# THE JOURNAL OF ENGINEERING GRAPHICS

FALL 1968 VOLUME 32 NUMBER 3 SERIES 97

Mr. Alfred Kreidler

Published By The Division Of Engineering Graphics, American Society Of Engineering Education

# The Journal of Engineering Graphics

FALL 1968 VOLUME 32 NUMBER 3 SERIES 97





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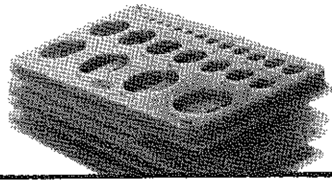

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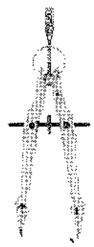

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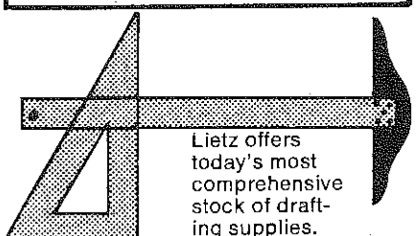

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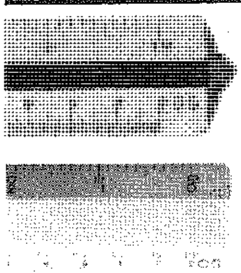

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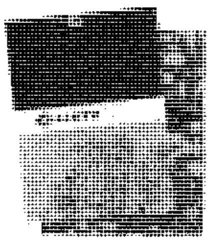

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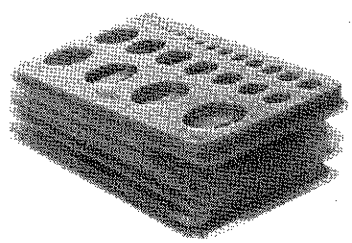

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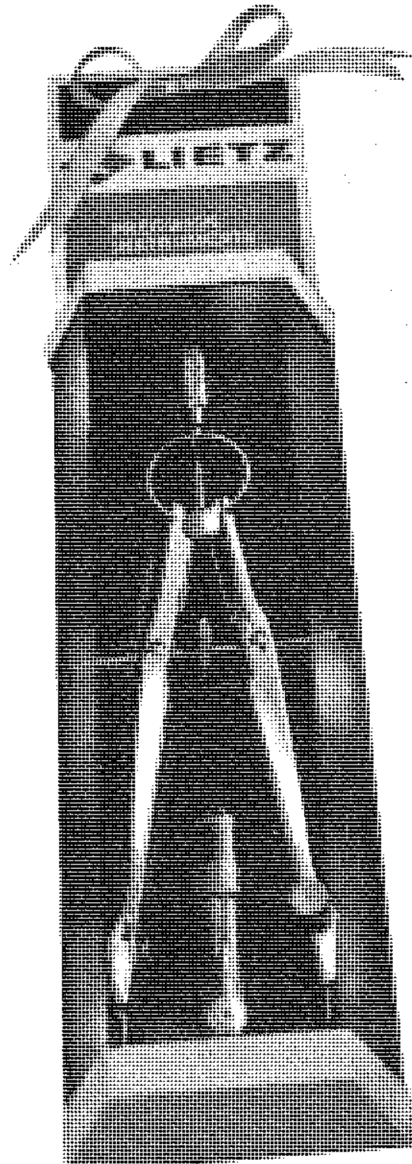

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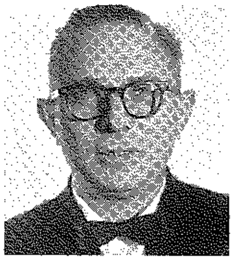


# Editors' Board

EDITORIAL

From June 15 to June 19 of 1968 the Engineering Graphics Division of A.S.E.E. reached a milestone in its history. During that time, design projects were displayed to show other engineering educators what our freshman engineering students are capable of doing with the aid of proper guidance. From all indications the work was well received by our colleagues in other disciplines.

In past editorials, the question "What are we to accomplish with our students?" was asked. The display should give us the answer. It seems that visitors, viewing the projects, were impressed more with the reports than with the various models, prototypes or other forms of illustrations, as was evidenced by their voting. These reports were nothing more than detailed accounts of the processes pursued by the designers (students) in arriving at conceptual solutions. This seems to indicate that our real task is to thoroughly acquaint the budding engineer with the methods by which information and original ideas are gathered and coordinated for the purpose of arriving at solutions of creative design.

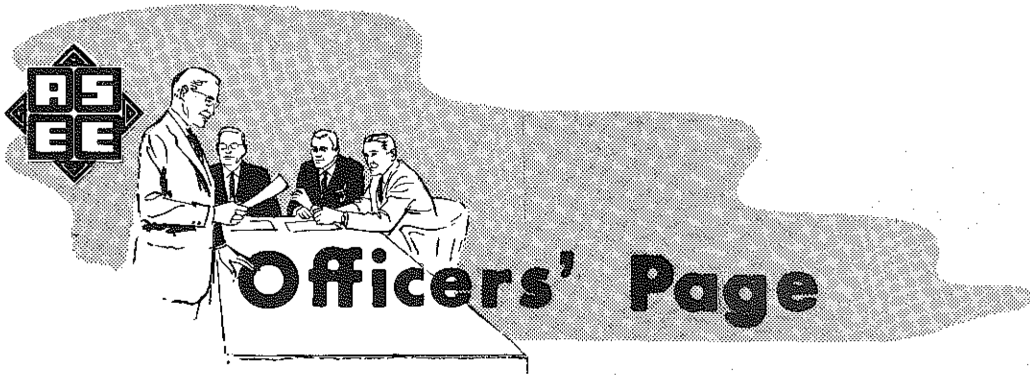
Does this mean that Graphics should be completely eliminated from our curriculum? To arrive at a ligical answer to this question we must first find answers to others, such as "What is the best way to convey creative ideas to others as well as to ourselves?", Are there methods of analysis other than the accepted and recognized mathematical, and if so what are they?", "Will devices, such as the computer, replace the importance of the knowledge of communicative and/or the analytical subject matter?". These and other questions must be asked and answered to assist us in preparing a meaningful curriculum leading to a thorough understanding of the design process. All of these queries must be considered carefully if our work is to be as necessary as was indicated at the Annual Meeting at U.C.L.A.

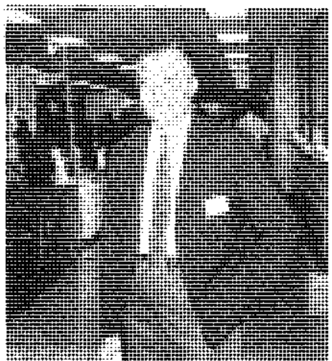
It is possible that the name of our Division is deceiving, not only to others but primarily to ourselves and thus retarding progressive change. Are we afraid to show anything but Graphics because that is how others know us? Are we afraid to show Graphics because we want to make the right impression in order to keep our jobs? If it would help, in any way, let us consider a change in the name of the Division, as has been suggested at the Mid-Year Meeting of 1968 in Tampa, Florida. The suggested change was to "Division of Engineering Graphics and Design". However, there may be other names which may be more indicative of the work that we must do. If so, let us consider them.

Whatever the name of the Division or of our individual departments, we must remember that our "Goal" is that of preparing the student for further study in the profession of engineering through a thorough understanding of the processes needed to arrive at creative design solutions. All of the subject matter included in our course should be geared toward that "Goal", and it behooves us to adapt our methods of presentation to best accomplish it.

To assist us in better presenting the process toward creative design, the Division has held its Summer School in 1967 and has also created a Graphics and Design Consultants Committee. To take advantage of the work done during that Summer School it is necessary for those who were in attendance to take the initiative in carrying the information to colleagues in their respective areas. The Graphics and Design Consultants Committee is composed of people who are not only capable of assisting in the organization of ways and means to bring information to others, but are also willing and anxious to help. It is our job to take advantage of the resources made available to us. It is our responsibility to serve our students most usefully in their preparation for a professional career in engineering.

Borah L. Kreimer



COMMENTS
by
Steve M. Slaby
Vice-Chairman
Division of Engineering Graphics, ASEE

I want to open these remarks by first thanking the members of the Division of Engineering Graphics for giving me the honor and the opportunity to serve them and the Division as Vice-Chairman. The challenge of following the previous distinguished officers is great, as well as the challenge of present and future direction of our discipline and our Division.

In recent years it has become very evident that the Division of Engineering Graphics has gained great internal strength due to the diversity of ideas and people that it contains. This diversity -- with unity -- is our greatest asset. The fundamental areas of engineering drawing and descriptive geometry continue to be the bedrock on which our Division stands and grows. Many of our people have branched out into the areas of computer graphics, graphical mathematics, and the broad area of design, -- especially conceptual design -- as well as the area of theoretical graphics.

The immediate future, as I see it, will involve four developments:

1. Design education will continue to expand and grow with new methods being devised to teach design at all levels and with more efficiency.

2. The area of theoretical graphics, dealing with abstract concepts of graphics will continue to gain more attention by our theoretically oriented colleagues and begin to interest the larger majority of our Division.

3. The Resolution, expressing the concern of the Division, vis-a-vis disadvantaged minorities in our country, which was passed at the Annual ASEE Meeting last June at UCLA makes clear our social responsibility to help remedy what is a tragic condition in our country. Programs, to implement the Resolution are presently being considered by our colleagues in the Division."

4. With all the broadening and enlarging of the scope of our Division (and its increasing diversity with unity) it is important that we should consider a change in the name of the Division. Perhaps a more inclusive name would be "Division of Engineering Graphics and Design.

5. The institution of a computerized graphics information retrieval system warrants our careful consideration. Over many years, much valuable graphical information has been developed in our excellent JOURNAL OF ENGINEERING

GRAPHICS. Professor Frank A. Heacock of Princeton gave us a major start in this direction by publishing his monumental work "Graphical Solutions of Technical Problems: Bibliography with Abstracts."

We must not hide our "candle under a bushel". The computerized graphic-information retrieval system will make graphics developments readily available to an exceptionally wide audience of scientists and engineers who currently are not aware of what we have to offer them. The five items above deal with topics which I hope the members of our Division will give serious thought to so that we can, as a Division, come up with the right answers for the Division, our students that we teach, the future of our field of endeavor, and ourselves. But last but not least -- the future of our country!

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## *Mr. ALFRED KREIDLER*

The Engineering Graphics Division of the American Society for Engineering Education can be thankful for its distant friend, Mr. Alfred Kreidler of Zurich, Switzerland. Mr. Kreidler has made possible two presently important items of interest to the division members. The first of these is the Kreidler Award for research in Graphics and the second being the successful venture of the Introductory Creative Design Display. Without doubt, the members of the Division would like to know more about Mr. Kreidler.

Mr. Kreidler first saw the light of day on September 2, 1897, in Stuttgart, Germany. His education took him through High School (Humanistic Gymnasium) before entering the military service in 1914. Before leaving army he achieved the rank of Lieutenant in the Cavalry, being decorated twice and wounded several times. At the close of World War I he entered the Technische Hochschule in Stuttgart, as an engineering student. He graduated in 1923 with honors. Mr. Kreidler has been married since 1929 and is the proud father of a son and a daughter.

Mr. Kreidler's first venture into industry was the operation of a small motorcycle factory. This lasted for a period of one year, after which he entered his father's business in 1924. It didn't take very long before young Alfred became the Plant Engineer, from which position he became the Technical Director and finally Plant Manager. Since 1942 he was the sole owner of Kreidler's Metal-und Drahtwerke in Stuttgart-Zuffenhausen, which is a metal rolling mill supplying at least 25% of the demand in West Germany.

At present, Mr. Kreidler has many industrial holdings including a motorcycle plant producing 22% of the total "bike" production in Germany. The 23 firms, which he either owns or controls, employs over 6000 poeple. Among the products produced by Mr. Kreidler's plants are clocks and watches, motorcycles, wire and extruded metals. Although much of these products are used in Germany, they are also exported to 30 countries throughout the world.

Mr. Kreidler's purpose in contributing to the advancement of research and ground and deep interest in stimulating creative ideas within the engineering profession.

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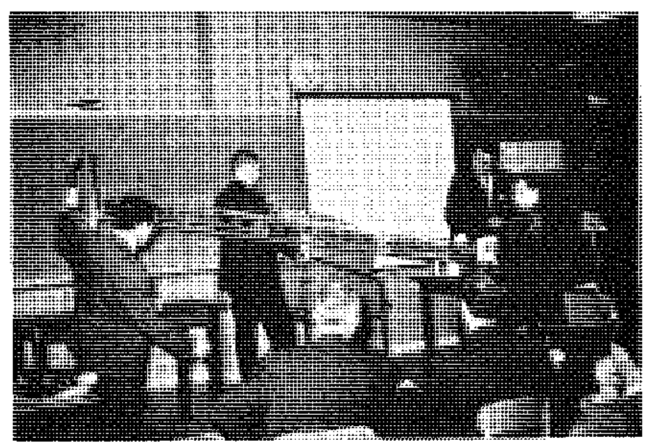
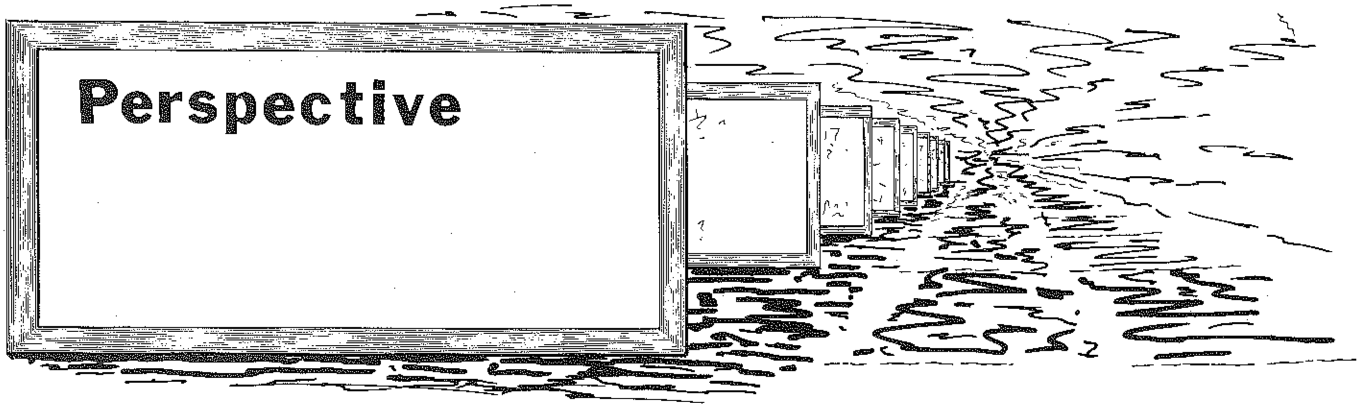


Students presenting original design




PAPERS WANTED

A letter was received by the editor of the JOURNAL OF ENGINEERING GRAPHICS which is, probably, of interest to many of the members of the Division of Engineering Graphics. Therefore

A letter was received by the editor of the Journal of Engineering Graphics , from the American Ordinance Association, which may be of interest to many members of the Division of Engineering Graphics. Therefore, the letter is being reprinted for the benefit of those who would like to take advantage of its conten contents.

Dear Mr. Kreimer:

The American Ordinance Association is a national society of American citizens dedicated to industrial preparedness for the national defense of the United States. One of the most prolific Sections of this Association is the Engineering Data Management Section.

On May 6, 7, and 8, 1969, the Engineering Data Management Section will hold its Eleventh Annual Meeting at the International Hotel, in Los Angeles, California. The theme of the meeting is - DATA'S ROLE IN DECISION MAKING. Sessions are planned on the following general areas -- the need, use and application of data in decision making; pros and cons of the acquisition of data; the worth of data; computer - aided design; impact of computer - aided design on procurements; etc. A more detailed line-up of suggested papers is attached.

We would be most grateful if you will call your readers' attention to the opportunity that this important meeting will offer them to state their views on Government Data through presentation of a formal paper.

Abstracts of papers pertinent to these and related subjects should be submitted to R. F. Franciose, Program Manager, General Electric Company, Corporate Engineering, One River Road (Bldg. 36 - 513), Schenectady, New York 12305, by January 15, 1969. Contributors will be notified by February 20, 1969, if their papers have been accepted. If the author is uncertain that the abstract is pertinent, it should be mailed to the above for consideration by his committee.

Sincerely,

R. F. Franciose
Program Manager
1969 Annual Meeting

Following are some subject areas where papers can be developed concerning the role of data management. These are not inclusive but merely represent the broad spectrum of data and the role it plays in management decisions:

1. Configuration Management as it applies to data management.
2. Configuration Management and its related data requirements
3. Impact of data on systems and contracts
4. Is data worth the price?
5. Other substitutes for data.
6. Why is data a problem?
7. The role of data in computer - aided design.
8. What is wrong with MIL-D-1000 and how would you change it?
9. How and who purges data?

(There are other subject areas that were suggested. These may be obtained by writing to the editor of the Journal or to Mr. Franciose)

## *DISTINGUISHED SERVICE AWARD*

Presented by
Robert H. Hammond
U.C.L.A. - June 1968

DIVISION OF ENGINEERING GRAPHICS
OF THE
AMERICAN SOCIETY
FOR
ENGINEERING EDUCATION
RESOLVED:
THAT, WITH THE PRESENTATION OF THIS AWARD, THE ENGINEERING GRAPHICS DIVISION OF THE AMERICAN SOCIETY FOR ENGINEERING EDUCATION BY THIS TOKEN ACKNOWLEDGES THE MANY DISTINGUISHED SERVICES RENDERED BY

B. LEIGHTON WELLMAN

THROUGH THE YEARS 1937-1968

THE SOCIETY EXPRESSES ITS DEEP APPRECIATION FOR THOSE SERVICES, AND THE GREAT PERSONAL PLEASURE OF THE INDIVIDUAL MEMBERS IN HAVING HIS FRIENDSHIP.

PRESENTED THIS NINETEENTH DAY OF JUNE IN THE YEAR OF OUR LORD NINETEEN HUNDRED SIXTY-EIGHT.

Eugene G. Paré — Chairman of the Division

Steve M. Slaby — Secretary of the Division

Mr. Chairman; Ladies and Gentlemen:

Tonight, for the 19th time, the Graphics Division will honor one of its members with the Distinguished Service Award, and itself be honored by having the privilege of associating with that member.

As you know, in order to receive this award a person must have made clearly recognizable contributions to Engineering Graphics in several of the following ways, of which item (e) shall not be omitted:

(a) Success as a teacher, both as to competence in subject matter and the ability to inspire his students to high achievement.

(b) Improvement of the tools of and conditions for teaching.

(c) Improvements of teaching, including development of teachers, development of testing and guidance programs, and coordination of fields of subject matter.

(d) Scholarly contributions of literature, honors, etc.

(e) Service to the Division as shown:

(1) by regular attendance at its meetings
(2) by service on its committees or as an officer with a record of achievement
(3) by contributions to its publications or summer school programs.

The candidates for the Distinguished Service Award can be proposed only by members of the Division, and we thank all those who submitted recommendations. Then it is the duty of Special Awards Committee, this year composed of J. Howard Porsch, E. W. Jacunski and myself, to select from those nominees the most deserving individual. This is a difficult task and took much deliberation, but the final decision was unanimous.

The stature of the eighteen previous recipients of the Distinguished Service Award is unmistakable. By the very nature of the award, coming late in the career of a teacher, not all the recipients are present with us tonight. However, we are honored by the presence of five of these distinguished men tonight and I would like them to stand as I call their names. In 1960 there was Cliff Springer; in 1961 Bill Street; in 1964 Warren Luzadder; in 1966 Jim Rising, and in 1967 Ivan Hill.

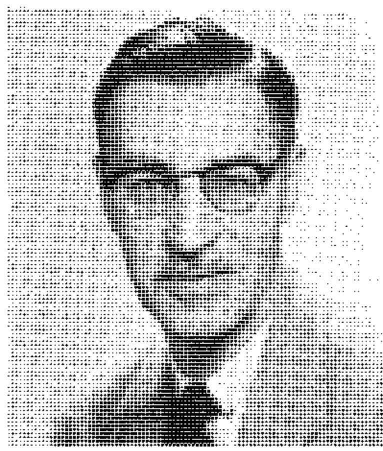
Tonight they will be joined by a new name. When the Special Awards Committee reviewed the qualifications of the nominees, one man stood out as eminently qualified in all criteria. Since you all know this man, I will introduce him by playing a game of "Who Am I" with you

Our new Distinguished Service Award recipient was born in Illinois where, in 1930 he received the B. S., with honors, in Mechanical Engineering and was a member of both Tau Beta Pi and Pi Tau Sigma. After graduation he joined the staff of his present school where in 1935 he received his M. S. and in 1938 became head of its Engineering Drawing Division. By a show of hands only, how many know his name?

Here are a few more clues. He developed a special interest in a particular field of Graphics and in 1948 produced a text in that field that proved popular to students and teachers alike. His latest book came out in 1966. If the book publishers had not been eager to print his books, he would have done so himself. His hobby is his basement print shop. We all look forward to his personalized Christmas cards. Now, how many know who he is?

Your last set of clues. He has given not only of himself to teaching. His two children are teachers. This is evidence enough of his love of teaching and his leadership. His many services to the Division have included being its Chairman. In fact, I had the pleasure of presenting him with his honorary gavel.

Now you all should know that our new recipient is B. Leighton Wellman.



Response
for the
1968 DISTINQUISHED SERVICE AWARD
of the
ENGINEERING GRAPHICS DIVISION, ASEE
by
B. LEIGHTON WELLMAN

How does one respond to an award like this? This must surely rank as the highest honor I have ever received for here I am doubly-honored -- by those of the past and those of the present. To join the ranks of eighteen men whose service and devotion to engineering education is legendary in the annals of graphics is distinction indeed, but to be placed in that select group by those of you who know me so well, and who are so well qualified to make that critical judgment, that is a miracle for which I shall be forever grateful.

It must be quite evident that I am finding mere words totally inadaquate to express my appreciation. As an apostle of graphics I have always proclaimed that one picture is better than a thousand words, and here I am without paper or blackboard, without pencil or chalk. If the emotions I feel at this moment were to be graphically portrayed, I am sure it would have to be done with a multiview drawing in order to show the true height, breadth, and depth of my feelings.

In this case all six of the principal

views would be necessary to fully delineate the many benefits that this division has given to me: the privilege of attending many carefully planned meetings, the stimulation of listening to good papers, the learning obtained from fine publications, the wisdom gleaned from your council meetings, the excitement of conversations in the corridors, and the opportunity to serve in all of this worthwhile activity.

Still the drawing would not be complete without many sectional views to reveal the insights I have been given in the solving of difficult problems, in the improvement of my teaching methods, in learning to cope with these changing times, and in trying to find the right path to better graphics instruction. There are still many hidden lines, but each time we meet, their meaning becomes clearer.

Although many drawings are complete in the principal views, that cannot be true of this one. Here there must be hundreds of auxiliary views, with more added each year, to show the many happy hours that Mrs. Wellman and I have enjoyed in your company. How fortunate it is that although there are only six principal views, there can be an infinite number of auxiliary views. There is no law of consrvation that limits the breadth and excitement of learning or the pleasures of being with good companions.

To the Award Committee and to the members of the Graphics Division I express my deep and heartfelt gratitude for this distinctive honor. To all you teachers of graphics who taught me, I declare my indebtedness and my thanks for all the good things you have given me in our years of association. The poet John Donne said, "No man is an island, entire of itself" and to that I add, "nor is any man complete without the help and fellowship of his friends and colleagues." Thank you for allowing me to be part of the whole.

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RESOLUTION
by the
DIVISION OF ENGINEERING GRAPHICS, ASEE
at the
Annual Banquet
June, 1968

Resolved:

That the Division of Engineering Graphics of the American Society for Engineering Education, at the Diamond Jubilee Meeting, held at the University of California in Los Angeles, June 1968, goes on record as expressing deep concern over the chasm which exists in our country between the various segments of our society.

We, as a Division, realize that we have a social responsibility, as educators, to fulfill the educational needs of all our citizens, especially the disadvantaged minority groups. We intend to take specific and immediate steps to alleviate this condition in our own area of endeavor.

We respectfully recommend that the American Society for Engineering Education also go on record, expressing this same concern and take action to devote a major effort to finding and implementing solutions to this problem.

We further instruct the secretary of the Division of Engineering Graphics to send copies of this resolution to the President of the American Society for Engineering Education, to the Editor of the Journal of Engineering Education, and to the Editor of the Journal of Engineering Graphics for inclusion in these journals.

ENGINEERING GRAPHICS DIVISION, ASEE
NOMINATIONS for 1969-1970

The following is the list of nominees prepared by the Nominating Committee for the year 1969-1970. Each nominee has been interviewed, and each has accepted the nomination. Additional nominees, by petition, must be submitted not later than January 31, 1969 (By-Laws, Art IV, Section 1b).

Vice-Chairman;
J. H. Earle; Texas A & M University
(A. S. Levens later declined nomination to accept overseas appointment)
(Second nominee to be announced in the Winter issue of the Journal)

Secretary;
J. R. Burnett; Michigan State Univ.
Forrest Woodworth; Univ. of Detroit

Advertising Manager of JEG;
A. L. Hoag; University of Washington
K. E. Kroner; Univ. of Massachusetts

Division Editor;
K. E. Botkin; Purdue University
P. Z. Bulkeley; Stanford University

Director;
A. P. McDonald; Rice University
G. J. Cowell; Univ. of South Florida

Submitted by the Nominating Committee
R. H. Hammond — W. J. Luzadder
E. W. Jacunski — Henry Krause
B. L. Wellman - chairman

## THE OPPENHEIMER AWARD

To encourage better presentation of papers on the program at meetings of the Engineering Graphics Division, the Frank Oppenheimer Award has been established. The award will be offered twice yearly; once at the Mid-Year Meeting and once at the Annual Meeting of the Division, and shall be based on the following:

1. Purpose
   To encourage and reward excellence in presentation of papers.
2. The Award
   The award shall consist of $100 accompanied by an appropriate certificate.
3. Eligibility
   Persons presenting papers listed on the official program of the meeting shall be eligible. Persons moderating or presiding at a session will normally not be eligible.
4. Judging
   The Awards Committee shall appoint three judges from among those members of the Division present at the meeting. The judges may recommend that the award be shared, or that it not be given at a particular meeting.
5. Requirements
   The following items will be considered in judging the presentations.
   a) Familiarity with Content - the speaker should give the impression that he speaks freely without notes.
   b) Timing - the speaker should stay within the time allotted.
   c) Delivery - the speaker should enunciate clearly, speak loud enough to be heard in the last row, use the microphone effectively when available.
   d) Visual Aids - use of visual aids should be rehearsed before the presentation to insure that equipment works smoothly. Comments should be made without notes when slides or movies are shown in darkened rooms.
   e) Enthusiam - enthusiasm should be maintained throughout presentation, and the voice should not sag.

6. Presentation
   The award shall be presented at the Banquet or Dinner Meeting of the Division, unless such meeting precedes a portion of the program. In the latter case it shall be presented at the end of the last session on the program

The Oppenheimer Award was made to PERCY HILL of Tufts University at the 1967-68 Mid-Winter Meeting and to GEORGE S. BEAKLEY of Arizona State University at the Annual Meeting at UCLA.

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## THE KREIDLER AWARD

The Kreidler Award is intended to encourage research in the field of Graphics and/or the use of Graphics in research in other fields. The award consists of $100 together with an appropriate certificate. The following guide lines have been established for this award:

1. Any article, paper, report or thesis concerning Graphics research may compete

2. Subject matter may include, but is not limited to, new application of graphical methods, new or unusual graphical problem solutions and studies of trends or needs of graphics in education or industry.

3. The research must have been completed during the twelve months ending on July 31 of each year.

4. The research must be brought to the attention of the Awards Committee. The committee will search diligently for all contributions to the literature but is not responsible for finding all of them.

5. The majority of the committee votes received will determine the winner.

6. The winner will be announced and the award made at the Engineering Graphics Division Mid-Year Meeting Dinner following the year covered by the competition.

The Kreidler Award was made at the 1967-68 Mid-Year Meeting to A. S. LEVENS and J. C. KOHLI of the University of California at Berkeley for "Computer-Aided Design Of Nomograms."

A. S. LEVENS

J. C. KOHLI

# AMERICAN SOCIETY FOR ENGINEERING EDUCATION
# DIVISION OF ENGINEERING GRAPHICS
## Officers and Committees

1968 - 1969

Full effectiveness can be attained by the Division only if the elected officers and appointed committees work together as a well organized and operating team.

Committees are appointed to fulfill specific objectives, but to keep activities strictly to these objectives is near impossible. Complete communication should keep all members informed and each committee chairman should not only make reports to the Division Chairman, but an annual composite report should be submitted to the Journal of Engineering Graphics for publication.

The Chairman of the Industrial Relations, Educational Relations, and Teaching Techniques Committees should work closely with the Graphics and Design Committee for effective communication and comprehensive guidance to the Division.

Each committee chairman should direct individual committee members and instruct them as to committee objectives (see Journal of Engineering Graphics, Volume 32, Number 1, Series 94, Page 16). A lack of individual performance indicates little interest and uninterested members should be omitted from the committee roster.

Each committee chairman should keep the Divisional Vice-Chairman and Chairman informed. Recommendations regarding committee membership should be made to the Divisional Vice Chairman early so that appointments can be cleared and approved by the Executive Committee at the Annual Meeting.

The Chairman of the Graphics and Design Committee should contact other committee chairmen for information having to do with general interest such as new industrial developments, effective teaching techniques, course development, open-end design projects, case studies, and the like. The Graphics and Design Committee should be the Division's agent in the field. Their guidance should help to firm up the Division's place in Engineering Education. This committee should act as a counsel to the Division and assist in implementing objectives in the broad field of engineering education, and more specifically, in engineering graphics and design. However, other committe chairmen should not wait for the Graphics and Design Committee Chairman's request for information. A combined effort should be our aim.

The following includes elective officers and appointed committees for the year 1968-1969:

### OFFICERS

| | |
|---|---|
| Chairman | - Earl D. Black, General Motors Institute |
| Vice-Chairman | - Steve M. Slaby, Princeton University |
| Secretary | - James H. Earle, Texas A & M University |
| Senior Council Member | - Eugene G. Paré, Washington State University |
| Treasurer | - Percy H. Hill, Tufts University |

EXECUTIVE COUNCIL
- Earl D Black, General Motors Institute, Chairman
- Steve M. Slaby, Princeton University, Vice-Chairman
- James H. Earle, Texas A & M University, Secretary
- Eugene G. Paré, Washington State University, Senior Council Member
- Percy H. Hill, Tufts University, Treasurer and Director
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CHAPLAIN
William E. Street, Louisiana State University

MID-YEAR MEETING

ENGINEERING GRAPHICS DIVISION
American Society for Engineering Education

Louisiana State University
January 23-25, 1969

## PROGRAM

Theme: Graphics Design and Research.

THURSDAY: January 23, 1969
Pleasant Hall

New Orleans Trip (Tentative) depending on the number of requests received when the General Program is sent out. Leave from lobby of Pleasant Hall at 8 a.m.

### REGISTRATION

3:00 - 5:00 p.m. - Lounge at Pleasant Hall

($5.00 per member, $2.00 each for ladies and others)

6:30 p.m. --EXECUTIVE COMMITTEE DINNER

(For executive committee members and invited guests)

Red River Room, L. S. U. Student Union

7:00 - 9:00 p.m. -- SOCIAL HOUR

148 Pleasant Hall for all members, wives, and guests. "Big Game Hunting in Africa and Alaska" Johnson S. Conner, Baton Rouge, Louisiana

FRIDAY: January 24, 1969

8:00 - 9:30 a.m. -- REGISTRATION

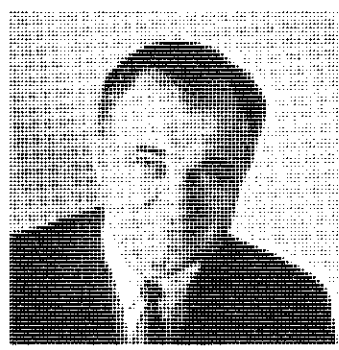
9:00 - 11:30 a.m. -- GENERAL SESSION

Greetings, W. E. Street, Louisiana State University

9:10 -- WELCOME ADDRESS

Dean Roger W. Richardson, College of Engineering, Louisiana State University

PRESIDING - STEVE M. SLABY, Princeton University



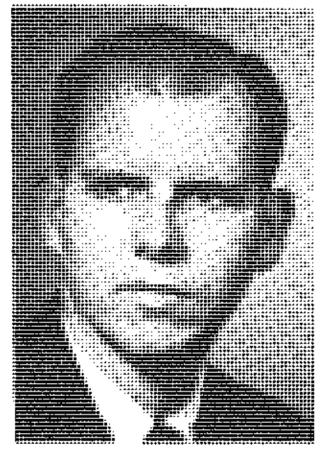
"Building Standardized Tests in Engineering Graphics"
Amogene F. DeVaney, Amarillo College

"What is Creative Design?"
F. L. LaRue, University of Southwestern Louisiana

"Creative Design in Engineering Graphics"
James H. Earle, Texas A&M University

Professor Amogene F. DeVaney

Professor F. L. LaRue



Professor James H. Earle

12:10 -- LUNCHEON - L. S. U. Student Union

PRESIDING -- EARL D. BLACK, Chairman
Engineering Graphics Division
American Society for
Engineering Education

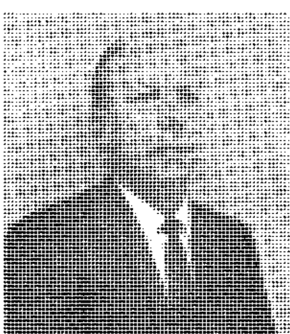
"Graphics as Viewed by a Professional Engineer"
C. Carter Brown,
Brown and Butler,
Baton Rouge, Louisiana

1:20 -- GROUP PICTURE

FRIDAY AFTERNOON, January 24, 1969

1:30 - 3:30 p.m. -- Room 148 Pleasant Hall

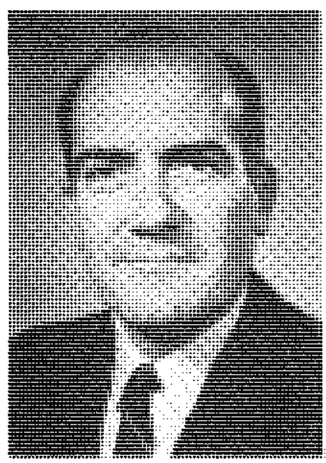
PRESIDING -- G. C. GRUBB
Arlington State College



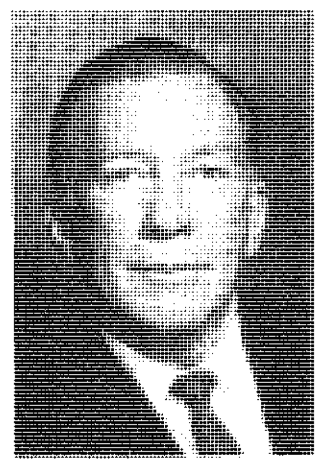
"Y14.5 Dimensioning and Tolerancing for Engineering Drawings and Unification of Drawing Practices"
P. A. Nicovich,
Sandia Corporation
Albuquerque, New Mexico

"Computer Graphics"
Eugene H. Brock,
National Aeronautics and Space Administration, Manned Spacecraft Center
Houston, Texas

"Graphics and Planning in the Architectural Profession"
W. R. (Dede) Matthews,
Matthews and Associates
Bryan, Texas



P. A. Nicovich



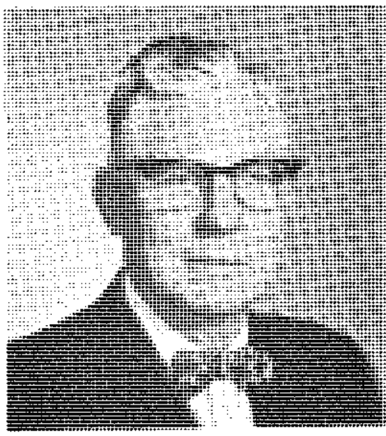
Egene H. Brock

W. R. (Dede) Matthews

3:30 - 4:30 -- COMMITTEE MEETINGS

6:30 p.m. -- ANNUAL BANQUET, Faculty Club

PRESIDING - EARL D. BLACK, Chairman
Engineering Graphics Division, American Society for Engineering Education



Entertainment - The Lackie Brothers, Baton Rouge, Louisiana

"How Important Are You to Your Community?"
Rabbi Walter G. Peiser,
Baton Rouge, Louisiana

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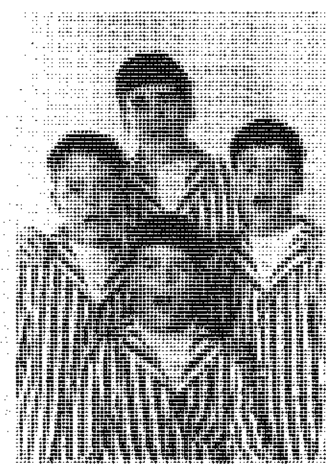

THE LACKIE BROTHERS

To help relax the mid-winter meeting attendees, a fine program of entertainment has been prepared. The entertainers will be four young men who go by the name of The Lackie Brothers.

They are a singing group specializing in Barbershop harmony, but also entertain with Folk and Religious music. As their name indicates, these young gentlemen are brothers. Jay is the oldest at 15 followed by Steve who is 13 and the twins, Jim and John, who are 12.

Since 1965 this group has made about 40 appearances at various social, civic, business and religious gatherings. They were first place winners in the 1965, 1966 and 1967 Kiwanis talent contests as well as the 1966 Greater Baton Rouge State Fair Talent Contest. In addition to singing, each of the boys plays at least one musical instrument.

Young, though they may be, their background appears to insure a most pleasant diversion from the rigor of the business of the meeting.

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SATURDAY MORNING: January 25, 1969

8:00 a.m. - Room 148 Pleasant Hall

PRESIDING - KENNETH E. BOTKIN
Purdue University

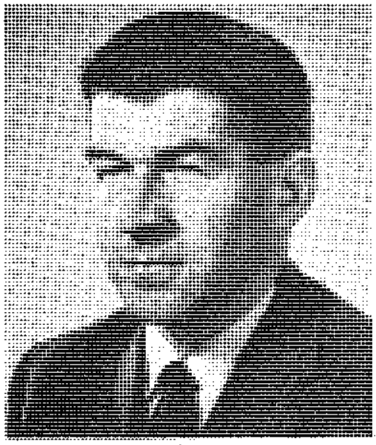
"The U. C. L. A. Creative Design Display"
William S. Chalk
University of Washington

"Studies in Computer Graphics"
Carl W. Bechtold
University of Colorado

"Graphics in Biodental Research"
Percy H. Hill
Tufts University

"Computer Aided Design and Computer Graphics in an Aircraft Company"
T. D. R. Neill
Lockheed-Georgia
Marietta, Georgia

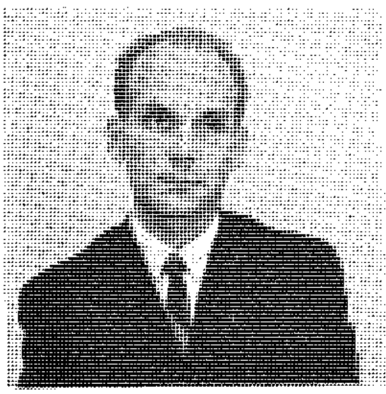
"Graphics in the Refining Industry"
Joseph F. Pevy, Designer
Humble Oil and Refining Co.
Baton Rouge, Louisiana



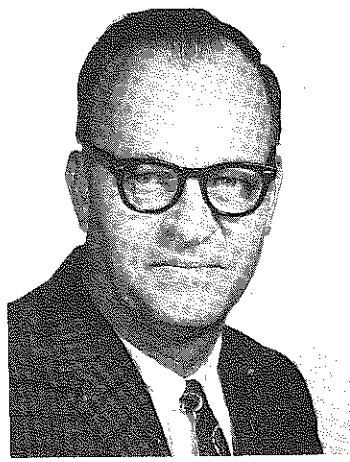
Professor William S. Chalk

Carl W. Bechtold

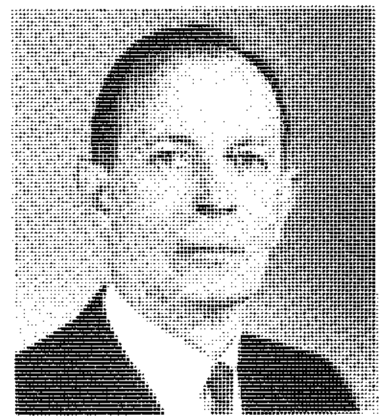
Professor Percy H. Hill



T. D. R. O'Neill



Joseph F. Pevy



C. Carter Brown

Editor's Note: The program for the Mid-Year Meeting has been presented to afford the members of the Engineering Graphics Division of ASEE the opportunity to make a definite decision as to whether they should be in attendance or not. From the program, one can see that many subjects, of interest to the membership, will be discussed. We must now ask ourselves whether we can afford to miss this meeting.

# REPORT OF ANNUAL DESIGN DISPLAY

by

John Barylski

Chairman - Displays Committee

We have every reason to be proud of our ASEE Engineering Graphics Division. The Introductory Creative Design Display was a program highlight at the ASEE Diamond Jubilee at UCLA. The enthusiastic comments of our engineering colleagues were evidence that our Graphics Division is a leader and contributes something that is progressive to engineering education.

Approximately 155 projects from 33 schools were on competetive display. The Displays Committee thanks all of the instructors who encouraged their students to participate. Please extend to these students a grateful "Thank You" and invite them to participate again at Penn State in 1969.

All projects were in the return mail on June 20th, except one; Project Coffee Dispenser - student Tom Brassfield - no further identification. Many such problems faced the Display Committee's organization crew. Prototypes were received broken, packages were misdirected, instructions for presentation were not followed, etc., etc.

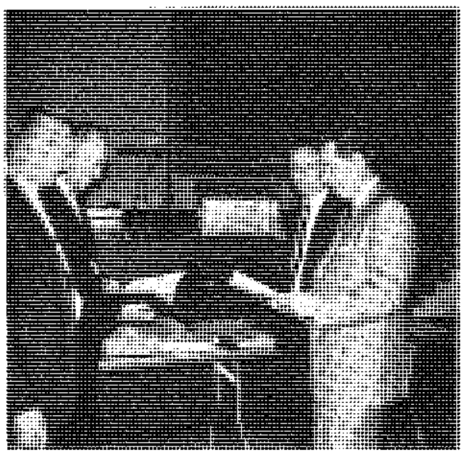
There are many to whom we are indebted for the success of our Display. An exhorbitant amount of work was accomplished to meet the promised opening hour. You all know the phrase "performing beyond the call of duty". Those who did just that are; Frank Oppenheimer, Wally Reynolds, Borah Kreimer, Bill Chalk, Al Hoag, Charles Simpson of UCLA, Earl Black, Bob Ritter, and Tim Nansen. There are many others who were instrumental in supplying the finishing touches before the opening bell. The ground work that was done by Bob Ritter and one of his students', Tim Nansen, set an excellent pattern for us to follow. We are indeed fortunate that Al Hoag will continue as chairman of the Awards Committee. He and the judges spent many hours evaluating and recording the projects. Our division is deeply indebted and grateful for the encouragement given to us by our friend and benefactor Mr. Alfred Kreidler of Zurich, Switzerland. His monetary donations were applied to the prizes and costs of the awards.

Visitors were at the opening on Sunday morning. It was extremely gratifying to observe the continuous line of engineering colleagues and engineering graphics associates who were examining and evaluating students' projects. Many interesting comments were overheard. I was intrigued by remarks that their students did work of better quality than those being displayed. Of course, they were invited to prove it at Penn State in 1969. Please start grooming your students for the next Annual Creative Design Display.

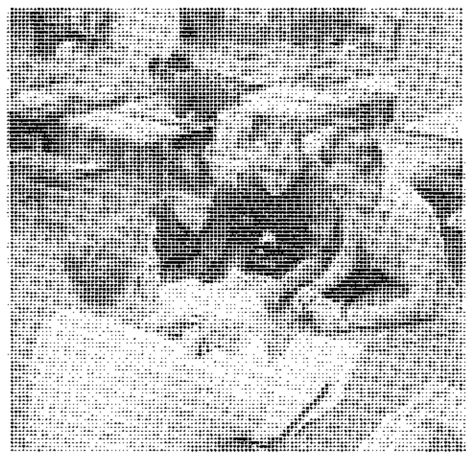
Al Hoag, Awards Committee Chmn. and John Barylski, Design Display Committee Chmn.

Articles publicizing this new venture appeared in the JOURNAL OF ENGINEERING GRAPHICS, NEWS-LETTERS, ENGINEERING GRAPHICS, GRAPHIC SCIENCE, the JOURNAL OF ENGINEERING EDUCATION and in the flyers from ASEE, followed by the preliminary program as well as the final program of the convention.

I could write pages concerning the encouragement and effective leadership given by the division chairman, Gene Paré. At UCLA he came to the display rooms early in the morning and worked until late at night. Twenty-four hours after others had left we were packing and shipping projects. Gene, you have been an inspiration. Under your leadership the professional image of the Engineering Graphics Division has continued to grow in stature and status. It was a privilege to serve as one of your committee chairmen.



Professor Ken Woodard discussing freshmen design projects with NASA engineers at the Northeastern University Suburban Campus



Students discussing design project with instructor at General Motors Institute

# INTRODUCTORY CREATIVE DESIGN DISPLAY

by
William S. Chalk

The first event listed on the program for the ASEE Diamond Jubilee Meeting, June 17 - 20, 1968 at UCLA was as follows:

> ENGINEERING GRAPHICS DIVISION
> Special Event
> "Introductory Creative Design Graphics Display, Rooms 3564 and 3677 Boelter Hall. An opportunity to examine array of competetive student projects and prototypes."

The expertly managed display was open to all attendees of the Jubilee Meeting from Sunday morning, June 16, to Wednesday afternoon, June 19.

Typical student projects are shown in Figure 1. For example, in the foreground is a Hexagonal Drop Leaf Table designed by M. J. Jankowski of the University of Wisconsin at Milwaukee. Mr. Jankowski's table and report was entered as a Freshman Individual Project, one of four categories for all entries. The four were Freshman Individual, Freshman Team, Sophomore Individual and Sophomore Team. The reports and prototypes or models were entered by engineering instructors from universities and colleges throughout the United States and Canada. Generally, each instructor selected representative student design projects from his school and arranged to have them at the display rooms in time for the meeting. Two instructors who entered their students' projects are shown in Figure 2. At the left is Jim Earle of Texas A & M University and at the right is Steve Slaby of Princeton University.

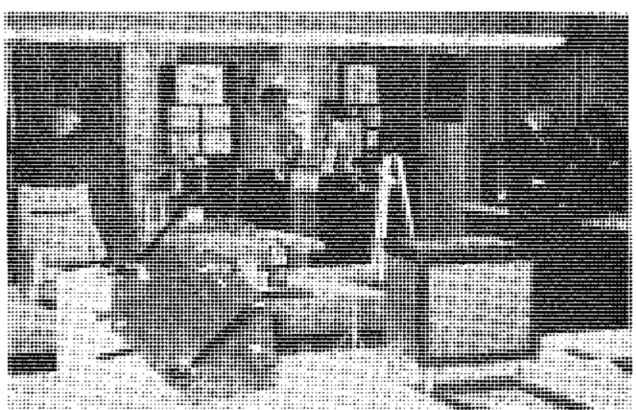


Figure 1

Four grand prizes and one hundred and eighteen ribbons were awarded. A panel of judges led by Al Hoag, Awards Committee

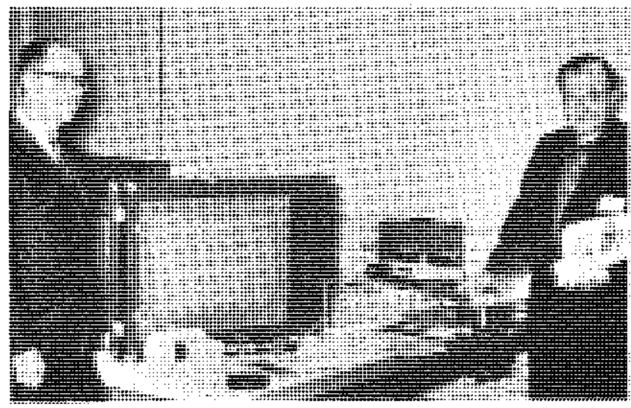


Figure 2

Chairman, had the arduous task (see Figure 3) of previewing all of the entries and then evaluating them for the purpose of awarding ribbons and finally for selecting four grand prize winners. The ribbons were given for Outstanding, Excellent and Honorable Mention projects. Essentially, the ribbons and prizes were awarded on the basis of how effectively the team of individual solved their problem and how well they communicated their solution.

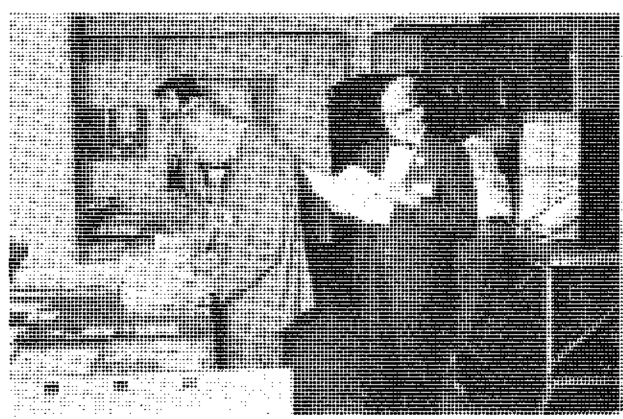


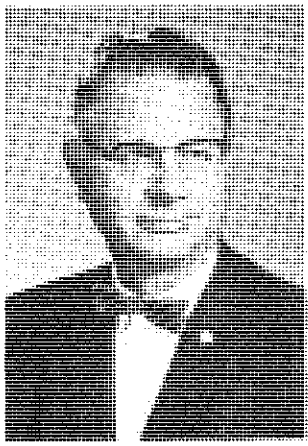
Figure 3

The grand prize winners were:

First Grand Prize - Team Project

"Automatic Adjustable Open-End Wrench"
Designers: Steve Lasswell
Mike Speights
Frank Ozuna
Ray Combes
Tom Farr
Paul Vaughan
Instructor: George C. Beakely
Arizona State University

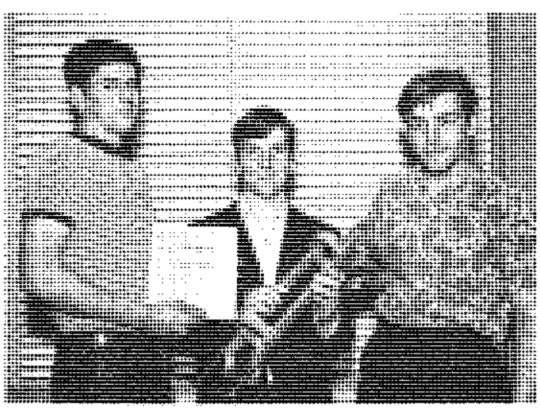
Stephen Laswell
Team Leader



George C. Beakley
Instructor

Second Grand Prize - Team Project

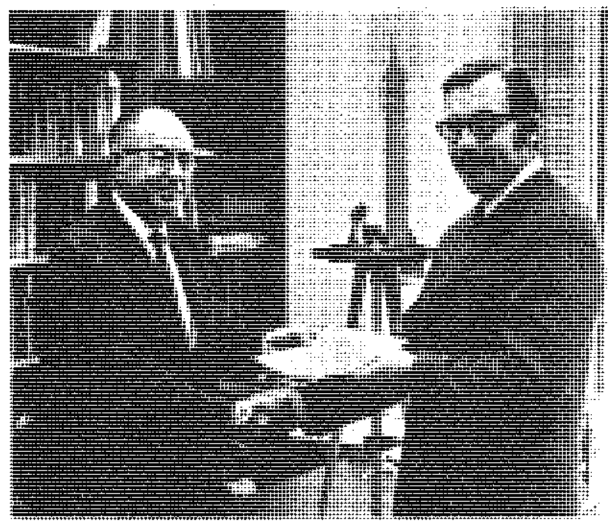
"Free Knee Joint Leg Brace"
Designers: Robert S. Mazaka
Paul Bibo
James Mallen
Instructor: Borah L. Kreimer
Northeastern University
Suburban Campus



Paul Bibo, James Mallen, Robert S. Mazake of Northeastern University Suburban Campus

First Grand Prize - Individual Project

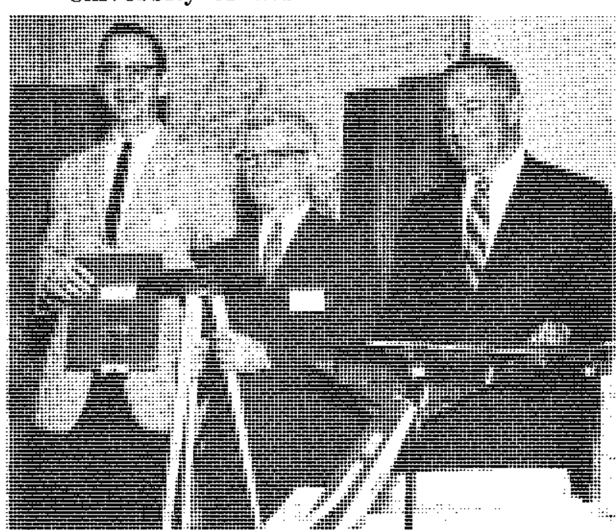
"A Reference Instrument For Setting Grades"
Designer: Ronald B. McHenry
Instructor: Alexander S. Levens
University of California at Berkeley



Professor Levens and Ronald B. McHenry. Award winning Reference Instrument is shown in the background.

Second Grand Prize - Individual Project

"Hexagonal Drop Leaf Table"
Designer: M. J. Jankowski
Instructor: Michael N. Besel
University of Wisconsin at Milwaukee



Albert L. Hoag, Awards Committee Chairman; John Barylski, Displays Committee Chairman; Michael N. Besel, University of Wisconsin at Milwaukee

The four winning projects will probably be on display at the Mid-Year Meeting at LSU.

Impressive certificates were sent to each individual and to each team member, whose project won a ribbon. A note, sent by Al Hoag, to the faculty representative at the student's school stated:

> "It is hoped that you will be able to arrange for some local publicity concerning the awards to the students from your school. Such publicity should serve as an incentive to this year's students to prepare even better projects for next year's display."

> "Please pass on to your students the congratulations of the judges, Awards Committee, Displays Committee and the officers of the Division. Their fine work made the Introductory Creative Design Display a dstinct success."

The success of the Display was due, to a large part, to the untiring efforts of John Barylski, Chairman of the Displays Committee, shown in Figure 4 putting the final touches to an exhibit from Stanford University. John spent many hours, days, and weeks prior to the meeting, planning, writing letters and solving a myriad of prblems which inevitably seem to occur in a nationwide endeavor.

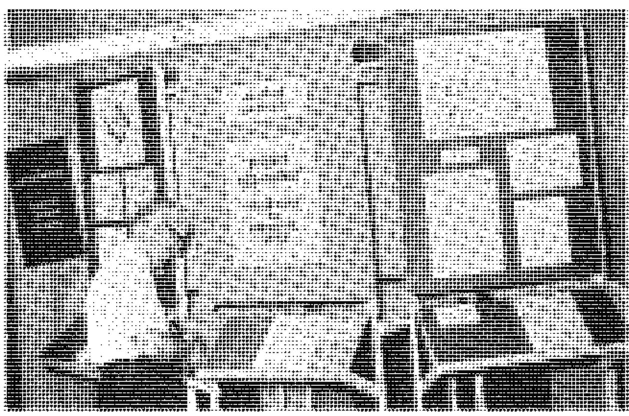


Figure 4

To alleviate some of these problems in the future, John, Al Hoag, Gene Pare, Borah Kreimer, Frank Oppenheimer and others suggest the following:

1. All entries from a particular school should be pre-judged and ranked by interested faculty members at the school.

2. All entries should include:
   a. A statement of the problem as presented to the student(s).
   b. An indication of the man-hours spent on the project as well as the time span alloted for the project.
   c. Explicit instructions as to how the project is to be displayed or preferably the display should be set up by a representative faculty member.
   d. Space requirements for each display. (A photograph of the display would be an excellent aid to the committee.)

Any suggestions that you may have for next year's Display would certainly be appreciated.

John Barylski's report to the Division Executive Committee, at UCLA, summarized his feelings toward many who were involved as participants or as observers.

"There were many who helped to make our Display a success. Special recognition of several who made my duties much lighter is in order. Without Bob Ritter on the program is a frightening thought. Bob has done a masterful job of coordinating people and activities. Charles Simpson, Secretary of the Executive Committee representing ASEE at UCLA, was extremely helpful to the Division. Miss Nicole Schoening, Supervisor of the Art Department of the UCLA bookstore, spent many hours planning, procuring personnel and materials while performing so many tasks that were necessary to organize a quality Display.

"Now as to the financing. Chairman Pare was able to discover and tap several sources. Our good friend Alfred Kreidler provided us with $1000 for the awards and certificates. Frank Oppenheimer, as usual, has looked after our interests. Al Hoag and his Awards Committee helped to complete our professional picture.

"Throughout the year our Displays Committee has been encouraged and strengthened by the effective leadership of our Division Chairman, Eugene G. Pare. The professional image of the Engineering Graphics Division has grown in stature. To Gene, "A grateful Thank You."

"Our Division has a great deal to offer to the Engineering Curriculum today. The Display is adaquate proof that design and engineering experience can be introduced at the freshman level."

OUTSTANDING PROJECTS
(BLUE RIBBON)
at the
INTRODUCTORY CREATIVE DESIGN DISPLAY
A.S.E.E. Annual Convention
U.C.L.A. - June 1968

ARIZONA STATE UNIVERSITY

1. Automatic Adjustable Open-End Wrench
Steve Lasswell, Mike Speights, Frank Ozuna, Ray Combes, Tom Farr, Paul Vaughan

2. Auto Dog Food Dispenser
Kerry Jones, Gary Roles, Alfonso Rodriquez, Frank Sanders

3. Automatic Temperature Control Valve
Robert G. Crafts, Thomas A Grimes David E. Brown, William Edge, Keenan Evans

4. Collapsible Canoe
Rick Morris, Joe Branom, Bob D'Autilia Ali Ghamdi, Charles Mackey, Scott Owen

5. Gasoline Rate Indicator
Robert E. Clark, John B. Berry, Billy T. Borders, Gaius P. Crosby, Gary R. Ginn, Hardy K. Lardskov

UNIVERSITY OF CALIFORNIA

6. A Reference Instrument for Setting Grades
Ronald B. McHenry

7. Cardboard Chair
Rod Neishi

ECOLE POLYTECHNIQUE de MONTREAL

8. Semi-Automatic Adjustable T-Square
Roy Gilles, Maurine Yammine, Richard Simard, R. Savage, Pham-Vam-Khanh

IOWA STATE UNIVERSITY

9. Adjustable Drafting Stool
Mike Shurfy, Joe Dahlman, Terry Morris, Terry Tenold

10. Gun Display Case
James Griffen, Bill Whitacre, Carl Carlson, Harlan Petty

11. Motorcycle Turn Signals
Reed Sevenson, Don Beal, Robert Jodeit, John Kesling

LOUISIANA STATE UNIVERSITY

12. Fallout Shelter
Walter Souder, Richard Theriot, Marvin Collins

McMASTER UNIVERSITY

13. Steerable Tobaggon
Don Phelps

UNIVERSITY OF NEBRASKA

14. Automatic Tractor Hitching Device
Robert Keasling, Richard Kober, Dwayne Arff, Tom McDivitt, Ted Flowerday

NORTHEASTERN UNIVERSITY
Suburban Campus

15. Collision Avoidance System
Arthur Knight, Robert Harris, Dennis Coscia

16. Free Knee-Joint Leg Brace
Robert S. Mazaka, Paul Bibo, James Mallen

17. Stair Climbing Wheel Chair
John Paldoian, Edward Joseph, Mark Carrig

STANFORD UNIVERSITY

18. Egg Cooker
Jurgen Gramckow

TEXAS A & M UNIVERSITY

19. Adjustable Television Stand
Alan Wiggins, Harold Dozier, John Zemanek, Elgin Sanders, Royce Swayne, Ronnie Reed

20. Bathing Apparatus for Handicapped
Greg Belin, William Boothe, John Blank Gary Bridges

21. New Design for Kyle Field
Robert Riggs, Dan Schleuter, Warren Potter, Ed Rhinehart, Scott Phillips

22. Offshore Access Platform
John Chaney, James Condry, Artie Fowler, Rufus Mathews, David O'Neal, Charles Russell

UNIVERSITY OF WISCONSIN - Miwaukee

33. Automatic Car Door Locking Device
R. Reinert, K. Summerfield, G. Pawzak

34. Educational Toy Illustrating a Principle of Modern Mathematics
Michael Block

35. Hexagonal Drop Leaf Table
M. J. Jankowski

36. Table-Lounge Combo
Robert Krzyzanowski

37. Touch-N-Tone - Toy to Improve Hand Coordination of Mentally Retarded
Douglas A. Severson

WESTERN NEW ENGLAND COLLEGE

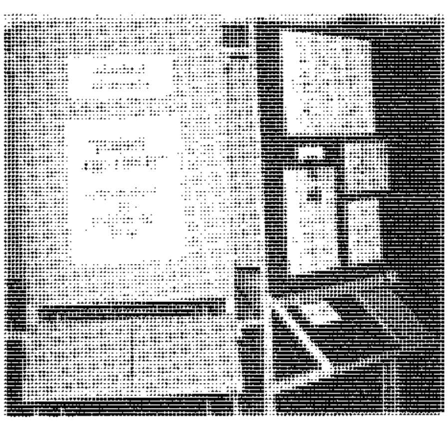
38. Mini Max Toilet Flush System
William Simons, Bovio Colabella, Alan Russell, John Brennen, Steven Smith

WORCESTER POLYTECHNIC INSTITUTE

39. Adjustable Desk and Chair
John Laramee, Ben Katcoff, James Kinney

40. An Improved Door Latch and Door Closer System
Bill Light, John Loehmann

41. Rocket Recovery System
Bruce Kniering, Dan King, William Nute



A Blue Ribbon Display

TUFTS UNIVERSITY

23. Polyhedral Ship
John W. McGillvray

VILLANOVA UNIVERSITY

24. Road Race Layout
Stephen L. Boheim, William T. Monagle

UNIVERSITY OF WASHINGTON

25. Games for Retarded Children
Tim Logan, Don Magnuson, Julian H. Brown

26. Home Fire Escape System
S. Streuker, J. Denhart, J. Rowand, J. Schaefer

27. Mechanical Loading Device for Levitation Apparatus
Richard Delmonte, Jim Bagne, Jack Lincoln, Gerry, Cysewski

28. Medical Ampoule Opener
Joe Garbini, Richard Barnett, Ken M. Bates

29. Radar Reflector Buoy
Stan Kaveckis, Boyd Morgenthaler, Del Clark, Phil Lust

30. Rotating Drawing Board
J. Sheadel, D. Zimmerman, J. Dineen, D. Kopp

31. Toys for Retarded Children
Steve Link, Beckie Wong, Charles Clayton

32. Wheel Chair Lift
Bill Gifford, Wayne Callop, Doug Sowder, Alex Vdolak

Jim Earle and John Barylski

# BRADDOCK LETTERING ANGLES

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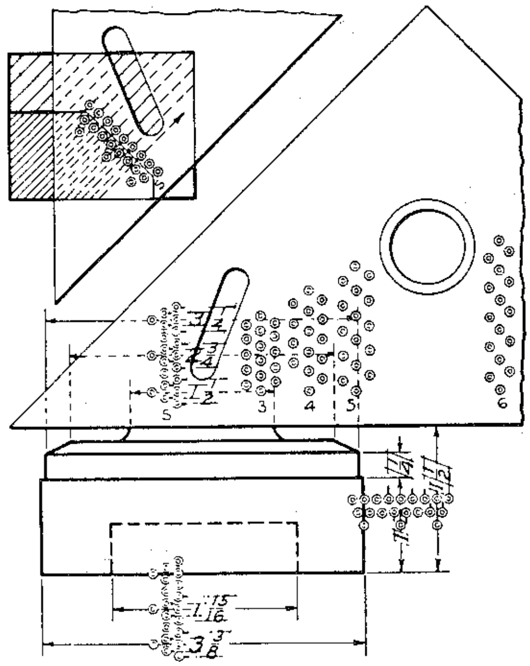
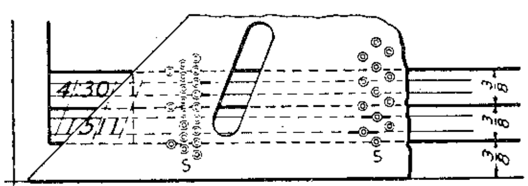


SYSTEMATIC DIMENSIONING



LAYING OUT TITLE STRIP

**Style "A"**

**5"-60**
**6"-60**
**7"-60**
**8"-60**
**9"-60**
**4"-45**
**5"-45**
**6"-45**
**7"-45**
**8"45**

**6"-45 Brd.-Rowe**

**8"-45 Style "C"**

**Style "B"**

**5"-60**
**6"-60**
**7"-60**
**8"-60**
**9"-60**
**4"-45**
**5"-45**
**6"-45**
**7"-45**
**8"-45**

**6"-45 Brd.-Rowe**

**Lettering Device**

**8"-45 Style "B" Brd.-Rowe**

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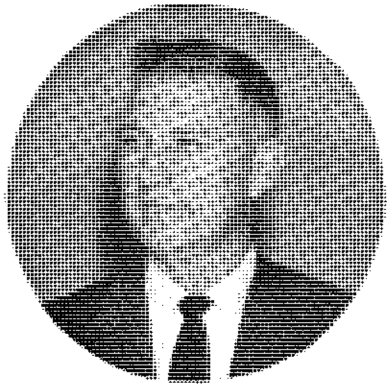

# SOME THOUGHTS ON THE WRITING OF DESIGN PROJECTS

Professor Percy H. Hill*
Tufts University

"Show Him The Way, But Do Not Take Him To The Place"
CONFUCIUS

We all know that the practice of engineering is a highly creative effort and self rewarding experience. It requires imagination and the application of precise knowledge of dedicated individuals to maintain and renew present day technology. It is difficult if not impossible to convince young engineering students (freshmen and sophomores) of the glamour of the profession if all of their college work is centered on material that is largely "state-of-the-art." Much of this material is problem orientated to teach fundamentals (more of what they were exposed to in high school). No wonder many of our best students either transfer or drop out of technical curricula.

The focus of a well-planned curriculum should be not only on "engineering analysis" based on the fundamental principles of science but also on "engineering design", the creative and imaginative aspects of engineering. One of the greatest problems an educator faces, however, is how to teach design. Probably the only effective means to date in teaching engineering design is to involve the student in "open-end" type design projects with proper organization and "coaching" from the responsible faculty. A design project allows the student to express himself as an individual (probably for the first time), to experience an involvement in the creative role of engineering, and to see a problem in its real world context (public acceptance, economics, safety, optimum solution, human factors, etc.).

It is the wise selection and careful writing of a design project for assignment to students that I wish to address myself to in this paper. A carefully selected and well written project will go a long way in the effective instruction of the design process. The project itself can be considered a self-instructional device. A poorly written project very quickly causes the student to lose interest and excitement for the design and results are usually trivial. Outside of actual classroom teaching, one of the most rewarding things we do in our profession is the design and preparation of class assignments. A bit more care and sometimes a special talent must be exercised, however, in the writing of a design project since the student will often spend several weeks proposing a solution and then present his findings in the form of a lengthy report. He must be strongly motivated and excited from the start to maintain a prolonged interest throughout the period of time when so many distractions bid for his time.

It is important in the choice of a desing project as well as in the presentation to remember its purpose as an assignment. As I see it, the purpose of a design project is to give the student an authentic experience in a realistic engineering situation, to show how knowledge gained is applied to problems of his invention, and to stimulate creative and imaginative thinking.

Although projects may be written on almost any subject in any style, the following rules are universal, as far as I am concerned, when it comes to composing the assignment:

(A) Projects should be placed in areas where easily accessible information sources are available. Even though the author supplies some background information, it is vital that students be required to do some research into the need. It is difficult to know

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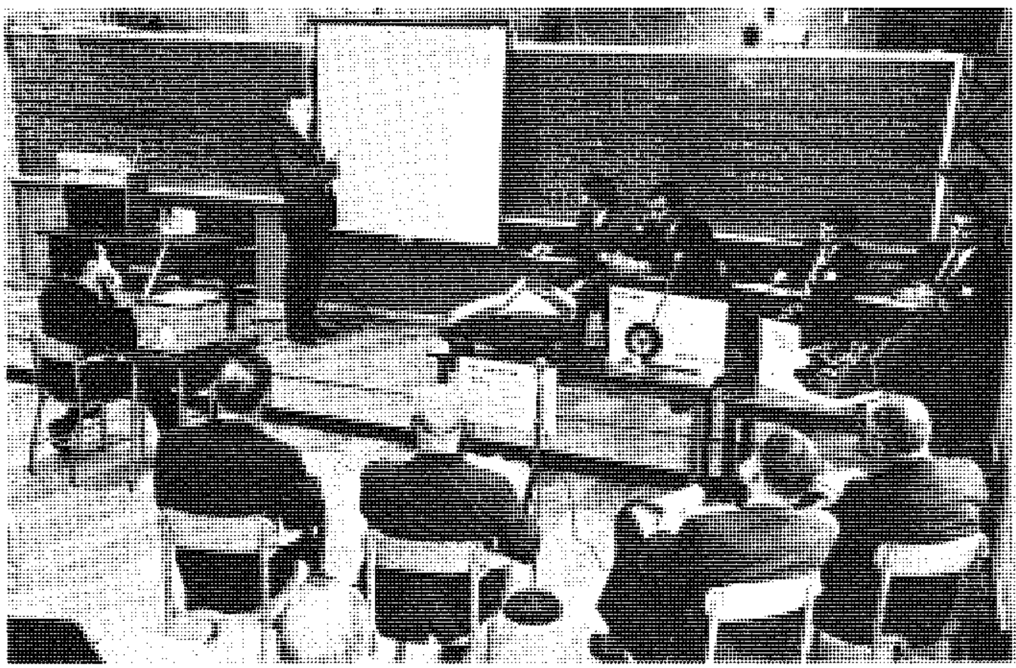
*Presented at the 12th New England Engineering Graphics Conference
April 13, 1968, Northeastern University

how much background information to furnish and still leave room for the student to research the literature. Most authors either supply too much or too little.

(B) For projects to be properly used as instruments to instruct the Design Process they must be "open-ended" in every sense. The need must be stated in general terms only. The student must be forced to identify the exact nature of the problem and determine the specifications (parameters or limits) of the "system" he chooses to design.

(C) The project should be in an area that is motivating to the student and at a level of sophistication that challenges his present knowledge, but not so sophisticated that it frustrates him or forces him to spend most of his time learning new techniques.

(D) The student should be told in a general way at the beginning of the semester what is expected of him on a design project and the design report. Once a project is assigned and the professor finds that he must instruct on each element of the design for the student to complete the work, it is obvious that the project is above the student's capability or poorly written. Once the project is assigned the professor should fill the role of "coach" and "critic" and offer encouragement to the student, but never instruct his ideas of the solution.



Student Design Critique at Tufts University

The following are suggested topics for design projects that I feel are appropriate at the freshman or sophomore level:

1. Mail handling and conveying systems (at Post Office or home delivery).
2. Light-weight power operated jack for automobiles.

} RESEARCH READILY AVAILABLE LOCALLY

3. Competitive electric iron (cordless, collapsible, light, starch dispenser, etc.). An excellent case could be written in the New Products area for this topic.

4. Redesign automotive dashboard and steering system to make unnecessary the use of passenger restraining systems such as belts.

5. Design of a remote control rear view mirror system for automotive vehicles to provide maximum visual information during critical maneuvers such as parking in heavy traffic.

HIGHLY MOTIVATING

6. System of semi-automatic self-service gasoline stations without attendants.

7. Spill-proof funnel to be used with gasoline when filling outboard motors, lawn mowers, snow blowers, etc.

APPEAL TO SAFETY

8. Miles per gallon indicator for automobiles.

9. Speedometer (MPH) for small sailboard with planing hulls (Shark, Sailfish, Sunfish, Scows, Moths, etc.).

10. Golf ball dispenser at driving range.

11. Method of retrieving balls at driving range.

12. Light, inexpensive, durable piers for lakes that can be set in place by one person (male or female) and can be easily adjusted to uneven bottom conditions.

13. Device for a male to cut his own hair.

14. Device for removing leaves from a lawn.

PERHAPS STUDENTS COULD BE GIVEN A CHOICE TO DESIGN IN AN AREA OF ACTIVE EXPERIENCE

15. Self-propelled water skis.

16. Child-proof medicine bottle.

17. Novel Writing Instrument for classroom lectures and demonstrations to replace the primitive blackboard.

18. Paint dispensing brush that need not be dipped into can as often as present.

STUDENTS COULD ALSO DO A MARKET SURVEY

19. Simple recoil device for lamp cord wire used on TV sets, radios, lamps, etc.

SAFETY APPEAL

20. Method of returning a parking meter to zero after occupant leaves, thereby saving funds for the town or city.

REALISTIC BACKGROUND MATERIAL MAY BE ADDED HERE (SOURCE - LOCAL POLICE)

CAN YOU ADD FIVE MORE?

21. ________________________________________

22. ________________________________________

23. ________________________________________

24. ________________________________________

25. ________________________________________

The following examples are illustrations of three methods of presenting design projects to students. Please note how an element of realism is achieved in each case:

THE HARDT TOOL AND HARDWARE COMPANY
11 STATE STREET - SOMERVILLE, MASS. 02144-628-5000

"Tools of Quality for the Working Man"

February 21, 1968

Mr. Percy H. Hill, Manager
ENGINEERING DESIGN GROUP, INC.
1200 Boston Avenue
Medford, Massachusetts 02155

Dear Mr. Hill:

---

TUFTS UNIVERSITY

Memorandum

To: Advanced Design Group    Date: March 11, 1968

From: Chief Project Engineer

Subject: Design of Underwater Work Tools under NAVY Contract.

Our company has been fortunate in being awarded a pilot design contract by U. S. Navy (Special Projects Office COMSUBPAC) to develop initial designs and ------------

---

AMERICAN-ENTERPRISES, INC.
1830 BOSTON AVENUE
MEDFORD, MASSACHUSETTS 02155
AREA CODE 617    776-2100, ext. 242

April 3, 1968

ANNOUNCEMENT OF DESIGN COMPETITION

It would not be appropriate for me to conclude this presentation without an example of the type of design project I have been driving at in this paper. I offer the following for your criticism:

COOPERATIVE FOR AMERICAN RELIEF EVERYWHERE, INC.

KATIGSAK BUILDING
KALAW AND MABINI STREETS
MIDWEST REGION
NIGERIA

CABLE CAREINC., NIGERIA
TELS. 482-6
483-6

VITA, INC.
230 State Street
Schenectady, New York 12305

Gentlemen:

I am a Peace Corps Volunteer in the Midwestern Region of Nigeria. Recently, I have been given the responsibility of expanding the primary school facilities in the region. In order to do this I will need detailed plans and materials estimates for simple, 3 room cement block school buildings.

Can you create for me, or put me in touch with, someone who can supply me with this sort of information? My needs are for plans which will not take a very high level of skill to carry out. Thus, for example, the rafter patterning and construction should be as basic as possible.

Questions that I'd be grateful if you'd answer in detail are:

1. Will I need to use reinforcing rod as an integral part of the wall or should that be confined only to the supporting pillars which will offer the main support to the wall?

2. Will the foundation have to be tied in to the cement slab floor, or should the floor be poured last?

3. Should I use any thing other than a wooden beam across the top of my window holes in order to support the weight of the wall above? What size beam (or piece of steel) is necessary to bridge what size gap with what amount of wall above it?

4. How much eave space is required to provide adequate shelter from hard tropical rain, thus allowing windows to remain open during rain storms?

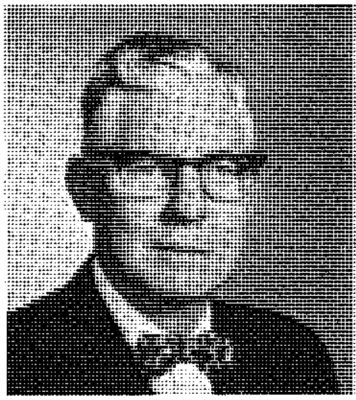
5. What is the simplest way to build a two-child primary school classroom bench and desk?

If you need any more detailed information in order to answer my questions, please write me as soon as possible.

Thank you for your assistance.

Yours,

Alan Crew



# EXPERIMENT WITH OPEN-LABORATORY INSTRUCTION IN ENGINEERING GRAPHICS

by
Earl D. Black
General Motors Institute

## PROPOSAL

A proposal was made to the administration to explore the effectiveness of open-laboratory attendance versus the conventionally scheduled laboratory. The proposal was approved and the objectives established were as follows:

To explore the possibility of student improvement in learning by the open-laboratory technique of instruction.

To determine the amount of instructor time required using the conventional method versus the open-laboratory method.

To explore the value of increased classroom instruction time compared to scheduled supervised laboratory instruction.

To examine the effect of reduced student teacher contact time.

To give the student more practice in self-direction in use of study hours.

To explore multi-group lecture possibilities and flexibility of class sizes.

To investigate possible relief in crowded laboratory conditions which may develop as student enrollment increases.

## OPERATIONAL PROCEDURE

Two teachers volunteered to conduct the experiment. They were assigned two classes each running two successive school terms. Each teacher had one group using the conventionally supervised laboratory method with eight (8) hours per week contact time divided in two sessions of one hour in class and three hours in supervised laboratory (2-6 total). The students were expected to spend two hours per week in outside related time (homework). The open-laboratory groups were scheduled with four hours of student-teacher contact time divided in two individual one-hour sessions of class time and two single hours of recitation time. Six hours per week were expected but unscheduled in laboratory and study time.

The class demonstration and instruction was approximately the same for both methods. The two methods deffered in that the recitation hour for the open-laboratory classes was used to discuss problem assignments, to give unit quizzes, answer student questions, review unit tests, and to coordinate the lecture material with laboratory assignments. During the day the teachers made an effort to be available for conference and individual assistance. A laboratory area was reserved for open-laboratory student use from 7:30 a.m. to 10:00 p.m. but students were permitted to do their laboratory assignments at home. The open-laboratory groups were expected to perform assignments as were sheduled for the conventional groups.

Both groups were given the same diagnostic test at the beginning of the course to establish class norms in ability and experience. This test consisted of two pages (8 problems) in shape analysis and association, one page (14 problems) in matching pictorial drawings of objects with corresponding multiview drawings, and one page (12 problems) in multiview line-completion drawings including sectional and auxiliary views. Students were allowed only one hour in which to complete the diagnostic test.

Both groups met with the teacher four times per week and were given the same type of assignments. One teacher used a team grouping for both classes. Two teams of six or seven students per team were formed from the conventional class. Three teams having five, five and seven students respectively were formed from the open-laboratory class. Group leaders were chosen by using the highest diagnostic test scores in each group. Students worked with the group leader and the teacher acted as a consultant. No student was assigned the same part drawing but his detail drawing was selected from the same assembly and required the coordination of the group leader to assure mating parts. Assignments were classified as easy, medium, and difficult. Grade values were 1, 2, 3, and 4. A student doing a 4-value drawing had four grades recorded on his record; a 3-value drawing had three grades recorded, etc.

During the recitation hour held for the open-laboratory group, the teacher devoted his time doing chalk-board demonstrations for individual and small student groups. The group leader also used this time to organize project assignment schedules. In fact, students were inclined to spend an extra 20 minutes in recitation hour normally used as recess time.

TESTING

The conventional-laboratory classes (82 students) averaged 82.44 on the diagnostic test; the open-laboratory classes (86 students) averaged 79.24 -- a score difference of 3.20 in favor of the conventional class group. The big difference in score was mainly in one class group.

A missing line test with 24 individual drawings to complete was given to both groups in the second week, fourth session. The conventional class had a grade spread of 58 to 96 and a media of 86; the open-laboratory class had a grade spread of 20 to 96 and a media of 80. The class averages for this test were: 79.3 for the conventional class and a 73.0 for the open-laboratory class; a difference of 6.3 in favor of the conventional class. However, the conventional class started with a diagnostic score advantage of 3.20. When this is considered, the conventional class had an approximate advantage of 3.1 at the end of the fourth session.

Even though the class test average was in favor of the conventional class laboratory students on the first test, the percentage of failures comparison was in favor of the open-laboratory class by nine per cent.

On the fourth week test (24 missing line drawings) the conventional class had a low score of 66 and a high grade of 99 with only one student failing; the average on this test was 83.3. The open-laboratory class had a low score of 44 and a high grade of 100, with three failures and an average score of 83.8 -- a 0.5 advantage over the conventional class-laboratory method. The failing student in the conventional class scored 68 on the first test and 66 on the second. The three failing students in the open-laboratory class scored 20 to 40, 48 to 64, and 56 to 64 respectively on the two tests.

The third test was a combination of missing-line completion and pictorial drawings for each, from page 116, Figure 6.53 from "Basic Graphics" by W. J. Luzadder (15 problems). The comparison of the two classes on this test is shown in Table No. 1.

TABLE NO. 1 -- TEST ANALYSIS

| | CONVENTIONAL CLASS | OPEN-LABORATORY CLASS |
|---|---|---|
| High Score | 98 | 100 |
| Low Score | 44 | 34 |
| Median | 77 | 91 |
| Average | 77 | 81.5 |
| Failures (Percent) | 30.7 | 29.4 |

The mid-term test required the students to design a Vibration Arrester (GMI Plate D-1903) between two non-intersecting oblique pipes. Students were required to think constructively by applying projection fundamentals to their own design to satisfy the given situation and problem requirements -- namely, a connector to securely hold the two oblique pipes firmly in position and change the rate of pipe vibration. Grades on this test were evaluated on a basis of 85 per cent for descriptive geometry applications and competence in graphical communication of ideas. Fifteen per cent of the grade was given for creative design ideas proposed.

A similar test in creative design was given at the end of the second six weeks. Three problems were used in one assignment:

GMI Plate D-1190 Plan of Die for Conical Clock Face.

GMI Plate D-1908 Grinding Fixture for Holding a Given Cutting Tool.

GMI Plate D-1917 Drying Fixture for Sheet Metal Part.

Students assigned the Clock Face were required to design 12, 3, 6, and 9 as they should appear in the clock face and some configuration at each 5-minute interval. This assignment required the division of the flat pattern of the clock face into 60 minute divisions starting with half minute spaces on each side of the face layout blank and the proper transfer of one numeral and two configurations of their design to a flat pattern layout of the stamping die required to make the clock face. No student had the same combination assigned.

The Grinding Fixture required a vise holder designed for the purpose of providing uniform cutting tools used in engineering production.

The Drying Fixture required the holding of an oblique surface of a sheet metal part in horizontal position while a slow-drying material applied to the surface sets in uniform thickness.

These three assignments were divided equally among the class and were distributed alternately. Students had permission to trade assignments if they wished, but there were no known exchanging and no obvious resistance to this kind of assignment. However, it did evoke numerous questions from both groups.

All students took the same final examination. There were 115 multiple choice questions, with 5 choices for each question. Forty-six were information recall and 69 questions required drawing analysis and recognition. The conventional class average on the final examination (machine scored) was 77.16 and the open-laboratory class average was 83.57 -- a score advantage of 6.41 in favor of the open-laboratory class. When the diagnostic score comparison is added, the score difference should be 9.61 in favor of the open-laboratory method.

At the end of the experimental comparison the open-laboratory students suggested that a test be run where both classes have regularly scheduled and supervised laboratory hours for the first six weeks and then go into the open-laboratory situation at the beginning of the second six weeks period. Those students who had no previous drawing felt that they would have profited by having regular supervised laboratory instruction at least for the beginneing of the course. Also, the second unit test in completion of missing line drawings appeared to make the students in the open-laboratory class more concerned where they made low scores.

## TIME CONSIDERATIONS

The open-laboratory students were asked to record the time spent on each drawing. A summary time sheet was kept in order to make a student time requirement comparison. The conventionally supervised laboratory class spent an average of 69 hours in scheduled laboratory time, while a number of students in the open-laboratory class used additional time. The average total time recorded on open-laboratory student drawings was 94.5 hours (including both related and instrument drawings). The student average actual laboratory time comparison is 5.8 hours per week spent by the conventional class students and 6.5 hours per week average spent by open-laboratory students -- a difference of 0.7 hours per week less for conventional laboratory students.

Teacher time and activity were both affected. Preparation for the two recitation hours was an added activity with the open-laboratory class. The students in this class often kept the teacher throughout the regular 20-minute recess time which came at the end of the hour. Individual students also continued questions and discussion with the teacher while walking to the office from the classroom. Unscheduled time spent with students in the conventional class was approximately 2.7 hours per week as compared with 5.5 hours per week with open-laboratory students. This time does not include preparation requirements. Preparation time required approximately one hour per week more for the open laboratory class due to discussion periods. Time allowance on Table No. 2 should also be inreased when instructors are teaching the course for the first time.

TABLE NO. 2 TEACHER TIME REQUIREMENTS

| | Conventional Class Hours/Wk | Open-Laboratory Class Hours/Wk |
|---|---|---|
| Class preparation, checking papers, instructional development, faculty conference conference, reports and records, counseling, other related activity. | 5 | 8 |
| Class time-lecture, demonstration, discussion discussion | 2 | 2 |
| Recitation-coordination of class coverage with laboratory assignments, informal discussion, unit quizzes, review of tests and assignment performance, team group organization, others. | 0 | 2 |
| Supervised laboratory-individual guidance, checking drawings, testing drawing-board demonstrations, counseling, others. | 6 | 0 |
| Totals | 13.0 | 12.0 |

## STUDENT ATTENDANCE

The open-laboratory class had 37% less hours absences. See Table No. 3 Absence Record.

TABLE NO. 3 ABSENCE RECORD

| | No. of Students | Total Hours Absent | Average |
|---|---|---|---|
| Conventional Convention Laboratory Class | 80 | 109 | 1.5 hrs. |
| Open-Laboratory Class | 79 | 34 | .43 hrs. |

## STUDENT REACTION

The "Student Evaluation of Teaching"* was used with a special questionnaire and check sheet. Students were asked;

1. If you did not go directly to the draw- and design laboratory to do your assignment, how did you "use" the time set aside?

| | |
|---|---|
| Study for other classes | 31% |
| Go to Cafeteria | 14% |
| Went to library | 14% |
| Went back to your room | 28% |

* Student check sheet was designed by Dr. A. J. Kubany, GMI Student Relations

Went to laboratory 13%

2. Did you feel you did well on the assignment problems without an instructor being present?

   Yes, 87% -- No, 13%

   Comment -- had more time -- just a bit rough, 25%

   Needed instructor often, 13%

3. Did you do the assignment alone?

| | |
|---|---|
| Yes | 26% |
| Most of the time | 15% |
| In a group | 42% |
| In a group some of the time | 21% |

   (answers to this question overlapped)

4. Do you know for certain that some students either traced or copied assignments?

   Remarks;

| | |
|---|---|
| I noticed nothing of this nature | 42% |
| Yes, it happens in all classes | 26% |
| Students checked with each other | 32% |

5. Which do you like better?

| | |
|---|---|
| The conventional laboratory | 59.4% |
| The open-laboratory | 40.6% |

   Comments;
   The open lab is more convenient
   Can finish assignment in one sitting
   Places responsibility on student
   I am a procrastinator, therefore, conventional is better for me
   Open-lab has its drawbacks
   Open-lab has less pressure
   Open-lab requires more time

6. Did you use the drawing laboratory after 5:00 P.M.?

| | |
|---|---|
| Yes | 82% |
| No | 18% |

7. If not (item 6) where did you do your drawings?

| | |
|---|---|
| At the fraternity | 41% |
| At home | 23% |

   Remarks
   Used the time set aside for the labs.
   Used the lab on Thursday and Saturday mornings.

8. Did you find it difficult to find the instructor for conference?

   No 83%

   Remarks
   Teacher was in his office when scheduled for lab.
   On occasions.
   Once, all ather times he was near.

9. Did you live in a fraternity?

| | |
|---|---|
| Yes | 33% |
| No | 67% |

10. Further comments -- in favor of:

   I liked the course, learned a lot, and am sure I can use it.
   Got more out of lab work than either class or recitation.
   I suggest continuing the open-lab experiment.
   Open-lab is great for those who have had previous experience; those who have not find it more difficult.
   It was a rewarding class.
   I would recommend open-lab for all drawing courses.
   Pressure of conventional method causes too much speed and needless errors.
   I am certain that I received much better grades on my drawings

than I would have if my time had been limited.

Further comments -- against:

Help from other students not entirely satisfactory.
A beginner needs the teacher's help more than can be given in open-lab classes.
We worked together much less in open-lab because we worked at different times.
Possibly only one extra recitation hour per week would be sufficient to give necessary instruction.
Temptation to copy is too great in open-lab class.
I made a lot of unnecessary mistakes working by myself.
I believe that the conventional lab to be the fairest, best and most learning type of situation.
Should schedule consultant for nights only.
Press of exam may make a difference in class performance.
The teacher should keep a close check on promptness to prevent student lags.
I am a commuting student and it was almost necessary for me to go directly to lab after recitation.
Occasionally, aword or two from an instructor would have saved me much time.
I found myself spending much more time on drawing than I would have in conventional lab.
The fellows in fraternities have copies of some of the assignments and use them to trace or copy.
I feel that new plates should be given to open-lab classes.
Why not reduce recitation time to once a week and one hour in lab the other?
A lab proctor should discourage copying.
The open-lab class just took two more hours from the time that we are already short of.
The teacher was thorough enough in class lecture that the recitation hour was needless for me.
Use less time on recitation days. give full time possible in lab.
I don't believe that freshmen at college level should be given responsibility of working by themselves; it is too frustrating.

TEACHERS CLASS LOG NOTES

The open-laboratory class seemed to be more keyed-up after the first team project was assigned and submitted for grade evaluation.

The open-laboratory class averaged approximately one more drawing per student during the first two weeks. However, the conventional class had one hour less in lab due to registration and an extra day off because of the labor day vacation.

One student from the conventional class requested to sit in on the lecture hour given the open-laboratory class. He attended the fourth class session only.

The recitation time for most open-laboratory class sessions was spent primarily in answering questions by students. Questions were numerous and more student participation occurred in the open-laboratory sessions.

All lectures and recitations for the open-laboratory class were held in the same class room.

A sense of rivalry between the classes appeared during the second week of school Section A. The open-laboratory class strove to better the results made by the conventional class. Cooperation was excellent from both classes. An attempt was made to avert the sense of rivalry during school Section B. Students in the open-laboratory class appeared to develop an aggressiveness not apparent in the conventional class. One student made an eraser model of a problem on a unit test to prove his answer. The regular award for such activity by a student was double credit -- -- 88 to 96 in this case.

Students in open-laboratory class asked so many questions in the fifth class session that the assignment was delayed to the recitation hour. The recitation hour has this advantage in availability of time.

Session 6 students in the open-laboratory class asked if they could forego the recitation and come into the office individually for answering questions. They were told that the decision would be made at the next recitation. As a result no questions were asked by the students of this class (scheduled time for this recitation was the hour before a regular holiday). As soon as assignment sheets were distributed, the entire class was transferred to the drawing laboratory and the students were put to work for one hour. Numerous questions then came from individuals when they began work. One student was overheard to remark to another that "we may learn a lot today after all." In fact, too many students crowded around the teacher's desk and were sent to their seats and counselled in groups of two.

Conversation with students during lunch hour in the cafeteria called attention to one advantage that the open-laboratory gives -- if the student is pressed for time in other classes he can spend the time preparing for that class and do his engineering graphics assignment after 5:30 P.M.

Open-laboratory students described the lecture hour as the teacher going "like blazes" with hardly time to ask a question, and desribed the recitation hour as much more leisurely and a combination of discussion and lecture.

Session 9 - Fundamentals of Dimensioning, was covered during the class session and assignments were worked out by the students in team, each student of a team working out the details for a different part in the assembly. The group leader coordinated the assignment for his team. This method worked well in teaching the comprehensive result and purpose of dimensioning in engineering design and production.

A few of the open-laboratory students requested extra copies of missing-line problems for practice after the fourth week test in projection. Section A students in the open-laboratory class began asking questions about how they were doing compared with the conventional class progress. They were told truthfully that the answer was unknown. They were told, however, about how many students had failed on the last test efforts and also the average difference between classes without class identification.

Team assignments do not reduce teacher time. In fact, individual student-teacher conferences increased considerably with the open-laboratory class students when the assignment required team work.

The open-laboratory class has the disadvantage of requiring the teacher to check on an increased number of drawings at the close of the grading period and tends to delay individual progress evaluation and reports to the records department. It also reduces the opportunity to mark and evaluate the student's work in his presence. At least a portion of the teacher's grading time is lost to ineffective review unless the student carefully reads and considers the markings and notes placed on his paper by the teacher. The open-laboratory class method also reduces the teacher's office efficiency due to interruptions by student and teacher conferences.

Both classes had two substitutions by other teachers. During one recitation session while the regular teacher was away, approximately half of the open-laboratory students failed to attend. However, all attended the following class meeting which had the substitute teacher in charge.

There was some difficulty in providing students in the open-laboratory class with consultant service. Students expected the teacher to be in his office constantly. Many questions which students asked in individual conferences were either in the textbook or GM Standards Reference Manual had students only used them.

Some difficulty was met with the open-laboratory students failing to do assignments as per schedule. In many instances, too, the the time required for doing the drawings was unrecorded and unrealistic. However, both classes averaged higher grades than normal. It is recognized that the conducting of the experiment may have inspired the teacher to more effective performance as well as students. On a creative type design problem, GM Plate D-1903 Vibration Arrester, the open-laboratory class produced three distinctly different solutions while the conventional class produced only one. The resulting designs is a comparison to 40 different solutions for this problem in the teachers collection. In the team-group situation one of the open-laboratory group leaders also revealed that members of his group did not want the small drawings nor did they want the "hairy assignments". He let the "kinda" choose their own from those given. This class was assigned a free selection from four different assemblies.

The open-laboratory class method tends to reduce absences from class. The conventional class students were absent a total of 109 hours (80 students) or an average of 1.36 hours per student. The open-laboratory class students were absent a total of only 34 hours (79 students) or an average of .43 hours per student. See Table No. 3.

The open-laboratory class method tends to encourage the student to be more alert in both class and discussion hours. It also inreases his time required to find the instructor when he has trouble and needs assistance.

The open-laboratory method gives students a chance to procrastinate and put off doing problem assignments as per course schedule.

Often the student got so far behind that he could not complete all assignments. Also, the delay caused a time lapse between the class coverage and actual performance that required the student to work from an inadequate set of notes and increased his difficulty. Under such conditions he was lax in seeing the instructor for needed help.

CONCLUSION

The objectives of the experiment were met.

1. Even though the 79 students assigned to the open-laboratory classes scored an average of 3.20 less than the conventional class average on the diagnostic test, they had closed the gap to a difference of .40 on the the six weeks progress grade and went ahead of the conventional class on both the final examination and term grade average by 6.41 on the final examination and 1.14 in the term grade average.

2. The total instruction time required for the open-laboratory class method was approximately one hour per week less than with the conventional class method. See Table No. 2.

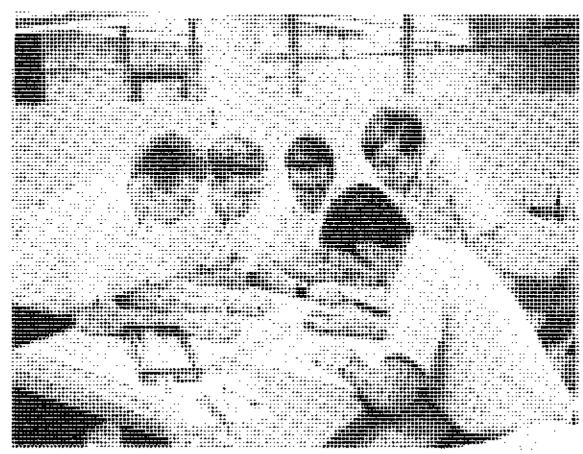
3. There appears to be some increase in effectiveness by the use of the open-laboratory class method of instruction as exhibited by final examination scores and team grade averages. See Table No. 4.

4. The student-teacher class-contact time was reduced approximately 4.7 hours per week by using the open-laboratory method. This reduction of time was partially lost by the difference of 2.9 hours per week in extra individual conference time and a further reduction in extra preparation time for discussion hours leaving a net reduction of one hour per week instructor time per class.

5. Students liked the chance to practice self direction in the use of study hours provided by the open-laboratory method. This advantage was off-set somewhat by the fact that these students spent approximately 35 minutes per student week more than required in the conventionally scheduled laboratory classes. This difference does not take into account the time needed by the conventional class students when they are assigned homework problems in sketching that was included in the time record submitted by the open-laboratory students.

6. The possibilities of class size flexibility was not thoroughly explored, but indications showed that some increase in class size may be practical. A later schedule had two classes meeting at a common hour during lecture only with seperate recitation hours which gave a saving of two more hours per week in instructor contact time with no loss of student hours.

7. The fact that students can successfully perform laboratory assignments after class recitations without restricted supervision makes it posible to increase the number of individual classes without increased laboratory facilities. There is no marked difference in student achievement by the use of either method. It should be considered, however, that the use of the open-laboratory method can be more difficult for the beginning teachers to use. Also, approximately 60 per cent of the students participating in the experiment prefer the conventionally supervised laboratory method.

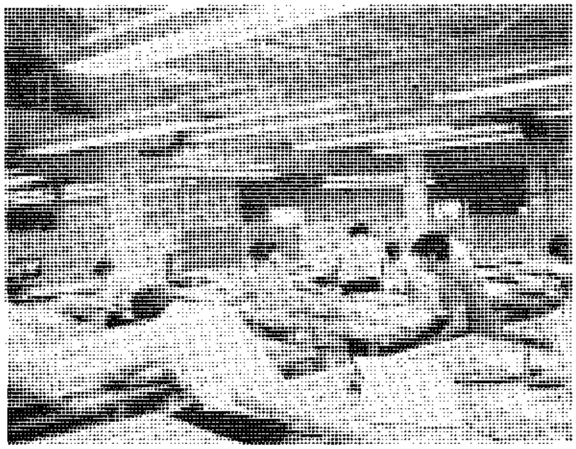


Students working as a team on a common design project

RECOMMENDATIONS

The number of students participating in this experiment may not be sufficient to provide data required to form hard and fast conclusions.

It would be wise to go into the open-laboratory method gradually making adjustments in the procedure as experience is acquired.



Students working in a regularly scheduled laboratory session.

Students in the open-laboratory class suggested that this method inflicts an extra hardship on those who have had no previous drafting courses. It is suggested that it would be highly desirable to use the conventionally scheduled and supervised laboratory method at least for the first four weeks before going into the use of the open-laboratory method.

It is recommended that the student-teacher contact time requirements be gradually reduced by shortening the recitation hour.

Should the open-laboratory method be broadly adopted, proctor laboratory assistants should be scheduled as needed throughout each school day to give students directed learning.

It is also recommended that a diagnostic test be given to all students taking a course in beginning engineering graphics. Such a test should immediately point out individual student difficulties or abilities and test scores could be recorded for future guidance.

TABLE NO.4 SUMMARY CHART

| Class | No. of students enrolled | No. of classes | No. of students complet-ing course | Diagnos-tic test average | 6-Weeks test average | 6-Weeks grade average | Term drawing time average (hours) | Student-teacher contact time average (hours) | Teacher extra time average* (hours) | Teacher class & laboratory time* | Final Exam average | Term grade average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Conven. Lab. | 82 | 4 | 80 | 82.44 | 82.65 | 86.06 | 71.0 | 186.5 | 32.5 | 110.0<br>219.0<br>(2 classes) | 77.16 | 85.15 |
| Open Lab. | 86 | 4 | 79 | 79.24 | 83.87 | 85.66 | 78.0 | 94.5 | 67.7 | 81.0<br>162.2<br>(2 classes) | 83.57 | 86.29 |
| Difference | 4 | 0 | 1 | 3.20 | 1.22 | .40 | 7.0 | 92.0 | 35.2 | 28.9<br>56.8 | 6.41 | 1.14 |

Students voting for Open-Laboratory Class = 86 = 40.5%

Students voting for Conventional Class = 100 = 59.5%

7 drop-outs in Open-Laboratory Class

2 drop-outs in Conventional Class

* This time does not include class preparation. Perhaps 30 minutes or more is required per week with open-laboratory classes. Comparative estimate is two hours per week with a conventional class and two hours and 30 minutes per week with an open-laboratory class method of teaching.

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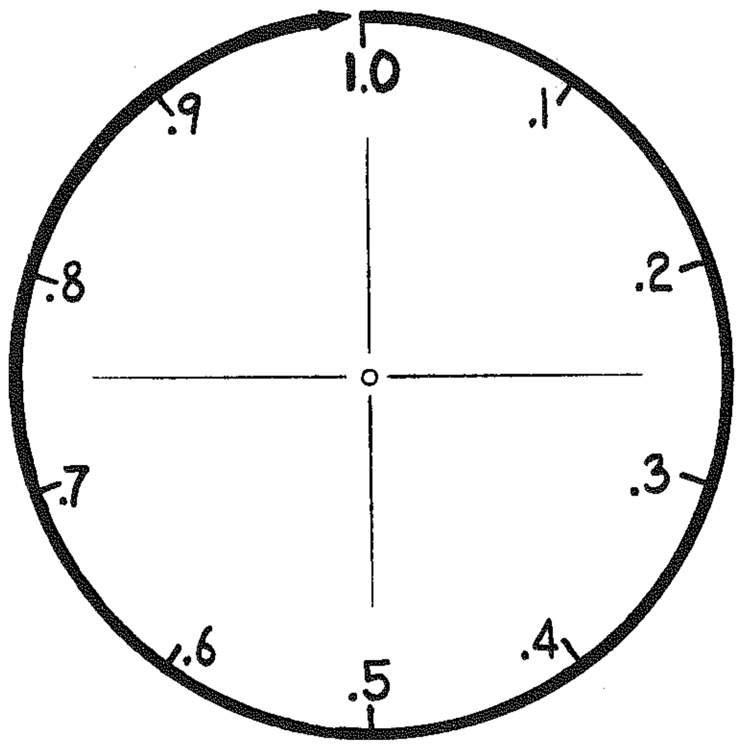


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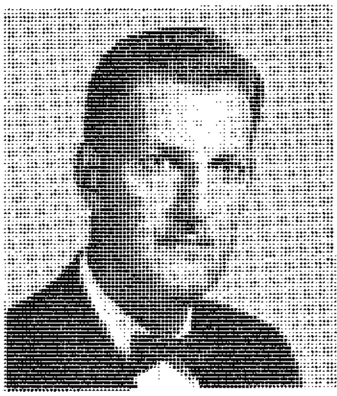

# COMMUNICATIONS
# A MEASURE OF MECHANICAL TECHNOLOGY PROGRAMS IN FLORIDA JUNIOR COLLEGES

by
Professor E. D. Davison
Department of Engineering Technology
St. Petersburg Junior College

With the publication of the McGraw report[1] attention was first drawn to the many different meanings of the word "technician". The knowledge gap between the engineer and the skilled production worker was at one time relatively small. In recent years this gap has widened at an exponential rate, creating an urgent demand for a new body of men. Our junior colleges and technical institutes throughout the country are attempting to meet this demand by programs designed to prepare technicians.

What is a technician?

One can receive a variety of answers. The man on the street might well consider his TV repairman a technician. Some automobile service organizations point with pride to their "ignition technicians". A local air conditioning firm would probably consider their installation men technicians. Many industries view their technicians as virtual junior engineers, granting them semi-professional status (with appropriate beginning salaries and fringe benefits).

All of these answers are correct. There is a wide spectrum of meanings to the word. Since the technician must bridge the gap between the engineer and the production worker, he must share the competencies of each. The worker represents manual dexterity; the engineer, knowledge. The technician must have both dexterity and knowledge. In what proportions? In various proportions, hence the spectrum.

At the end of the spectrum the technician is primarily interested in manual dexterity. He is essentially a worker having a limited amount of specialized knowledge. He is an industrial technician. In contrast, the engineering technician depends little upon skill. He has a limited experience in the operation of production machniery -- sufficient to have a practical appreciation of the capabilities and limitations of the operator. More important is his academic background. He has been educated in depth in his specialty. In addition he is graduated with a sound base in physical sciences, mathematics, graphics, English composition or communication and as much in the way of general education courses as a crowded curriculum will permit. He is a knowledgeable person who can work with the engineer at his level and at the same time deal with the worker in a practical way. More than that, he has the capability of expanding in his or related fields. He is much sought after by industry.

Most of Florida's 28 junior colleges have associate degree programs in the various technologies. Depending primarily upon the local needs of the community, these programs will be of varying levels, and the graduates will find themselves limited to certain positions within the technician spectrum. Some will become vocationally-oriented industrial technicians; others are fully qualified to become engineering technicians in the strongest sense of the word. This might give rise to some confusion in the mind of one who is a stranger to technical education.

How would an industrial concern recruiting mechanical engineering technicians in the state of Florida know where to look?

The first answer might be to visit only those junior colleges with ECPD accredited programs. Under those circumstances a recruiter would be assured the institution he was visiting had a high level program. In Florida, however, the State Board of Education will no longer permit a junior college to seek specialized accreditation. Only one institution had an ECPD accredited curriculum of any sort when this restriction went into effect. Such a situation

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[1] James L. McGraw, Ed Characteristics of Excellence in Engineering Technology Education, ASEE, 1962

requires, therefore, that those who would evaluate a curriculum must use other criteria.

## COMMUNICATIONS

An effective criteria is the probability that the graduate will be able to communicate with the engineer in all media. If the technician is to work closely with the engineer, he must have an effective control of the written language, the spoken language, the mathematical language, and the graphical language. Any program that purports to prepare engineering technicians must, then, make ample provision for the development of proficiency in all aspects of communication.

There is considerable variation in the extent to which that is being done in the engineering technology programs in this state.

A comparison of the catalogs from two Florida junior colleges will illustrate the variation:

Quoting from junior college "A":

"The basic objective of technical education is to prepare qualified technicians in preselected fields. The technical programs emphasize the understanding of basic principles of science rather than the acquisition of manual skills .... Graduates will have acquired the vocabulary of the engineer and will understand many of the basic principles that are the foundation of technical progress."

From junior college "B"

"..... a two year program designed to prepare the student who may choose the universal language of the engineering world. The graduates of this program will have an understanding of engineering fundamentals, skill in drafting and the practical application of that skill in design problems. This program will prepare the graduates for opportunities in various industries where drafting and design elements are involved. Typical of those positions are draftsman, printed wiring draftsman, junior designer, associate engineer, engineering technician and engineering aide."(Emphasis supplied)

"A" makes an honest straight-forward statement of its objective. There is no embellishment, there is no appeal to the masses. "B", on the other hand, is covering all bets. Its program allegedly will qualify the student for everything from a printed wiring technician to an "associate engineer". One would suspect the Administration to be primarily concerned with increased enrollments.

Comparing pertinent course descriptions:

JC "A":

"Engineering Drawing I & II
Drawing lettering dimensioning. Geometric construction, orthographic projection, isometric, oblique, working and assembly drawings and freehand sketching."

"Advanced Engineering Drawing I & II
Drawings involving assemblies, gears, cams, machine mechanisms and analysis of motions obtained."

JC"B":

"Engineering Drawing
Fundamentals of engineering drawing using mechanical engineering concepts -- use of tools, lettering, orthographic projection including auxiliary views, sectional views, threads and fasteners, dimensioning and tolerancing, shop processes and working drawings."

Note the absence of any pictorial drawing or freehand sketching in the JC"B" description. Note also the application of graphics to the specifics of mechanical design situations in Advanced Engineering Drawing I&II, JC"A".

Making further comparisons:

JC"A":

"Elementary Machine Design
Analytical design of bearings, clutches, couplings, gearing systems and power shafting. Methods of construction correction, specifications of materials and manufacturing processes."

"Applied Machine Design
Application and utilization of courses previously taken to complete basic and selective design problems. Tool design, general machine design, piping design, and pneumatic and hydraulic systems. Designing for strength, serviceability, economy and reliability."

JC"B":

"Drafting and Design Problems
An applications course in which the student is assigned projects and does all the drafting and design required for the ultimate manufacture and production of the items."
(continued on page 54)

# Problem Books for Engineering Graphics

## Book I

by **James S. Rising** and **Carl A. Arnbal**
*Iowa State University*

This set of engineering graphics problems is keyed to the first 16 units of the text and is designed for a semester's work. Contained are 76 sheets of problems; layouts for practice of graphical theory, engineering applications and worded problems; and quality green tinted drawing paper for all problems.

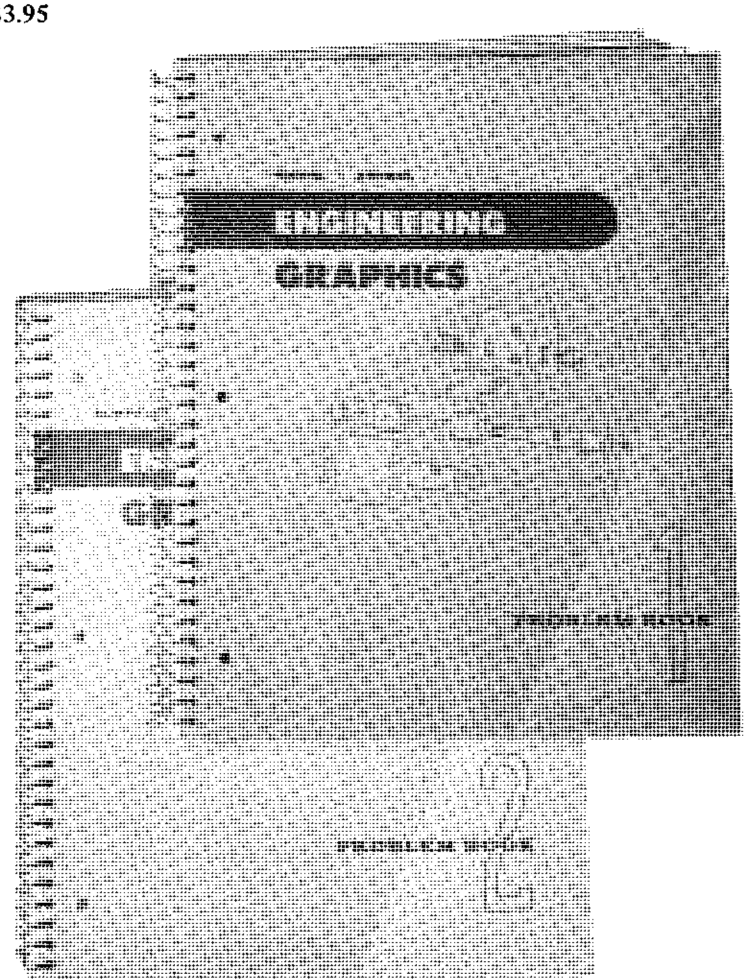
**$3.95**

## Book II

by **Maurice W. Almfeldt** and **Carl A. Arnbal**
*Iowa State University*

This set of engineering graphics problems is keyed to nnits 17-37 of the text and is designed for a semester's work. This workbook contains 88 sheets of problems; graph paper in 10 x 10, log and semi-log for the graphical analyses found in units 33-37; and quality green tinted drawing paper for all problems.

**$4.95**




NOTE: An answer key is available for those problems in Books I and II.

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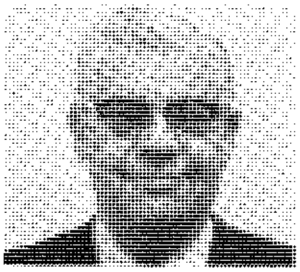
# ENGINEERING GRAPHICS APPLICATION AT LTV AEROSPACE CORPORATION



PRESENTED TO

THE AMERICAN SOCIETY OF ENGINEERING EDUCATION MEETING
AT
TEXAS A&M UNIVERSITY
ON
23 MARCH 1968

BY

R. D. FURAY
LTV AEROSPACE CORPORATION
VOUGHT AERONAUTICS DIVISION
DALLAS, TEXAS

My discussion this morning will highlight some of the practical, everyday applications of Engineering Graphics at the LTV Aerospace Corporation. Engineering Graphics is a broad subject with almost limitless applications. Even when related to the LTV Aerospace Corporation, which is a multidivision corporation, the subject far exceeds the time permitted.

So let's focus our attention more sharply on two specific points which must be remembered throughout this presentation.

First, I am associated with the Vought Aeronautics Division of the LTV Aerospace Corporation. The prime product of this division is military and commercial aircraft.

Secondly, my examples will be centered around the applications of Engineering Graphics as used by the design engineer, as opposed to the analytical or staff engineer.

This discussion, then, will pertain directly to the design engineer's applications of Engineering Graphics in the design of aircraft. The distinction between the types of engineers and the products they design is important to remember, if we are to avoid confusion and misunderstanding. All engineers must indeed have an adequate knowledge of the fundamentals of Engineering Graphics. All engineers must be able to clearly converse with one another through the use of graphics.

Analytical engineers must be able to transmit ideas, via sketches, using the basic techniques of graphics. These same engineers must be able to quickly and correctly interpret the accurate scale graphics prepared by the design engineer.

The design engineer, unlike the analytical engineer, must be proficient in his use of Engineering Graphics. This proficiency will result from experience, providing there is an adequate foundation of the basic fundamentals of Engineering Graphics upon which to build.

I particularly welcome this opportunity to discuss this subject with you, the people who are in the education field, because there are increasing indications that Engineering Graphics is receiving a diminishing portion of the engineering student's curriculum. This situation creates a growing concern among us in dustry who are daily involved with the design of the products our companies produce.

I recently attended a seminar on the subject of Engineering Graphics sponsored by a prominent university. One of the speakers from industry emphasized the projected increase in the number of engineers which will be needed during the next decade.

On the same program, a faculty member of the university outlined the manner by which his institution had recently reduced the hours which had been previously allocated to teaching Engineering Graphics. The reason for the reduction was to provide time for other subjects. This reduction was accomplished by combining three previous courses into one. Engineering Graphics at this university now encompasses what used to be "Beginning Drawing," "Descriptive Geometry," and "Advance Drawing."

The above rearrangement required that certain aspects of Engineering Graphics be omitted and that the retained material be presented much faster. This faculty member admitted that this change made it much more difficult for the student to grasp the subject, and he further admitted that industry will be left with the task of completing the students' education by on-the-job training.

I am in no way implying specific criticism of this particular university. I am using this university only as a current typical example of a growing trend.

The need for additional engineers has been increasing over the past several years. During the same period, many colleges and universities have been gradually reducing the Engineering Graphics portion of their curriculum. The results are quite apparent when a new college graduate becomes employed as a design engineer.

At the present, this condition is considered tolerable, but marginal. But when we project our thoughts a few years hence, we can readily foresee an increased number of graduate design engineers with an inadequate knowledge of Engineering Graphics. Such a condition becomes frightening to industry, because Engineering Graphics is indeed a prime tool of the design engineer.

You and I are well aware that technological advances have resulted in the need for new subjects. In addition, a greater depth of certain subjects must be made available to the potential engineer. These new subjects, and those of greater depth, do indeed take time. Time which is often gained by reducing the time alloted for teaching Engineering Graphics. This reduction is often so large that it is detrimental to the potential design engineer.

The foregoing leads me directly to my purpose in being here this morning. I hope to outline realistic reasons why an aircraft design engineer, if he is to satisfactorily compete with his colleagues in industry, needs a thorough knowledge of Engineering Graphics.

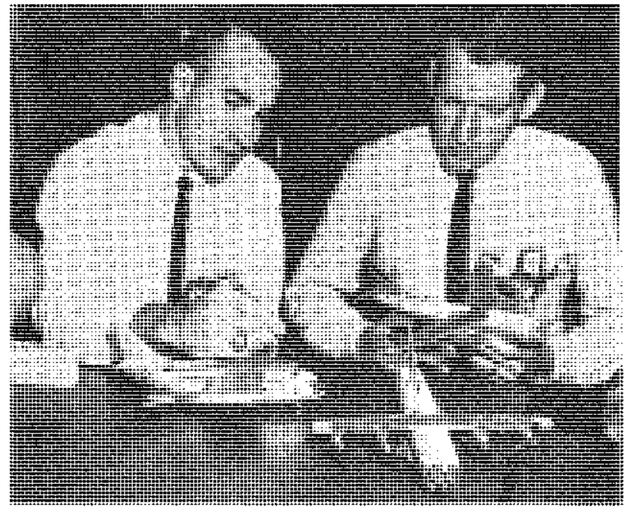
You, as educators, will then be better able to place Engineering Graphics in its proper perspective with the increasing multidude of technical subjects that must be available to the potential design engineer.

In discussing the application of Engineering Graphics, I like to think of them in two phases- first the Creative Phase and secondly the Documentation Phase.

For the moment I will not further define these two phases. I believe a review of the chronological sequence of events leading to the released drawings of a new, or modified aircraft, will easily make the distinction.

At Vought Aeronautics Division we have what we call an Advanced Systems Department reporting directly to the Vice President-Engineering. This department is composed of various types of engineers, including a nucleus of design engineers who work directly at a drafting board. These design engineers are continually performing the following tasks:

1. Investigating various methods of improving existing aircraft to better perform the mission for which they were produced.



2. Investigating possible changes to existing aircraft so they can perform additional missions.

3. Performing preliminary design studies of the next generation of aircraft.

4. Performing conceptual design studies of advanced aircraft, or second-generation vehicles.

5. Preparing specific proposals based upon a customer's expressed needs.

All of the above tasks have an obvious common denominator - new business - without which no company can long survive.

Let me cite some specific examples of these tasks. Assume that our company is currently producing an attack aircraft. Our company is convinced that, if this attack aircraft could be economically redesigned to permit it to perform the mission of a tanker, the customer would be interested in awarding a new contract.

The tanker version must obviously carry more fuel. It must be equipped with a boom through which the fuel is transmitted to the receiving aircraft. The tanker must have stronger structure to carry the increased load, and on and on.

The use of graphics is not required to

calculate the additional volume of fuel which will be required; but I defy anyone to adequately locate such fuel in the aircraft without the aid of graphics.

Bulkheads will have to be relocated or added. Outside contours may be revised. The volume of irregular shaped fuel tanks must be calculated. Various types of equipment must be relocated and added. The mechanism for operating the boom must be defined, and a place in the aircraft must be found for such mechanism.

Such changes and additions can be visualized and coordinated only by the design engineer's use of Engineering Graphics.

Let me cite another example. Assume that the customer has expressed an interest in procuring a two-place trainer version of a currently produced single-place fighter aircraft.

The design problems will obviously vary between these two examples. Instead of increased fuel for a tanker aircraft, an additional pilot must be added in the trainer version. But, as with the first example, the design engineer must use his prime tool - Engineering Graphics. He must find room for the extra pilot. He must relocate equipment, and possibly the wing, to maintain an adequate center-of-gravity location. He must revise the cockpit arrangement for dual controls, instruments, vision, etc.

Let me give you one more example. Instead of modifying an existing aircraft, assume we are going to design a new generation aircraft. In this case, there is nothing to modify. The design engineer must start from scratch, if you will, on a blank piece of vellum. He must, by the use of Engineering Graphics, compile a coordinate, three-dimensional visualization of all aspects of this new aircraft.

The following list represents a few of the items that must be determined by the use of graphics:

- The outside lines of the aircraft
- The location of the wing, the wingfold, the variable sweep
- The aircraft configuration with respect to the carrier elevators
- The number of aircraft that can simultaneously fit on the flight deck
- The location of the basic structure, bulkheads, panels, longerons, floors, etc.
- The location of the fuel, air-conditioning, oxygen, and numerous other equipment items
- The definition, location, and basic geometry of the landing gear
- The definition of the cockpit size and arrangement
- The location of the guns, ammunition, rockets, etc.

The list goes on and on.

Admittedly, the depth of the design during this phase does not permit the fabrication of hardware. But the design must be sufficiently adequate to assure that, on an award of a contract, the product can in fact be produced for the price, delivery, performance, etc., that has been agreed upon. You can readily see that the use of inadequate, or incomplete, graphics during this phase can have a direct effect on the profit, or loss, in building the final product.

Let me hasten to say that 1 am in no way to imply that new products are created by Engineering Graphics alone. Far from it. Many staff engineers who do not use but who must understand graphics are a necessity in the design of any product.

But neither can new products be created without the widespread use of Engineering Graphics. The staff engineers and the design engineers must work as a coordinated team.

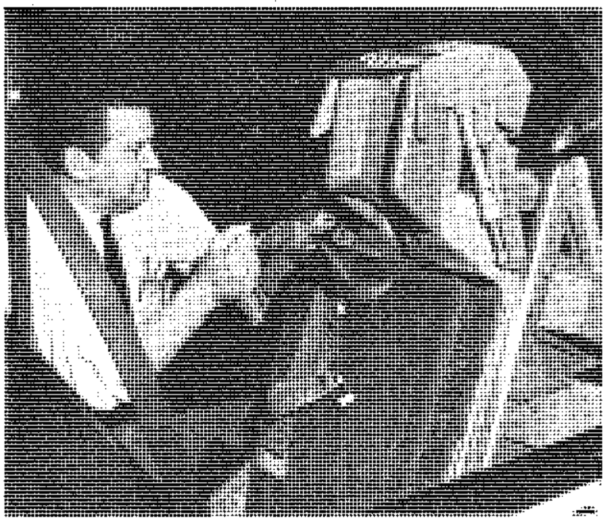
The men using Engineering Graphics in the Advanced Systems Department are not mere draftsmen. They are design engineers with adequate technical knowledge who have a responsibility for creating new, salable products.

So much for the conceptual phase of designing aircraft. Let's move on to the detail design phase which follows the award of a contract.

No hardware can be built from the conceptual type studies. But hardware must be built before it is sold, and it must be designed in detail, piece by piece, before it can be built.

The conceptual studies and proposals discussed will have been prepared by a small nucleus of design engineers.

In contrast, the completion of the detail design phase will require the use of several hundred desgin engineers. These design engineers cover a multitude of backgrounds. The fuselage and wing must be designed by structural design engineers. Human factors design engineers are involved with the aspects of the pilot, such as seating, ejecting, and cockpit



arrangement. Fluid system design engineers are required for fuel, oil, hydraulic, and similar systems. Mechanical design engineers design the control system, the landing gear, and similar mechanisms.

And, of course, scattered throughout the aircraft are scores of items of an electrical/electronic design engineers.

These various backgrounds highlight the fact that design engineers from many fields are all vitally associated with the total design of an aircraft.

These hundreds of design engineers embark on the task of designing approximately 22,000 different contractor-built parts for a single-place military aircraft. Add the parts which must be designed by vendors, the assemblies of the detail parts, and the 22,000 parts increase drastically.

Unlike the conceptual phase, the design engineer must now resolve all detail aspects of the finished product, essentially to the level of locating each rivet.

Let me give you an idea of the number of hours that to into the application of graphics during the detail design phase of a single-place military aircraft. Although specific figures for individual companies will vary, they all will be comparable to the following industrial average.

It can be expected that 45,000 to 50,000 square feet of formal engineering drawings will be required. The design time, that is, the time to prepare the engineering definition prior to starting the final drawings, averages 7 to 9 hours per square foot of final drawing. This amounts to approximately 400,000 hours used by product design engineers to define the engineering requirements on layouts, using Engineering Graphics. In addition, it can be expected that another 200,000 hours will be required to prepare the final engineering drawings. This total of 600,000 hours is approximately half of the total engineering budget for the initial detail design of a single-place military aircraft.

From these figures you can begin to appreciate the part that Engineering Graphics plays in design. Almost 40 percent of the total engineering budget is applied to Creative Graphics.

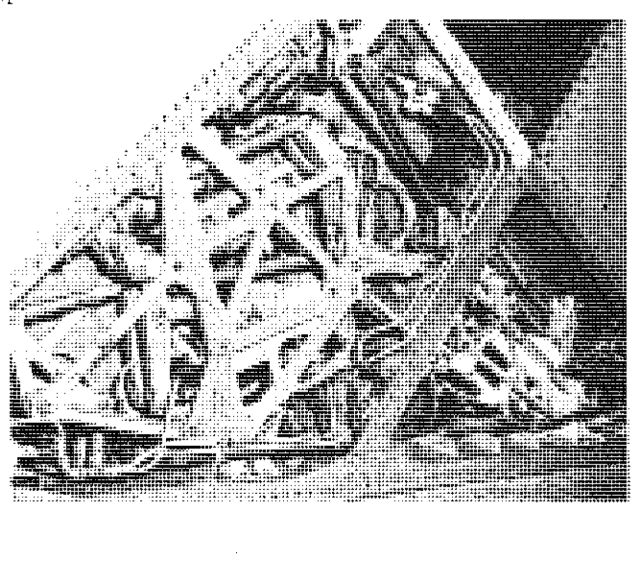
Now let me mention some of the detail design applications which require so many hours.

Consider the structural design engineer whose task it is to design a bulkhead. Remember, I am now discussing the detail design phase. This structural design engineer must resolve all aspects of his bulkhead. This includes such things as the location, size and/or shape of doublers, webs, joggles, holes, stiffeners, supports, attachments, and more. These items must be designed with respect to the outside contour, inside duct contour, longeron locations, etc.

Loads must be carried by physical hardware. This hardware must be lightweight and easily manufactured, and it must clear other structure and equipment.

This design engineer must coordinate his structure with the requirements of many other designers, each with an equally important task.

Fuel lines, hydraulic lines, air-conditioning plumbing, ammunition chutes, electrical bundles, and controls rods are typical items which must pass through the bulkhead. In addition, there will be certain equipment items which will be mounted to the bulkhead. And, of course, all of these mountings must be accomplished so that no two items are in the same place at the same time.



Can you visualize the chaso that would result without the use of graphics to provide the three-demensional visualization necessary to assure the necessary coordination?

But you might ask why a draftsman could not perform these same functions. Since we are still in the Creative Phase, the evolution of this bulkhead requires advanced technical skills, in addition to graphics. Such skills are not generally associated with a draftsman.

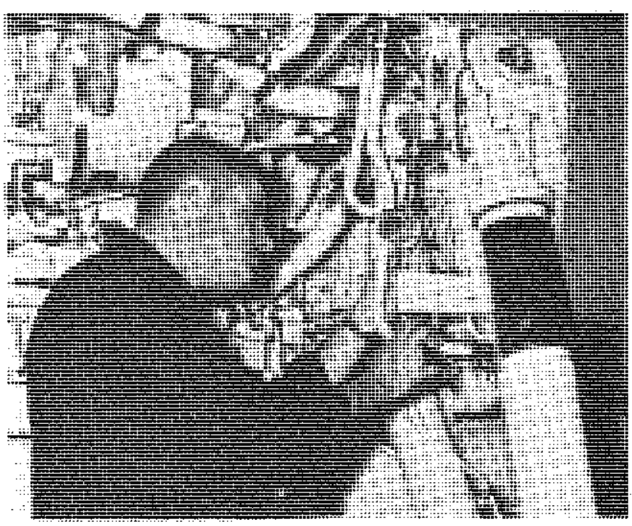
All design is a compromise. Such compromises can be adequately accomplished only by the design engineer who has the proper balance of technical and graphic skills.

How about the design engineer who is designing the control system between the cockpit and the wing outer panel? His task does not isolate him to the design of a single bulkhead or wing rib. His task is to design the geometry of the control system through a large portion of the aircraft. Pushrod and bellcrank lengths, as well as mounting, clearance, safety, and rigging provisions, must be resolved by graphics.

A detail discussion would consume far more time than is permitted this morning. But the following examples are typical uses of graphics in the detail design of aircraft.

1. The outline of the windshield must be established to assure that the pilot has adequate vision, regardless of his size or seat position.

2. The cockpit arrangement must provide the pilot with adequate vision of all instruments; with access to all controls, switches, and buttons; and with freedome of movement.



3. The landing gear geometry must provide adequate ground clearance, retraction mechanism, load-carrying members; and it must nestle snuggly within the aircraft when retracted.

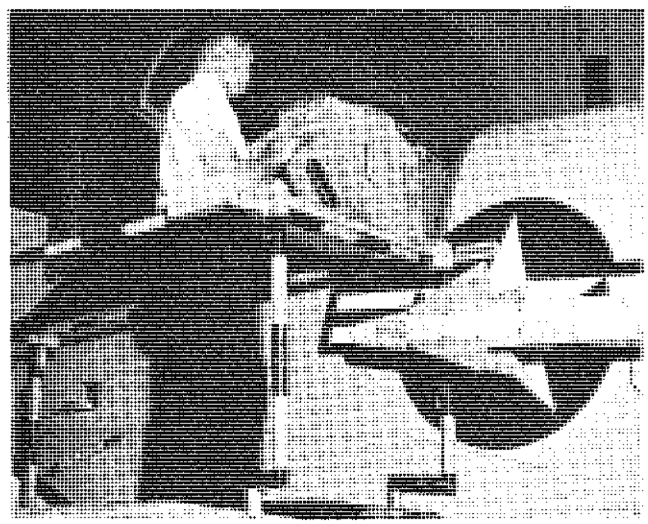
4. The engine-mounting provisions and removal clearances must be established.

5. Hydraulic strut design including the stroke, piston diameter, inlet and outlet ports, and mounting provisions must be defined.

6. Special mechanisms for a multitude of purposes must be established.

7. Overall coordination, elimination of interferences, access provisions for maintenance and service are prime requisites of the detail design phase.

8. The routing of plumbing lines and electrical cables must be planned.



9. Space allocation for the multitude of equipment items that must be installed must be provided.

These few examples, and the hours allocated to the graphics portion of a detail design program, will portray the importance of Creative Graphics.

To this point in the design program we have been determining the various requirements of the bits-and-pieces of hardware, as well as the assembly and installation requirements.

The next step is the Documentation Phase. No discussion regarding the application of graphics could be complete without mentioning the final engineering drawing. This is the document which accumulates all the efforts of the design engineer and arranges them in a language that can be understood by the engineer and the craftsman alike.

Bear in mind that during the Creative Phase the design engineer is determining what is needed. He is constantly compromising between the structural, space, weight, cost, and similar type requirements. This compromise is accomplished by graphically expressing the requirements, changing, rearranging, and redoing these requirements for the purpose of evolving the best combination.

Once finalized, these requirements must be converted into an engineering drawing. This drawing is primarily a graphic picture, supplemented by text, which fully defines the actual hardware to be produced. Additional engineering drawings are required to indicate the assembled condition of all of the bits and pieces.

Finally, installation drawings must be prepared to show the final positioning of the part or assemblies in the aircraft.

To be adequate, all engineering drawings must be complete, accurate, and clear. It is imperative that all the users of an engineering drawing have a single interpretation - this interpretation must be the same as that which the engineer intended. This can be obtained only by the use of standard Engineering Graphics, which must be known by the engineer.

In today's environment, Engineering Graphics cannot be discussed without a word or two about computers. I am sure that all of you, and perhaps all of your students, are aware of the growing use of computers in the field of graphics. Because of this knowledge, there is perhaps a growing feeling that the increasing reduction in teaching Engineering Graphics will be offset by the use of these computers.

There are computers on today's market which use a cathode-ray tube and a light pencil. These computers can be used, to a degree, for Creative or Documentation Graphics. But their applications are currently limited, and they do not yet nearly fill the total need for aircraft design.

To be sure, in years to come, advancement in the field of computers may well provide an electromechanical means to practically assist the design engineer. But how many years will it take - 10, 15, 25? In the meantime, we cannot avoid using Engineering Graphics as we know them today.

Even assuming that the computer will eventually be more feasible for design. I'm not sure they will ever completely replace, or take over, the designer's use and need of Engineering Graphics.

This assumption is based on the fact that at the seminar mentioned earlier, there were over 100 companies represented. About 25% of the discussions at that two-day seminar were on the subject of computers.

But during a general discussion period at the close of the seminar, the consensus of those attending was that no matter how good these exotic computers were, and they do have limitations, most companies could not afford them.

To be sure, there are less exotic computer-operated monsters available today. We use a large mechanical drafting machine, operated by a computer-prepared tape resulting from an individual program, to prepare portions of some engineering drawings. We also currently use a plotter which will mechanically prepare wiring diagrams from an established program. We have a machine which, by tracing an orthographic drawing, will convert the drawing into an isometric presentation.

If what we hear about computers is true, they will eventually do everything for us. It seems logical, then, to assume that they will ultimately do our graphics.

But I am thoroughly convinced that this will not happen, in a practical sense, during at least the next decade, and probably not for some time thereafter.

In preparing this presentation, I have come to the conclusion that defining the applications of Engineering Graphics, by word descriptions, is almost as difficult as designing without the use of graphics.

In summary, let me review some of the basic uses of Engineering Graphics in the design of aircraft. We have seen that conceptual design, wherein new products are evolved either through modification of existing products or by establishing a new concept, requires extreme use of Engineering Graphics. Analysis alone is insufficient for a manufacturer to, in fact, produce a product that the customer has ordered.

The detail design of products requires an extended use of Engineering Graphics to resolve the many compromises of the physical aspects of the product. The fact that it is known that fuel must go from point A to point B, at a given flow rate with a specified pressure drop, is not enough. Physical hardware must be conceived to perform this function, and this can be done only through the use of graphics.

And finally, Engineering Graphics is used to document the engineering requirements in a language that can be understood by the craftsman who is to build the hardware, assemble the parts, and make the final installations.

Only through the use of Engineering Graphics do we have a visual medium for developing a physical system and its components. A design engineer without graphics is like a blind man without a seeing-eye dog - virtually helpless.

If any of you are in the Dallas area, I invite you to come to the Vought Aeronautics Division of LTV Aerospace Corporation. If you will contact me, I will make every effort to show you "Engineering Graphics in Action"!

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Communications (continued from page 45)

This latter course is not a design course. It, like the others listed below, is a drafting course. Mere inclusion of the word, design, in the title does not enrich the course content. In the absence of any evidence that the students are given preparation in mechanics, kinematics or strength of materials one could seriously question the statement that the student "does all the design required for the ultimate manufacture and production of the items."

JC "B"(Cont.):

"Basic Electronic Drafting"

"Advanced Electronic Drafting"

"Mapping & Topographical Drafting"

"Architectural Drafting & Design"

JC "A":

"Report Writing"
The fundamentals of industrial reporting with emphasis on the technique of presenting information graphically as well as in clear, concise written form."

JC "B":

"Technical Report Writing II"
(No course description available)

JC "A":

Required mathematics courses are Algebra and Trigonometry and Applied Calculus.

JC "B":

Required mathematics courses are Slide Rule and Use of Tables, Applied Algebra, and Applied Trigonometry... no calculus.

JC "A" clearly has established a high level program. It is rigorous, challanging, demanding but rewarding in terms of the sound educational base it provides. It is equally obvious that a graduate of the JC "B" program will be far better equipped to serve as a draftsman than as an engineering technician.

No attempt is made to compare the quality of the two programs, nor is there any desire to ridicule or embarrass JC "B". The institution is undoubtedly serving the needs of its particular community very well. Nevertheless, by maintaining the fiction that its graduates are qualified to become "engineering aides" "associate engineers" or "engineering technicians" it is guilty of misleading the public. Whether the deception is deliberate or whether it stems from a singular lack of knowledge of the technician spectrum is not really the point. The fact is, the deception is quickly revealed by the deficiencies in communications in the curriculum.

Communications in the sense used here connotes far more than the mere transmittal of information. It implies a dialogue or conversation in which there exists a measure of rapport rarely found in other fields of endeavor. The true engineering technician is not an engineer and makes no pretense of being one. He does, however, to a limited degree, think like an engineer. This is possible because in his preparation he has shared many of the academic experiences of the engineering students. Such common ground is found in those studies relating to communications: Engineering Graphics (not "Drafting"), Machine Design, Mathematics, Writing. Their importance is manifest if the graduate is to occupy a position at that end of the spectrum.

The prudent administrator will be straightforward in his statements of course objectives. The true level of his curriculum is de facto established by the nature of the communications courses within it.

# A NEW SOLUTION METHOD for CYLINDER -and CONE PROBLEMS

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## 1. Introduction

In a parallel orthographic projection, the base of a right circular cylinder or cone remains circular only if the axis of the cylinder (or cone) is perpendicular to the projection plane. In any other case, the circular base yields an ellipse. This causes difficulties when dealing with projections of a cylinder or a cone. If a second projection of a point or a generator, given in one projection, is sought recourse to the elliptic base projection is impracticable because of the inaccuracy involved. Other methods are laborious and involve a large number of operations.

This paper presents a new and different approach to right cylinder and cone projections, which may simplify many solutions. A right circular cylinder or cone, in an arbitrary position with respect to the projection plane, can be sectioned in such a manner, that the resulting ellipse gives a circular projection on that plane. This ellipse can serve as base on which all generators are constructed, and itself being a circle in projection, all difficulties entailed by an elliptic base are obviated.

## 2. Projections of right circular cylinder

Theorem. Given a projection plane $\pi_j$ (in an orthographic projection) and a cylinder with its axis inclined towards the plane. The cylinder may be sectioned by a plane $\alpha$ to give an ellipse whose projection on $\pi_j$ is a circle.

Proof. We choose a plane $\alpha$ as follows (Fig. 1). Let $\pi_i$ be a plane perpendicular to

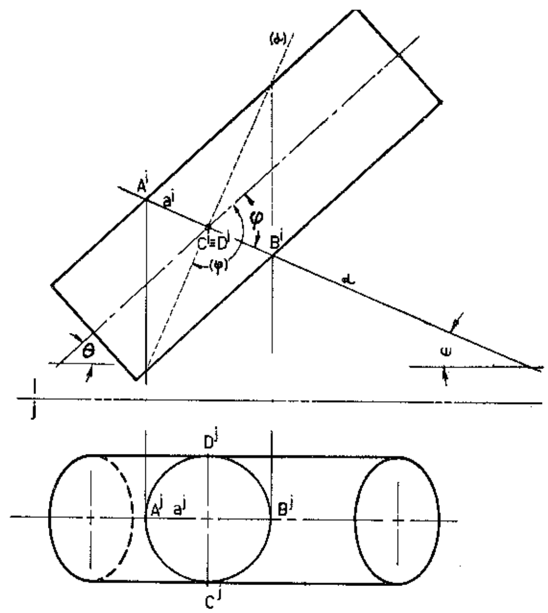



Fig. 1 Section through a cylinder resulting in a circular in projection.

$\pi_j$ and parallel to the cylinder axis. A plane perpendicular to $\pi_i$ sections the cylinder in an ellipse with axes b = CD (equal to the cylinder diameter) and a = AB = $b/\sin\Phi$, $\Phi$ being the angle between plane $\alpha$ and the cylinder axis. a is parallel to $\pi_i$ , and b perpendicular to it and parallel to $\pi_j$. The projection of this ellipse on $\pi_j$ is another ellipse whose axes are in turn the projections of those of the former.

Axis b, parallel to $\pi_j$, retains its length in the projection, while a is shortened and its new length is $a^j = a \cos\psi = (b/\sin\Phi) \cos\psi$, $\psi$ being the angle between planes $\alpha$ and $\pi_j$.

Proposition. An angle $\psi$ exists in which $a^j = b^j = b$. If $\theta$ is the angle formed by the cylinder axis with $\pi_j$, then $\Phi = \psi + \theta$ and $a^j = b^j \cos \psi)/\sin(\psi + \theta)$.

Equality of $a^j$ and $b^j$ is conditional on $\cos\psi = \sin(\psi+\theta)$, which is the case for $\psi = \frac{1}{2}(\frac{\pi}{2} - \theta)$. Hence the plane $\alpha$ forming this angle with $\pi_j$ yields a section as required. Another plane forming an angle $\psi = \frac{1}{2}(\frac{\pi}{2} + \theta)$ with $\pi$; and perpendicular to $\pi_i$ yields a section as required as well. A particular case is that of the cylinder axis parallel to $\pi_j$, i.e. $\psi = \pi/4$.

In practice, there is no need to calculate the angle in constructing the required plane. We start from the required circle, which should be a projection of the section ellipse on $\pi_j$, and with the aid of projective lines to the projection on $\pi_i$ obtain readily the projection of $\alpha$.

The following is application of the proposed method.

3. Identification of generators and points on the surface of an inclined cylinder.

Given a right circular cylinder with its axis parallel to the projection plane $\pi_2$ (Fig. 2). A generator a on its surface is given in one projection, say on $\pi_2$, and the projection on $\pi_1$ is sought.

Solution. The base of the cylinder projected into an ellipse cannot be useful while solving the problem. We do it as follows. The cylinder is sectioned by a plane so that the projection of the section on $\pi_1$ is a circle (see #2 above). Let A'' be a point common to a'' and $\alpha''$, i.e. a projection of the piercing point of a and $\alpha$ A' should be on the circle $\rho$, and is obtained with the aid of projecting rays. a' is parallel to the cylinder axis through A'.

Conversely, if a' is given, a'' is obtainable in the same manner by finding A' (the common point of a' and $\rho$) and then A'' and a''.

A similar problem is finding the second projection of a point B on the cylinder surface, given in one projection. The solution is obtained by drawing a generator through B, or by drawing the plane $\alpha$, through B (i.e. B' on the sectioning circle $\rho$).

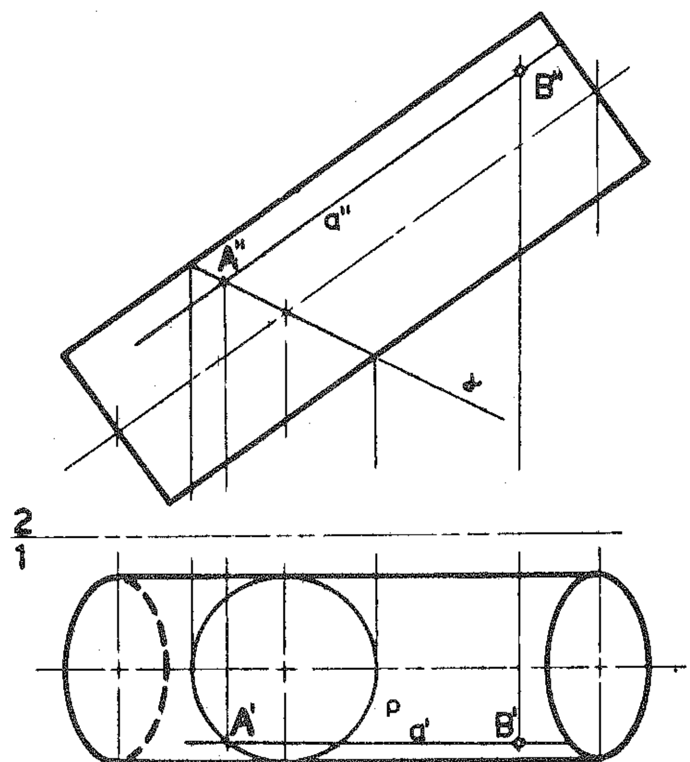



Fig. 2 Identification of a generator and a point on a cylinder surface.

4. Intersection line of two cylinders parallel to one of the projection planes (Fig. 3).

Given two circular cylinders with axes m and n parallel to $\pi_2$. These are sectioned, respectively, by planes $\alpha$ and $\beta$ so as to give circles on $\pi_1$. To determine the sought line of intersection, the cylinders are sectioned by planes parallel to $\pi_2$. This yields generators coincident, on $\pi_1$, with the projection of the sectioning plane. To obtain their intersection points, the generators should be identified on $\pi_2$ as described under #2.

The advantages, in the given case, of using the ellipse with a circular projection instead of the base of the cylinder, are:

(a) There is no need to use compasses for identifying the generators - a set - square and T-square suffice.

(b) The common mistake of assigning a generator to the wrong cylinder is obviated.

(c) The theoretical explanation is simple and readily recalled.

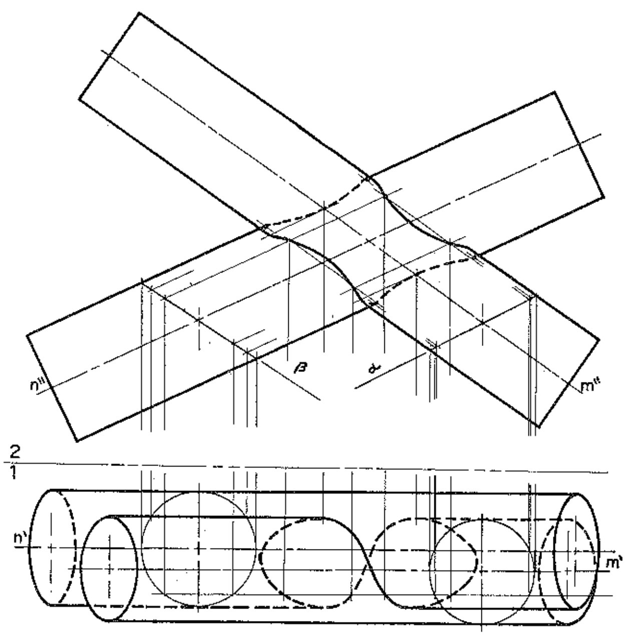



Fig. 3 Intersection of a pair of cylinders parallel to $\pi_2$.

5. Determination of piercing point of straight line and cylinder.

Given a cylinder, with axis n parallel to $\pi_2$ and a straight line a (Fig. 4), and its points of intersection with a are sought: we draw a plane $\alpha$ sectioning the cylinder to give the circular projection $\rho$, and another plane $\beta \equiv (a, e)$ through a, parallel to the cylinder axis. The projection on $\pi_2$ of the intersection line u of the two planes coincides with that of $\alpha$. u'' yields u', which cuts the circle at points H' and G' of the cylinder surface. The generators through H' and G' lie on $\beta$, and cut a at A' and B', which are the projections of the sought piercing points. Projection rays to a'' yield the matching projection A'', B''.

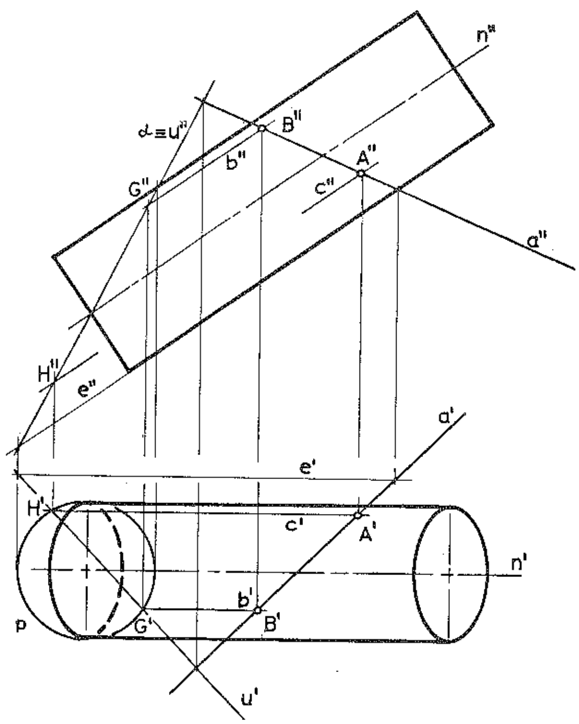



Fig. 4 Piercing of a straight line and cylinder surface.

6. Projections of right circular cone.

In analogy to the theorem proved under #2, we formulate the following:

Theorem. Given a right circular cone with its axis inclined towards the projection plane $\pi_j$. A plane can be found sectioning the cone in an ellipse whose projection on $\pi_j$ is a circle.

Proof (Fig. 5). We project the cone on plane $\pi_i$ parallel to its axis and perpendicular to $\pi_j$. The resulting projection is a triangle. We inscribe in the cone a sphere with centre at point O on the cone axis. Its projection on $\pi_i$ is the circle $\sigma$. The radius of the inscribed sphere is obtainable exactly from that of $\sigma$. A circle $\rho$ about $O^j$, with the same radius, yields the projection of the sphere on $\pi_j$. Tangents to $\rho$ through $V^j$ are exact projections of the contour generators. The projection on $\pi_i$ of the circle of tangency of the cone to the sphere is the segment CB.

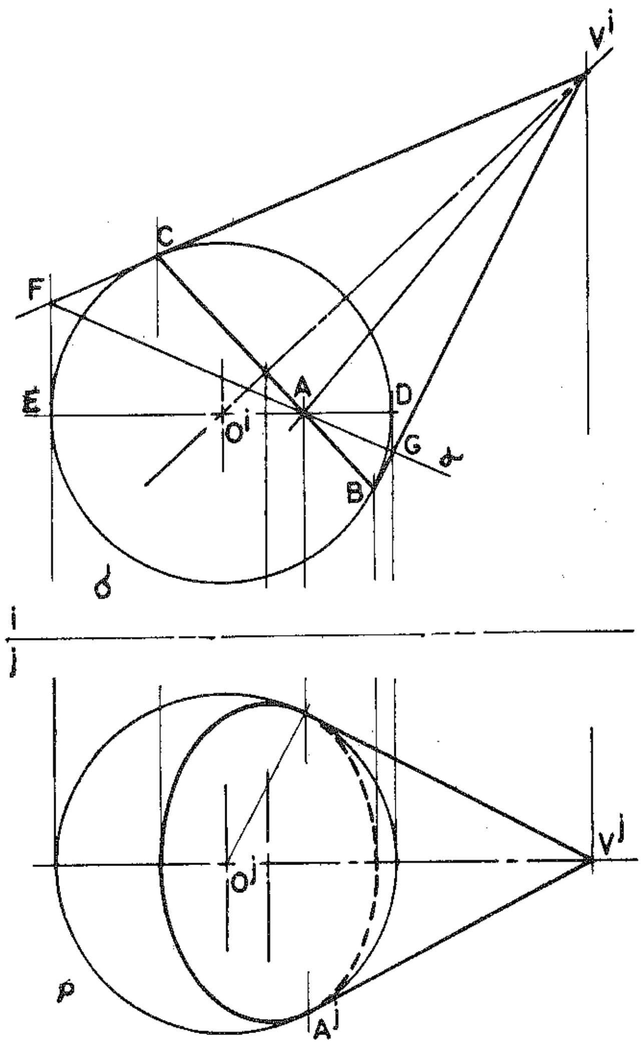



Fig. 5 Section through a cone, resulting a circular, in projection.

We now inscribe the sphere in a cylinder perpendicular to $\pi_j$, whose projection on $\pi_j$ concides with the circle $\rho$, and the projection on $\pi_i$ of their circle of tangency is the segment ED.

The contour generators of the cylinder on $\pi_i$ cut those of the cone at four points, two of which are F and G.

<u>Proposition.</u> A plane $\alpha$ through F and G perpendicular to $\pi_i$ sections the cone and the cylinder in congruent ellipses. They already have a common major axis. It will be proved that there exists an additional common point.

As the contour generators of both the cylinder and the cone are tangential to the circle $\sigma$, FG, CB and ED are concurrent (readily proved by projective geometry). This point (A) is an intersection point of the two circles of tangency of the sphere, i.e. it belongs both to the cone and to the cylinder, and since plane $\alpha$ passes through it, the two ellipses have an additional common point - i.e. they are coincident. This ellipse, as a section of the cylinder, gives the circle $\rho$ on $\pi_j$. We have thus found a plane $\alpha$ sectioning the cone in an ellipse with a circular projection on $\pi_j$.

There exists, of course, one more such plane, namely the one through the other pair of intersecting points of the generators.

The practical construction of a cone parallel to one of the projection planes is as follows: if the cone is parallel to $\pi_j$, a tangent circle $\sigma$ is described in that plane, yielding a circle $\rho$ with equal radius on $\pi_j$, with the contour generators tangent to it. The circle $\rho$ is the projection of the sought section by plane $\alpha$. Projecting rays tangent to $\rho$ (and to $\sigma$) cut the contour generators of the cone in $\pi_i$ at points F and G, defining the sought plane $\alpha$.

A particular case is when the cone axis is inclined towards $\pi_j$, so that the projection of the vertex falls within that of the base (Fig. 6). In the former case, had the contour generators been obtained by other means, the circle **ρ** would have sufficed to define $\alpha$; in the present case, however, both circles are indispensable, and **σ** yields **ρ** . As the generator VB of the cone forms a very acute angle with the projecting ray tangent to the circle, we shall use A as a second point for obtaining the projection of plane $\alpha$ on $\pi_i$. (A is the point common to CB and ED).

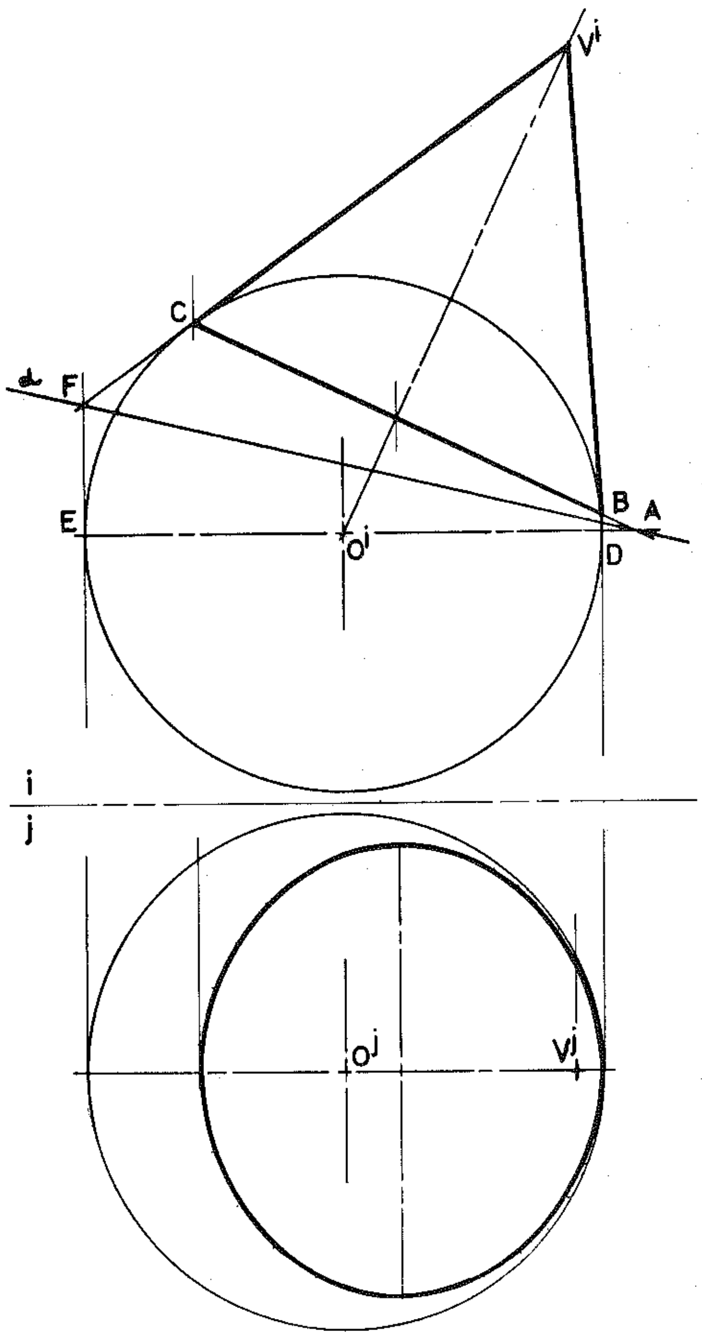



Fig. 6 Section through a cone in a special position, resulting a circular in projection.

7. <u>Identification of generators and points on the surface of an inclined cone.</u>

<u>Problem.</u> Given a right circular cone with its axis parallel to $\pi_2$ (Fig. 7). A generator <u>a</u> of the cone surface is given in one projection, say on $\pi_1$ and its projection on $\pi_2$ is sought.

The cone is sectioned by the plane $\alpha$ so as to give a circle **ρ** on $\pi_i$ (as under #6). A' is the common point of **ρ** and a' , i. e. the projection of the piercing point of <u>a</u> and $\alpha$. A'' is obtained by drawing a projecting ray to the straight line representing the projecting of $\alpha$ on $\pi_2$. a'' is the line through A'' and V''. If a'' is given, A'' is the common point of $\alpha''$ and a'', and a projecting ray from A'' to **ρ** yields A' and a'.

If a point B on the cone surface is given in one projection, its second projection is obtained by drawing a generator through it.

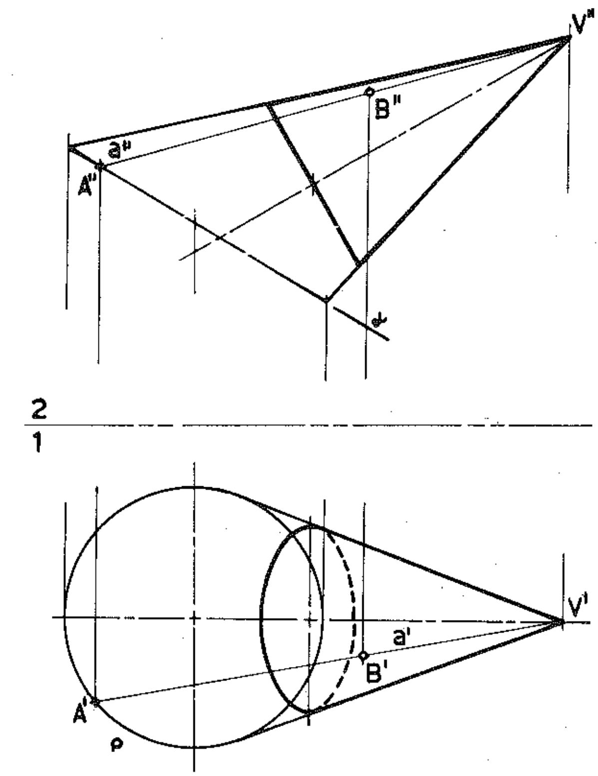



Fig. 7 Identification of a generator and a point on a cone surface.

8. Determination of the piercing points of a straight line and a cone.

Given a cone with its axis parallel to one of the projection planes, and a straight line a . Their points of piercing are readily obtainable in the same manner as for a straight line and a cylinder (#5).

9. Intersection of a pair of cones with axes parallel to the projection plane.

A pair of right circular cones are given, one (vertex V) with its axis perpendicular to $\pi_i$, and the other (vertex W) with its axis parallel to both projection planes (Fig. 8). Their line of intersection is sought.

In solving the problem, cone W may be sectioned to give a circle either on $\pi_1$ or on $\pi_2$, with the procedure differing accordingly. We adopt the first alternative.

A circle $\rho$, (which is the projection of the intersection between $\alpha$ and cone W on $\pi_1$) and the projection of $\alpha$ on $\pi_2$, are constructed (#6). Let the straight line t be the intersection of $\alpha$ and $\beta$, and the base plane of cone V. We find P, Q, the intersection points of VW with $\alpha$ and $\beta$ respectively. VW is the axis of the fan of planes cutting cones V and W along generators. Each plane of the fan cuts $\alpha$ and $\beta$ along lines through Q and P respectively, intersecting on t.

We define a plane of the fan by its intersection line with one of the pair $\alpha$ and $\beta$; its intersection point with t, yields the corresponding intersection with the other planes of the pair. We thus have the generators cut by the plane along both cones, and the sought intersection points. For example, in Fig. 8 the plane is defined by its intersection line a with $\alpha$. Connecting A with P yields its intersection line b with $\beta$. The generators drawn by the plane on the cones are DW, EW, VC, VB, resp.

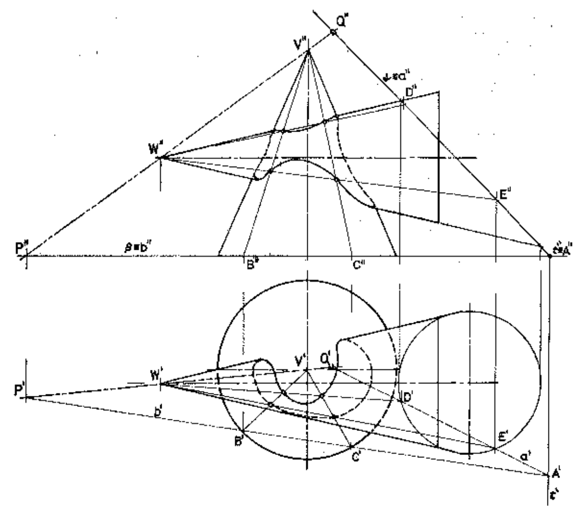


Fig. 8 Intersection of a pair of cones parallel to $\pi_2$. (First alternative).

The method yields all important points (end points and contour points), saves the need for a third projection and permits evaluation of the intersection (complete or partial) with the aid of a single projection.

Solution of the problem by sectioning to get the circle on $\pi_2$ (Fig. 9) yields the intersection line in its projection on $\pi_2$ without recourse to the other projection.

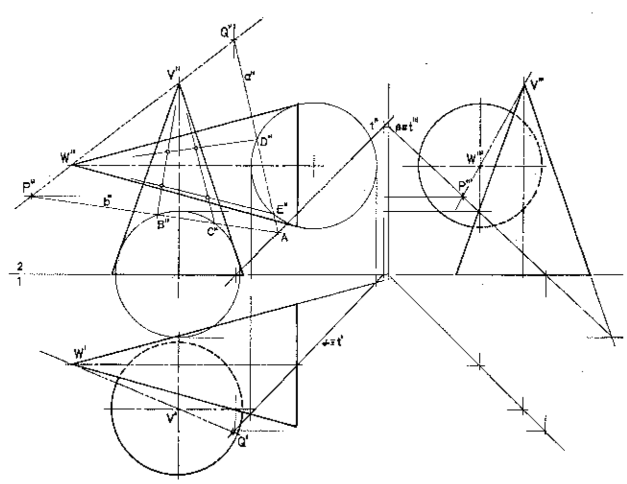


Fig. 9 Intersection of a pair of cones parallel to $\pi_2$. (Second alternative).

## 10. Intersection of a pair of right circular cones with axes parallel to planes perpendicular to each other.

Given two cones, V and W, with their axes parallel to $\pi_1$, and $\pi_2$ respectively. Their line of intersection is readily obtainable as follows (Fig. 10).

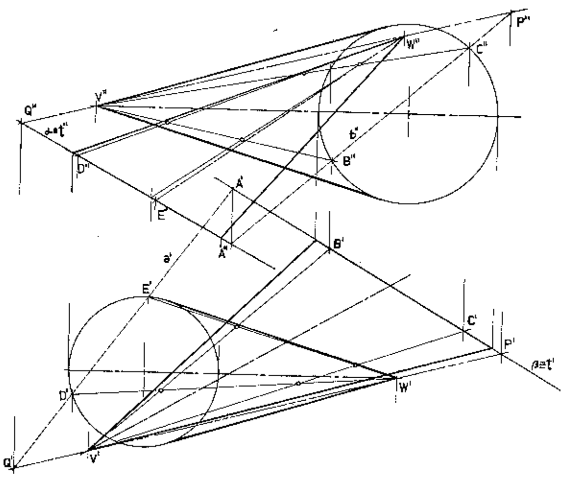



Fig. 10 Intersection of pair of cones parallel to the projection plane.

Two planes $\alpha$ and $\beta$ are drawn, $\alpha$ sections cone W to give a circle on $\pi_1$ and $\beta$ sections cone V to give an $\pi_2$. The projection of their intersection line t coincides with that of $\alpha$ on $\pi_2$ and with that of $\beta$ on $\pi_1$. The straight line, VW pierces $\alpha$ and $\beta$ at Q and P respectively, is the axis of the fan of planes cutting both cones along generators. We define a plane of the fan by its intersection line with, say, $\alpha$, which is $\underline{a}$, passing through Q and cutting t at A. The straight line b = (AP) is the intersection line of the same plane with $\beta$. The generators obtained on cone V, (VB, VC) cut the generators obtained on cone W, (WD, WE) at four points, along the line of intersection. The final result is shown in Fig. 11.

The same procedure may be used for a pair of cylinders ( or a cylinder and a cone) with their axes parallel to the planes of projection.

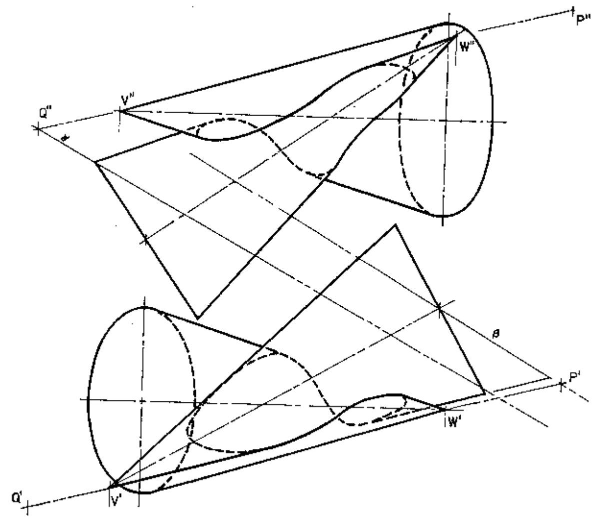



Fig. 11 Intersection of pair of cones parallel to the projection plane (complete solution).

## 11. A right circular cylinder in arbitrary position with respect to the planes of projection.

Given a right circular cylinder with its axis inclined towards the planes of projection, and a plane $\alpha$ is sought, its intersection with the cylinder giving a circle on one of the planes (Fig. 12).

If the circle is required on $\pi_1$, we construct an auxiliary plane $\pi_4$ perpendicular to it and parallel to the cylinder axis, in which case $\alpha$ can be constructed perpendicular to $\pi_4$, sectioning the cylinder as required. We shall define $\alpha$ by t (its trace on $\pi_1$) and a straight line $\underline{a}$ (whose projection on $\pi_1$ coincides with that of the cylinder axis), intersecting at F. The center of the ellipse R lies on $\underline{a}$. t" will coincide with the axis 2/1 and a" is the straight line R"F".

## 12. Identification of generators and points on the surface of a cylinder in arbitrary position with respect to the planes of projection (Fig. 12).

Given a generator b in its projection on $\pi_2$. Its second projection b' is sought. We choose a straight line e in $\alpha$, with e" coincident with b'', and find e', whose intersection point B' with the circle is that of the generator b with $\alpha$. The straight line through B' parallel to the cylinder axis is the sought b'. (The opposite intersection point on the circle is a point of a generator coincident with b'' on $\pi_2$).

If the generator d is given in its projection on $\pi_1$ and d'' is sought, it is found as follows: D', the projection of the piercing point D of d with $\alpha$, is the point of intersection of d' and the circle $\rho$ ; D'' is obtainable as a point of the given $\alpha$ ; and the straight line through D'' parallel to the cylinder axis is the sought projection d''.

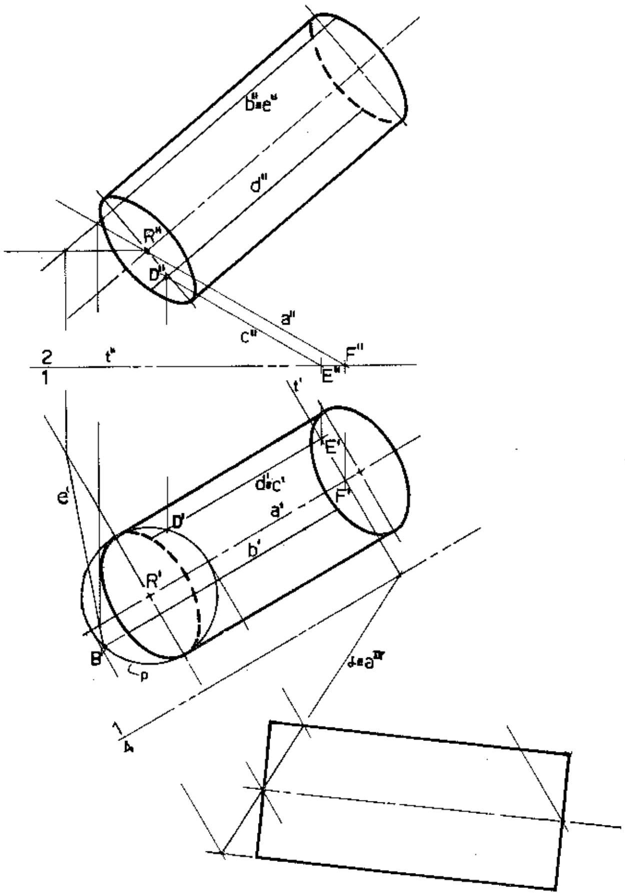


Fig. 12 Determination of a section circular in projection, and identification of generators in a cylinder in arbitrary position.

A second projection of a point on the surface of a cylinder is identified through the projection of the generator on which the point lies.

13. Determination of the Intersection Line of a pair of cylinders with axes respectively inclined and perpendicular to the planes of projection (Fig. 13).

Given a pair of cylinders, one (n) with its axis perpendicular to $\pi_1$ and one (m) with its

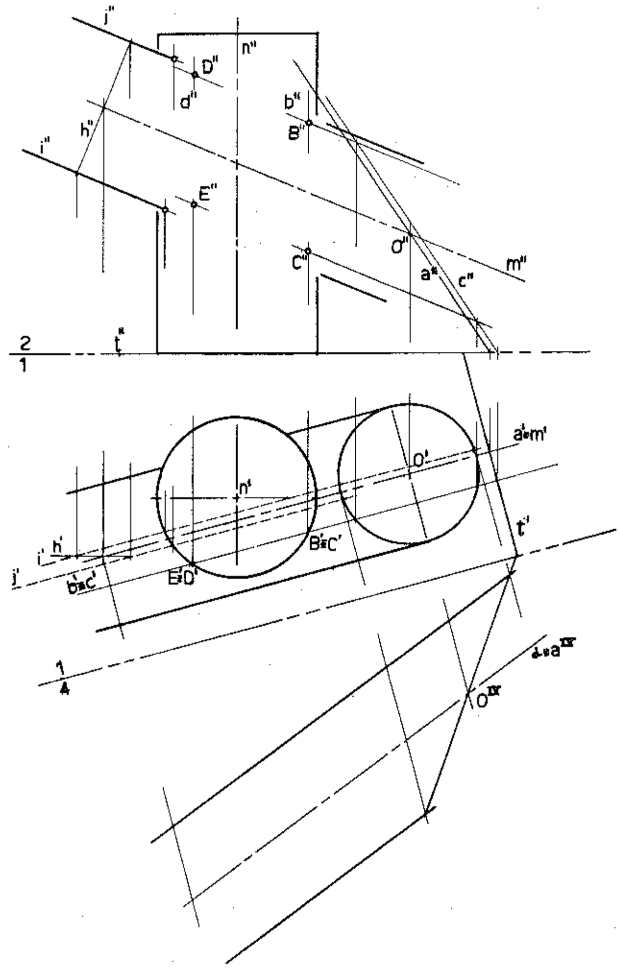


Fig. 13 Intersection of a pair of cylinders, one perpendicular to projection plane and one in arbitrary position.

axis in an arbitrary inclined position. Their line of intersection is sought.

On $\pi_1$ this line is part of the circle (the projection of the base of n ) contained within cylinder m. On $\pi_2$, it is given by the second projections of its points as points on the surface of cylinder m. If we seek intersection points on the contour of cylinder m on $\pi_2$, the generators of this contour should be identified on $\pi_1$. This is simple, as these two generators, i and j, cut the diameter of the base of the cylinder parallel to $\pi_2$ (frontal line h). With h' known, i' and j' can be found. As a result all the important points can be found. The final result is shown in Fig. 14.

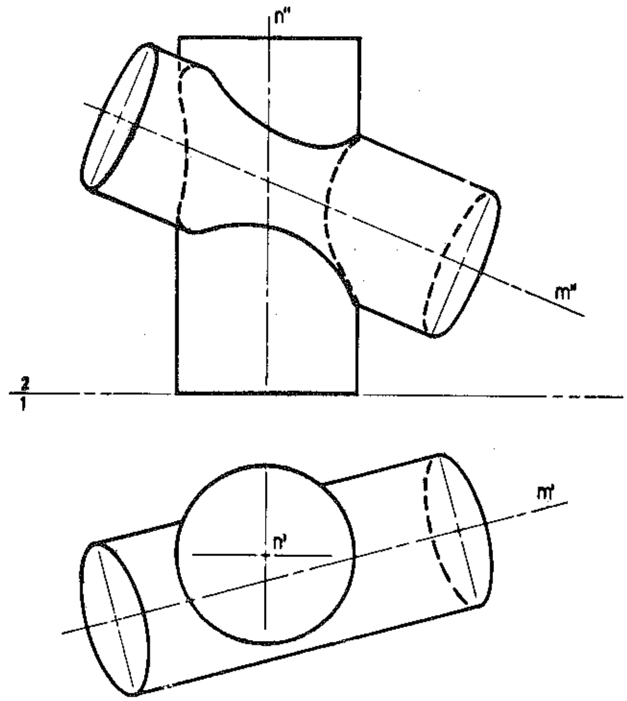



Fig. 14 Intersection of a pair of cylinders, one perpendicular to projection plane and one in arbitrary position (complete solution).

14. A right circular cone in arbitrary position with respect to the planes of projection.

Given a right circular cone with vertex V and its axis inclined to the planes of projection. A sectioning plane is sought, giving a circle on one of them (Fig. 15).

As in the case of the cylinder (#11), the plane $\alpha$ is determined with the aid of an auxiliary plane $\pi_4$ parallel to the cone axis and

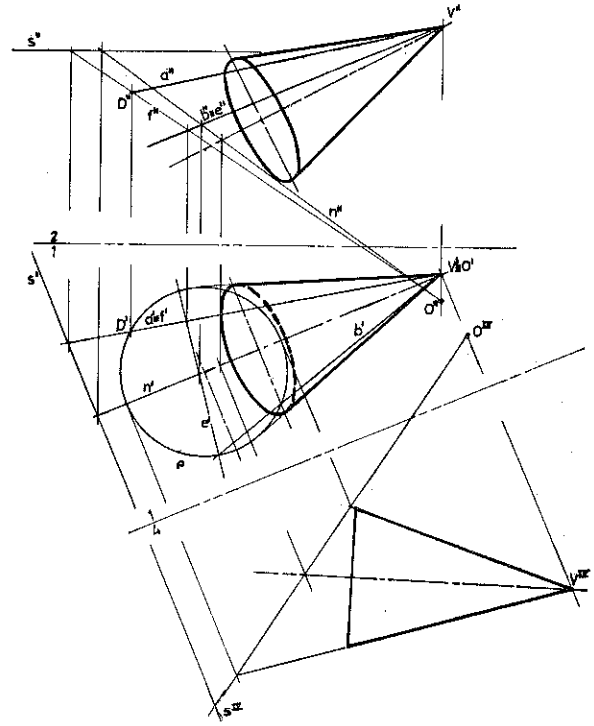


Fig. 15 Determination of a section circular in projection, and identification of generators in a cone in arbitrary position.

perpendicular to the plane of projection in question (say $\pi_1$). $\alpha$ is defined by the straight line and point O. Every generator cuts $\alpha$ at a point of the ellipse (circle $\rho$). Given a generator in its projection b'' on the cone surface, and b' is sought. We choose a straight line e on $\alpha$ such that e'' coincides with b''. We find e' and its intersection point with the circle $\rho$, which is also the piercing point of the generator b with $\alpha$. Connecting it with V', we obtain the sought projection. (The other intersection point on the circle is a point of a generator coincident with b'' on $\pi_2$).

Given a generator a in projection on $\pi_1$, and a'' is sought. The projection on $\pi_1$, of its piercing point D with $\alpha$ is the intersection point of a' and $\rho$. D'' is obtainable as a point of $\alpha$, and V''D'' is the sought projection a'' of the generator.

A second projection of a point on the cone surface is identified through the projection of the generator on which it lies.

15. Determination of the intersection line of a pair of cones in arbitrary positions with respect to the planes of projection (Fig. 16).

Given a pair of cones V and W, with their axes inclined towards the planes of projection. Cone V is sectioned by a plane $\alpha$ perpendicular to $\pi_4$ to give a circle $\rho$ on $\pi_1$, and cone W - by a plane $\beta$ perpendicular to $\pi_5$ (the counterpart of $\pi_4$ with regard to W) to give a circle $\sigma$ on $_1$.

We find the intersection line XY of $\alpha$ and $\beta$ on $\pi_1$ and $\pi_2$. (The projection of XY on $\pi_4$ is coincident with that of $\alpha$, and that on $\pi_5$ - with that of $\beta$ ; (this may be utilized for finding X'Y' and X''Y''). Then connect the cone verticles by the straight line VW, to serve as axis of the fan of planes sectioning

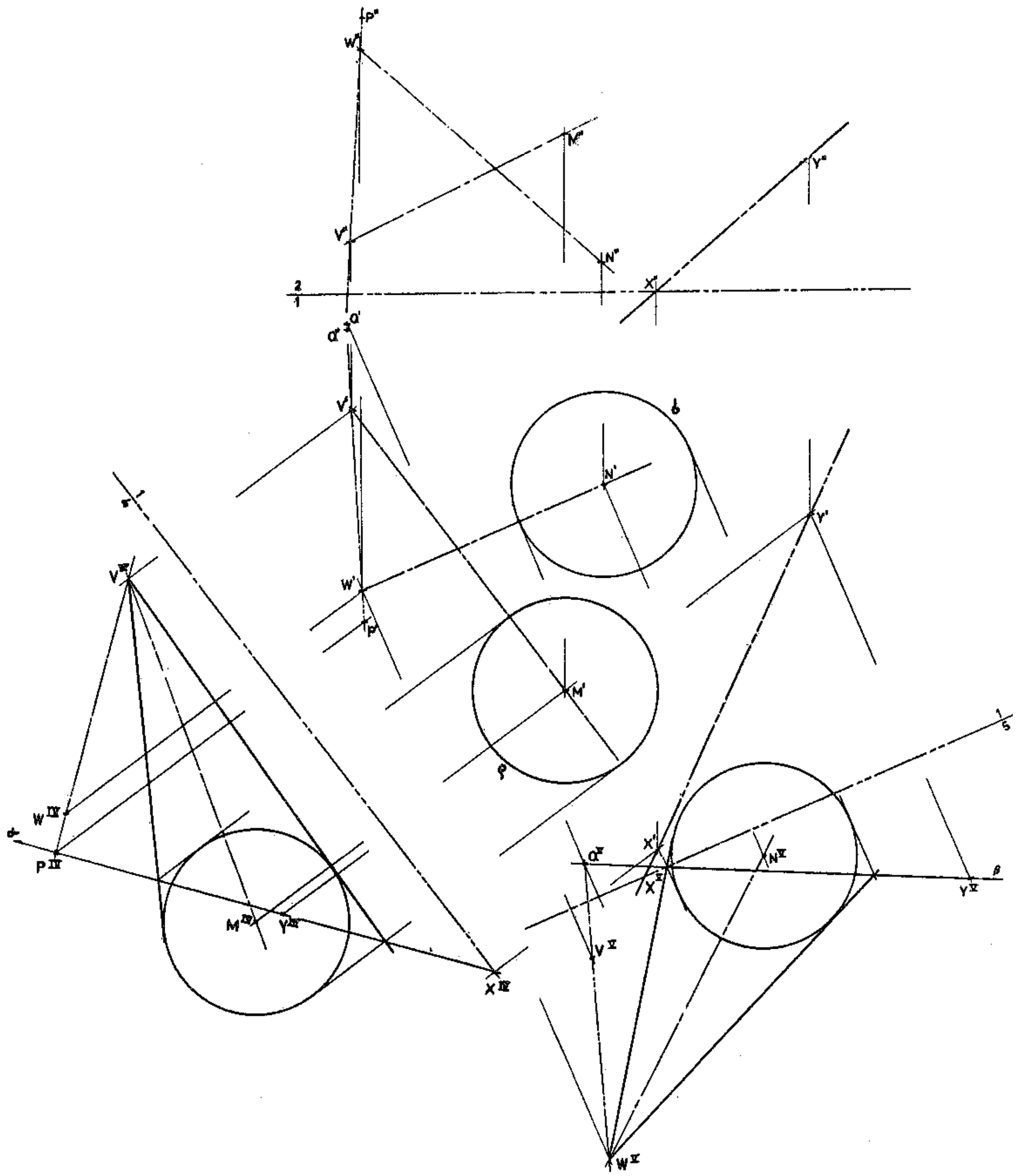



Fig. 16 Intersection of a pair of cones in arbitrary positions - determination of intersection points.

the cones along pairs of generators. This axis cuts $\alpha$ at P (obtained on $\pi_4$) and $\boldsymbol{\beta}$ at Q (obtained on $\pi_5$). The auxiliary construction is now complete.

We define a plane of the fan, sectioning the cones along to generators, by building $a' \equiv (P', A')$(Fig. 17), $\underline{a}$ being the trace of this plane on $\alpha$ , and A its intersection point with XY . b(Q,A) is, the trace of the plane on $\beta$ . a' cuts $\rho$ at B' and C', which, connected with V', give the section generators on the first cone. Similarly, b' cuts the circle $\rho$ at D' and E', which in turn, connected with W', give the corresponding generators on the second cone. These four coplanar generators yield four points of the sought intersection line.

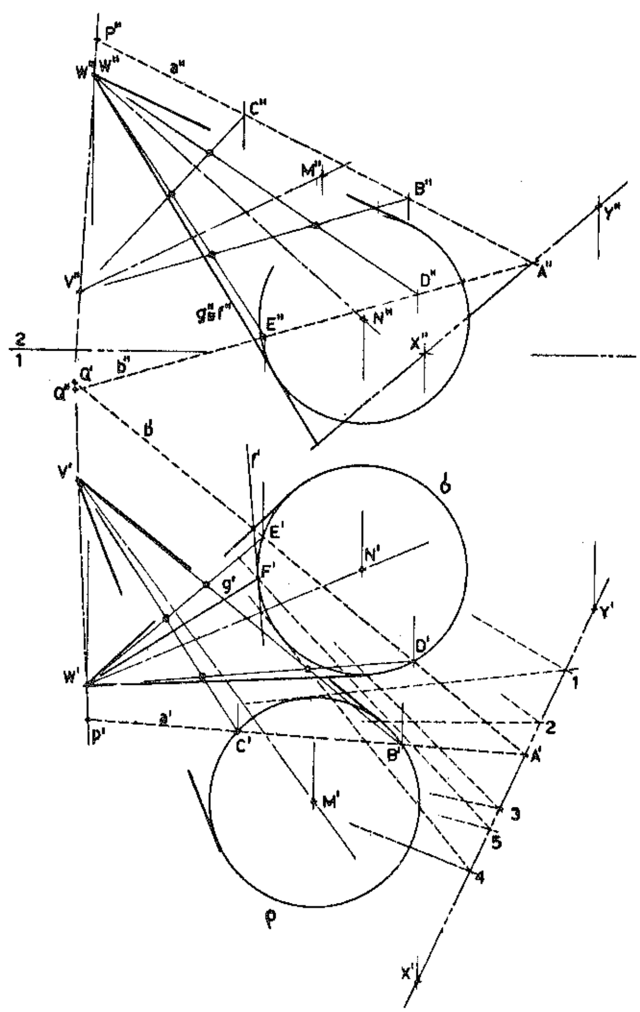



Fig. 17

By finding the projections of $\underline{a}$ and b on $\pi_2$, the projections of the four generators are similarly obtainable in that plane.

By this means, all important points of the sought line can be obtained,. For example, a section through point 1 is extremal, being tangent to circle $\rho$ ; sections through 2 and 3 yield points on the respective contours of cones V and W on $\pi_1$ ; and a section through 4 is similarly extremal being tangent to $\sigma$.

If we seek points on the contours on $\pi_2$ (say on g, the contour of W) we have to find F - the intersection point of g on $\boldsymbol{\beta}$, with the aid of a straight line f with $g'' \equiv f''$ (f' being tangent to $\sigma$ at F). The plane through PQF cutting XY at point 5 yields a sought point on g on $\pi_2$.

The final result is shown in Fig. 18.

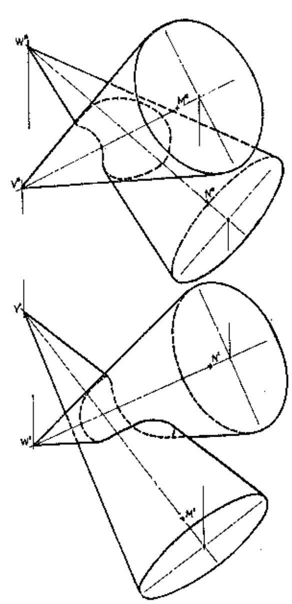
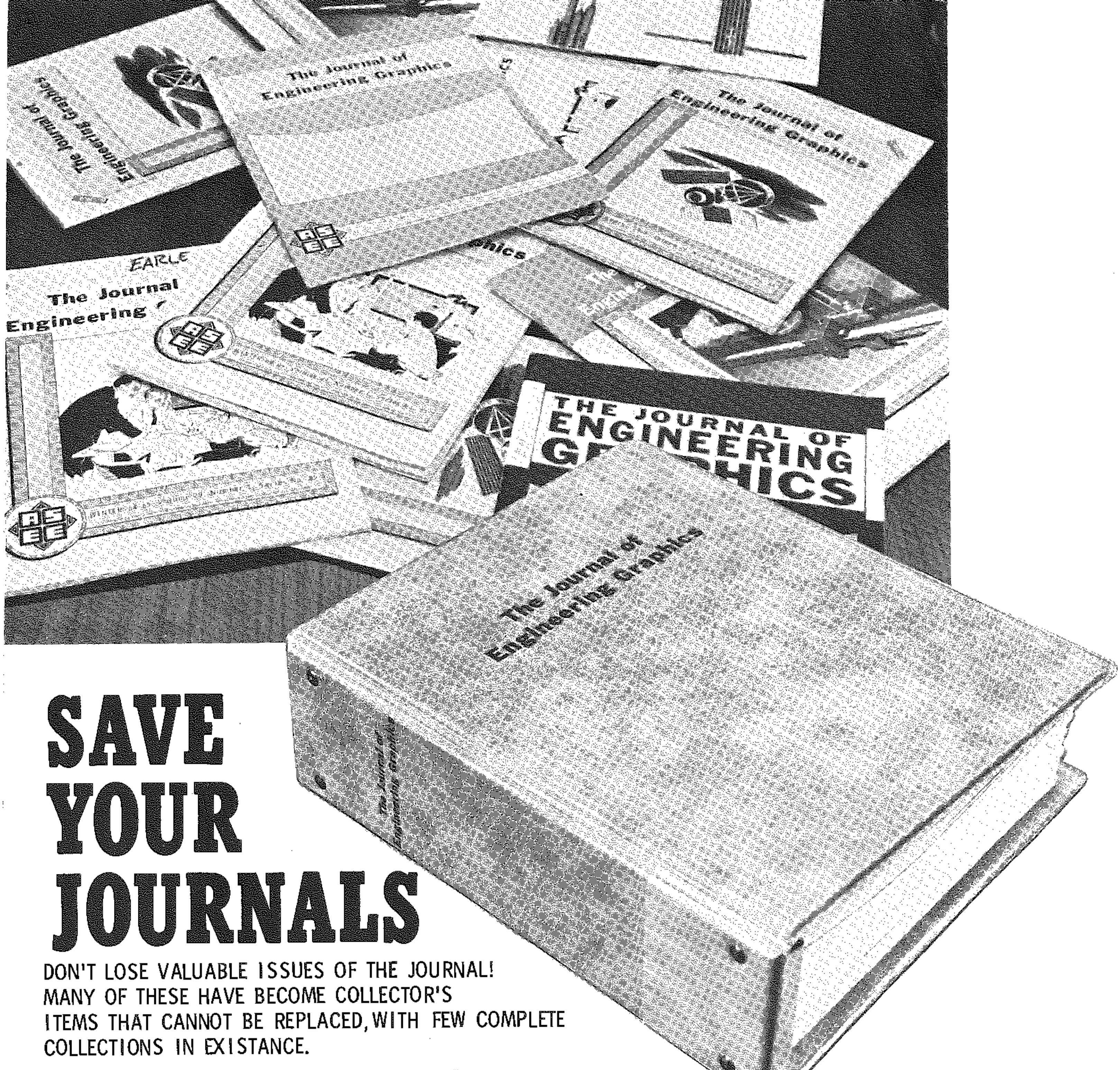



Fig. 18 Intersection of a pair of cones in arbitrary positions )comlete solution)

The above example is a typical "nightmare problem", solved fairly easily by the proposed method. As the sought points are obtainable with the aid of a single projection, the line of intersection can be determined in an orthographic projection for example axonometry, without recourse to the fundamental projections.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