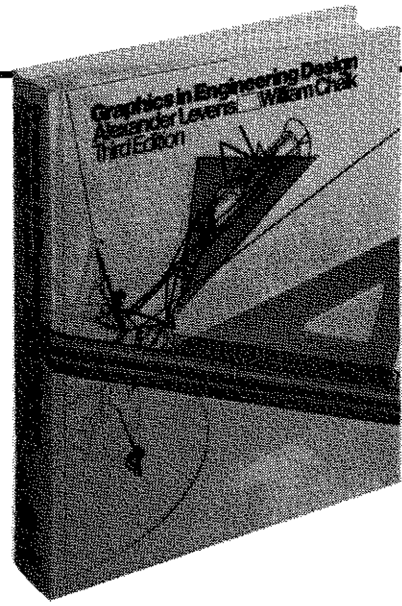
METRIC

ENGINEERING DESIGN GRAPHICS JOURNAL

FALL 1980 VOLUME 44 NUMBER 3

MARY PLUMB BLADE
DISTINGUISHED SERVICE AWARD



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ENGINEERING DESIGN GRAPHICS JOURNAL

CALENDAR

ASEE ANNUAL CONFERENCES

1981 - University of Southern California
Los Angeles, June 22 - 25

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

1983 -

EDGD MIDYEAR CONFERENCES

1980 - V.P.I. & S.U.
Williamsburg, VA Nov 23-25

1981 - The University of Louisville
Louisville, KY (Tentative)

1982 - California Polytechnic Univ.
Pomona, CA (Tentative)

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

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ENGINEERING DESIGN GRAPHICS JOURNAL OBJECTIVES:

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

DEADLINES FOR AUTHORS AND ADVERTISERS

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

STYLE GUIDE FOR JOURNAL AUTHORS

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

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

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

3. Two copies of each manuscript are required.

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

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

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

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

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

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

9. Send all material, in one mailing to:

Mary A. Jasper, Editor
P.O. Drawer HT
Miss. State University
Miss. State, MS 39762

REVIEW OF ARTICLES

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

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

THE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

Engineering Design Graphics Journal

FALL 1980 VOLUME 44 NUMBER 3

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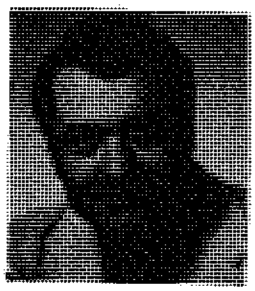


This first issue of the academic year always includes an organizational chart of the Division, and I am again - as always - impressed by quality of the officers whose names appear there. I consider it an honor to be surrounded and working with such fine people. The Division is fortunate to have them, too, because they are and will be needed. 1980 and the next few years hold great potential for change and could very well be pivotal for the Division.

Probably the most powerful agent among the elements of change is computer graphics. The explosive growth of computer graphics in industry and even in the home staggers the imagination. Everywhere industries of all kinds are installing new computer graphic equipment and planning for more. The capabilities of these units are impressive to say the very least, and consequently there are those who do or will see in those capabilities the total elimination of "traditional" engineering graphics.

In a limited sense, this may very well prove true. Failure by industry to exploit the documentation speed and accuracy offered by such computer graphics units would be inappropriate at best, financially irresponsible in fact. On that basis, some industrialists and educators are now and will continue to advocate "conversion" to computer graphics in our coursework. While this may be desirable, there are at least two good reasons to pause and consider carefully before entering into any "conversion" lightly.

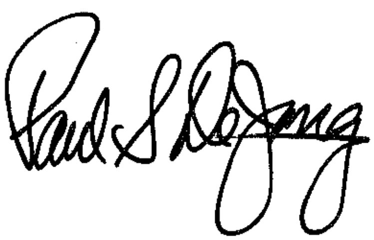
In the midst of what may be a rather confusing debate, we must not forget that the computer and computer graphics are <u>tools</u>, just like the slide rule and drafting machine.

Universities do not have the financial base to support the purchase of large numbers of up-to-date expensive equipment in this fast changing technology. What a freshman can learn will be sadly outdated by graduation day, and industry - while it would like to see computer graphics experience in our graduates - typically spends much less time training CG operators than it does in company orientation training.

<u>Tools</u> are not the basis of an education. Our goals must be to teach the student to think logically, visualize clearly, and communicate effectively - to other people, not computers.

We have learned from at least one generation that being able to press a button marked "log" or "cos" does not improve one's understanding of the significance of the number thus gained; it seems to have the reverse effect. Similarly, we should have found that gazing at a vivid image on a TV screen does not enhance visualization ability.

Let's remember that when the chips are down, the really <u>important</u> communication is done between people and with one's self. We can best serve our first-year students by teaching them to visualize and communicate clearly. If we fail to recognize this high calling we may find our coursework right where the Model T change-gear lathe is now.



and...

** IMPORTANT **

ASEE has asked us to assemble a list of recipients of the Oppenheimer Award.

If you won, or know someone who won the Oppenheimer Award, please send me the name and date with some documentation if possible.

CHAPLAIN
Clarence Hall
Louisana State Univ.

SECRETARY-TREASURER
Charles W. Keith (82)
Kent State University

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Penn State University

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1980 - 1981

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Amarillo College

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U. of Mass.

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Ohio State University
Liaison
W. George Devens
V.P.I. & S.U.

Annual Conference 1981
Program Chair.
Betty Prescott
San Joaquin Delta College

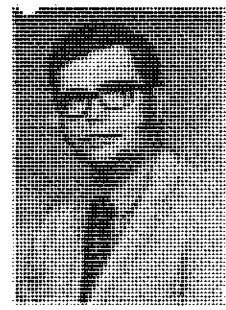
CANDIDATES FOR OFFICE

Arvid R. Eide
Iowa State University
Ames, IA

Arv is a Professor and Chairman of the Department of Freshman Engineering. He received his B.S. in 1962, M.S. in 1967 and Ph.D. in 1973; he is a registered Professional Engineer in Mechanical Engineering and has worked as a test engineer and for a heating-air conditioning firm. He has authored various text and work books in graphics and engineering problem-solving, and has presented papers on instructional innovation at EDGD meetings.

Arv has served our division well as Director of Programs (1977-1980) and has won two Oppenheimer Awards, as well as being the Dow Outstanding Young Faculty Award in 1974

VICE-CHAIRMAN (1981-82):

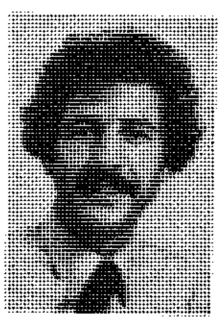


Larry D. Goss
Indiana State University
Evansville, IN

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

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

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



Jay S. Abramowitz
Indiana University- Purdue
Fort Wayne, IN

Jay is an Associate Professor of Mechanical Engineering at the Indiana-Purdue campus in Fort Wayne. He received his B.S.E. from CCNY, M.S.M.E. from the University of Bridgeport and his Ph.D. from the University of Arizona. His teaching responsibilities are in mechanical design and his research interests are directed toward computer analysis of mechanical system vibrations.

He served as an exchange professor with Trent Polytechnic in England and has traveled extensively in Europe. He is active in the Industrial consulting field and has authored papers primarily in the fields of mechanical design and education.

In addition to the above activities, Jay <u>runs</u> an average of six miles a day!

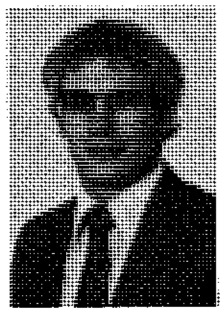
DIRECTOR OF ZONES ACTIVITIES (1981-84)

Peter Miller
Purdue University

Pete is an Assistant Professor of Engineering Graphics at Purdue University. He received his Bachelor's Degree in Visual Design and his Master's Degree in Industrial Design -- both from Purdue. Pete was Program Chairman for the 1980 Annual meeting in San Francisco, and has presented papers at various EDGD meetings.

Pete is interested in Photography, Woodworking, and does free-lance design work. In addition, he is a licensed real-estate broker.

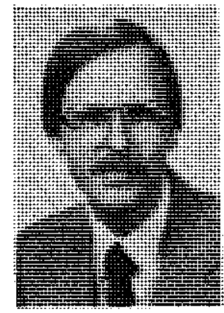
DIRECTOR OF TECHNICAL AND PROFESSIONAL ACTIVITIES: (1981-84)



William A. Miller
Western Carolina University
Cullowhee, NC

Bill is Associate Professor in the Department of Industrial Education and Technology, and is in charge of the manufacturing engineering technology curriculum. He his Bachelor's Degrees in Vocational Education ('68) and M.E. Technology ('75), and his Master's Degrees in Vocational Education ('70) and Industrial Engineering ('79), all from the University of Cincinnatti

He is a Registered Professional Engineer in the State of Kentucky, and has been president of the Ohio Association for Engineering Graphics. Bill is active member of S.M.E. and A.I.I.E. and has served on various EDGD committees. His hobbies are tennis, racquetball, camping and hiking.



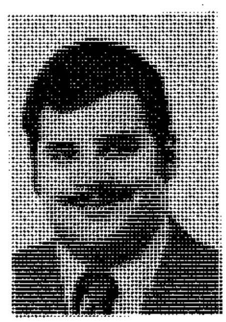
Larry Northup
Iowa State University
Ames, IA

Larry is presently Professor of Freshman Engineering at Iowa State. His degrees include a B.S. and M.S. in Aeronautical Engineering and a Ph.D. in Aeronautical-Mechanical Engineering. He is a registered Mechanical Engineer in the State of Iowa.

In 1976, Larry received the Dow Award for Young Engineering Faculty. His contributions to ASEE include writing for the ASEE publication, "Teaching Aids in the College Classroom". He is the immediate past-chairman of the Freshman Engineering Curriculum Committee for the EDGD. Larry has also co-authored <u>Engineering Fundamentals and Problem Solving</u>.

One of Larry's favorite past-time is tending and riding his (pet) motorcycle.

ADVERTISING MANAGER-<u>EDG JOURNAL</u>: (1981-84)



Frank M. Croft
University of Louisville

Frank is presently on leave from the University of Louisville and is at Clemson University studying for a Ph.D. in Transportation Engineering. At U of L, Frank is an Assistant Professor of Engineering Graphics and Civil Technology. He holds a B.S. in Aerospace Engineering and a Master's Degree in C.E. Frank is a registered Professional Engineer with industrial experience and has had consulting work in the graphics arts area.

An active member of the ASEE and EDGD since 1973, Frank has presented papers at midwinter and annual meetings and currently serves as Associate Editor of the <u>EDG Journal</u>.

Robert P. Kelso
Louisiana Tech. University
Ruston, LA

Pat left the presidency of his stockbrokerage firm to begin teaching in 1973. He is assistant professor in the Department of Computer Science and Industrial Engineering at Louisiana Tech, with a B.A. in physics and math and an M.A. in art. His teaching experience includes four courses which he developed personally.

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

The Division of Engineering Design Graphics
American Society for Engineering Education

has bestowed upon

Mary Plumb Blade

its highest honor

THE DISTINGUISHED SERVICE AWARD

for her continuous devotion and service to her students, her colleagues, the Division, and engineering education in general and as an expression of the regard and respect of her professional peers.

Mary Blade has an amazing number of diverse interests. Her many activities since she became the first woman electrical engineering graduate of the University of Utah include work as an engineer and designer; mountain climbing; etching and printmaking; and the establishment of a small press which has published several books.

As Professor of Mechanical Engineering at Cooper Union, Mary was deeply interested in her students. Her courses incorporated innovative teaching methods. She did not slip into the practice of giving the same old problems year after year, but presented her students with new and challenging material to develop their ability to apply fundamentals. Model building when appropriate, use of the computer as an engineering tool, use of both graphical and numerical methods characterized her courses.

Mary joined ASEE in 1949. Her activities in the Division include Chairman of the Theoretical Graphics Committee, Division Secretary, and Editor of the *Journal of Engineering Graphics*. She has presented numerous papers to the Division and has directed several workshops for its members.

In addition to her teaching duties at Cooper Union, Mary directed the school's summer camp for twelve years and became Associate Dean of Engineering a few years before her retirement. On that occasion, the title Professor Emerita of Mechanical Engineering was conferred upon her. However, as mentioned in one of the numerous citations she received, retirement was just one of the mileposts in the continuation of a long and distinguished career.

The Division proudly presents Mary Plumb Blade its 1980 Distinguished Service Award.

Presented this day June 24, 1980
at the ASEE Annual Conference, University of Massachusetts

Leon M. Billow
Chairman

Charles W. Keith
Secretary-Treasurer

1980
DISTINGUISHED SERVICE AWARD

MARY PLUMB BLADE

Editorial Note: Although I have attended ASEE annual meetings since 1972, I did not hear of Mary Blade until 1973, when, after the meeting at RPI, one of my colleagues asked me if I had "met Mary Blade". In retrospect, I can only comment that one does not "meet" someone like our honored 1980 D.S.A. recipient, one "encounters" Mary; and having done so, the experience becomes a "Close Encounter of the BEST Kind!"

The short remarks here do not do justice to the extemporaneous presentation by Robert LaRue at the 1980 EDGD Awards Banquet, at Amherst, MA. Nor do they begin to recount the inspirational message which Mary Blade gave as her acceptance speech. Perhaps the Journal readers will understand that sometimes speeches, such as these, cannot be written nor repeated. Speeches like Bob's presentation and Mary's acceptance are written in the hearts of those of us who listened.

Mary Blade is now, and always has been an "activist" for causes, both social and academic. Her contributions to Engineering Education are numerous -- as are her varied interests. She contributes to the fine arts -- talents and time -- as an author, publisher, painter and sculptress. Her contributions to the study of theoretical graphics are legend, but she has also fielded design teams which have won awards in the EDGD Creative Design Display Competitions.

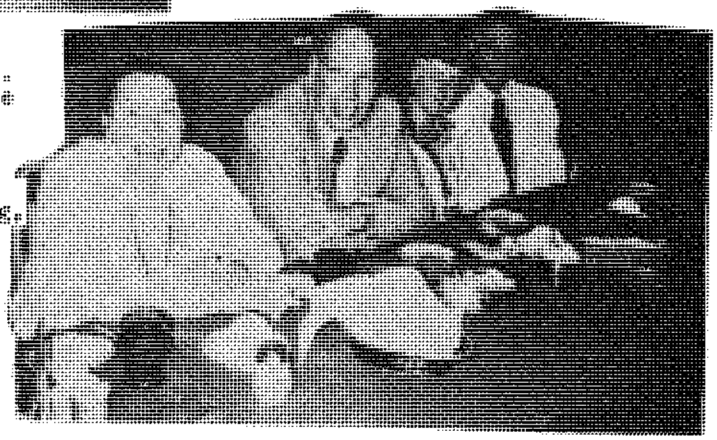
She has been Editor (1961-1964) of the Journal of Engineering Graphics, and has contributed many articles to the EDG Journal since her tenure in that office. At present she is a review critic for the Journal

In 1978 she led a workshop on Theoretical Graphics during the International Conference on Descriptive Geometry held before the ASEE Annual Meeting in Vancouver, British Columbia. She is immediate past-chairman of the Theoretical Graphics Committee of the EDGD.

at the awards banquet

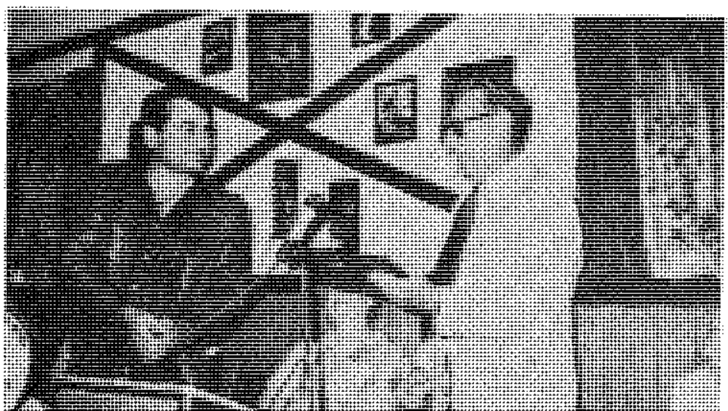
Well, there was a little overflow!

Margaret Eller, who took all the pictures on these pages, is so talented. With one "snap", she recorded all of the head table at the Awards Banquet.



Above, L to R; Klaus Kroner, Judy deJong, Bob LaRue, Katie Billow, Paul deJong, Helen Kroner, Lee Billow.

On the right, L to R; Mary Blade, Ed and Helen Knoblock, and Ellis Blade.

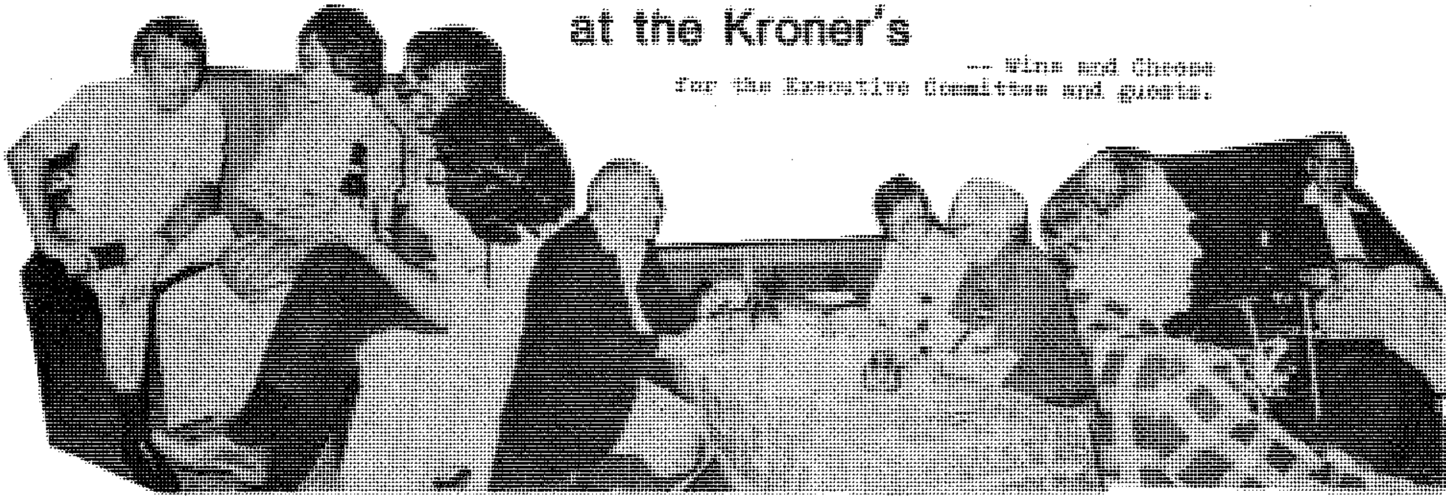


The passing of power(?) from Lee to Paul (or vice-versa!)

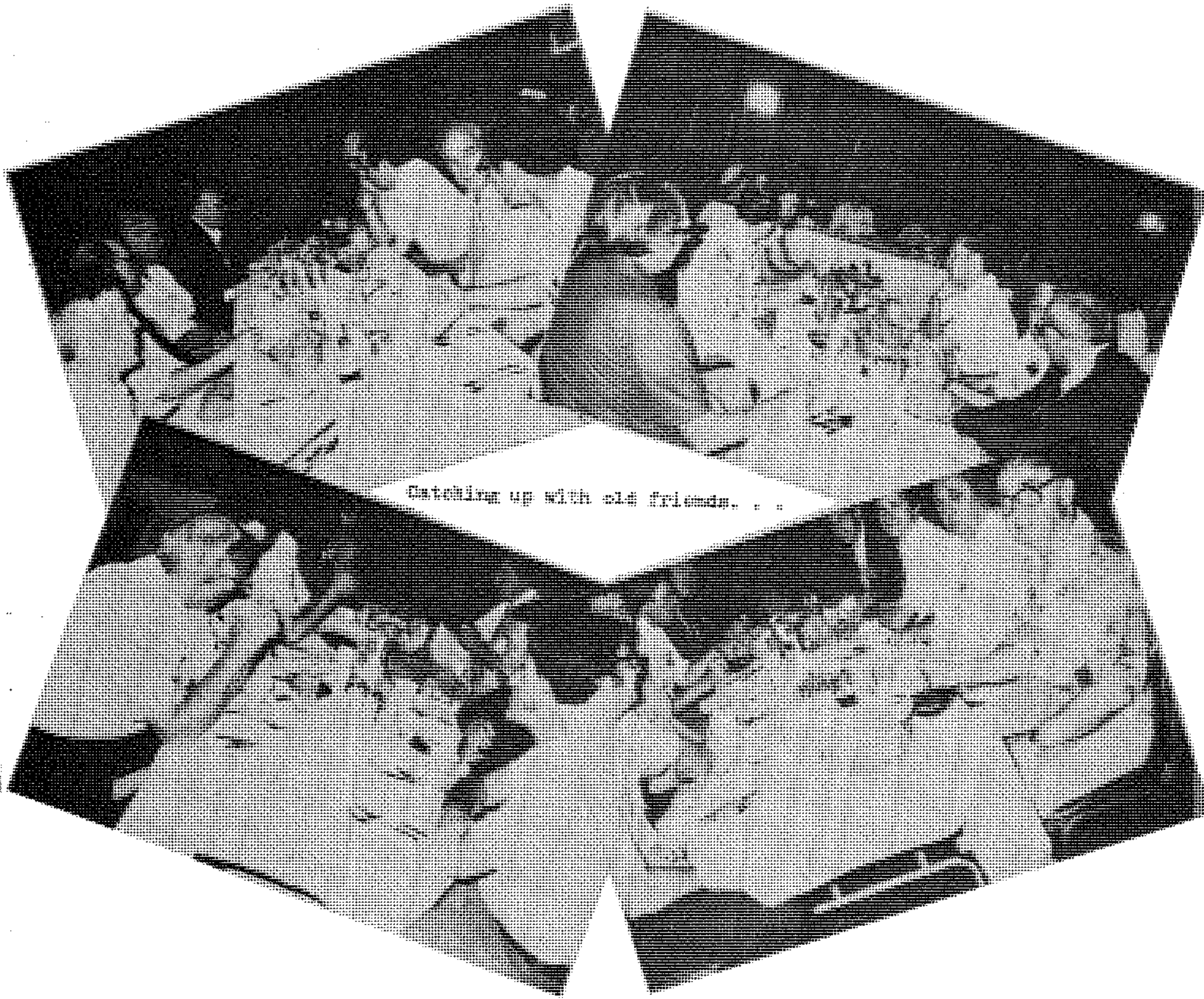
Mary Blade reflects on Engineering Graphics.

at the Kroner's

-- Wine and Cheese for the Executive Committee and guests.

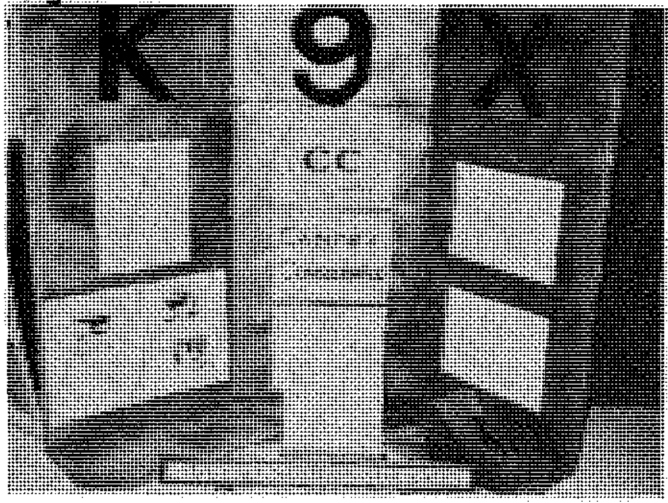


at the business luncheon

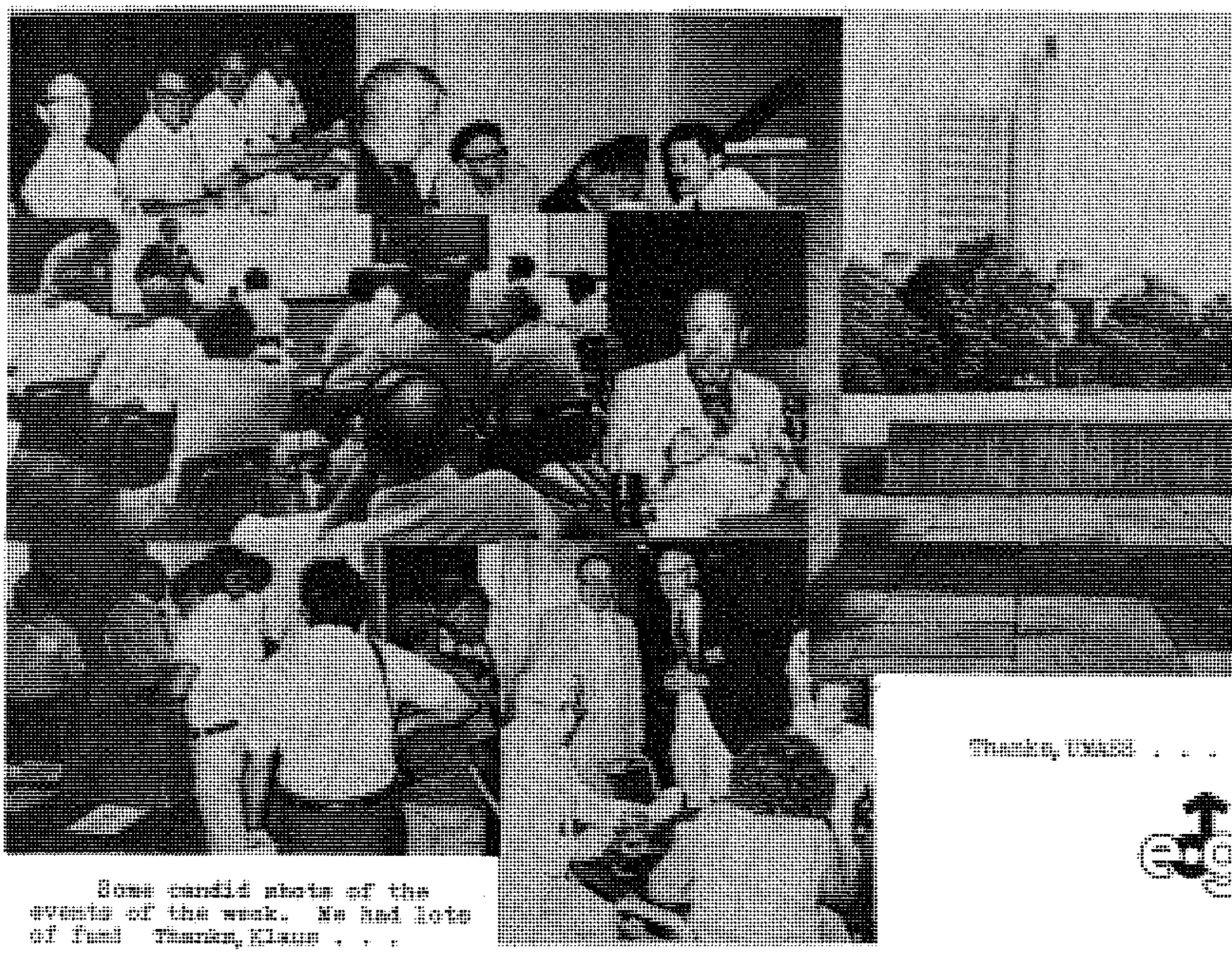


Catching up with old friends. . .

at the creative design display



Something to whet your appetite for the Winter Journal -- more complete coverage of the Creative Design Display.



Some candid shots of the events of the week. We had lots of fun! Thanks, Klaus . . .

Thanks, UMASS . . .

MIDYEAR MEETING-- COLONIAL WILLIAMSBURG

"A Note from the Host"

W. George Devens
Professor and Director
Division of Engineering Fundamentals
VPI & SU
Blacksburg, VA

Dear Colleague,

The Annual Mid-Year Conference of the Engineering Design Graphics Division, ASEE, will be held in Colonial Williamsburg, Virginia, from Sunday, November 23, to Wednesday, November 26, 1980.

Accommodations have been reserved in the Williamsburg Lodge and Colonial Houses. Conference events will take place in the Lodge. All rooms are $60/day single or double. Some of you traveling alone may wish to make prior arrangements to share a room with another member. Reservations for rooms after the end of the conference at noon on Wednesday should be requested immediately on an individual basis from the Reservations Manager, P.O. Drawer B, Williamsburg, VA 23185 or call toll-free 1-800-446-8956. The Conference Rate is valid only for the nights of November 23, 24, and 25.

The registration fee of $50 for members and $40 for spouses includes your "Williamsburg Ticket" (entry to all exhibits and free local bus transportation), two lunches and two "Hospitality Hours" at the Market Square Tavern, plus guided tours for spouses and members. You may also wish to visit nearby historic Yorktown, Jamestown, and the famous Williamsburg Pottery Factory.

Williamsburg should be its finest for this pre-Thanksgiving meeting. We look forward to seeing you there.

Sincerely,

Bil Devens

W. George Devens
Professor and Director

for your Host Committee

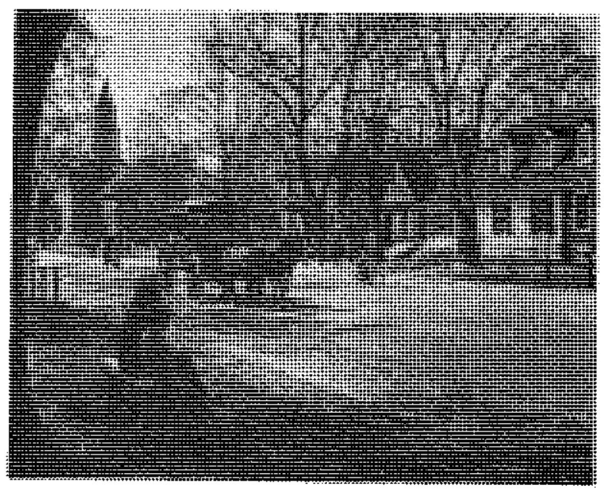
TECHNICAL PROGRAM

Jon M. Duff
Program Chairman
Ohio State University
Columbus, OH

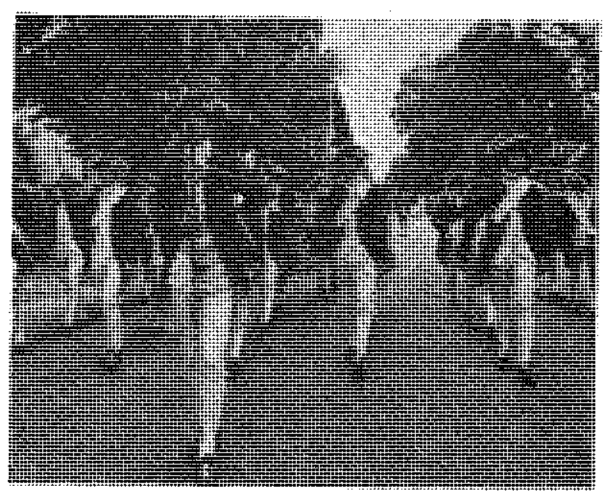
<u>SUNDAY AFTERNOON</u>, NOVEMBER 23

3:00-5:00	REGISTRATION-East Gallery Member Fee: $50.00 Spouse Fee: $40.00
7:00	EXECUTIVE COMMITTEE DINNER Room A, Lodge (For Executive Committee Members, Spouses, and Invited Guests)
8:00	HOSPITALITY HOUR Market Square Tavern (All Members, Spouses and Guests)

<u>MONDAY MORNING</u>, NOVEMBER 24

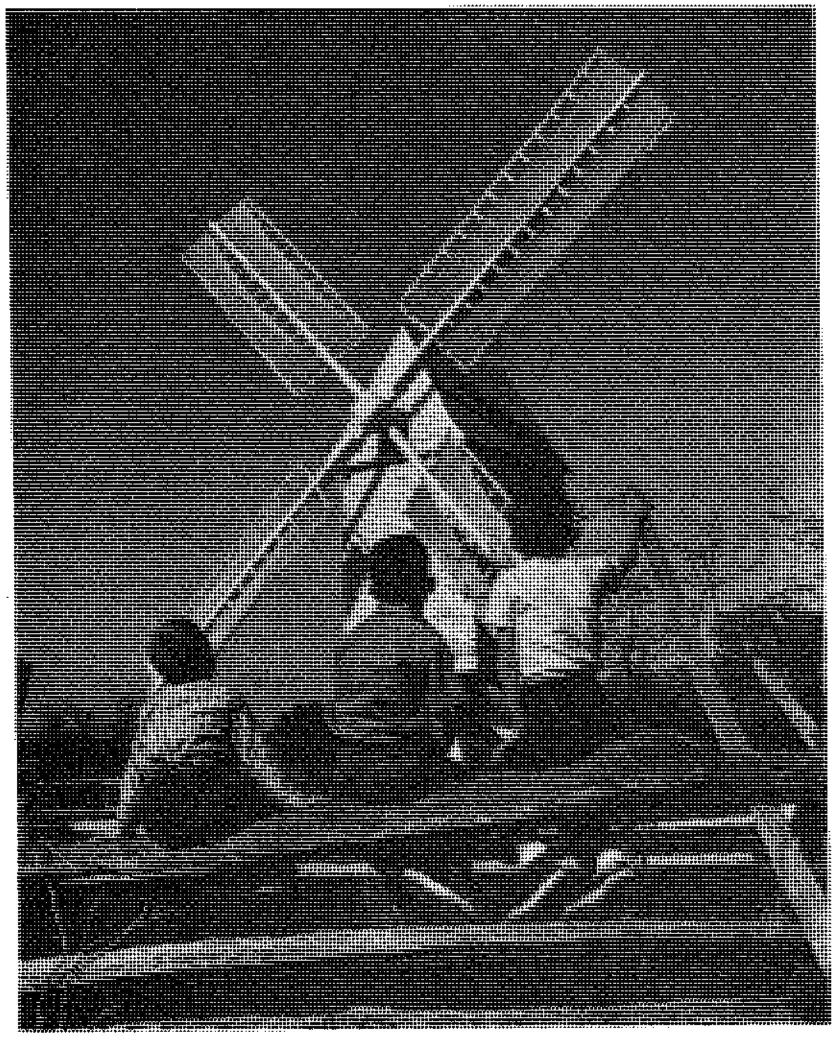


8:00-9:00	REGISTRATION-East Gallery
9:00	GREETINGS AND WELCOME Room DEF W. George Devens, VPI & SU Conference Chairman
9:00	INTRODUCTIONS Jon M. Duff, Ohio State Univ. Program Chairman
9:30	SESSION ONE TRENDS IN TEACHING GRAPHICS "Computer Graphics in Undergraduate Engineering and Technology Education" Daniel L. Ryan, Clemson Univ.
10:30	COFFEE BREAK
11:00	"Basic Graphics in the Eighties - EDGD Gives Its Input" Peter Miller, Purdue University
12:15	BUSINESS LUNCHEON Room B Presiding: Paul S. DeJong Chairman, EDGD Iowa State University



<u>MONDAY AFTERNOON</u>, NOVEMBER 24

1:45	SESSION TWO THE QUESTIONS OF TEACHING GRAPHICS Room DEF "Teaching Graphics" Robert Kelso, Louisiana Tech University
2:15	"Lest We Lose Sight of the Goals . . . " Paul S. DeJong, Iowa State University
3:00	COMMITTEE MEETINGS (To be Announced)



TUESDAY, NOVEMBER 25

8:30	SESSION THREE THE BUSINESS OF MAKING GRAPHICS Room DEF "Consulting in Graphics-Good for the Instructor and Good for the Student" Larry Goss, Indiana State Univ.
9:15	"Research in Graphics - Research Using Graphics" Herbert H. Gernandt, Jet Propulsion Laboratory
9:45	"Computer Graphics - The Full Range of Services" George M. Lotz, The Bendix Corp.
10:30	COFFEE BREAK
11:00	"Comments on Automated Graphics and the Role of the Teacher, Engineer and Operator" Talat D. Itil, Itil Interactive Associates
11:45	"Report to the Conference-EDGD Survey" Peter Miller, Purdue University
12:30	LUNCHEON (with Spouses) Room AB
1:30	"Archaeology in Williamsburg" Ivor Noel Hume Group Photo
2:15	Walking Tour of Williamsburg
6:00	HOSPITALITY HOUR Market Square Tavern
7:00	ANNUAL BANQUET North Ballroom Presiding: Paul S. DeJong Chairman, EDGD Iowa State University Presentation of the Oppenheimer Award Closing Remarks

WEDNESDAY MORNING, NOVEMBER 26

Continue Tour of Colonial Williamsburg

EDITOR'S PAGE

EDGD COMMITTEES NEED YOU!!!!!

.....An Editorial

So many of our membership are not aware of the objectives of the various committees of the division. Our chairman is certainly aware of this as are each of the past-chairmen because so few of EDGD members "sign up" for any of the several interest areas included with the ballots for each year. Excuses range from, "I'm on too many committees on my home campus now!!" to "What is that committee trying to achieve? I might join if I knew what the committee objectives were!"

To the former "excuse-maker" we say that most committee business is handled by mail. If you are fortunate enough to be able to attend a midwinter meeting, a time "block" is usually set aside for committee meetings.

For the latter "excuse-maker", we present the following pages of the division publication. Committee objectives and membership are listed along with the recent accomplishments where these have been made available.

Why not join one of these groups by letting the chairperson (or the Director in charge) know of your interest. His/her name and address are listed with the committee membership in most cases.

The most important reason for being involved in one of the division committees is that each one of us believes that Engineering Graphics (either with or without Design) is basic to the education of future engineers. The exchange of ideas, goals and methods of implementation is accomplished by these committees. Anyone who attends a session sponsored or co-sponsored by the EDGD at either an annual conference or mid-winter meeting can tell you that new ideas abound, and that nobody goes away without a few notions of improving their own classroom image.

But, committee membership needs industrial input, too! What industry wants and needs is vital to those of us who teach engineers and technology majors. Therefore, those who read this and who <u>are</u> involved either in full-time or part-time industrial work, be advised that the EDGD committees NEED YOU, TOO!!!

Mary A. Jasper-Editor

Clip on Dashed line

AWRIGHT, ALREADY!! **You talked me into it!!**

PLEASE sign me up for the following committee(s):

LIAISON ☐

- Membership Activities ☐
- Educational Relations ☐
- Industrial Relations ☐
- International Relations ☐

PUBLICATIONS ☐

ZONE ACTIVITIES ☐

Zones 1 ☐ , 2 ☐ , 3 ☐ , 4 ☐

PROGRAMS ☐

TECHNICAL AND PROFESSIONAL ☐

- Computer Graphics ☐
- Engineering Design Education ☐
- Freshman Engineering ☐
- Human Factors ☐
- Metrication ☐
- Teaching Techniques ☐
- Theoretical Graphics ☐

MY NAME ______________________

MY ADDRESS ______________________

MY CITY,STATE,ZIP ______________________

MY TELEPHONE ____/________________

Send to: Jack C. Brown
Vice-Chairman, EDGD
PO Box 1941
University, AL 35486

COMMITTEE REPORTS

LIAISON

Jack C. Brown
University of Alabama
Tuscaloosa, AL

In the past, the organization of the EDG EDG Division has functioned well in certain areas. However, this past year, certain deficiencies were noted in the areas covered by the Liaison Director. The problems were discussed by the Executive Council and some changes in organization were implemented. In addition, the director and each committee chairman were asked to detail specific charges or tasks which will be used to focus the work efforts of the committee. The following report represents the fruit of this effort.

Committee on Educational Relations

1. During the EDG Division conferences, hold committee meetings to review and/or modify the committee's charge so as to make the committee's efforts more effective in promoting the advancement of Engineering Design Graphics.

2. Enlist committee members who will work toward establishing a positive program within the committee activities: The following activities should be considered and additions/deletions made in accordance with the wishes of the Educational Relations committee.

   a. Generate (or cause to be generated) timely articles to the journals which are of general interest to the division membership.

   b. Input to the program committee appropriate topics for consideration at meetings or special workshops.

   c. Promote quality graphics programs to be held at each sectional meeting.

   d. Promote activities which encourage people to become graphics teachers and then improve themselves once they become graphics teachers.

3. Establish liaison with ERM.

4. Submit timely reports of committee activities to the Liaison Director for inclusion in the report to EDG Division at the annual and mid-year conferences. Committee organization including names, addresses, and telephone numbers should normally be included in the report.

Committee on Membership Activities

1. During the EDG Division conferences, hold committee meetings to review and/or modify the committee's charge so as to make the committee's efforts more effective in promoting the advancement of Engineering Design Graphics.

2. Enlist committee members who will work toward establishing a positive program within the committee activities: The following activities should be considered and additions/deletions made in accordance with the wishes of the Membership Activities committee.

   a. Promote activities which encourage people interested in graphics to become participating members of the EDG Division of the ASEE.

   b. Formulate and publish affirmative action plans/statements whenever appropriate. Serve as the clearing house to announce available grants, conferences, and any other activities within the area of affirmative action.

   c. Through the EDG Journal, generate promotional material which can be used in the recruitment of new members.

3. Establish and maintain liaison with EDG representatives in each section to promote membership at the grass roots level by such activities as:

   a. EDG oriented programs at sectional meetings.

   b. Organized membership drives in each state.

4. Submit timely reports of committee activities to the Liaison Director for inclusion in the report to the EDG division at the annual and mid-year conferences. Committee organization should include names, addresses and telephone numbers.

Committee on Industrial Relations

1. During the EDG Division conferences, hold committee meetings to review and/or modify the committee's charge so as to make the committee's efforts more effective in promoting the advancement of Engineering Design Graphics.

COMMITTEE REPORTS

2. Enlist committee members who will work toward establishing a positive program within the committee activities: The following activities should be considered and additions/deletions made in accordance with the wishes of the Industrial Relations committee.

   a. Generate (or cause to be generated) timely articles to the journals which are of general interest to the division membership.

   b. Input to the program committee appropriate topics for consideration at meetings or special workshops.

   c. Promote involvement of people from industry in each sectional and division meeting/conference.

   d. Promote activities which will encourage people from industry to become members of the EDG Division of the ASEE.

Committee on International Relations

1. During the EDG Division conferences, hold committee meetings to review and/or modify the committee's charge so as to make the committee's efforts more effective in promoting the advancement of Engineering Design Graphics.

2. Enlist committee members who will work toward establishing a positive program within the committee activities: The following activities should be considered and additions/deletions made in accordance with the wishes of the International Relations committee.

3. Establish Liaison with RWI.

4. Submit timely reports of committee activities to the Liaison Director for inclusion in the report to the EDG Division at the annual and mid-year conferences. Committee organization including names, addresses, and telephone numbers should normally be included in the report.

   a. Generate (or cause to be generated) timely articles to the journals which are of general interest to the division membership.

   b. Input to the program committee appropriate topics for consideration at meetings or special workshops.

   c. Plan conferences which would be of such magnitude of interest that the conferences would draw international attendance.

3. Submit timely reports of committee activities to the Liaison Director for inclusion in the report to the EDG Division at the annual and mid-year conferences. Committee organization including names, addresses and telephone numbers should normally be included in the report.

The new Director of Liaison is listed below.

Merwin L. Weed, Director of Liaison
The Pennsylvania State University
McKeesport Campus
McKeesport, PA 15131

ZONE ACTIVITIES

GEORGE PANKRATZ
The University of Toledo
Toledo, OH

THE ZONES COMMITTEE NEEDS HELP!

Relatively few current or prospective EDG Division members have the opportunity, either because of timing or lack of travel funds, to attend the June Annual Conferences or our Mid-Winter meetings. Most of the twelve ASEE sections, however, hold fall or spring conferences which are more accessible geographically. If sessions could be scheduled at these meetings which would be of topical interest to the teachers of graphics and design at universities, colleges, junior colleges, and technical institutes, attendance by members of this group would be stimulated. Also, hopefully, new members for the EDG Division could be identified and enrolled to continue to advance our proud tradition of over fifty years of activity and service.

What the Zones Committee needs, therefore, are volunteers from each area of the country to work with the section meeting planners to make sure that subjects of suitable interest are included in conference programs, and to help disseminate invitations to these meetings to as large a potential audience as possible. If you have an interest in doing liaison work of this kind, please communicate with Professor George E. Pankratz, EDG Zones Committee Chairman, The University of Toledo, Toledo, Ohio 43606. Our current four zone sub-chairmen are:

Robert Lang - Northeastern Univ.
Francis Mosillo - U. of Ill.-Chicago
Louis Skubic-South Dakota
Wally Reynolds - Cal Poly-San Luis /Obispo

COMMITTEE REPORTS

These men are capable leaders, but they need more grass-roots coverage to carry our message to all parts of the USA.

Along this line, Ohio -- for 20 years -- has had an Association for Engineering Graphics which sponsors annual meetings for teachers of drawing and design with nearly 200 names on its mailing list. An article about OAEG by Prof. Charles Keith of Kent State appeared in the Spring 1978 issue of the EDG Journal. Anyone who might desire more information about the formation or operation of this organization may contact Prof. Keith or Prof. Pankratz.

PROGRAMS

Arvid R. Eide
Iowa State University
Ames, IA

Present and Future Programs

June 23-26, 1980

Current Meeting
University of Mass.
Arvid Eide - Program Chairman - I.S.U.
Committee: Billow, DeJong, Eide

November 23-25, 1980

Mid-Year Meeting
VPI & SU - Colonial Williamsburg
Jon M. Duff - Prog. Chmn.-Ohio State
W. G. Devens - Liaison - VPI & SU
Committee: Billow, DeJong, Jenison

June 22-25, 1981

Annual Meeting
Los Angeles, CA

Recommendations and Requests

It continues to be difficult, if not impossible, to receive voluntary program participation. When individuals do submit papers, they seldom can be categorized into a common session.

It has been my philosophy to ask Technical and Professional Activities Chairpersons to act as "Session Coordinators". These committees at the present time consist of: Graphics Technology, Computer Graphics, Human Factors in Design, Theoretical Graphics, Engineering Design Education, Metrication, Teaching Techniques, and Freshman Engineering.

The incoming Program Chairman, Rollie Jenison, and myself have considered the program for Los Angeles, and we have selected tentative areas:

A. Engineering Graphics
   1. Computer Graphics (Instructional methods for freshmen)
   2. New teaching techniques.

B. Design
   1. Creative design projects
   2. Innovative freshman courses

C. Freshman year activities
   1. Accreditation processes
   2. Innovative freshman programs

D. Effective teaching
   1. As applied to any of areas A, B, C
   2. Handling large classes (250)

If you have any interest in participation, please contact Rollie at the address below.

Program Director
Rollie Jenison
Iowa State University
Freshman Engineering
112 Marston Hall
College of Engineering
Ames, IA 50011

Ph. 515/294-8355

PLEASE NOTE: Papers for the Annual Meeting are due to the Program Director by November 15, 1981

TECHNICAL & PROFESSIONAL

Larry Goss
University of Indiana/Evansville
Evansville, IN

The following report represents the activities of the various Technical and Professional Committees, under the able leadership of Director Larry Goss, during the past year.

Teaching Techniques Committee

Sponsored a paper session at the 1980 (Nov. 1979) midyear meeting.

Committee members have had articles published in the EDG Journal.

Committee members have been responding to media questions put to them by mail.

COMMITTEE REPORTS

This committee is presently in need of a Chairman. Current membership:

HAILU BOGALE-Prestonburg Community College
MARY COPELAND-W.Arkansas Community College
AMOGENE DEVANEY-Amarillo College
GEORGE DEVENS-VPI & SU
WILLIAM ELWOOD-University of Alabama
MARGARET ELLER-LSU (retired)
HOWARD HEDINGER-Florida
LESTER JOHNSON-Savannah State College
ROBERT KELSO-Louisiana Tech
LOUIS SKUBIC-South Dakota State Univ.
HENRY STARKEY-Pennsylvania State Univ.
DEAN STEWART-Miss. State University
MERWIN WEED-Pennsylvania State Univ.
P.J. ZSOMBOR-MURRAY-McGill University

Freshman Engineering Committee

Sponsored two sessions at 1980 Annual Meeting.

Possible co-sponsor of mini-plenary at 1981 Annual Meeting.

Currently examining accreditation guidelines for the freshman year.

This committee is currently in need of a chairman. Current membership:

BLAINE BUTLER-Purdue University
ROBERT FOSTER-Pennsylvania State Univ.
HUGH KEEDY-Vanderbilt University
WILLIAM LEBOLD-Purdue University
WILLIAM ROGERS-VPI & SU
DONALD COLE-University of Louisville
CLARENCE HALL-Louisiana State Univ.
LARRY NORTHUP-Iowa State University
GEORGE BEAKLEY-Arizona State University

Human Factors Committee

Francis Jankowski, Chairman
Department of Engineering
Wright State University
Dayton, OH 45435

No report.

Computer Graphics Committee

Computer Graphics Workshop held after 1980 Annual Meeting, UMASS.

Paper session sponsored at 1980 Annual Meeting, UMASS.

Scheduled committee meeting at 1980 annual meeting, UMASS.

Francis A. Mosillo-Chairman
Systems Engineering Department
Univ. of Illinois at Chicago Circle
PO Box 4348
Chicago, IL 60680
Ph. 313/996-2260 or 3444

Committee membership:

ROBERT BEIL-Vanderbilt University
JOHN CLAUSEN-University of Minnesota
JOHN DEMEL-Ohio State University
EUGENE FICHTER-Oregon State University
ROBERT HARVEY-College of DuPage
DARRYL JANOWICZ-Wester Michigan Univ.
ROLLIE JENISON-Iowa State University
KLAUS KRONER-University of Mass.
ROBERT LARUE-Ohio State University
ROBERT MCDOUGAL-University of Nebraska
EDWARD MOCHEL-University of Virginia
JACOB WOLF-Ohio State University
JAMES BURNETT-Michigan State University

Engineering Design Education Committee

Warren White-Chairman
Centenary College
Shreveport, LA 71104

No report.

Metrication Committee

Co-sponsored a session at the 1979 Annual Meeting, L.S.U.

Two papers published in EDG Journal.

Edward V. Mochel-Chairman
University of Virginia
School of Engrg. & Applied Science
Charlottesville, VA 22901
Ph. 804/924-7421

Committee membership:

CLAUDE DEGUISE-Ecole Polytechnique
HOWARD HEDINGER-Florida
K. HOWARD
LESTER JOHNSON-Savannah State College
HENRY KROEZE-University of Wisconsin
KLAUS KRONER-University of Massachusetts
KENNETH MEEK-St. Lawrence College
WILLIAM VANDERWALL-NC State University

Theoretical Graphics Committee

This committee needs a chairman.

No report since the ICDG, Vancouver, B.C.

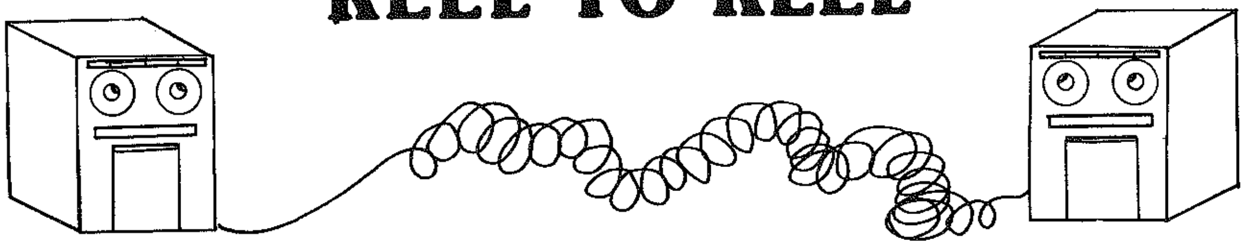
Chairman's Special Committee of Authority

This committee, initiated by Leon Billow, has the charge to answer and advise the EDGD membership on technical problems which may arise in daily endeavor, whether in the classroom or in research.

Committee membership:

EUGENE PARE'-Washington State Univ.
ROBERT LOVING-Illinois Inst. of Tech.
WILLIAM ROGERS-VPI & SU
ROBERT HAMMOND-NC State University

REEL TO REEL



A Report of the COMPUTER GRAPHICS Committee

Robert McDougal
The University of Nebraska
Lincoln, Nebraska

In 1978 a survey was conducted by the author to determine the trend of Engineering Graphics at Universitites throughout the USA and Canada. Two hundred colleges were contacted with only fifty-eight responding to the request for information. Resulting from the survey was a paper entitled "Engineering Graphics Teaching Aids" which was presented at the 86th Annual ASEE Conference at the University of British Columbia.

The Computer Graphics Committee of the Engineering Design Graphics Division of the ASEE suggested that a list of Computer Graphics textbooks, manuals, computer software, etc. being used at that time by those universities responding to the survey be submitted for publication in the Engineering Design Graphics Journal. Based on this request, the following tables have been prepared.

Table number one is a list of textbooks and the universities using them.

Table number two represents a list of workbooks, manuals, handouts, etc., which the representative universities were using at the time.

Information concerning the publisher or writer of the supplements is included if it was available.

TABLE 1

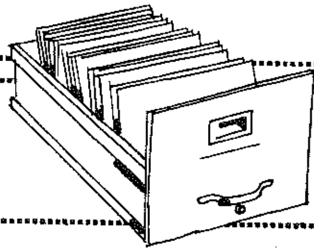
Computer Graphics Textbooks

Text	University
Principles of Interactive Computer Graphics by William Newman and Robert Sproull. (McGraw-Hill)	Univ. of Cal. (LA) Case Western Reserve Columbia University Univ. of Connecticut Louisiana State Univ. Univ. of Missouri (Col) Montana State Univ. Naval Postgrad. School Sou. Methodist Univ. Syracuse University Texas A & M Univ. Univ. of Virginia Univ. of Waterloo Wayne State Univ. Worcester Polytech. Yale University
Mathematical Elements for Computer Graphics by David Rogers & J. Adams (McGraw-Hill)	Columbia Univ. New Mexico State Univ. Syracuse University Texas A & M Univ. Univ. of Tulsa U.S. Naval Academy Wayne State University
Interactive Graphics for Computer Aided Design by David Prince. (Addison-Wesley)	Georgia Tech U.S. Naval Academy Wayne State University
Graphics User's Manual by Purdue University	Louisiana State Univ. Purdue University
CalComp Programming for Digital Plotters by R. T. DeLorm & L. Kersten (Univ. of Nebraska Press)	Univ. of Nebraska (Lincoln) Univ. of Nebraska (Omaha)
An Introduction to Computer-Aided Design by Mischke (Prentice-Hall)	Texas A & M Univ. U.S. Naval Academy
Programming Calcomp Pen Plotters by Computer Products Inc.	Univ. of Idaho
Computer Graphics for Engineers Published by Marcel-Dekker	Clemson University
Engineering Drawing and Computer Applications by Mosillo and Pancner	Univ. of Illinois (at Chicago Circle)
Elements of Computer Graphics by Rogers & Odaues	Louisiana State U.
Introduction to Digital Computer Plotting by T.C. Smith & Y.C. Pao (Gordon & Breach)	Univ. of Nebraska (Lincoln)
Digital Computer Plotting by F. K. Brown	Northeastern Univ.
Introduction to FORTRAN IV by Hammond, Rogers and Houck	New Mexico State U.
Programmed Graphics by W. Schneerer (McGraw-Hill)	Univ. of Rochester
Projective Geometry by Rosenbaum (Addison Wesley)	Univ. of Rochester
Engineering Applications of Digital Computers by Bashkow	U.S. Naval Academy
Pertinent Concepts in Computer Graphics by Fauman & Nieuvergelt	U.S. Naval Academy
Computer-Aided Integrated Circuit Design by Herskowitz	U.S. Naval Academy
Programming with FORTRAN IV by Gottfried (Quantum)	Univ. of Nebraska (Lincoln)

TABLE 2

Workbooks, Manuals, Handouts and Software

Supplement	University
"TDGRAPH-3D-Pictures"	Univ. of Calif. (Davis)
"Departmental Handouts"	Univ. of Colorado (Boulder)
"Univ. Graphics Manuals, IBM" "Manual PLOT10"	Columbia Univ.
"Plotter Package Handout (CALCOMP)" Computer Center	Univ. of Missouri (Rolla)
"IBM 1627 Plotter Manual" "IBM 1130 College Prepared Users Manual"	Ohio University
"Users' Guide to GPAK" "Users' Manual for FLECS" "Notes from 1978 PAR-U.of Rochester"	Univ. of Rochester
"Status Report of the Graphics Standards Planning Committee of ACMISIGGRAPH"	S.M.U.
"APL Visions Documentation and Users' Manual"	Syracuse University
"Handouts (ES120C-Module L)"	Vanderbilt Univ.
"Incremental Curve Generation" Harvard Technical Report "B-Spline Bezier Curves" Utah Technical Report "Hidden Line Algorithms" Technical Report	Yale University



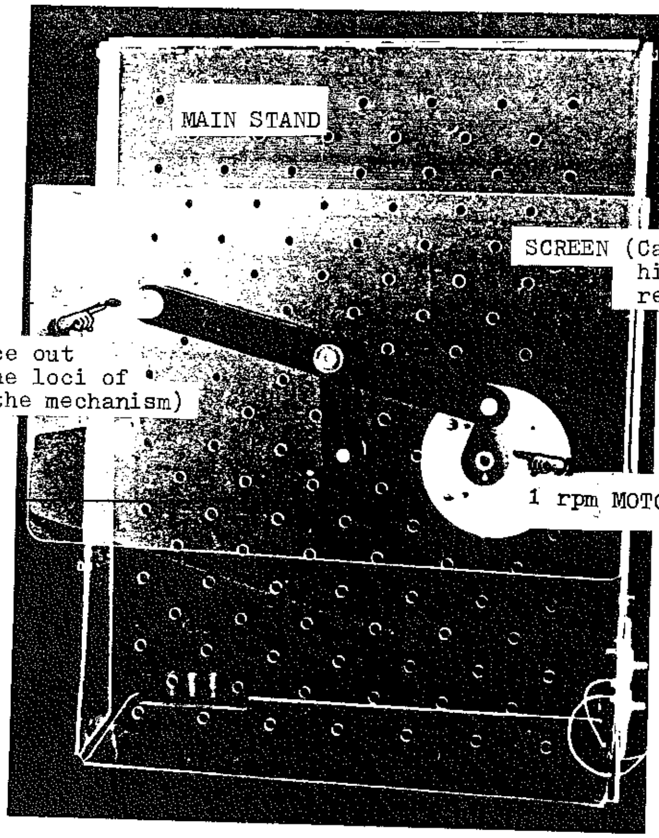
file to file

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

KINEMATICS DISPLAY UNIT

A New Concept in the Study of Kinematics Problems

Bryan M. Dwyer
Vancouver, B.C.

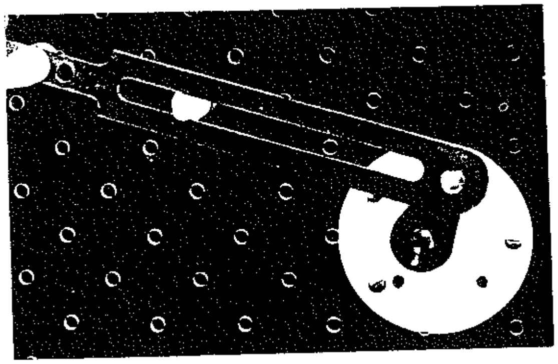


One of the main difficulties encountered in teaching kinematics of mechanisms, loci of a point on a mechanism or cam design is the ability to construct the diagrams efficiently and effectively on the chalk board while still maintaining the attention and interest of the students.

Presented herein is a way to make an immediate impict with the subject and arouse interest and inquiry among the students about the kinematics of machine and cam design.

The display unit can be made both pleasing and functional by the use of clear and colored acrylics in its construction. The main unit is drilled so that almost any configuration of mechanism can be quickly plugged into the board. An electric motor (1 rpm) is used to turn the mechanism, giving the student ample time to observe its geometry.

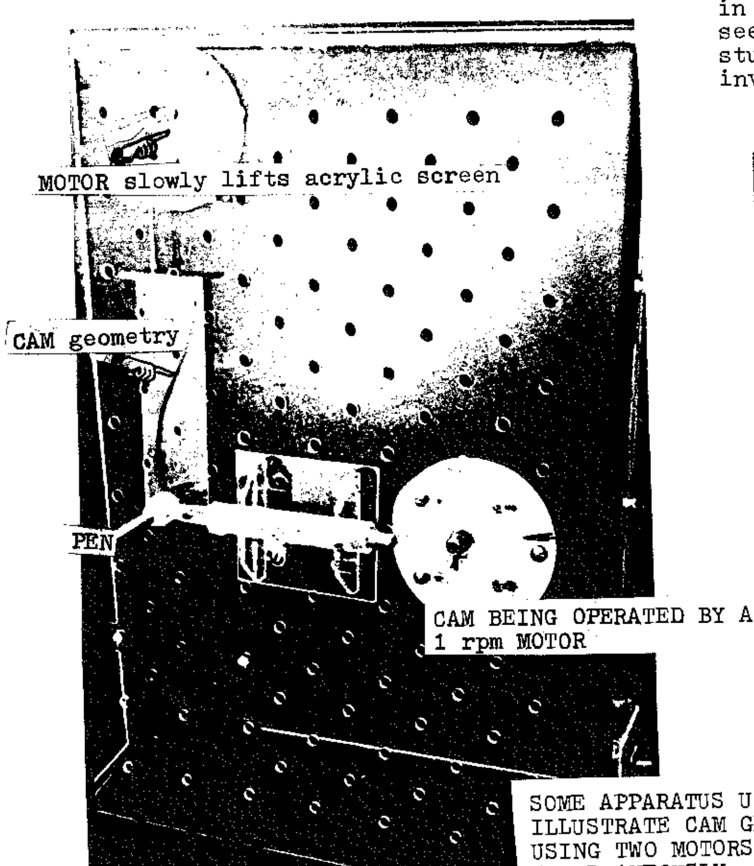
The photographs show just a few of the mechanisms that can be produced and used on this unit. Each mechanism has a variety of installation positions which would change its resulting geometry. Using two motors, one having a variable speed control, simple harmonic motion of a point on a mechanism can be demonstrated.



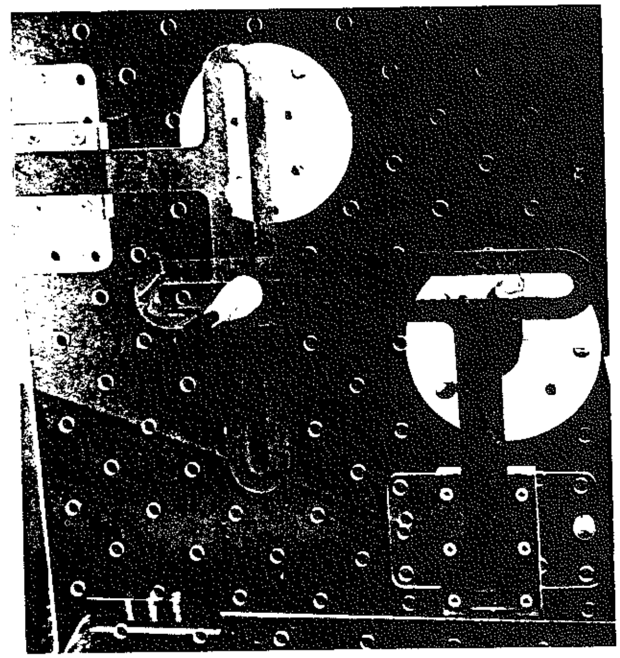
SLOTTED LINK MECHANISM

Radial plate cams can be designed by students and produced in the school workshop using $\frac{1}{4}$ in. acrylic sheet and cutting it with a band saw. These can be graphically displayed on the unit. By this method several different cams can be studied during one lesson.

Simple mechanisms also may be set up on the display unit and their relative velocities observed; or, by using a pen attachment, the loci of a point on the mechanism may be traced on the screen that clips onto the front of the unit. The screen may then be used on the overhead projector for further student discussion or it may be used on an office copier for permanent prints.

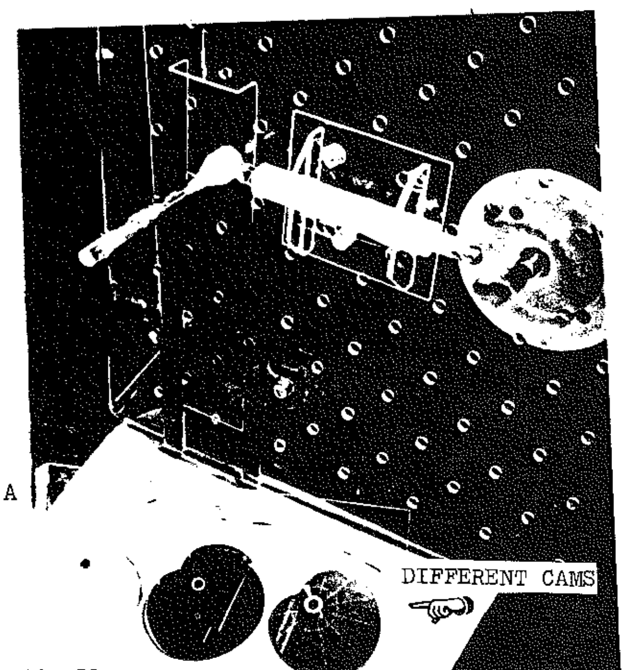


SOME APPARATUS USED TO ILLUSTRATE CAM GEOMETRY USING TWO MOTORS RUNNING SIMULTANEOUSLY



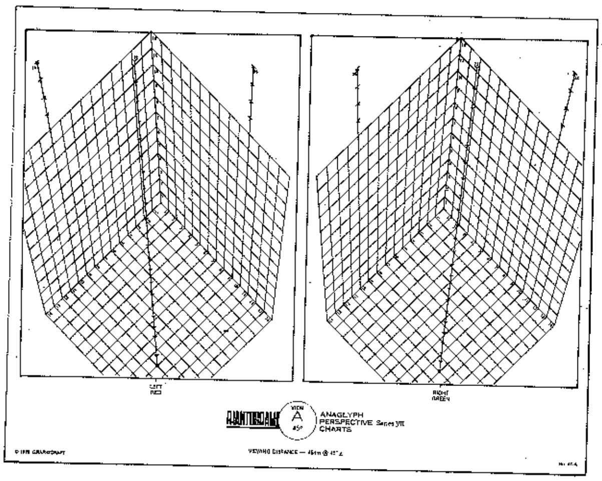
SIMPLE HARMONIC MOTION

This unit provides an ideal opportunity for teachers to discuss with students the design features of a mechanism, its applications and variations while the linkage or cam is still in operation. This advantage -- actually seeing the mechanism operating -- gives the student a lasting impression of the geometry involved in design.



IT'S ALL IN HOW YOU LOOK AT IT

Simplified, practical anaglyphic system speeds engineering graphics teaching



Raymond Nicyper
GraphiCraft
P.O. Box 509
Westport, CT 16880

Two-color stereographic drawings never were easy to construct. Now they've gotten a lot easier. Anaglyphs, the double pictures that show each eye a different image in order to create an illusion of depth, aren't new. They were used by Socrates.

Now, working, learning and communicating with this medium will become more widely available with a system initiated by Aladar Heppes and others in Hungary soon after World War II. Refinement, de-bugging and development of Heppes' ideas have finally reached a point where they can be put to general classroom use. The outgrowth of this work, the Phantogram underlay drawing guide system, meets a definite need in engineering education. It will probably find many applications in a wide range of industrial and research endeavors as well.

The educational problem, in practical terms, is that there simply aren't enough teaching hours and learning hours to do everything. Students must learn to visualize complex solid shapes and geometric relationships among locations that are expressed in terms of three-dimensional coordinates. Yet they can't "see" what they're doing until they master spatial concepts.

A human brain and a digital computer -- which, of course, is the creation of human brains -- approach solid geometry differently. Our brains are conditioned to interpret what we feel and what we see. While each eye sees two-dimensional images, the brain combines great numbers of these images from different viewpoints and comes up with three-dimensional concepts. For close-in scrutiny, and when a shift in viewpoint is impractical, our brains combine the two flat images available to our two eyes.

Stereoscopic vision or depth perception is never taught in the academic sense of teaching and learning. Our brains normally develop the faculty for performing this solid-geometry operation, and our eyes normally furnish adequate input data.

An ability to deal with three dimensions quantitatively, which can be taught in the academic sense of the word, is conceivably possible but practically very difficult unless the student is able to "see" space relationships. Those ancient brain functions, which we humans share with other creatures on the evolutionary ladder, provide a biological bridge to the abstractions of engineering graphics.

Whether or not some gifted individuals may be able to think three-dimensionally without eye/brain-related aids, it is a demonstrated fact that such aids are a tremendous help, both to the student and to the teacher. Axonometric modes, such as oblique and isometric, naturally find a place in the teaching process. So do hastily-sketched perspective views. But the distortions built into axonometric constructions and the artistic limitations of most free-hand sketchers are definite drawbacks. Our brains crave something that seems more "real" -- a viewpoint "in perspective" -- information "in depth."

Here is where the available teaching and learning time begins to run out. It isn't easy to make accurate 3-point perspective drawings, and it's more difficult yet to make good stereographic pairs, starting from theoretical scratch. Learning how to construct them is surely a desirable accomplishment, but it takes time.

Spending that time is hard to justify, because stereo visualization is just a means to an end in the strictly engineering education. Depth perception enables an individual to use his or her own intellect more creatively and, sometimes, to communicate with other human beings. Yet, once the stereo imagery has served its purpose, other kinds of graphic representations, physical models and digital software become the stuff of communication and utilization.

The Phantogram system of constructing stereographic drawings bypasses the necessity of spending long hours mastering the geometry of perspective. An entire classroom can use this system to create constructions that look "real" when viewed through anaglyphoscopic red and green spectacles. Each student plots the diagrams following simple, straightforward procedures that are easy to check as the work progresses. The teacher is free to concentrate on the main objective — on the relationships among points, lines, planes, curved surfaces, shapes and spaces that a technically-trained mind will be expected to comprehend.

What looks like 3-point perspective in the Phantogram stereo system is actually drawn on paper as a stretched-out one-point perspective image. This system employs a horizontal base grid that is pure, undistorted orthographic projection. Transforming such a straight-on view into a perspective view is then accomplished in the most ingenuously simple manner. The viewer lays it on a flat table and looks at it from an angle of about 45 degrees! That way, the only necessity is to construct the verticals so that they converge appropriately when viewed from this same oblique angle.

Kits of Phantogram perspective charts, designed for repeated re-use with tracing paper or film overlays, have stereo pairs of elongated perspective grid patterns printed on them.

Each pattern is made up of three grids, a base grid and two sidewall grids, to represent three mutually perpendicular planes. The sidewall grids rise from the back edges of the base grid, so that the perspective drawing will normally be constructed above the base and in front of the sidewalls. It appears, thus, in a sort of stage setting -- not behind the bars of a cage.

Horizontal lines of the sidewall grids do not converge. They are all parallel to corresponding lines on the rectilinear base grid. The rules of perspective govern their vertical spacing. Vertical lines of the sidewall grids pass through intersections of base grid horizontals, and they all converge toward a common vanishing point. With this arrangement, any horizontal plane at any level constructed from the sidewall grids will be made up of perfect squares. It shows a true, square-on, undistorted view of the object, pattern, map, architectural plan or whatever. It becomes a perspective view only when the viewer sees it an angle.

To construct a perspective drawing using this system, the student first plots the object or pattern on all three grids according to the rules of orthographic projection. As the grids are beyond and below where the perspective drawing will be, these orthographic plots are made according to first-angle, not our customary third-angle projection. The plan-view plot on the base grid will be true to scale without distortion. Elevation views may need to be drawn undistorted first, then transferred by plotting point-by-point onto the perspective sidewall grids. While each view will normally be located inside its printed grid, there is no hard rule against extensions beyond those areas.

Now, each point on the object or pattern is projected into the stage setting formed by the three grids. It can be projected from layout plots on any two grids, then checked for correspondence against the third grid plot. Any errors that show up here can be diagnosed and corrected before the work goes any further.

Projection lines are always parallel to the printed grid lines. In fact, horizontal projection lines are all parallel to one another in each horizontal axis. Only the vertical projection lines diverge. It's a simple matter to align them with nearby grid verticals, which are clearly visible under the tracing.

The perspective view itself can be construced by connecting projected points. As it takes shape, the student may elect to go over prominent features with heavier lines.

This same image construction process is performed twice, once on each grid of the stereographic pair printed on the chart. Each time, the frame lines are traced, too, to provide a locating reference.

At this point, the two perspective views are ready to be combined on a single tracing. The first thing to do is to trace the chart frame lines on that tracing. They serve as its locating reference so that it can be laid over either perspective drawing of the pair without losing the two-eye orientation.

Any lines or points that lie on the base grid should be the same on both drawings. If there is a plan view on this grid, it should be traced from one drawing with a brown marker. Then, it can be checked against the other drawing for coincidence. The reason for brown is that, containing both colors, it can be seen through both the red and green filters of the stereo viewer.

The perspective drawing that was made on the chart side marked LEFT RED should be traced with a red marker. This image will actually be seen by the right eye through the green filter. Only the perspective drawing itself, not the orthographic views nor the projection lines that were used to construct it should be traced.

With the same tracing aligned over the locating reference frame of the drawing that was made on the chart side marked RIGHT GREEN, the two-color assembly is completed by tracing its perspective drawing with a green marker. This is what the left eye will see through the red filter.

When it is placed over a white or neutral buff backing, the two-color anaglyph is ready for viewing through the filtering two-color spectacles that select what each eye can see.

The problems of individual adaptation to this kind of stereo presentation are the same as those encountered with traditional two-color stereo systems. Some students find it harder than others do. Impaired vision in one eye is often compensated by dominance of the other eye. People who normally wear glasses for reading and close work, as a rule, must wear them along with the red and green viewing spectacles in order to see height and depth in the stereo combination.

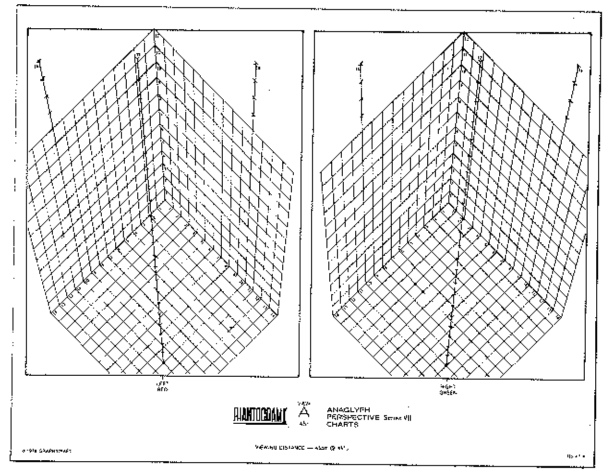
The problems of achievement by students and of guidance by teachers are reduced drastically by the Phantogram system. Each student can check his or her own construction work at every point in the drawing sequence. The teacher, with a grid that is a duplicate of the one the student is using, can spot errors very quickly and easily. Guidance of students while their work is in progress and grading the work they turn in no longer need to be time-consuming searches.

Using the Phantogram system, students can all be constructing the same stereographic image at the same time, and what they accomplish can be appraised against a uniform standard.

Experimental tests of the Phantogram system of anaglyptography have been going on for the last ten years. Some details have been modified as a response to classroom experience. In their present form, the materials, methods and instructions have proved eminently practical.

Many other possibilities are being considered. One is using an overhead projector to show Phantogram images. Another, which appears quite feasible, is the use of color slides made by photographing the diagrams from a 45-degree angle.

The Phantogram package, available from GraphiCraft in Westport, Connecticut, includes charts for a selection of grid pairs with directions of view that differ by 30-degree intervals, colored marker pencils, viewers, and complete step-by-step instructions. The instruction manual is illustrated with examples of anaglyphic drawings that "stand up" right off the page when viewed through the red and green spectacles.



A typical Phantogram stereo tracing chart. Note that the base grids are true views and that their locations in the reference frames are identical.

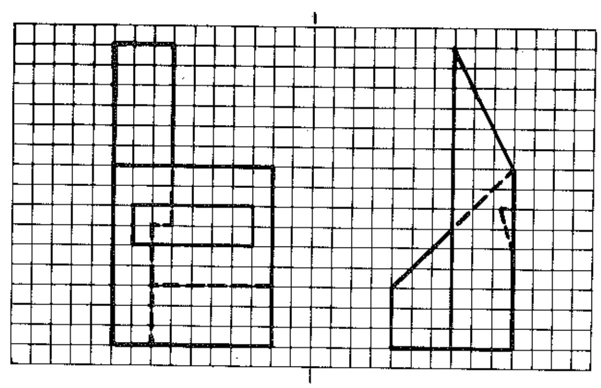


Fig. 2

Sidewall grid plots may be constructed in first-angle orthographic projection before they are transferred to the perspective tracings.

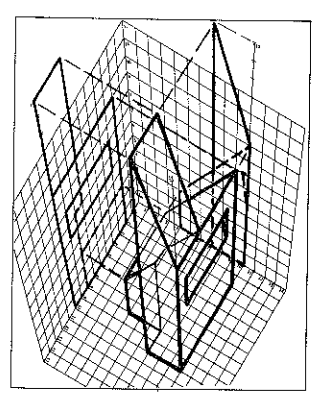


Fig. 3

This is how one image of a pair is constructed on the Phantogram chart. When the page is viewed at about 45 degrees, the structure appears in true perspective.

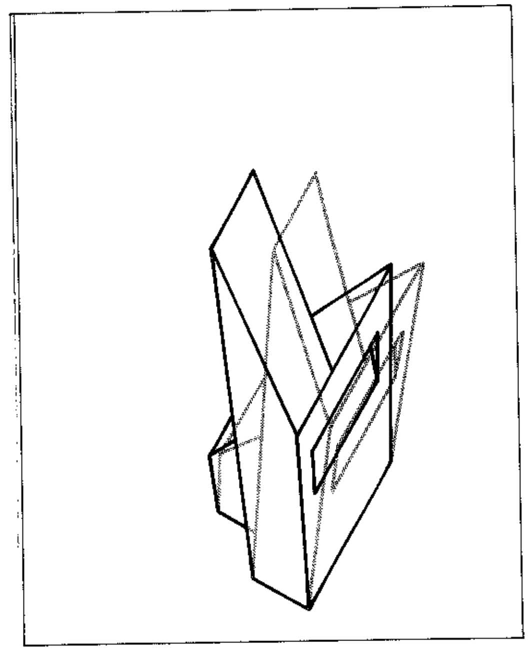


Fig. 4

When the two images of a pair are combined on a single tracing, they will correspond to reality as it is seen separately by two eyes.

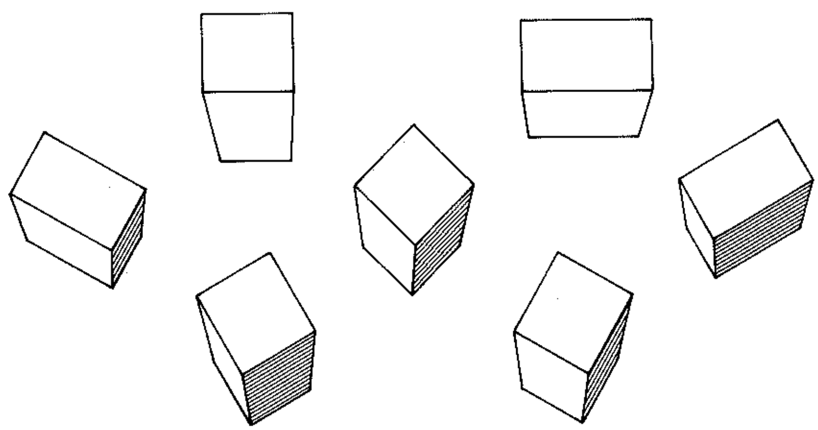
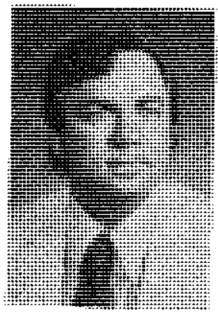


Fig. 5

The Phantogram package contains seven stereo pair perspective charts for these directions of view.

INATE GEOMETRY?



Robert P. Kelso
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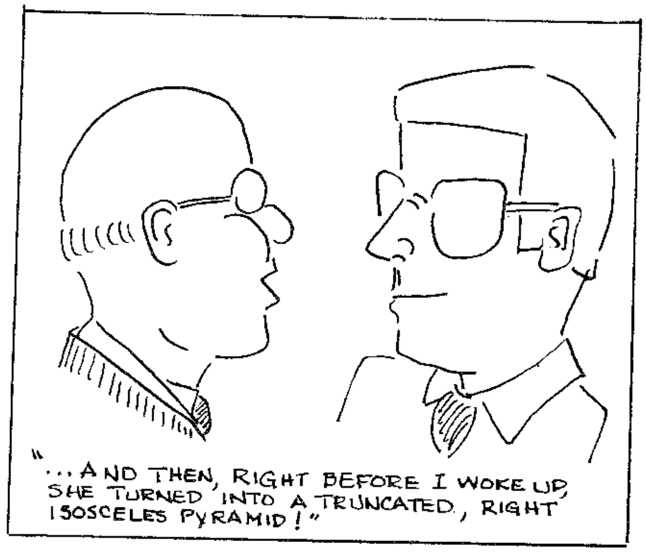


The piece below was passed to me by Associate Dean H.L. Henry of Louisiana Tech University. The sender was unidentified and we have been unable to identify the publication. I suggest there is fundamental linkage between Shepard's statement here, "... the visual cortex must already have its own inner representations of ... beauty ..." and Reinhard Lehnert's Visual Music (EDGJ, Fall 1978, page 42), Jay Hambidge's Dynamic Symmetry, Le Corbusier's Modulator series, and others.

ABOUT ONE PERSON IN 10 OCCASIONALLY EXPERIENCES A STRANGE PHENOMENON JUST BEFOR WAKING UP

Stanford, Calif. *** (U.S./R&D) -- About one person in 10 occasionally experiences a strange phenomenon just before waking up.

BACKGROUND: While still suspended in the 'hypnopompic' state that sometimes precedes full awakening, the waker experiences a spontaneous and extraordinarily vivid visual image of a space-filling design of arresting geometrical regularity and beauty.

Such visions were the subject of a recent Sigma Xi lecture by Roger N. Shepard, professor of psychology at Stanford. He asked those in the audience who had experienced such phenomena to raise their hands. Twenty people out of an audience of 100 did so. Shepard expressed pleasure, saying "This is above average."

Shepard developed the theory in his talk that the geometrical regularities in some spontaneous visual images may stem from neural mechanisms underlying everyday perception, and possibly some of our highest creative achievements. "The familiar saying 'Beauty is in the eye of the beholder' appears to hold a certain and in some respects beautiful truth," he said. "Of course, 'eye' must be taken here only as a metaphorical reference to the brain. "But how does the brain determine what is to be experienced as beautiful?" It would seem that the visual cortex must already have its own inner representations of the beautiful that, somewhat in the manner of a set of cut-out patterns or templates, can be matched against any sensory input to permit a determination of beauty according to goodness of fit. "Early 'imprinting' may have a permanent and idiosyncratic influence on every individual's later perception of faces and standards of physiognomic beauty." Shepard described, and illustrated on the screen, his own first experience of a "hypnopompic" vision: "I experienced a spontaneous and extraordinarily vivid visual image of a space-filling design of arresting geometrical regularity and beauty... Extending before me was an infinite array of diamond-shaped amber regions, each filled with a regular pattern of identical black arrow-or spade-like forms, all pointing straight upward or, in alternative diamonds, to the left...A lattice work of delicately beveled edges with the appearance of polished and gleaming gold framed the rhombic regions, and the whole array shimmered before me in perfect amber and gold splendor..."

On fully awakening a moment later, Shepard quickly sketched the pattern while it was still vibrantly fresh in his memory. On subsequent occasions, Shepard made color drawings of other such visions. He showed a number of them on the screen, in full color. The audience applauded their beauty. Shepard went on: "The spontaneous emergence of geometrically regular images in twilight states evidently is not unique to me... Well after I had completed the reconstruction of my own images I came across a lecture 'On Sensorial Vision' published in 1867 by the eminent 19th century British astronomer-philosopher Sir John Hershcel, describing how on several occasions he experienced 'involuntary production of visual impressions, into which geometrical regularity of form enters as a leading character...' "However rare the completely autonomous emergence of such geometrically regular images may be, visual phenomena suggestive of the same kaleidoscopic powers of the brain can often be precipitated by hallucinogenic agents, or by electrical or other unstructured stimulation....Perhaps the most stunning portrayals of geometrically regular hallicinatory patterns are the embroideries by which the Huichol Indians of Mexico claim to recreate, externally, the inner visions they experience after eating peyote...Despite the endless variations and colors of these embroideries, the majority share the underlying motif of the thombic lattice that figures so prominently among the spontaneous images experienced by Hershcel and myself."

Later in his lecture Shepard suggested that perhaps it was no accident that Einstein's greatest immediate predecessor, James Clerk Maxwell, arrived at his celebrated electromagnetic equations by envisioning a geometrically regular space-filling array of rotating cylinders and counter-rotating balls.

Shepard also drew attention to similar phenomena experienced by James D. Watson, cocracker of the genetic code and by Nicola Tesia, inventor of the self-starting induction motor.

"I believe that these powers of spatial structuring underlie the perception of relations and motions in space, and the appreciation of geometrically regular patterns by all of us," Shepard said.

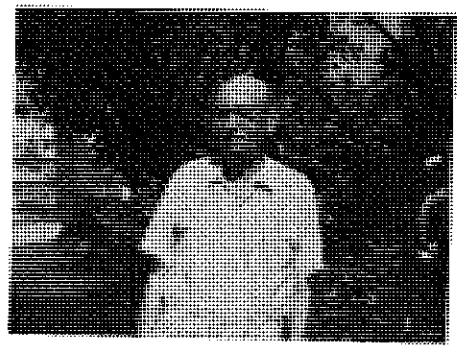
"These same powers may be at the root of diverse artistic and scientific achievements--ranging from the engaging designs of primitive artisans throughout the world to the most profound and far-reaching revolutions of modern science and technology." (13-05305R738C)

<u>Editor's Note</u>: Pat Kelso has since found the source from whence this report came. It is:

United States Research and Development
Government Data Publications
Washington, D.C./New York, NY

QUIZZES AGAIN!! T + F + N

Irwin Wladaver
Associate Professor Emeritus
of Mechanical Engineering
New York University



You cannot imagine the pleasure that Merwin L. Weed's article, "QUIZ TIME!" brought to my restless retirement. I had begun to brood about my wasted life. I had studied drawing (excuse me: I mean graphics) and descriptive geometry and had taught the two subjects, finally realizing that they were only one subject. I had even surreptiously gone ahead with my studies to take a doctorate with the words descriptive geometry in the title of the dissertation. As Casey Stengel used to say, you could look it up. But with the onrush of time, the few articles on descriptive geometry became rarer, some medium and some well done. True enough, we did have occasional pieces about four-dimensional (4-D) descriptive geometry by visitors from outer spaces like Brazil and Israel --Ernesto C. Lindgren and Luisa Bonfiglioli are outstanding, brilliant protagonists--I don't remember many local adherents. What I do remember, after becoming a highly vocal conscientious objector to 4-D, being informed that I didn't know the color of Napoleon's white horse in 3-D or 4-D.

Many items capped the climax: page upon page of computer readout; sines, cosines, and other signs; square roots, especially the square root of -1 (=i); thetas, lambdas, phi, and fees: esoteric constructions that are far above my head (maybe my head is too low), and there is evidence that I am not alone in failing to extricate myself from the Ariadne-like maze of certain tangent circles and Kelso puzzles (remember John Rule and his Fido puzzle?) On the other hand, I was utterly fascinated by Reinhard Lehnert's world of the squares because of my sixteen years in the carpet and linoleum business. But where did descriptive geometry go? But for the ICDG during Dr. DeVaney's chairmanship, I would have suspected that the subject was at best quiescent and at worst moribund.

Professor Weed breathed new life into my sagging spirits. Somewhere descriptive geometry was still alive! Why else would the revered JOURNAL publish Weed's story on quizzes? Would the editor dare publish another? What's there to lose? Publish or perish.

In 1945 the NYU College of Engineering had to handle five sections of descriptive geometry in the Day Division and three sections the Evening. Since we needed six evenings for the three Evening Division sections, Saturday morning was declared an evening. The smallest Day section had 75 students and the largest had 110. The Evening Division classes were "normal:" 45 to 50 each. There was enough work for the small staff and the thought of grading final examinations was horrendous.

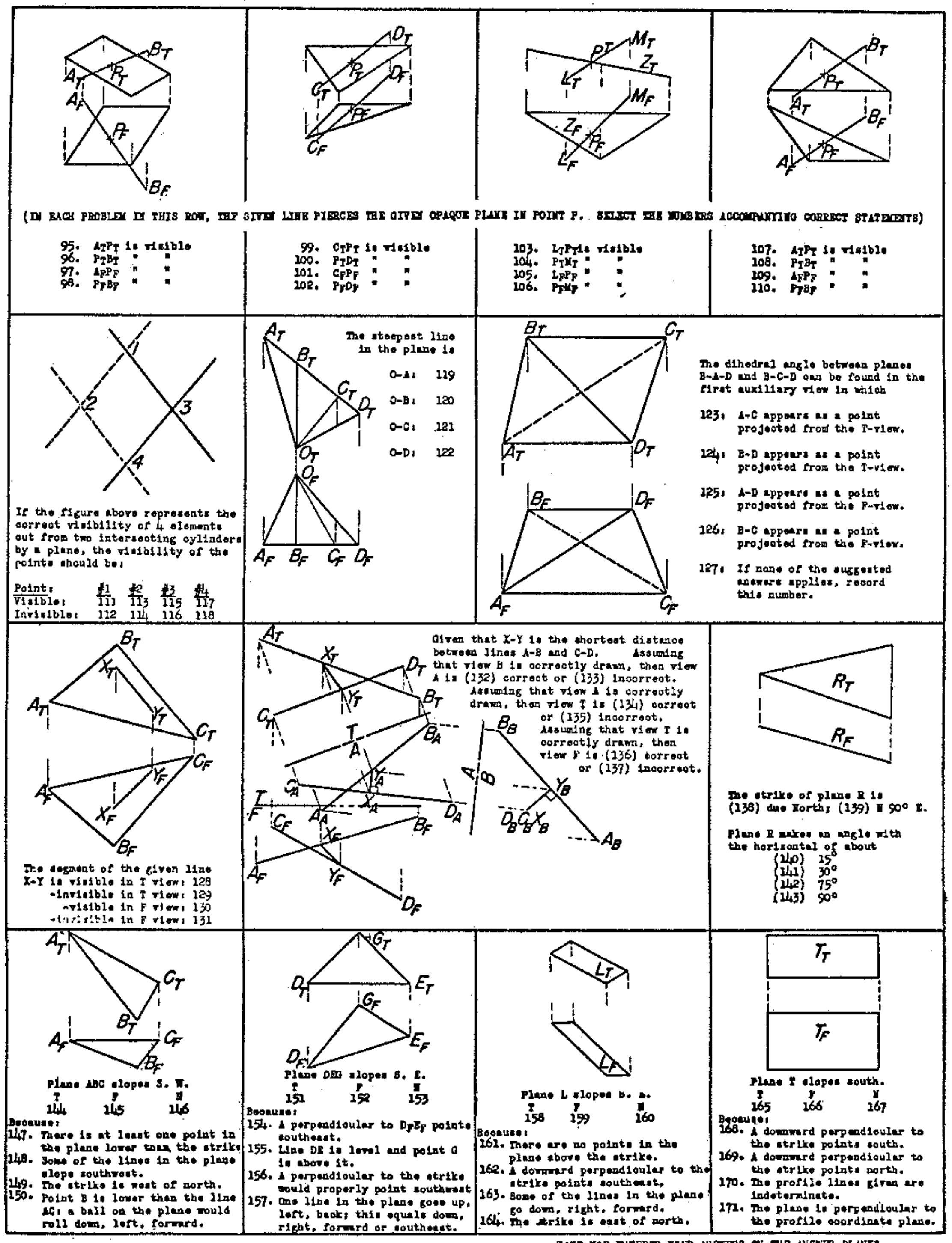
Of course we knew about True-False exams. They were easy to grade and everybody had used them with success, easy enough to claim but not so easy to prove. Some students refuse to guess "T" or "F," preferring certainty to possible penalty for a wrong guess. Others say, "Sure I guess. At worst it's 50-50. If I have an inkling on the topic, my chances are much greater for a correct guess." Should a wrong guess be penalized? Was it a wrong guess or bad reasoning; was the statement of the problem badly worded or ambiguous or a word misspelled? The realities, however, demand that when six hundred students, give or take a few dropouts, have to take final examinations, the exams have to be reasonably challenging and yet be easy to grade if only for the survival of the teaching staff.

We devised an examination with "T" and "F" response but we added the letter "N," defined by one student as "N-sufficient N-formation." In part, twenty-four exam problems require the choice of T, F, or N followed by the selection of at least one reason that would support the choice of the selected T, F, or N. Each letter T, F, and N and each supporting reason for the chosen letter was identified by a number. The identifying number then had to be recorded on an Answer Sheet. But just because a stated reason happened to be a truth, for example, "Parallel lines do not intersect," did not justify its selection unless it supported the T, F, or N of the specific problem.

Did all this put an end to guessing? I doubt it. In fact, the stated "reasons" probably helped students now and then to reach a T, F, or N judgment by doing some unaccustomed thinking. We are not prejudiced against students' thinking even at the end of a course. Incidentally, plausible "reasons" for "F" choices were difficult to make up without appearing ludicrous and obvious.

Two of the seven pages that made up the whole examination accompany this manuscript. The problems on the other pages did not have any "reasons" to be selected. But some did require quite minor construction, enough to justify a compass, a protractor, a scale, and a pair of triangles to test parallelism and perpendicularity. All problems were T, F, or N.

All statements unaccompanied by drawings also were provided with T, F, or N to chose from. These were by no means easy to devise. Is the answer instantly obvious? Is the statement possibly ambiguous? Is this one so easy no one will get it wrong? Should "never" never be used? How about "all?"


(IN EACH PROBLEM IN THIS ROW, THE GIVEN LINE PIERCES THE GIVEN OPAQUE PLANE IN POINT P. SELECT THE NUMBERS ACCOMPANYING CORRECT STATEMENTS)

95. A_TP_T is visible
96. P_TB_T " "
97. A_FP_F " "
98. P_FB_F " "

99. C_TP_T is visible
100. P_TD_T " "
101. C_FP_F " "
102. P_FD_F " "

103. L_TP_T is visible
104. P_TM_T " "
105. L_FP_F " "
106. P_FM_F " "

107. A_TP_T is visible
108. P_TB_T " "
109. A_FP_F " "
110. P_FB_F " "

If the figure above represents the correct visibility of 4 elements cut from two intersecting cylinders by a plane, the visibility of the points should be:

Point:	#1	#2	#3	#4
Visible:	111	113	115	117
Invisible:	112	114	116	118

The steepest line in the plane is

O-A: 119

O-B: 120

O-C: 121

O-D: 122

The dihedral angle between planes B-A-D and B-C-D can be found in the first auxiliary view in which

123: A-C appears as a point projected from the T-view.

124: B-D appears as a point projected from the T-view.

125: A-D appears as a point projected from the F-view.

126: B-C appears as a point projected from the F-view.

127: If none of the suggested answers applies, record this number.

The segment of the given line X-Y is visible in T view: 128
-invisible in T view: 129
-visible in F view: 130
-invisible in F view: 131

Given that X-Y is the shortest distance between lines A-B and C-D. Assuming that view B is correctly drawn, then view A is (132) correct or (133) incorrect. Assuming that view A is correctly drawn, then view T is (134) correct or (135) incorrect. Assuming that view T is correctly drawn, then view F is (136) correct or (137) incorrect.

The strike of plane R is (138) due North; (139) N 90° E.

Plane R makes an angle with the horizontal of about
(140) 15°
(141) 30°
(142) 75°
(143) 90°

Plane ABC slopes S. W.

T	F	N
144	145	146

Because:
147. There is at least one point in the plane lower than the strike
148. Some of the lines in the plane slope southwest.
149. The strike is west of north.
150. Point B is lower then the line AC: a ball on the plane would roll down, left, forward.

Plane DEG slopes S. E.

T	F	N
151	152	153

Because:
154. A perpendicular to D_FE_F points southeast.
155. Line DE is level and point G is above it.
156. A perpendicular to the strike would properly point southwest
157. One line in the plane goes up, left, back; this equals down, right, forward or southeast.

Plane L slopes S. E.

T	F	N
158	159	160

Because:
161. There are no points in the plane above the strike.
162. A downward perpendicular to the strike points southeast.
163. Some of the lines in the plane go down, right, forward.
164. The strike is east of north.

Plane T slopes south.

T	F	N
165	166	167

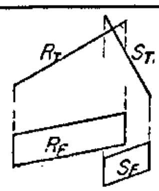
Because:
168. A downward perpendicular to the strike points south.
169. A downward perpendicular to the strike points north.
170. The profile lines given are indeterminate.
171. The plane is perpendicular to the profile coordinate plane.

HAVE YOU ENTERED YOUR ANSWERS ON THE ANSWER BLANK?

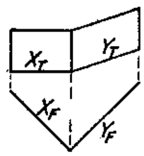
If I were to ask you whether parallel lines intersect, you might answer "N," because I didn't say whether I was referring to descriptive geometry, projective geometry in general, or to a special case in projective geometry. As we all know, descriptive geometry is a special case in projective geometry. Of course our students would not be troubled by that question on parallel lines. But the statement, "Non-parallel lines intersect," is a good one for an "N" response.

If anyone would like to use the accompanying material, do so in any way you wish. If you find ways to expand or improve it, I hope you get your ideas to the editor with a view to publish them. It will turn out to be good exercise.

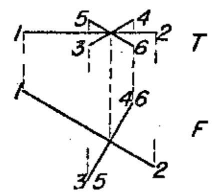
Thanks to Professor Weed for helping to resurrect 3-D descriptive geometry. The report of its death has been greatly exaggerated.



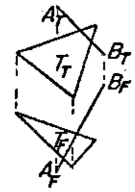
Planes R and S are perpendicular.
T - 172 F - 173 N - 174
Because:
175. They do not intersect.
176. Since both are perpendicular to E, they make 90° with each other.
177. Vertical planes are perpendicular.
178. A line in R can be drawn perpendicular to S.



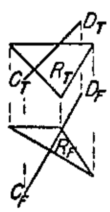
Planes X and Y are perpendicular.
T - 179 F - 180 N - 181
Because:
182. X slopes east; Y slopes west.
183. A point view of their common lines shows them at 90°.
184. A line in each can be drawn perpendicular to the other plane.
185. The profile line of intersection is indeterminate.



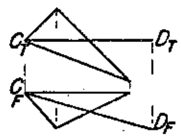
Line 1-2 is perpendicular to line 3-4 and to line 5-6.
T - 186 F - 187 N - 188
Because:
189. A right angle is projected on F, to which line 1-2 is parallel.
190. Two lines cannot be perpendicular at a common point.



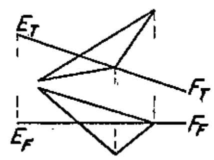
Line AB is perpendicular to plane T.
T - 191 F - 192 N - 193
Because:
194. Evidence is lacking.
195. If true lengths were drawn in each view, the projections of AB would be perpendicular to them.
196. It lies in the given plane.



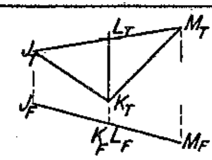
Line CD is perpendicular to plane R.
T - 197 F - 198 N - 199
Because:
200. Evidence is lacking
201. The views of CD are perpendicular to true length lines in like views.
202. It lies in the given plane.



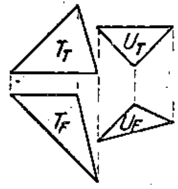
C_FD_F is the strike of the plane.
T - 203 F - 204 N - 205
Because:
206. Its corresponding view is level.
207. It is not the projection of a level line.
208. Its bearing is N. 80° W.
209. A perpendicular line goes SW.



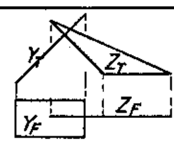
E_TF_T is the strike of the plane.
T - 210 F - 211 N - 212
Because:
213. It is a level line.
214. It is not horizontal.
215. The plane slopes in its direction.
216. It is the projection of a level line but not in the given plane.



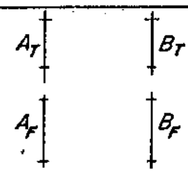
L_TK_T is the strike of the plane.
T - 217 F - 218 N - 219
Because:
220. KL is an indeterminate, profile line.
221. It is the T-projection of a level line in the plane.
222. It bears due north.
223. The plane slopes Southeast.



Planes T and U are perpendicular.
T - 224 F - 225 N - 226
Because:
227. A line in U is perpendicular to plane T.
228. No line in either plane is perpendicular to the other.
229. The line of intersection is not given.



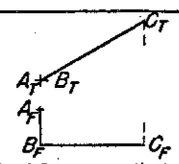
Planes Y and Z are perpendicular.
T - 230 F - 231 N - 232
Because:
233. A line in either can be drawn perpendicular to the other.
234. No line in either plane is perpendicular to the other.
235. The line of intersection would be a profile line



Lines A and B are parallel

T	F	N
236	237	238

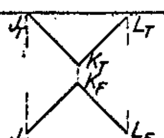
Because:
239. Their projections are parallel.
240. Their projections are not parallel.
241. Their projections are not fully established.
242. Their projections would be parallel in an end view.



Lines A and B are perpendicular.

T	F	N
243	244	245

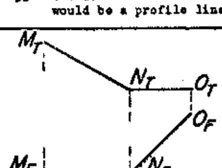
Because:
246. A right angle is projected on the T plane, to which BC is parallel.
247. A right angle is projected on the front plane, to which AB is parallel.
248. If one line is parallel to a coordinate plane a line intersecting it projects 90°.
249. AB is a profile line.



Lines JK and KL are perpendicular.

T	F	N
250	251	252

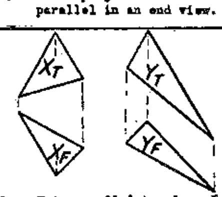
Because:
253. Neither line is projected in true length.
254. The plane JKL slopes north.
255. If a right angle projects in two adjacent views, the lines cannot be perpendicular.
256. For a right angle to be projected as a right angle, at least one of the perpendicular lines must be parallel to a coordinate plane.



Lines MN and NO are perpendicular.

T	F	N
257	258	259

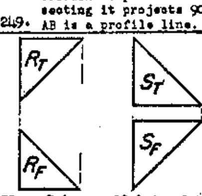
Because:
260. Both lines are in true length.
261. A right angle is not projected if both are in true length.
262. If they were perpendicular and also in true length in respective views, right angles would be seen in both views.
263. It is impossible to tell by inspection of this case.



Plane X is parallel to plane Y.

T	F	N
264	265	266

Because:
267. At least one line in each plane is parallel to one line in the other plane.
268. Profile lines can be drawn in both planes.
269. A line in plane X intersects plane Y.
270. Some other reason not given here.



Plane R is parallel to plane S.

T	F	N
271	272	273

Because:
274. Parallel planes have parallel projections.
275. A line can be drawn in each plane parallel to a line in the other plane.
276. The given profile lines are not definitely established.
277. Their projections are not parallel.

HAVE YOU ENTERED YOUR ANSWERS ON THE ANSWER BLANK?

THE EXTENSION OF SHIRO ODAKA'S EQUATIONS FOR PERSPECTIVE PROJECTION TO FOUR DIMENSIONS

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ABSTRACT

This paper presents an extension of Shiro Odaka's equations for perspective projection to spaces of more than three dimensions. Diagrams are presented to demonstrate the graphics involved.

INTRODUCTION

A fundamental problem in the two-dimensional representation of four or more dimensions is the fact that a four-dimensional "space" has a three-dimensional cross-section. This means that if a four-dimensional figure such as a hypercube is projected to a point, that there is no way of making a single two-dimensional projection of it because any plane will intercept <u>some</u>, but not <u>all</u> of the lines of projection. When so-called "perspective" projections of four-dimensional figures are made in two dimensions, they really consist of two stages of projection as follows: The figure is projected to a point and then a three-dimensional cross-section is taken, then the three-dimensional cross-section is projected to a point and a two-dimensional cross-section is taken of <u>that</u> projection. This is how the projections of hypercubes in "perspective" were made by A. Michael Noll and later by Tom Banchoff and Charles Strauss of Brown University in their computer generated films.

Consequently, the <u>mathematical</u> extension of Shiro Odaka's equations would apply to a three-dimensional expression of a four-dimensional figure, a four-dimensional expression of a five-dimensional figure, etc.

Since the projection of a four-dimensional figure in perspective to two dimensions entails two independent station points, as described above, it is only necessary to consider one cell of the hypercube as a perspective projection of a cube, such as Odaka has described, and then introduce a <u>fourth</u> arbitrary vanishing point to complete the hypercube, each cell of which conforms to Odaka's equations. For every additional dimension it is only necessary to add an additional arbitrary vanishing point.

THE BASIC APPLICATION OF ODAKA'S EQUATIONS TO THE PERSPECTIVE REPRESENTATION OF THE HYPERCUBE

The following equations are Odaka's equations for perspective projection from the <u>Proceedings of the International Conference on Descriptive Geometry</u>, Vancouver, B.C., 1978:

$$\left.\begin{aligned}
&\frac{a^2 - ca\cdot\cos\beta - ab\cdot\cos\gamma + bc\cdot\cos\alpha}{b^2 - ab\cdot\cos\gamma - bc\cdot\cos\alpha + ca\cdot\cos\beta} = \left(\frac{e}{d}\cdot\frac{a-d}{b-e}\right)^2,\\
&\frac{b^2 - ab\cdot\cos\gamma - bc\cdot\cos\alpha + ca\cdot\cos\beta}{c^2 - bc\cdot\cos\alpha - ca\cdot\cos\beta + ab\cdot\cos\gamma} = \left(\frac{f}{e}\cdot\frac{b-e}{c-f}\right)^2,\\
&(\alpha + \beta + \gamma = 4R\angle).
\end{aligned}\right\} (1)$$

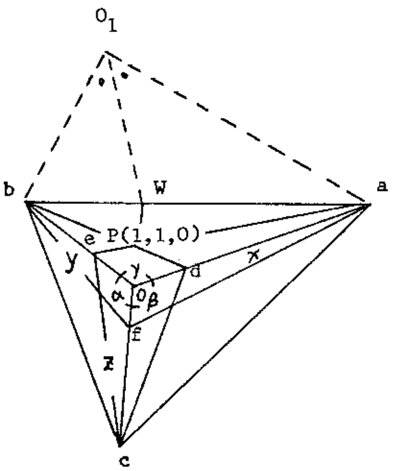


Fig. 1

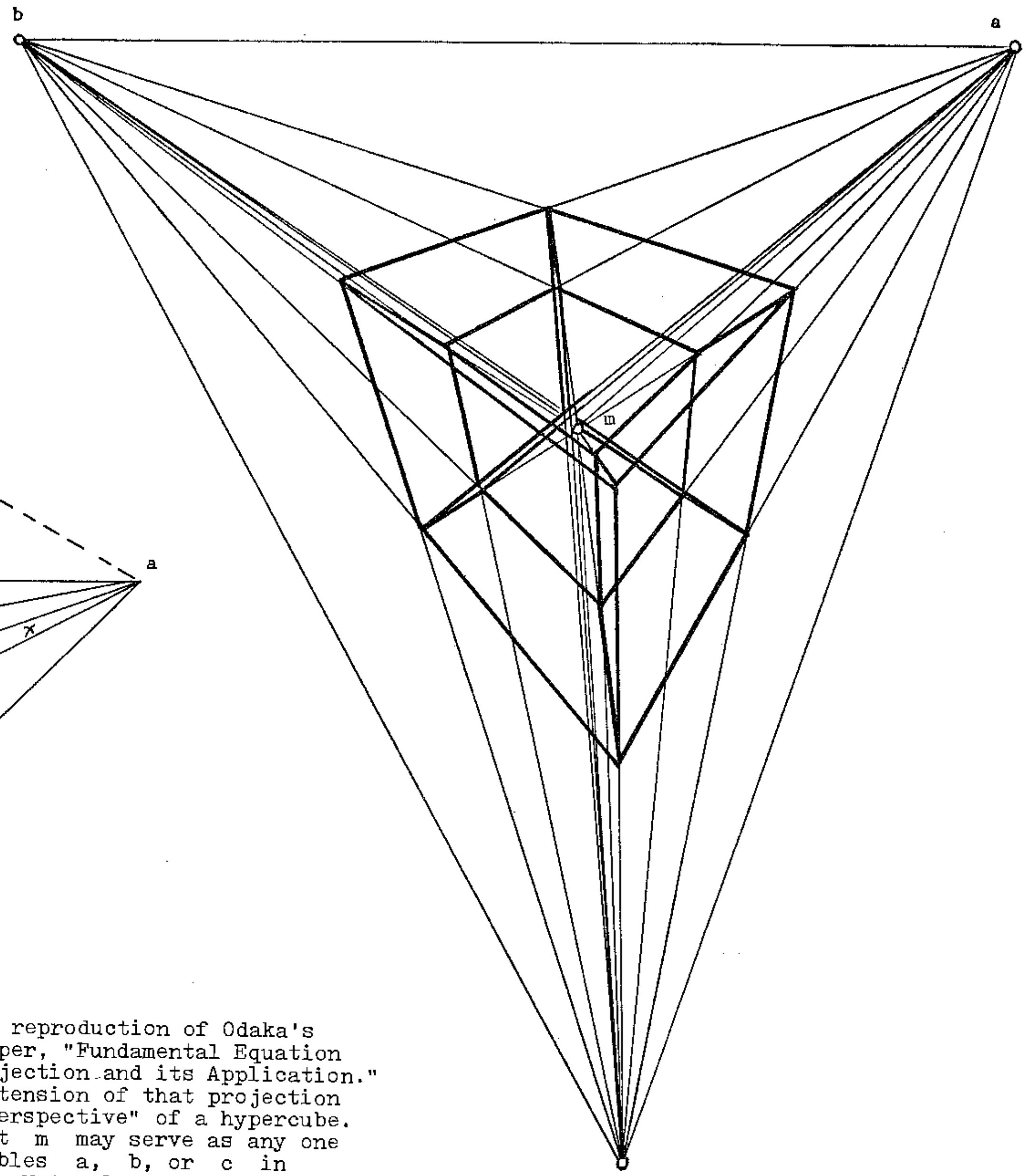


Fig. 2

Figure 1 is a reproduction of Odaka's figure from his paper, "Fundamental Equation of Perspective Projection and its Application." Figure 2 is the extension of that projection to a four-point "perspective" of a hypercube. Note that the point m may serve as any one of the three variables a, b, or c in Odaka's equations. Note also that the relative variables a, b, c and m are completely arbitrary depending upon the particular position of two completely independent station points, one in four-dimensional space and the other in three-dimensional space. There is one possible unique case where the stationpoint is the same point in both cases, in which case the projection is a simple cube in three dimensions. In that case the fourth vanishing point does not exist.

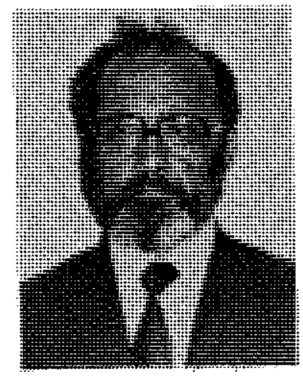
It will be noted that each cell of this hypercube is in three-point perspective, and that there eight of these cells in all. Each one may be regarded as a separate three-dimensional space. Each cell may thus be seen to be in a distinct perspective projection, some more extreme than others, but consistent, never-the-less.

The remainder of Odaka's equations may be applied to each individual three-point system, the four points taken three at a time in turn.

CONCLUDING REMARKS

The above system is of particular interest when two of the coordinate lines are considered imaginary. In such a case it is then possible to express graphically many of the concepts of projective geometry that involve infinity that are beyond expressibility in a three-dimensional perspective system.

A NOTE ON FUNICULAR DIAGRAMS FOR THREE-DIMENSIONAL SYSTEMS OF FORCES



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The writing of this Note was prompted by the publication in the EDG Journal of Hugh Munson's paper "The Rationale of the Funicular Diagram" (Spring 1980, Vol. 44, No. 2). The construction and various applications of funicular diagrams to coplanar force systems are explained (adequately or otherwise) in most textbooks dealing with static equilibria of rigid bodies. I am not, however, aware of any publications describing the use of funicular diagrams for the solution of problems involving spatial force systems. The proposed constructions are based on the following "rationale":

1. A closed vector diagram in SPACE incorporates THREE equilibrium equations ($\Sigma F_x=0$, $\Sigma F_y=0$ and $\Sigma F_z=0$)

2. An orthographic projection of a closed polygon is a closed polygon.

3. In general, a spatial system of forces may be resolved into two systems: A coplanar system consisting of orthographic projections of all the forces in space on a plane P; a system of forces perpendicular to P.

4. A funicular diagram constructed for an orthographic projection of a spatial system of forces on any plane incorporates the equation $\Sigma M_n=0$, where ΣM_n is the sum of moments of all the forces about an axis normal to the projection plane.

Consider, for example, the problem of determing the reactions R_A, R_B and R_C at supports A, B and C (Figure 1) of a rigid body in equilibrium loaded with a three-dimensional system of forces. For simplicity, but without the loss of generality, in this example, the system consists of two skew forces F_1 and F_2 represented in two orthographic views ("Plan" and "Elevation" in Figure 1). Since, in general, each support may involve 6 unknown parameters (say, 3 components of each, the vector-force and the vector-moment) and we have altogether only 6 equations of equilibrium, some assumptions need to bw made about the nature of the supports. Quite arbitrarily, we assume that

(i) each support is a frictionless spherical hinge (i.e. incapable of transmitting moments), and that

(ii) the directions of the reactions at the supports are given in the plan view (shown in "Plan" in dashed lines).

We now have a spatial system of forces with 6 unknown parameters and the graphical solution used consists of the following steps:

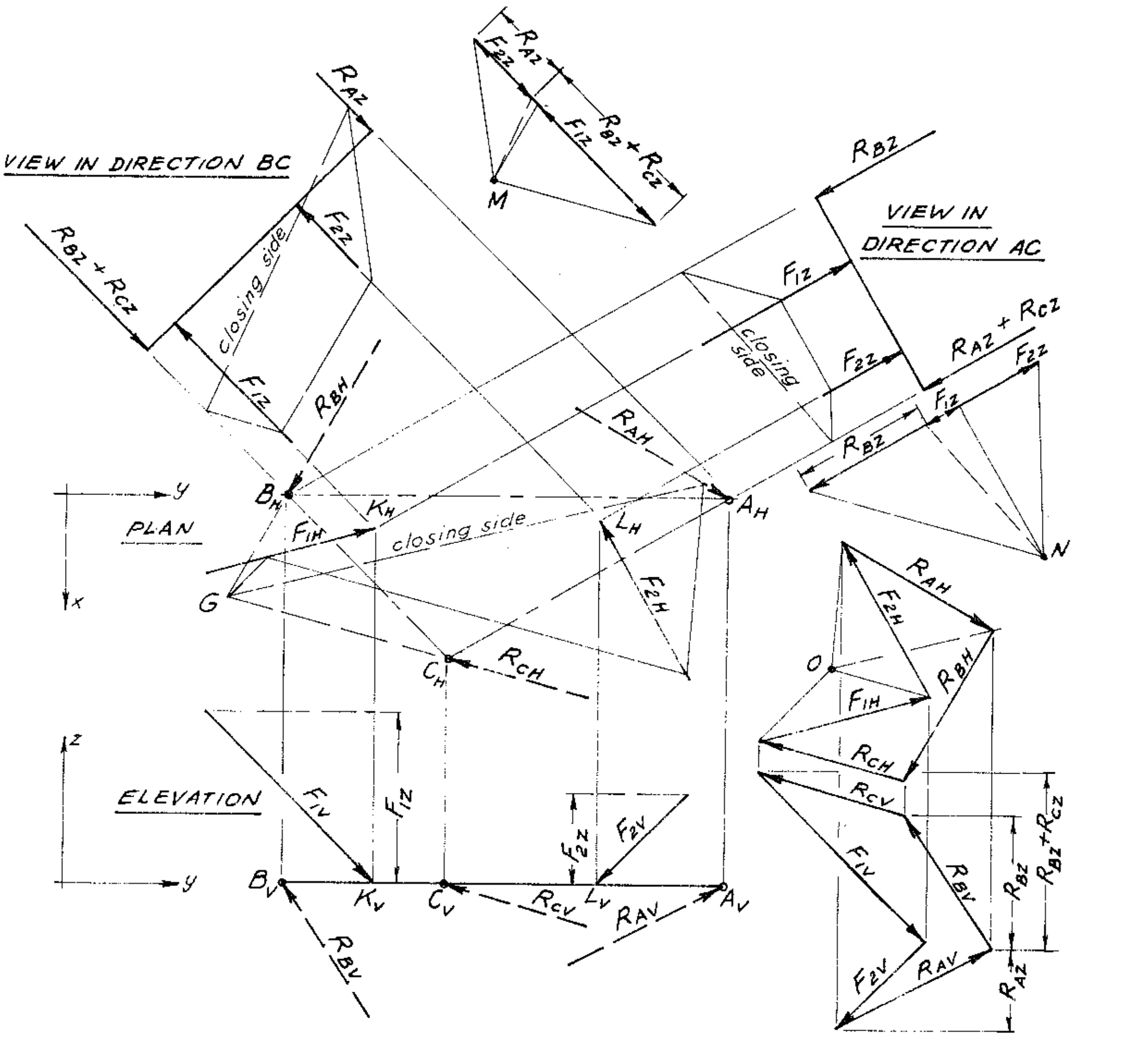


FIGURE 1.

1. Construct a force and a funicular diatram for the system shown in the "Plan" regarding the forces as co-planar and beginning the funicular diagram at the point G of intersection of any two given directions of reactions. This construction is equivalent to solving the three equations of equilibrium $\Sigma F_x=0$, $\Sigma F_y=0$ and $\Sigma M_z=0$ and it results in defining the magnitudes of the plan views R_{AH}, R_{BH}, and R_{CH} of the reactions R_A, R_B and R_C at the supports A, B, and C respectively.

2. Construct the view in directions BC and AC of the vertical components F_{1Z} and F_{2Z} of the forces F_1 and F_2 applied at points K and L of the intersection of the lines of action of these forces with the plane ABC. F_{1Z} and F_{2Z} are easily found from the "Elevation".

3. Construct force and funicular diagrams for each of the views in directions BC and AC. These constructions are equivalent to solving the equations $\Sigma M_{BC}=0$ and $\Sigma M_{AC}=0$ (where ΣM_{BC} and ΣM_{AC} are the sums of moments of all the forces about the lines BC and AC respectively) and yield two more unknowns, -- the vertical components R_{AZ} and R_{BZ} of the reactions R_A and R_B respectively.

4. Construct a force diagram for the "Elevation" using R_{AZ} and R_{BZ} and placing this diagram in a projective correspondence with the diagram already constructed for the "Plan". This construction is equivalent to solving the sixth equation of equilibrium $\Sigma F_Z=0$ and yields the elevation R_{CV} of the reaction R_C.

The problem may now be regarded as solved since each of the reactions R_A, R_B and R_C is represented (to some known scale) by its two orthographic views fully defining their magnitudes and directions in space.

The reader is invited to try the method described for any other set of assumptions about the nature of the supports, each time ensuring that the problem remains statically determinate and to develop possible "shortcuts".

In paragraph 2. of the solution above, we referred to points K and L of intersection of the lines of action F_1 and F_2 with the plane ABC. It may happen that one or more of the given forces is parallel to the plane ABC or that the points of intersection of these forces with the plane ABC are inaccessible on the drawing. This difficulty may be overcome by resolving the forces in question into two components, each of which intersects the plane ABC at convenient points (Figure 2.)

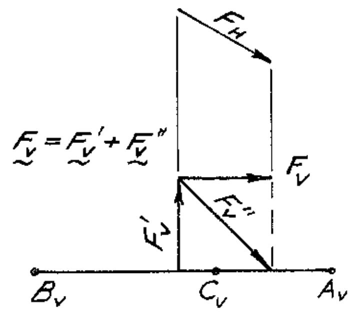
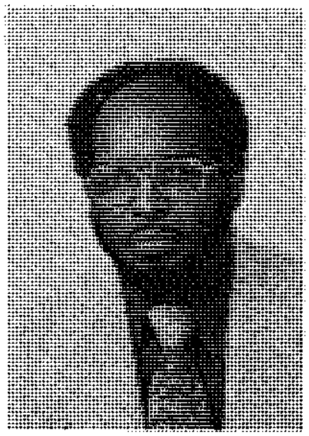


FIGURE 2.

An investigation into applications of funicular diagrams to the solution of problems involving three-dimensional force systems may provide the readers with new ideas and result in some ingenious constructions.

Jobs

A DIAGRAMMATIC REPRESENTATION OF THE BASIC MOTION EQUATIONS



Lyndon O. Barton
E. I. DuPont de Nemours & Co.
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For many students of elementary mechanics, and also for designers, quick recall of the basic motion equations can be difficult, and often if the appropriate references are not readily available, precious time is lost in trying to derive the desired relationships. To avoid this situation, there is presented here a simple diagrammatic approach that can be a useful alternative to the normal derivations.

Referring to Figure 1, and considering rectilinear motion, let

v_1 (side of small square) represent initial linear velocity,

v_2 (side of large square) represent final linear velocity, and

$\underline{a}t$ ("$\underline{a}$" times "t") represent the difference between v_1 and v_2 where

$\underline{a}$ = uniform linear acceleration

t = time

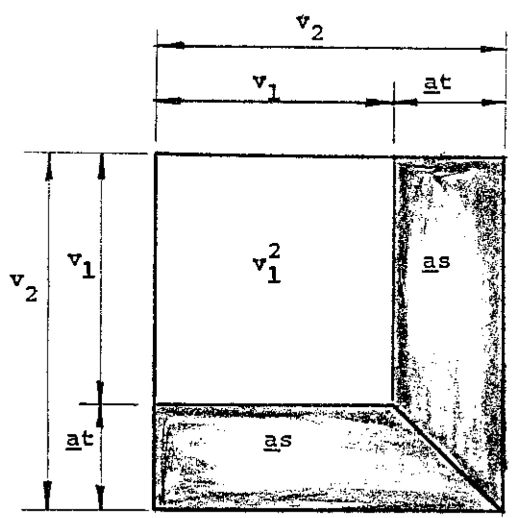

FIGURE 1 - RECTILINEAR MOTION

Then, in equation form

$$v_2 = v_1 + \underline{a}t \quad \dots\dots\dots\dots (1)$$

Also, let the area of each trapezoid be represented by $\underline{a}s$ ("$\underline{a}$" times "s"), where

$\underline{a}$ = uniform acceleration (as before), and

s = displacement

Then, in equation form

$$v_2^2 = v_1^2 + 2\,\underline{a}s \quad \dots\dots\dots\dots (2)$$

and $\underline{a}s = v_1\underline{a}t + 1/2\,(\underline{a}t)^2$

or $s = v_1 t + 1/2\,\underline{a}t^2 \quad \dots\dots\dots\dots (3)$

Similarly, for angular motion, refer to Figure 2 and let

ω_1 represent initial angular velocity

ω_2 represent final angular velocity

α represent angular acceleration, and

θ represent angular displacement

Then, the angular relationships become

$$\omega_2 = \omega_1 + \alpha t \quad \dots\dots\dots\dots (4)$$

$$\omega_2^2 = \omega_1^2 + 2\alpha\,\theta \quad \dots\dots\dots\dots (5)$$

and $\theta = \omega_1 t + 1/2\,\alpha t^2 \quad \dots\dots\dots\dots (6)$

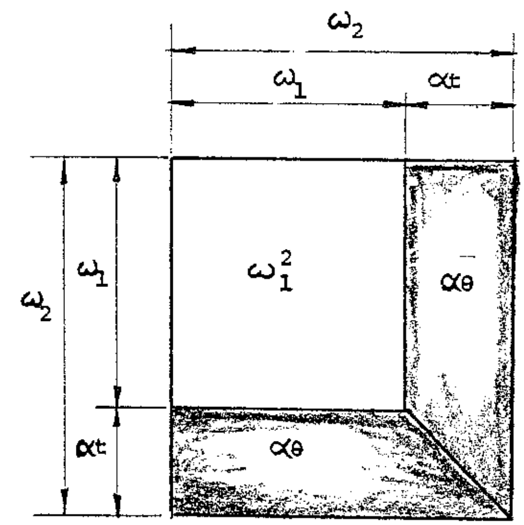

FIGURE 2 - ANGULAR MOTION

Note that the above relationships are all general, since they assume a positive uniform acceleration. However, if a negative uniform acceleration (or deceleration) condition exists, the appropriate negative sign must be assigned to $\underline{a}$ or α to produce positive numerical results. But the importance of this approach is that the basic forms of the equations are readily derived from the graphical representations.

A MATHEMATICAL EQUATION FOR DETERMINING ELLIPSE ANGLES ON THE ISOMETRIC PROTRACTOR

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The graphic method for finding the ellipse angles when constructing an isometric protractor has been given by Thomas (1978, pp. 89-91). This paper will describe a new mathematical method for solving the ellipse angles on an isometric protractor.

Before addressing the problem, we need to review the method for constructing an isometric protractor. A simple graphic procedure using the circle-projection method is generally employed to construct an isometric protractor as shown in Figure 1.

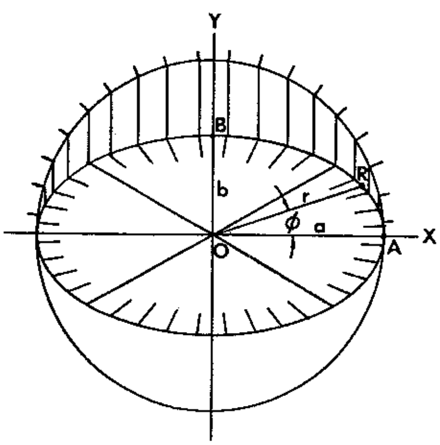

FIGURE 1.

From Fig. 1, let's assume that we want to find the ellipse angle for a radial line O R, which is ϕ^{o} with the semimajor diameter O A. Then, the horizontal component x and the vertical component y of the line O R are given by:

$$x = a \cos\phi \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \quad (1)$$

$$y = b \sin\phi \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \quad (2)$$

where a is the semimajor diameter and b is the semiminor diameter (Rogers & Adams, 1976, p. 105). By means of Pythagoream theorem, the length of the radial line O R is:

$$\begin{aligned} r &= \sqrt{x^2 + y^2} \\ &= \sqrt{a^2 \cos^2\phi + b^2 \sin^2\phi} \\ &= \sqrt{a^2 \cos^2\phi + b^2(1 - \cos^2\phi)} \\ &= \sqrt{(a^2 - b^2)\cos^2\phi + b^2} \quad . \; . \; . \quad (3) \end{aligned}$$

Let's assume that the length of the semimajor diameter a is unity, then the length of the semiminor diameter b is found by multiplying the sine of the isometric angle (35.26^{o}) by the semimajor diameter:

$$\begin{aligned} b &= a \sin 35.26^{o} \\ &= 1(0.5773) \\ &= 0.5773 \end{aligned}$$

Thus, from Eq. (3), the length of a radial line on an isometric protractor is:

$$r = \sqrt{(a^2 - b^2)\cos^2\phi + b^2}$$
$$= \sqrt{(1 - 0.5773^2)\cos^2\phi + 0.5773^2}$$
$$= \sqrt{0.6667\cos^2\phi + 0.3333} \quad . . . (4)$$

Let the ellipse angle for a radial line on an isometric protractor be θ . Based on the theorem by Land (1979), which states that the foreshortening of an axis in an isometric projection is equal to the cosine of its ellipse angle, we obtain:

$$r = \cos\theta$$

or

$$\theta = \cos^{-1} r \quad . . . . (5)$$

Substituting Eq. (4) into Eq. (5) yields:

$$\theta = \cos^{-1}\sqrt{0.6667\cos^2\phi + 0.3333} \quad . . (6)$$

Eq. (6) is the fundamental equation for constructing the ellipse angles on an isometric protractor. Therefore, the ellipse angle for the radial line 0 R where $\phi = 30^\circ$ is:

$$\theta = \cos^{-1}\sqrt{0.6667\cdot\cos^2 30^\circ + 0.3333}$$
$$= \cos^{-1}\sqrt{0.6667\cdot(0.8660)^2 + 0.3333}$$
$$= \cos^{-1} 0.9192$$

or $\theta = 24.09^\circ$

When ϕ is 45°, the radial line becomes an isometric line. Using Eq. (6), we obtain:

$$\theta = \cos^{-1}\sqrt{0.6667\cdot\cos^2 45^\circ + 0.3333}$$
$$= \cos^{-1} 0.8165$$

or $\theta = 35.26^\circ$

The result is the commonly known isometric ellipse angle since the radial line is an isometric line.

When ϕ is 0°, the radial line becomes the semimajor diameter. Eq. (6) becomes:

$$\theta_{min} = \cos^{-1}\sqrt{0.6667\cdot 1 + 0.3333}$$
$$= \cos^{-1} 1$$

or

$\theta_{min} = 0^\circ$, which is the minimum angle for θ .

When ϕ is 90°, the radial line becomes the semiminor diameter. Eq. (6) becomes:

$$\theta_{max} = \cos^{-1}\sqrt{0 + 0.3333}$$
$$= \cos^{-1} 0.5773$$

or

$\theta_{max} = 54.74^\circ$, which is the maximum angle for θ .

Thus, the values of the ellipse angles on an isometric protractor fall within the range of 0° to 55°.

Using Eq. (6), the approximate ellipse angles on an isometric protractor can be determined as shown in Fig. 2.

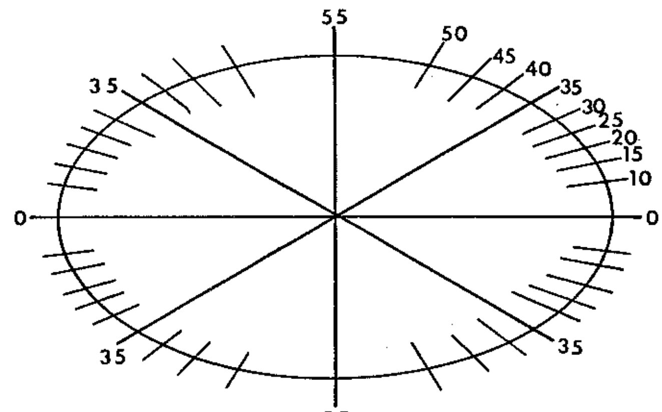

FIGURE 2.

The isometric protractor with ellipse angles is a versatile instrument that measures isometric angles and shows the proper ellipse guide angles to use on inclined planes. It is commercially available from various firms. Every technical illustrator should own one and use it.

We can also apply equation (6) directly to solving the ellipse guide angle for any inclined plane in an isometric projection. Let's consider the object with an inclined plane as shown in Fig. 3. A hole is drilled perpendicular to the inclined plane. Use the following procedure to find the proper ellipse guide angle for the drilled hole:

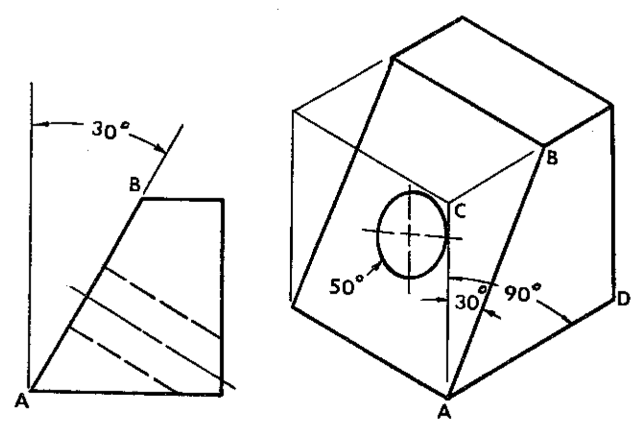

FIGURE 3.

1. Draw the object in isometric. The inclined line AB can be drawn by means of box construction, or by means of the circle-construction method (Thomas, 1978, p. 89), or by using the isometric protractor.

2. We should note that the inclined line AB is drawn within an acute 90° isometric angle ∠CAD. When an inclined line is drawn within and acute 90° isometric angle, the ellipse guide angle θ for a hole perpendicular to the inclined plane is:

$$\theta = \cos^{-1}\sqrt{0.6667\cdot\cos^2(45^\circ + \phi) + 0.3333} \quad (7)$$

where ϕ is the angle of inclination. Thus, the ellipse guide angle for the drilled hole is:

$$\theta = \cos^{-1}\sqrt{0.6667\cdot\cos^2(45^\circ + 30^\circ) + 0.3333}$$
$$= \cos^{-1}\sqrt{0.6667\cdot(0.2588)^2 + 0.3333}$$
$$= \cos^{-1} 0.6148$$

or

$\theta = 52.06^\circ$ (Use 50° ellipse guide in actual drawing.)

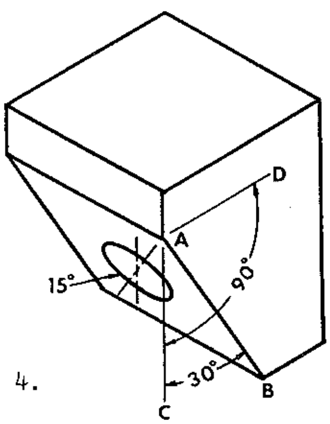

FIGURE 4.

Let's consider another example as shown in Fig. 4. We should note that the inclined line AB is drawn within an obtuse 90° isometric angle, the ellipse guide angle for a perpendicular hole is:

$$\theta = \cos^{-1}\sqrt{0.6667\cdot\cos^2(45^\circ - \phi) + 0.3333} \quad (8)$$

Thus, the ellipse guide angle for the hole is:

$$\theta = \cos^{-1}\sqrt{0.6667\cdot\cos^2(45^\circ - 30^\circ) + 0.3333}$$
$$= \cos^{-1}\sqrt{0.6667\cdot(0.9659)^2 + 0.3333}$$
$$= \cos^{-1} 0.9774$$

or

$\theta = 12.20^\circ$ (Use 10° or 15° ellipse guide.)

Combining Eqs. (7) and (8) into one, we can formulate an equation for the ellipse guide angle of an inclined plan in an isometric drawing as follows.

$$\theta = \cos^{-1}\sqrt{0.6667\cdot\cos^2(45^\circ \pm \phi) + 0.3333} \quad . . (9)$$

where ϕ is positive when the inclined line is drawn witin an acute 90° isometric angle and ϕ is negative when drawn within an obtuse angle. An example of such a drawing is shown in Fig. (5)

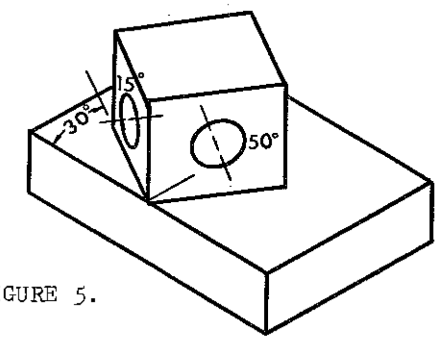

FIGURE 5.

In sum, this paper provides a mathematical foundation for solving ellipse angles on an isometric protractor. Using Eq. (6), an isometric protractor with ellipse angles can be constructed easily. When an isometric protractor is not available, Eq. (9) can be used conveniently to find the proper ellipse guide angle for any inclined plane in an isometric drawing.

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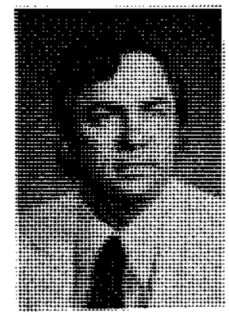
THE GEOMETRY OF AESTHETICS --CASE STUDY II



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·Background:

The Geometry of Aesthetics - A Case Study (I), EDGJ, Vol. 44, No. 2, attempts to demonstrate that aesthetics in design is a function of geometrically similar shapes and that the greatest design beauty is achieved when these shapes are certain irrationally (Dynamically) dimensioned shapes, e.g., the height-to-width ratio of, say, rectangular shapes to be used are: $1:\sqrt{2}$, $1:\sqrt{3}$, $1:\sqrt{5}$, $1:\sqrt{6}$, etc., as well as the Golden Section, 1:0.6180.... (It should be noted that although rational ratios: $1:\sqrt{4}$, $1:\sqrt{9}$, etc., are Static, when used in conjunction with Dynamic ratios, they exhibit both Dynamic and Static properties.) This demonstration was accomplished by a harmonic analysis on a work of recognized great art and noting the designer's use of these principles. This article is another demonstration, this time on a recognized successful commercial design: Figure 1. It is not a harmonic analysis, but geometric derivations of the harmonically derived design features.

·Scenario:

In 1915 the designer Alexander Samuelson of the Root Glass Company is herein speculated to have made a number of trial and error designs to insure that his visualization of the bottle would accommodate the specified volume. It is further speculated that he began his design with no specified parameters other than the bottle opening, 1.00 (25.40 mm) diameter, and, perhaps, also the base diameter. It is further speculated that the designer determined the final dimensions by scaling the finished design rather than by mathematical determinations. Scaling is considered sufficiently accurate for aesthetic purposes.

In scaling the design, "eyeball" judgmental errors were inevitable and the amount of each of these errors is shown herein. In each case it is less than one part in a hundred in all but the shorter measurements.

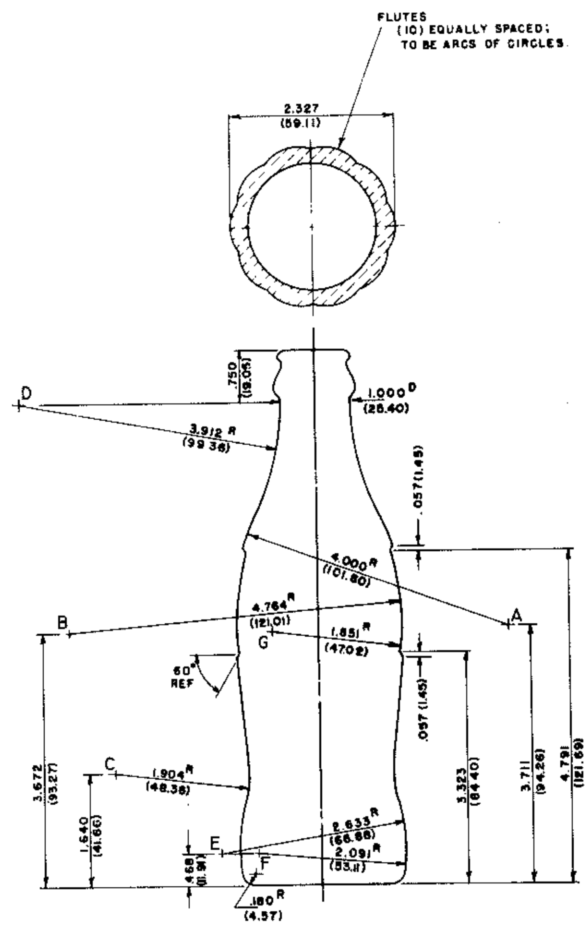


FIGURE 1

General Approach:

The design may be considered in four parts: (1) determining the overall height and width (diameter) dimensions (Fig. 2); (2) determining the dimensions for the trademark panel and crown (Fig. 3); (3) determining the centers and radii of seven circles arcs used in the design (Fig. 4 - Fig. 9). There are two values associated with each circle arc center: the vertical locational dimension and the horizontal locational dimension. These seven circle arc centers are given alphabetical identifications; (4) determining the centers and radii of the flutes arcs as seen in a right section perpendicular to the bottle center line (Fig. 10).

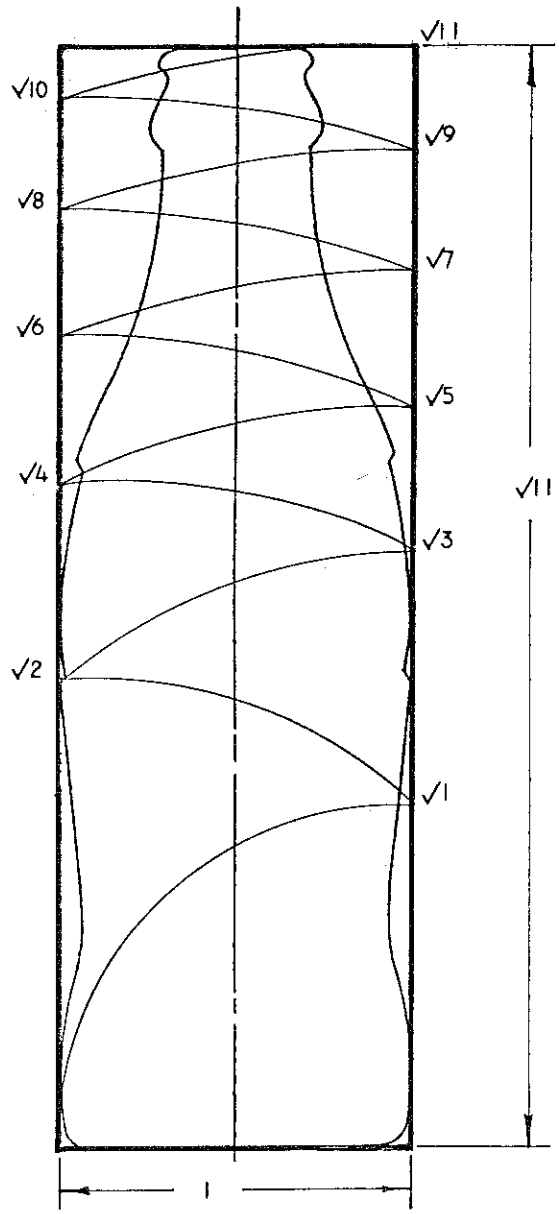


FIGURE 2

·Analysis:

Figure 2. (The actual height dimension: 7.750 (196.85) ± 0.47 (1.19).) The base dimension may or may not have been a specified design parameter. In either case the height-to-width ratio is determined to be 1:√11. (Vertical measuring error: 0.8 mm. Percent error: 0.4%).

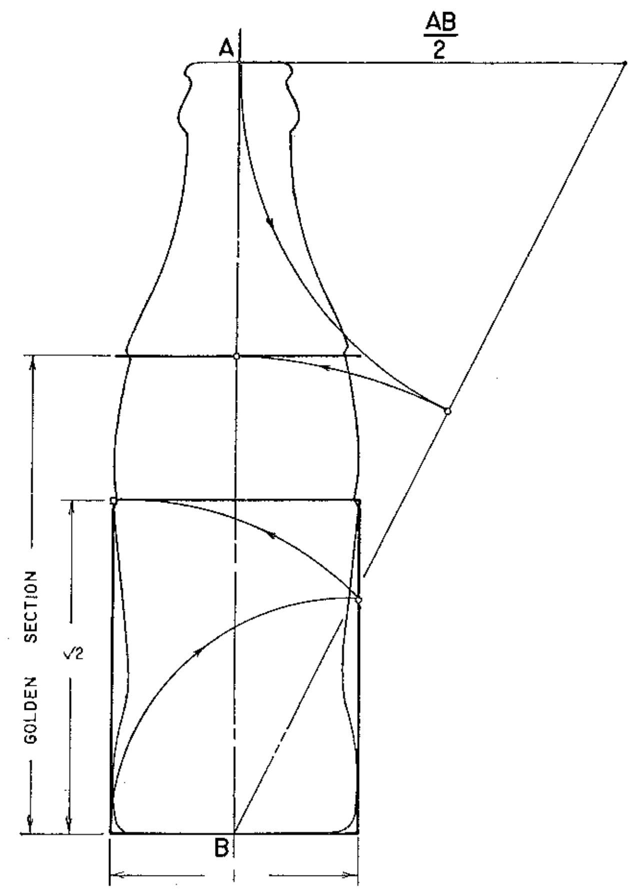


FIGURE 3

Figure 3. The vertical dimensions, measured in an upward direction from the base, to the lower and upper limits of the trademark panel are determined. The panel lower limit vertical dimension is √2 times the base width (diameter). (Vertical measuring error: 0.8 mm. Percent error: 0.9%). The upper limit is the Golden Section (0.6180...) of the height. (Vertical measuring error: .04 mm. Percent error: .03%). For the crown vertical dimension, see Figure 7.

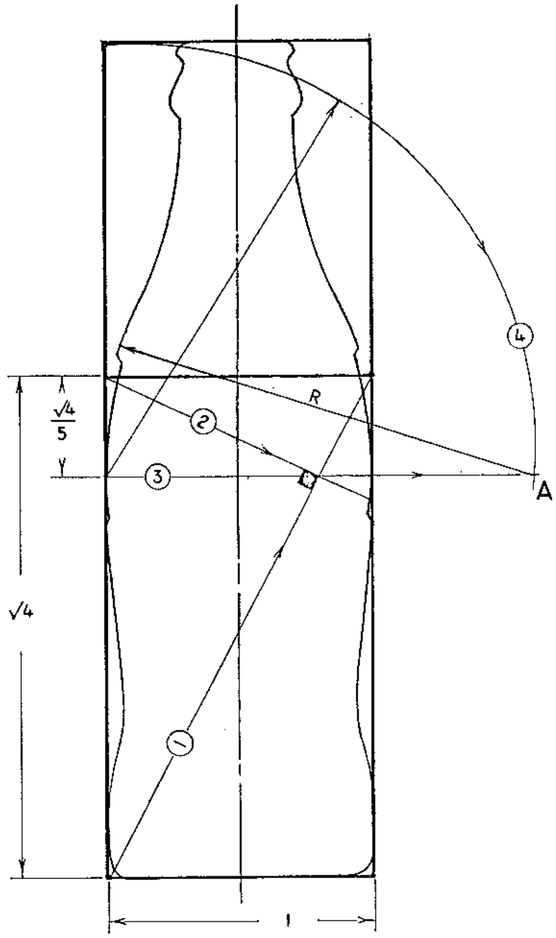
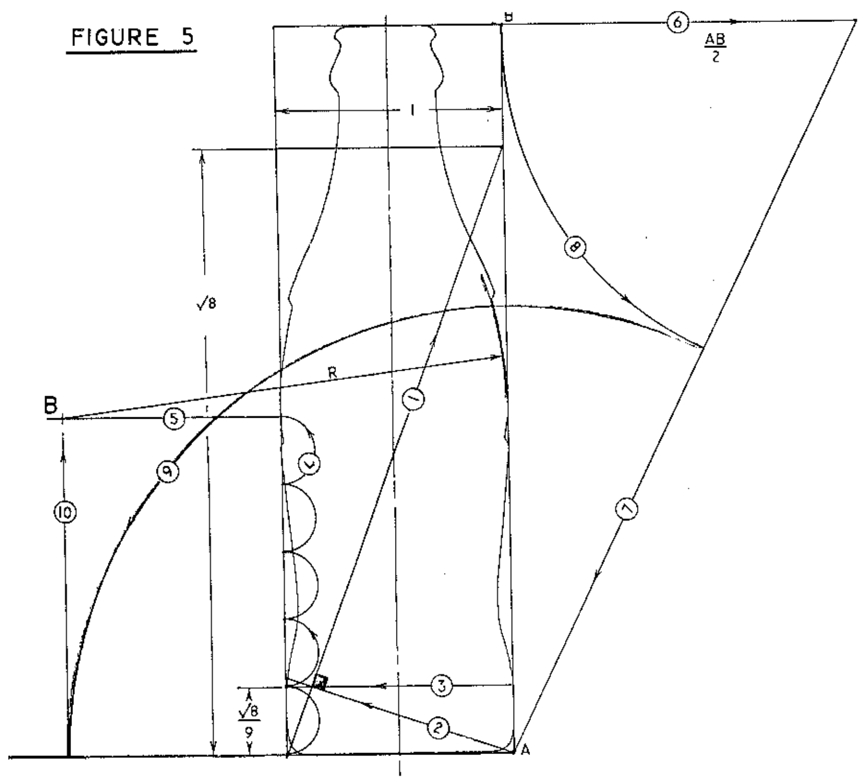


FIGURE 4

Figure 4. For center A, the vertical dimension is determined by the use of a root four (√4) rectangle. (For construction, see Fig. 2) A diagonal is constructed on the rectangle then a perpendicular-to-the-diagonal-through-a-corner, which is the reciprocal. The resulting point of intersection may be used to divide each side of the root four rectangle into fifths and is so used to determine the vertical dimension. (Vertical measuring error: 0.3 mm. Percent error: 0.3%). To determine the horizontal dimension and the radius, the remainder of the bottle height is rebated on to the vertical dimension. (Horizontal measuring error: 0.7 mm. Percent error: 0.7%). The sequence of drawing is shown by the encircled numbers.

Figure 5. For center B, the vertical dimension is determined by the use of a root eight rectangle (for construction, see Fig. 2), a diagonal, and a reciprocal. The resulting point of intersection may be used to divide the root eight rectangle into ninths and is so used (to determine 5/9·√8) to locate the vertical dimension. (Vertical measuring error: 0.4 mm. Percent error: 0.4%). The horizontal dimension as well as the radius is equal to the Golden Section (0.618...) of the bottle height. The center is located by the intersection of sequence lines (5) and (10). (Horizontal and radius measuring error: 0.4 mm. Percent error: 0.5%).

FIGURE 5



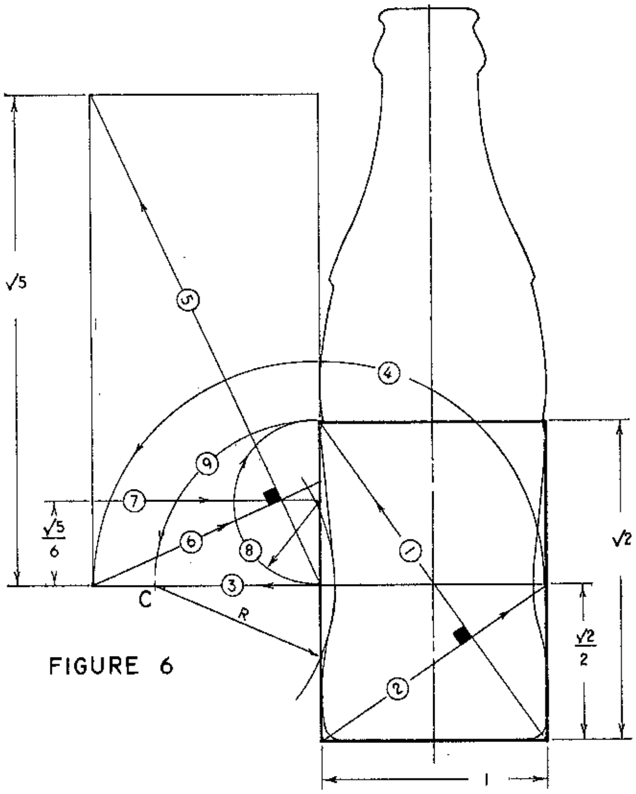


FIGURE 6

Figure 6. For center C, the vertical dir sion is determined by a root two rectangle, a diagonal, and a reciprocal. The intersection this latter line with the rectangle determines the vertical dimension. (Vertical measuring error: 0.1 mm. Percent error: 0.3%). The horizontal dimension is determine by a root five rectangle, a diagonal, and a reciprocal (to determine $2/6 \cdot \sqrt{5}$). The horizontal dimension is determined from this latter line. Point C is the intersection of sequence lines (3) and (9) . (Horizontal and radius measurin error: 0.9 mm. Percent error: 1.8%). The radius is determined by the point of intersection of sequence line (7) with the root five rectangle.

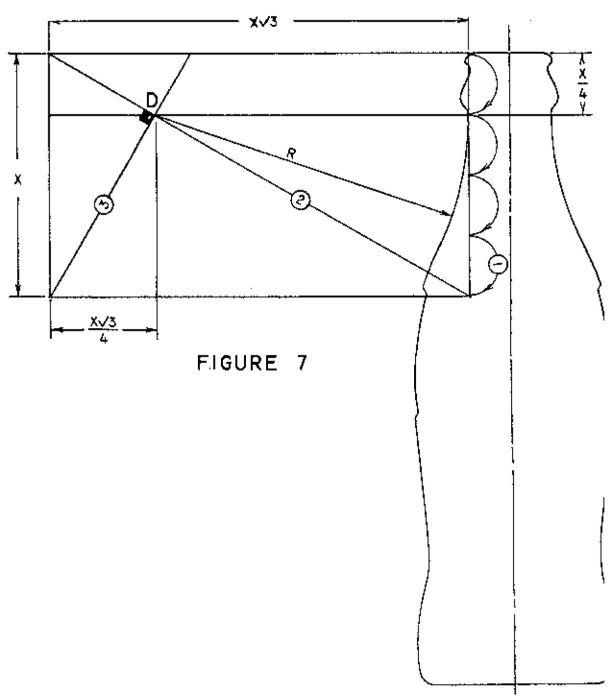


FIGURE 7

Figure 7. For center D, the vertical dimension, measured in a downward direction from the top, is equal to the crown's vertical dimension, i.e., a root eleven rectangle minus a root nine rectangle (see Fig. 2). Using the multiple of 4 times this distance as unity (rather than the base diameter as was used for the previous root rectangles) a root three rectangle, a diagonal, and a reciprocal are constructed. The point of intersection of these lines is point D. (Vertical measuring error for center D and the crown: 0.3 mm. Percent error: 1.8%. Horizontal and radius measuring error: 0.4 mm. Percent error: 0.4%).

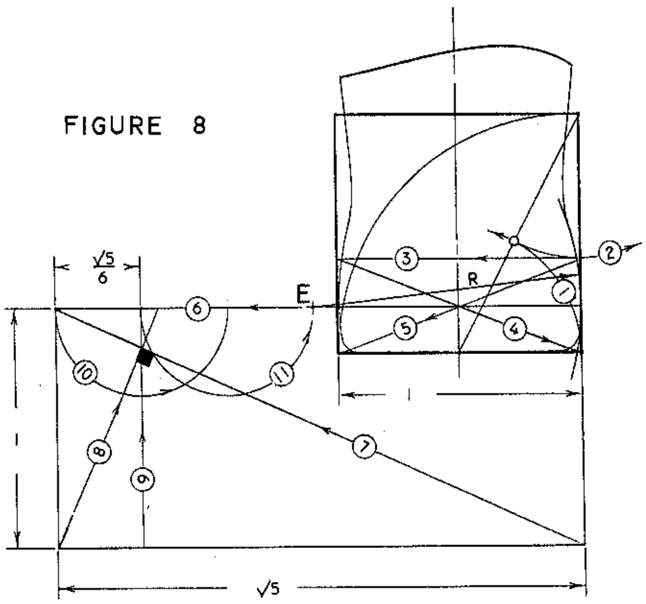


Figure 8. For center E, the vertical dimension is equal to one-half of the Golden Section (0.6180...) of a root one rectangle (square). (Vertical measuring error: 0.6 mm. Percent error: 5.2%). The horizontal dimension is determined from a root five rectangle, a diagonal, and a reciprocal (to determine 3/6·√5). Point E is the intersection of sequence lines ⑥ and ⑪ . (Horizontal and radius measuring error: 0.8 mm. Percent error: 1.2%).

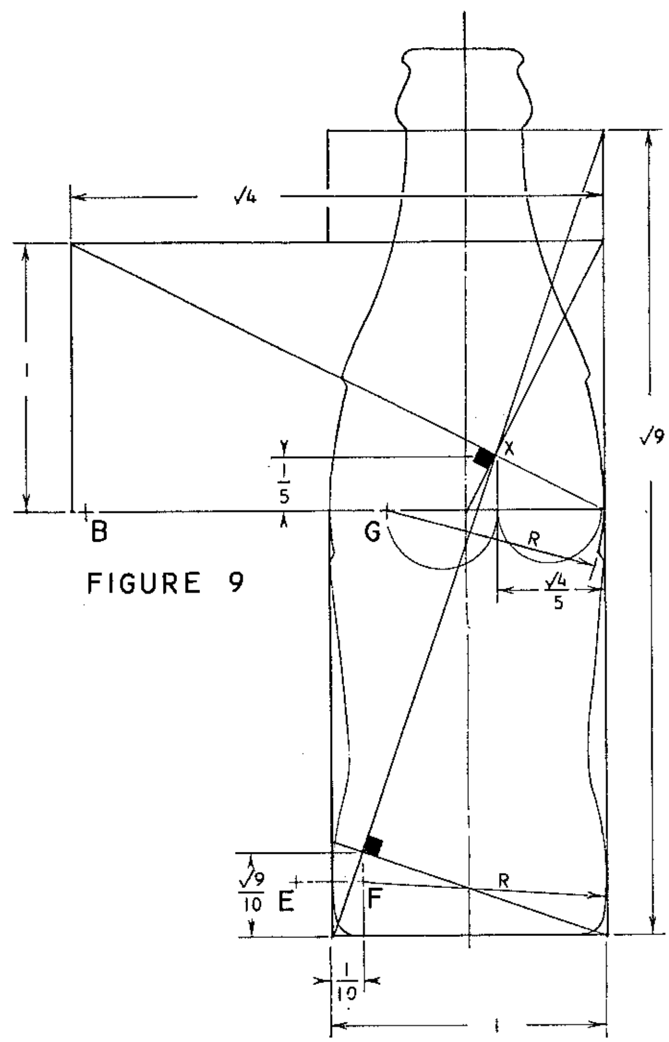


Figure 9. Centers F and G demonstrate a harmonic relationship as shown by the three intersections at point X. A true harmonic analysis of the bottle should reveal countless geometric relationships among all the foregoing center points. For center F the vertical dimension is the same as for point E. The horizontal dimension is determined by a root nine rectangle, a diagonal, and a reciprocal (to determine 1/10). (Horizontal and radius measuring error: 0.09 mm. Percent error: 0.2%). For center G, the vertical dimension is the same as for point B. The horizontal dimension is determined by a root four rectangle, a diagonal, and a reciprocal (to determine 2/5·√4). (Horizontal and radius measuring error: 0.3 mm. Percent error: 0.6%).

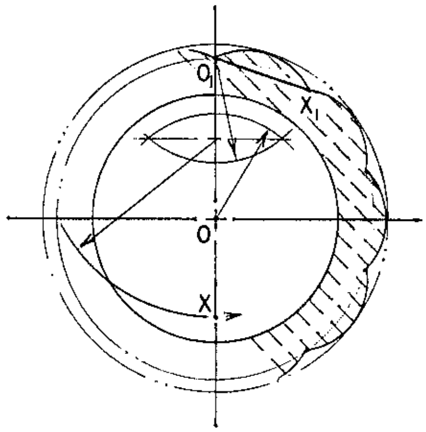


FIGURE 10

Figure 10. The bottle is fluted by 10 equal-radius circles arcs. One side of a decagon inscribed within a circle is equal to the Golden Section (0.6180...) of the radius. With the depth of the flutes specified as: 0.063 (1.59 mm) and the Golden Section (0.6180...) chord length geometrically determined as shown, the radius and centers of the flutes may be determined by routine geometric methods.

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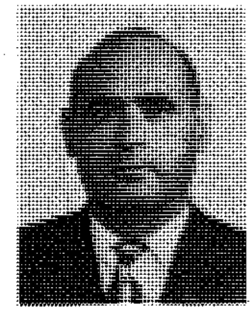
The Curves of Life

Writer's Note: The usage of the word symmetry is as used by ancient Greeks and is closer to the modern usage of the word proportion.

JOBS

Engineering and Computer Graphics. The Department of Mechanical Engineering-Engineering Mechanics at Michigan Technological University invites applicants for a tenure track faculty appointment at the assistant professor level in the area of engineering and computer grahics. Applications should have at least an M.S. degree in engineering or related areas and have a strong background in the area of interactive computer graphics including 3D refresh and raster displays, computer hardware and software. Industrial engineering graphics experience, evidence of inventiveness and other related accomplishments will be given special consideration. Duties will include teaching at primarily the undergraduate level with excellent potential for development in the graduate program, activity in specialty areas, and appropriate course and laboratory development. Interested persons should write to: David A. Carlson, Department of Mechanical Engineering-Engineering Mechanics, Michigan Technological University, Houghton, Michigan 49931; Phone (906) 487-2551 or 487-2292 and should include a resume and the names and adresses of three references. Will consider U.S. citizens and permanent residents only. Michigan Technological University is an equal opportunity educational institution/equal opprotunity employer.

DESIGNING A CAM BY MEANS OF A COMPUTER



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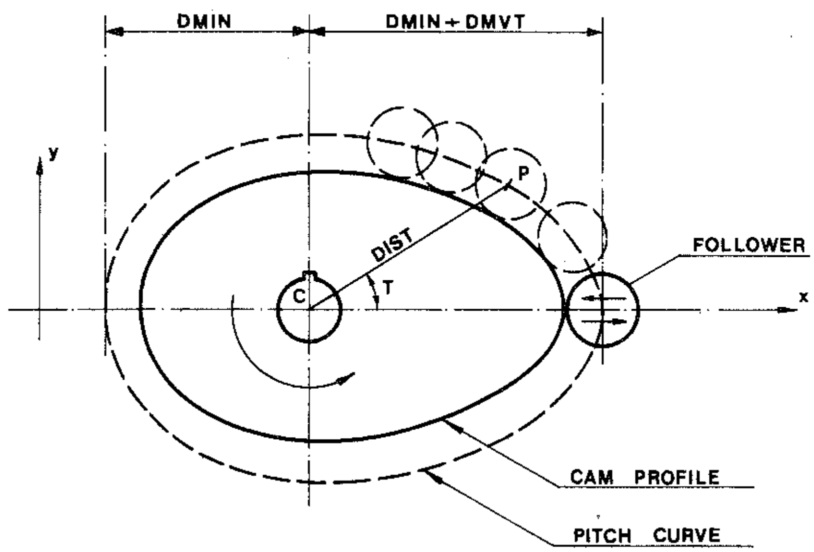


fig.1 CAM DESIGN

In most cases, the design of a cam profile does not present a difficult problem, except for the tedious work required in tracing the actual profile, once the pitch curve has been calculated and drawn.

Here is a typical example, where the services of a computer and its plotter could be called upon to produce rapidly and accurately a drawing of both the pitch curve and the cam profile, in addition to the output of a list showing precise distances from the cam rotation center to the pitch curve, in relation to the angular movement of the cam.

CAM DESIGN: If we assume, for a plate cam, as shown in Fig. 1:

C = cam rotation center
P = any point on the pitch curve
DMIN = minimum distance CP
DMVT = length of follower movement
T = angle of CP with horizontal axis.
FR = follower radius,

we can establish the coordinates of point P in relation to the system x,y as:

XP = XC + CP * CØS(T)

YP = YC + CP * SIN(T)

In general practice, the shape of the pitch curve is obtained after establishing the values of DMIN, DMVT and the motion variation, that is the function of the follower movement in relation to the cam rotation angle T.

The cam profile is obtained by drawing the tangent curve to a series of circles centered on the pitch curve and having FR as a radius.

It is obvious that the design engineer is limited to the accurace of his drafting instruments in drawing the pitch curve corresponding to his calculations, and the subsequent circles - or arcs - centered on the pitch curve, in order to obtain the cam profile.

On the other hand, the computer could dig into its "library" for the program fitting the particular motion, and all the design engineer has left to do, is supply th pertinent data to characterize the size and shape of the cam.

Thus, through the computer plotter, a drawing is produced within minutes, in which the accuracy of the calculations is far beyond any practical requirements and in which the cam profile is obtained by means of a tremendous number of FR circles - or arcs - in the number of 360 or more.

As previously mentioned, a list of CP distances could also be supplied in relation to every 1,2 . . . 5 degrees of rotation of the cam, for possible sharpness corrections of the pitch line by the design engineer, in addition to his other considerations.

MOTION PROGRAMMING: The most common forms of the follower motions could be programmed as SUBROUTINES without great difficulty.

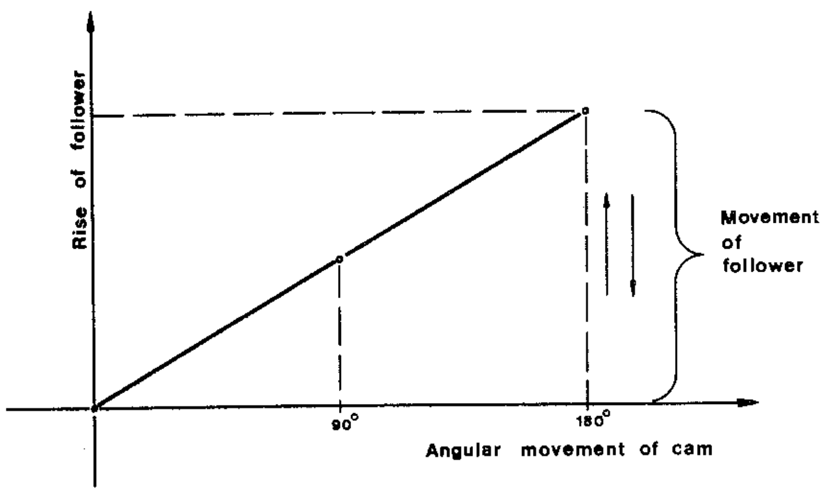


fig. 2 UNIFORM MOTION

(1) Uniform Motion, in which, of course, the distance from the cam rotation center to the pitch line increases or decreases uniformly, as shown analytically in Fig. 2.

The corresponding part of a typical subroutine would read in FORTRAN:

```
----------
----------
 DT=6.28319/(2*N)        --- angle incr.
 M=2*N+1                 --- compl.rot.
                             divisions
 J=N+1                   --- div. in 180°
 DØ 10  I=1,M            --- starting a
                             loop.
    T=(I-1)*DT
    Q=1
    IF(I.GT.J)Q=-1

    SIZE=DMIN+Q*DMVT-Q*DMVT*(I-1)/N

    XP=XC+SIZE*CØS(T)         --- this is length
                                  CP
    YP=YC+SIZE*SIN(T)         --- pitch coordinates
    WRITE(6,1)T,SIZE,XP,YP    --- list output
    CALL PLØT ----            --- drawing the pitch
                                  curve
    -------------
    -------------
    CALL CIRCLE--
                              --- for cam
 (ØR)CALL ARC-----                profile
    -------------
 10 CONTINUE                  --- end of loop
```

(2) Harmonic Motion, in which the distance from the cam rotation center to the pitch line increases or decreases harmonically - cosine curve -, as shown in Fig. 3.

The corresponding part of a typical subroutine would read:

```
  -----------
  DØ  20  I=1,M
  T=(I-1)*DT
  SIZE=DMIN+0.5*DMVT*(1+CØS(T))
  XP=XC+SIZE*CØS(T)
  YP=YC+SIZE*SIN(T)
  --  --  --
  --  --  --
  CALL CIRCLE  ---
  --  --  --
20 CØNTINUE
  --  --  --
```

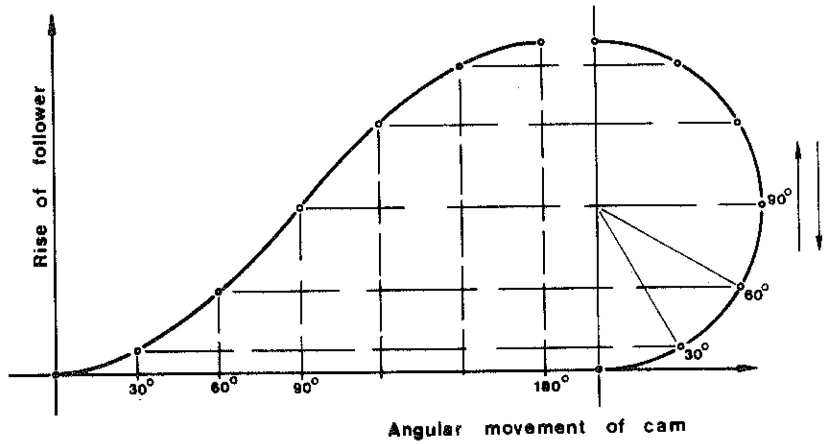


fig. 3 HARMONIC MOTION

(3) Uniformly accelerated or retarded motion, in which the distance from the cam rotation center to the pitch line, varies in an arithmetic progression form with its elements increasing or decreasing in value, by cycles, as shown in Fig. 4.

The corresponding part of a typical subroutine would read:

```
    -----------
    -----------
    EL=2*DMVT/(N*(1+N/2) --- assuming the
                             const.diff.=1
    ACC=0.
    DØ  30  I=1,M
    T=(I-1)*DT
    J=N/2+1
    K=N+1
    L=3*N/2+1
    IF(I.LE.J)GØ TØ 310
    IF(I.GT.J.AND.I.LE.K)GØ TØ 320
    IF(I.GT.K.AND.I.LE.L)GØ TØ 330
    ACC=ACC+(M-I+1)*EL
    SIZE=DMIN+DMVT/2+ACC
    GØ TØ 350
310 ACC=ACC+(I-1)*EL
    SIZE=DMIN+DMVT-ACC
    ----------
```

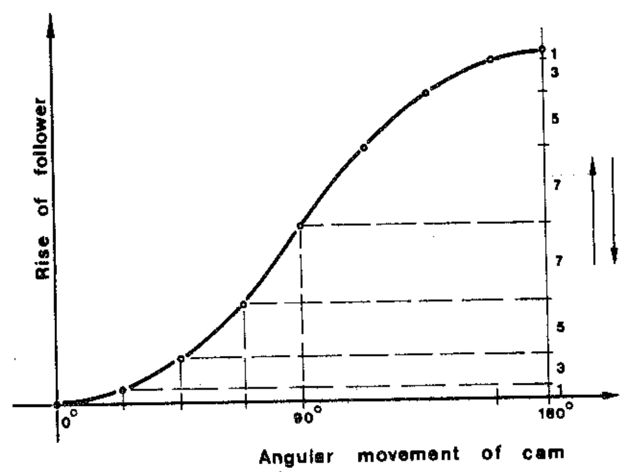


fig. 4 UNIFORMLY ACCELERATED MOTION

```
320 ----------
330 ----------
350 XP=XC+SIZE*CØS(T)
    YP=YC+SIZE*SIN(T)
    ----------
    ----------
 30 CØNTINUE
    ----------
```

<u>COMPUTER OUTPUT</u>: Feeding the specific program to the computer would lead to an output of both the drawing of the cam corresponding to the given data, and a list of CP distances in relation to angle T. Figures 5, 7 and 9 show the cam profile for various motions of the follower. Figures 6, 8 and 10 show part of CP lists for 5 degree increments of angle T, as well as the corresponding XP, YP pitch coordinates.

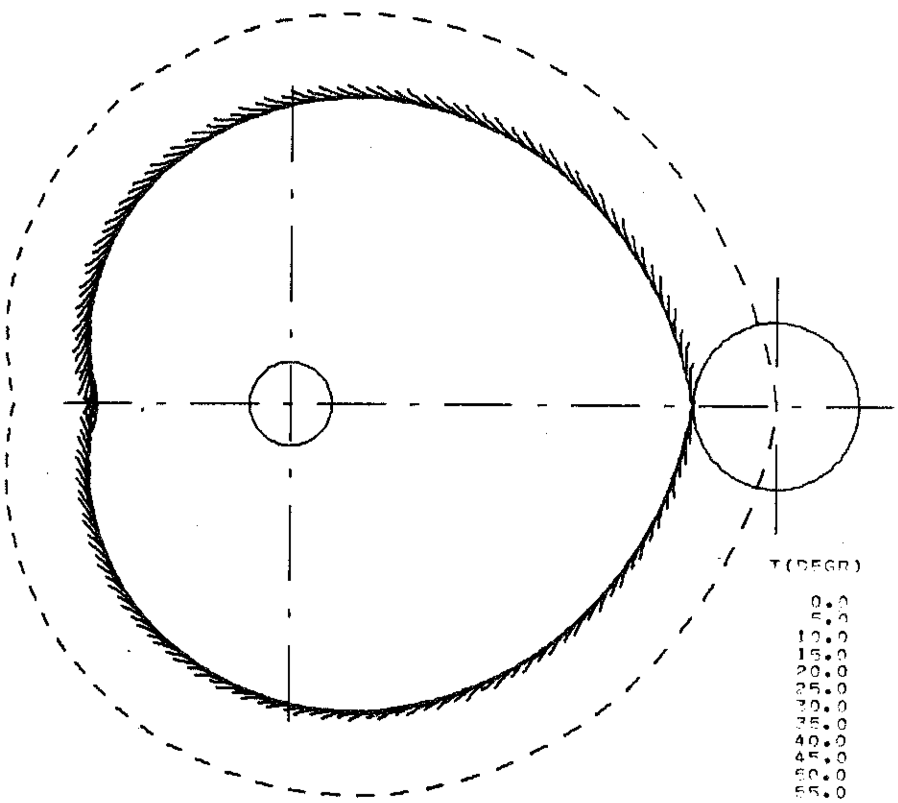


fig. 5 CAM PROFILE FOR UNIFORM MOTION

T(DEGR)	SIZE	XP	YP
0.0	3.500	6.000	0.0
5.0	3.458	5.945	0.301
10.0	3.417	5.965	0.593
15.0	3.375	5.760	0.874
20.0	3.333	5.632	1.140
25.0	3.292	5.483	1.391
30.0	3.250	5.315	1.625
35.0	3.208	5.128	1.840
40.0	3.167	4.926	2.035
45.0	3.125	4.710	2.210
50.0	3.083	4.482	2.362
55.0	3.042	4.245	2.492
60.0	3.000	4.000	2.598
65.0	2.958	3.750	2.681
70.0	2.917	3.496	2.741
75.0	2.875	3.244	2.777
80.0	2.833	2.992	2.790
85.0	2.792	2.743	2.781
90.0	2.750	2.500	2.750
95.0	2.708	2.264	2.698
100.0	2.667	2.037	2.626
105.0	2.625	1.821	2.536
110.0	2.583	1.616	2.429
15.0	2.542	1.426	2.304
[illegible]	2.500	1.250	2.165
2..	2.458	1.090	2.014
260..	417	0.947	1.951
265.0	5	0.821	1.679
270.0		0.717	1.500
275.0	2.7..	0.623	1.314
280.0	2.833	551	1.125
285.0	2.875		0.977
290.0	2.917		0.741
295.0	2.958	3.7..	.550
300.0	3.000	4.000	.2
305.0	3.042	4.245	
310.0	3.083	4.482	-2..
315.0	3.125	4.710	-2.210
320.0	3.167	4.926	-2.035
325.0	3.208	5.128	-1.840
330.0	3.250	5.315	-1.625
335.0	3.292	5.483	-1.391
340.0	3.333	5.632	-1.140
345.0	3.375	5.760	-0.874
350.0	3.417	5.965	-0.593
355.0	3.458	5.945	-0.301
360.0	3.500	6.000	0.000

fig. 6 DISTANCES FROM CAM ROT. CENTER TO PITCH CURVE (UNIFORM MOTION)

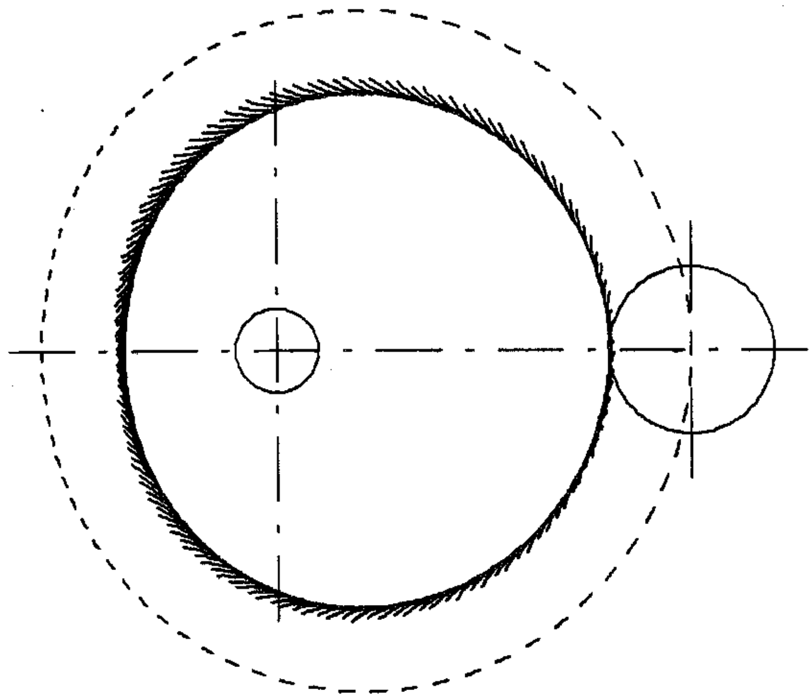


fig. 7 CAM PROFILE FOR HARMONIC MOTION

T(DEGR)	SIZE	XP	YP
0.0	3.000	5.500	0.0
5.0	2.998	5.496	0.261
10.0	2.990	5.445	0.519
15.0	2.978	5.376	0.771
20.0	2.961	5.282	1.013
25.0	2.939	5.164	1.242
30.0	2.917	5.023	1.456
35.0	2.892	4.861	1.653
40.0	2.848	4.682	1.831
45.0	2.810	4.487	1.987
50.0	2.768	4.279	2.120
55.0	2.723	4.062	2.230
60.0	2.675	3.837	2.317
65.0	2.625	3.609	2.379
70.0	2.572	3.380	2.417
75.0	2.519	3.152	2.432
80.0	2.463	2.928	2.425
85.0	2.407	2.710	2.397
90.0	2.350	2.500	2.350
95.0	2.293	2.300	2.285
100.0	2.237	2.112	2.203
105.0	2.182	1.935	2.107
110.0	2.129	1.772	1.999
[illegible]	2.075	1.623	1.991
	2.025	1.488	1.754
255.[illegible]	[illegible]	1.366	1.620
260.0			1.490
265.0	2.2[illegible]	[illegible]	[illegible]
270.0	2.350	2.500	
275.0	2.407	2.710	-2.[illegible]
280.0	2.463	2.928	-2.425
285.0	2.518	3.152	-2.432
290.0	2.572	3.380	-2.417
295.0	2.625	3.609	-2.379
300.0	2.675	3.838	-2.317
305.0	2.723	4.062	-2.230
310.0	2.768	4.279	-2.120
315.0	2.810	4.487	-1.987
320.0	2.848	4.682	-1.831
325.0	2.882	4.861	-1.653
330.0	2.913	5.023	-1.456
335.0	2.939	5.164	-1.242
340.0	2.961	5.282	-1.013
345.0	2.978	5.376	-0.771
350.0	2.990	5.445	-0.519
355.0	2.998	5.486	-0.261
360.0	3.000	5.500	0.000

fig. 8 DISTANCES FROM CAM ROT. CENTER TO PITCH CURVE (HARMONIC MOTION)

REMARKS:

(1) The previous calculations apply to plate cams. However, the same principles could be applied to cylindrical cams, in which more than one complete turn could be considered, as long as the follower returns to its starting point.

(2) Furthermore, a combination of motions could be considered to suit the design requirements. The pertinent computer programs could be applied if the loops therein complete one another.

Here again, a list of CP distances could be obtained, as well as the plotting of the development of the pitch line in diagram form.

(3) Although no reference was made to motions other than the most common mentioned, it is evident that other motions, such as that of an offset or rocker follower - movements outside the cam axis - could be considered, i.e., programmed, as long as the motion function and its trajectory are well defined.

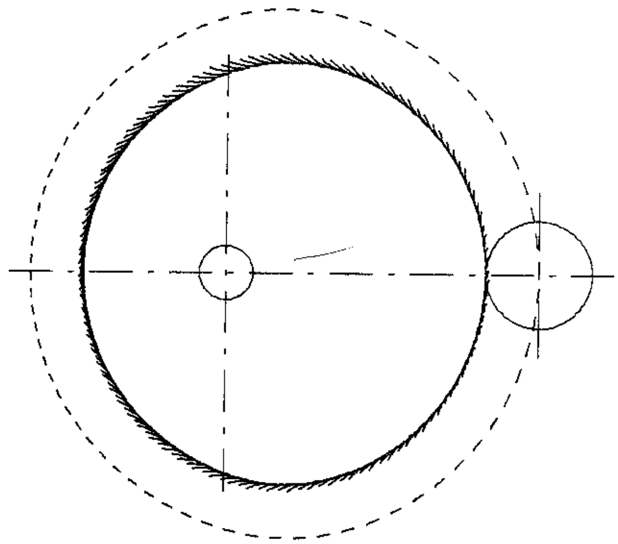


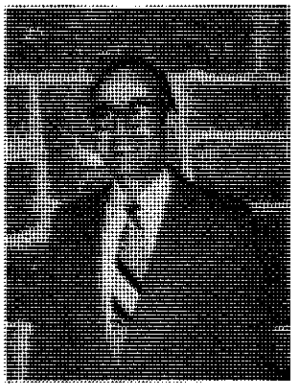
fig. 9 CAM PROFILE FOR UNIFORMLY ACCELERATED MOTION

T(DEGR)	SIZE	XP	YP
0.0	3.500	6.000	0.0
5.0	3.497	5.984	0.305
10.0	3.490	5.937	0.606
15.0	3.480	5.861	0.901
20.0	3.465	5.756	1.195
25.0	3.446	5.623	1.456
30.0	3.424	5.465	1.712
35.0	3.398	5.283	1.949
40.0	3.367	5.079	2.164
45.0	3.333	4.857	2.357
50.0	3.295	4.618	2.524
55.0	3.253	4.366	2.665
60.0	3.207	4.104	2.778
65.0	3.157	3.834	2.862
70.0	3.104	3.562	2.917
75.0	3.046	3.288	2.942
80.0	2.985	3.018	2.939
85.0	2.919	2.754	2.908
90.0	2.850	2.500	2.850
95.0	2.781	2.258	2.770
100.0	2.715	2.028	2.674
105.0	2.654	1.813	2.563
110.0	2.596	1.612	2.440
115.0	2.543	1.425	2.304
[illegible]	2.493	1.254	2.159
[illegible]	2.447	1.097	2.004
[illegible]	[illegible]	0.954	1.842
230.0	[illegible]	[illegible].826	1.674
235.0	2.[illegible]	[illegible]	1.499
240.0	2.493	[illegible]	[illegible]
245.0	2.543	1.4[illegible]	[illegible]
250.0	2.596	1.612	-2.4[illegible]
255.0	2.654	1.813	-2.563
260.0	2.715	2.028	-2.674
265.0	2.781	2.258	-2.770
270.0	2.850	2.500	-2.850
275.0	2.919	2.754	-2.908
280.0	2.985	3.018	-2.939
285.0	3.046	3.288	-2.942
290.0	3.104	3.562	-2.917
295.0	3.157	3.834	-2.862
300.0	3.207	4.104	-2.778
305.0	3.253	4.366	-2.665
310.0	3.295	4.618	-2.524
315.0	3.333	4.857	-2.357
320.0	3.367	5.079	-2.164
325.0	3.398	5.283	-1.949
330.0	3.424	5.465	-1.712
335.0	3.446	5.623	-1.456
340.0	3.465	5.756	-1.195
345.0	3.480	5.861	-0.901
350.0	3.490	5.937	-0.606
355.0	3.497	5.984	-0.305
360.0	3.500	6.000	0.000

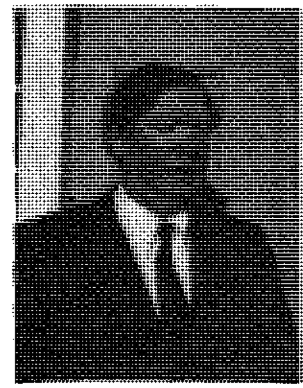
fig. 10 DISTANCES FROM CAM ROT. CENTER TO PITCH CURVE (UNIFORMLY ACCELERATED MOTION)

SUMMARY: As we have seen, in the case of a cam design the computer can be of real help to the design engineer, providing him with as great a number of alternatives as desired, for his decision making and optimal design.

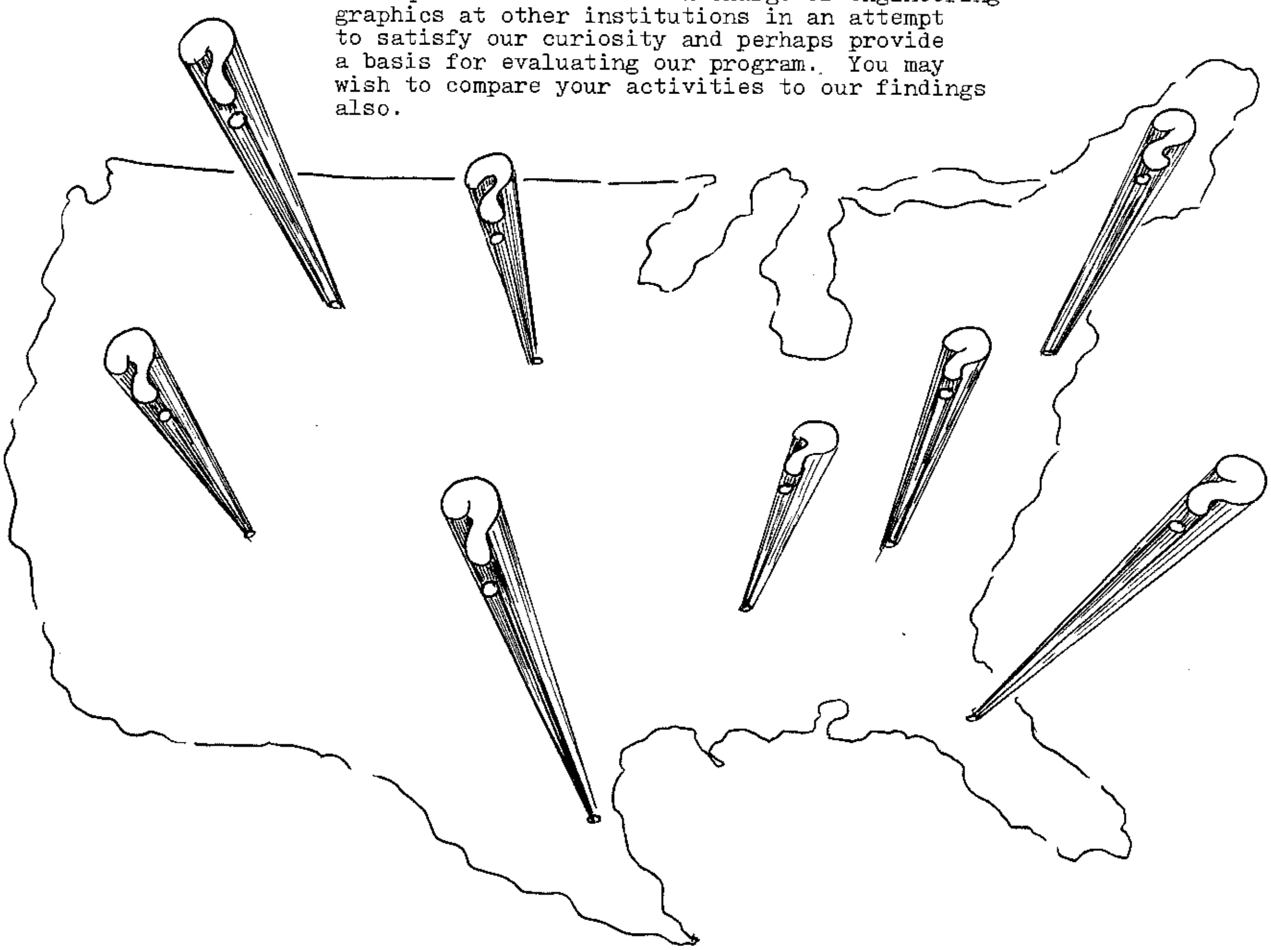
SOME QUESTIONS AND ANSWERS



Richard E. Keebler
Norman Buchanan
The Pennsylvania State University
University Park, PA



How often have you wondered how graphics courses in other colleges or universities are administered and taught? We recently asked some questions of those in charge of engineering graphics at other institutions in an attempt to satisfy our curiosity and perhaps provide a basis for evaluating our program. You may wish to compare your activities to our findings also.



We received 16 replies to questionnaires sent out to 31 institutions, almost all using the same graphics textbook -- Earle's Engineering Graphics, 3rd Edition, published by Addison-Wesley. A summary of the replies is given below. Please don't be dismayed if some of the numbers don't seem to add up; some replies didn't answer all questions and some questions were answered in slightly different ways. Also, you should recognize that responses were intended to represent averages at each institution. Therefore, the spreads of some answers from various individual instructors might actually be larger than the ranges of answers given in the summary.

ENGINEERING GRAPHICS QUESTIONNAIRE RESPONSES

The answers to the following questions use as an example a class of about 30 students and the most usual methods used by instructors. Underlined numbers represent frequencies of given responses.

1. Title and author of workbook, if one is used:

   (a,b,c) Graphics and Geometry 1, 2, or 3, Earle, et al. - 4

   (d) Graphics for Engineers, Earle - 1

   (e) Geometry for Engineers, Earle - 2

   (f) Local productions - 5

   (g) Graphics Communications, Analysis and Design, Wood and Pauli - 1

   (h) Descriptive Geometry Worksheets, Paré, et al. - 1

   (i) Technical Drawing Problems, Giesecke, et al. - 1

   (k) Drafting Fundamentals - 1

2. For the typical course using the above workbook, how many plates do you require students to complete?

   18-1, 24-1, 32 to 35-1, 35 to 40-1, 40-4, 37-1, 45-1, 50-2, 54-1, 61-1, 88-1

3. How many clock hours a week does the class meet?

   3-2, 4-2, 4.5-1, 5-3, 6-7, 7-1

4. How many weeks does the course run?

   10-5, 14-1, 15-3, 16-5, 17-2

5. How many credits are given for this?

   1-1, 2-5, 3-8, 4-2

6. For how many total credits do you use the workbook?

   2-3, 2.5-1, 3-5, 4-1

7. What portions of the workbook do you find most useful? (Letters in parentheses refer to 1 above.)

   Plate numbers: All-1(a, b, or c); depends on student experience-1(a); 51 to 73-1(c); 28 to 36, 51-57-1(b); 18 to 25, 27 to 30, 33, 34, 36 to 38, 40 to 48-1(e); all-1(g); all-1(j)

8. What portions have been found least useful?

   Plate numbers: 94 to 101, 104 to 106-1(c); 91 to 99-1(b); 26, 31, 32, 35, 39-1(e); ch. 12-1(j)

9. How are lecture and drawing times apportioned in an average class period?

   % lecture (remainder drawing): 10 to 15-1, 10 to 50-1, 16-1, 20-4, 25-1, 30-1, 33-2, 40-3, 50-1

10. Is homework required of students?

    No-4, yes-12

11. If yes, what is the time (minutes) required for one daily homework assignment?

    Varies-1, as required-1, 30-4, 40-1, 60-3, 60 to 90-1, 90-1

12. How are plates graded?

    letter-3, number-13

13. What advantages do you see with that system of grading?

    Number- more flexibility, easy accumulation and weighting at end of term, good correlation to %, etc.

    Letter- students know where they stand, works best for me

14. What is the average time (minutes) spent by the instructor grading a set of plates? (Assume 30 plates for uniformity.)

    10±-1, 25-1, 30-1, 30 to 60-2, 60-3, 75-1, 90-4, 120-1, 180-1

15. How many students a term or semester are considered a full load for one instructor?

    22/course-1, 20 to 25-1, 24-1, 30 to 40-1, 60-1, 70-1, 75-1, 80-1, 100-1, 120-2, 140 to 150-1, 150 lower division, 30 upper division-1

16. In correcting plates, are detailed comments used or are errors noted only?

    Comments-5, errors only-1, both-8, comment and text reference "code"-1

17. If comments are used, what do you estimate is their relative value to the student compared with noting errors only?

    25% better-3, 50% better-10

18. What is your estimate of the value to the student of returned, corrected plates?

    100%(absolutely essential)-12, 80%-1, 50%-1

19. What percentage of a student's final grade is determined by tests or quizzes?

    10-2, 20-1, 25-1, 33-3, 35-1, 40-1, 50-4, 63-1, 67-1, 75-1

20. Are tests, quizzes, etc. open book (including completed plates) or closed book?

    Open-3, closed-12, combination-1.

21. Is a project required of students at the end of a course?

    No-3, yes-13 (2 during term in one case)

22. If yes, is it an individual or team project and what percentage of the final grade does it represent?

    Individual-5, team-6

    2 plates worth-1, 5%-1, 10%-1, 15%-4, 25%-3, 33 1/3%-2, 35%-1

23. Is a final comprehensive exam given?

    No-8 (2 mid-terms in 1 case), yes-7

24. Is any type of laboratory work, such as "hands-on" experimental measurements lab, used in conjunction with the graphics work?

    No-13, yes-1 (usually), drawing only-1

It can be seen that almost half of the respondents use one of Earle's workbooks in conjunction with his text. Whatever the plate source, however, the average number used is 45, given the 18 - 88 spread. Such a large range could result from variations in the amount of material on a plate, in the parts of a plate actually used for a course, and from the different lengths of the school terms.

There doesn't appear to be a strong correlation among questions three, four, and five. Neither the number of weeks in a school term nor the number of hours a class meets each week seem to have a direct relationship to the number of credits awarded for the course, as shown in Figure 1. The variations may be the result of different amounts of material covered, different amounts of work required outside of class (most do require homework), or possibly different interpretations of the questions asked.

FIGURE 1

Weeks	Hrs/wk	Credits
10	3 4.5 5 6 7	4 1 3 3 4
14	4	2
15	5 6 6	3 2 2
16	3 4 6 6 6	3 3 2 2 3
17	5 6	3 3

Half of those using a number system of grading use a 0 or 1 to 10 scale. The others each use a different scale, such as: 5 to 1, 12 to 0, 100 to 0, etc.

The large spread in numbers of students considered a full load for one instructor for one term is quite interesting and not really explainable. It may be that some of the smaller numbers represent only the graphics portion of an otherwise larger load for an instructor. Also the question might have been interpreted to mean the number of students per course, which would result in some low numbers. The one reply indicatting 22 students per course did not state how many courses were involved so that the full instructor load could not be determined.

As seen in question 16, most use comments in correcting plates, only one indicating they were not used. One other recorded "errors only" but stated that comments were sometimes used.

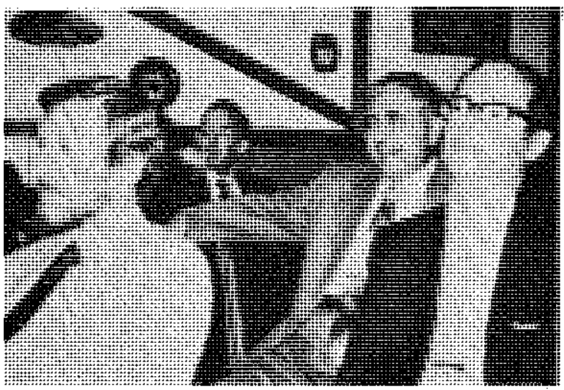
While most agreed that it was absolutely essential to return plates to students, there was a question as to the use made of them. One remark offered was that about half the students look at the grade only, that they are interested not so much in what was missed and why but mainly how much was missed. It may be that others have similar opinions that simply were not expressed in their replies.

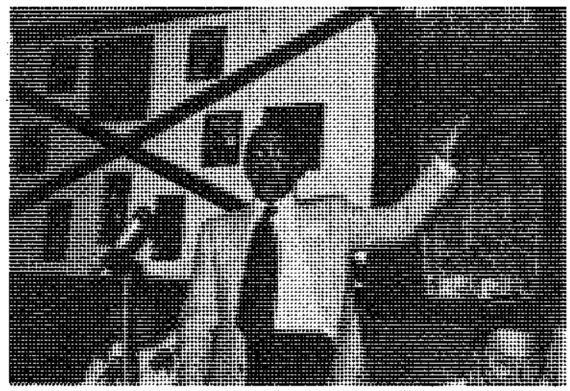
With the foregoing information it is hoped that we have answered some questions for the reader. At least we hope to have provided a basis for you to compare your graphics program with what is being done in some other institutions.

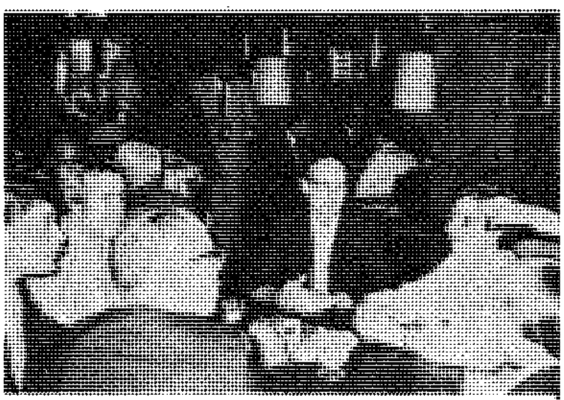
Those who responded to this survey are:

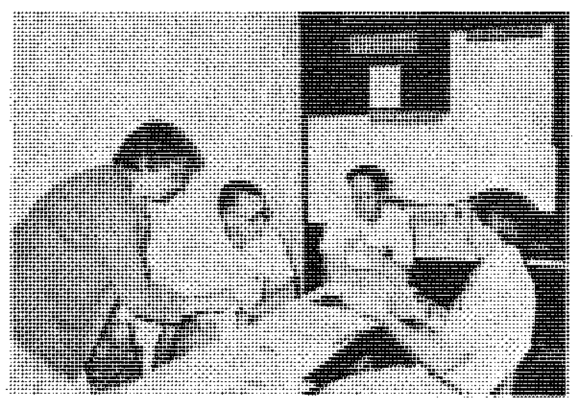
UNIVERSITY OF CALIFORNIA, Berkeley
CALIFORNIA STATE UNIVERSITY, Long Beach
SANTA ROSA JUNIOR COLLEGE
UNIVERSITY OF COLORADO, Boulder
INDIANA INSTITUTE OF TECHNOLOGY
KANSAS STATE UNIVERSITY
MICHIGAN STATE UNIVERSITY
MISSISSIPPI STATE UNIVERSITY
UNIVERSITY OF NEBRASKA, Omaha
GLASSBORO STATE COLLEGE
S.U.N.Y. COLLEGE AT Oswego
UNIVERSITY OF TOLEDO
LEHIGH UNIVERSITY
PENNSYLVANIA STATE UNIVERSITY
VILLANOVA UNIVERSITY
TEXAS A & M UNIVERSITY

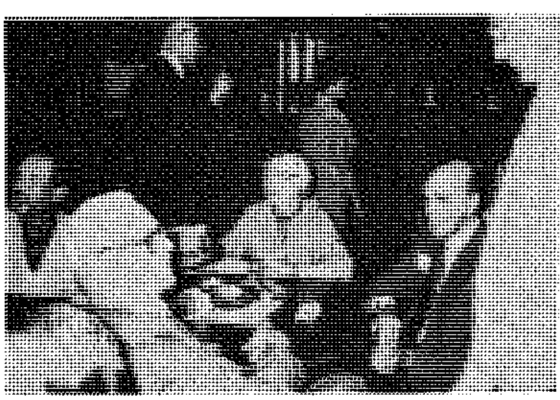
Some MORE Candid Camera from AMHERST 1980

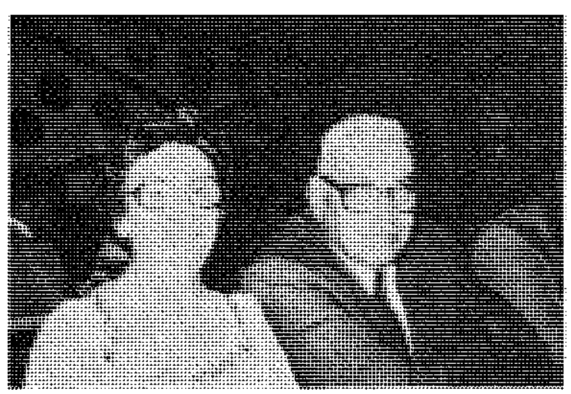












PREPARING FRESHMEN FOR COMPUTER GRAPHICS

Francis Mosillo
University of Illinois
Chicago Circle
Chicago, Illinois

In the past, most schools introduced their students to computer graphics in upper level courses where the students already had experience in both graphics and the computer. Today more and more schools are interested in integrating the computer graphics work into their basic graphics courses. The University of Illinois at Chicago Circle has been using this integrated approach since 1972. This paper will describe how, after many years of trial and error, the current method of teaching is being used to bring students to computer graphics involvement without any previous knowledge of computer programming <u>or</u> graphics. In fact, if the computer portion did not in some way support the graphical needs of the course, it was modified or eliminated from the course during the "evolution" of this material.

First of all, one must recognize that implementing computer graphics into a graphics course does not deal only with student or instructor problems. The involvement with the computer facility system and personnel is usually a major stumbling block. There are a variety of ways to get the students' names into the computer memory so that they will have their own personal account to enable them to run their programs. The Circle facility has had a variety of ways of getting the students into the system, and this fact has caused more problems than the actual learning of computer graphics. At this point the graphics personnel should not falter, nor become discouraged. They must work harder to limit the amount of aggravation (the students may have to go through) in order to make this a satisfying experience for the students rather than a frustrating one.

DAY	TOPICS
1	Introduction & Lettering
2	Two-Dimensional Drawings. Hazeltine 1500 Terminal.
3	Test I (one hour) Computer Facility & WYLBUR
4	Oblique Drawing
5	Computer Drawing Logic
6	Multiview Drawing
7	Multiview Principles
8	Test II (one hour) Computer Drawn Multiviews
9	Necessary Views
10	Line and Plane Relationships to the Principal Planes of Projection.
11	Locating Points and Lines in Space (Principal Views only)
12	Locating Points and Lines in Space (Auxiliary Views)
13	Auxiliary View Applications
14	Test III (one hour) Computer Drawn Auxiliary Views.
15	Sections and Conventions
16	Shop Procedures
17	Working Drawings
18	Professional Applications
19	Drawing Control & Reproduction
20	Test IV (two hours)

Figure 1 - Topic Outline of Basic Graphics Course with Introduction to Computer Graphics (Each Day is a two-hour period)

Basically the system facility at the Chicago Circle campus is as follows. First, they must type their information onto a Hazeltine 1500 CRT terminal. The WYLBUR language is used to process the programs through the computer. Numbered bins are available for the students to pick up their output material. The use of the Hazeltine machines and the WYLBUR language is a common item that the students must use for all future courses utilizing the computer. Therefore this particular experience is useful to the students not only in the graphics course but in other courses.

To make this process as painless as possible for the students, and yet not absorb a great deal of graphics time, several programs have been developed to expedite the students through this system.

At the beginning of the second week of classes, the student inputs a single line program. The line of code looks as follows:

```
$JOB SYSEMON P=START
```

This one line of code gives the student experience on the Hazeltine machine, the WYLBUR language, and the computer facilities system for picking up output. It also is a check to determine whether or not the student actually has an active account in the system.

```
OUTPUT OF THE START PROGRAM (VERSION STARTFF)
UPDATED 7-31-79 BY DSL
---------------------------------------------

CONGRATULATIONS. YOU HAVE SUCESSFULLY COMPLETED
PHASE I OF THIS COMPUTER ASSIGNMENT. IF YOU WISH,
YOU MAY USE THE PLATO SYSTEM TO TAKE LESSONS
RELATING TO THIS COURSE. THE INITIAL "DRAWING"
LESSON IS A SIMPLE INTRODUCTION TO MULTIVIEW AND
PICTORIAL DRAWING. READ THE PLATO INSTRUCTION
SHEET (DISTRIBUTED IN CLASS) FOR MORE DETAILS.
PLATO IS IN THE BASEMENT OF BURNHAM HALL, ROOM
B13.

AS PHASE II, THE GRADE AVERAGE PROGRAM MU
CONTAIN ALL OF                ITEMS TYP
   AUR'S CO
```

Figure 2 - Output of START Program

The output that the student receives first of all congratulates him for getting "through" the system, and then introduces him/her to a tutoring computer graphics system which can teach those without any previous graphics background a little bit more about graphics itself. However, the primary information received from this output is what is called the grade average program. The instructions give the format the students must use in developing a simple 4 or 5 line "program" which will give them a means of calculating their grade throughout the quarter. This program also gives them a projection of what their final grade could be if they worked at a specific level for the balance of the course. This program looks as follows:

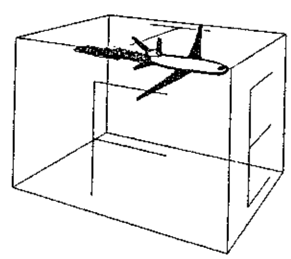
```
$JOB SYSEMON P=GAFF
185 JONES, R.A. SECTION B5 DESK 85 WN'80
01 1 9.5
02 1 8.5
03 2 7.5
```

The output (Fig. 3) not only shows the student's numerical average, but also a graph which shows the letter grade at that point, as well as the breakdown of the letter grade within the course.

```
------------------------------------------
 185 JONES,R.A. SECTION B5 DESK 85 WN'80
------------------------------------------

*STUDENT INPUTS*         ***GRAPH OF STUDENT'S DAILY AVERAGE*********
DAY UNITS GRADE AVERAGE   6         7         8         9        10
                          +.........+.........+.........+.........+
 1    1    9.5   95.00%  .EEEEEEEEEEDDDDCCCCCCCCCCBBBBBBBBBAAA
 2    1    8.5   90.00%  .EEEEEEEEEEDDDDCCCCCCCCCCBBBBBB
 3    2    7.5   82.50%  .EEEEEEEEEEDDDDCCCCCCC

ATTENDANCE AND QUALITY ARE THE PRIMARY
INGREDIENTS FOR A GOOD GRADE.  HOWEVER, ONE'S
GRADE AVERAGE MAY BE IMPROVED BY DOING REPLACEMENT
EXERCISES DURING THE LAST HALF OF THE QUARTER.


IF LEVEL OF REMAINING          FINAL AVERAGE
WORK IS:                       WILL BE:
          8.5                            84.84%
          9.0                            89.52%
          9.5                            94.19%
         10.0                            98.87%
```

Figure 3 - Output of Grade Average Program

The computer assignments just described are not to be done independently, but in parallel with the instructor's choice of graphics topics such as lettering, sketching, drafting, pictorial drawings, graphs, etc. The class session prior to the lecturing of multi-views, for example, is one in which the students are introduced to a computer graphics program called SPACEVU. This material is not described to the students as a programming language, but as a three-dimensional visualization mode of thought.



```
OBJS AA
OFF A 0.0 2.0 2.5
ON  B 0.0 0.0 2.5
ON  C 3.0 0.0 2.5
ON  D 3.0 2.0 2.5
ON  E 3.0 2.0 0.0
ON  F 3.0 0.0 0.0
ON  C
OFF F
ON  G 0.0 0.0 0.0
ON  B
OFF G
ON  H 0.0 2.0 0.0
ON  E
OFF H
ON  A
ON  D
```

Figure 4 - Object Development

That is, the students are introduced to Computer Graphics logic which requires them to visualize the path a skywriting airplane would follow to produce a three-dimensional line object. The end points of the corners of this object are located in space by using a standard mathematical coordinate system in three dimensions. Note that this computer graphics experience utilizes the students' previous knowledge of a mathematical coordinate system as well as making them visualize in three dimensional space. The computer involvement here is minimized to introduce the students to computer graphics while not only teaching them about the computer, but graphics as well. The output (Fig. 5) from this simplified program gives them a pictorial of their results that they have visualized and typed into the computer, and also gives them the six principal views drawn in the required locations. The lecture following this introduction to computer

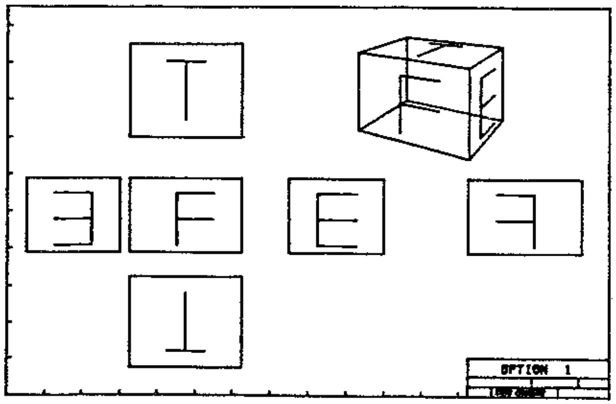


Figure 5 - Output of Initially Developed Object.

graphics is an introduction to multi-views. actually, at this point most students have not picked up their output from the computer to see the pictorial and six principal views drawn, so what is done in the classroom (Fig. 6) is to draw the principal views of the same object and then, at the next class session, they can compare their drawn version with their computer output. During this period of study, the students have actually learned about multi-views and are experiencing computer graphics logic at the same time which adds a little spice to the traditional topic.

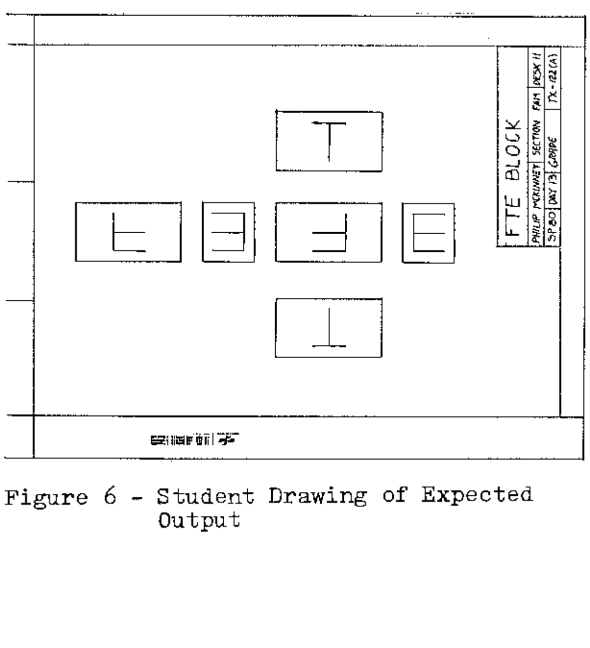
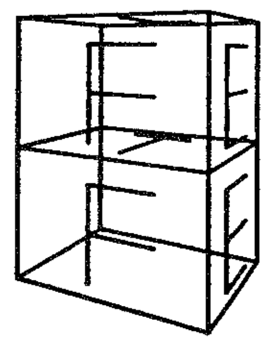


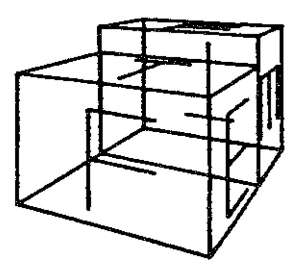
Figure 6 - Student Drawing of Expected Output

About the fourth week of the quarter the final lecture on computer graphics is given. The students already being aware of the command that develops the object in three dimensional space, are introduced at this time to the manipulative commands which translate, rotate, assemble, and scale (shrink or enlarge) various datasets (objects). The structures of these commands were designed to further exercise the student's spatial visualization faculties. That is, the desired movement must be thought of (visualized) as a three dimensional movement and not as a flattened shape on a flat sheet of paper. None of the above commands "do" any drawing. The command which states what view is to be drawn and where it is to be drawn on the paper, is a two-dimensional command which measures the student's ability to place views in projection and recognize, among other things, the orientation of each view.



TRAN AA 0.0 2.0 0.0 BB

Figure 7 - Object Translated in Three-Dimensional Space.



ROTA AA X -90.0 BB

Figure 8 - Object Rotated about the X-Coordinate Axis.

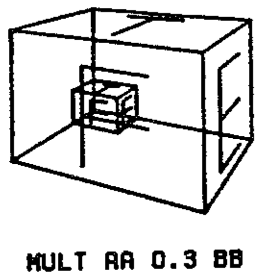


Figure 9 - Three-Dimensional Shrinking of Object.

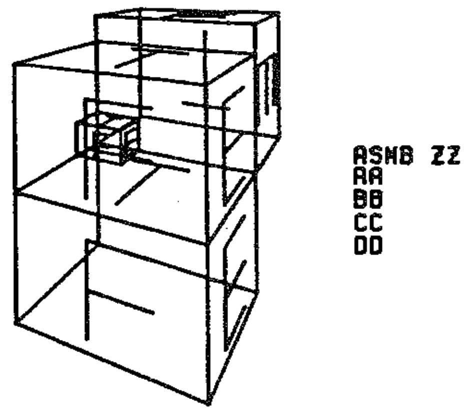


Figure 10 - The Combining of Previously Established Objects into one Dataset.

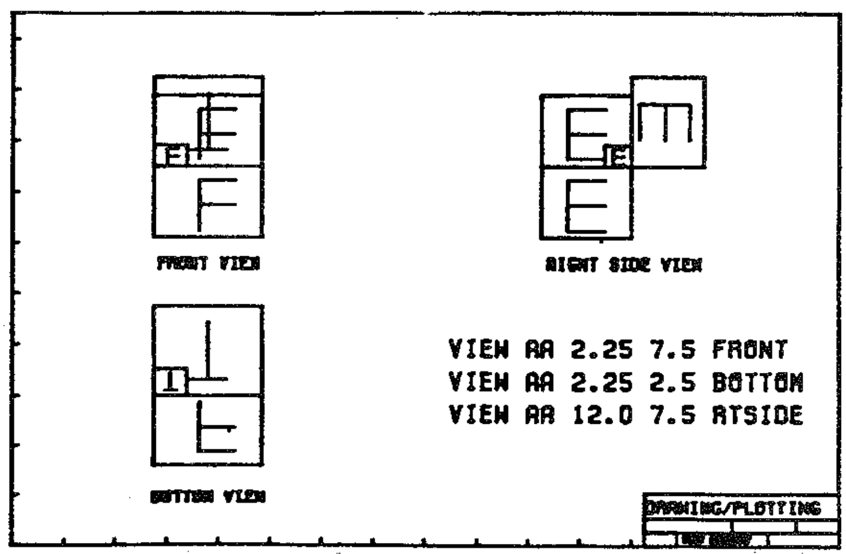
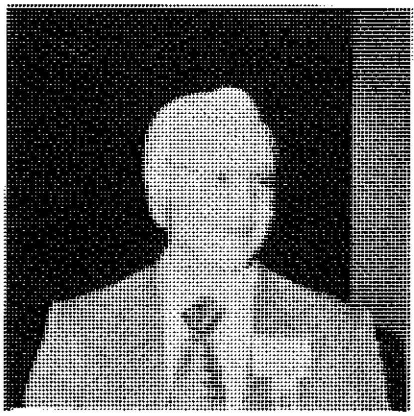


Figure 11 - Multiview Presentation.

The balance of the quarter can be used to teach any of the traditional graphics topics with or without the computer. However, experience has shown that students are willing to spend many extra hours working on these traditional graphics areas using the computer rather than working hours on drawing them by hand. How this is handled is, of course, at the discretion of the instructor, but experience will again show that more will be learned by giving the students additional experience on the computer in parallel with the traditional graphics work.

PRACTICAL CLASSROOM COMPUTER GRAPHICS



Wilbur B. Pearson
Assoc. Prof. Emeritus
Mississippi State University
Miss. State, MS

The idea of teaching computer graphics in the engineering freshman class room is disturbing to most graphics instructors. Lack of familiarity with the computer and computer science, and the "bugaboo" of the many machine languages and methods of programming contribute in large measure to this. The lack of sophisticated equipment for graphic output and familiarity with its use is also a deterrant.

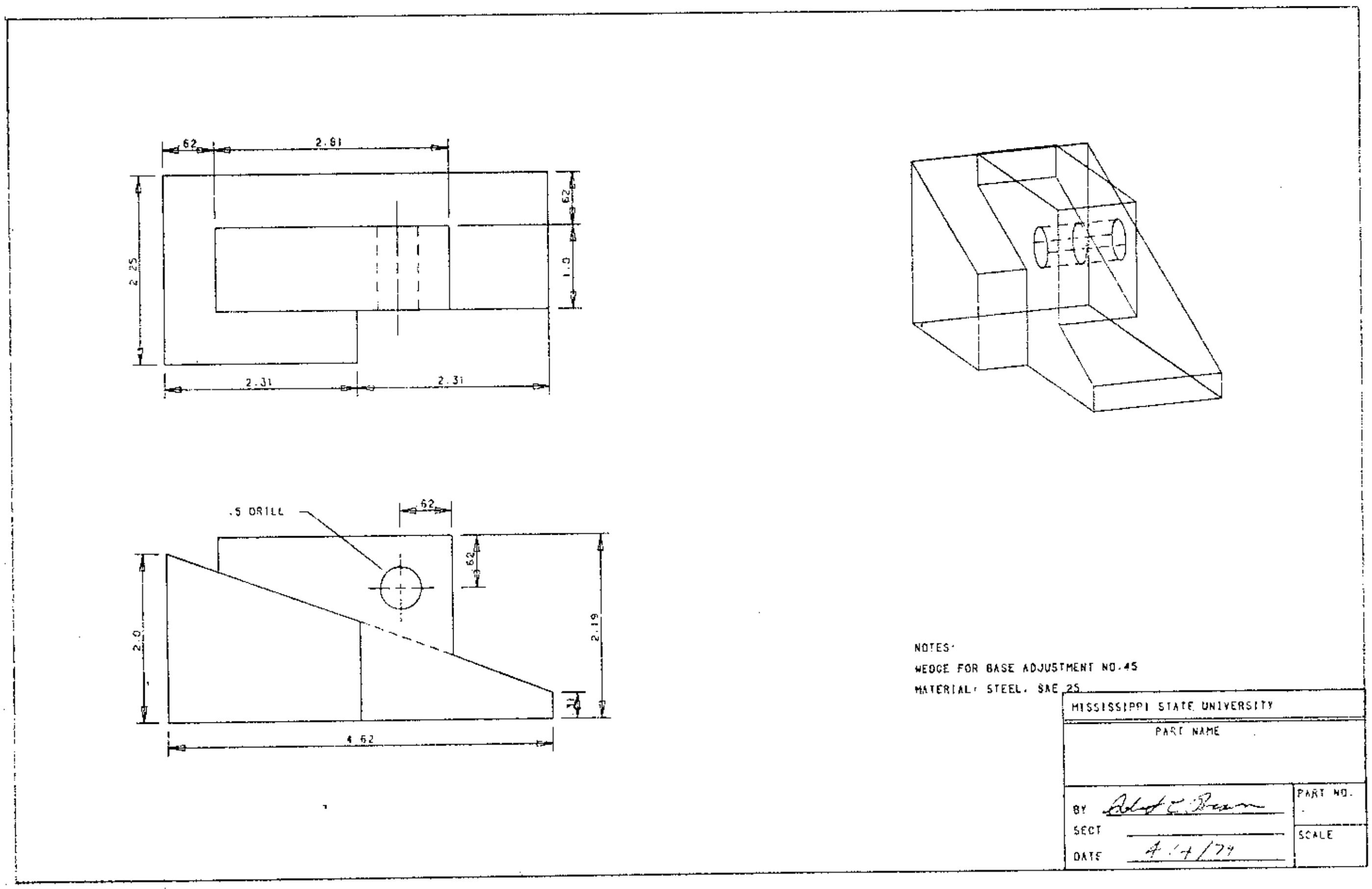
The difficulties involved in teaching computer graphics in the freshman class room have largely been overcome at Mississippi State University. This was accomplished by building on and refining the use of DRAWL (short for Draw Language) and DRAWL software. The DRAWL was originally developed at the University of Michigan as a sub-routine of Fortran IV by Professor B. Herzog, to enable the use to program the drawing of an object on the computer-plotter. The prepared calling statements include supplementary code words or commands which allow the user to define objects in terms of points and lines in space, combine objects into assemblies, and manipulate these objects or assemblies into various positions and views to produce graphical output of the results, such as drawings made by a plotter. The emphasis is on the planning of graphical compositions (drawings) and not on computer programming as such.

The graphics student with little or no computer science knowledge or programming skill can -- with the use of DRAWL -- soon be producing multiview and three-dimensional pictorial plotter drawings. This has been demonstrated at Mississippi State University where the author, over a period of several years, has expanded the use of DRAWL and developed a full semester course of instruction in computer graphics.

- Lectures outlining step-by-step procedure in programming the drawing of objects of various two- and three-dimensional shapes, followed by "hands on" laboratory experience with the computer-plotter.
- Exercises in plotting shapes, and the manipulation of geometric shapes in space to obtain specific orientation of various views.
- Example guide problems are included in the text for easy reference on any and all procedures.

For two years, now, two weeks of instruction in computer graphics has been included in the second semester course in engineering design graphics for all engineering freshmen at Mississippi State University. The text (2) being used was prepared by the author to include only the abbreviated method of programming drawings by means of DRAWL data cards. The results have been most gratifying. Students develop a capability to prepare fully dimensioned multiview and pictorial drawings of simple industrial type objects during this time.

The text (1) now being used for this course was developed by the author from his notes, based upon documentation of his work in computer graphics over the past several years. The method of teaching and the description of activities are as follows:



Following is an outline for instruction of computer graphics for freshman graphics classes. Each item represents a lecture subject, and corresponds to a chapter heading in the text. Appropriate class room time is given following each lecture for workshop in that phase of instruction. Each workshop period involves a further step in the execution of a computer graphics drawing.

- Introduction and Two-Dimensional Drawing.
- Transformations, Three-Dimensional Drawing, Collection of Parts into Assemblies
- DRAWL Library of Parts, Scaling, Dimensioning
- Envelope of Lines, Perspective Drawing.
- Overlaying of Drawings, CalComp Plotter.

An electrostatic type plotter located in the University Computing Center has been available for use by the student. Although the overall plot size produced is small (10"x10") this has served well as a graphic output device for student work since plots are generated instantaneously. Through a National Science Foundation Grant, the author sought and obtained approval for the installation of a drum type plotter. This plotter was operable by the 1979 Spring semester, and greatly enhanced the work in computer graphics. Because of the greater time and expense required to operate this plotter, only selected final drawings are run on this machine. The drum plotter installation includes a small cathode ray tube for communication with the computer center. Work is presently going forward to program the system to display a programmed drawing on the tube. In this way a drawing may be checked out before being drawn on the plotter.

The foregoing shows how a modest system for teaching computer graphics may be improved and enhanced as means become available. However, emphasis is made here that work toward a computer graphics capability was begun at Mississippi State before a plotter of any sort was available. At the start, the computer was programmed to print-plot, with asterisks, the points generated in the program of a drawing. By visualizing the imaginary lines connecting these points, the drawing could be reviewed and checked for accuracy. In the interest of economy, a plan is presently being considered to revert to print-plotting (the drawing, in asterisks, appears with the program on regular print-out paper) for the bulk of student exercises, reserving the plotter for more important final drawings.

Mississippi State University, like many other medium-to-large institutions, has found that implementation of computer education for students in this computer age is not only expensive in computer time involved, but also it is enormously expensive in maintaining the necessary equipment for student use. Traditionally, the "batch-card" method has always been used for education and research; but, key-punch machines are mis-used, abused and eventually wear out. Card-readers become antiquated and costly to maintain; and as always, personnel in non-tenured positions move on to better opportunities offered by industry. Therefore, plans are underway to replace all of the key-punch/card readers on the main campus with CRT consoles for every department which uses the main computer facility. How this change-over will affect the computer graphics program at Mississippi State University is a question which will only be answered in time.

Other computer graphics systems involving mini-computers with their own software or languages are now being offered on the market. Some departments on this campus have already purchased such hardware/software for their own teaching and research requirements. However, none of the systems seem to have the capability that the DRAWL language has. Discretion should be employed when considering these systems to avoid possible limitations. Capability for three-dimensional work, curve-fitting, annotations and dimensions, etc. should be investigated.

The DRAWL language has been tested and proven in the class room. It makes use of the capacity of central computer. The DRAWL software can be made available with adjustments to suit most approved type computer systems. It is an extrememly powerful, yet simple to use language for drawing composition. It provides an infinite variety for three dimensional work in pictorials. For these reasons and because of the experience outlined in this article, the DRAWL is recommended as a machine language for teaching computer graphics.

Finally, it should be evident from all of the above that highly sophisticated equipment is not essential to the teaching of practical class room computer graphics.

REFERENCES

(1) Practical Computer Graphics, published by W.B. Pearson, c 1979.

(2) Computer/Plotter Drawing with DRAWL Data Cards, published by W.B. Pearson, c 1979.

PUZZLE CORNER

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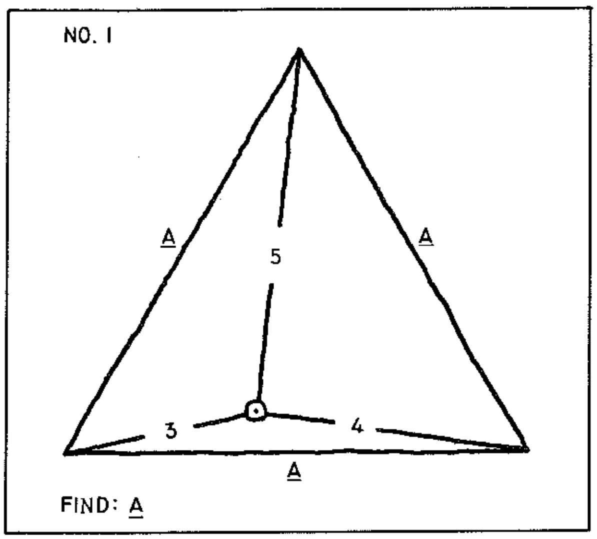

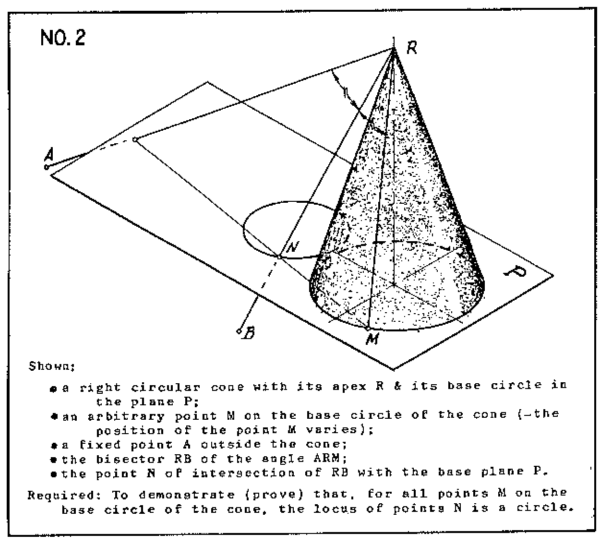

We have two new puzzles this time; No. 1 is a suggestion from Dick Leuba of North Carolina State University and No. 2 is from Abe Rotenberg of the University of Melbourne, Australia. Our own approach to Abe's puzzle is to plot piercing points to "see" if they form a circle but Abe makes the point that just because they might look like they form a circle doesn't mean they do form a circle. He says a proof/demonstration exists without resorting to inductive reasoning.

Mail solutions before March 1, 1981 to:

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Ruston, LA 71272

We want to thank Walter Brown of Santa Rosa Junior College, Santa Rosa, California, for inspiring the Spring '80 problem.

Fig. 1 (a pictorial) and Fig. 2 are from Chi-Di Lin of The Anhwei Institute of Technology, the P. R. of China, and is the General Solution to the Spring '80 puzzle. bc and de are the given lines. Line ab is constructed parallel and equal-length to de. (For clarity de is not projected into the auxiliaries but if done so will always appear equal-length and parallel to ab including the final auxiliary where a typical solution is seen.) In order to achieve the view such that the apparent lengths ratio of the two lines is, say, 2:3, point g is located on ab such that it divides ab into a length one-half of ab and point k is located on bc such that it divides bc into a length one-third of bc. Line gk is drawn and a (elliptical) cone is constructed with apex at b and a circular base plane perpendicular to gk at midpoint M. The determination of the diameter length is apparent from the Fig. 1 pictorial. The elements of this cone represent all the lines-of-sight which will yield all of the solution views, i.e., it is the General Solution.

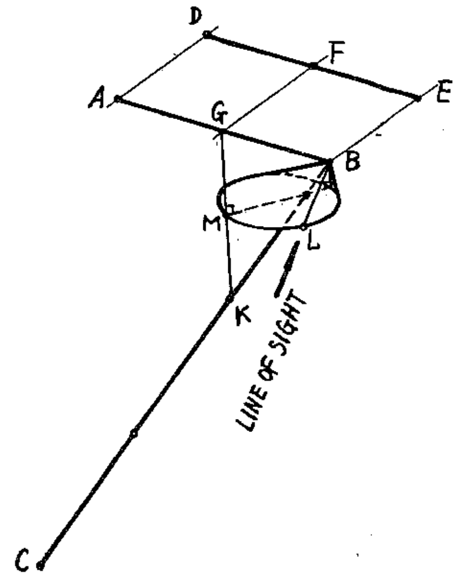


FIGURE 1

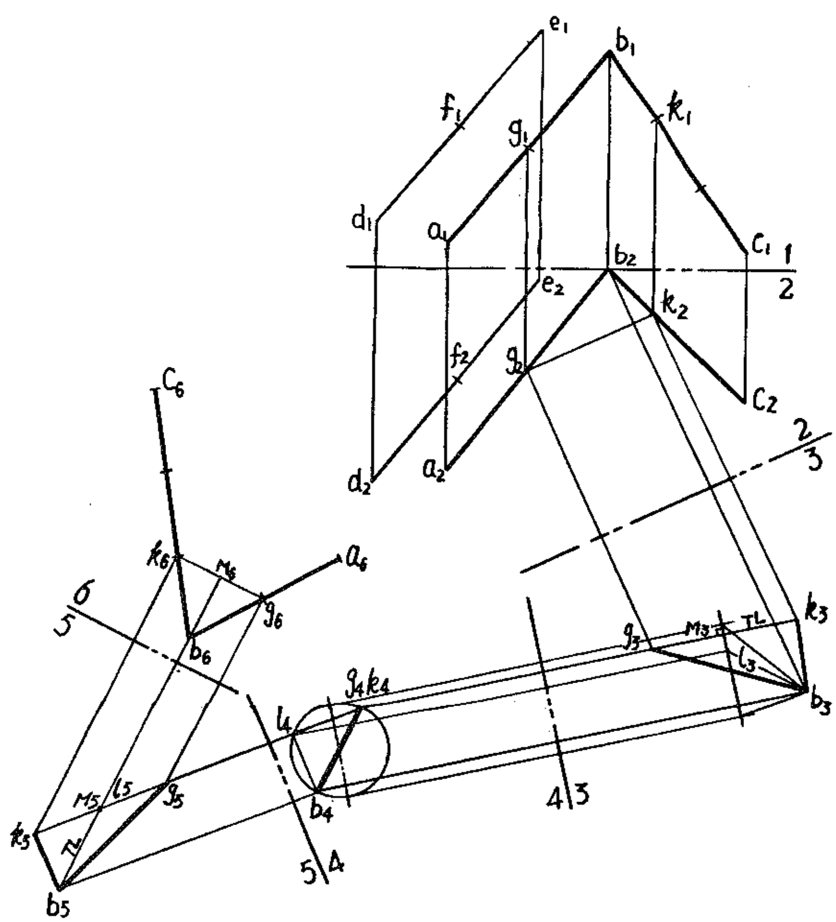


FIGURE 2

For comparison, Fig. 3 is a rerun of the General Solution such that any pair of nonparallel lines will appear equal-length, i.e., the "specified" ratio is 1:1. (We call it the Rotenberg Equal Length General Solution after its originator, Abe Rotenberg.)

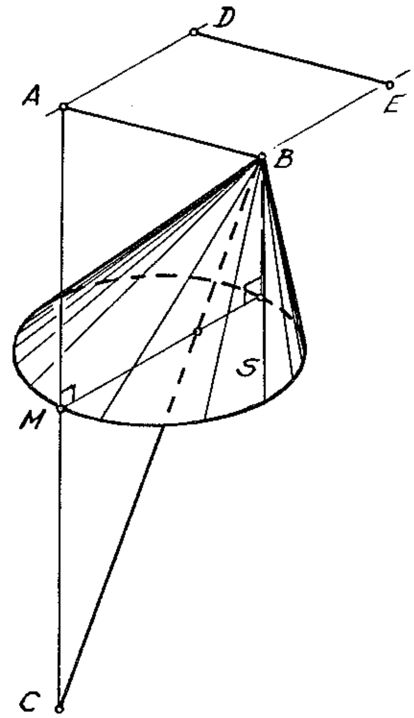


FIGURE 3

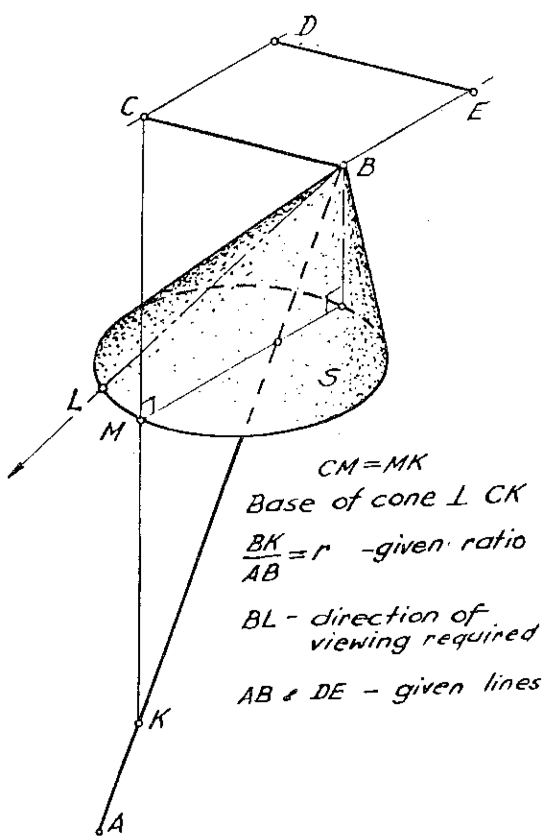


FIGURE 4

Spring 1980 Puzzle	
Given:	Adjacent orthographic views of two skew lines in general positions and of general lengths.
Determine:	An orthographic view(s) such that the apparent lengths of the given lines are of a specified ratio.

Fig. 4 is Abe's solution to the Spring '80 puzzle. Note the "reciprocal" type approach as compared to Chi-Di Lin's.

Fig. 5 is a "filler" which ran in the Winter '79 issue. Additional solutions to Fig. 5 are shown in Fig. 6 and are from Mr. Wang Shu of the China University of Science and Technology, Hefei, Anhui, The Peoples Republic of China.

Fig. 7 is also from Wang Shu and is closely related to the Fig. 6 problem. His graphics are as elegant as his solutions. They are drawn very nearly to the size seen reproduced here. These solutions seem to lead to Fig. 8. Does a solution exist and if so is there a limit to the number of concentric circles for which solutions exist?

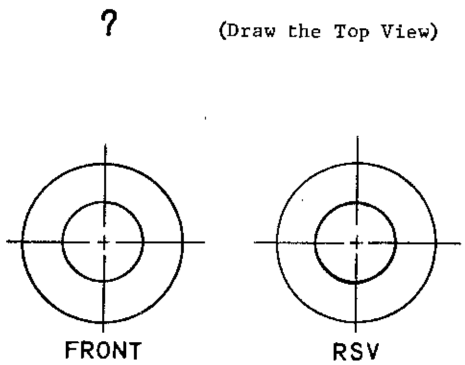


FIGURE 5

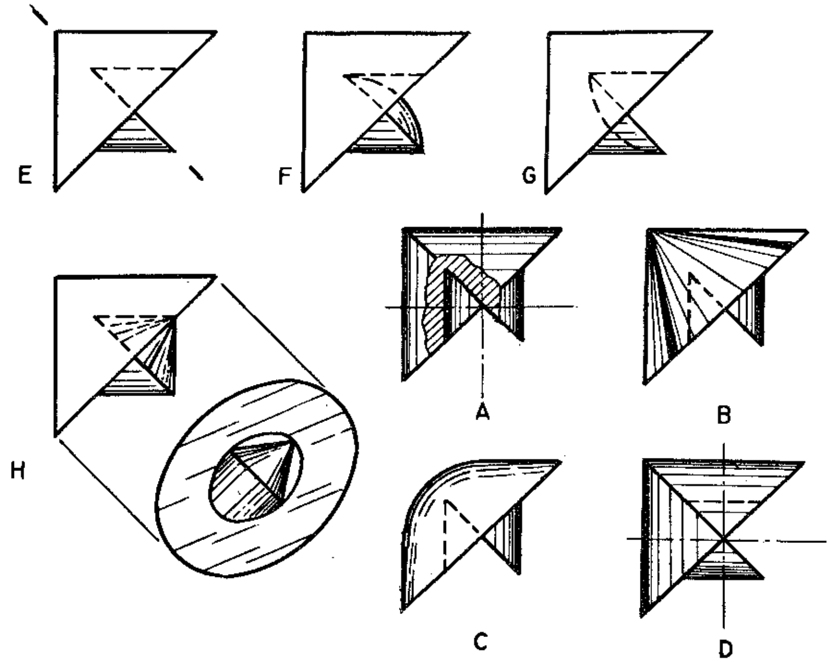


FIGURE 6

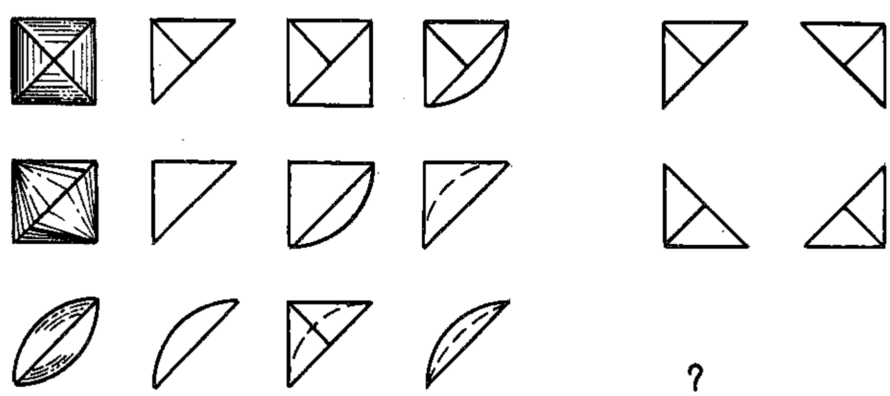
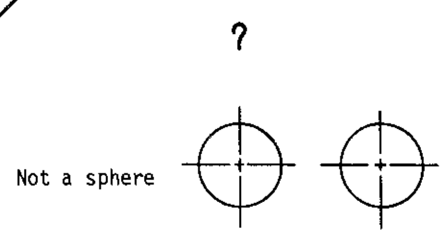


FIGURE 7



? (Draw the Top View)

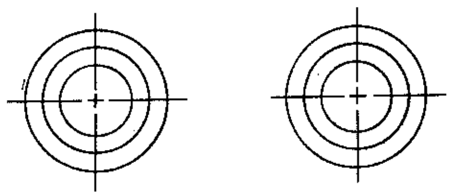


FIGURE 8

For the Perplexahedron addicts -- and this includes me, (see EDGJ, Vol. 43, No. 1 to Vol. 44, No. 2) there are two new solutions, these from Chi-Di Lin: Fig. 9 and Fig. 11. All previous "no calculations" solutions rely on determining the line-of-intersection between two elliptical cones by standard cutting plane methods which means plotting an elliptical curve which inevitably means some degree of "approximation". Chi-Di Lin avoids this by using the phenomenon that conjugate axes of an ellipse project as appearing perpendicular and equal-length in the view where the ellipse projects as appearing as a circle.

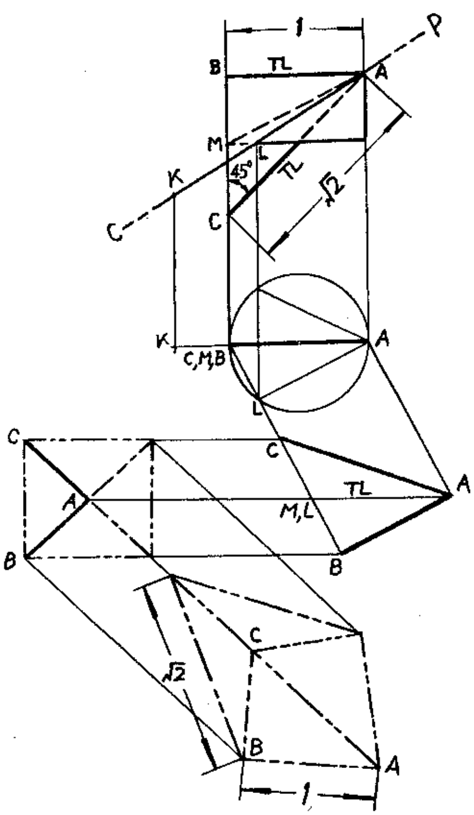


FIGURE 9

In Fig. 9, ABC is one of the planes of the Perplexahedron. Chi-Di Lin treats AB and AC as conjugate axes radii of some undrawn ellipse. Then by Plane Geometry techniques (see Fig. 11) he constructs the major axis (radius), AK, of that ellipse. This major axis corresponds to the line-of-intersection between the two cones in the top view. The problem is then solved by completing the view in which the line-of-intersection appears as a point.

The reason the major axis corresponds to the line of intersection in the top view, Chi-Di Lin argues, is that when the ellipse is viewed as a circle the line of sight will be parallel to a (cutting) plane which-must-be-perpendicular-to-the-plane-of-the-ellipse-and-which-must-also-intersect-the-plane-of-

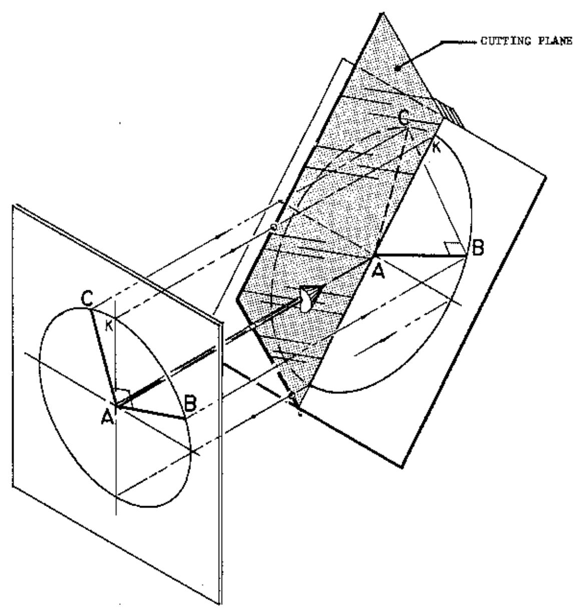


FIGURE 10

the-ellipse-along-the-major-axis. Fig. 10. It follows, then, that the line of sight will be the line of intersection this plane makes with either or both of the two General Solution cones (the "Rotenberg Parallel Lines Cone" and/or the " 'Corner's Perpendicular Lines Cone") which is to say that the lines of intersection created by the cutting plane are also the lines of intersection between the two cones!

1. AD=AC. D is on CB extended.
2. DO=OB.
3. With O as the center and OA as the radius, strike a circle arc intersecting CB extended at E and F.
4. Then BE=AK=$\frac{1}{2}$ major axis and FB=AG=$\frac{1}{2}$ minor axis.
5. A$\overline{G}$=AG (The ellipse needn't be constructed.)

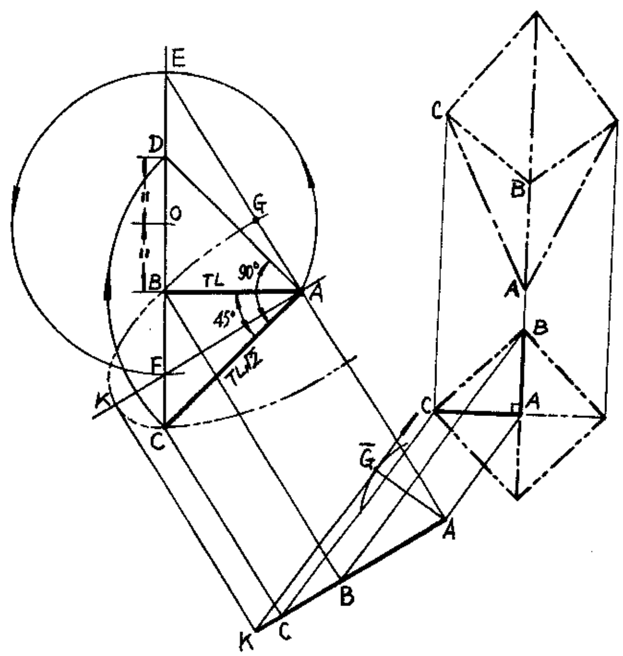


FIGURE 11

In Fig. 11 the first auxiliary is achieved by projecting perpendicular-to-the-major-axis-AK-and-parallel-to-the-minor-axis-AG in order to keep the major axis TL and also show the minor axis as a point in the EV-of-the-plane-of-the-ellipse. The problem then becomes one of finding the direction of projection such that the major axis AK will appear foreshortened to equal (the TL of) the minor axis length AG in order to achieve the circle view of the ellipse (which is where the conjugate axis, AB and AC, will also appear perpendicular and equal-length.) This is accomplished by striking a circle arc of radius length equal to AG, A$\overline{G}$, from one end, A, of the major axis and projecting from the other end, K, in a direction which is perpendicular to A$\overline{G}$, i.e., tangent to the arc.

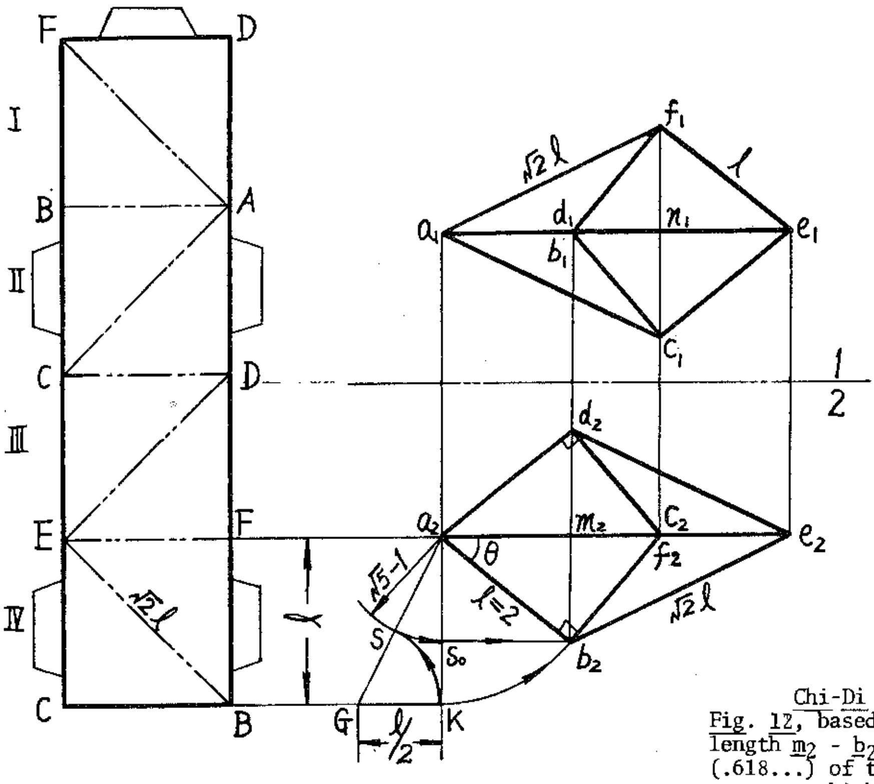


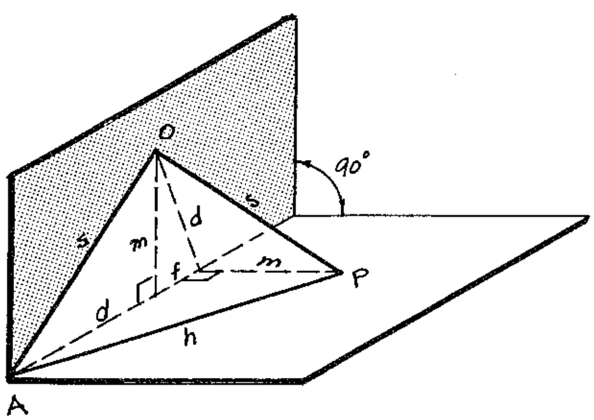
FIGURE 12

Chi-Di Lin also furnishes another solution, Fig. 12, based on a calculation that shows length m_2 - b_2 is equal to the golden section (.618...) of the unit length ℓ and shows the geometry which yields that length as it is applied to the Perplexahedron.

Since several solvers have used that calculation it is shown here as submitted by Dick Leuba: Fig. 13.

'See ya in the spring issue.

PAT



AOP: Right △

s = 1

h = $\sqrt{2}$

Find: m

FIGURE 13

$h^2 = 2s^2$

$m^2 + d^2 = s^2$

$f^2 + m^2 = d^2$

$(d + f)^2 + m^2 = h^2$

Pythagorean expressions from the diagram

combining these formula and simplifying...

$$s^4 - 3m^2s^2 + m^4 = 0$$

letting s = 1...

$$m^4 - 3m^2 + 1 = 0$$

applying the quadratic formula and solving for m,...

$$m_{1,2} = +1.622 \ldots \left(\pm\sqrt{\frac{3+\sqrt{5}}{2}} \right)$$

$$m_{3,4} = +0.618 \ldots \left(\pm\sqrt{\frac{3-\sqrt{5}}{2}} \right)$$

since m < s, and since m is positive...

$$m = 0.618\ldots \text{or}$$

$$m = \sqrt{\frac{3-\sqrt{5}}{2}}$$

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Take some more tea the March Hare said to Alice earnestly

I've had nothing yet Alice replied in an offended tone

so I can't take anymore.

You mean you can't take

LESS said the Hatter.

It's very easy to take

MORE

than nothing.

ALICE IN WONDERLAND · GW · LEWIS CARROLL

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