Universal language. I have insisted for many years that Drawing and Descriptive Geometry be given preference in engineering curricula to any other languages other than English . . . Even for the candidate for the Master of Science and Ph. D. degrees in certain engineering fields, mastery of the Graphic Arts may prove more useful than an extra foreign language". Needless to say, most engineering schools in the U.S. did not accept the advice given by Professor Potter. Instead, they cut many fundamental studies, such as graphics, to make room for advanced technical studies.

The shift away from the basic courses has lead to an illiteracy in engineering. Any engineer who does not know Graphics may be directly compared to a Judge who has no knowledge of the law. No one wants to be in the court of a Judge who lacks knowledge of the law, although several organizations and institutions seem not to grasp this fine point because they have minimized graphics in the past. However, some institutions are realizing the importance of graphics. The College of Engineering at the University of Alabama has reorganized to include Engineering Graphics as a separate department. When announcing the change in organization, the Dean stated "the reason for the change is to give graphics more emphasis and better visibility."

Needless to say I am excited about the future of graphics on this campus and also I am excited about the future of the Engineering Design Graphics Division. Those in attendence at the annual meeting in L.A. pledged their support. If each of you will earnestly make the following pledge, this organization will meet your needs:

> I hereby promise and affirm that I will support this Division to the fullest of my ability; furthermore, I will (before 1982) enlist someone to join this Division and I will actively participate in the affairs of this Division; furthermore, unless I have actively participated in this Division, I promise not to criticize the actions of the Division or its members. With my fellow associates as witnesses, these promises are freely made to advance this Division to where it is second to none.

If you tryly accept this pledge, please do two things: 1. Send me your suggestions as to how the Division could be improved and 2. Start making plans to attend the Mid-year conference which will be in the first week of January, 1982 in Louisville, KY. Let's talk more about this committment.

Jack C. Brown

Jack C. Brown
Chairman, EDGD

DISTINGUISHED SERVICE AWARD

The Division of Engineering Design Graphics
American Society for Engineering Education

has bestowed upon

Robert Dean LaRue

its highest honor

THE DISTINGUISHED SERVICE AWARD

for his dedicated service to the Division and to engineering education, his devotion to his students and colleagues, and as an expression of admiration and respect of his professional peers.

Robert Dean LaRue, Professor of Engineering Design Graphics and Computer and Information Science, Ohio State University, has an outstanding record of professional service and accomplishment.

He received a B. S. Degree in Mechanical Engineering from the University of Idaho in 1944, and immediately entered the United States Navy. After his discharge from active duty he remained in the Naval Reserve where he achieved the rank of Lieutenant Commander. He continued his education at Idaho University and obtained a B. S. in Agricultural Engineering and a M. S. in Mechanical Engineering. It was while serving as a Teaching Assistant at this time that his interest in teaching began. He has been an Assistant Professor at South Dakota School of Mines and Technology and a Professor at Colorado State University before going to Ohio State University in 1965.

Bob has always considered teaching to be his most important role as an educator. He has developed and taught honors and regular courses for freshmen engineers in computer programming and engineering graphics. He has significantly influenced the content and direction of graphics by his interest and innovation in computer graphics. It is through his foresight and efforts that computer graphics is now taught as part of the engineering graphics courses in many engineering colleges. He serves as a consultant in computer graphics to industry and colleges.

Bob joined ASEE in 1956, and has served the Division, his section and the national organization in many capacities. The most recent of these has been as chairman-elect of the North Central Section and as vice-president for Member Affairs, ASEE. He has served the Division as Circulation Manager and Treasurer of the *Journal of Engineering Design Graphics*, as a staff member for two summer schools, Coordinator of the Creative Engineering Design Display, Secretary, Vice-chairman and Chairman in 1975-76. Since that time he has served as director for two workshops on Computer Graphics. He is the author of a textbook on engineering graphics, published articles and presented papers and many conferences.

He is a member of Sigma Tau, Ohio Association for Engineering Graphics, and a registered professional engineer.

The Division proudly presents Robert Dean LaRue its 1981 Distinguished Service Award.

Presented this day June 23, 1981
at the Annual Conference, University of Southern California

Chairman

ENGINEERING DESIGN GRAPHICS DIVISION 19 28 ASEE

ENGINEERING DESIGN GRAPHICS DIVISION

ENGINEERING GRAPHICS--Past , Present and Future

NOTE: Without "hard" copy of Bob's acceptance speech as recipient of the EDGD 1981 "Distinguished Service Award", the Journal asked our good friend to write up his "philosophy" of Engineering Graphics. He did what one would expect a computer fancier to do!. HE WROTE HIS "PHILOSOPHY"ON A WORD PROCESSOR -- right margin-justified and all. The Journal wishes all contributers were so helpful!--Ed.

Robert D. LaRue
Professor, Engineering Graphics
The Ohio State University

Being notified that I was the recipient of the Division's Distinguished Service Award for 1981 started some thought processes in which I reviewed my participation in Divisional activities since attending my first meeting in 1956. Of course I tried to list all of the meetings - both Annual Conference and Midyear - I had attended. Instead of thinking of places, I found myself remembering people.

People in the Graphics Division have always been special. It goes without saying that Midyear meetings have always been well run and enjoyable to attend. Faculty of the ASEE Annual Conference host institution who were active Division members invariably held important position in planning and running the Conference. At least two Annual Conference Chairmen have been Division members.

I'm sure that all those who have received this Award would agree that their being considered for the Award was due to the help of the entire Division. I want to extend my sincere thanks for all the help I have received. Furthermore, one of the great advantages of being in this Division is the great number of wonderful friends I have acquired over the years. Thanks again!

At one time, the Division was the largest and strongest in ASEE. Then the trend toward engineering science began. Graphics, belonging to the practical side of engineering (at least from the viewpoint of many), began to decline. Programs at many schools were reduced or eliminated. The introduction of computer graphics may have also contributed to the decline of traditional graphics. There are those misguided individuals who would say, "We don't need this because the computer can do it."

At the present time, some members who have been very active in the Division are working to establish a Freshman Engineering Division in the Society. Apparently they feel their positions are more viable in such a Division than in the Engineering Design Graphics Division. The formation of such a Division will undoubtedly reduce the number of members who declare EDGD their first divisional choice.

However, there appears to be a trend to change engineering education to include less science and more practicality. The Associate Dean of Engineering at another large university recently asked me, "Aren't you glad you lasted until graphics was no longer a dirty word?" Furthermore, the current Division Chairman is also Chairman of a newly established graphics department.

The fallacy of computer graphics eliminating the need for manual, pencil pushing graphics is shown by talking to managers of computerized drafting systems (one application of interactive computer graphics). These people want individuals with a very strong background in drafting to become users of their systems. The same philosphy applies in many instances to engineers who are going into computer aided design. They need a background in graphics to effectively use computer graphics.

Graphics programs of the future should include both manual and computer graphics. The cost of computing systems with graphic capabilities is decreasing to the point where these tools should be available in paractically every school. With such systems, students will gain the experience needed to work in computer aided design. In addition, it will be possible to increase subject matter coverage in some areas to the level at which instruction was formerly given. It is interesting to note that many entering freshmen already have personalized computers which can produce graphic output.

The missing element in this picture will be instructors who have a good knowledge of graphics (especially descriptive geometry) and computer graphics (including programming). For a considerable time, there will be a need for the development of software for computer graphics.

The challenge to the Graphics Division is to develop workshops and summer schools (of several weeks duration) in which the individuals necessary for the Engineering Graphics of the future can be trained. If this is done, the Division may be able to regain the leading position in ASEE that it once had.

GUEST EDITORIAL

(Still more on "REGISTER OR PERISH")

Mary. . .

This is not an original story. The first time I heard it I was in my cradle in my native shtetl, Warsaw, Poland. (Who had cradles in the ghetto?, although you could "ghetto" one for a price!!)

Not only is this not an original story. I had intended it as a preamble to a more serious piece on certain pro's (no offence intended) and certain con's (again, noi), but I liked it after I read it and corrected some typos (!). I could write "the more serious piece" and still may on "Register, Publish, or Perish".

Signed /Vlad/

Dr. Irwin Wladaver
1500 Bay Road, #415
Miami Beach, Florida 33139

Rabbi Yessef was the only semi-official in the tiny shtetl. By definition, a shtetl is an isolated village reachable in winter by snowy, muddy, rutted trails and in summer by the same trails now choked with dust. Anyway, the shtetl was too small to support a policeman or a judge. For any problem, "See the Rabbi". The Rabbi dispensed advice and justice. When advice failed, he dispensed with justice and used his judgment. It always worked.

One day the thirty-years' war between Reb (Mr.) Yankel and his wife Rachel came to a fever pitch and the decision was, "We ask the Rabbi to decide who is wrong and, maybe, who is right."

They approached the Rabbi and explained that they needed his help. Of course, the Rabbi's wife, Rifka, knew the whole story and long since had told the Rabbi about the differences that had plagued Yankel and Rachel all that time; even so, she decided to eavesdrop. Had to. Who wouldn't?

Rabbi Yussef asked Yankel to leave the room while he would listen to Rachel make her case with Yankel absent. The Rabbi listened, his head cocked to the left, and when Rachel finished telling her side of the story, he said, "Rachel, I think you are right. Please leave now and send Yankel in. I must hear what he has to say."

Then Yankel came in. The Rabbi listened, his head cocked to the right this time to avoid partiality. When Yankel finished telling his side of the story, the Rabbi said, "Yankel, I think you are right. Please tell Rachel I said so."

The Rabbi's wife would have exploded, but any rabbi is due great deference for his learning; she had to content herself with the complaint: "My Darling Rabbi! How can you tell the wife that she is right and then tell her husband that he is also right? It's impossible they should both be right!"

The Rabbi answered, "Rifka, I'll tell you something: YOU ARE RIGHT, TOO."

COME TO "LOO-UH-VULL"

ASEE ENGINEERING DESIGN GRAPHICS DIVISION MID-YEAR MEETING JANUARY 3-5, 1982

FRANK M. CROFT
SPEED SCIENTIFIC SCHOOL
UNIVERSITY OF LOUISVILLE
LOUISVILLE, KY

We at the University of Louisville are delighted to host the annual mid-year meeting of the EDGD. The meeting is scheduled for January 3-5, 1982. We sincerely hope all of you plan to attend and sample "Kentuckiana Hospitality". We know you will not be disappointed.

Located at the "Falls of the Ohio", Louisville began as a settlement of English, Scotch, and Irish families led by George Rogers Clark and his troops in 1776. The settlement prospered and later was named Louisville in honor of King Louis XVI of France. The correct pronounciation of the city is "Louieville", however natives generally pronounce it "Loo-uh-vull".

The University of Louisville is the nation's oldest municipal institution. It was established in 1798 and is now a state-supported school. The Speed Scientific School, the University's school of engineering and technology, was established in 1924 as a result of an endowment from the James Breckenridge Speed Foundation. The school offers degree programs in 7 areas of engineering and 4 areas of technology.

This year's meeting will be held at the Executive Inn Hotel which is near the University and the airport. All technical sessions, demonstrations, the business luncheon, and the awards banquet will be held at the hotel. You are encouraged to make your room reservations directly with the hotel by using the reservation card printed below. This reservation card will also accompany the registration materials that will be mailed later. Room rates will be $36 for a single and $43 for a double. This arrangement is more efficient for managing transportation and will provide an excellent atmosphere for the meeting. Informal tours of the University and the Speed School Complex are planned so attendees can become more familiar with the school.

The spouse program for this year's meeting should be entertaining and informative. Tours of the Louisville Stoneware Company, the J.B. Speed Art Museum, and the Kentucky Derby Museum are planned. A luncheon on Monday, January 4 is also planned and will be held at one of Louisville's fine restaurants.

The Louisville metropolitan area and Kentucky in general offer a wide variety events and attractions for those attendees who wish to sight-see. The following list presents some of the sight-seeing attractions that are open in January.

Metro-Louisville Area

Rauch Memorial Planetarium
Kentucky Derby Museum
Farmington Mansion (Historical Sight)
Hadley Pottery Company
Bakery Square (Shops restored to 1890's)
Museum of Natural History
American Saddle Horse Museum
Riverfront Plaza & Belvedere (Ice skating)
Actors Theatre

Close to Louisville

Mammouth Cave National Park
My Old Kentucky Home State Park
Custer Residence
Fort Knox-Gold Depository
Patton Museum of Calvary & Armor
State Capitol
Daniel Boone Grave
Shakertown

An outstanding program has been put together by Barry Crittenden of VPI as can be seen below. This program coupled with the attractiveness of the Louisville area as well as the Executive Inn Hotel should produce a meeting that will be enjoyed by all and remembered as one of the better mid-year meetings the EDGD has had. Come to "Loo-uh-vull" and enjoy yourself!

PROGRAM/PROGRAM/PROGRAM/PROGRAM/PROGRAM/P

Sunday, January 3, 1982

6:00 -	Executive Committee Dinner and Meeting

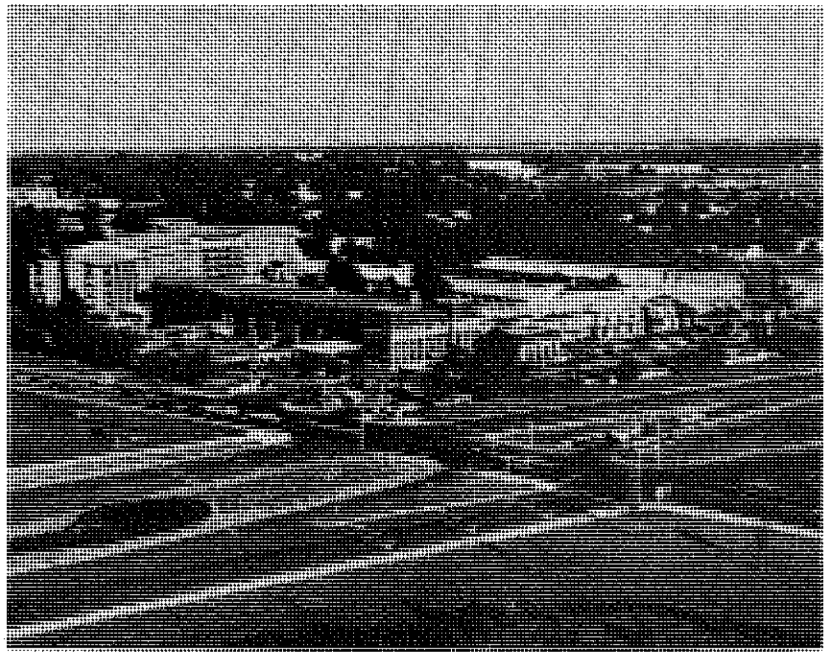
Monday January 4, 1982

8:00 - 8:30	Registration
8:30 - 8:45	Introduction & Welcome
8:45 - 9:30	William A. Miller, Western Carolina University "Occupational Importance of Engineering Graphics- As Seen by Engineering Technology Graduates".
9:30 - 10:30	Larry G. Richards, University of Virginia "Investments in the Future: Reflections on University - Industry Relations".
10:30 - 10:45	COFFEE BREAK-Visit Exhibits
10:45 - 11:30	Sharon R. Heckman, U.S. Army Corp of Engineers "Graphics Usage by the Corp of Engineers".
11:30 - 12:00	Break to set tables for luncheon Visit Exhibits!
12:00 - 1:15	Business Luncheon
1:30 - 2:30	Yuan H. Liu, Miami University-Hamilton (Ohio) "Design of Fixtures to Hold Inserts for Ever-Strait Doors".
2:30 - 3:30	Abram Rotenburg, University of Melbourne (Australia) "JOHNNY-An Algorithm for Reading Orthographic Drawings".
3:30 - 3:45	COFFEE & SOFT DRINK BREAK-Visit Exhibits!
3:45 - 4:45	Daniel J. Goldstein, Naval Sea Systems Command "Student Exposure to Calcomp - The Graphics Details".
7:00 - 8:00	SEMINAR - Rapid Draw System of Ink on Film Technique Presented by: James Kester Koh-I-Noor Rapidograph Inc.

Tuesday January 5,1982

9:00 - 12:00	Industrial Tour (Tentative plans are to tour the Ford Truck Plant In Louisville) Bus will leave at 9:00 AM
1:00 - 1:45	Gary D. Shulenburg, Newport News Shipbuilding "Graphics at Newport News Shipbuilding".
1:45 - 2:30	Rollie Jensen, Iowa State University "An Engineering Graphics Instructional Facility Utilizing Computer Graphics".
2:30 - 2:45	COFFEE & SOFT DRINK BREAK Visit Exhibits!
2:45 - 3:30	Roscoe L. Pershing, Deere & Company "CAD/CAM and Engineering Integration".
3:30 - 4:30	V. O. Thomas, Royal Melbourne Institute of Technology (Australia) "An Interactive Computer Program on Exterior Algebra for Descriptive Geometry & Computer Graphics".
6:30 - 7:30	Social Hour
7:30	EDGD Awards Banquet

LOUISVILLE EXECUTIVE INN HOTEL -- Site of the 1982 EDGD Mid-Year Meeting



For Reservations:

Mail this form directly to:

Executive Inn
Watterson Expressway at Fairgrounds
Louisville, Kentucky 40213

Phone: (502) 367-6161

PLEASE RESERVE:

() Single (one person)
() 2 Double Beds ( )Persons
() Suite ( )Persons
() Connecting Rooms ( )Persons

Arrival Date______________

Number of Nights__________

Note: This reservation held until 6:00 P.M. unless payment guaranteed by company or a prepaid deposit.

Name______________________________

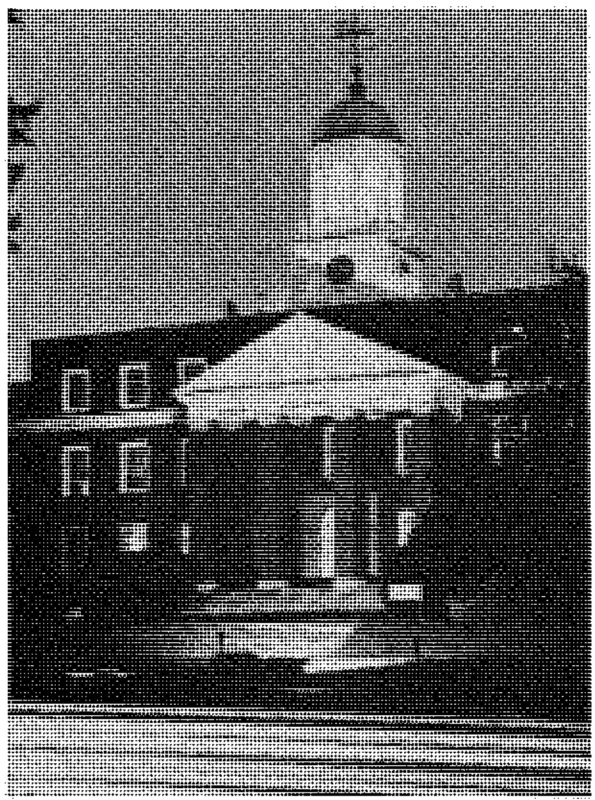
Firm______________________________

Street____________________________

City______________________________

State________________ Zip__________

EDGD Mid-Year Meeting Jan. 3-5, 1982



JAMES BRECKENRIDGE SPEED HALL
Main Building of the Speed
Scientific School Complex.

USC '81

SOME COMMON CHARACTERISTICS IN INDUSTRIAL APPLICATIONS OF CAD/CAM

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ABSTRACT

This paper represents the result of an inquiry sent to several industrial representatives asking for their response to questions related to their use of Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM).

The results indicate that the most common use of CAD is in the areas of; the design of machine and structural elements and electrical circuit boards; the solution to problems using programs in finite element analysis, et al; interactive graphics design using software programs such as CADAM developed by the Lockheed Corporation.

The most common use of CAM is for scheduling; inventory and process control; numerically controlled machines; materials handling and monitoring; interactive parts nesting and testing procedures.

In addition to CAD/CAM, Computer Aided Drafting was mentioned as being popular with several of those responding.

In the author's opinion, there is sufficient interest and application of CAD/CAM in industry to make it a required (or optional) subject for all undergraduate and graduate engineering students attending an accredited institution of higher learning.

INTRODUCTION

The digital computer has had a tremendous influence on the accomplishments of the profession of engineering. In the beginning, its primary application was to solve the more difficult, time consuming mathematical equations associated with engineering design and analysis. As new developments in computer hardware became available and the cost of computer hardware and software was reduced, the use of the digital computer has been expanded to include many other applications such as computer graphics, computer aided design, computer drafting, numerically controlled machinery, robotics, scheduling and performance control, maintenance of personnel records and many other applications.

This paper will suggest those applications of the digital computer which are most commonly used by a variety of industries who had responded to a questionnaire sent to them by the author. The questions posed were directed toward the areas of Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM).

The main purpose of this study is an attempt to determine those characteristics of CAD/CAM which are most common to the industrial representatives who use them. It is hoped that the result will be beneficial to colleges which are including CAD/CAM in the curriculum of undergraduate and graduate students.

THE SURVEY

Letters were sent to approximately 150 industrial representatives. A broad cross section of industry was contacted, including both large and small manufacturers and engineering consulting firms. Only 52 responded to the inquiry. Forty indicated that they were using either CAD, CAM, or both and twelve indicated that they were not using either CAD or CAM. Several of those responding negatively stated that CAD/CAM was in their future plans and therefore suggested that an introduction to CAD/CAM be included in the engineering curriculum offered at colleges and universities.

Table No. 1 is a condensation of those areas of CAD/CAM and Computer Aided Drafting (CADR) which are most used in industry.

An observation of the tabulated results indicates that the greatest use of Computer Aided Design is in designing machine and structural elements and circuit boards; secondly, as a problem solving tool utilizing software programs in finite element analysis, and thirdly, the application of interactive graphics design using software packages similar to CADAM.

The most widely use of Computer Aided Manufacturing is in the area of scheduling, inventory, performance control, production and process control, personnel records, etc.; secondly, numerically controlled machines for manufacturing operations, and lastly for materials handling, interactive parts nesting, and nondestructive testing and field testing procedure.

Table No. 2 identifies some of those responding representatives of industry who are presently using CAD or CAM and indicates the areas which are being utilized.

Table No. 3 is a list of those industrial representatives who were not using CAD/CAM at the time of their response to the questionnaire. Some reasons cited were: Company is too small to justify the expense of computer hardware; the type of manufacturing, etc. did not lend itself to the use of the computer.

Table No. 4 represents a tabulated summary of the results of the survey including the number of respondents utilizing the three areas indicated.

TABLE No. 1. Application of CAD/CAM in Industry

Application	No. of Reps. Using the Application
CAD	
1. Designing of machine and structural elements and circuitboards	21
2. Problem solving	17
3. Interactive graphics design	14
CADR	
4. Edit and alteration of existing drawings	14
5. Automated drafting	25
CAM	
6. Scheduling inventory, control processes, personnel records, etc.	20
7. Numerically controlled machines	19
8. Materials handling and monitoring	8
9. Interactive parts nesting	4
10. Nondestructive and other testing	3

TABLE No. 2. Industrial Representatives Using CAD/CAM

Industrial Representative	Use of CAD/CAM*
Allis Chalmers	2,4,5,6,7,9
American Plywood Assn.	1,2,6,8
AMOCO (Std. Oil Co. of Ind.)	3,5,6,7
ARMCO Building Systems	1,5,7
Bechtel Power Corp. (Eng. Div.)	2,5
Bell Laboratories	1,5
Black & Veatch	1,3,5,6
Brunswick Co. (Defence Div.)	7
Burlington Northern	1,5
City of Los Angeles (County Engineer)	1,2
Colt Industries (Fairbanks Morse Pump Div.)	1,2,7
Deere & Co. (Manufacturing Eng. Div.)	2,3,4,6,7,8,9,10
Firestone Tire & Rubber Co.	5,6,7
Fisher Controls Co.	1,2,6,7
Ford Tractor Div.	1,2,3,4,5,6
General Dynamics (Electric Boat Div.)	2,3,4,7,9,10
General Motors Corp.	1,2,3,4,5,6,7,8,9,10
General Portland Inc.	6
International Paper Co.	6,7,8
Johns-Manville Sales Corp.	4,5,6
Martin Marietta Aerospace	1,3,4,5,6,7,8
McDonnell Douglas (Aircraft Co.)	3,5,7
McDonnell Douglas (Astronautics Co.)	1,3,4,5,7
Monsanto Co. (Eng. Dept.)	1,5
Phillips Petroleum Co. (Corporate Eng. Div.)	2,3,4,5
Proctor & Gamble	2,3,4,5,6,7
Republic Steel	1,5,7
Sandia Laboratories	1,2,3,4,6,7
Texaco (Computer Services Dept.)	1,3,4,5
The Schemmer Assoc. Inc. (Architectural Dept.)	1,5,6
Trane Co.	1,2,4,5,7,9
Union Oil Co. of California	2,5,6,8
Union Pacific R.R. Co.	5,6,8
United Technologies Research Center	1,6
Valmont Ind. Inc.	2,3
Western Electric	1,2,4,5,6,8
Westinghouse Elec. Corp. (R & D Center)	1,5,7

*Refer to Table No. 1 for Explanation of Application of CAD/CAM

TABLE No. 3. Industrial Representatives Not Using CAD/CAM

Adams Engineering Co.

Boise Cascade Corp.

Detroit Testing Machine Co.

Georgia Pacific Corp.

Gilson Screen Co.

Iowa-Illinois Gas & Electric Co.

Klett Manufacturing Co.

Marathon Pipeline Co.

Market Forge Co.

Nebraska Department of Roads

Steiger Tractor Co.

SATEC Systems, Inc.

TABLE No. 4. INDUSTRIAL COMPUTER AIDED APPLICATIONS

Computer Aided Drafting		(39)
a. Automated Drafting	(25)	
b. Edit and Alteration of Existing Drawings	(14)	
Computer Aided Design		(52)
a. Designing of Machine and Structural Elements and Circuit Boards	(21)	
b. Problem Solving	(17)	
c. Interactive Graphics Design	(14)	
Computer Aided Manufacturing		(54)
a. Scheduling, Inventory, Control Processes, Personnel Records, etc.	(20)	
b. Numerically Controlled Machines	(19)	
c. Materials Handling and Monitoring	(8)	
d. Interactive Parts Nesting	(4)	
e. Nondestructive and Other Testing Procedures	(3)	

APPLICATION AND ADVANTAGES OF CAD/CAM *

1. An opportunity for the engineer to be more creative.
2. Reduced manufacturing cost and reduced lead times.
3. "Computer graphics is probably the most important reason that CAD/CAM has been so widely accepted and implemented. It provides instant results of your interactions and provides instant results of your interactions and provides a work environment that is difficult to beat for problem solving."
4. Being able to "remote" graphics devices.
5. Has enabled General Motors to produce product designs and master wood models on a timely basis, at less cost, and with improved quality resulting in finished products that are not only more dimensionally accurate, but are being designed and engineered in half the time required by previous manual techniques.
6. Evaluating the structural characteristics of a design by computer simulation makes it possible to design and engineer vehicles with optimum weight and strength.
7. Provides visual simulation to determine: If different seating arrangements comply with federal visibility standards; if the visibility of a typical driver is obscured by posts or pillars or if the steering wheel blocks the view of the instrument panel; if the luggage compartment storage capacity is adequate, etc.
8. Numerically controlled milling machines produce accurate model parts, greatly accelerating the development of the design program.
9. Assists tooling engineers, using graphics consoles, in designing welding fixtures and determine the optimum orientation of the welding gun. The computer then automatically places the weld guns in the proper position and maintains proper clearances.
10. Provides optimum use of material by determining the material pattern that will create the least waste and process the information so the material may be cut by a numerically controlled fabric cutter.
11. Provides a means of maintaining tolerances by automatic inspection as a part progresses through the various machining operations.
12. Used in testing laboratories where complex tests and calculations must be conducted and analyzed in a relatively short period of time.
13. Used to monitor functions on the manufacturing floor to improve operating efficiency and effectiveness.

* From GM Paper "CAD/CAM at General Motors" by Frank Stoneking, Department Head, General Motors Manufacturing Development presented at the Deere & Co. CAD/CAM Conference on January 16, 1980.

SUMMARY AND CONCLUSIONS

In the author's opinion, the survey was unsuccessful in determining to what extent CAD/CAM is being utilized in industry in that only about one-third of those contacted responded to the questionnaire. If one is to assume that those who did not respond were not using CAD/CAM, then less than one-third of industry is using it.

A positive result of the survey, in the author's opinion, is the information related to those areas of CAD/CAM which are most utilized by those responding positively. It does provide some input which could be beneficial to the engineering college that is either planning to include CAD/CAM in their curriculum or already is offering such instruction.

The major auto manufacturers and many of the major manufacturers of agricultural and industrial equipment are presently using CAD/CAM. The time saved in both the design and manufacture of their product is phenominal and in their opinion justifies the expense of the hardware and software necessary to utilize the program.

It seems CAD/CAM is here to stay and therefore should be a mandatory requisite of all engineering students whose future responsibility will be in the areas of the design and manufacture of mechanical, electrical and structural components as well as those industrial engineers who will be responsible for plant operations and overall economy.

USC '81

AN INDUSTRY PERSPECTIVE OF THE COMPUTER GRAPHICS CHALLENGE

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Computer graphics is the driving force behind what will become a major industrial revolution.

Graphics dates to antiquity as an effective means of exchanging ideas. Its effectiveness lies in its simplistic universality; hence, a picture is indeed worth a thousand words. Even today we attempt to communicate to the galaxies using graphics.

Since the accuracy of hand drawn graphics is often inadequate because of imperfectly perceived geometry and shaky hands, the technical drawing of today uses graphic conventions such as dashed lines, blend notations and fat pencils to form a 2-dimensional representation of a 3-dimensional object.

Dimensions are then added to give the illusion of a precise definition of that object. In reality, many objects simply cannot exist as they are drawn and it falls the lot of the model maker to reconcile these aberrations.

What's so revolutionary about <u>computer</u> graphics?

With computer graphics - for the first time - we have the potential for simply creating an accurate mathematical model of a geometric object in machine readable form.

The full implications of this premise are still being explored. Only three of these implications are treated here, and these only briefly.

First; the premise states that we can, or at least have the potential to, create a mathematical model of a geometric object using computer graphics. This implies that trained personnel are required to enter and geometrically define these objects.

This presents the first challenge to both industry and educators. Data entry people must be capable of both defining geometry in analytical terms and must be computer literate.

Industry and educational institutions should attach only a secondary importance to being trained in the use of a specific graphics system. (Man-centuries of software are being written everyday, educators could never begin to keep up with expanding software.) I could care less if training is on Computervision, Applicon, Calma or any other specific equipment. I'm interested in finding someone who understands planes, surfaces, arc definition, and B-splines.

The tools of the draftsman (pencil, T-square, compass, and template) are useless to the data entry person: the "geometric model maker". The geometric model maker (this process has amazing parallels to the shop model maker) uses analytical geometry to define to the computer an object as it really exists in 3-dimensions. Corners must intersect, no dimension is forgotten, or the model will be in error and cannot be constructed.

In addition, the graphics model maker should be computer literate. Computer graphics in the 80's will see the computer emerge from a remote, somewhat mysterious device to being an integral part of our corporate and personal lives. The data entry person of the 80's should understand data bases, data base structure, bits and bytes and CPU's.

Assuming this challenge has been (or at least can be) met, we can now create a mathematical model -- a data base -- which is in a machine readable form.

I think at this point one might pause and ask WHY?

Why create a computer data base? Contrary to popular wisdom, the answer is not productivity. It may well take longer to create a 3-dimensional geometric data base than to create a conventional drawing.

Then, why? I think we might find the answer in an interesting parallel. I'm sure you all remember trigonometric tables. I'm sure your favorite handbook has the pages marked. Then someone decided to put trig tables in a computer data base and the scientific calculator was born. Now then, you're in your office and you discover you need the sine of 38 degrees. The handbook, within arms length, will give you the correct value, as will the calculator in the office next door, which do you use?

I dare say the majority of you would walk next door, but why? Because once you have the sine of 38 degrees on the calculator, you continue toward a final solution much faster.

Similarly, with computer graphics, we need the geometric data base but, the real value of the data base comes in what we can do with it after the model has been created.

This presents the second challenge: Now that we have all these data, and can manipulate them very quickly with the computer -- what are we going to do with them?

Are we smart enough to know what we want to know?

While a traditional 2-dimensional drawing may be sufficient, it certainly doesn't exploit the data base.

We must learn to convert data (lines, arcs, fillets, circles) into information (mass, volume, centroid).

Only after we learn to extract the essence of the geometric object from the data can we gain understanding of the object and its relationship to its surroundings.

It is the educator's challenge to produce data analysts who are well enough trained to change data into information. Engineering information such as fit, function, stress, and performance. Accounting information such as labor and material cost. Manufacturing information such as cycle time, mold design, and die design.

This leads to the third challenge, which is to be creative and intuitive enough to use this wealth of timely information to act and react.

The effect of this change in method of geometric description on industry is truly revolutionary. Traditional job descriptions such as designer, detailer, N/C programmer, product engineer, and process engineer begin to blur.

It no longer takes a specialist to interpret a 2-dimensional drawing for complex engineering calculations, the computer can analyze the data and provide results. Since a die design is derived directly from the part geometry, the computer can design a complex die with little human intervention. Inspection is no longer a process of comparing a 3-dimensional part to an interpretation of a 2-dimensional representation of a 3-dimensional part; it becomes a computer comparison of a 3-dimensional model to a 3-dimensional part, quickly and accurately.

We are in business to make a product at a profit. By changing the definition of the product from a 2-dimensional paper representation (subject to human interpretaiton) to a 3-dimensional mathematical model from which consistent, accurate information can be extracted at lightning speeds, we have impacted the entire corporate structure.

Those of us who thought we had purchased an automated drafting machine soon discovered we had a different kind of beast by the tail.

Those of us who have lived with computer graphics soon discovered we had a tiger by the tail.

And those of us who are beginning to understand the implications of computer graphics have discovered we not only have the tiger by the tail, but he's off and running.

The challenge to you as educators is to provide:

1. People who are trained to define analytically, in 3-dimensional terms, a geometric object.

2. People who can convert data to information.

3. People who are creative and intuitive enough to use that information to create a better product and a better tomorrow.

INTEGRATING COMPUTER GRAPHICS INTO A TECHNICIAN TRAINING PROGRAM

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Abstract

Colleges and industry both face similar problems in trying to shorten the time lag between adding a new technology and developing trained manpower. Computer graphics is high cost technology that faces shortages of trained manpower in many occupations, and computer graphics was chosen by the Milwaukee Area Technical College (MATC) as the area with which to develop a model for career planning and partnership with industry. MATC has proceeded with an NSF-CAUSE Project to retrain faculty, develop curriculum, develop partnerships with industry and workers, and simulate a work environment. With the assistance of a major vendor, Computervision Corporation, as a partner, the computer graphics skills are being integrated into eleven occupational programs. The curriculum update resulted in modification of appropriate instructional units as well as the addition of a basic operator course and advanced courses. In the first year, over 200 students were enrolled in two-credit courses.

Introduction

The information explosion and rapid technological changes have created a time lag between what is taught and the real technical skills that are needed. The revitalization of American industry must include colleges as well as industry. The Milwaukee Area Technical College has chosen computer graphics as an advanced technology for developing a model partnership with industry, using a continuous career development plan permitting industry, college, and workers to modernize in harmony.

Improving productivity of American industry usually requires an investment in advanced technology to modernize plant and equipment and then to retrain its technologically obsolete workers. The workers facing displacement and layoff as a result of technological improvements should have the choice of either working with the technology through retraining or accepting early retirement, as discussed in "The Redundant Worker" by Peter Drucker (Wall Street Journal, September 25, 1979).

Computer graphics is one of the new technologies which, when coupled with numerically controlled machines, is capable of automating the total factory; and it becomes the challenge of industry, worker, and college to solve the displaced worker problem. This technology confronts engineers, designers, draftspersons, machine operators, machinists, welders, assembly persons, and others with the possibility of being displaced. As a result of the need for automation, most firms try to convert to the new technical processes but meet the resistance of the established workers.

The designer has a difficult time accepting the idea that a computer graphics terminal is capable of increasing productivity by anywhere from two to ten times. Initial resistance is hard to overcome when the worker who has spent 25 years at a drawing board cannot conceive a new creative role at the terminal or accept the newly required skills. Third party educators can help firms solve this dilemna by changing work attitudes and providing new skills to veteran workers.

Within a manufacturing center, it is estimated that 85 to 95 percent of the workers do not require college degrees. The educational needs of the majority work force in developing new occupational skills, communication skills, and human relations skills can be met at the two-year college. It is at the technical college or community college that training for the majority of technologically obsolete workers is also likely to occur. The aim is to provide low-cost education with current skills for associate degree students and to upgrade employed technicians, both of which are within the mission of a two year college.

Four-year engineering colleges and graduate schools have the challenge of educating engineers to be more effective managers of both the advanced technological worker and equipment. The engineer/manager who knows the talents and requirements of each technical worker can develop an efficient team capable of maximum productivity in a revitalized industry. The primary motivation of team members is the increased resposibility of participation and the opportunity to advance to higher team positions with the help of a continuous career development program.

The technical college is challenged to provide technicians with up-to-date marketable skills. The Milwaukee Area Technical College has accepted the challenge to integrate new skills in existing occupational programs. New occupational programs may evolve as a result of this effort. The redevelopment of the occupational programs to meet technological advances has progressed at MATC by its taking advantage of existing instructional development strategies with a special effort to minimize the high costs involved. Attention was required to the following areas:

Curriculum Development

The occupational advisory committees emphasize the importance of well-developed basic occupational skills in all technical programs. The experiences of our advisory committee members indicated that the inadequately prepared draftsperson will only multiply errors while working with computer graphics. This error rate reduces the chance of reaching the expected productivity improvement on this capital intensive investment. Sound basic engineering skills are a needed priority to achieve full potential of this new technology.

There is always a need to add new technology to the content of courses and programs. Since time is a restrictive constant, limited options emerge: either increased study effort must be expected of students, more effective instruction will be required, or instructional units need to be deleted from the courses. Traditional instruction may require several hours of student time at an assignment or lab exercise to develop a single basic skill. In contrast, the same basic skill or concept may be learned, along with several other skills, in the same time frame at the graphics terminal. If computer graphics provides accelerated skill development, then traditional courses may now have more room for these new units of instruction.

The relevance of the curriculum depends upon a close interface with the student, instructor, occupation, industry, and the vendors who develop the technology. This interface is enhanced through the use of occupational advisory committees, faculty employment, cooperative student placement, resource centers for industry information exchanges and vendor equipment displays, training sites in industry, and other means.

Simulating the Work Environment

The educational facility must be planned to provide experiences closely resembling on-the-job training. The cost of high technology can be reduced through donations from industries that are involved in training, courses at industrial sites, equipment loans from vendors, foundation grants, and the formation of regional centers which can be shared with universities and industries for required training. In some cases, industry can sub-contract the facility for third shift production, further reducing training costs. Experiential learning in a technical college facility, along with alternative strategies such as cooperative education, aids in providing real world job experiences

Faculty Retraining

The resistant attitudes toward computer graphics are as prominent in college faculties as they are in industry, and are as difficult to modify. Through a faculty development program, the faculty can learn about new technologies and may even change their resistant attitudes through such strategies as workshops that are conducted for industry, or through cooperative employment in industry. Such a program emphasizes a continuous update of occupational skills through industry articulation and improvement of teaching techniques.

Partnership of College, Student (Worker), and Industry

The development of a technical college/industry partnership is important for communicating opportunities for self-improvement to each employee. When the firm, working cooperatively with the college, establishes an opportunity for assessment of each employee's individual skills and goals, growth toward new jobs becomes available to all, thereby reducing the prospect of becoming a displaced worker. The relation ship among the technical college, the employer, and the worker helps promote the attainment of new skills and the adjustment of career goals to meet technological and personal needs on the job. These relevant skills required on the job are now considered as part of the regular curriculum because of improved communication within this partnership. Additionally, cooperative employment for students and teachers feeds relevant experiences back into full-time programs.

Implementation at MATC

The emphasis at MATC has been first, to develop basic engineering skills, and second, to provide skills in applying computer graphics to solve typical engineering/design problems. The challenge has been to determine exactly how computer graphics skills can be integrated into an already-filled curriculum. Each course and objective must be analyzed to integrate these new concepts and experiences in the two-year program. MATC, with the help of an advisory committee, has identified eleven occupational programs, ranging from engineering to graphic arts, business, and health areas, that require computer graphics skills.

The first priority is the Mechanical Design Technician Program, where computer graphics objectives have been integrated into at least six courses. In addition, two new computer graphics courses have been developed -- an introductory course to provide computer graphics operational skills and an advanced course to make applications of mechanical design problems, including 3-D and descriptive geometry. The introductory course is also open to students in Electrical Technology, Civil Technology, Numerical Control, Commercial Art, Printing, Architectural Technology, and other areas.

The next effort will be to develop an advanced computer graphics course for the Electrical Technology Program to include printed circuit and electrical schematics; the Civil Technology Program to include structural detailing and additional courses in mapping and city planning; and the Numerical Control program with an applications course.

The introductory course began after a six-week NSF (National Science Foundation) Project initiated to develop the curriculum and learn to operate a computer graphics system. The system was installed in June of 1980, and the first course began in August of the same year. It was offered in four introductory sections and one technical high school section, for a total of 65 students (20 full-time, 34 continuing education, and 11 high school). The developing faculty included a local CAD (Computer Aided Design) manager with previous computer graphics teaching experience in the Brigham Young University program. Also, during the fall, a one-day seminar was held and attended by 174 participants representing 60 industries and 9 colleges, with approximately 25 percent having computer graphics installations. This seminar divided into the project priority areas of mechnical, electrical, civil, and numerical control. Each of the four applications area groups discussed a user survey completed by participants at pre-registration, applications as presented by industry users, and modifications needed to teach computer graphics applications in the individual programs.

In the second semester, two advanced sections of computer graphics are being offered in the Mechanical Design Program, six introductory sections, and one technical high school section, for a total of 140 students. This includes 40 full-time students, 10 high school students, and 90 continuing education students with backgrounds ranging from draftspersons to chief engineers of user and prospective user companies. Additional advanced application courses in civil, electrical and numerical control will be offered in the summer and continued in the fall.

The success of this program is attributed to faculty retraining; curriculum development, funded by NSF-CAUSE Project; a "real work" environment in the college; and the partnership with local industry, high school, and universities.

The system includes four computer graphics storage tube design stations, digitizer/plotter minicomputer, and associated software, partially funded by Computervision Corporation and the National Science Foundation. The software provided in this project allows emphasis to be placed on teaching rather than writing programs; as a result, the Computer Graphics Coordinator is chiefly involved in developing workshops and courses for faculty and industry rather than programming. Hardware maintenance is provided under a maintenance contract, and a software specialist will be added in the second year of the project.

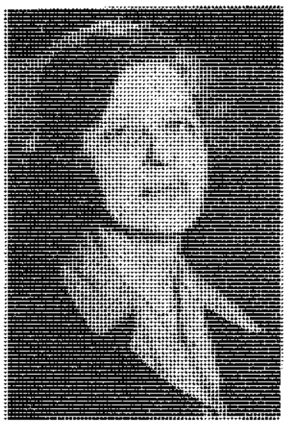
The National Computer Graphics Association (NCGA) established its Wisconsin State Chapter Headquarters at MATC, which enhances industry/college communication.

Chapter plans include seminars and workshops in the application areas; a forum for users, vendors, managers, and educators; a resource center for application information; and a newsletter to keep communication flowing. The Productivity Information Center of the Department of Commerce has provided resource materials to serve as an extended service of the Washington, D.C. center.

A 14-minute MATC audiovisual program, "Partners in Progress", promotes the plan for continuous career development through partnerships. This slide-tape program describes computer graphics applications and the role of each partner. The active relationship established with industry has already resulted in substantial donations and joint efforts of industry persons and regular college faculty in teaching courses and seminars, thereby providing students with a relevant, needed curriculum. The relationship with local universities has provided graduate students to help run the lab during evening and Saturday hours. Also, the graduate students have opportunities to conduct research that is mutually beneficial. This university/technical college/industry articulation assists in communicating preparation requirements for various technical career levels of workers, technicians, engineers, and managers. Success at a college is usually evident in the student response, and in the first year of this project, over 200 students were registered in computer graphics courses, while in January a waiting list for courses to be offered next year included names of over 100 students.

(This material is based upon work supported by the National Science Foundation under Grant Number SER8005315).

COMPUTER-GENERATED GRAPHICS TESTS



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ABSTRACT

A system of computer-administered graphics testing in engineering was implemented at Triton College three years ago. This paper discusses reasons for utilizing computer-administered testing, including its effectiveness as a component of self-paced instruction and cost. In addition, methods employed in programming, file generation and manipulation are discussed. The implementation of this program for multiple section/instructor courses is also discussed. Finally, results of a student evaluation instrument are presented.

INTRODUCTION

Several studies on learning and retention indicate that students learn at different rates and students learn best when their individual rates are accomodated[1, 2, 3]. Therefore, graphics at Triton College is taught in a semi-self-paced format in which students may proceed at their own pace as long as they maintain minimum rates of progress
maintain minimum rates of progress[4]. Since testing is used as the method for determining proficiency, a large test data bank containing similar problems of comparable difficulty had to be generated. The tests had to be readily available yet secure from unsupervised student access. The cost of testing had to be minimal. Given these requirements, computer-generated tests were the most feasible solution.

At Triton, part-time instructors are hired to teach a number of engineering courses. In fact, seventy percent of graphics courses are taught by part-time instructors. The use of a common test problem data bank helps to promote uniform competency levels between sections.

METHOD

In order to teach graphics as a self-paced course, the course is subdivided into modules. The graphics modules are:

1. Points and Lines in Space
2. Lines and Planes in Space
3. Isometric, Orthographic, Cabinet and Cavalier Drawings, Sections
4. Dimensioning, Tolerancing and Graphs

Each student, upon completing a module, has to take a test to determine proficiency of the material. One possible grading/re-testing procedure used is shown in Figure (1).

Because the course is taught in a modified self-paced manner, testing for each module must be completed within a set time period. During this time, students may take tests at any time that the computer is up and proctors are available in an independent learning laboratory on campus (approximately seventy hours per week).

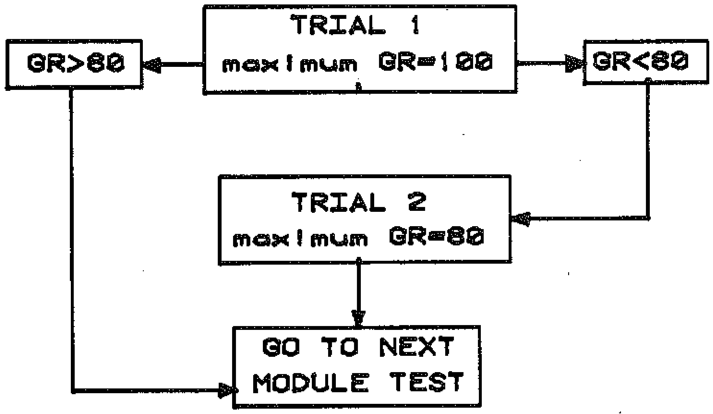

FIGURE (1) - GRADING AND RE-TESTING PROCEDURE

Module tests contain four problems per test. The content of each module is classified into four general categories or types for the purposes of consistent test generation. For instance, for test 3, the following types of problems exist:

1. Given isometric, draw orthographic.
2. Given orthographic, draw isometric.
3. Given orthographic, draw cabinet/cavalier.
4. Draw required section.

Each student's test includes one problem of each type. Thus, a student is insured that the content of his or her module test will be comparable to tests taken by other students. For each type of problem, at least thirty variations testing the concept are included in the problem data bank. Furthermore, an attempt has been made to make problems somewhat consistent in level of difficulty. (A consultant was hired to delete and alter problems that were outstandingly easy or hard.) Test problems are selected randomly from this file of problems.

PROCEDURE

The programming system uses the following files:

1. Student Management
2. Problem
3. Answer

These files are manipulated by the following programs:

1. Initialization
2. Testing
3. Answer

Two types of interactions with the computer take place; those by instructors and those by students. At the beginning of each semester, faculty members use the initialization origran ti ebter akk stydent management file. At this time, each faculty member also has the option of choosing to alter the number of retests permitted per test. At any time during the semester, faculty may access the answer program/file to obtain answers to the most recent test taken by any student for any module. Student progress may be monitored at any time, since up-to-date records are kept of all test-taking activities.

Students use only the testing program. This program manipulates the student and problem files and prints out a test if all internal and external criteria are met. The sequence of events which occurs when the student interacts with the computer are shown in Figure (2).

(A) STUDENT IDENTIFICATION

(B) TEST NUMBER

(C) INFORMATION FOR STUDENT FILE

(D) PROBLEM NUMBERS

(E) LOCATING AND STORING PROBLEMS

(F) PRINTING

(G) DIAGRAMS

FIGURE (2) - PROGRAMMING SEQUENCE

(A) Students first enter their identification numbers. These numbers identify the course, section and student. The computer, according to the program, chooses the correct student file and searches for the student information. If there is no match for that student number in the file, the computer prints an error message. The student is then given another chance (up to three) to enter the correct number.

(B) If the computer matches the identification number in its file, the student is asked to enter the module (test) number for the desired test. The computer checks for validity, and if it finds the number to be invalid, an error message is written: The student is again given up to three more chances to enter a valid number. This number is used to select the correct problem file.

(C) Once the student enters a valid number, the program requires the computer to read information for the selected module from the student file. This information includes the number of times a test for the module has been attempted, the permitted number of re-tests and the problems that were assigned for previous attempts.

(D) Next, the computer chooses random numbers (within the bounds of the number of problems of each type) and checks these against the problem numbers previously assigned. If the numbers match, it chooses a new random number. In this way, no student gets the same problem on more than one test.

(E) The program then calls for the problems to be found in the problem file and written into a temporary file. When problems of every type have been found, the information on the number of attempts and problems assigned is stored in the student file and the file is closed.

(F) The problems are then printed on the terminal and the program is finished.

(G) Students get diagrams if needed from a monitor. Test problems relating to descriptive geometry are digitized, or verbally described, hence, no diagrams are needed. For the drafting exams, diagrams are needed. Triton College owns Tektronix equipment, which can be interactive with the main frame computer. Thus, the diagrams could be computer generated. Since the cost for this is prohibitive, the diagrams are identified by number in the test printout. A proctor matches the number to a drawing, hands it to the student and collects and refiles them after completion of a test. A flow diagram of the testing procedure is shown in Figure (3).

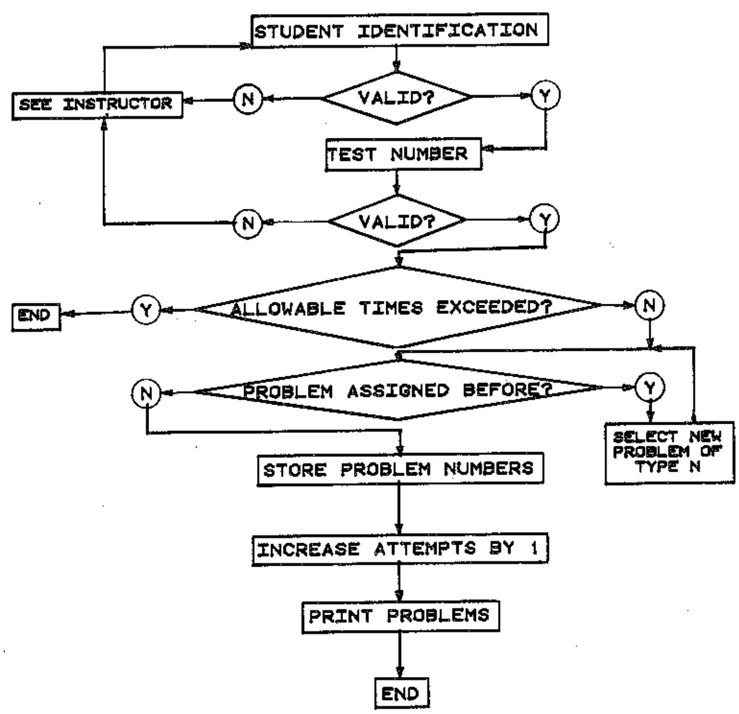

FIGURE (3) - FLOW CHART

In order to rapidly access tests and types within tests in the problem file a set of 3 keys were devised. These are shown in Figure (4).

RECORD NUMBER	LINE NUMBER	TEXT
1	100	#050000200498008650122701812
2	200	#0490309030
3	300	#0004008401810911
4	400	#01.01.01.02

FIGURE (4) - KEY SYSTEM

The records yield the following information:

Record 1

Column 1	#
Column 2-3	Number of tests
Column 4-8	Record number where test 1 begins
Column 9-13	Record number where test 2 begins
Column 14-18	Record number where test 3 begins
Column 19-23	Record number where test 4 begins
Column 24-28	Record number where test final begins

Record 2

Column 1	#
Column 2-3	Number of types of test 1
Column 4-5	Number of problems of type 1
Column 6-7	Number of problems of type 2
Column 8-9	Number of problems of type 3
Column 10-11	Number of problems of type 4

Record 3

Column 1	#
Column 2-5	Record where type 1 begins
Column 6-9	Record where type 2 begins
Column 10-13	Record where type 3 begins
Column 14-17	Record where type 4 begins

Record 4

Column 1	#
Column 2-3	Test number
Column 5-6	Type number
Column 8-9	Problem number
Column 11-12	Number of lines in problem

ITEM: I LIKED TAKING TESTS ON THE COMPUTER

COURSE	STRONGLY DISAGREE	NOT AGREE	NEUTRAL	AGREE	STRONGLY AGREE
STATICS/ DYNAMICS	9%	4%	23%	23%	41%
GRAPHICS	0%	18%	9%	55%	18%

FIGURE (5) - STUDENT EVALUATION

RESULTS

Computer generated testing was initially implemented in one pilot section. Students received instructions for getting on the computer, and testing proceeded. Terminals were installed in an independent learning laboratory where clerks are on duty seventy hours per week. Students accessed the computer, received printouts and proceeded to testing stations where they received diagrams, if needed. They had fify minutes to take the test under supervised conditions. The time recorded on the printout had to coincide with test check-in time to prevent cheating. All printouts were turned in to prevent security problems. Since each attempt to take a test by every student was recorded by the computer, students could not abscond with tests without being quickly apprehended.

The pilot trial raised a number of problems particularly concerning clarity of problem statement and diagrams and typographical errors. After major corrections were made, the second phase of implementation was initiated. Two new instructors participated in the program. It rapidly became evident that a training session was not sufficient to orient new faculty to the system. As a result, a reference manual was written for instructors. The manual includes:

1. Codes for faculty access.
2. Tasks to be performed at the beginning of the semester by faculty to initialize all files and move programs to student user codes.
3. Listing of all programs, fully documented.
4. Methods used for making changes such as addition or deletion of problems or correction of problems.

The manual was written assuming that the reader knew FORTRAN but was not aware of editing procedures on the Triton system (Burroughs 6803). FORTRAN was chosen as the language, even though at times it was cumbersome, because most engineers (part-time instructors at Triton) knew the language.

DISCUSSION

The evaluation of the courses was formal and informal. The informal portion consisted of student input in the form of complaints about test problems. Alterations were made in response to valid complaints. A formal questionnaire consisting of eighty questions was administered to each student at the end of the semester. When questioned on whether or no they liked the computer testing, the results shown in Figure (5) occurred.

The costs of running the testing on the computer have been much less than non-computer-based, self-paced tests. The student-per-semester cost was $.64 for graphics. Two new terminals were purchased at the initiation of testing. However, since the computer time each student uses per semester is much less than one hour, both terminals were used primarily for other functions. Paper costs are identical to costs for printed tests. No new proctors/clerks have been hired as a result of the computer testing. When costs of typing and reproducing traditional tests are included, computer testing becomes more cost-effective than the traditional testing techniques.

CONCLUSIONS

The present system of computer testing is being improved both in terms of efficiency and educational effectiveness. Problems are being replaced, corrected and edited. New problems are being added whenever instructors find appropriate problems. If an instructor wishes to test an entire class (midterm or final), a multiple copy procedure has been incorporated in the system.

A file maintenance program is being written to make additions, deletions or changes to problems easier. The instruc- will no longer be required to learn a command and edit language in order to complete these tasks. The new file maintenance program will only require responses to simple questions written in English. Every effort is being made to generate a system of programs that is transportable to other schools and other computer systems.

The author wishes to express her gratitude to the National science Foundation for partly funding the work presented in this paper under an NSF/CAUSE grant. Programs were developed by Allyn Barnett while he was a student at Triton and IIT.

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USC '81

GEOMETRIC DIMENSIONING AND TOLERANCING FOR ENGINEERING DRAWINGS PER AMERICAN NATIONAL STANDARD (ANSI) Y14.5

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From a government contract report --- "The contractor is entitled to apply is interpretation of the meaning of the specifications and drawings furnished him by the government in the invitation to bid and contract which were prepared by the government, despite the fact that the government's interpretation of the drawings and specifications was equally reasonable with that of the contractor. The drawings and specifications were not in direct conflict, but were susceptible of the two reasonable constructions. The rule in such cases is that the interpretation of the party which did not prepare the documents will be considered controlling, since the other party has the opportunity of making any necessary clarification."*

It is essential that all engineering drawings be unambiguous. Dimensioning and Tolerancing ANSI Y14.5 is a system whose principles aid in the single interpretation of drawings. Within its definitions, this document also permits for the allowance of maximum tolerance, the ability to expose the actual relationship of features within a given part, as well as completeness, clarity and uniformity.

This method of dimensioning and tolerancing is not new. The first ANSI publication was in 1966 -- published by the American Society of Mechanical Engineers with the Department of Defence acceptance. An understanding of the concepts of geometric dimensioning and tolerancing is becoming increasingly necessary to anyone associated with today's engineering drawings. Without this knowledge, it would be very unlikely that a user could interpret correctly a mechanical drawing that was drawn under the intricacies of ANSI Y14.5.

*Ed Geiger Construction Co., Inc. (1959) ASBCA No. 5001, 59-1 BCA, paragraph 2078

In the traditional Coordinate Tolerancing System many drawings were not completely defined, and were consequently, ambiguous in nature. With no accepted standard interpretation, and without legal foundation, "good workmanship practices" has become its defense. "Good workmanship practices" are left to opinion; consequently, the acceptance and necessity of a national standard. Y14.5 does not replace the archaic plus and minus system ,only supplements it.

The following are examples of basic dimensioning and tolerancing problems and clarification of requirements with the application of the principles within Y14.5.

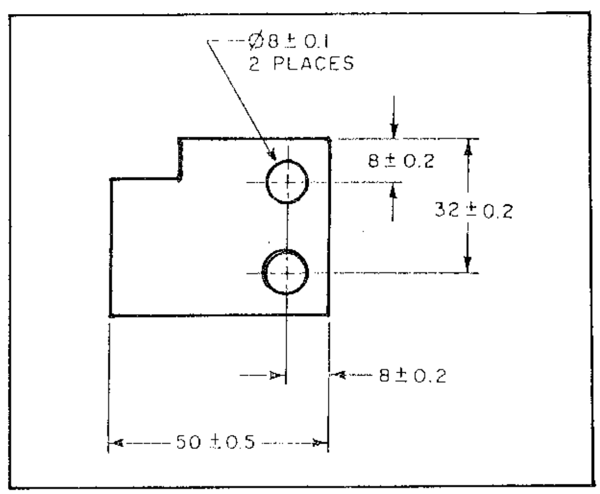


FIGURE 1. COORDINATE DIMENSIONS AND TOLERANCES

Inherent within a pure rectangular coordinate toleranced drawing (Figure 1) is a question of verification. How does one physically inspect the actual position of the two 8 diameter holes on the fabricated part with respect to the outer edges from which they are located? A variety of origins for measurements is possible, and in fact permissible, because the origin is undefined and left to interpretation (Figure 2). The fundamental misbelief is that there is an unwritten requirement that in this case, the vertical edge in question is perfectly square to the horizontal edge. There is no interrelationship of features unless so specified. With no form requirements in effect, it is governed only by its tolerance of size. The principles of datum referencing confront this very issue by relating features (in this case, the 8 diameter holes) of a part to appropriate datums. A set of three mutually perpendicular planes (Figure 3), called the datum reference frame, permits the positioning of the actual part in a single, repeatable manner. Figure 4 is a geometrically dimensioned and toleranced alternate of Figure 1.

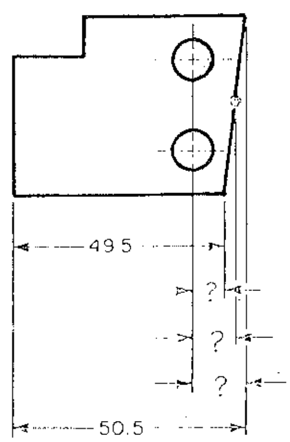


FIGURE 2. HOW ARE HOLES VERIFIED?

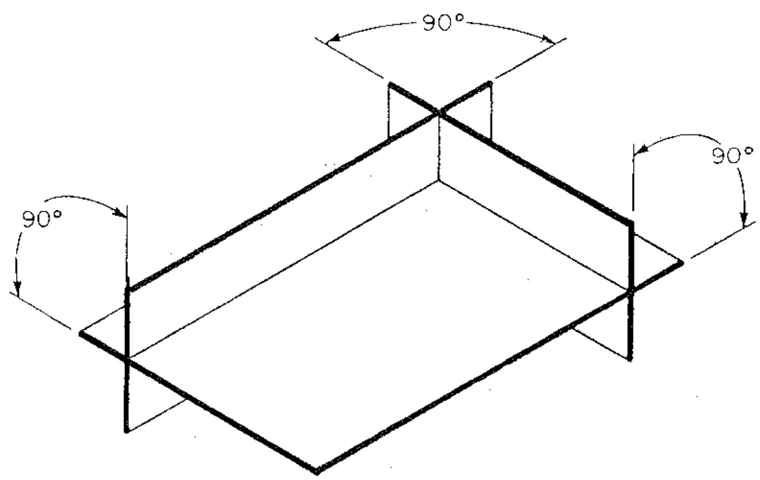


FIGURE 3. DATUM REFERENCE FRAME (3 MUTUALLY PERPENDICULAR PLANES)

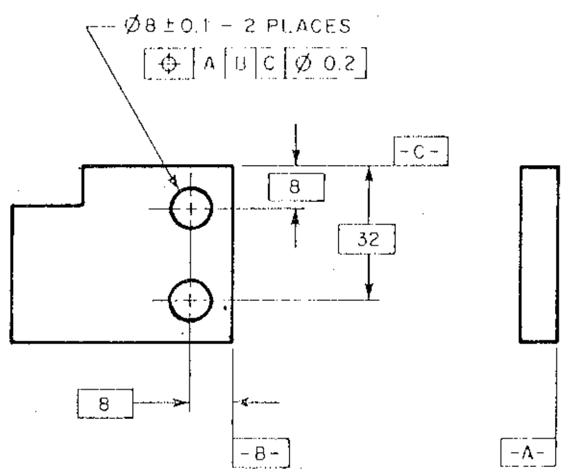


FIGURE 4. GEOMETRIC DIMENSIONING AND TOLERANCE EQUIVALENT OF FIGURE 1.

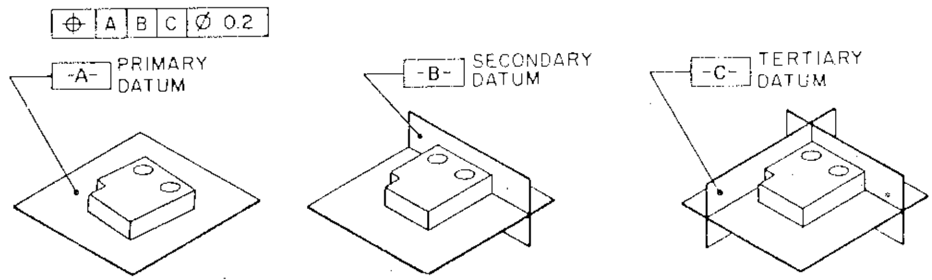


FIGURE 5. POSITIONING THE PART UPON A DATUM REFERENCE FRAME

The sequence datums as assigned in the feature control block will determine the procedure in which a given aprt is positioned upon the datum reference frame (Figure 5). When the actual part is located upon the datum reference frame, all measurements are then taken from these three mutually perpendicular planes. These datum planes exist in the selected inspection equipment. The probability of correct and repeatable measurements is insured.

A given feature, such as a hole, requires as a minimum, a size and location definition. The Coordinate Tolerancing System can perform this task, but only by treating them as separate entities. In some instances, it may be desired that an interrelationship of size and location be reflected. This interrelationship is practiced in our everyday lives. Y14.5 only refined and documented this concept.

As a practical example, you are going to mount a plaque on two 1/2" dowels, 12" apart, which are protruding from a wall (Figure 6). With a 1/2" diameter bit, you drill 2 holes 12" apart through your plaque. If the plaque cannot be assembled over the dowels, what would your assembly solution be? A common and logical fix would be to redrill the holes with a larger bit. Now the plate is assembled and the task is successfully completed. In a simple analysis of the procedure described, we find that an interrelationship between size and location was performed. The problem in the first attempt at assembly was that the holes were out of location, yet the fix was to attack the size (Figure 7). Within the Coordinate Tolerancing System, this marriage between size and location is very difficult to define. This relationship is documented within the usage of the "maximum material condition" (MMC) concept of Y14.5.

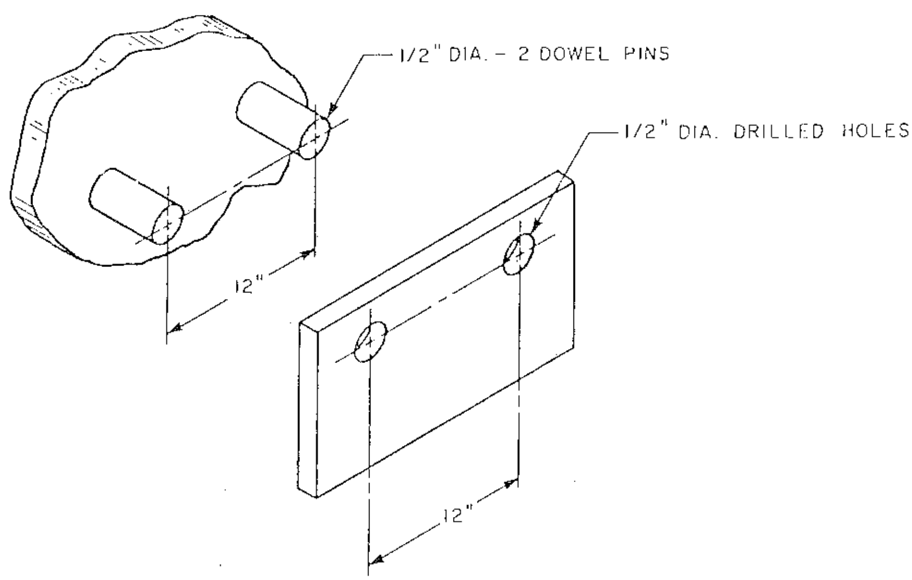


FIGURE 6.

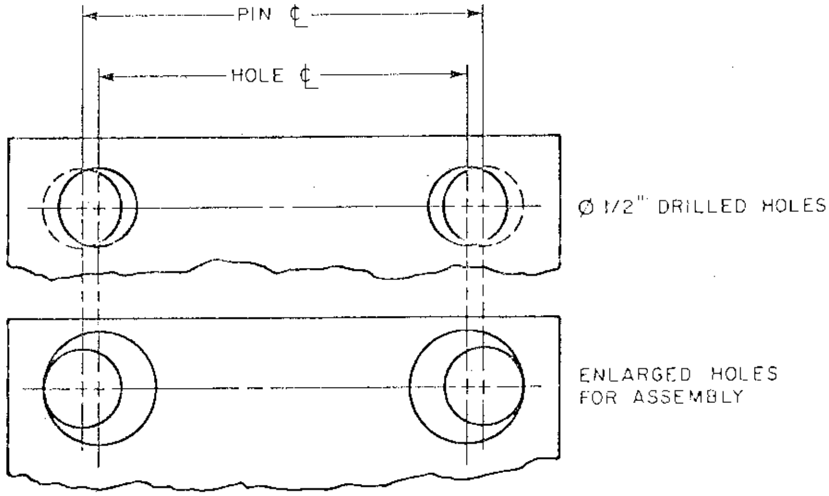
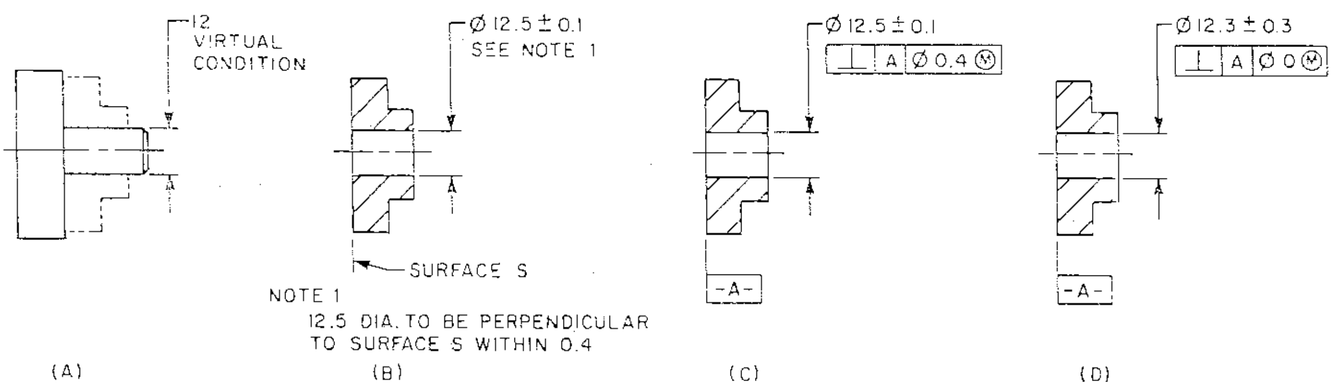


FIGURE 7.

With this minimum explanation of datum and maximum material condition, let us confront an archaic concept that application of tolerances must be "worse case", with "worse case" defined as the parts must always assemble regardless of where the actual features are within the full spectrum of their defined tolerances. If inspection is based solely on the acceptance of "good" parts, then further discussion is not necessary. But if there is rejection of "good" parts due only to a limited dimensioning and tolerancing vocabulary, then further discussion is not only necessary but mandatory. As a means of explanation, another design premise is offered.



COORDINATE TOL.	
⊥ ALLOWED	ACTUAL HOLE SIZE
—	—
—	—
—	—
—	—
0.4	12.4
0.4	12.5
0.4	12.6

MMC	
⊥ ALLOWED	ACTUAL HOLE SIZE
—	—
—	—
—	—
—	—
0.4	12.4
0.5	12.5
0.6	12.6

ZERO TOL. AT MMC	
⊥ ALLOWED	ACTUAL HOLE SIZE
0	12
0.1	12.1
0.2	12.2
0.3	12.3
0.4	12.4
0.5	12.5
0.6	12.6

FIGURE 8.

You are designing a flange whose primary requirement is that it seats against the mating part shoulder (Figure 8a) and be as snug fitting around the shaft as possible, as a secondary requirement.

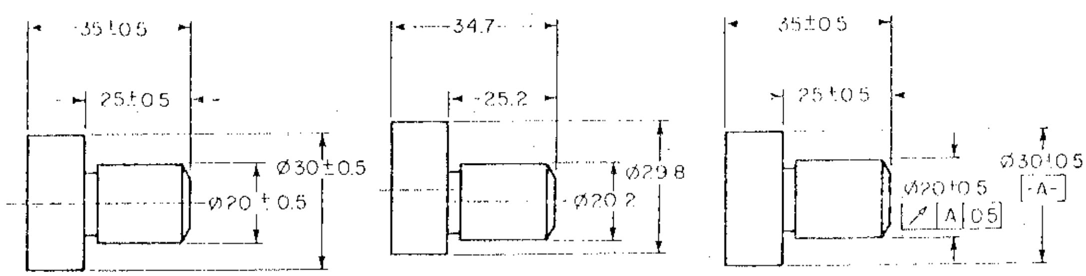
Under the "old"system, dimensioning options are limited (Figure 8b). Now using the same degree of tolerancing in conjunction with the MMC concept, we have this marriage of size and form (in this case, perpendicularity). The definition of maximum material condition is that the perpendicularity tolerance only applies when the feature (12.5 hole) is a maximum material condition (MMC of 12.5 ± 0.1 is 12.4 - hole contains the maximum material within the specified tolerance).

If the actual hole size deviated from MMC (within the allowable size tolerance), add the amount of this deviation directly to the applicable form tolerance (Figure 8c). If the actual hole is 12.4, then 0.4 is the allowable perpendicularity tolerance, but if the hole is 12.6 (still an acceptable size), the deviation from MMC of 0.2 is added to the 0.4 perpendicularity tolerance. An examination of this condition will reveal that it will still assemble and maintain design integrity. The difference lies in the larger permissible perpendicularity tolerance. To further expand this concept, let us introduce "zero tolerance at MMC".

This extension is based on a total relationship between size and form. Again, using the same tolerance limits, size = ± 0.1 = 0.2, total and form (perpendicularity) 0.4, and applying them totally (0.2 + 0.4 = 0.6) to the size (Figure 8d). With this dimensioning scheme, the same interchange of size and form as "MMC" defines, exists. Thus, if the actual hole size were 12, there is a zero perpendicular tolerance, but if this hole size deviates from MMC, the amount of deviation may be applied to form. With this example let us review . . . returning to the design requirements, primary = surface of flange to set on shoulder, secondary = hole as snug as possible around shaft.

Now examining the allowed tolerance excursions of both size and form, we will discover that under the "old" system of restricted vocabulary, the perfect part or near perfect part, as defined by our design requirements, must be rejected. In other words, we know what we want, but are unable to define it under the restrictive Coordinate Tolerancing System.

There is another fundamental drawing question. What do centerlines control when shown on a mechanical drawing? Figure 9a is a stepped shaft with size dimensions and tolerances. Is there a relationship between the 20 and 30 diameters? Fibure 9b is an actual part fabricated to satisfy the drawing requirements of tolerances, thus it passes inspection. But this part appears to have an eccentricity between the 20 and 30 diameters. Because there is no specified drawing requirement for their interrelationship, this visually inspected misalignment cannot be grounds for rejection. To assume that some control is specified because of a drawn imaginary centerline, is without legal foundation. A definition of centerline is "centerlines are used to define cylindrical shapes". Diameters drawn about a common centerline cannot be interpreted as a degree of interrelationship.



(A) REQUIREMENTS PER DRAWING

(B) ACTUAL PART

(C) RUNOUT REQUIREMENT CONTROLS THE INTERRELATIONSHIP OF THESE TWO DIAMETERS

FIGURE 9.

As a solution, eliminating time consuming text writing and its inherent danger of multiple interpretation, Y14.5's geometric characteristic symbol "runout" may be used as shown in Figure 9c. Runout tolerance is used to control such relatiohships. The location of the Ø 20 with respect to the Ø 30 is essentially a surface inspection and the recognition of the Ø 20 centerline is indirect at best.

There has been a flagrant misuse of the concept of concentricity. A definition of concentricity is, "having a common center". There may be instances where centers are of prime importance, but it must be understood that its verification is time consuming and expensive. Although runout is a more stringent requirement, it would be much more economical to consider its use as a replacement for concentricity.

USC '81

COMPUTER GRAPHICS AS AN AID IN BEGINNING DESIGN PROJECTS

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INTRODUCTION

The history of computer graphics at Texas A&M goes back to 1971 although it wasn't until 1978 that an ongoing program was developed in the Engineering Design Graphics Department, where the beginning engineering design classes are taught. At that time Dr. John Demel, Dr. Robert Wilke and others set up the first in-house computer graphics system on a Techtronics 4013 terminal using a system called Wylbur tied to the campus's Amdahl main-frame computer. Demel (now of Ohio State) and Wilke also developed a software package called "Creator" as a part of their work in developing the department's first Computer Graphics Course, EDG 408, "Computer Design Graphics". The "Creator" program and EDG 408 course development have been described in several articles published in the E.D.G. Journal.

Subsequent to EDG 408, a junior/senior level course, additional developments were begun in 1979/80 to incorporate Computer Graphics into the freshman level courses so that students would be better able to meet the needs of industry. Two pilot courses were taught in summer school 79 & 80, using the system developed for EDG 408. This report covers those tests, their results, and outlines our next steps in this development process.

SCOPE

The Engineering Design Graphics Department at A&M has the primary function of teaching two beginning graphics courses to all freshman engineering students. The first course, EDG 105, is Engineering Graphics and the second, EDG 106, is Engineering Descriptive Geometry. This year we had over 2,700 students in both courses with next year being projected for ovwr 3,000. The ultimate goal of teaching computer graphics and computer aided design to <u>all</u> engineering freshmen is to say the least, "challenging".

SYSTEM

Each student station is the same as used for the upper division 408 course. Our basic terminal is a Lear-Siegler alpha numeric CRT with an added Digital Engineering graphics board. A North Star Horizon microcomputer with dual floppy disk drives, a digitizer board & plotter by Houston Instrument and a Heath printer complete the system. We now have 3 student stations with 5 being projected in the Fall, 1981.

Various software programs form the CREATOR package and others developed from the 408 courses were used in the freshman pilot studies. Examples of some available programs are TEXT, BARGRAPH, PIEGRAPH, SKETCH 2D, PLOT 2D and PLOT 3D.

DESIGN SEQUENCE

The design project is an integral part of each of the two beginning graphics courses. In EDG 105, the design project takes up about one-sixth of the total course. The students, working in groups of 6 to 8, go through the design process from problem identification to the selection of one single best idea, but not including working drawings.

The EDG 106 class goes through a similar process but carries the design through a set of working drawings, and a group oral presentation. Visiting outside engineers come in twice during the semester for student consultation and critique. In 106 the project comprises about one-third of the course.

The computer graphics pilot studies were made in EDG 106 classes with the computer & software introduced as a part of the project design process. Each class was divided in two, one-half taught by conventional methods, the other half with the computer. All software was user oriented. The major programs available for the various design steps were:

Problem Identification	:	TEXT, FILES, GRAPHS
Preliminary Ideas	:	TEXT, SKETCH2D, PLOT 3D, 3DINPUT
Refinement	:	PLOT 3D, 3DINPUT, CURFIT KINEMATICS, INTERSECTIONS
Analysis	:	LATHE, MILL, WELD, KINEMATICS, BEAM, CIRCUIT, CAM
Decision	:	TEXT, BREAKEVEN GRAPH, DECISION TABLE
Implementation	:	ASSEMBLY, 3DINPUT,3DPLOT, PLOT 2D

RESULTS

In general the students found that the TEXT program was useful in writing reports and tables. Figure #1 shows a typical page from a student report written with TEXT. The BARGRAPH & PIEGRAPH programs were also widely used. Figures #2 and #3 are examples of graphs students generated for their projects using these programs. The bargraph in Figure #2 was drawn entirely on the plotter but the pie graph in Figure #3 utilized the printer to do the characters in the lower right hand corner while the graph was being plotted on the plotter.

SKETCH 2D was somewhat less used due to its more complex nature, especially in the plotting of characters on the sketches. Many students took a short cut by adding hand lettering to the sketch drawn via the digitizer board. Figure #4 is an example of this. However, a few very conscientious students were able to get the computer to do both the lettering and the drawing. Figure #5 is an example of a completely computer drawn sketch.

PLOT 2D and PLOT 3D were used to make scale drawings. Data files stored data points and the respective drawings were taken from there. Figure #6 shows an example of a student's scale drawing. In this example, the computer plotted the orthographic views, the isometric insert and the dimension lines. Only the letters (characters) were added by hand. Due to the apparent complexity of these programs, only about one-half of the student design teams used PLOT 2D and PLOT 3D.

Only two of the twenty teams attempted to do an entire set of working drawings with none of the groups actually getting them completed. This minimal success was due to both software and hardware problems. The plotters were particularly prone to breakdowns. About this time we also realized that we had greatly underestimated the need for maintenance on our systems. Actual annual cost of repairs approached ten percent of the initial cost. Downtime hampered the students productivity and enthusiasm.

CONCLUSIONS

Although the students were generally enthused about using the computer, there were numerous rough spots. There were scheduling problems in getting students on the machines. Hardware downtime was also a problem. It was also felt that not enough "rubbed off" on the students. In the pinch of time students would opt to do a drawing or lettering "by hand" rather than to try to "dig" out of the user's guide how to do the job by computer.

Figure 1.

```
BBB
B  B
B  B
BBB
B  B
B  BTTTT
BBB  T
     T
     T
     T
     T
     T
```

DESIGN EVALUATION

DESIGN 1: PINNED CHOCK
DESIGN 2: HALF ROUND CHOCK
DESIGN 3: LOCK CHOCK

MAXIMUM VALUES	ANALYSIS FACTORS	DESIGNS 1	DESIGNS 2	DESIGNS 3
4	FUNCTION	2.5	3	3
1	HUMAN FACTORS	0.3	0.8	0.5
1	MARKET ANALYSIS	0.4	0.8	0.5
1.5	STRENGTH	1.4	1	1.2
1	PRODUCTION	0.7	0.7	0.5
	PROCEDURES	0.7	0.7	0.5
3	COST	2	2.3	2.2
2	PROFITABILITY	0.8	1.3	1
0.5	APPEARANCE	0.2	0.4	0.3
1	EASE OF STORAGE	0.8	0.9	0.8
1.5	SAFETY	0.7	1.1	0.8
2	UNIQUE	1.3	1.4	2
18.5	TOTALS	11.1	13.7	12.7

CONCLUSION:

THE HALF ROUND CHOCK WAS SELECTED DUE TO IT'S OVERALL EFFICIENCY AND INEXPENSIVE DESIGN. IT PROVIDES A SAFER, MORE VERSATILE TOOL FOR THE CONSUMER. THE HALF ROUND CHOCK ALSO HAS FEWER MOVING PARTS THAN THE LOCKED CHOCK AND CAN BE OPERATED MUCH EASIER THAN EITHER THE PINNED OR LOCKED CHOCKS. BY USING THE ATTACHED ROPE THE CHOCK CAN BE MOVED WITHOUT REQUIRING THE OPERATOR TO REACH BENEATH THE TRUCK. IF SUCCESSFUL, THE HALF ROUND CHOCK HAS THE CAPABILITY OF BEING ADAPTED FOR AIRCRAFT AND OTHER WHEELED OBJECTS.

Figure 2.

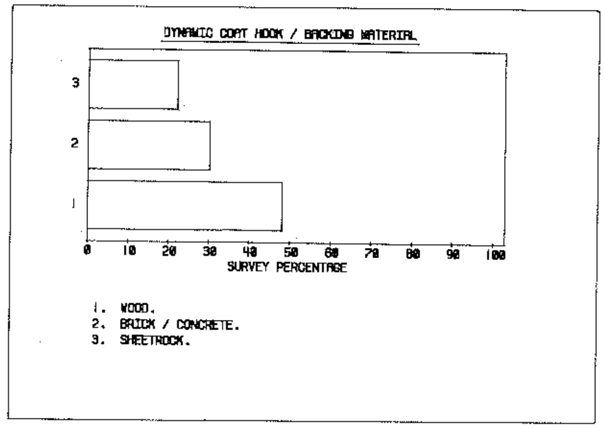


Figure 3.

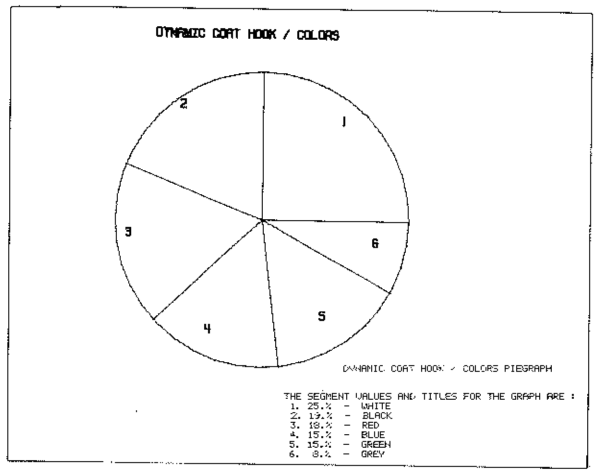


Figure 4.

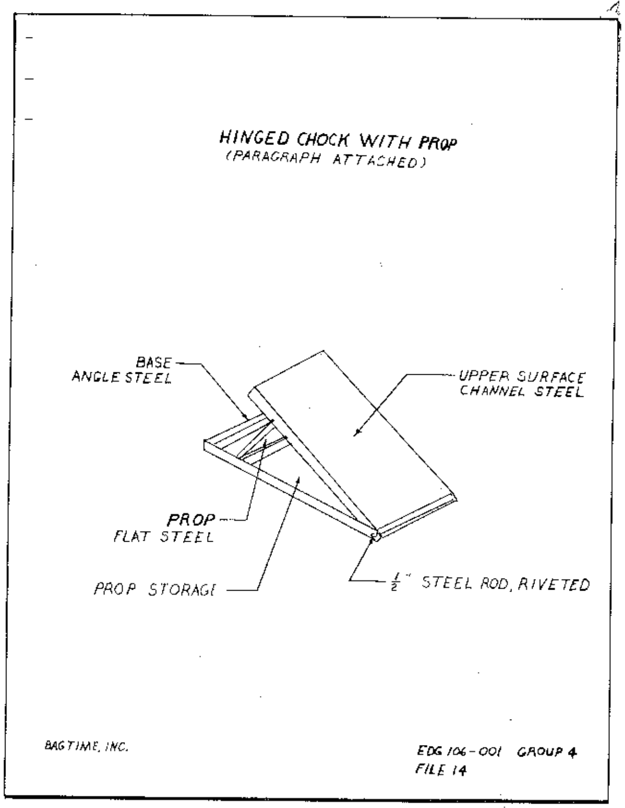
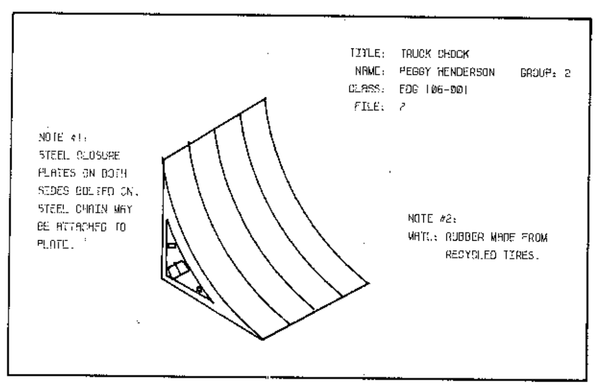


Figure 5.



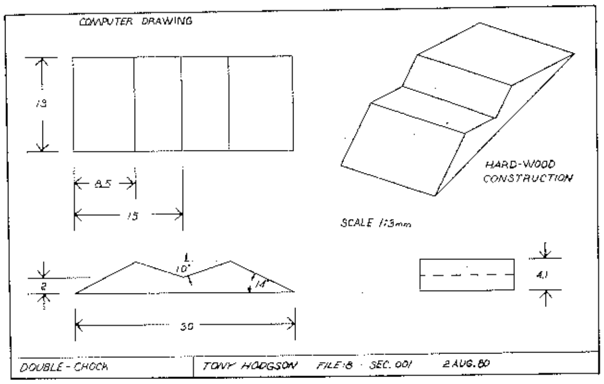


Figure 6.

We concluded that it would probably be better to introduce computer graphics even earlier to the students; to introduce it in their first semester of drawing.

RECOMMENDATIONS

We are now at that point. In Fall, '81, the computer graphics principles will be introduced in one of our EDG 105 classes, with a pilot program in a second summer session 105 class this summer. Ms. Retha Groom is heading up this study as a part of her graduate research. The class will be divided into two groups, experimental and control. The use of the computer will not be particularly emphasized for the design process but as a tool in solving any graphics problems. It is anticipated then, that the students should feel more comfortable in utilizing that knowledge when working on their projects.

The methodology would go something like this: Say there were three plates on orthographic projection. The first plate would be an easy one and everyone would work it together to get the idea. The second plate would be a simple application of the principle to drive the concept home and each student would work this plate individually using conventional methods. However, on the third plate (for even greater application), the experimental group would use the computer and the control group would use conventional methods. Plans are to use the following topics for computer application.

1. Bar Graphs
2. Pie Charts
3. Orthographic Drawings
4. Isometric Drawings
5. Oblique Drawings

SUMMARY

An "armchair" summary of our progress in teaching computer graphics to freshmen would be:

1. Students are generally favorable toward computer graphics.
2. The earlier students are introduced to computer graphics the better.
3. Maintenance of the hardware was more of a problem than we expected.
4. The use of computers in graphics does not eliminate the need for teaching fundamentals.
5. There's a lot more for us to learn about effectively teaching computer graphics at freshman levels.

We want to include computer graphics experience early in the student's curriculum to give him as much "hands on" experience as possible in preparation for his professional career. We are spending approximately $10,000 for each station and are a long way from being able to give computer graphics instruction to each of the 3,000 students passing through our department. But we are making headway. We have to because we don't have a choice. The future of our engineers is at stake.

CREATIVE ENGINEERING DESIGN DISPLAY

ASEE ANNUAL CONFERENCE
UNIVERSITY OF SOUTHERN CALIFORNIA
June 1981

The Creative Engineering Design Display, 1981, under the able direction of Robert Foster, (Penn State University), with the help of Jon Jensen (Marquette University), was a great success. An area directly west of the registration area was set aside by conference officials for this purpose. This area was well-visited by most of the conference attendees, and was the traditional meeting place of EDGD members, their friends, and their families.

Although there were not as many entries in the various categories this year, those projects which were entered were of exceptionally high quality -- especially those projects in the freshman category.

Several students were on hand from Northeastern University, as well as those from nearby schools such as Santa Rosa Junior College and Arizona State University. These kids really did all of the legwork for the CEDD Committee, and did not disappear at the end of the conference, but helped Bob and Jon with the packing and crating of entries which were not hand carried.

The Division is grateful to all of those who helped make this CEDD such a success this year. Many thanks go to the industrial contributers for their continued support of this event. On the following pages you will find the winners in each of the categories, as well as a list of the judges who had a very difficult time reaching their decision. Photographs of some of the projects were taken by Margaret Eller, who is always there with her trusty camera, at the right time and just when we need her.

The Editor

WINNER - JAMES S. RISING AWARD

FIRST PRIZE - FRESHMAN DIVISION

Project: Construction Blocks for Preschoolers

School: Marquette University
Faculty Member(s): Jon Jensen
Student Designer(s): John Stillmank, Carol Carfrae, Lauren Healy, Brian Hill, Jeff Westcott, Greg Marsh.

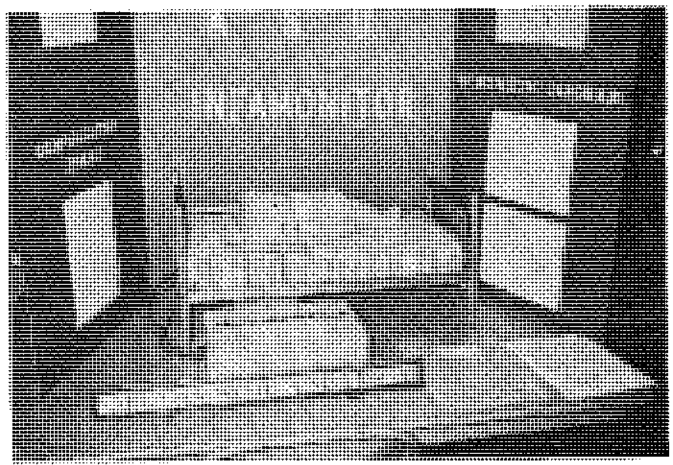
Project in METRIC UNITS only

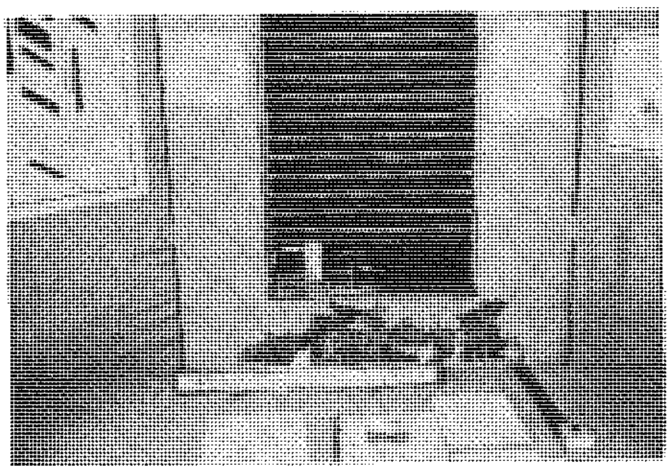
SECOND PRIZE - FRESHMAN DIVISION

Project: SIDSED, INC. - The Infamonitor

School: Arizona State University, College of Engineering & Applied Sciences
Faculty Member(s): Dr. George C. Beakley
Student Designer(s): Daniel K. Hegel, Stephen W. Schneider, Lauren H. Sato, Paul D. Glosniak, Stuart M. Leslie, Timothy A. Streccius.

Project in METRIC UNITS only





THIRD PRIZE - FRESHMAN DIVISION

Project: P.A.W.S. - Power Activated Window Screens

School: Arizona State University, College of Engineering & Applied Sciences
Faculty Member(s): Dr. George C. Beakley
Student Designer(s): James W. Doane, Robert R. Kaye, Jr., D. Robert Lee, Mark D. Ralston, John M. Rayhel, Lawrence T. Wolfson.

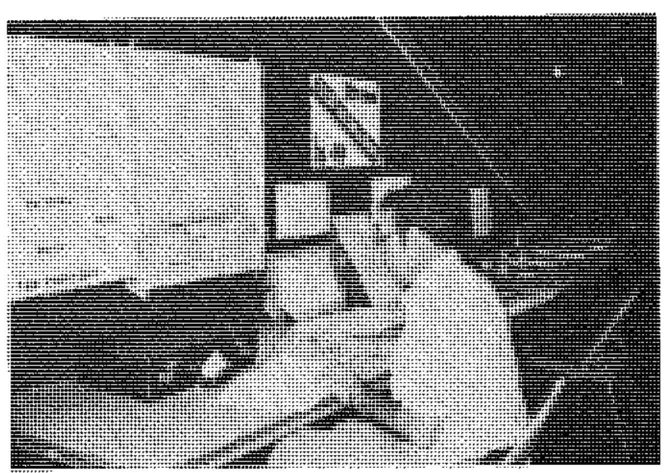
Project in METRIC UNITS only

FIRST PRIZE - SENIOR DIVISION

Project: Sailboat Keel Battery

School: United States Naval Academy
Faculty Member(s): Bruce Rankin, Cdr. Ron Erchul
Student Designer(s): M. V. Gallet, M. A. Carr, M. J. Giancatarino, R. V. Vranicar

Project in METRIC UNITS Partially



FRESHMAN ENTRIES - HONORABLE MENTION

Project: An Ethanol Extruder

School: University of Nebraska - Lincoln
Faculty Member(s): Robert McDougal
Student Designer(s): Donald Gee, Trent Miller, Dan Tushick, Mark Davidson, Dan Smith.

Project in METRIC UNITS partially

Project: Motorcycle Trailer

School: University of Nebraska - Lincoln
Faculty Member(s): Donald Pierce
Student Designer(s): Terry Graham, Eric Lederer, Diane Ogren, Mike Schmidt.

METRIC Information Not Given.

Project: A Screwdriver for the Specialty Advertising Screwdriver

School: Marquette University
Faculty Member(s): Jon Jensen
Student Designer(s): Joseph Lipic, Ray Gagnon, Luis Garcia, Eduardo Fernandez.

Design Applicable to Existing Product in ENGLISH UNITS.

Project: Refute, Inc.-Utilization of Waste Cardboard by E.T. Company

School: Western New England College School of Engineering
Faculty Member(s): Alan K. Karplus
Student Designer(s): Steve Belden, Sven Swanson, Stanford Smith, Kevin Beauchemin.

Project in ENGLISH UNITS.

Project: Refute, Inc.-Utilization of Waste Cardboard by "The Fourth Dimensions"

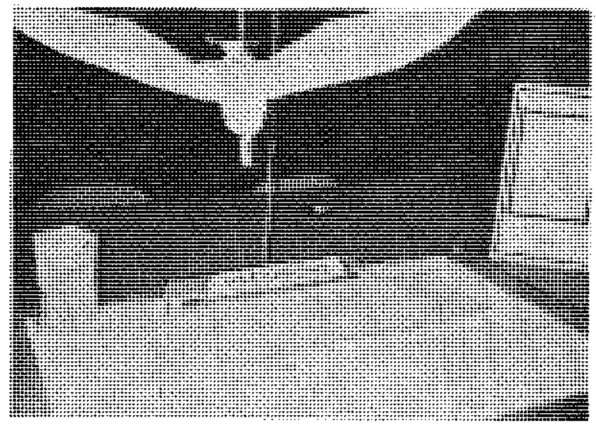
School: Western New England College, School of Engineering
Faculty Member(s): Alan K. Karplus
Student Designer(s): Kathleen Brown, Jahangir Mahallati, Carleton Silver, Timothy Kendrick.

Project in ENGLISH UNITS.

Project: Electronic Recovery System for Model Rockets.

School: Milwaukee School of Engineering
Faculty Member(s): Waldemar Gerassimoff
Student Designer(s): Michael Dolinac

Project in ENGLISH UNITS.



Project: Scarecrow

School: Santa Rosa Junior College
Faculty Member(s): Walter N. Brown
Student Designer(s): Clifford Fischer

Project in Metric Units Partially.

Project: Flood Control Water Retention Basin

School: Villanova University
Faculty Member(s): A. Holeczy
Student Designer(s): Kurt Conti, Mike Stein.

Project in ENGLISH UNITS

Project: Tripod for Paraplegics

School: Northeastern University (Lincoln College)
Faculty Member(s): -----
Student Designer(s): Kenneth A. Nadeau, Peter C. Cranshaw, Stephen A. Morris.

Project in ENGLISH UNITS

Project: Wheelchair Book Transporter

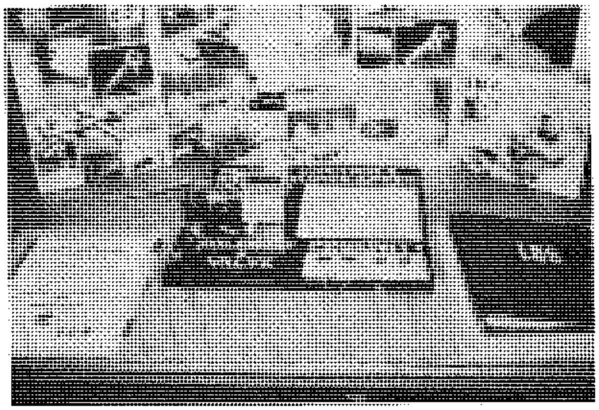
School: Northeastern University (Lincoln College)
Faculty Member(s): -----
Student Designer(s): Frank N. Bassett, Frederick N. Bassett, William Cullity, Jr.

Project in METRIC UNITS Partially

Project: Sit-Up Device

School: University of Wisconsin-Milwaukee
Faculty Member(s): Oved Friedman
Student Designer(s): Jeffrey Behnke, Mary Haubert, Steven Richtes, Norman Rivedal, Michael Schultz.

Project in ENGLISH UNITS.



Project: Faucet Controls for Disabled People

School: University of Wisconsin-Milwaukee
Faculty Member(s): Vjekoslav Pavelic
Student Designer(s): Lisa Carrara, Scott Henke, Ralph Niess, Randall Ploetz.

Project in ENGLISH UNITS.

Project: Improved Rail Fastener

School: Iowa State University
Faculty Member(s): Paul S. De Jong
Student Designer(s): John R. Sutton, Preston McDaniel, Chris Harrison, Todd Bertram, Joseph Schumacher,

METRIC Information not given.

Project: Communication Tower De-Icing System.

School: Iowa State University
Faculty Member(s): Robert J. Bernhard
Student Designer(s): Dean Kolosiek, Scott Leahy, Kevin Shields, Mark Walters.

Project in METRIC UNITS Partially.

Project: Card Shuffler

School: Ecole Polytechnique-University of Montreal, CANADA
Faculty Member(s): Marc Sauvageau
Student Designer(s): Alain Aubuchon, Normand Brais, Luc Lapaerriere, Yvon Orban.

Project in Metric Units Partially

Project: The Design of a Portable Microfiche Reader.

School: Indiana State University Evansville
Faculty Member: Larry D. Goss
Student Designer(s): G. Wayne Hile, Max Emmick, Cathy Cromer, Steve Stallions.

Project in METRIC UNITS only.

SOPHOMORE DIVISION - HONORABLE MENTION

Project: Inexpensive Over-Speed Protection

School: University of Wisconsin-Milwaukee
Faculty Member(s): Steven Salamon
Student Designer(s): Willi Hampel, Thomas Hesselink, James Kajus, Konstautim Prives, Thomas Schaefer.

Project in ENGLISH UNITS.

JUNIOR DIVISION - HONORABLE MENTION

Project: Lake Front Defender

School: University of Wisconsin-Milwaukee
Faculty Member(s): John N. Ong
Student Designer(s); Hathlool Al-Hathlool, Saleh Erayani, Gary Hohnl, Randolph Lepianka, Joseph Marks, Adeeb Rahman.

Project in ENGLISH UNITS.

SENIOR DIVISION - HONORABLE MENTION

Project: Redesign of Rockwell-Goss Metric Horizontal Drive Clutch

School: Marquette University
Faculty Member(s) Robert Weber
Student Designer(s): Peter Bourgeois, Randall Jaudak, Christopher Wieloch.

Design applicable to existing product in ENGLISH UNITS.

Project: Electrical Design Project - "Design Process for Packaging IC Electronic Dice"

School: Milwaukee School of Engineering
Faculty Member(s): Ray W. Palmer
Student Designer(s): Andis Nikurs,

Project in ENGLISH UNITS.

Project: Time Lapse Devices

School: University of Wisconsin-Milwaukee
Faculty Member(s): Steven Salamon
Student Designer(s): James Flanagan, Thomas Karwoski, John Lapinski, Ronald Tump, John Wozniak.

METRIC Information not given.

Project: Document Transport

School: Southern Methodist University
Faculty Member(s): Charles M. Lovas
Student Designer(s): Jerry Drake, Walt Marusak, Rick Ramirez, Bahram Rezaie.

Project in METRIC UNITS Partially.

JUDGES FOR THE 1981 CREATIVE ENGINEERING DESIGN DISPLAY

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ACHIEVING COGNITIVE, AFFECTIVE AND PSYCHOMOTOR EDUCATIONAL OBJECTIVES BY MEANS OF A DESIGN PROJECT

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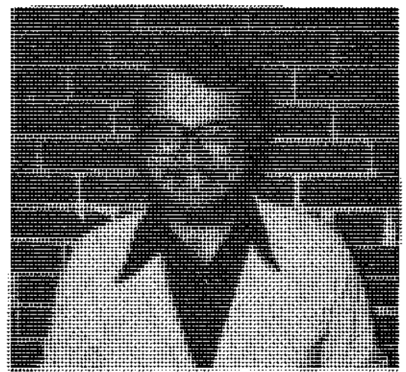

Ketchum[1] recently discussed the teaching of engineering design in terms of the educational objectives which were classified by Bloom et al.[2,3,4] as cognitive, affective or psychomotor. He noted that design courses are primarily concerned with the highest-level cognitive objectives (i.e., comprehension, application, analysis, synthesis and evaluation) and he demonstrated how one may effectively target and achieve these goals in the classroom.

Certain features of the freshmen engineering design graphics course which I teach at Northeastern University allow me to accomplish the additional educational goals described as affective of psychomotor.

Affective objectives (which involve emotional and attitudinal concerns) can be achieved through the appropriate choice of engineering design topics involving the disabled, the elderly, the disadvantaged and those who are living in underdeveloped regions. Psychomotor objectives (dealing with speech and other physical skills) can be developed in the student through written, graphical and oral presentations of his design efforts, and by requiring students to communicate directly with potential design users, engineers, government officials and others who may provide crucial information for the design. The entire spectrum of educational objectives can thereby be included in the design program.

Table 1 presents a brief summary of the course. As can be seen, it is an ambitious, ten-week program which is required of all freshman engineering majors. (Different instructors of the course emphasize certain topics more than others; the program described here is that which is taught by me.) Furthermore, grading requirements are strict and student performance is of high calibre.

Table 2 details the design project which must be completed by each group of two or three students. Each group must choose a real-life engineering problem which is faced by the handicapped. (Table 3 lists some previous design projects completed by students.) My colleague at Northeastern University, Professor Borah Kreimer, has successfully imposed this requirement upon his engineering technology (B.E.T.) design graphics courses (a three-term sequence for several years; I have employed the requirement for more than one year in the (single term) B.S. design graphics course. It has also been successfully employed elsewhere.[5]

PREREQUISITES: None; course is required for all engineering freshmen.

CREDIT: Four (4) quarter credit hours.

COURSE TOPICS:

- Graphics - orthographic projection, pictorials, sectioning, dimensioning, assembly drawings.
- Design - design components, case studies, design process, personal and societal values in design, survey of engineering disciplines, written and oral communication.

TEXTS: Lang and Brown[6];
Voland[7] (forthcoming in Fall, 1981).

SCHEDULING:
- Ten (10) week quarter course (plus one week for examinations).
- Class meets three (3) days per week, sixty-five (65) minutes per meeting.
- Class size ranges from 25 to 60 students (average: 40); beginning in Fall, 1981, class size per meeting is scheduled to increase.

TUTORING: Available from departmentally sponsored workshops in which undergraduate upperclassmen tutor freshmen (graphics only).

GRADING: Students are graded in accordance with the following standard, viz.

0-59% = Fail, 60-62% = D-, 63-67% = D, 68-69% = D+, 70-72% = C-, 73-77% = C, 78-79% = C+, 80-82% = B-, 83-87% = B, 88-89% = B+, 90-92% = A-, 93-100% = A.. (A+ is not available as a course grade.)

RESULTS:
- Fall, 1980 - three sections totaling 117 students; mean grade = 3.28 (3.0 = B, 4.0 = A).
- Winter, 1981-three sections totaling 88 students; mean grade = 3.43 (3.0 = B, 4.0 = A).
- Spring, 1981-three sections totaling 88 students; mean grade = 3.19 (3.0 = B, 4.0 = A).

TABLE 1: Description of the Engineering Design Graphics Course in the B.S. program at Northeastern University as taught by the author.

CONCLUSION

Several distinct conclusions have been reached as a result of this course format. These are as follows:

(1) Problems dealing with stark human need familiarize the engineering student with not only his intellectual abilities but also with his attitudes and values toward those to be served by his efforts.

(2) In conjunction with (1), the student must speak directly to the potential user of his design. This is, of course, excellent design practice since the designer must know the specific needs of his customer. In dealing directly with the potential user, the student becomes more aware of his responsibility as a problem-solver.

(3) The students become aware of the wide range of human-need problems toward which they can direct their efforts as professional engineers.

(4) Students realize that engineering is truly a team effort which includes technicians, administrators, therapists (or other specialists), salespeople, lawyers, government workers, customers and others.

(5) Design is recognized by the students as a combination of creativity and hard work, such as gathering information, identifying and reformulating design goals, analysis, scheduling appointments with those who may provide crucial information, etc.

WRITTEN PORTION: Performed in four sections, i.e.,

SECTION I - Identify (a) problem to be solved,
(b) general and specific goals which must be achieved by a solution to the problem, and
(c) task specifications or boundaries which restrict design solutions and concepts.

SECTION II - Present ideas to achieve each goal; present combinations or sets of these ideas which form total design solutions. Each group must develop at least three preliminary design solutions to the problem.

SECTION III - A decision matrix is developed in which all designs are evaluated and compared; a 'best' design solution is chosen based upon this comparison.

SECTION IV - The 'best' design solution is presented in a set of fully-dimensioned orthographic views, pictorials, assembly drawings, schematics, sectionals or with a combination of these types of drawings.
A bill of materials is also submitted.
Finally, each member of the design team must write a brief (one or two pages) conclusion.

ORAL PORTION: Consists of two efforts, i.e.,

- Ten or fifteen minute presentation before the class. Each student is encouraged to use an opaque projector, overhead projector, chalkboard and other audio-visual aids.
- Questioning in class of another group after their presentation; a summary of each group's oral presentation must be submitted for use by the 'questioning group' in their preparation of questions.

RESTRICTIONS/REQUIREMENTS:

- Problem to be chosen must be one which is currently faced by the handicapped.
- Group members must speak to potential user(s).
- Group members must seek information from written resources (books, journals, manufacturers' catalogs, etc.) and human beings (personnel of the University Office of Services for the Handicapped, hospital personnel, engineers, government workers, manufacturers' representatives, etc.).
- Design group must consist of two or three members.
- Individual members must sign their own contributions.
- Written material must be typed.
- No late work is accepted; deadlines must be met.

TABLE 2: Design Project Guidelines.

(6) Upon completion of the course, students realize that they can apply their (albeit limited) technical knowledge to a challenging engineering problem and produce a feasible solution. This is a very important development if students are to become confident of their abilities and creativity. This is, in fact, the primary reason that I believe freshmen, not juniors or seniors, should complete a design course. Although limited in their technical expertise, they can solve real-life engineering problems through physical intuition and some knowledge of physics, with (minimal) guidance from their instructor. The experience will make them better pupils in subsequent engineering courses, and better workers in the industrial world.

(7) Students also recognize the advantages and disadvantages of working as a member of a design team. Disagreements, scheduling and other difficulties are coupled with such positive aspects as group-inspired enthusiasm and a sharing of the workload.

- Access to Public Transportation (Wheelchair Users)
- All-weather Wheelchair
- Bookshelves for Wheelchair Users
- Calculator for the Blind
- Doorbell for the Deaf
- Doorknob for the Disabled
- Fire Alarm for the Deaf and Blind
- Fire Escape for Wheelchair Users
- Fire Extinguisher for the Handicapped
- Improved Prothesis
- Kitchen for Wheelchair Users
- Playground for the Handicapped
- Shovel for a One-armed Person
- Step- or Curb-climbing Wheelchair

TABLE 3: Examples of Previous Class Design Projects

(8) Oral presentations provide a sharing of experience and an opportunity for a critical examination of results. Students produce higher quality work when they know that their work will be viewed by the entire class. Furthermore, a time limit for oral presentations forces the student to be disciplined in his planning and his evaluation of his results. Finally, the preparation of questions concerning a demonstrating group's design project (based upon a written summary of the demonstrating group's oral presentation which is provided to the interrogating group) emphasizes that an engineer may be asked to review and criticize a colleague's work.

(9) Sectioning of the written report allows the student to
  (a) concentrate upon a particular phase of the design process,
  (b) Focus his efforts toward narrowly-defined goals and
  (c) pace himself so that a term project is not both begun and finished in one night at the end of the term.

Finally, student response - in addition to student performance - has been overwhelmingly positive. During the coming academic year, we intend to initiate (in response to student requests) an engineering student design organization which will provide the opportunity for students to complete their designs to aid the handicapped by constructing working prototypes.

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3. Krathwoh., D.R., B.S. Bloom and B.B. Masia, Taxonomy of Educational Objectives, Handbook II: Affective Domain, McKay, New York, 1964.

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GRAPHICS AND DESIGN IN THE ENGINEERING CURRICULUM

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INTRODUCTION

Instructors of engineering design graphics courses continue to confront fellow educators and administrators who fail to recognize the necessity for these courses in engineering education. The allocation of curricular time for design and graphics can be justified by a number of arguments involving both specific and general educational goals. In addition to providing students with a description of the work performed in various engineering disciplines, the following goals can be achieved in these courses.

DESIGN

Design courses offer the full range of educational objectives to the student. Educational objectives have been classified by Bloom et al.[1,2,3] as cognitive (intellectual abilities, knowledge and recall), affective (emotional and attitudinal concerns), and psychomotor (speech and other physical skills). Ketchum[4] has stated that design courses are primarily concerned with the highest-level cognitive objectives of comprehension, application, analysis, synthesis and evaluation. In addition, affective objectives can be introduced in design courses through projects dealing with the needs of the disabled, the elderly, the disadvantaged and others who need the creative problem-solving abilities of engineers.

Psychomotor objectives can be achieved through oral, written and graphical presentations by students of their design projects, and by requiring students to communicate directly with potential users, engineers, manufacturers, distributors, and others from whom information for the design may be obtained.

GRAPHICS

Land's review[5] of the contribution of technical drawing to civilization provides ample evidence that graphics has been recognized as fundamental to architecture, design, manufacturing, surveying and other engineering areas. Graphics includes:[6]

-graphical mathematics,
-descriptive geometry,
-vector analysis,
-working drawings,
-computer graphics.

Graphics offers two general areas for development to the student; these areas can be described as "communication" and "visualization".

Communication:

As was noted in the 1964 Divisional Committee Report on Goals of Engineering Education[7], there are three modes of communication which we can identify: linguistics (verbal), mathematics (abstract symbolism) and graphics (visual symbolism). Graphics is a concise, accurate universal language (with its own grammar and style[8]) with which engineers, draftsmen and designers communicate with one another and also with the public. Engineering students must be fluent in this technical language of their discipline if they are to be valuable and able workers.

Visualization:

Graphics is indisputably linked with design; it has been said to be the foundation upon which all designing is based[8] and the vehicle by which design areas should be taught[9]. It develops the ability to visualize devices and systems. (Graphical models include free-body diagrams, schematics, bond graphs and other visual representations of physical systems and processes.) Perhaps its greatest contribution to the student is its demand that he or she develop insight and disciplined thinking in addition to physical skills. French warned[8] in 1913 that the higher values and contributions of graphics courses in the engineering curriculum must not be overlooked.

Computer graphics is producing the current revitalization of technical drawing in engineering education. Fundamental (manual) graphics methods must be mastered by the student if he is to fully utilize computerized systems, as noted by both educators[5,10] and those in industry[6]. In 1964 the Engineering Graphics Division of the ASEE concluded[7] (not surprisingly) that a freshman engineering graphics course is a necessary element for a successful engineering curriculum. Computer graphics simply increases the necessity for such a course.

CONCLUSION

Engineering design graphics courses offer the opportunity to achieve a wide range of educational goals to the instructor. Together with physics and mathematics, they form the foundation of a freshman engineering program.

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4. Ketchum, L.H. Jr., "Teaching Engineering Design", Engineering Education, Vol. 71, No. 8, pp. 797-801 (1981).

5. Land, Ming H., "Historical Development of Graphics", Engineering Design Graphics Journal, Vol. 40, No. 2, pp. 28-33 (1976).

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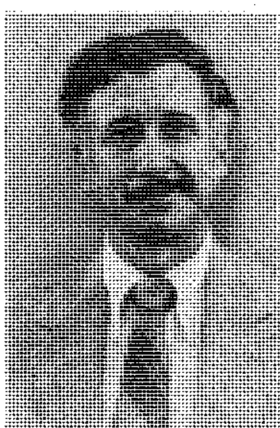
COMPUTER GRAPHICS USE IN FRESHMAN ENGINEERING DESIGN PROJECTS



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UNIVERSITY OF TEXAS AT AUSTIN
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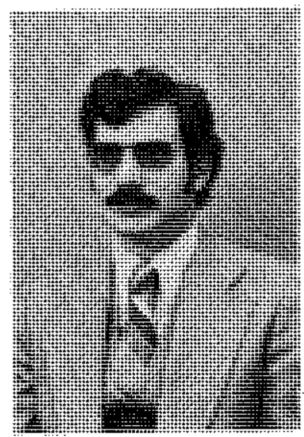

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Introduction

Typical course work in freshman engineering curricula includes topics on design, computer programming, and engineering graphics. The increasing use of computer graphics in industry has stimulated efforts to incorporate computer graphics in the freshman engineering programs at many universities. For the new engineering student, computer graphics adds a dynamic approach to drawing and offers a new tool for design. To the student who is unfamiliar with computers, computer graphics also offers a vibrant introduction to computer technology and programming. The two major problems associated with incorporating computer graphics in education are obtaining the needed computer hardware (1) and determining the best instructional approach (2). For the latter problem, the major dilemna is whether to teach computer graphics before, during, or after computer programming. The following paper describes one approach towards using computer graphics in a freshman engineering graphics and design course.

Computer Graphics Hardware Configuration

At the University of Texas at Austin, a computer graphics laboratory has been established that is primarily dedicated to the freshman engineering program. The facility is housed in the Mechanical Engineering Department and has been in operation since the Fall 1979 semester. The laboratory currently has eight Hewlett-Packard 2647A stand-alone graphics terminals. The 2647A terminal features a raster scan CRT with a resolution of 720 x 360. The terminal has approximately 16K bytes of user memory, and is programmable in BASIC and AGL (Hewlett-Packard's A Graphics Language). The terminal also features a cassette data cartridge for off-line storage.

The freshman computer graphics laboragory is divided into two groups of four terminals each. Each group is connected to a Hewlett-Packard 2631G impact printer/plotter for hardcopy output. In addition, one group of four terminals has been expanded to offer interactive computer-aided design capabilities, as shown in Figure 1. These design peripherals include a four-color pen plotter and digitizer board.

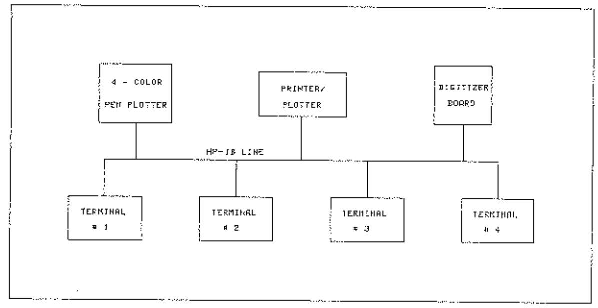


Figure 1.

Course Description

The freshman engineering curriculum at the University of Texas at Austin consists of two fundamental engineering courses, in addition to basic math and science courses. These courses are ME 201G "Engineering Graphical Communication" and XE 202 "Introduction to Engineering." The engineering graphics ME 201G course is taught within the Mechanical Engineering Department, while the XE 202 course is taught separately within each engineering department (Aerospace, Civil, Chemical, Electrical, Mechanical, or Petroleum). Each course is worth two credits. A series of five computer graphics modules has been incorporated into the ME 201G graphics course (3). The XE 202 course usually includes computer programming and a design project, but as presently taught, is not related to the graphics course.

For the past two years, a trial freshman course has been taught that merges concepts in graphics, design and computer programming into a combined 4-credit ME 201G/202 course. The entitled "Introduction to Engineering Design and Graphical Communication", and has been extensively detailed in an earlier paper (4). Approximately 30-50 students, mostly mechanical engineering freshmen, have taken the course each semester. The principal teaching objectives of the course are fourfold:

1. Design Process
2. Engineering Graphics
3. Computer Programming
4. Engineering Communication

As a part of this effort, computer graphics is introduced both as a programming aid and as a design tool. Each student in the class is assigned a freshman design project that requires the use of the HP-2647A computer graphics terminal and related design peripheral devices. The following section relates some typical examples of how computer graphics is used in these design projects.

COMPUTER GRAPHICS DESIGN PROBLEMS

Computer Programming Exercise (Fig. 2)

In order to develop programming skill on the graphics terminal, a number of BASIC programming exercises are assigned to the student early in the course. The programs are usually short, and are designed to teach fundamental concepts such as input-output, looping, and subprograms. The output of the program typically consists of a graphics display, such as shown in Figure 2. A computer graphics workbook (5) is used to assist in this phase of instruction.

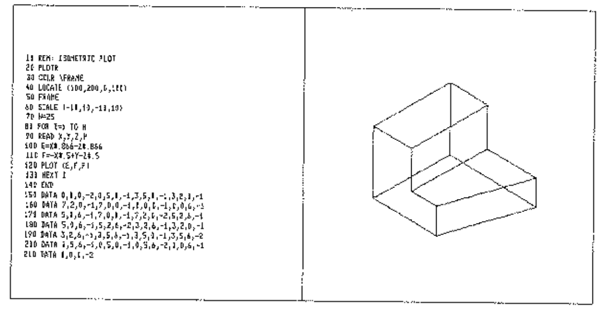


Figure 2.

Orthographic Drawing (Fig. 3)

A common application of computer graphics in design projects is to make an orthographic drawing of one or more design components. On the HP-2647A graphics terminal, there are several methods that the student can employ in order to construct orthographic views. Using a rubber band mode on the terminal, the student can make straight line drawings directly through keyboard control. The student can also choose to use a canned subroutine program that accepts coordinate data of the object and then plots a three-view orthographic drawing of the object. Such a program was used to construct the pet feeder design in Figure 3. A third approach would be to have the student develop his/her own orthographic subroutine, that could then be used to construct three-view drawings of any number of design components. This is routinely done in the course.

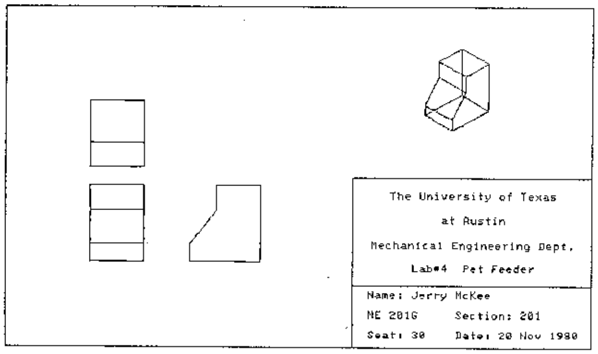


Figure 3.

Isometric Element Design (Figure 4)

The freshman design projects assigned in the course frequently require the use of standard mechanical components or elements. Computer graphics can be applied in this area to make simple isometric pictorials of the design element. An example of a plunger spring design for an aluminum can crusher is shown in Figure 4. The pictorial was made by continually changing the y-coordinate of an isometric circle projected in the X-Z plane. The student can interactively change the geometric shape of the spring to better conform to the design specifications.

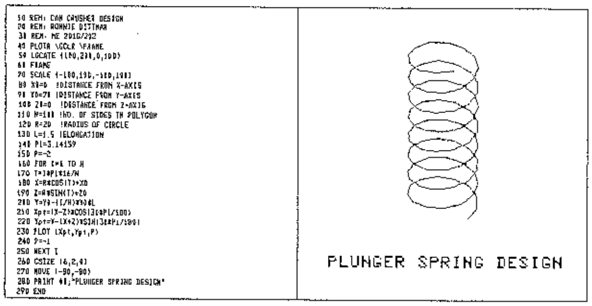


Figure 4.

Isometric Wire Model (Figure 5)

The students quite often like to have an overall pictorial of their design which can be viewed on the CRT screen. This can be accomplished by making an isometric wire model of the object. A general software routine like the one listed in Figure 2 could be used for this task. An alternative approach is shown in Figure 5 in which an isometric drawing of a backyard greenhouse frame is constructed. Since the data coordinates of the frame consisted primarily of curves, a special routine using isometric semi-ellipses was employed in the computer graphics design.

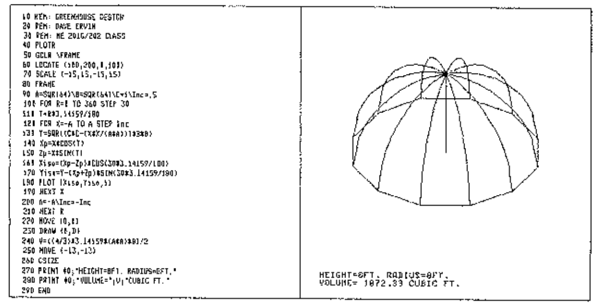


Figure 5.

Digitizing a Sketch (Figure 6)

Sketching preliminary ideas is an important stage in the freshman design process. Freehand sketches can be transformed into computer graphics drawings through the use of a digitizer board. Figure 6 depicts a typical example of a design sketch that could be entered into the computer through a digitizer. The data being digitized could be immediately displayed on the screen while simultaneously being stored in memory for use in future programs. The example in Figure 6 shows the human factors involved in transporting a portable shower.

Flow Chart Construction (Figure 7)

Many design applications consist of systems for which it is not feasible to make a physical drawing. The flow chart is a common graphical technique to show the interconnections between components in a system. A flow chart can be constructed on the CRT through the use of the rubber band line or by developing a program that selects common chart symbols from a menu. Figure 7 is a flow chart that shows the electrical connections for a windshield defroster design developed by a student in the class.

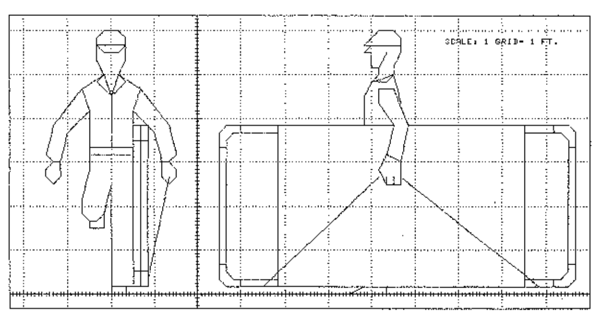


Figure 6.

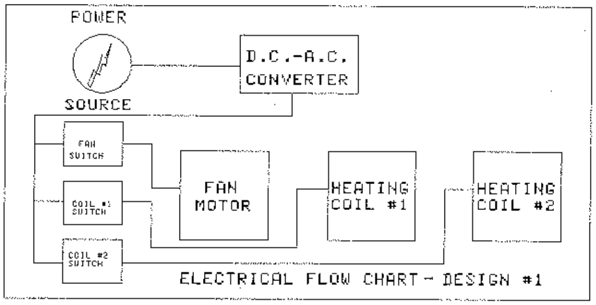


Figure 7.

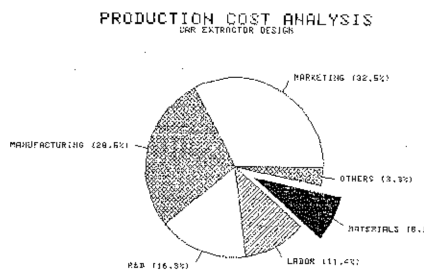


Figure 8.

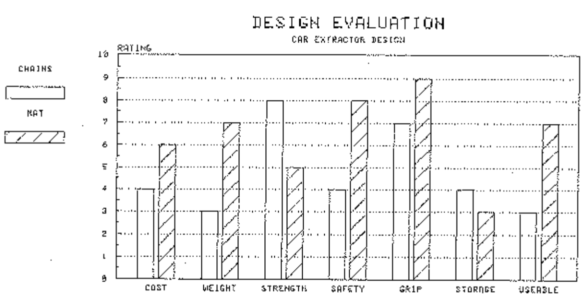


Figure 9.

Use of Business Graphics (Figures 8 and 9)

A important aspect of the freshman design projects is the generation of a technical report. Numerical and business data associated with the report can best be presented in graphical form. Several of the programming exercises(5) in the course actually require that the students develop routines for bar and broken-line graphs. However, when generating business graphics for their reports, most students utilize a canned software package called MULTIPLOT that is supplied by Hewlett-Packard. This software can be used to draw the following types of graphs: pie, bar, linear, semilog, and log-log. Figures 8 and 9 depict examples of a pie graph and bar graph, respectively, that were used for the cost analysis and evaluation of a design for a car tire extractor.

DISCUSSION AND CONCLUSIONS

Experiences with this trial course during the past two years suggest that computer graphics can be readily integrated into the freshman engineering curriculum. Our success is partly due to the fact that the two pre-existing freshman mechanical engineering courses at the University of Texas at Austin already contained much of the instructional ingredients needed for this new combined course. Namely, the teaching objectives for design, graphics, and computer programming were already ingrained in the freshman curriculum. However, this is true for many freshman engineering programs at other universities, and with a slight re-arrangement of the instructional sequence, computer graphics could be incorporated into the freshman course work at other universities in a fashion similar to our program at the University of Texas at Austin.

As mentioned earlier, computer graphics is used in the course both as a programming aid and as a design tool. The computer graphics terminal offers insight into the man/machine interface that is characteristic of new trends in computing. Teaching computer programming through the us of interactive computer graphics has the advantage in that the output can be readily viewed by the programmer for errors. The experience gained during the programming phase can then be used by the students to generate computer graphics solutions to their design projects. This not only provides them an opportunity to apply their programming skills to open-ended problems, but also offers them keen insight into the value of computer-aided design.

Our freshman computer graphics program at the University of Texas at Austin continues to expand. We are currently refining canned computer graphics software to make orthographic drawings, to rotate isometric pictorials, and to construct graphics and charts. We are also developing a mini-CAD (computer-aided design) system that will be suitable for our freshman design projects. The mini-CAD system will consist of a set of software modules to be used for design activities such as: interactive digitizing, vector analysis, materials selection, element design, economic analysis and more. It is possible that in the near future a much larger number of freshman students will be taking the combined ME 201G/202 course. This will require careful evaluation of our current instructional plan and may necessitate expansion of our computer graphics hardware facilities. In addition, we will be offering a full undergraduate course in engineering computer graphics that could be taken as an elective follow-up to the freshman computer graphics exposure. As we gain more experience in this new area of engineering education, we will be in a better position to assess the impact of computer graphics on the freshman engineering curriculum.

REFERENCES

1. Barr, R. E. and Demel, J. T., "How to Choose a Computer Graphics System for Education." Engineering Education, vol. 70, no. 8, 1980, pp 828-832.
2. Barr, R. E., "Computer Graphics in the Freshman Engineering Program at the University of Texas at Austin," 1980 Frontiers in Education Conference Proceedings, Houston, Texas, Oct. 1980, pp. 352-355.
3. Hamilton, P. S., Barr, R. E., and Juricic, D., "Implementation of Computer Graphics Exercises in Freshman Engineering Graphics Education," Computers and Graphics, (in press).
4. Barr, R. E., "An Introduction to Mechanical Engineering through Design and Computer Graphics," International Journal of Mechanical Engineering Education, (in press).
5. Demel, J. T., Wilke, R. A., Coppinger, J. T., and Barr, R. E., Computer Graphics, Creative Publishing Company, College Station, Texas, 1979, 92 pages.

Figure 1. Hardware configuration for one four-terminal system in the freshman computer graphics laboratory at the University of Texas at Austin.

Figure 2. Typical computer graphics programming exercise assigned in the course.

Figure 3. Orthographic drawing of a pet feeder design using a canned software program (courtesy Jerry McKee).

Figure 4. Isometric display of a plunger spring design (courtesy of Ronnie Dittmar).

Figure 5. Isometric wire model of the frame for a backyard greenhouse (courtesy of Dave Ervin).

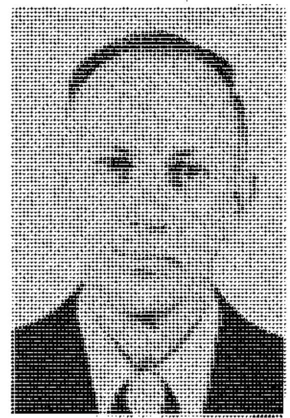
Figure 6. Typical example of a sketch that is entered into the computer terminal through a digitizer board. The design shows the human factors associated with carrying a portable shower (courtesy of Leonard Leinweiber).

Figure 7. A flow chart showing the electrical connections for a windshield defroster design (courtesy of John Bishop)

Figure 8. A pie graph used to analyze the production costs for a car tire extractor design (courtesy of Kent Gillig)

Figure 9. A bar chart used to evaluate the relative merits of two different designs for a car tire extractor (courtesy of Kent Gillig).

DESIGN AT THE FRESHMAN LEVEL??



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As teachers of Engineering Design Graphics, we are sometimes criticized by our students and by faculty in the various engineering disciplines for teaching design at the freshman level. Of course, we all know the original purpose for including design at the freshman level was to help solve the problem of declining enrollments and to stimulate interest in engineering by getting students involved in the solution of engineering type problems. In an effort to verify that the design project approach was achieving these purposes, and other worthwhile goals which evolved, a number of graphics departments have polled students at the end of their courses by means of confidential questionnaires. This provided an immediate feedback and basis for implementing some changes in techniques as well as the answer to our original question--or so it seems.

Put yourself in the freshman's place. What kind of answers would you give and on what criteria would your answers be based? Who, on the other hand, would be most qualified to provide unbiased answers? Those students who have passed a design graphics course, completed at least a baccalaureate degree in engineering and are practicing engineers would be the lo logical group to ask such questions.

Just such a poll has been made and the findings will follow. The poll included all graduates of engineering from McNeese State University for the period Fall 1972 through Fall 1978. Forty-five percent of the questionnaires were completed and returned.

The engineering graduates were asked to rate each of the graphics <u>course</u> objectives and design <u>project</u> objectives according to their relevance to actual engineering practice. They were also asked to rate the extent to which these objectives were accomplished. To take advantage of the opportunity to obtain data helpful in evaluating other aspects of the course, additional information was requested.

Specific graphics topics were rated on their value in engineering practice. Respondents checked or listed other topics which they thought should be taught in graphics. Six short-answer questions and a comment section rounded out the form.

Figures 1 through 4 summarize the findings regarding course and design project objectives. Table 1 shows the responses to specific questions.

When asked, "What single aspect of the course did you like most?", the design project was specified by 30.8% of the respondents--the most frequently mentioned item. Only 11.5% listed the design project as the single aspect of the course which they liked the least.

From this data, it is concluded that, at McNeese State University, the design project has made an important contribution to the education of its graduates. Armed with this thought, the composite responses to specific items and the many helpful comments and suggestions, the team design project approach will be improved and continue to be an integral part of Engineering Design Graphics at McNeese.

Figure 1

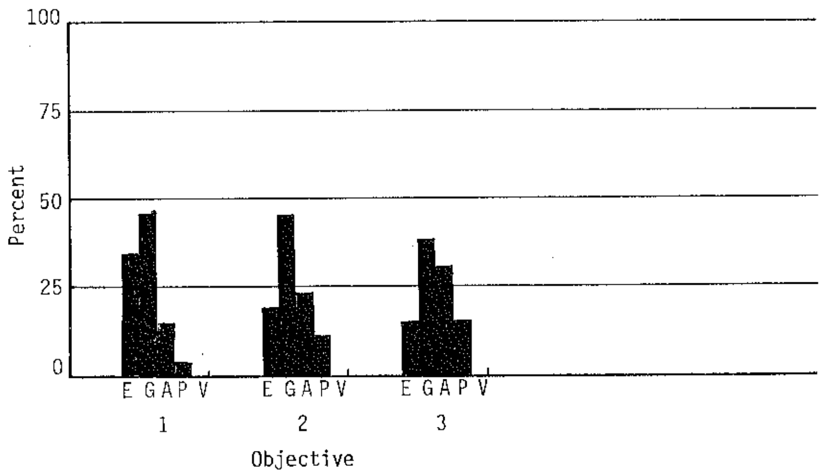


Figure 2

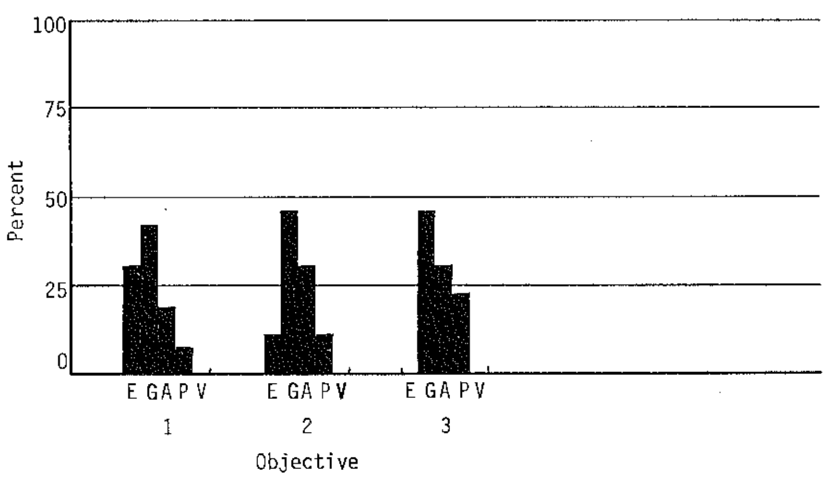
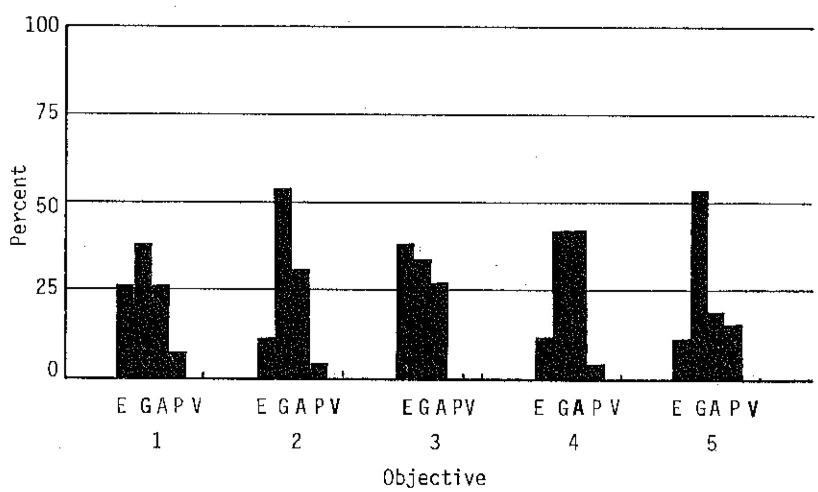


Figure 3



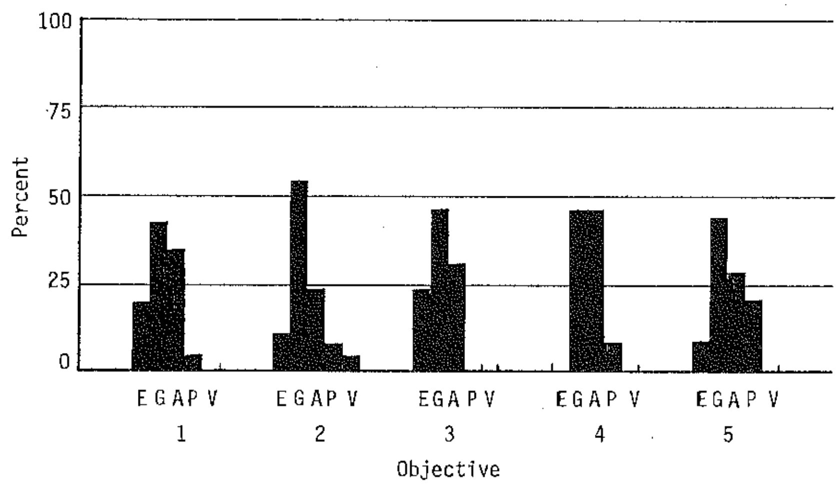


Figure 4

Figure 1. Rating of Course Objectives According to Their Relevance in Actual Engineering Practice

Legend:

Objectives:

1. To help the student acquire a knowledge of the fundamental principles of graphics as applied to engineering.

2. To help the student develop the skills required to use graphics as a tool to help solve engineering problems

3. To help the student learn about the engineering design process

Rating Scale: E-Excellent, G-Good, A-Average, P-Poor, V-Very Poor

Figure 2. Rating of the Extent to Which the Course Objectives Were Accomplished

Legend:

Objectives:

1. To help the student acquire a knowledge of the fundamental principles of graphics as applied to engineering.

2. To help the student develop the skills required to use graphics as a tool to help solve engineering problems

3. To help the student learn about the engineering design process

Rating Scale: E-Escellent, G-Good, A-Average, P-Poor, V-Very Poor

Figure 3. Rating of the Design Project Objectives According to Their Relevance to Actual Engineering Practice

Legend:

Objectives:

1. To help the student learn the principles of solving engineering problems

2. To help the student learn about the engineering profession

3. To help the student learn how to present problem solutions in graphical, written and oral form

4. To help the student learn how to relate other subjects to the solution of engineering problems

5. To help the student learn about the applications of engineering courses in the solution of engineering problems

Rating Scale: E-Excellent, G-Good, A-Average, P-Poor, V-Very Poor

Figure 4. Rating of the Extent to Which the Design Project Objectives Were Accomplished

Legend:

Objectives:

1. To help the student learn the principles of solving engineering problems
2. To help the student learn about the engineering profession
3. To help the student learn how to present problem solutions in graphical, written and oral form
4. To help the student learn how to relate other subjects to the solution of engineering problems
5. To help the student learn about the applications of engineering courses in the solution of engineering problems

Rating Scale: E-Excellent, G-Good, A-Average, P-Poor, V-Very Poor

Table 1. Responses to Specific Questions

Question	Yes	No
1. Should the design project be retained as part of the engineering graphics course?	80.8%	19.2%
2. Should the team approach on design projects be used in preference to individual projects?	84.0%	16.0%
3. Do you think what you learned in graphics has been helpful on the job?	92.3%	7.7%

REVIEWER'S COMMENTS

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NOTE: When Professor Goss reviewed this paper for the Journal he made some very thought-provoking comments. These comments came as a result of some research and quite a bit of experience which Goss has had in connection with teaching design and implementing surveys of this type. For this reason, some of Larry's comments are presented here for the readers to peruse, ponder and maybe -- just maybe -- be directed to sample their own graduates for supporting data.-Ed.

"I am always skeptical of data presented in percentage form. It's so easy to make things look good that way. This article looks reasonably bonafide on the surface, but a little investigation turned up the following facts. . .

"The sample size for this survey is somewhere around 50 (45% of approximately 120 graduates over a 6 year period) but somewhere in the neighborhood of 1000 students have been through the design sequence in the freshman year of this curriculum (extrapolated data from published figures in Engineering Education.) Five percent may be an adequate sample rate for quality control purposes in manufacturing, but I question its validity in an opinion survey when there does not appear to be any evidence of an attempt to control the sample with respect to rank in graduating class, grade achieved in the course in question, or a number of other controls and/or correlations that could have been made. (I am assuming, by the way, that all engineering freshmen are required to take this course).

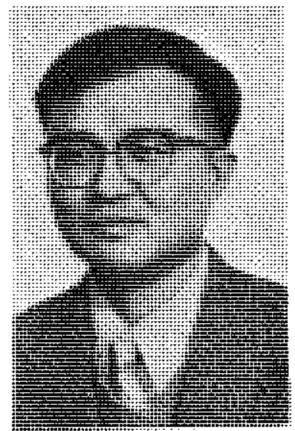
"In short, this appears to be a . . . survey derived from the program's successful graduates. Results from this type of survey are so questionable that ABET no longer uses this process' to obtain information from graduates of curricula that are presented for accreditation. I would like to know what the graduates who transferred out of engineering, the drop-outs, and the academically terminated students think of this design program. If they respond in a similar positive manner to a similar questionnaire, then maybe something really worthwhile is taking place in that course.

". . . If the paper is accepted . . . I still have serious questions concerning the interpretation of results. For instance, in Figure 1 the objective showing the least favorable opinion by graduates is the one related to the design process. In Figure 2, the objective showing the least favorable opinion is also the one related to the design process. This means that of the stated objectives in the survey those related to engineering design were the least relevant and most poorly accomplished.

"Similarly, an examination of Figures 3 and 4 indicates that these graduates perceived the design project experience as good preparation for presentation techniques, but it was ranked lower in the accomplishment of the primary objective of relating other subject areas to the solution of engineering problems."

NOTE: There you have it, design fans! We will appreciate your comments either for or against the article or the review. Let us hear from you.-Ed.

DESIGN OF FIXTURES TO HOLD INSERTS FOR EVER-STRAIT DOORS



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SUMMARY

This was a research project on fixture design. The fixtures, presently used for holding eleven different configurations of inserts in place for laying a bead of hot-melt caulking in grooves of each insert, were inappropriately designed. The inserts were for Ever-Strait doors made by the Pease Company (now called Pease Industries, Inc. and referred to hereafter as the corporation where applicable) in Fairfield, Ohio. This problem was explained to me on August 27, 1980, by Mr. William M. Bursk, Manager of Pease Technical Center. Mr. Bursk indicated that the problem needed to be resolved and asked if my students and I could help design fixtures to replace those presently used, as the Pease Industries, Inc., lacked manpower to do the job.

I talked to my students in our Die Design class about the problem and asked if anybody would be interested in resolving the problem as extra work for the class. Five students wished to get involved in the research project. Serving as the leader for the research project, I explained to the five students the desired type of fixtures to be designed and suggested that each of them visit the actual working situation in the Fairfield Plant of the Pease Industries, Inc. Also, I told them the actual working distances of the autoglazer above the worktable on which the fixtures would be set. In addition, I provided each of them with a copy of Ever-Strait Doors Systems 1980, showing the eleven different configurations of inserts and a copy of the blueprints for each of the inserts.

We started to work on the research project in early September, 1980, and usually met once a week for one hour on Thursdays at 6:00 p.m. to discuss and exchange ideas on fixture design. We completed the project by making two model fixtures during the latter part of November, 1980. One fixture can hold seven different configurations of inserts and the other one, four. We completed assembly and detail drawings for each of the two fixtures by December 30, 1980. Mr. Bursk described, in writing, the two fixtures we designed as unique, refreshing, most helpful, and increasing production and quality of the Pease industries, Inc.'s automatic door light caulking machine. He also indicated that the Pease Industries, Inc. will make, in September, 1981, a prototype of the two fixtures we designed and will invite us to the plant to look at its operation. Two major challenges we encountered throughout the fixture design process were (a) performing the design work free of charge and (b) finding the time to meet one hour a week for discussion. In closing, conducting this research project in fixture design was significant and rewarding to both Miami University and the Pease Industries, Inc.

STATEMENT OF THE PROBLEM

The eleven fixtures (see Figs. 1 through 11), presently used for holding eleven different configurations of inserts (see Figs. 12 through 14) in place for laying a bead of hot-melt caulking in grooves of each insert, were inappropriately designed. Each of the eleven fixtures and its corresponding insert is tabulated below.

FIXTURE	MATING INSERT
Fig. 1	3rd from left, Fig. 12
Fig. 2	1st from left, Fig. 12
Fig. 3	2nd from left, Fig. 12
Fig. 4	1st from left, Fig. 13
Fig. 5	2nd from left, Fig. 13
Fig. 6	3rd from left, Fig. 13
Fig. 7	4th from left, Fig. 13
Fig. 8	1st from left, Fig. 14
Fig. 9	2nd from left, Fig. 14
Fig. 10	3rd from left, Fig. 14
Fig. 11	4th from left, Fig. 14

The inserts are for Ever-Strait doors made by Pease Industries, Inc., Fairfield, OH.

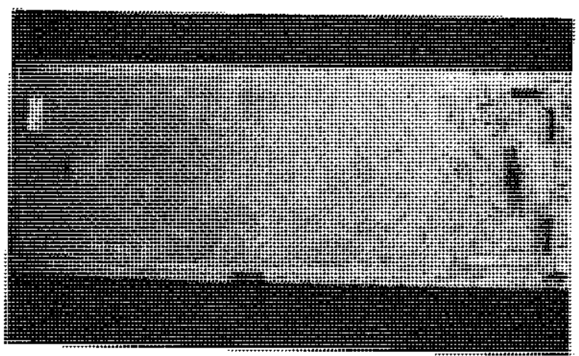


Fig. 1 Fixture of L-34 and L-38.

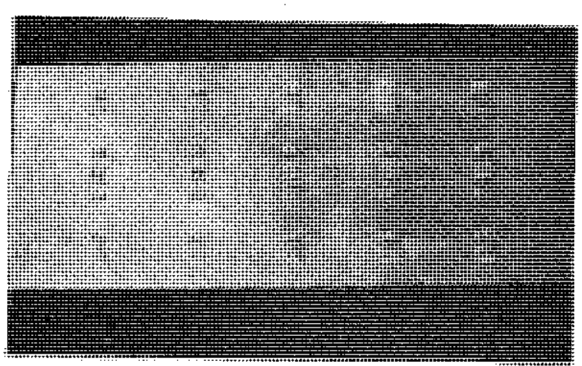


Fig. 2 Fixture of L-S34 and L-S38.

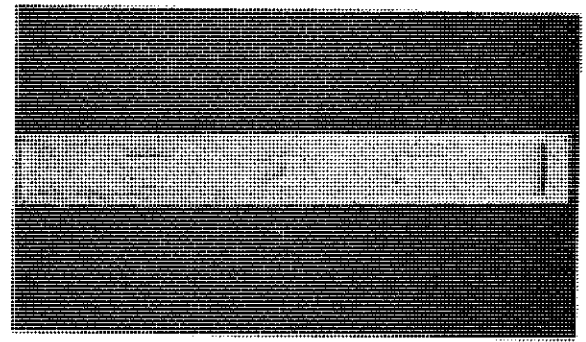


Fig. 3 Fixture of L-51.

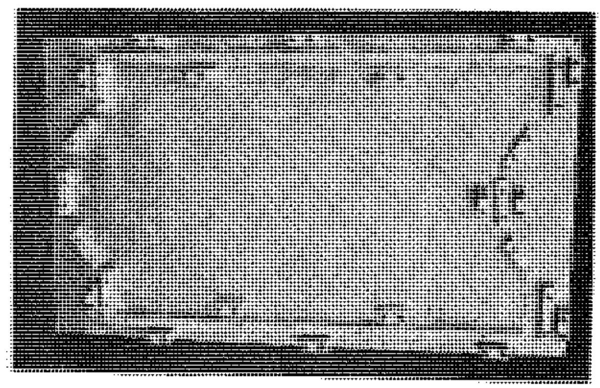


Fig. 4 Fixture of L-57, L-58, and L-60.

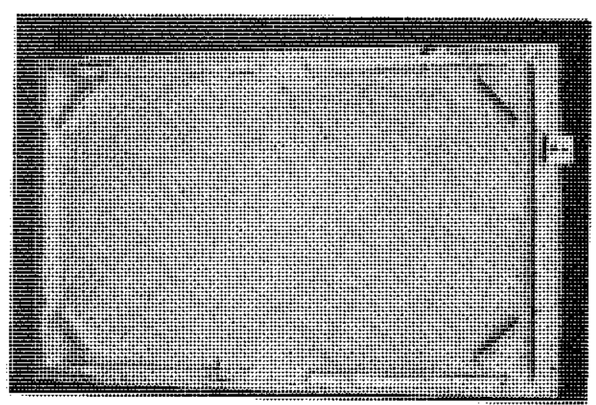


Fig. 5 Fixture of L-53, L-54, and L-55.

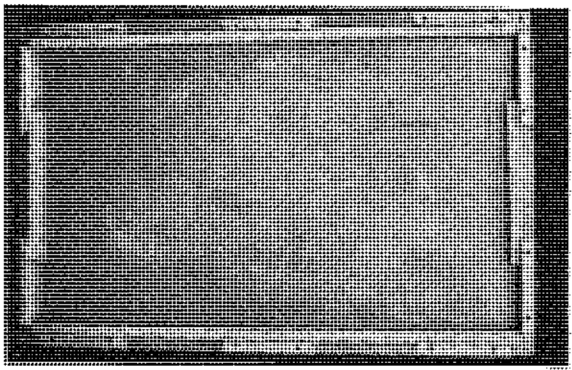


Fig. 6 Fixture of L-09.

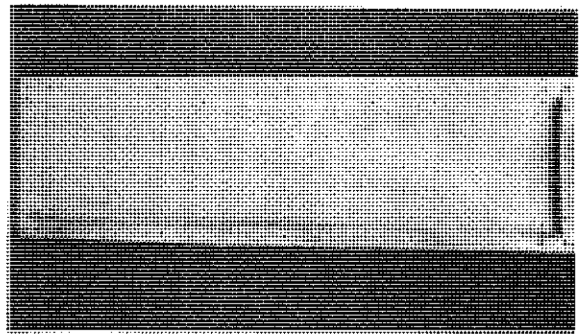


Fig. 7 Fixture of L-82, L-85, L-86, L-87, L-S09, and L-S89.

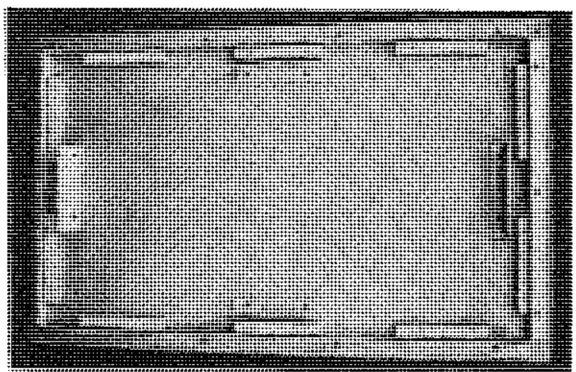


Fig. 8 Fixture of L-03.

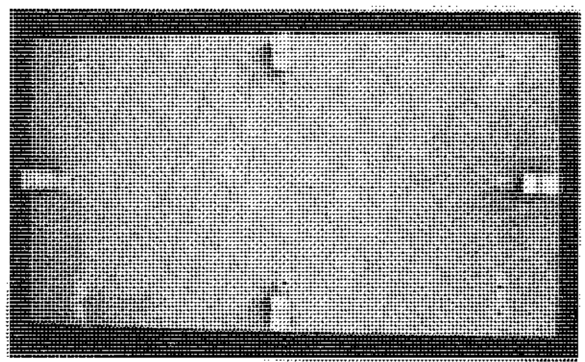


Fig. 9 Fixture of LF-27 and LF-28.

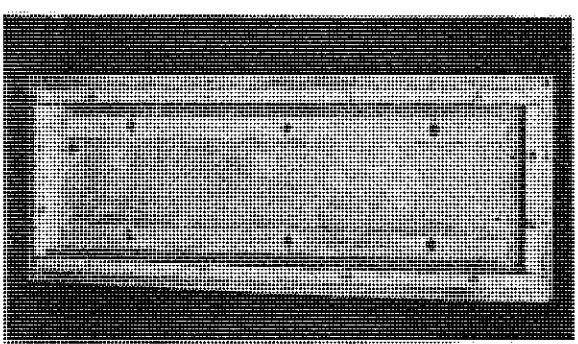


Fig. 10 Fixture of L-83.

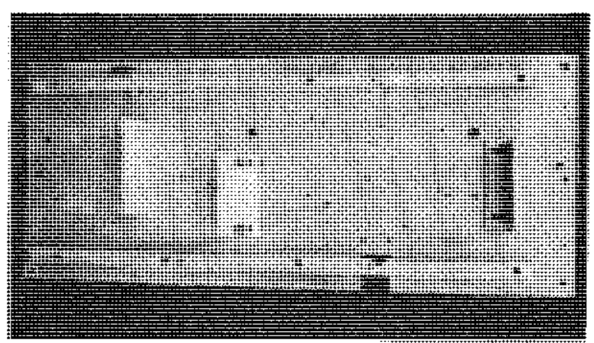


Fig. 11 Fixture of L-78 and L-80.

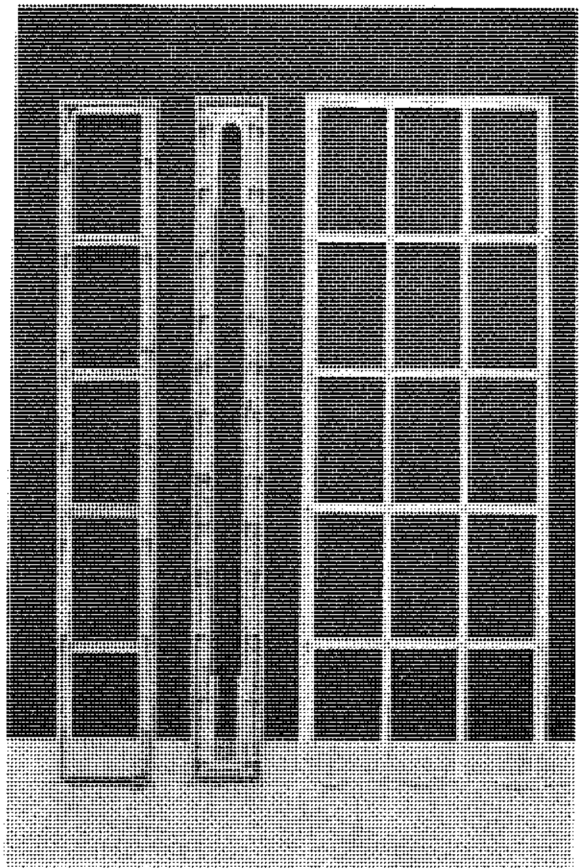


Fig. 12 Three mating inserts of fixtures shown in Figs. 1, 2, and 3.

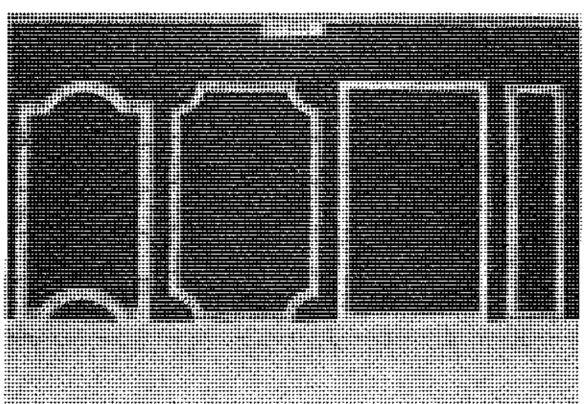


Fig. 13 Four mating inserts of fixtures shown in Figs. 4, 5, and 6.

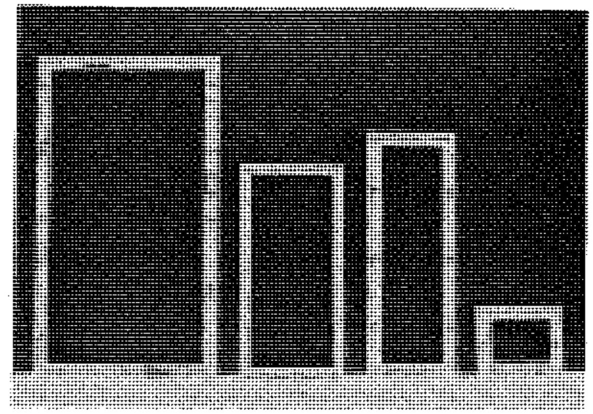


Fig. 14 Four mating inserts of fixtures shown in Figs. 8, 9, 10, and 11.

There are three main reasons for the eleven fixtures being inappropriately designed. First, each of the eleven fixtures can hold only one configuration of insert. Second, each fixture cannot tightly hold its mating insert. Third, there is no specific place to set each fixture on the worktable. Because of the above reasons, the employee cannot work efficiently; that is, too much time was spent to (1) adjust each of the inserts to appropriately fit its mating fixture; and, (2) set each fixture on the worktable in the right place.

INDUSTRY INVOLVEMENT AND TEAM EFFORT

Industry Involvement. The Pease Industries, Inc., Ever-Strait Door Division, Fairfield, OH, through Mr. William M. Bursk, Manager Pease Technical Center, explained to me on August 27, 1980, the above problem at the site of the working area where the fixtures were used in the Fairfield plant. Mr. Bursk indicated that the problem needed to be resolved and asked if my students and I could help design fixtures to replace those currently used, because the corporation lacked manpower to do the work.

During the process of fixture design, the corporation upon my request, provided me with the following materials:

1. Six copies of Ever-Strait Door Systems 1980, published by Pease Industries, Inc., showing the eleven different configurations of inserts.

2. Six copies of blueprints for each of the eleven different configurations of inserts.

3. A set of eleven sample inserts.

4. Two pieces of plywood, 8'x3'x½" and 4'x3'x½"; thirty-four steel pins, 3/8" dia. x 3" long; and, thirty-four cast iron plates, 2"x2"x¼". These materials were used for making two

model fixtures, and the above eleven sample inserts, for setting on the top of the two model fixtures for experimental purposes.

Team Effort. Five of my students and I worked as a team to design the fixtures. The five students were Ahijah M. Israel, James R. Steinkamp, Chris P. Surface, William M. Truett, and Dennis L. Weinman. All of the five students were registered in our Die Design class and were interested in designing the fixtures as outside work for the class.

PROCEDURE AND RESULTS

The procedure and results were as delineated below.

1. I observed the actual working situation and objects (see Fig. 15) relative to this research project. The objects included a worktable, a fixture set on the worktable, two identical inserts set on the fixture, a putty pump (Fig. 16) which provided hot-melt caulking for the auto-glazer (Fig. 17), and a numerical control machine (Fig. 18) which controlled the operation of the auto-glazer. Also, the working distances of the auto-glazer over the worktable were measured as 12'x3' and the closest distance between the head of the auto-glazer and the worktable as $1\frac{1}{4}$".

2. I shared the information indicated under item 1 with each of the five students involved in this research project and suggested that each of them visit the actual working situation in the Fairfield Plant.

3. I provided each of them a copy of the reference manual, showing the eleven different configurations of inserts and a copy of blueprints for each of the inserts.

4. I told the five students that the desired type of fixture should be able to hold several different configurations of inserts.

5. The five students and I worked on the research project from early September 1980 through the latter part of December 1980. We usually met for discussion on Thursdays from 6:00 p.m. until 7:00 p.m. in Room 302, Drafting Lab, Auditorium and Technical Building, Miami University-Hamilton Campus.

6. Two model fixtures were designed and completed by November 26, 1980. One fixture (see Fig. 19) can hold seven different configurations of inserts (see Figs. 20 through 23) and the other one (see Fig. 24), four different configurations of inserts (see Figs. 25 through 28). The two fixtures can simultaneously be set on the worktable for use.

7. We completed, by December 30, 1980, two assembly and detail drawings, an assembly drawing, and three detail drawings (see drawings 1 through 6) for the two fixtures.

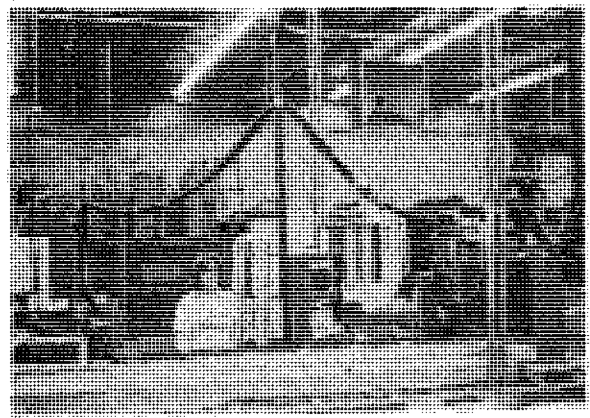


Fig. 15 The actual working situation and objects relative to this research project.

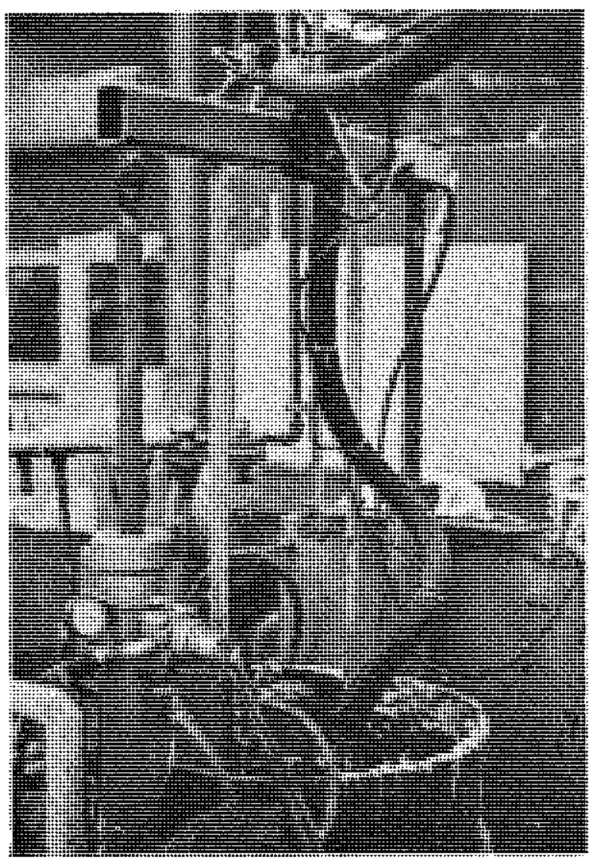
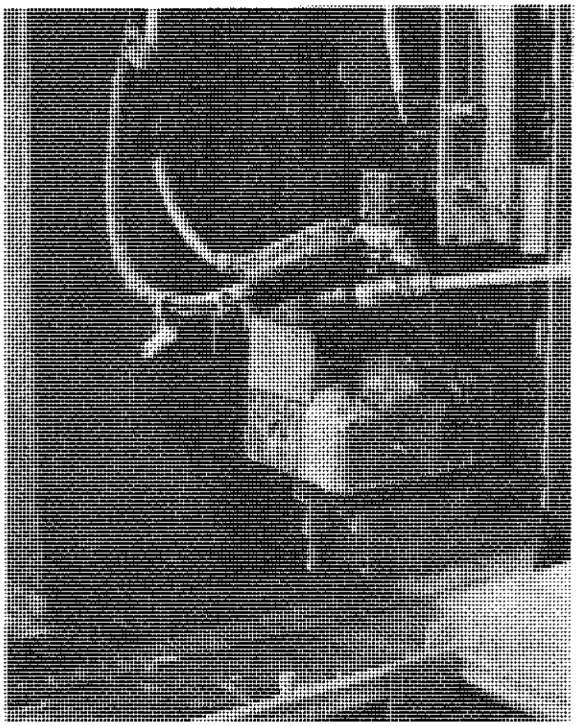


Fig. 16 The putty pump which provides hot melt caulking for the auto-glazer

Fig. 17 The auto-glazer which lays a bead of hot-melt caulking in grooves of each insert.



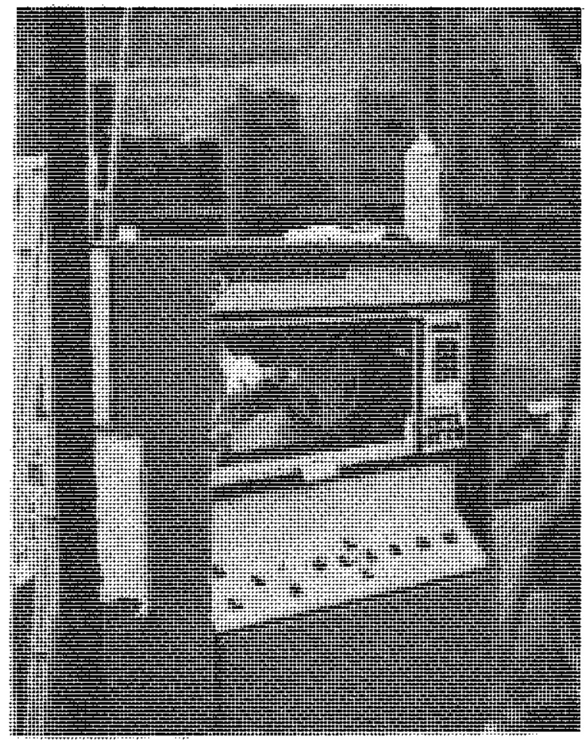


Fig. 18 The numerical control machine which controls the operation of the auto-glazer.

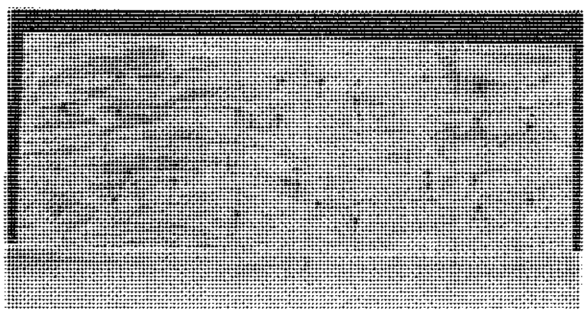


Fig. 19 Fixture 1 which can hold seven different configurations of inserts.

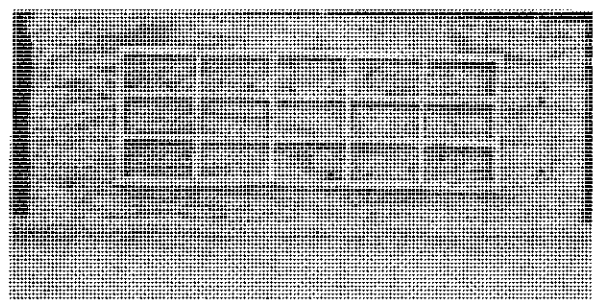


Fig. 20 Fixture 1 holding the insert of L-34 and L-38.

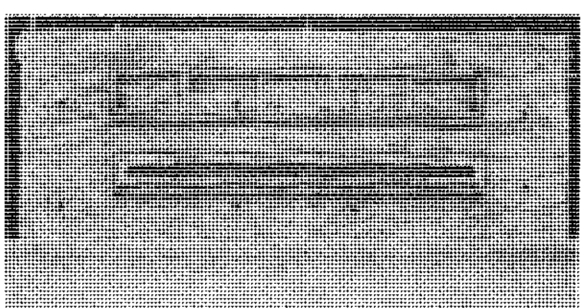


Fig. 21 Fixture 1 holding both the insert of L-S34 and L-S38, shown at the top and that of L-51, shown at the bottom.

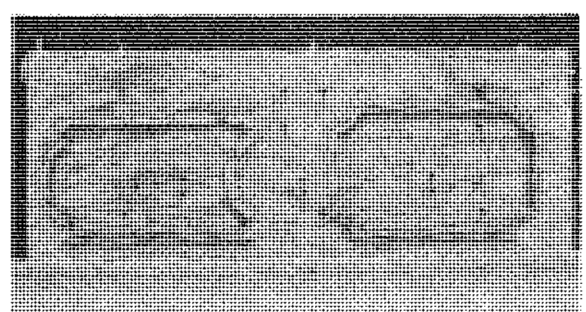


Fig. 22 Fixture 1 holding both the insert of L-57, L-58, and L-60, shown to the left, and that of L-53, L-54, and L-55, shown to right.

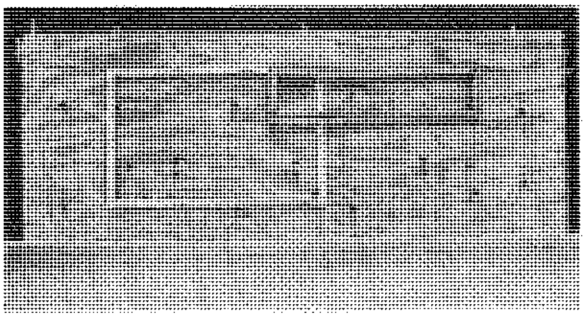


Fig. 23 Fixture 1 holding both the insert of L-09, shown to the left, and that of L-82, L-85, L-86, L-87, L-S09, and L-S89, to the right.

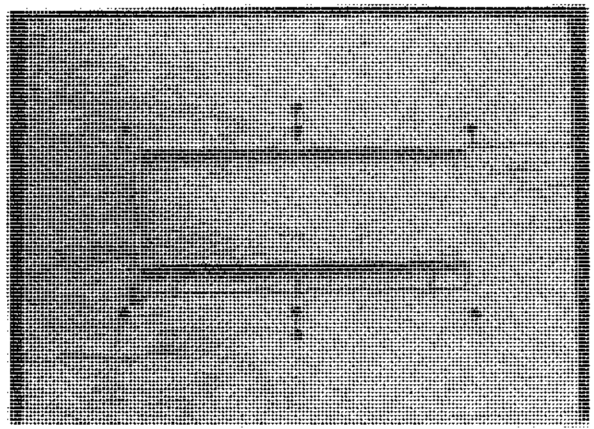


Fig. 24 Fixture 2 which can hold four different configurations of inserts.

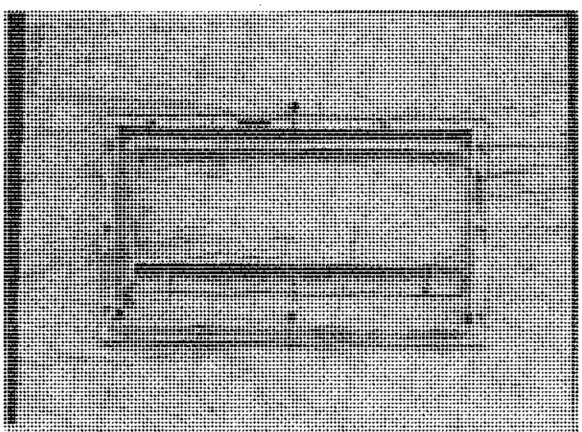


Fig. 25 Fixture 2 holding the insert of L-03.

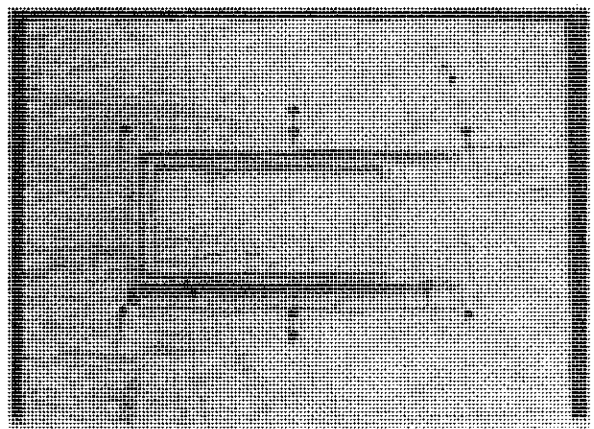


Fig. 26 Fixture 2 holding the insert of LF-27 and LF-28.

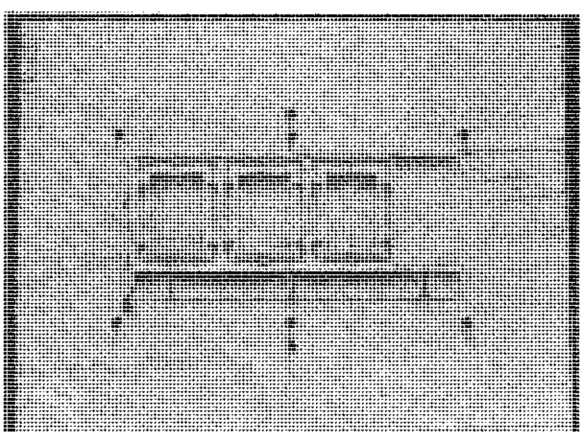


Fig. 28 Fixture 2 holding the insert of L-78 and L-80.

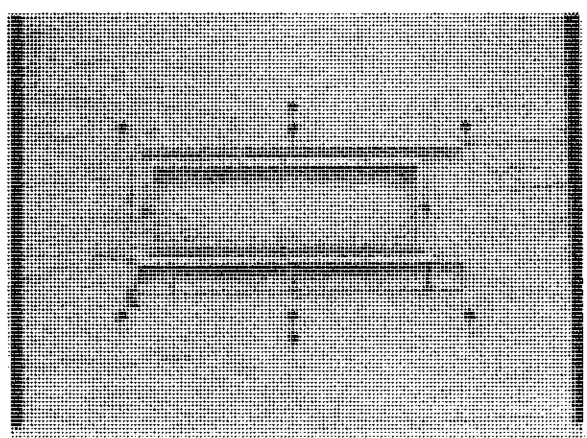
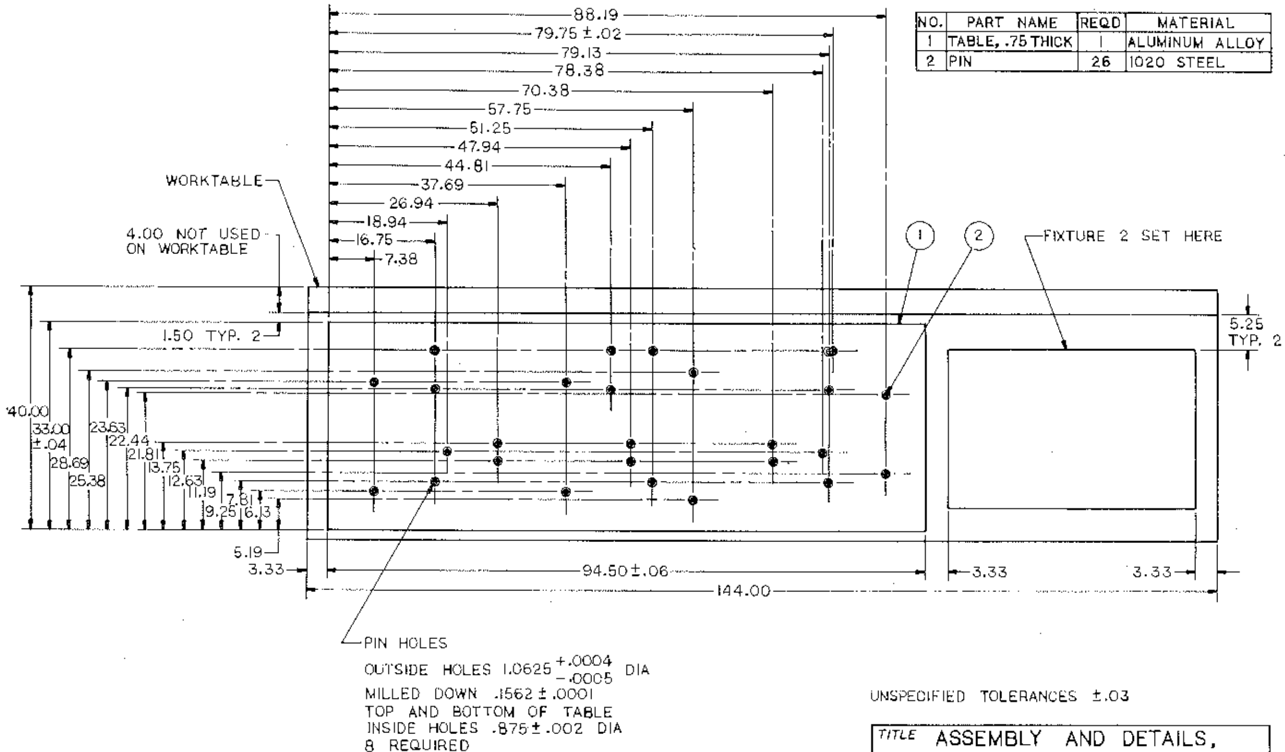


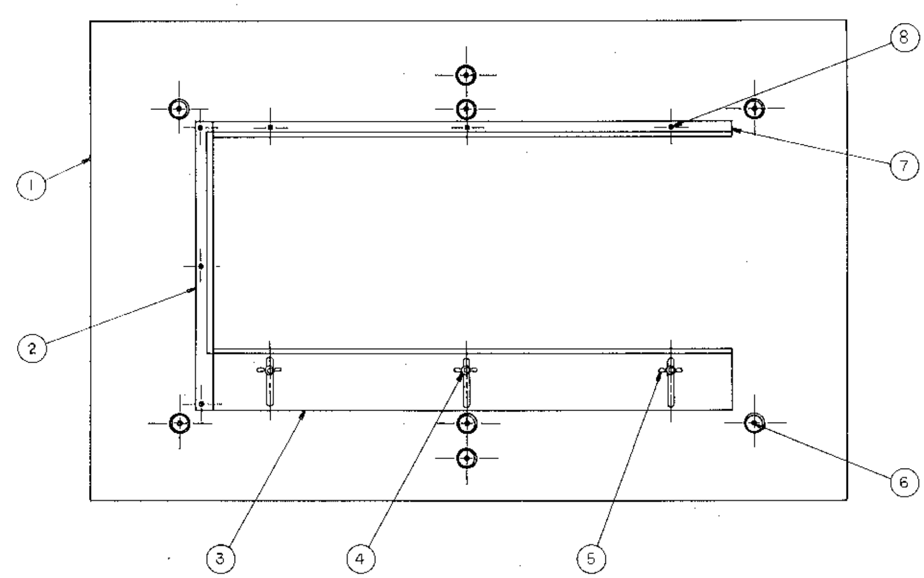
Fig. 27 Fixture 2 holding the insert of L-83.

NO.	PART NAME	REQD	MATERIAL
1	TABLE, .75 THICK	1	ALUMINUM ALLOY
2	PIN	26	1020 STEEL



UNSPECIFIED TOLERANCES ±.03

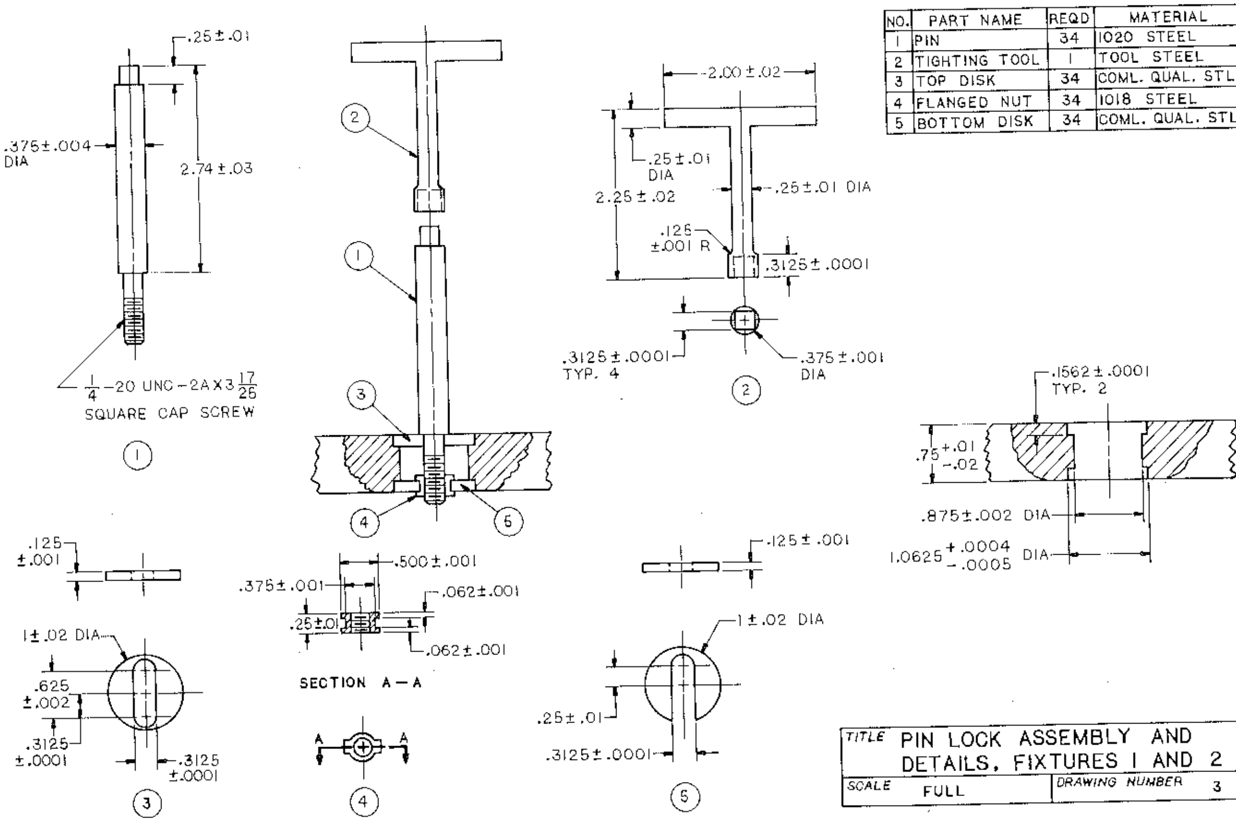
TITLE	ASSEMBLY AND DETAILS, FIXTURE 1		
SCALE	1/12 = 1	DRAWING NUMBER	1



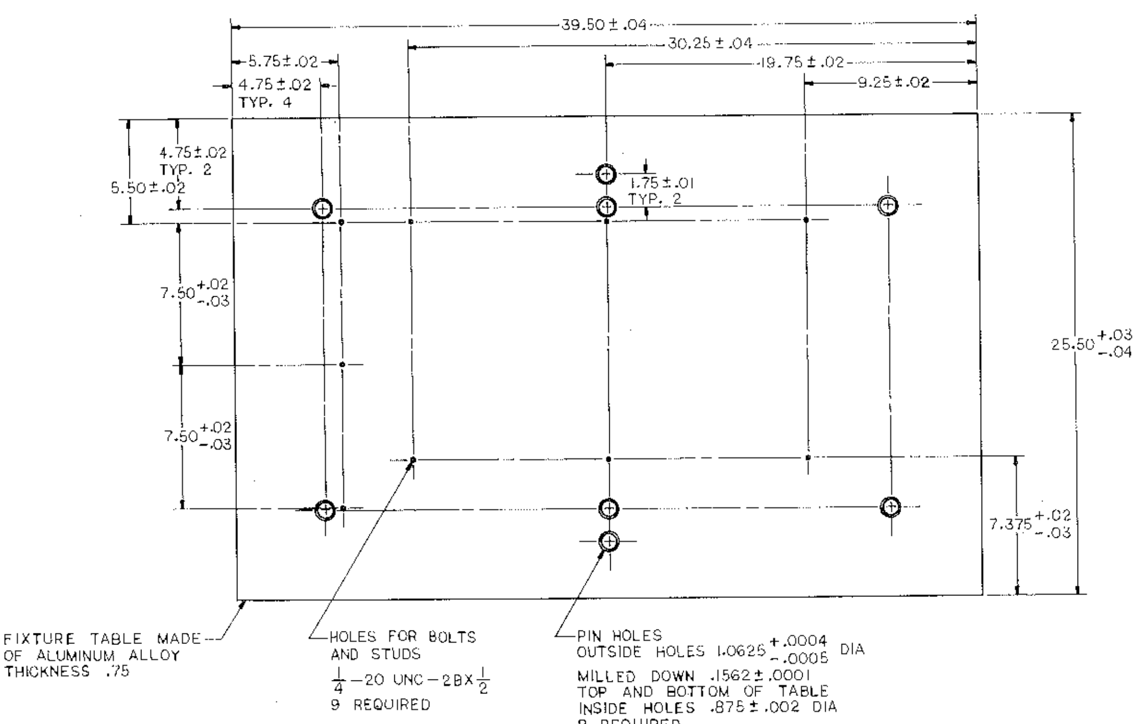
NO.	PART NAME	REQD	MATERIAL
8	BOLT	6	1020 STEEL
7	FIXED RAIL	1	ALUMINUM ALLOY
6	PIN	8	1020 STEEL
5	WING NUT	3	1020 STEEL
4	STUD	3	1020 STEEL
3	MOVABLE RAIL	1	ALUMINUM ALLOY
2	FIXED RAIL	1	ALUMINUM ALLOY
1	TABLE	1	ALUMINUM ALLOY

TITLE	FIXTURE 2 ASSEMBLY		
SCALE	1/4 = 1	DRAWING NUMBER	2

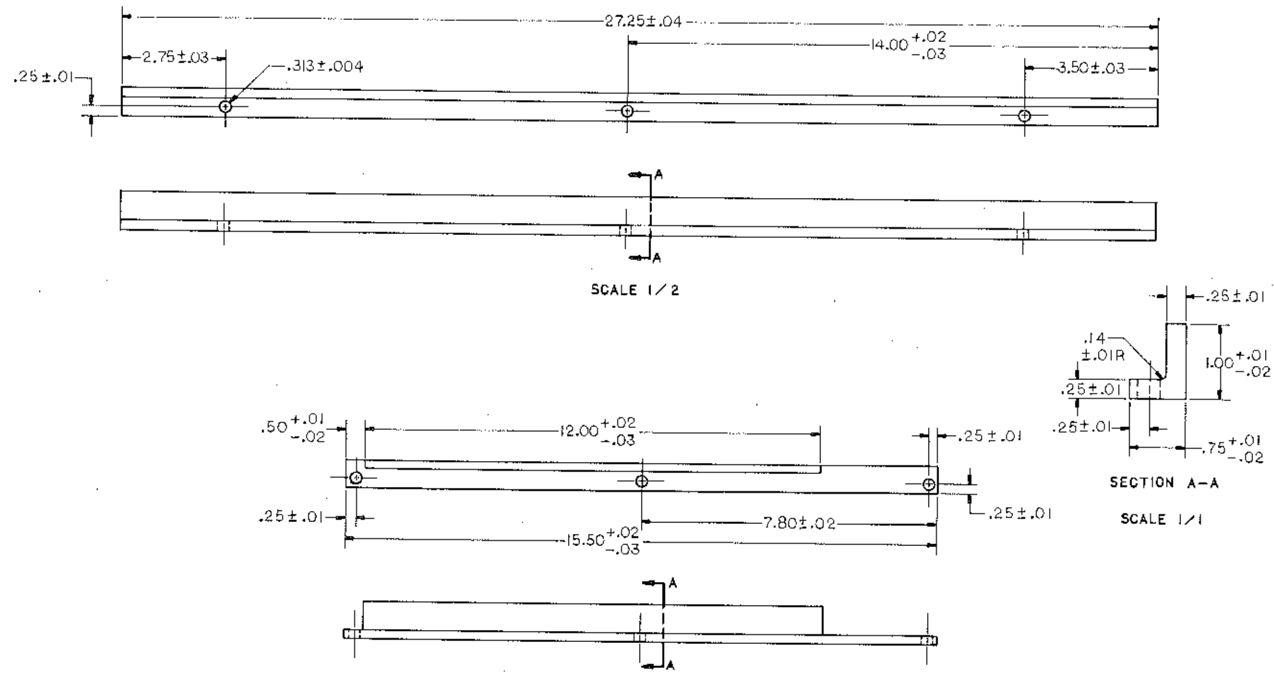
NO.	PART NAME	REQD	MATERIAL
1	PIN	34	1020 STEEL
2	TIGHTING TOOL	1	TOOL STEEL
3	TOP DISK	34	COML. QUAL. STL.
4	FLANGED NUT	34	1018 STEEL
5	BOTTOM DISK	34	COML. QUAL. STL.



TITLE	PIN LOCK ASSEMBLY AND DETAILS, FIXTURES 1 AND 2
SCALE FULL	DRAWING NUMBER 3



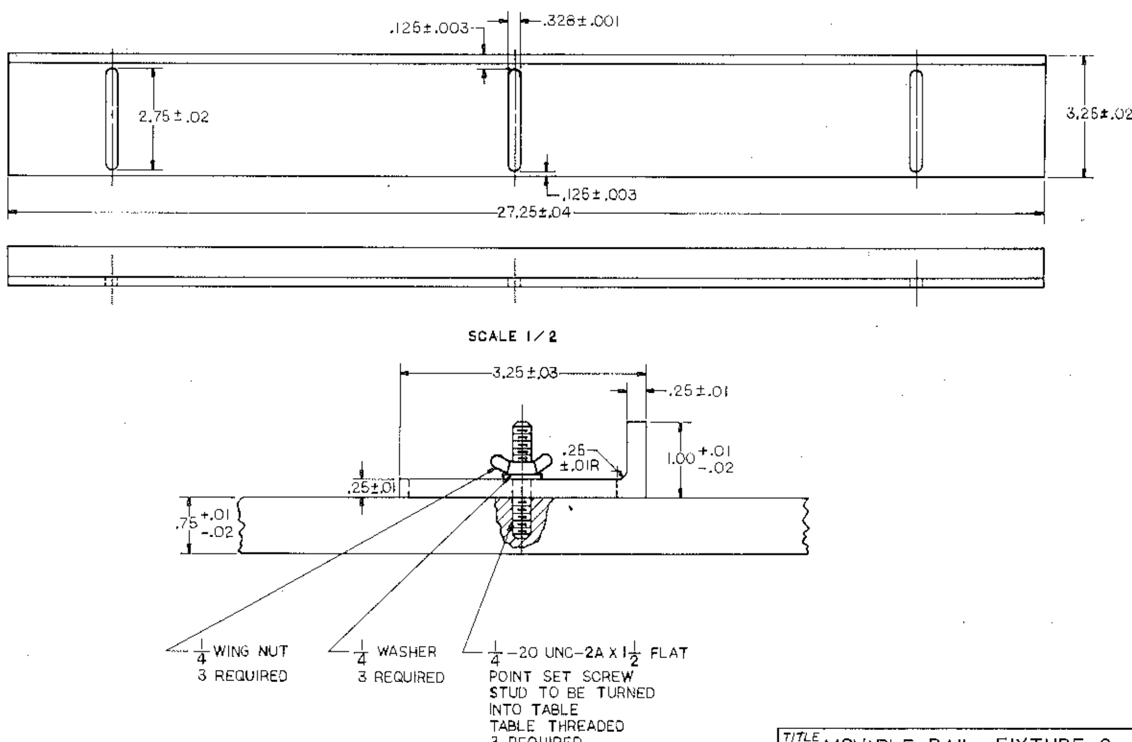
TITLE	TABLE, FIXTURE 2
SCALE 1/4 = 1	DRAWING NUMBER 4



SCALE 1/2

NOTES:
1. RAILS HELD BY $\frac{1}{4}$-20 UNC-2A BOLTS.
2. HOLES IN TABLE THREADED.

TITLE FIXED RAILS, FIXTURE 2	
SCALE AS NOTED	DRAWING NUMBER 5



SCALE 1/1

TITLE MOVABLE RAIL, FIXTURE 2	
SCALE AS NOTED	DRAWING NUMBER 6

FEEDBACK

On November 26, 1980, I invited Mr. Bursk to visit Miami University-Hamilton Campus to inspect the two model fixtures that we designed. He was very satisfied with the work we had done and said that they were simple, workable, and economical. Later, he wrote me two letters describing the two fixtures we designed. The first letter indicated that "Your uniqueness of design is refreshing and most helpful." The second letter described them as "the present project of successfully developing a fixture to increase production and quality of our automatic door light caulking machine encouraged us to continue the program with you.

Since he liked the two fixtures which we designed, we completed assembly and detail drawings for each fixture in late December 1980 and submitted to him four copies of each drawing in early January 1981. He indicated that Pease would make, in September, 1981, a prototype of the two fixtures which we designed and will invite us to the plant to view the operation.

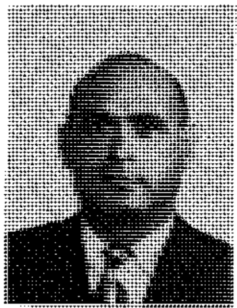
CHALLENGES

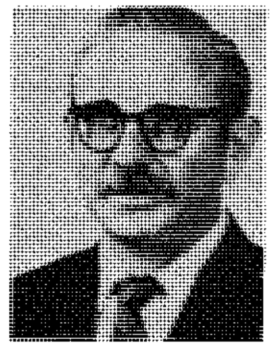
Two major challenges we encountered throughout the process of fixture design were: (a) performing the design work free of charge and (b) finding the time to meet one hour a week for discussion. Since the design work was conducted free of charge, every student involved sometimes showed a lack of enthusiasm, although they were assured, before we started the project, that the extra work would enhance their final grades for the Die Design class which they were taking, and that Mr. Bursk would write each of them a letter of commendation. At the end of the First Semester 1980-81, I carried out my promise to each of the five students and each of them received a letter from Mr. Bursk in January 1981. Another challenge encountered was finding a one hour period per week available to everybody so that we could meet and discuss. Because each student had a different class schedule and two of the five students worked full-time off campus, we usually met with at least one student absent.

CONCLUSION

In closing, conducting this research project in fixture design was significant and rewarding. The two fixtures we designed were of mutual benefit. The Pease Industries, Inc. can use the two fixtures to increase production and quality of the corporation's automatic door light caulking machine. The five students involved in the project and I gained the practical experience of solving problems of fixture design.

COMPUTER AIDED DESIGN OF A DOOR HANDLE





YAAQOV ARWAS
TECHNION - ISRAEL INSTITUTE OF TECHNOLOGY

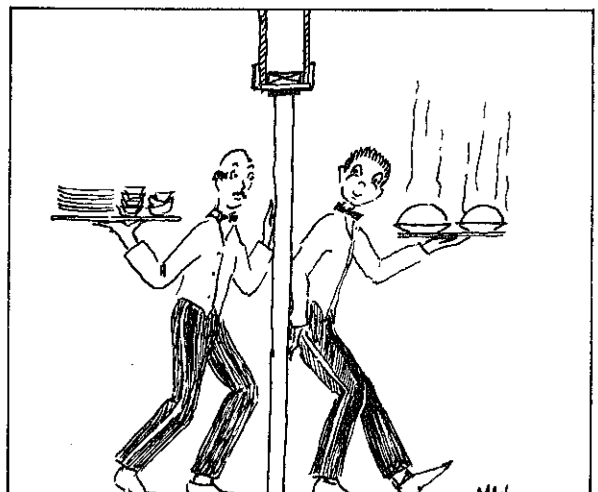
BORAH L. KREIMER
NORTHEASTERN UNIVERSITY

The PUSH-PULL type of door is, in most cases, very practical. However, its handle, or knob, has not been given the attention that it needs.

We all know how frustrating is the feeling that one has when pulling instead of pushing on the "PUSH" side of such a door and vice versa. The fact that the sign "PUSH or PULL" is sometimes added on the door does not necessarily flash an immediate command to the hand nerve. Our computer-mind must first translate the word into the correct command, which may not precede the instinctive gesture of the hand, thus causing the subsequent inconvenience of a conflicting counter-command.

Consideration should also be given to the possibility of someone else being on the opposite side of the door -- assuming that the door is not transparent -- who will resort to pressure in order to cause a movement in the desired direction. This situation could lead to a somewhat frustrating, although very slight, physical pain.

All this generally leads to the shrugging of the user's shoulders without a second thought. That is, until that individual has to use such a door again, presumably, with no better results.



(No Caption Needed)

To solve this problem, the designer will have to determine the requirements for a successful solution before attempting to develop a design. After considering all of the factors involved in the problem, the designer will make a decision as to the best design, hopefully from a variety of several different design concepts answering the requirements of the problem solution.

One possible solution would be to remove the handle - or knob - on the PUSH side of the door, thus eliminating any desire to pull. A plate with an attractive design could be fixed to the door, as shown in Fig. 1. This may be used with or without the addition of the PUSH sign. On the PULL side the door handle should be designed in such a way as to be practical and easy to pull by, both, right-handed and left-handed people. Furthermore, it should facilitate the pulling action while "punishing" the user if he (or she) tries to pull the door.

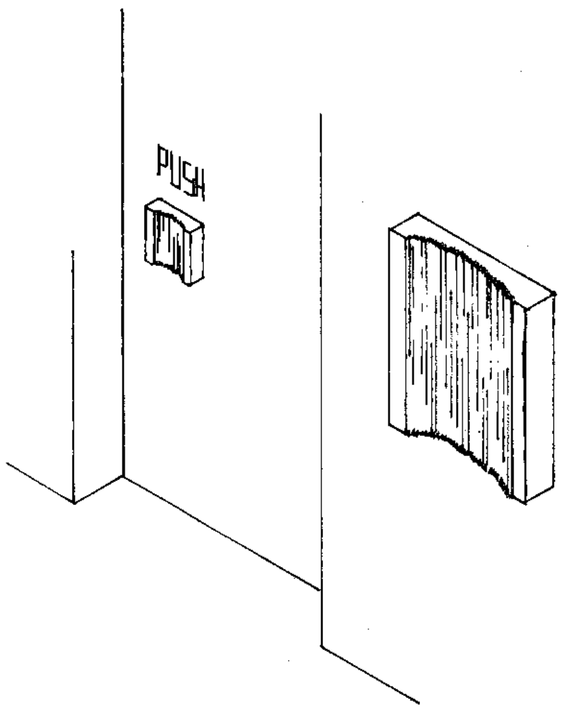


Fig. 1 **The PUSH plate**

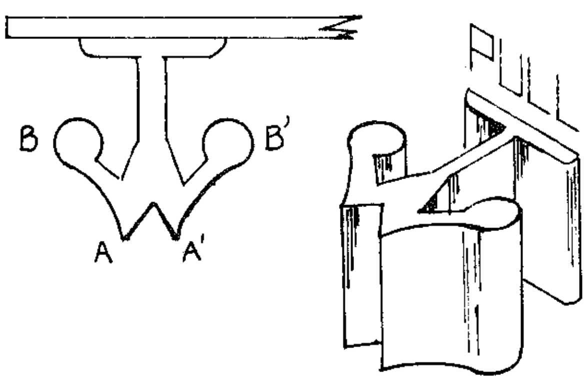


Fig. 2 **The PULL plate**

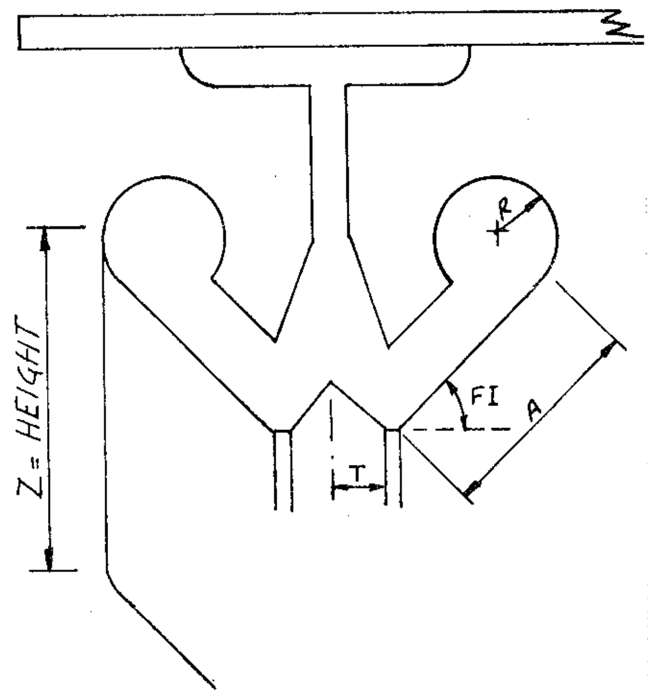


Fig. 3 **The parameters**

These premises led to the design of the door handle shown in Fig. 2, as one alternate solution. This fixture may be with or without the addition of the sign "PULL". Note the somewhat sharp edges at points A and A' to serve as a deterrant to push, while the curved shape at B and at B' invites the individual to pull.

Since we now have a general idea of the concept, it is necessary to find alternatives in order to determine optimal proportions for this design. The parameter dimensions T, R, A, Z and the angle FI, shown in Fig. 3, could, for instance, be given different independent values. Other parameters could replace, or be added to, these as required, thus producing variations from which the designer -- or the customer, for that matter -- could choose.

A computer program in which the parameters T, R, A, Z and FI could be introduced with as many alternate values as desired. This would enable the computer to plot many variations of the design concept. Using FORTRAN IV as the computer language to provide top views and isometric drawings of the handle, the program could be as follows:

```
READ (5,1)T,R,A,Z,FI

CALL PLØT...
CALL PLØT...          ...for straight lines
CALL ARC (XC,YC,R,160,141,161)
CALL ARC (...         ...for Arcs R

CALL PLØT...
CALL PLØT...          ...for more straight lines
```

```
CALL ISØM (T,0.,0.,W1,V1)...starting the
CALL ISØM (...                isometric drawing
CALL PLØT (...
CALL PLØT (...

CALL ELLIPS (WC,ZC,AZ,BZ,180,136,181)...
                   ...for the isometric circle
```

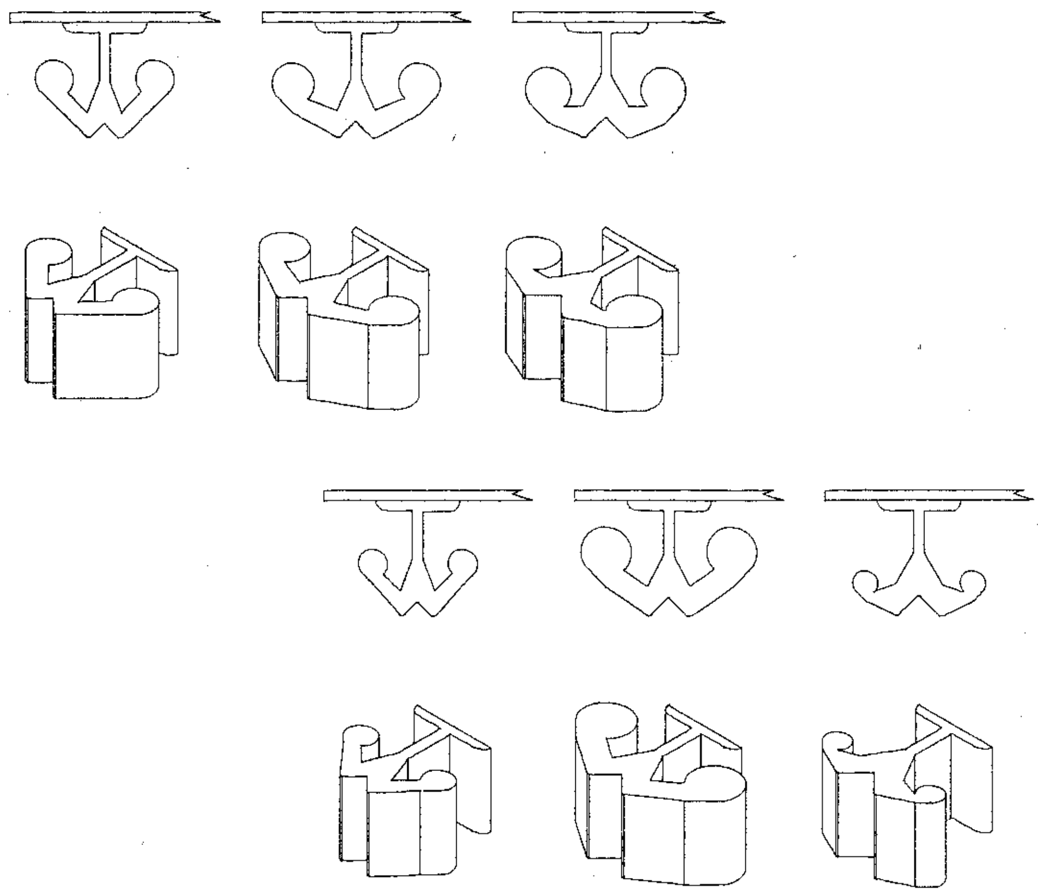


Fig. 4. Various computer-plotted alternatives.

Alternating data for different values of the parameters, in this program, served to produce six (6) different shapes of the concept shown in Fig. 4. These are, obviously, only a few of the many alternatives that could have been produced with little additional effort.

In conclusion, we have gone through typical steps to find a suitable design concept to a problem. Using the computer to plot many variations to a design concept, the designer could determine the optimal shape of this design idea.

RESULTS OF GRAPHICS SURVEY

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The following is a report of the findings of a survey recently conducted concerning the teaching of Graphics in Engineering curricula in ABET accredited institutions. Of 248 Questionaires mailed, there were 142 responses. The results are as shown below.

Question No. 1 Do you teach Descriptive Geometry as a required part of your Engineering curricula?

Yes 79 No 63

Question No. 2 Do you integrate Descriptive Geometry into your Engineering Drawing/Engineering Graphics course? If answer is "Yes", what percent of the course is devoted to Descriptive Geometry?

Yes 94 % *
No 48

*Descriptive Geometry comprises:

60-90%........................4
30-35%........................39
10-25%........................38
5% and below....................5
No percent indicated...........8

The responses (64) of "Yes" to Questions 1 and 2 indicate that Descriptive Geometry is required and integrated into the Engineering Drawing/Engineering Graphics course.

The responses (15) of "Yes" to Question 1 and "No" to Question 2 designate that Descriptive Geometry is a separate course.

Note: The affirmative responses to Question 1 show that over half of the responding institutions require Descriptive Geometry as a part of their Engineering curricula.

The responses (30) of "No" to Question 1 and "Yes" to Question 2 specify that Descriptive Geometry is not required but integrated into the Engineering Drawing/Engineering Graphics course.

The responses (33) of "No" to Questions 1 and 2 point out that Descriptive Geometry is not taught separately or integrated with Engineering Drawing/Engineering Graphics as a required part of the curricula. This does not exclude its being offered as an elective. However, within this group of responses five (5) cases specifically indicate that drawing courses are not offered at all.

Question No. 3 Is your Engineering Graphics a Separate Service Department of Engineering or is it a subsidiary of Civil, Mechanical, or other?

Separate Service Dept. 27
Subsidiary of ** 110

**Subsidiary of:

Mechanical..........................40
Civil...............................11
Engineering/General Engineering.......11
Mechanical & Civil....................6
Engineering Technology................6
Industrial............................5
Engineering Science...................4
Other Engineering Categories..........27

Question No. 4 Does the structure of your drawing course allow for one individual to cover the lecture section and graduate assistants to teach the laboratory sections? If not, would you comment on your arrangements on the back of this page.

Yes 46 No 91

Note: The response of "Yes" to the above indicated that the structure outlined there was comparable to the one that they utilize. The responses of "No" implied that for the most part the same individual had the responsibility for both lab and lecture. Exceptions are noted below.

Responses (7) in which the instructor lectures and has assistants (other faculty, graduates or undergraduates) do the lab work. Included in this group are three cases in which the instructor is present in the lab with the students.

Responses (3) in which graduates handle the complete section, both lab and lecture, under the supervision of a faculty member. In one case the course is self-paced.

Responses (2) in which undergraduates handle the complete section (both lecture and lab) under advisement from faculty in charge.

Responses (2) in which undergraduates do just the lab work with guidance from the faculty in charge of the graphics program.

Responses (2) in which the lecture material is either audio-visual or audio-tutorial format with a teaching assistant for lab or with the same instructor coordinating the tutorial and lab.

Responses (2) in which Graphics is integrated into another course taught by either faculty or graduate assistants.

Question No. 5 What are the credentials of the faculty (full-time only) in your institution who teach the Graphics course? Indicate number in each category using the highest degree only.

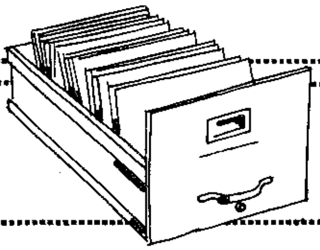
Title	Engineering Degrees			Other Degrees	Years in Industry			
	BS	MS	PHD		1-5	6-10	12-23	25-35
Instr.	44				26	4	-	-
		35			30	4	2	-
(PE-1)*			1		1	-	-	-
				16	1	-	4	-
Ass't	10				4	2	1	-
Prof.		79			29	22	10	4
(PE-16)*			37		23	9	3	-
				8	-	3	-	-
Assoc.	7				2	-	-	-
Prof.		74			23	16	15	-
(PE-23)*			39		18	11	4	-
				2	1	1	-	-
Full	3				1	-	1	-
Prof.		39			16	7	2	-
(PE-14)*			39		16	17	7	-
				2	1	-	2	-
Totals	64	227	116					

* Number of faculty reported as being Professional Engineers.

The cooperation of all respondents is greatly appreciated. If I can be of further service, please do not hesitate to contact me.

Betty J. Butler
Instructor, Engineering Graphics
UMC-UMKC
Old Library Bldg.
Room 303
Kansas City, Mo. 64110

file to file

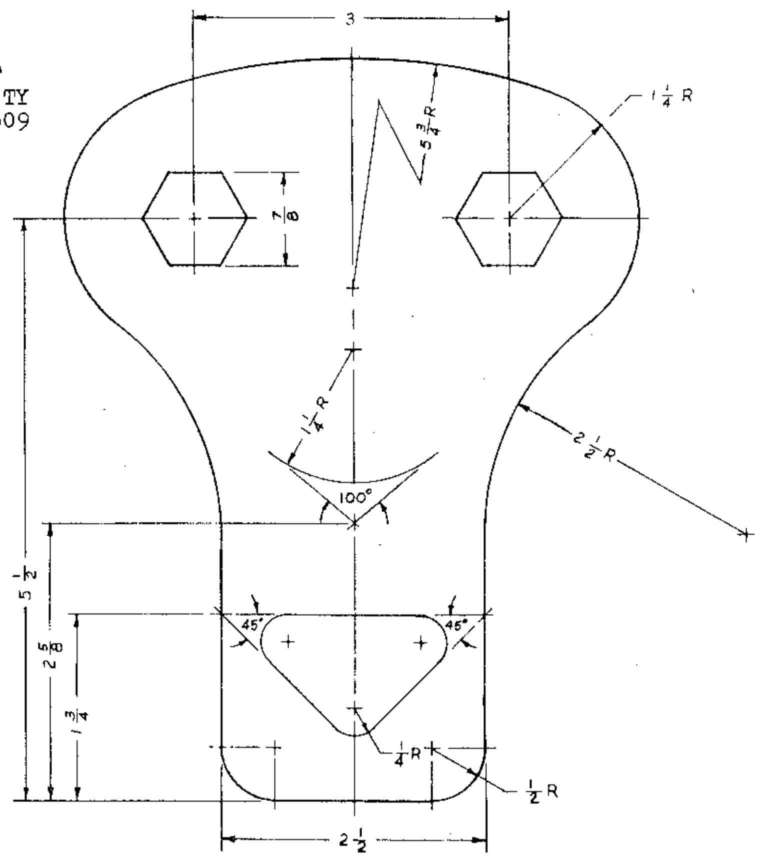


Many "on the line" teachers have ideas, suggestions, techniques, problems and questions they would like to share with the society. "File to File" provides the place for exchange of professional information. If you have an item for exchange, submit it to "File to File", EDGD Journal, PO Drawer HT, Miss State, MS, 39762.

Note: This exercise was passed along to us by Pat Kelso, who happened to be cleaning off his desk this last year as he moved from one office to another. The letter to Pat is dated 1979 -- does this sound familiar to any of you out there in "teaching Land"? Anyhow, Pat forwarded it on to me, and since I continually rack my books and brain for something other than an offset cam (for a geometric construction exercise), I thought this was interesting, and warranted sharing with the readership. Hope this tickles your drawing instruments, as it did mine! --Ed.

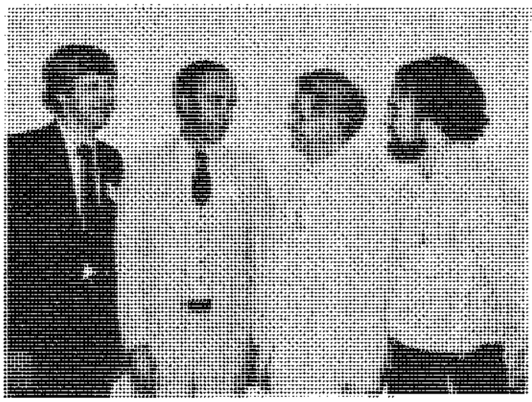
FUN DRAWING

DONALD L. ELFERT
ENGINEERING DEPARTMENT
McNEESE STATE UNIVERSITY
LAKE CHARLES, LA 70609

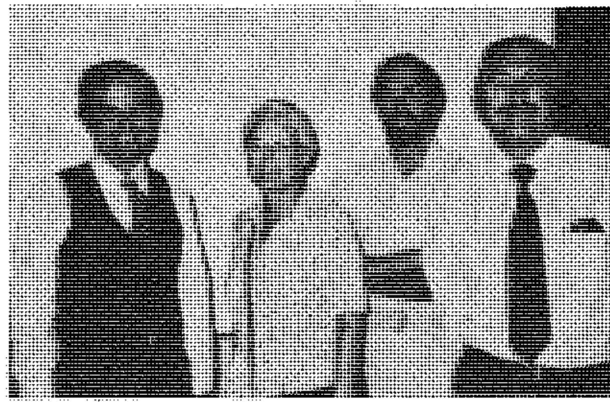


Application of an important graphics principle in the classroom is often accomplished with an exercise which is boring to students. One exercise is usually needed to apply each principle. Thus, many are required to "cover the material". The accompanying figure was developed in an effort to put a little FUN in learning graphic geometry and to include the most important principles of that topic. It will be obvious to the graphics teacher that the drawing includes: (1) an arc tangent to a right angle, (2) an arc tangent to an acute angle, (3) an arc tangent to an obtuse angle, (4) an arc tangent to two arcs, (5) an arc tangetn to an arc and straight line, and (6) hexagons. Try it and have FUN.

ANNUAL MEETING

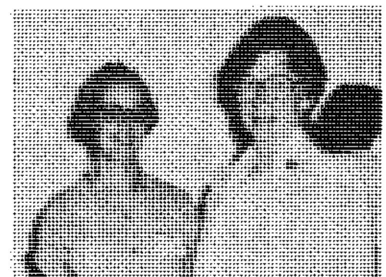


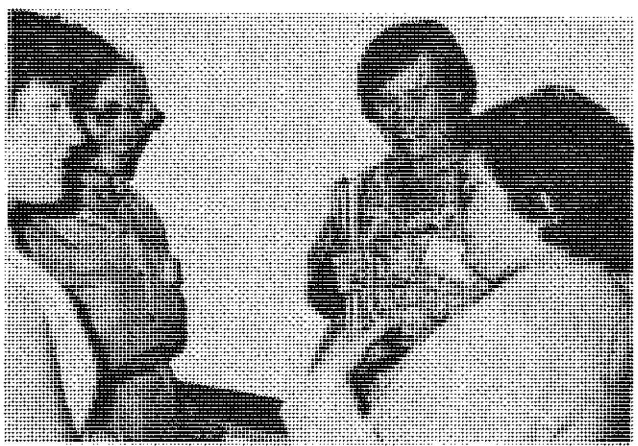
SESSION 1638: Needs of Computer Graphics Staff in Industry:
L to R: C.J. Bluhm (Whirlpool corp.); Victor Langer (MATS); R. McDougal (U. of Nebraska); Mark Shepard (RPI).

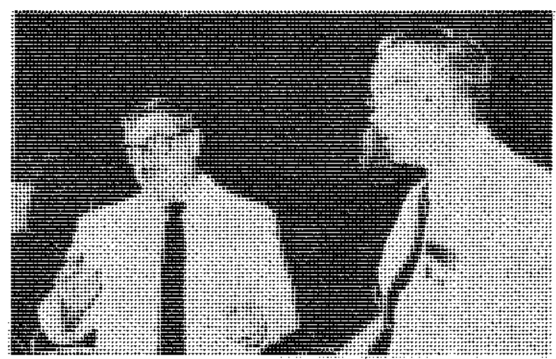


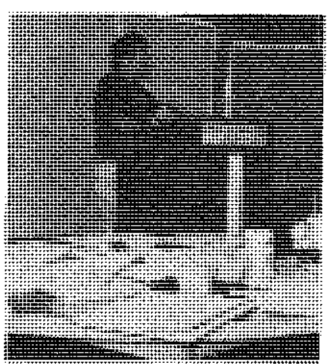
SESSION 3238: Human Factors in Engineering Education.
L to R: Gene Garfinkle (Design Group); Betty Prescott (USC/EDGD/Prog.Chr.); John Kreifeldt, (Tufts Univ.); Robert Bescoe (Prof. Improvmnt. Company).

SESSION 2238: Women in Engineering: A Status Report.
Clockwise Photos: Lois Greenfield (U. of Wisc.) and Ada Pressman (S.W.E.); Bill LeBold and Blaine Butler (Purdue Univ.); Gayle Mitchell (Miss. State), Greenfield, Lois Graham (I.I.T.), and Mary Kummer (Penn. State. Univ.).





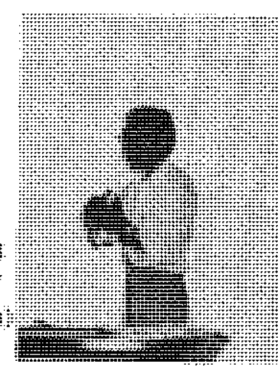




SESSION 3438: EDGD Business Luncheon.
Paul DeJong at the podium.

SESSION 3538: How Geometric Dimensioning and Tolerancing Can Save Industry Money.

George Tokunaga (Lawrence Livermore Lab.) and his presentation.

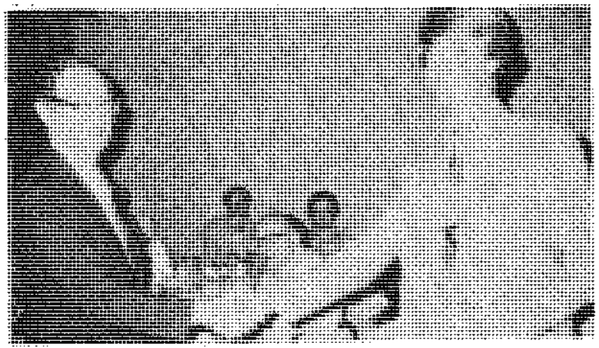


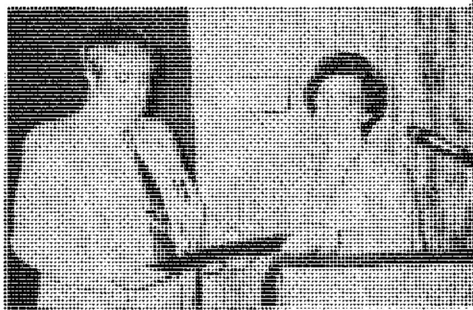
ENGINEERING DESIGN GRAPHICS DIVISION

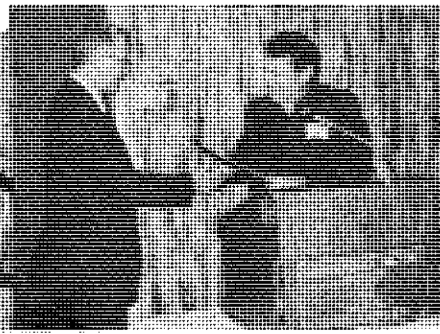
ANNUAL MEETING

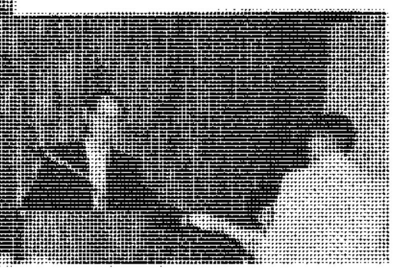
SESSION 2738: EDGD Awards Banquet.

Clockwise Photos: Robert Foster presents 2nd place freshman award to Dan Hegel (Arizona State Univ.); Foster (Penn State) presents Senior Division award to Lee Billow (U.S. Naval Academy); Outgoing Chair, Paul DeJong (Iowa State) receiving plaque from Incoming Chair, Jack C. Brown, (Univ. of Alabama); Sentimental Robert D. Larue (Ohio State) receiving the Distinguished Service Award from Past Chair, Amogene DeVaney.

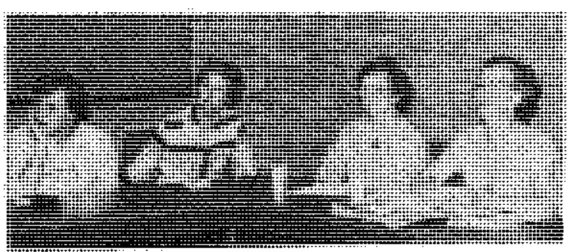






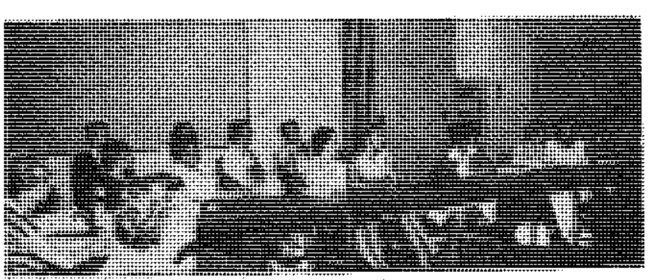


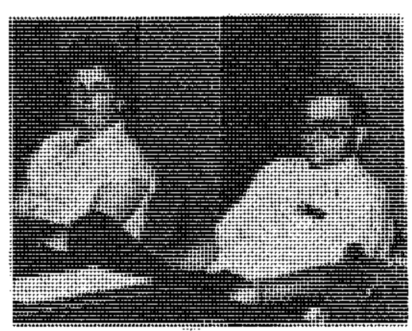
Again, the Journal is indebted to Margaret Eller for the photographs of the sessions at the USC Annual Meeting which you see on these two pages. As usual, Margaret has outdone herself. Betty Prescott, Program Chair for this meeting, really put together some interesting and informative sessions. To both of these ladies, as well as the session moderators and participants, we give our appreciation for a job well done.-= Ed.



SESSION 3695: Engineering-Academ a or Industry? (Co-sponsored by EDGD)

Clockwise Photos: (Below), Pat Shamany and Larry Goss (Indiana State Univ.); Standing Room, Only (SRO) Crowd at session's question and answer period; (Top Left), Lois Graham, Margaret Eller (How'd she do that?), Amogene Devaney, and Betty Lou Bailey (G.E.).





ENGINEERING DESIGN GRAPHICS DIVISION

ANNUAL CONFERENCE 1981
EDGD ANNUAL REPORTS

CHAIR'S REPORT

The Chair is pleased to report that as a consequence of the effort of a great number of talented people, and through no fault of his own, the Division has had a very successful year.

We have gained some 47 new members according to lists sent by ASEE. Each of these has been sent a letter of welcome by the Chair and we hope to see them at our future meetings. Garland Hilliard is working at reidentifying all the inactive members and contacting them.

Our Midyear conference at Williamsburg was a huge success, with fine technical sessions, superb hospitality, fascinating tours, and excellent comraderie. Our sincere thanks to its contributers and to Bud Devens, his staff, and their wives for yet another job well done. We also thank Frank Oppenheimer for continuing his philanthropic work with the Oppenheimer Award, which was won by Larry Goss.

Mary Jasper and her staff produced three more outstanding issues of the JOURNAL under difficult conditions arising from high enrollment and heavy workloads. We owe a great deal -- as many will attest -- to the Brown Publishing Company and Ed. O'Neill and his staff who work hard to produce the JOURNAL at a ridiculously low price to the Division. Without their help, it is questionable that the JOURNAL could survive.

The Creative Engineering Design Display continues to be an important element in the Society's Annual Conference. Bob Foster and his committee have coordinated a smooth-running display and enlisted the aid of a group of distinguished judges to help in the design competition. Millie Rising again gave $100 for the James S. Rising Award which goes to the First Place Freshman Team in this year's display.

As a follow-up of the recommendations of the Freshman committee, both NSPE and ABET were contacted to obtain their endorsement of graphics as a necessary element of engineering education. We have, so far, received good response to this effort. NSPE's Practice Division is unanimously in support of our initiative. ABET will next meet in October and has the item on its agenda.

We continue to have many challenges. The Division needs more members from the Western states. I sincerely hope that some of the casual attendees at the 1981 conference will become active members. Travel costs can be expected to affect greatly attendance at future Annual and Midyear conferences, and more Section activity is needed to assure that Section conferences can provide the interaction needed in the Society and our Division in particular.

This also means that communications through the JOURNAL and possibly Newsletter will become more important to maintain member contacts. All of these -- membership, Section activity, and communications, present great challenges to the Division and must be faced if the Division is to maintain a position of leadership in the academic community.

Unfortunately, the Chair has very little control over these in the final analysis; it is in the hands of those officers who are "on the firing line" to make great changes. Dedication and hard work are the only means to attain these ends; the statement that "there's no free lunch" applies well.

To the new officers, my congratulations and best wishes in working with these challenges.

Paul S. DeJong, P.E.
Chair
EDGD

LIAISON COMMITTEES

Liaison Director

Merwin L. Weed
Penn State University
McKeesport, PA 15131
Phone: 412 678-9501 (Office
412 673-5351 (Home)

Committee Chairs

Educational Relations

Margaret W. Eller
5743 Burgundy Avenue
Baton Rouge, LA 70808
Phone: 504 927-5356

Membership Activities

Garland Hilliard
510 Poe Hall
N.C. State University
Raleigh, NC 27607
Phone: 919 737-2234

Industrial Relations

Peter Miller
2827 US 52W
Lafayette, IN 47906
Phone: 317 463-9872

International Relations

Clarence Hall
Louisiana State University
CEBA Hall
Baton Rouge, LA 70803
Phone: 504 388-8781

INDIVIDUAL COMMITTEE REPORTS

Educational Relations

From: Margaret Eller, Educational Relations Chair

1. The past year's activities were activities of the chairman rather than activities of the broup. Although the group had listed topics to explore, the chairman did not coordinate any exploration. The big event this year was the chairman's coordination of event #3695, a joint meeting sponsored by the Women in Academia of SWE, and of Women in Engineering of ASEE. EDGD was one of the co-sponsors of the event on Wednesday, June 24, at 3:45 pm. There was a "full house" for the round-table discussion with "Standing Room Only".

2. Enclosed is the list of committee members as of January 1981. A letter was sent to each of these members at that time. I have heard nothing from any of the Committee since then, and I was too preoccupied to push anyone into doing something.

3. Having been elected to the Board of Directors of the Women in Engineering Committee, and appointed Chair of SWE's Women in Academia Committee, I am offering my resignation as Chair of this committee. I think Ed Galbraith would be a good chairman. I will remain a member of the committee, and if I am needed, will do whatever I can to help.

MEMBERSHIP LIST - 1/81 - EDUCATION COMMITTEE

Edward Galbraith
Ind'l and Mfg. dept.
Cal. State Polytechnic Univ. - Pomona
3801 W. Temple Avenue
Pomona, CA 91768
Phone: 714 598-4365

Jon Duff
Engineering Graphics Dept.
Room 240 Hitchock Hall
Ohio State University
Columbus, OH 43210
Phone: 614 422-1291

Elizabeth A. Prescott
Engineering Technology
San Joaquin Delta College
5151 Pacific Avenue
Stockton, CA 95207
Phone: 209 478-2011 x 230

William A. Miller
Ind'l Education & Technology
Western Carolina University
Cullowhee, NC 28723

Betty J. Butler
UMC/UMKC
Old Library Building
c/o Switchboard
Kansas City, MO 64110
Phone: 816 276-1676

Margaret Eller
5734 Burgundy
Baton Rouge, LA 70806
Phone: 504 927-5356

Membership Activities
From: Garland Hilliard, Chair

We have received 17 new members into the division this year as listed by ASEE. Each new member has received a letter of welcome from our president Paul DeJong and a copy of the JOURNAL.

The committee is also pursuing some 300 division members lost when the $1.50 dues took effect. Each individual will receive a letter and a copy of the JOURNAL.

Industrial Relations

From: Peter Miller, Chair

The committee is working to increase industrial participation in the Engineering Design Graphics Division. A seminar was to be held this past academic year for industrial personnel involved in graphics. Fruits of this effort have not yet been realized.

International Relations

From: Clarence Hall, Chair

Clarence Hall's committee is for the most part the staff at Louisiana State University.

He is working on tentative plans to visit China in connection with his activities with computer graphics. He is interested in the possibility of having an International Conference in Japan.

Closing Comment

It is the hope of the Liaison Director that each member of the Division take it upon himself to recruit new members from both education and industrial circles.

TECHNICAL AND PROFESSIONAL COMMITTEES

Director - 1980-81

Larry Goss
Engineering Technology
Indiana State University
Evansville, IN 47712
Phone: 812 464-1892

Director - 1981-82

Larry Northup
Dept. of Freshman Engineering
Iowa State University - Marston Hall
Ames, IA 50011
Phone: 515 294-8355

Note: In an effort for the membership to understand the workings of the Technical and Professional Committees, Larry Goss, outgoing Director, asked that the charges be reprinted in this Journal as a part of his annual report.-Ed.

Teaching Techniques

Charge: To help in the dissemination of information concerning new developments in media, methods, and techniques for instruction in Engineering Graphics and Design. This activity can involve, but is not limited to, the design, testing, and evaluation of instructional methods in the classroom and reviews of commercially prepared media. Reports from the activities of this committee generally take the form of articles or short items for publication in the EDG JOURNAL and/or papers presented at the annual ASEE or midyear EDG Division meetings.

Freshman Engineering

Charge: To represent the interests of EDGD members who are involved with engineering students at the freshman level outside the traditional graphics and design disciplines. Examples are: orientation, advising, problem solving courses (analysis or computation), and the integrated freshman programs.

Human Factors

Charge: To help the membership of the EDG Division to be knowledgeable about and correctly use human factors information. This committee also strives to coordinate its activities with other divisions of ASEE that also make use of human factors information Reports from the members of this committee frequently are in the form of case histories which are reported at paper sessions during Division and ASEE meetings.

Computer Graphics

Charge: To coordinate and sponsor EDG Division activities regarding the use of computer graphics in teaching, analysis, and communication. Results of the activities of this committee generally take the form of papers presented at the ASEE annual meeting or workshops sponsored by the EDG Division.

Engineering Design Education

Charge: To disseminate information on the teaching of engineering design; particularly at the freshman engineering level and/or in conjunction with graphics, computation, or survey courses in engineering fundamentals.

Metrication

Charge: To support and aid the membership of the EDG Division to properly utilize SI units in graphics and design courses. Activities of this committee generally include sponsoring paper sessions at meetings and/ or articles for publication in the EDG JOURNAL.

Theoretical Graphics

Charge: To help the membership of the EDG Division to extend its knowledge in the theory of graphical representation and analysis. Activities of members of this committee generally result in articles submitted for publication to the EDG JOURNAL.

PROGRAM

Director - 1981-82

Rollie Jenison
Dept. of Freshman Engrg.
Iowa State University - Marston Hall
Ames, Iowa 50011
Phone: 515 294-8355

CURRENT AND FUTURE PROGRAMS

June 21-25, 1981

1981 Annual Meeting
USC - Los Angeles
Pgm. Chr. - Betty Prescott
San Joaquin Delta College
5151 Pacific Avenue
Stockton, CA 96207
Phone: 209 478-2011 x 236

January 3 - 5, 1982

1981-82 Midyear Meeting
University of Louisville, KY
Pgm. Chr. - Barry Crittenden
Div. of Engineering Fundamentals
VPI & SU
Blacksburg, VA 24061
Phone: 703 961-5011

June 21-24, 1982

1982 Annual Meeting
Texas A & M, College Station, TX
Pgm. Chr. - Ron Barr
Mechanical Engineering Department
University of Texas
Austin, TX 78712
Phone: 512 471-1482

Comments

Many challenges face those of us involved in engineering education. Our programs will be addressing these challenges. We need to be solving the problems of increasing enrollment, of hiring and maintaining quality faculty, and of improving our courses and instruction in the areas of graphics and design. We need to take advantage of the exciting opportunities available in computer graphics, metrication and innovative teaching methods.

If you would like to present a paper or be a session coordinator, please contact the appropriate program chairman. We need your expertise and we can provide the forum for you to inform us of your new and innovative ideas.

I wish to extend my thanks to Betty Prescott for her efforts in organizing an excellent program for the Los Angeles meeting. I know Barry and Ron are working to develop strong programs for Louisville and Texas A & M. Let's give them our support.

CANDIDATES FOR OFFICE

VICE-CHAIRMAN (1982-1983)

Larry D. Goss
Indiana State University
Evansville, IN

Larry served on the faculty at Oklahoma State, the West Virginia Institute of Technology, and has been at ISU/Evansville since 1975.

A member of ASEE since 1966, Larry has been involved with the EDGD (Director of Technical and Professional Activities, 1978-1981, Program Chairman for the Mid-year Meeting at U. of Alabama in 1978) and the ERM, conducting twelve effective teaching institutes. He won the Dow Award in 1971.

Larry is involved in Graphic Consulting activities with Industry, and has an on-going interest in geneology. In addition he tunes pianos and repairs small gasoline engines -- for fun and profit.

Mary A. Jasper
Mississippi State University
Miss. State, MS

Mary tagged along to the ASEE meeting in Lubbock in 1972 and got involved in Creative Design the next year. She has served on the Creative Engineering Design Display Committee, and has chaired the Engineering Design Education Committee in the Division.

She is on the staff of the Engineering Graphics Department at Miss. State, and is responsible for coordinating the computer graphics effort there. In addition, she is presently serving her last year as Director of Publications/Journal Editor.

Her "spare"time is devoted to her family -- a very understanding husband, five teen-agers, three dogs, and five cats.

SECRETARY-TREASURER (1982-1985)

Francis Mosillo
University of Illinois - at Chicago Circle
Chicago, IL

Francis has been teaching at the University of Illinois (Chicago Campuses) since 1955. His current interests and activities are in the CAD/CAM area and he has assisted in coordinating many sessions for the annual meetings in the computer graphics area.

His current division responsibilities are as chairman of the Computer Graphics and Zone II Committees. He has (1) articles published in ERM, EDGJ and others; (2) delivered several papers at the annual ASEE meetings; and (3) has published a workbook-text for freshmen in Engineering/Computer Graphics.

Ed Mochel
University of Virginia
Charlottesville, VA

Ed has a B.S. and M.S.s

Ed has a B.S. in Ch.E. and a M.S. in Engineering Graphics from Illinois Institute of Technology. He has been a member of the EDG Division for many years, serving as Chair of the Computer Graphics Committee, Metrication Committee and has led a summer school in Computer Graphics at Texas Tech University.

He is a regular participant in Annual and Mid-Year meetings and has presented papers at several of the more recent conferences. He has authored a text-book in Engineering Graphics, in addition.

DIRECTOR OF PUBLICATIONS - Editor (EDG Journal) - (1982-1985)

Robert P. Kelso
Louisiana Tech. University
Ruston, LA

Pat left the presidency of his stock-brokerage firm to begin teaching in 1973. He is assistant professor in the department of Computer Science and Industrial Engineering at Louisiana Tech, with a B.A. in physics and math and an M.A. in art. His teaching experience includes four courses which he developed personally, and he is presently involved in "doing" computer graphics.

He is a recipient of the Distinguished Engineering Service Award from LA. Tech. Engineering Foundation, has received several grants and engages in professional business consulting and text reviewing. He has had a number of articles published in the EDG Journal and is currently Assistant Editor of the "Puzzle Corner".

Jon M. Duff
Ohio State University
Columbus, OH

Jon (pronounced "yawn") received his B.S. and M.S. degrees in Industrial Education from Purdue University, and his Ph.D. degree in Technical Art Education from Ohio State University, where he is presently teaching.

He has been active in the EDGD for several years, and has presented several papers at Annual and Mid-Year conferences, and is a regular contributer to the EDG Journal.

Jon has had experience as a Layout and Keyline Artist, Design Illustrator, Medical and Scientific Illustrator, Graphic Consultant and Educational Package Designer.

ENGINEERING DESIGN GRAPHICS DIVISION - ASEE

PUZZLE CORNER

PROF. ROBERT P. KELSO, ASS'T EDITOR
ENGINEERING DESIGN GRAPHICS JOURNAL
DEPT IND ENGINEERING & COMP SCIENCE
LOUISIANA TECH UNIVERSITY
RUSTON, LA 71272

SPRING AND FALL '81 PUZZLE

Given: Four non-parallel unlimited skew lines in general positions.

Determine: The center of the sphere which is tangent to all the given lines.

Sharpen your lead! Switch on the computer! There is still no solution to the Spring '81 puzzle! For your chance at immorality, mail solutions to Bob Kelso before March 1, 1982.

The solutions of our good friend (we hope), Abe Rotenberg of University of Melbourne, missed the deadline for the Spring '81 issue. As usual, they are "beauts." Fig. 1 is the problem. Fig. 2 and Fig. 3, with explanations are Abe's solution to No. 1 (in Fig. 1). In the Spring '81 solution to this problem, Chi Di Lin of Anhwei Institute of Technology, the P. R. of China, derived the answer: $A=\sqrt{25+12\sqrt{3}}$ which we simplified to 6.7664... Abe's answer: A = 20/3, which we simplify to 6.6666.... Why this difference, we are not sure. If it is profound, perchance, we will want to hear from the principals or other interested readers (by the December 15, 1981, deadline, please).

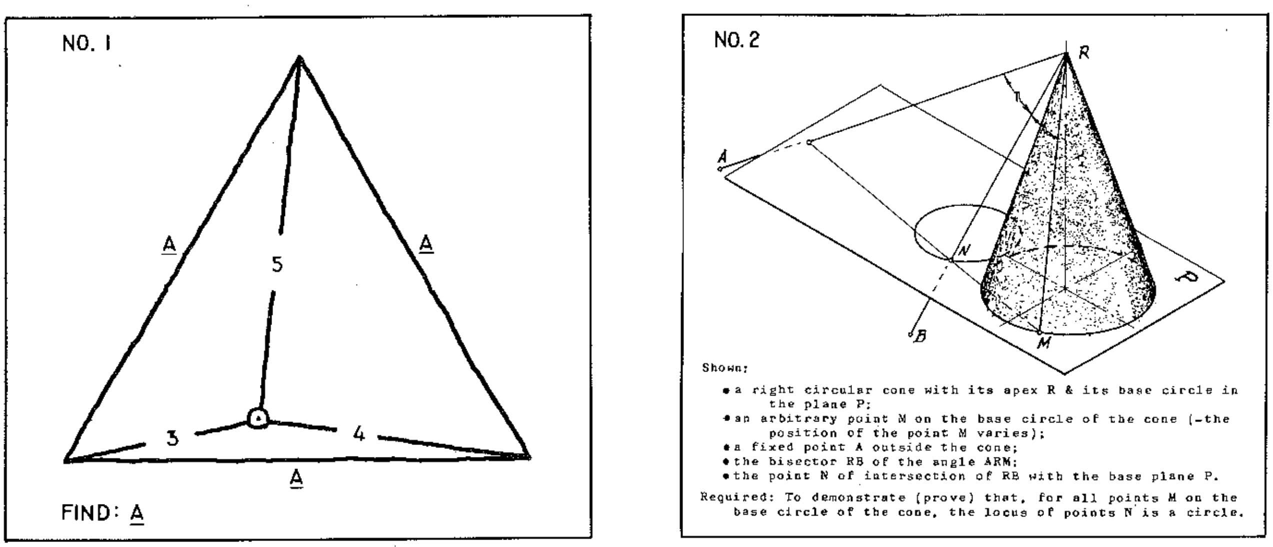


FIG 1

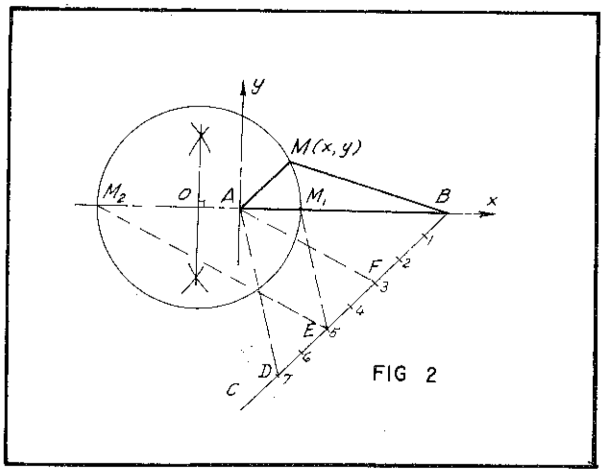


FIG 2

Fig. 4 and explanation are Abe's solution to No. 2 (in Fig. 1). Recall that Abe posed this problem.

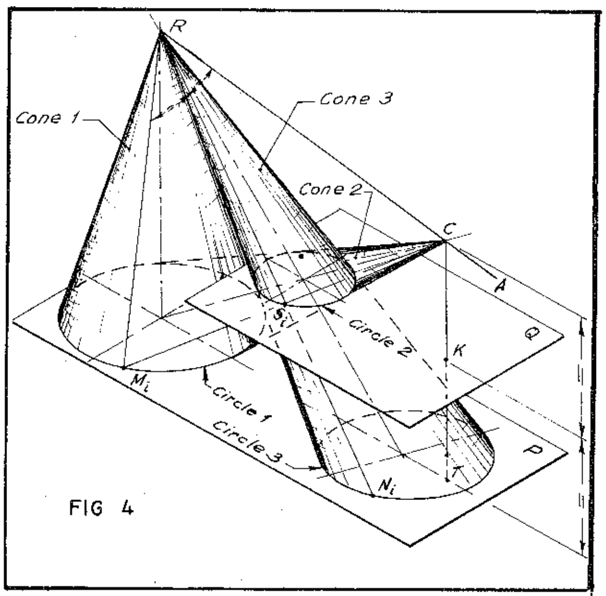


FIG 4

In the Fall '80 issue, it was posed: does a solution exist, given Fig. 5? If so, is there a limit to the number of concentric circles for which solutions continue to exist? Wang Shu of China University of Science and Technology, People's Republic of China, eloquently states his conclusion:

> "After mature consideration I may say that no solution exists.... A limit to the number of concentric circles there is only two. If the number of concentric circles be increased, more unvisible circles will tend to appear."

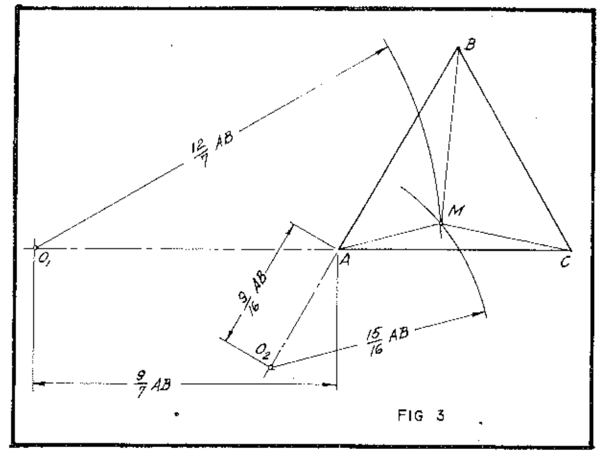


FIG 3

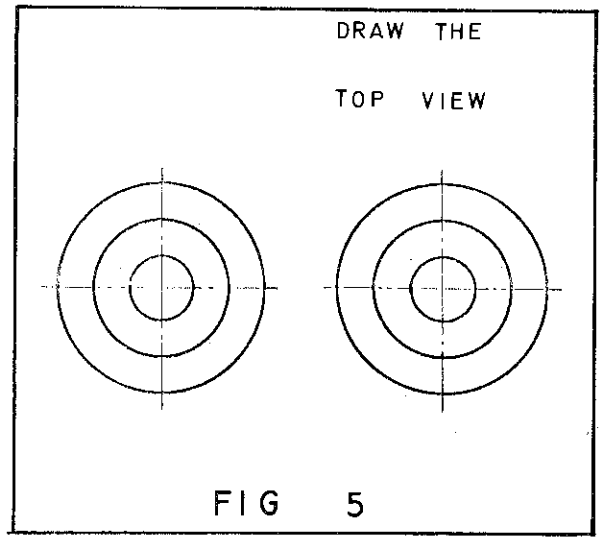


FIG 5

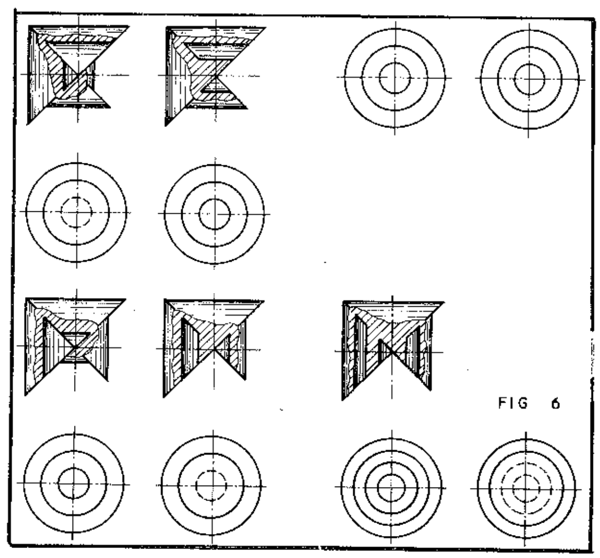


FIG 6

A SOLUTION TO PROBLEM NO. 1

(Figure 3)

(i) Construct an equilateral triangle ABC

(ii) Using t=3/4, construct a circle with radius R_1 = 12AB/7 and AO_1 = 9AB/7

(iii) Using t=3/5, construct a circle with radius R_2 = 15AB/16 and AO_2 = 9AB/16

M is that point of intersection of the two circles which is inside the triange ABC and it satisfies the condition AM:BM:CM = 3:5:4

(iv) Define the scale of the drawing:

A=3AB/AM=4AB/CM=5AB/BM=20/3

NOTE: The values of R_1, R_2, AO_1 and AO_2 need not be calculated; they may be obtained as a result of the following construction (Fig. 1): Let t=a/b, where a and b are positive integers. Draw an arbitrary line BC. Plot (a+b) arbitrary but equal divisions on BC. In Fig. 1 a=2 & b=5. BD=a+b divisions, BE=b divisions and BF = a-b divisions. Draw DA and EM_1 // DA to locate M_1. Draw FA and EM_2 // FA to locate M_2. Construct O as the midpoint of M_1M_2 (i.e., $OM_1=OM_2$). O is the required centre & OM_1 the radius of the circle.

A SOLUTION TO PROBLEM NO. 1

We begin with proving the following:

THEOREM: Let AB (Figure 2) be a line segment of unit length and t a real positive number, $t \neq 1$. Then, the geometric locus of points M are such that AM/BM = t is a circle with radius R (see below) and centre O collinear with AB, where

$$AO = t^2/(1 - t^2); \quad R^2 = t^2/(1 - t^2)^2$$

PROOF: $AM^2=x^2+y^2$; $BM^2=(1-x)^2+y^2$

Hence, $(x^2+y^2)/((1-x^2)+y^2) = t^2$

or

$$(x + t^2/(1-t^2))^2 + y^2 = (t/(1-t^2))^2 \qquad (1)$$

Equation (1) represents a circle with Radius R and centre O such that

$$R^2 = t^2/(1 - t^2)^2; \; AO=t^2/(1-t^2) \text{ Q.E.D}$$

NOTE: AO and AB have the same direction for t less than unity, opposite directions for t greater than unity.

SOLUTION TO FALL '80 PUZZLE NO. 2

In Fig. 4 let Cone 1 be the given right circular cone; R, the vertex of Cone 1; P, the given plane perpendicular to the axis of rotation of Cone 1; Circle 1, the line of intersection of Cone 1 with P; A, the given point; M_i, an arbitrary point on Circle 1; C, a point on the line RA such that $RC=RM_i$; T, a point of P such that CT is perpendicular to P; K, a point of CT such that KC=KT; and Q, a plane parallel to P through K.

The locus of all lines CM_i is the oblique conical surface Cone 2. The line of intersection of Cone 2 with the plane Q is the Circle 2, every point S_i of which divides the respective generator CM_i of Cone 2 into two equal parts, i.e., $CS_i = S_iM_i$.

Consider the triangle RCM_i: since $RC=RM_i$ and $CS_i=S_iM_i$, RS_i is the bisector of $\angle CRM_i$.

Consider now the oblique Cone 3 with vertex R and Circle 2 as its directrix: since P // Q, the line of intersection of Cone 2 with the plane P is a circle (Circle 3) which also is the locus of points N_i of intersection of the bisectors RS_i with the plane P. Q.E.D.

(Note his, we think well chosen, "unvisible" --- as opposed to "invisible.") Fig. 6 is his very elegant graphic and seems to be an every-possible (best)-case type of analysis.

FALL '79 PUZZLE

Given: Two adjacent orthographic views of an angle of general size defined by intersecting lines of general lengths and in general positions.

Required: A Non-Normal orthographic view* of the plane of the angle such that the angle appears true size.

*and, if possible, all the views such that the angle appears true size as defined by a General Solution (see Puzzle Corner, Winter '79, Spring '79, and below).

FIG 7

Fig. 7 is the Fall '79 puzzle. Abe (and the 'corner') submitted solutions which the 'corner' labeled (Spring '80) as General Solutions. But, these are not general solutions. They are Conditional Invariants as identified by Abe in his article (Spring '81), "On Conditional Invariants of Orthographic Projections." His article, in the opinion of the "corner," is significant because it identifies a broader class of solutions than hitherto identified in Descriptive Geometry (we think). For example, the General Solution seems to be a subset of Conditional Invariants. In any event, we are going to try and "fix" the Spring '80 Puzzle Corner, at least as it applies to Abe's solution. We will try to fix the "corner" submission at a later date.

Fig. 8-A is from Abe's "Conditional Invariant" Spring '81 paper and is also the solution to Fig. 7. AOC is the given angle. Through line CO, plane P is passed to any general position. From any point A on line AC, line AE is dropped to plane P, so as to be perpendicular to the plane. About the perpendicular (AE) a right circular cone is constructed on plane P so that the angle between the cone elements and its base is equal to the given angle AOC. Naturally, a view in the direction of any tangent to the base plane circle will show the angle between the limiting cone element and the base plane as being equal to angle AOC. If this tangent is now deliberately passed through point O, then a view in the direction of this tangent will show line AO and the limiting element as appearing as

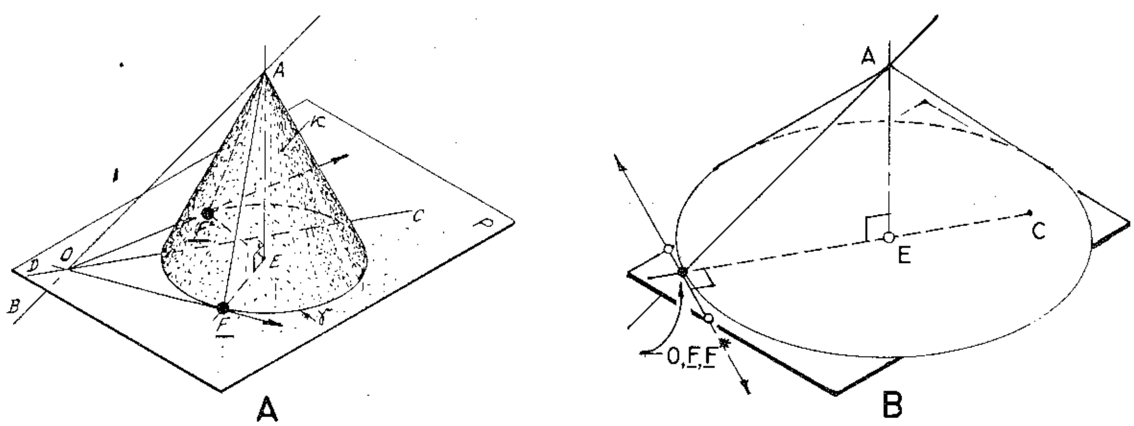


FIG 8

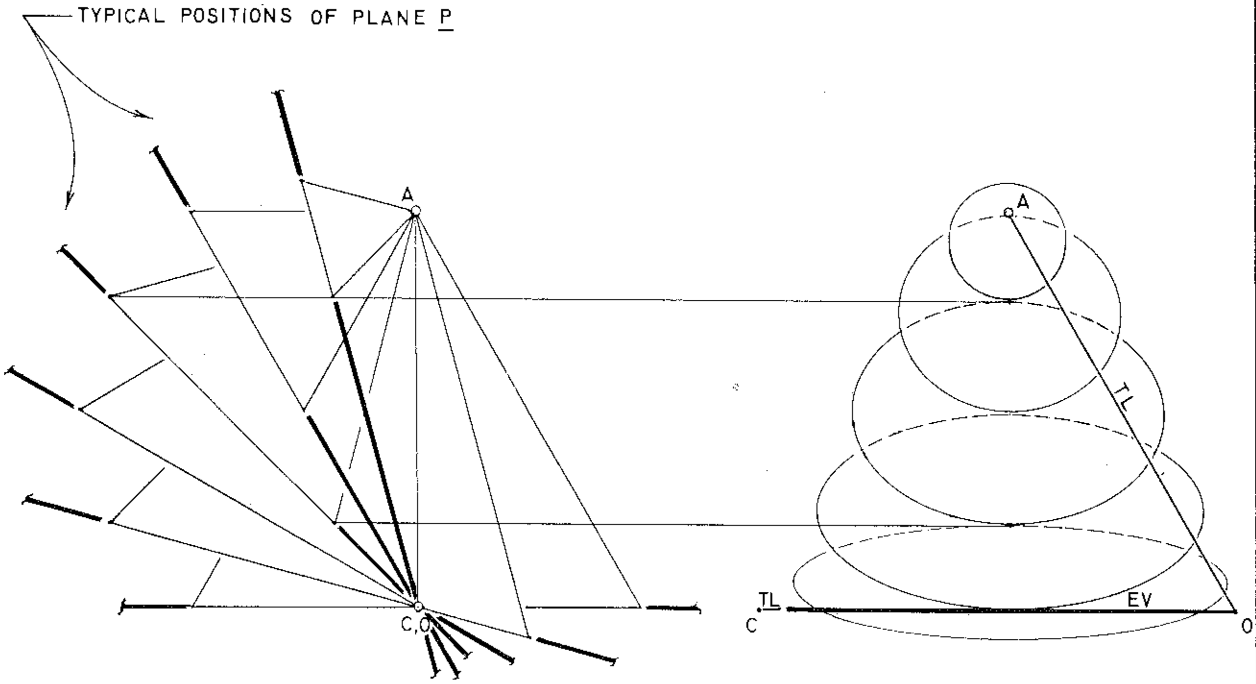


FIG 9

one line (coincident) and also line CO and the cone base plane (plane P) as appearing as one line. That is to say, a view in the direction of any such tangent through O will show the true size of the angle AOC.

If the plane of AOC happens to be perpendicular to plane P, the solution in Fig. 8-B appears. The solution rationale holds, of course, for any general position of plane P.

Fig. 9 is (1) a view (Front) as seen in the direction of CO and shows different and representative positions of the cone as plane P pivots 90° about line CO, and (2) the right side view shows only the cone bases in the representative positions.

Fig. 10 is the same as Fig. 9, except plane P is omitted (for clarity). As the cone base moves through the various positions, it creates a strangely shaped

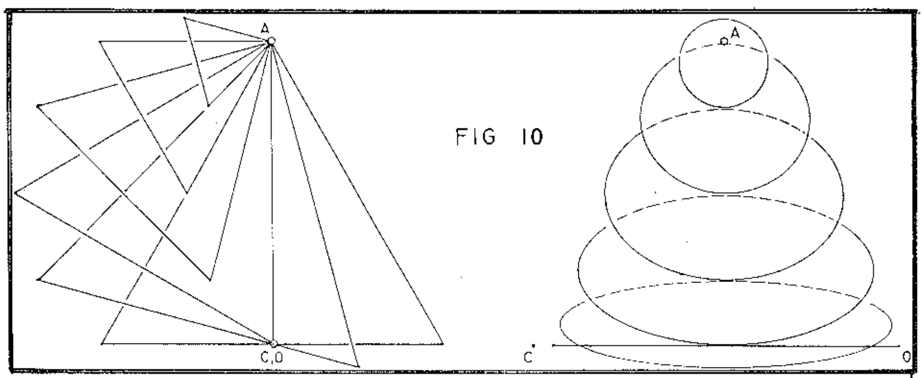


FIG 10

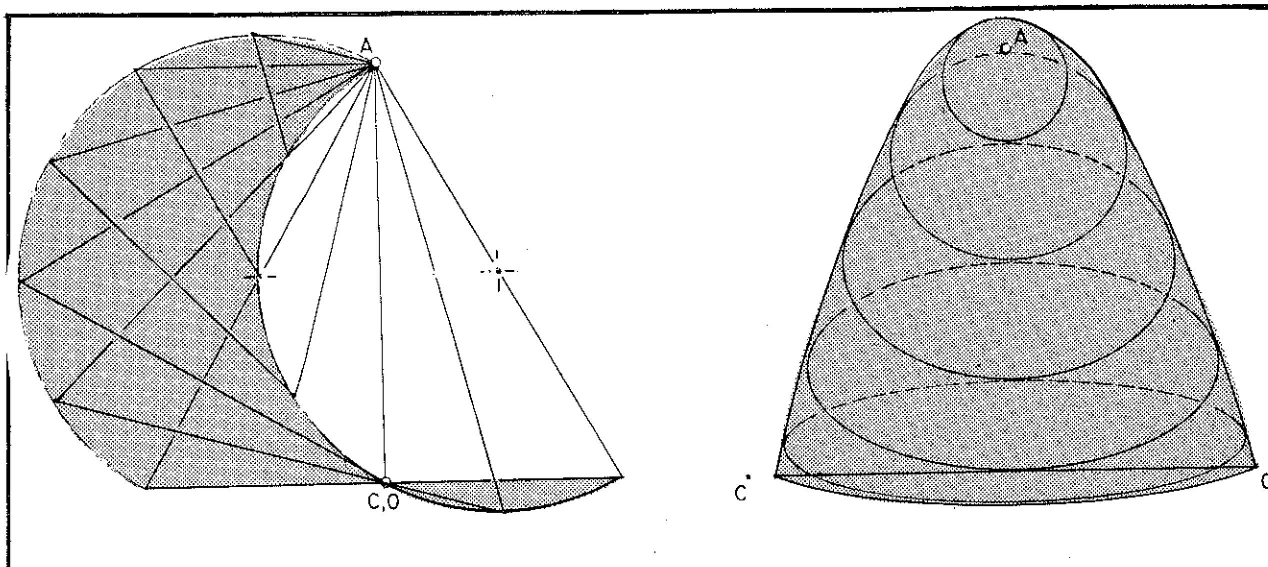


FIG 11

volume in space, Fig 11. Fig. 12 is an illustration. If plane P is considered to pivot throughout 180° the symmetry of the figure (as used in Abe's paper) is seen in Fig. 13.

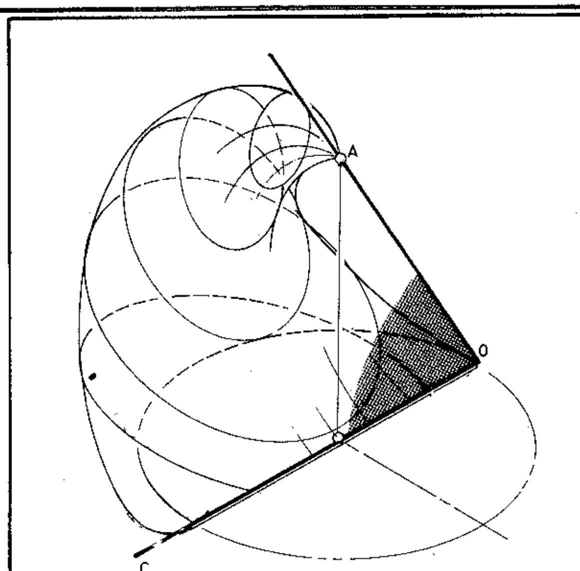


FIG 12

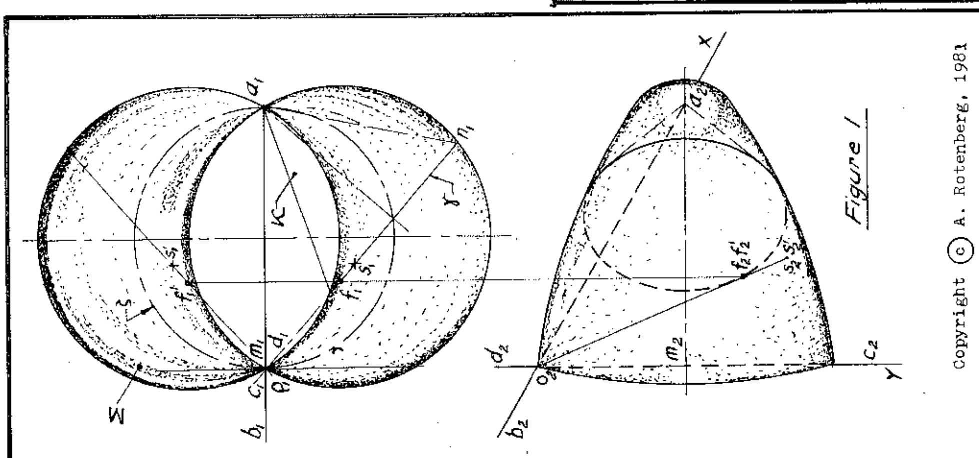


FIG 13

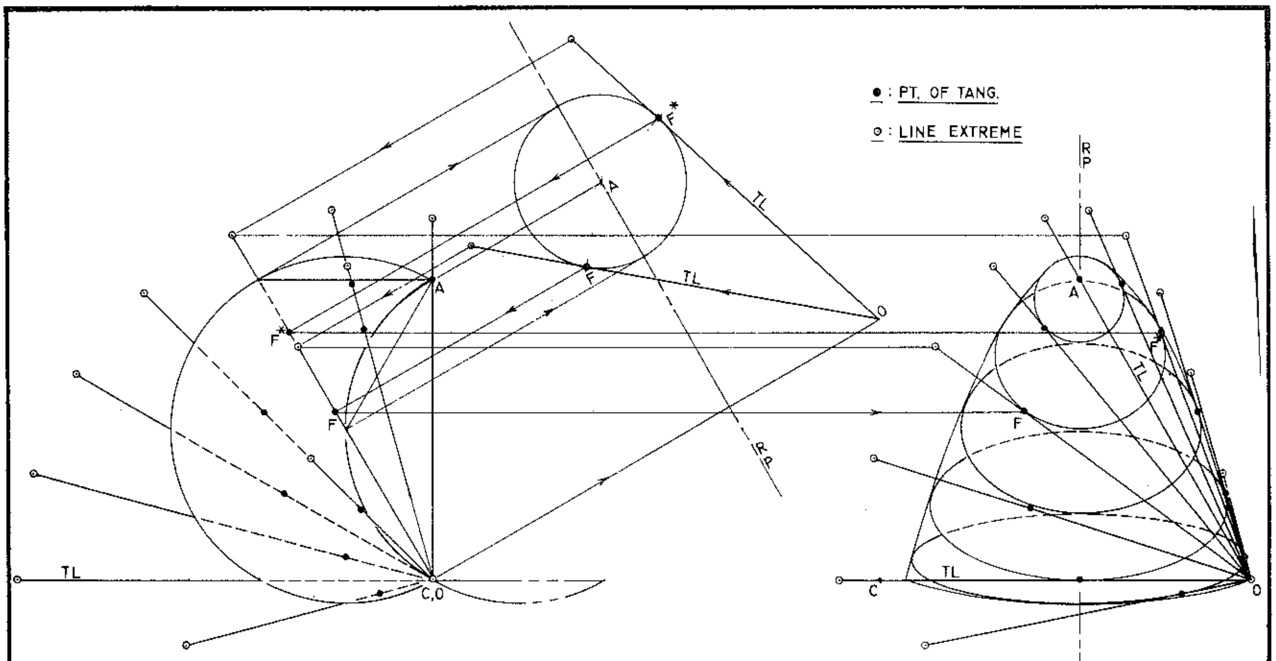


FIG 14

The locus of all lines-through-O-tangent-to-this-volume-surface is, therefore, the locus of lines-of-sight such that the given angle will appear true-size. As each position of the cone will accommodate two such tangent-lines-through-point-O there are two such loci. One through F and one through F*. Fig. 14.

If the locus of only one of these tangent-sets, say F (not F*), is plotted about both objects of the symmetrical configuration, then the ruled surface in Fig. 15 is created.

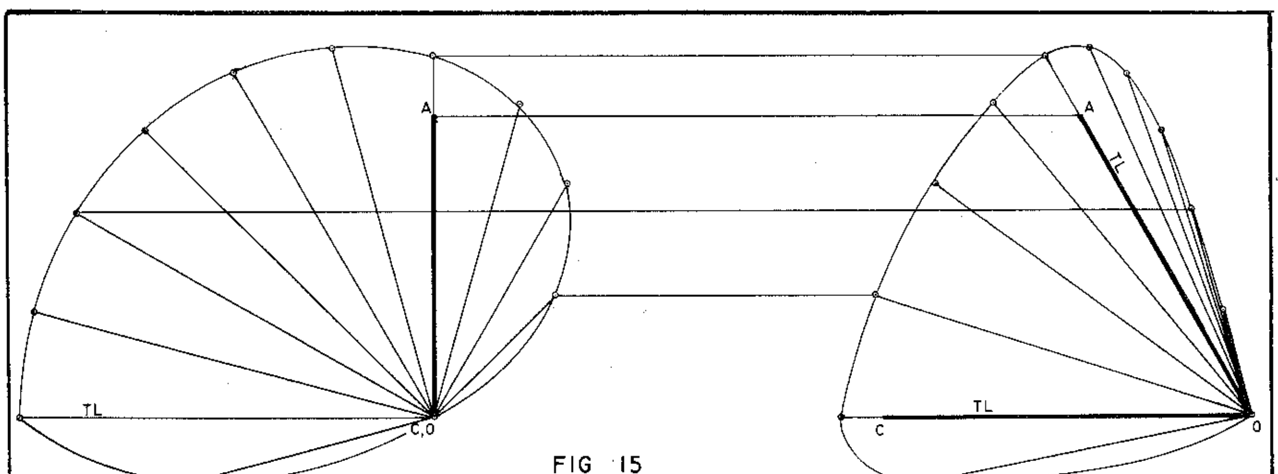


FIG 15

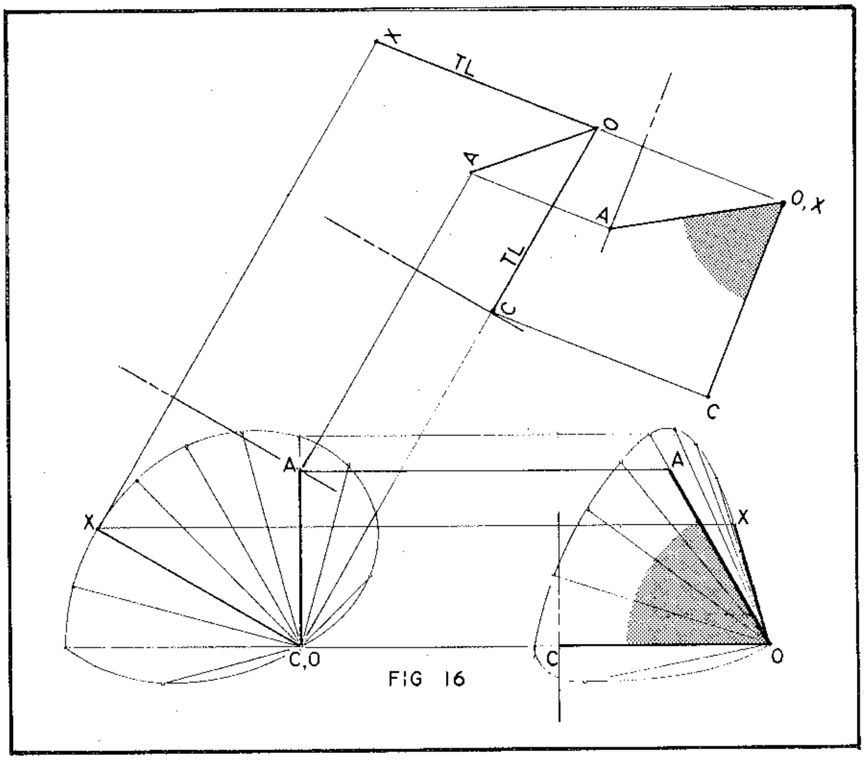


FIG 16

(To convince our, perhaps, flagging confidence that this business actually works, a view in the direction of an arbitrary element OX is projected. It verifies the predicted condition that the resulting size of angle AOC will be true size. Fig. 16)

If, now the F* set of tangents is plotted similarly to the F set, then another ruled surface is created. Fig. 17. If only one such surface existed, it would be a general solution (which is actually a type of conditional invariant). Since more than one exists, it is "just" a Conditional Invariant.

Note that another plane P' may now be passed through line AO with a perpendicular to this plane from any point on CO and the whole process repeated. This would create two more conditional invariant surfaces for a total of four.

Our files are down to one more puzzle. More puzzle suggestions and a broader participation is solicited. Also, if anyone is interested in taking over the 'corner, please drop us a line.

See y'a at the mid-winter,

Pat

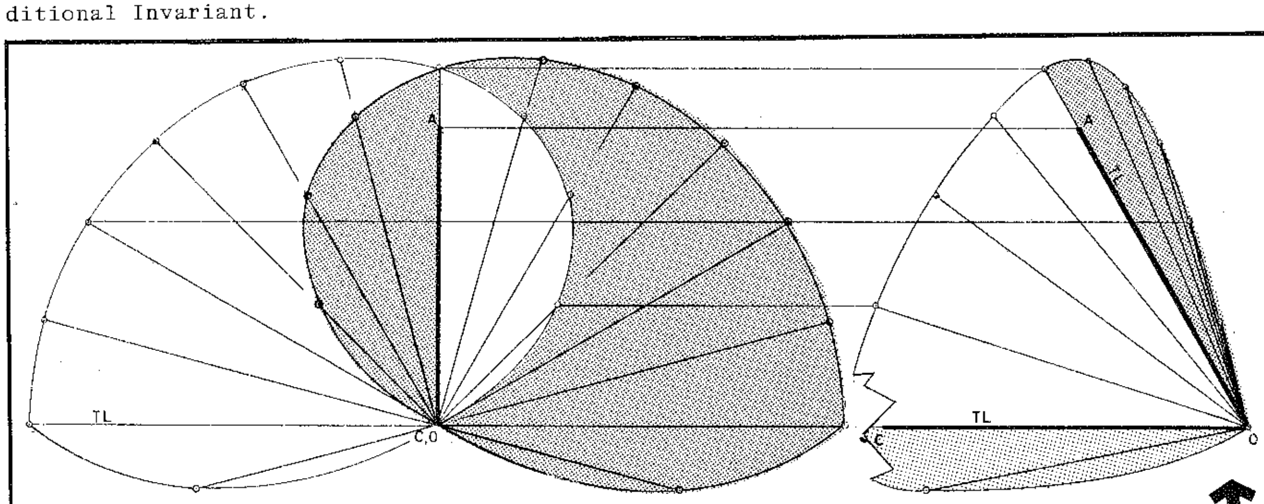


FIG 17

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smells
better
than a
cabbage
it is
foolish
to
conclude
that therefore
it
makes
better
soup

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