ENGINEERING DESIGN GRAPHICS JOURNAL

FALL 1977 VOLUME 41 NUMBER 3

Percy Hill

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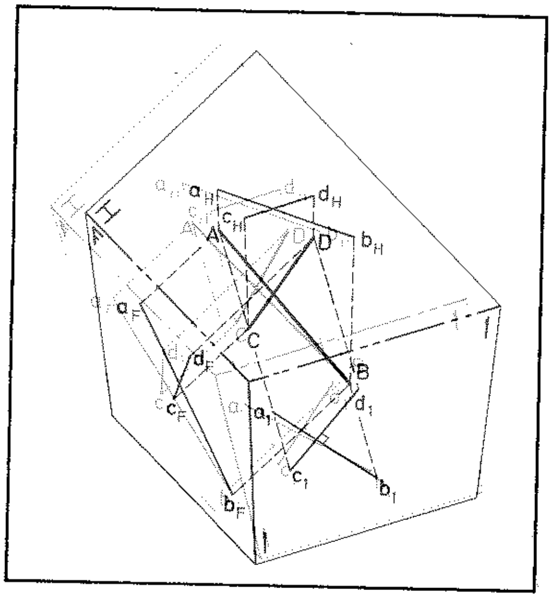

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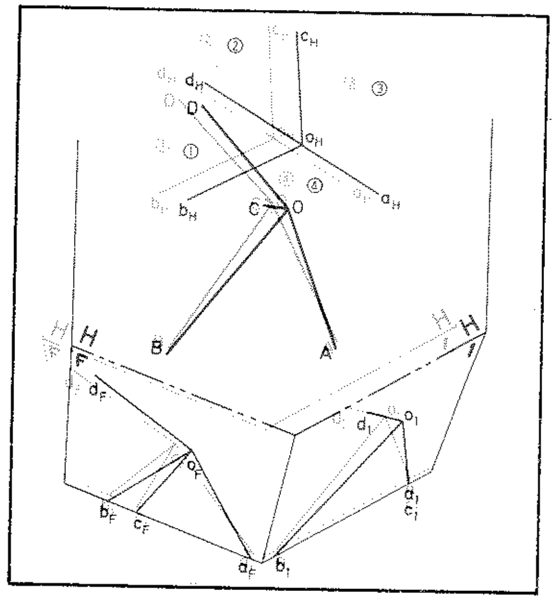

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CALENDAR

ASEE ANNUAL CONFERENCES

1978-University of British Columbis, Vancouver. June 19-22

1979-Louisiana State University

1980-

1981-University of Southern California.

EDGD MIDYEAR CONFERENCES

1978-University of Alabama, January 1978

1979-Mississippi State

1980-Cogswell College

1981-North Carolina State

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 practioners 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 practioners 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 appropriate 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.

STYLE GUIDE FOR JOURNAL AUTHORS

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

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 such 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 8-1/2 x 11. If necessary, make 8-1/2 x 11 or smaller photo copies 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.

6. Please make all changes in your manuscript prior to submitting it. Check carefully spelling, structure, and clarity 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 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:
Paul S. DeJong, Editor
403 Marston Hall
Iowa State University
Ames, Iowa 50011

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 newsworthy items will not be reviewed in this manner, but will be accepted at the discretion of the editors.

deadlines for author

DEADLINES FOR AUTHORS AND ADVERTISERS
The following deadlines for the submission of articles, announcements, or advertising for the three issues of the JOURNAL:
Fall--September 15
Winter--December 1
Spring--February 15

THE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

Engineering Design Graphics Journal

FALL 1977 VOLUME 41 NUMBER 3

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LETTERS

To The Editor,

As many of the Journal's readers know, metrication has been a favorite topic of mine for several years. Thus I read with particular interest Mr. Leidel's article in the Winter '77 issue entitled "We've Got Those Metrication Blues". I believe the author touches upon a subject which needs discussing. The matter of appropriate metric drafting scales has not received the attention it should.

My personal preference in this matter is to utilize scale ratios which follow the pattern of the "preferred series". This would be in accord with the thinking of the Geological Survey. The producers of the topographic quadrangle maps seem to be leaning towards adopting a modified form of the R10 series of preferred numbers,, both for map scales and contour intervals. The true R10 series includes the numbers 1.00, 1.25, 1.60, 2.00, 2.50, 3.15, 4.00, 5.00, 6.30, and 8.00. The Geological Survey, however, will limit itself to the use of the numbers 1,2, and 5. Thus suitable topographic map scales would be:

1: 10 000	1: 100 000	1: 1 000 000
1: 20 000	1: 200 000	1: 2 000 000
1: 50 000	1: 500 000	1: 3 000 000

Contour intervals are proposed to be 1, 2, 5, 10, 20, 50, or 100 meters. The rational system of preferred numbers constitutes the basis for most metric engineering standards. It would seem logical to standardize drafting scales using the same rationale. My suggestion would be to consider the following range of scales for use on engineering drawings:

1: 0.1	1:1	1:10
1: 0.2	1:2	1:30
1: 0.5	1:5	1:50

These ratios would also have the advantage of following the simple decimal pattern inherent in the metric system, rather than being expressed in fractions.

Hopefully, the EDG Division's ad hoc Metric Committee can address itself to this question of proper scales and encourage other professional engineering societies to agree on a set of standard drawing scales. Thank you for the opportunity to participate in this discussion.

Klaus E. Kroner
University of Massachusetts

THE IMPORTANCE OF DESCRIPTIVE GEOMETRY IN SECONDARY AND UNIVERSITY TEACHING.

For many years the teaching of descriptive geometry in high schools and universities seems to have been rather neglected. At least such is my experience during 45 years of teaching. Not only in the instruction at technical schools of all sorts but also in the teaching of natural sciences the capacity of visualization of 3-dimensional objects is essential. But only a small part of students possess this capacity to a considerable extent, sufficient for these branches of science. (Only about 20%) The rest has to attain it by systematic training which consists in methodical learning of descriptive geometry. It is needless to speak about the necessity of visualization in the different technical sciences where the application of descriptive geometry is obvious. But also in anatomy, surgery, X-ray diagnostics, biology, biochemistry, astronomy, aeronautics, modern chemistry in general, especially in crystallography the capacity of visualizing objects in space is indispensable. Here are some examples. How should a student perceive the anion $B_{12}H_{12}^{-2}$ where the ligands (atoms of Bohr) are situated at the vertices of an icosahedron and the atoms are exchanged for atoms of carbon when certain other chemical compounds are formed? How could he see the crystalline struture when it consists of elementary cells repeating themselves periodically by translation in three different directions? Is it possible to understand in chemical kinetics a reaction where in the beginning the atoms are arranged in one way and at the end in another without visualizing the pattern in space?

The insufficient teaching and deficiency in knowledge of descriptive geometry is felt in technical sciences since a good many years. One could hardly deny the necessity of studying general surfaces of higher order mathematically defined or empirically obtained for the purposes of construction of machines. The theory of shells in architecture and engineering is closely connected with the theory of ruled surfaces. Only descriptive geometry can furnish the constructive treatment of such surfaces. Would it not be useful to enlarge the programs of engineering schools in this respect? In the theory of shells strong mathematical tools are necessary, mostly partial differential equations. But what is the use of the solution of such an equation if there is no mental picture of it in space? Many problems in this domain can be treated exactly or with high approximation by graphical methods which may prove to be rather simple if a good knowledge of descriptive and synthetic geometry is applied. For instance, the two main curvatures and the Gaussian curvature in some point of the surface can be determined by such means and also many other things. Photogrammetric and aerophotogrammatric problems in geodesy can be thoroughly understood only by a good knowledge of descriptive geometry and a well developed capacity of visualization.

It would be desirable to improve teaching by giving descriptive geometry more attention and enlarge the program or introduce this discipline in schools where it is needed.

Dr. Vilko Nice
Professor
Kaciceve ul. 36/III
41000 Zagreb, Jugoslaviga

EDITOR'S PAGE

Frank M. Croft
University of Louisville
Associate Editor, EDGJ

A FEW SALUTES..........

I never cease to be impressed by the calibre of people who make up the EDGD and it is a source of great satisfaction and a rather tough measure to live up to if one is to keep their company. Just a brief scan of this issue will bring you in contact with some terrific people..... the candidates, authors, officers, and of course, Percy Hill, the deserving DSA recipient. Congratulations again, Percy.

Along this line, another fine person, Garland Hilliard, had to give up his work as Associate Editor when he was elected circulation manager. The Division, Jim Earle and I all owe Garland a vote of appreciation for his hard work on the Journal.

We also want to recognize the wives and husbands of these people for their patience and support. Particularly we want to thank Charlotte Hill, Percy's charming wife. We hope we will continue to see them both at future meetings.

And an introduction..........

I was really a bit concerned where to find a dynamic individual to fill Garland's rather large professional shoes, but Frank Croft responded to a call put out for a volunteer at Grand Forks.

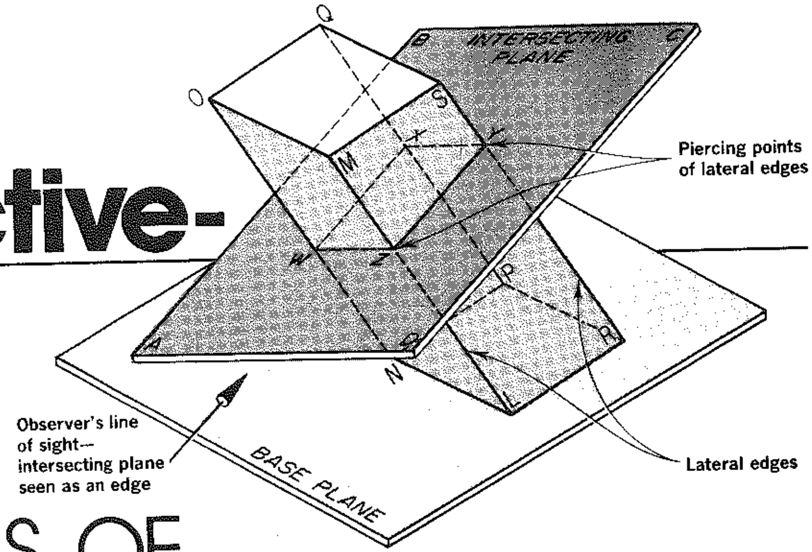
Frank has taken this particularly pugnacious bull by the horns and done an admirable job with this, his, first issue, and has earned a real vote of confidence and our gratitude for it. Gathering the Division news is a big task and requires a lot of backup work that never shows. I hope all committee chairmen and others with Division activity interest items will get in touch with Frank, with their announcements.

Frank, who holds a B.S. in Aerospace and M.S. in Civil Engineering, is an associate professor of Engineering Graphics and Civil Technology at Speed Scientific School at the University of Louisville, a position he took about a year ago after a stint at West Virginia Tech. Before getting into the teaching game, he spent four years at McDonnel-Douglas where he supervised and coordinated special graphics for printed circuits and similar items.

Glad to have you on the staff, Frank!

Paul S DeJong

A New Perspective-



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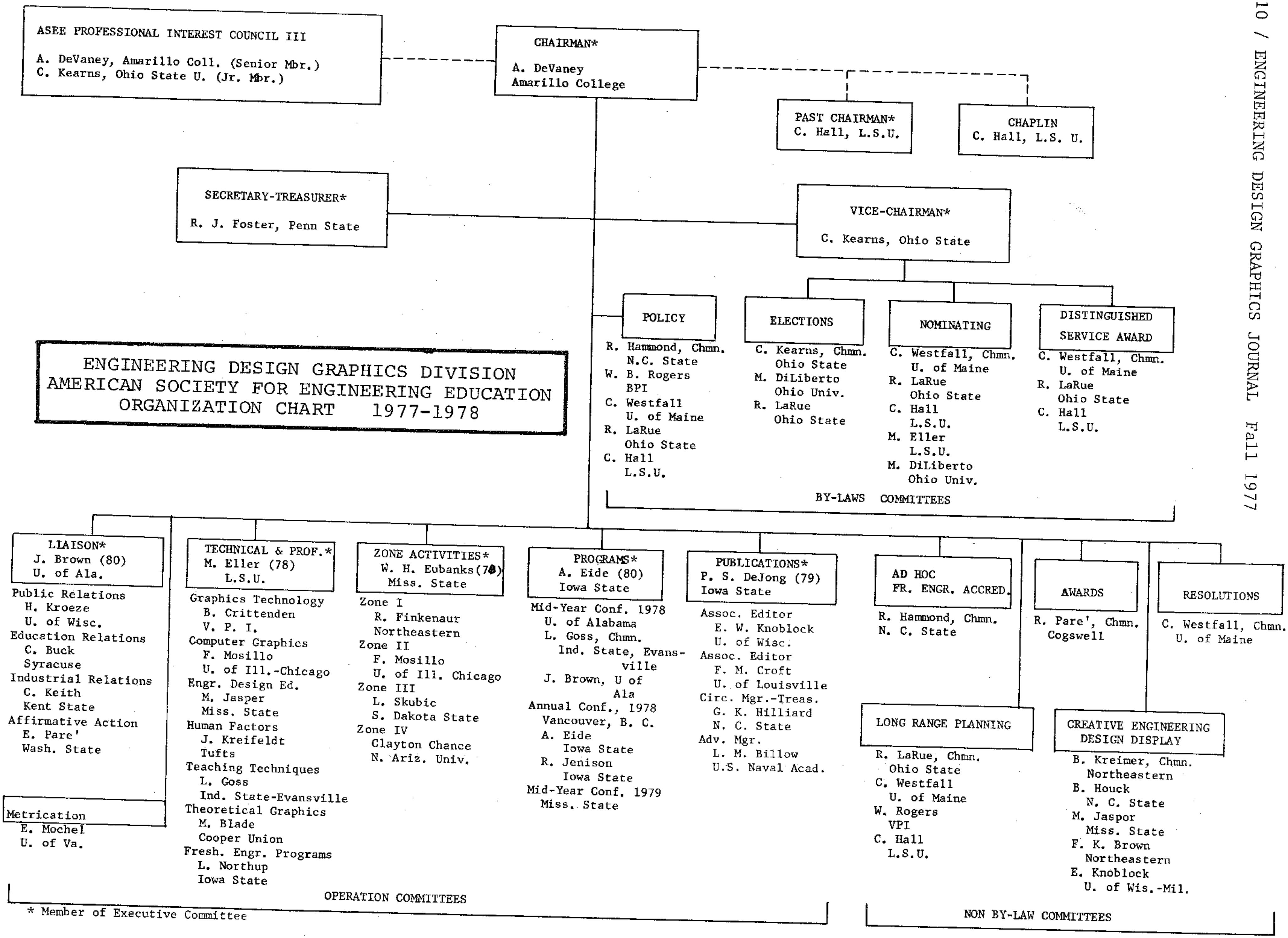

* Member of Executive Committee

Chairman's Message

Amogene F. DeVaney
Amarillo College
Chairman, 1977-78

I would like to begin my year as chairman of this Division by thanking each of you for your confidence in me and for giving me this opportunity to repay the Division in a small way for the contribution it has made to my professional growth over the many years that I have been a member. It would have been difficult to gain the insight into this discipline without active participation in the conferences and reading the Journal of this Division.

My first act as chairman is to thank the 1976-77 officers for their work in the Division. Clarence Hall worked most diligently on behalf of this organization with ASEE officials, various Sections and Divisions. He is outspoken and staunch in his support for the Division. Robert LaRue, as past chairman, was most helpful with advise and guidance when it was needed. Past chairmen play a very important part in the operation of our Division, and this help is sincerely appreciated by new chairmen.

The Division is endebted to Robert Hammond and the Policy Committee for giving us such a workable set of By-Laws. The Directors of the various committees are functioning well. In an organization such as ours, communication is difficult. It takes so long to send out information and receive a response that chairmen of committees often become discouraged. However, it is through these Directors and their committees that much of the real activity of the Division takes place. I want to thank each of the Directors and members of their committees for the time they devote to the work of the Division.

In behalf of the Division I want to recognize the dedication of Gordon Sanders and Klaus Kroner who go off the Executive Committee this year. They have both made valuable contributions to the Division over a period of many years. It hardly seems adequate to just say, "Thank you. The work you have done is greatly appreciated."

Our special thanks to Tim Coppinger and Claude DeGuise for the fine Mid-Year Conference in Montreal, and to Margaret Eller who arranged an excellent program for the Annual Conference in Grand Forks. I am sorry that any of you had to miss the opportunity for growth that these conferences provided. Planning a program that will meet the diverse interests of our membership is a challenge to our Director of Programs and his chairmen. Let Arvid Eide know what you would like.

This year, 1977-78, promises to be an exciting one for the members of the Division. I am pleased that I will serve as your chairman for our Fiftieth Anniversary Year. All of our programs this year will reflect this theme. Plan to attend the conferences and help commemorate this Year. The Mid-Year Conference will be held at the University of Alabama with Jack Brown as host and Larry Goss as Program Chairman. The years activities will culminate in the International Conference on Descriptive Geometry in Vancouver, B.C. which will be followed immediately by the Annual Conference of ASEE. Clarence Hall is Program Chairman for the International Conference and Arvid Eide, Director of Programs, will be chairman of the Annual Conference program. He will be assisted by Roland Jenison. The Executive Committee approved the appointment of a Long Range Planning Committee which will consider trends in engineering education and how the Division can best meet the needs of our membership in light of these changes. Robert LaRue will be chairman of this committee. The Awards committee under Ron Paré will consider the suggestion that the Division set up additional awards to recognize unique contributions to the Division and to Engineering Graphics.

The Journal continues to offer vital contribution to our discipline. I want to thank Paul DeJong and his staff for the continued excellence of the Journal. The Newsletter which was authorized last year by the Executive Committee is a welcome vehicle for communicating with our membership. Let me know what you think of it.

Through the efforts of previous administrations this Division is well organized and financially strong. The Division has always operated on the basis of limited financial resources. All projects must be financially self-supporting. For example, the Creative Design Display Committee received some money initially from ASEE, but it now depends on industrial contributions for its continued operation. We are fortunate that this project has been as outstanding success which is principally due to the people who put it together. For the past two years Menno DiLiberto and his committee have done an excellent job with the Display. The International Conference on Descriptive Geometry to be held in Vancouver in 1978 must pay its own way through registration fees, since the ASEE Board did not grant the funds which we requested. Financial considerations sometimes prevent us from doing things for our membership that we would like to do; however, the Executive Committee decided again this year not to assess Division dues. Look over the budget for 1977-78 which appears elsewhere in this Journal.

The entire Executive Committee and I will do our best for the Division in 1977-78, but progress can only be achieved through your support, your work and your enthusiasm. While we have been elected to carry on the business of the Division, we can only do this as you would like it done if we know what you desire. We invite your comments, suggestions and criticism. It is through our mutual effort that we will make this a dynamic year for the Engineering Design Graphics Division.

Mid-Year Conference

UNIVERSITY OF ALABAMA

The Engineering Technology faculty of the University of Alabama will host the Mid-year Conference of the Engineering Design Graphics Division of ASEE. Make plans now to attend the conference in Tuscaloosa, Alabama on January 5 and 6, 1978. Activities will begin on Wednesday afternoon, January 4, with a visit to a large lock-dam of the Black Warrior River System which annually moves more tonnages than the Rhine River in Europe. The tour will be followed by a reception sponsored by the exhibitor at the Conference.

The University's 270 academic programs and 16,000 students are served by approximately 900 faculty members and 550 administrators and other professionals. Numerous motels and restaurants are located within easy access to the campus. Facilities for lodging and meals will be handled by the host committee at a reduced cost; however, each attendee may make his own reservation. No accommodation shortage is expected to occur.

Tuscaloosa, a sprawling community of 80,000 population is located on the banks of the Black Warrior River. Its history, as well as that of the University, dates back to the early 1800's. Several fine examples of antibellum homes can be seen on the streets of the older parts of the town. The historic buildings on the University campus include the President's Mansion, considered one of the finest examples of Greek Revival architecture in America.

The climate is mild. The lowest average temperature is 46.9°F which occurs in January. The annual rainfall of 52.46 inches is fairly well distributed throughout the year.

Tuscaloosa is served by Southern Airways. Transportation will be provided between the airport and the campus.

Registration forms will be mailed in ample time for you to make your plans to attend. In the event that you do not receive one, please contact Dr. Jack C. Brown, Chairman Host Committee, Box 1941, University, AL 35486, telephone (205) 348-6320.

PROGRAM

ENGINEERING DESIGN GRAPHICS DIVISION

This year's theme for the Mid-Year Conference is "Update in '78". In keeping with this theme, many of the papers to be presented will report on the latest developments in a number of areas of interest to our members. Four main topics have been selected for emphasis at this year's meeting: computer graphics, SI units, engineering design, and the freshman engineering program. As of this writing the following list of titles and authors have been accepted for the program:

Using Graphics to Teach Computer Programming-John T. Dremel

The Graphics Van-C. Fred White

Application of Human Factors to Engineering Design-C. L. Mauro

Engineering Design-A Necessity for Engineering Education-Lee Harrisberger

Photogrammetric Application of Descriptive Geometry-J. E. Parker

SI Units in Descriptive Geometry-Frank M. Croft

Metrics in the Supermarket-L. D. Goss

The Freshman Engineering Program-Robert H. Hammond

Using Computer Programming to Teach Graphics-Robert D. LaRue

Acceptance of several other papers is pending. Time is being set aside in order that the Dividion Committees can meet to allow members of each committee to plan inputs to the Annual Conference.

Larry D. Goss
Program Chairman
ISUE

ASEE Annual Conference

ABOUT GRAND FORKS......

Professor Margaret Eller
Louisiana State University

One of the usual features of the Fall issue of the Journal is a summary of the Annual ASEE Conference held in June. Although written for the benefit of those members who could not be present, an objective summary is valuable in evaluating the events and activities that took place. Program chairmen, however, are hardly the ones most capable of writing an objective summary. They are naturally biased; the events which they schedule are always outstanding.

The Engineering Design Graphics Division program, although not tied into the ASEE theme: "Food, Resources, Energy, and Environment: the Critical Interfaces" (FREE), contained events that were of interest to various groups.

Mary Blade produced a session on Spatial Geometry Problems, which served to give us a taste of, and whet our appetites for, the June '78 Descriptive Geometry Workshop in Vancouver. Other speakers in her event were Kalinath Mukkerjee, Thomas Elsner, and Walter Cibulskis.

A session devoted to Computer Graphics was directed particularly to those of us who wanted to know everything about how to begin teaching the subject and were afraid to try. Francis Mosillo reported on his experience with a large class. A small class experience was described by Carl Gausewitz, and an account of the evolution of a year's course of study was given by Robert Beil.

A Human Factors session, moderated by John Kreifeldt, featured Charles Kubokawa from NASA, Tom Cannon, president of his own company, and Stephan Habsburg from General Motors Design Staff. These representatives from industry focused on the problems involved in designing new products for humans.

Other sessions in which the EDGD was a co-sponsor were produced by the Metrication Committee and ERM, a Division which is always very creative in its "Creativity" sessions.

One of the most important results of this Conference was the forming of a new Technical-Professional Committee for Freshman Engineering Programs. A structured session on Tuesday morning and a rap session on Thursday brought out a surprising number of attendees.

The Creative Design display was expertly conducted by Menno DiLiberto and is a good story by itself.

The Awards Banquet and business luncheon were held off-campus and were well attended. Although exact numbers are not available, it is a fair estimate that between 60-70 members of the EDGD attended the Conference.

The University of North Dakota provided excellent accommodations, meals, and services, including regular and emergency transportation. The June weather was somewhat chillier than some of us expected-particularly those of us from the South. However, the excitement of meeting old friends and renewing acquaintances served to keep us warm. The more EDGD Conferences we attend, the more we look forward to attending the next one.

SEE YOU IN ALABAMA!

Margaret Eller
Program Chairman
LSU

Creative Engineering Design Display

The Tenth Annual "Creative Engineering Design Display" for 1977 was held at the University of North Dakota in Grand Forks, North Dakota. Although things got hectic at times, Dr. Menno DiLiberto, Committee Chairman, Ohio University, reports the responsibility for this year was made a lot easier due to the hard work of the following committee members: Mary Jasper, Mississippi State; Ron Pare', Cogswell College; Leon Billow, Naval Academy; Robert Snortland, University of North Dakota.

A total of 49 design projects were on display at this year's conference and the number of entries in each category was as follows:

	1977	1976
Freshmen	29	32
Sophomore	3	4
Junior	2	5
Senior	14	12
Graduate	1	0
	49	53

The winner's in each category were -

FRESHMEN CATEGORY

First Place: University of New Mexico
Kaibito Irrigation Project

Second Place: University of Wisconsin-Milwaukee - Project Center Stand

Third Place: Arizona State University
The "Watt Watcher" Automatic Lighting System

Fourth Place: Iowa State University
Electrical Automatic Shut-Off

SOPHOMORE CATEGORY

First Place: University of Wisconsin-Milwaukee - Back to the Cartridge

JUNIOR CATEGORY

First Place: Northeastern University
Design and Analysis of a Hydrofoil Craft

SENIOR CATEGORY

First Place: University of Bridgeport
The Free Rotating Hull Concept "A"

Second Place: U.S. Naval Academy
The Design of a Training Ship for the Naval Academy--YP675

Third Place: Northeastern University
Urban Vehicle

GRADUATE CATEGORY

First Place: University of Wisconsin - Milwaukee - Parking Analysis and Community Development Study

The committee wishes to acknowledge the following individuals who gave of their time and expertise to evaluate this year's entries:

Prof. Daniel L. Babcock
University of Missouri-Rolla

Dr. Lionel V. Baldwin, Dean
Colorado State University

Dr. H. Maurice Carlson
Lafayette College

Dr. Leslie A. Clayton, Chairman
Boyle Engineering Corp.

Dr. Edward J. Cook, Assoc. Dean
U.S. Naval Academy

Dr. Stuart Coward
North Carolina State University

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General Motors Institute

Mr. Paul Doigan
General Electric Company

Dr. Basil R. Myers, Dean
University of Maine at Orona

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Dr. David R. Reyes-Guerra
Engineers Council for Professional Dev.

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Dr. John P. Uldrick, Prof.
U.S. Naval Academy

Dr. Lyle C. Wilcox, Dean
Clemson University

Dr. Carl Zorowski, Head
North Carolina State University

Prof. Richard Kombrink
California Polytechnic State Univ.

David Schumacher
North Virginia Community College

John McDonough
University of Maine-Orono

The committee wishes to acknowledge the following companies for their financial support which allowed us to award plaques and certificates to each of the winners:

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Union Carbide Corporation
Wiley & Sons, Inc., John

In addition, we gratefully acknowledge the Freshmen Memorial Award for the family of James S. Rising.

In conclusion, the committee wishes to thank all those who helped make the 1977 Creative Engineering Design Display a success. If you have any recommendations or suggestions for next year's display, please send them to our display chairman for next year, Professor Borah L. Kreimer, Northeastern University, 360 Huntington Avenue, Boston, Mass., 02115.

KROEZE TO METRIC BOARD

Henry Kroeze, of the University of Wisconsin at Waukesha has been nominated by the White House to serve on the United States Metric Board and should be confirmed by the Senate soon. This board, created by the Metric Act of 1975, will set policy, coordinate systematic changeover, and influence

dinate systematic changeover, influence new standards, and work for uniformity of codes. Professor Kroeze is one of only about 15 individuals nominated to this extremely important committee, and was sponsored by AIIE, NSPE, the Wisconsin Society of Professional Engineers and industrial organizations. Congratulations, Henry!

Announcement

The Division's Metrication Committee requests possible topics in the general area of metrication which would be of particular interest for programs at future conferences. Also, if you know of potential speakers, please let us have their names and addresses. Send this information to:

Ed Mochel
Thorton Hall
University of Virginia
Charlottesville, VA 22901

International Conference on Descriptive Geometry

June 14-18, 1978

Vancouver, B. C., Canada

Sponsored by the Engineering Design Graphics Division, ASEE

INTRODUCTION

This is the 50th year of the Engineering Design Graphics Division. In these fifty years the Division has exerted significant leadership in engineering education. This leadership continues with the convening of the International Conference on Descriptive Geometry on June 14-18 in Vancouver, B. C.

We are now in a new era of space description because of the revolutionary use of computers. However, though computers can enable us to do formidable and hitherto virtually impossible arithmetic calculation, it is still necessary for us to develop the mental concepts and visualize the space relations underlying engineering problems.

Gaspard Monge's method, which he invented 200 years ago, substituted geometric methods for lengthy arithmetical calculations. The geometric, graphic results enabled complex spatial relations to be illustrated, described and comprehended visually.

These geometric and graphic methods have become an integral part of engineering problem formulation and solution as well as the keystone in all aspects of manufacturing. Indeed, when we take a look at engineering practice, it is evident that concepts of Descriptive Geometry are increasingly necessary as our technology becomes more sophisticated. It was possible, in Smeaton's time, to take down the walls of a cooperage as a model for the Eddystone Lighthouse in 1757. But today we require the methods of Descriptive Geometry to design and build such advanced structures as our space vehicles or to visualize and understand complex invisible structures as DNA.

Today we can use the mathematical methods of matrix transformation and vector analysis to describe or map any set of points in space. Futhermore, we can operate on these space points to draw lines, generate surfaces, transform projections, and give us answers to "best solutions" under many sets of constraints, in numerical as well as graphic form. All this we can do with computers. However, the "sine qua non" which we cannot do without, are the conceptual methods of space problem solving which are the essence of Descriptive Geometry; the basic thought processes for designing computer and graphic problem solutions and for much of the inventions of modern technology.

The conference gives educators an opportunity to access new developments in applications of Descriptive Geometry. The conference program will include many stimulating paper presentations and discussions. Participants may choose from three workshops offered by people who are outstanding in their field. There will be time for conversation, discussion with speakers and social gatherings. As of this writing, ten nations will be represented at the conference. This event should be of interest to all our members.

MAKE PLANS TO ATTEND.

SOME OF THE SCHEDULED PAPERS

Synergetics: The Structure of Ordered Space, A. L. Loeb, Harvard

Descriptive Geometry of Reflections, A. Rotenbury, Australia

Mongean Descriptive Geometry, Claude DeGuise, Canada

Descriptive Geometry as Taught at the Universidad Central De Venezuela, H. Osers, Venezuela

Graphic Science in Engineering Education in Tohoku University, Nannichi, Japan

Manufacturing Processes, Geometrical Possibilities, L. Alting, Denmark

Problems of Descriptive Geometry in the Calculus of Variations: Soap Bubbles, Crystals, Etc., F. J. Almgren, Princeton

Graphical Composition and Resolution of Vectors in Space, H. Niayesh, Iran

Computer-Aided Tracing of an Equilibrium Line on Intersecting Surfaces of Revolution, Y. Charit, Israel

ORDER OF EVENTS

Wednesday June 14, 1978	
Late Registration and Check-In Walter Gage Residence Hall	1-5pm
Opening of Conference Walter Gage Hall	7:00pm
Session I	
Social	9:00pm
Thursday, June 15, 1978	
Registration and Check-In Walter Gage Hall	8:30am
Morning Sessions	8:30am
Lunch Break	
Afternoon Sessions	
Dinner Break	
Evening Session	7:00pm
Social	9:00pm
Friday, June 16, 1978	
Workshops	8:30am-4:30pm
Evening Session	7:00pm
Social	9:00pm
Saturday, June 17, 1978	
Workshops	8:30am-4:30pm
Reception and Dinner	6:00pm
Sunday, June 18, 1978	
Reports and conference conclusions	8:30am-11:30pm

ACCOMMODATIONS

Those wishing room accommodations will be housed in Walter Gage Residence Hall on the campus of the University of British Columbia. Single rooms are $10.50, Children under 12 with family $4.00, Suites (single occupancy) $21.00 (double) $27.00. There is a 5% tax on rooms. Credit cards are not accepted.

FOOD SERVICE

Meals are served directly across the street in the Student Union Building on an individual cash basis. All meals will be taken here except the Saturday night dinner which will be a served meal in the Faculty Club. This will be paid when paying registration.

REGISTRATION

The program and registration material will be mailed out the first of February. Last date for preregistration will be April 25, 1978. The registration fee will be $60. This includes a copy of the proceedings which will be mailed to you after the conference, material for one workshop and the refreshments at breaks. This fee also covers building use costs. Late registration will be $75. If you preregister for ICDG and the Annual Conference of ASEE, you will be able to pick up your registration packet for both conferences when you arrive at the Walter Gage Residence Hall for the ICDG. You may keep the same room provided you have reserved the room by preregistration with ASEE.

CONFERENCE OFFICIALS

Amogene F. DeVaney
General Chairman
Box 447
Amarillo College
Amarillo, Texas 79178

Clarence E. Hall
Program Chairman
142 Atkinson Hall
Louisiana State University
Baton Rouge, La. 70803

Jack C. Brown
Registration Chairman
University of Alabama
Box 1904
University, Alabama 35486

Garland K. Hilliard, Jr.
Editor of the Proceedings
Box 5518
North Carolina State University
Raleigh, North Carolina 27607

Mary Blade
Workshop Director
Cooper Union
New York, New York 10003

Robert D. LaRue
Workshop Director
Ohio State University
2070 Neil Avenue
Columbus, Ohio 43210

The site for the 1979-80 Mid-year conference has been selected. Cogswell College will host this meeting in San Francisco, but the exact dates have yet to be determined. Possible dates are: 1. late November, 2. two weeks before Christmas, 3. the end of January, or 4. mid-March. You are encouraged to indicate your preference for any of these or other dates. First, notify the host, Dean Ronald Pare' at Cogswell College, 600 Stockton Street, San Francisco, California, 94108. Second, contact any member of the Executive Committee with your preference.

A Last Chance
or
Put Up Or Shut Up

The ASEE Accreditation Committee has asked the Engineering Design Graphics Division to provide them with some guidelines for the accreditation of freshman engineering programs. This is a natural request since each year finds an increasing number of Schools of Engineering with Departments or Divisions, primarily staffed by members of the Engineering Design Graphics Division, whose overall concern is the teaching and coordination of the freshman year.

The Fall, 1976, issue of the Engineering Design Graphics Journal carried an article listing some suggested criteria for the freshman year, and asking for comments. Only a few comments were received. These were not sufficient in number to reflect any consensus of opinion, so no revision of the suggested criteria was made. However a final report must soon be made to the ASEE Accreditation Committee.

At the 1977 Annual ASEE Conference, the Executive Committee of the Engineering Design Graphics Division decided that a final appeal for comments be made by again publishing the suggested criteria in this publication. Comments are urgently requested both by those who agree with the criteria and by those who disagree and have other suggestions. Send any comments to me at the address shown below in time for them to be reported on at the 1978 Mid-Year Conference (Alabama). There will be a Workshop during that meeting to consolidate all comments and arrive at a final report which will then be submitted to the ASEE. So if you have any ideas or comments, pro or con, let me hear from you. Also plan to attend the Mid-Year Conference. Remember that if you do not express yourself by letter of by attendance, you will have no input and hence no reason or justification to object to the final report.

Robert H. Hammond
Freshman Engineering and Student Services Division
North Carolina State University
Box 5518
Raleigh, NC 27607

Freshman Engineering Criteria

1. The requirements which must be met by students seeking admission to the freshman engineering program should be clearly stated in the official catalog of the institution.

2. In addition to meeting other institutional undergraduate requirements (i.e., physical education, English, ROTC, etc.), the freshman engineering program should include the following:

   a. Mathematics - Analytic Geometry and Calculus (2 Semesters/3 Quarters)

   b. English - Sufficient to meet institutional requirements with a minimum of 1 Semester/Quarter emphasis on composition.

   c. Chemistry - General Chemistry with accompanying laboratory (2 Semesters/3 Quarters)

   d. Physics - General Physics to include light, sound, mechanics, electricity, and magnetism. (Pre or corequisite; first semester of Calculus -- may be in Sophomore year)

   e. Engineering Graphics - Minimum of one Semester or equivalent. To include representational graphics and industrial practices.

   f. Engineering Fundamentals - Minimum of one Semester of equivalent. To include an introduction to engineering fields and engineering design.

3. The freshman engineering program should be interdisciplinary with the following purposes:

   a. To introduce the freshman student to the engineering profession and its various fields and functions.

   b. To assist the freshman student to intelligently choose his major field of study.

   c. To adequately prepare the freshman student, through foundation courses basic to all engineering disciplines for further study and practice in his chosen engineering field.

George C. Beakley
Arvid R. Eide
Robert D. LaRue
Fred O. Leidel
William B. Rogers
David W. Teeter
Robert H. Hammond, Chairman

Are you involved in Technical-Professional Committees?

The number and activities of Technical-Professional Committees is growing! Some changes have already been made this year!

There is a new chairman for Teaching Techniques, and there is an entirely new Committee for Freshman Engineering.

If you are not now involved with the Committee of your choice, drop a line to its chairman (address below) and express your interest.

GRAPHICS TECHNOLOGY COMMITTEE

Professor Barry Crittenden
Division of Engineering Fundamentals
Viginia Polytechnic Institute and
State University (VPI & SU)
Blacksburg, Virginia 24061 (703) 951-6555

COMPUTER GRAPHICS COMMITTEE

Professor Francis Mosillo
Department of Systems Engineering
University of Illinois at Chicago Circle
Box 4348
Chicago, Illinois 60680 (312) 996-2260

HUMAN FACTORS IN DESIGN COMMITTEE

Dr. John Kreifeldt
Department of Engineering Design
Tufts University
Medford, Massachusetts 02155

THEORETICAL GRAPHICS COMMITTEE

Professor Mary F. Blade
Mechanical Engineering Department
The Cooper Union
Cooper Square
New York, New York 10003 (212) 254-6300

ENGINEERING DESIGN EDUCATION COMMITTEE

Professor Mary Jasper
P.O. Box 155
Mississippi State University
Mississippi State, Mississippi 39762

METRICATION COMMITTEE

Professor Edward J. Mochel
Department of Mechanical Engineering
School of Engineering and Applied Science
University of Virginia
Charlottesville, Virginia 22901

TEACHING TECHNIQUES COMMITTEE

Professor Larry D. Goss
Department of Technology
Indiana State University
Evansville, Indiana 47712

FRESHMAN ENGINEERING COMMITTEE

Professor Larry Northup
104 Marston Hall
Iowa State University
Ames, Iowa 5001 (515) 294-5933

Papers Anyone?

The Engineering Design Graphics Division of the American Society for Engineering Education is conducting a study of the use of instructional modules in Engineering Graphics in technical institutes, community colleges, engineering colleges, and industry. Modular instruction is defined as any essentially self-contained material that is designed to be used by the student, either in class or in self-study situations, to master a topic or sequence of topics. The length could vary from a single short lesson to a full length course.

The papers will be submitted to a Project Staff and the active participants will be selected from the papers submitted. These papers will be exchanged among the active participants for written commentary. On June 16-17, 1978, in Vancouver, B. C. the active participants, project staff and any interested persons will convene for a two-day workshop. The purpose of the workshop will be to refine issues and to evaluate the potential use of modular instruction for Engineering Graphics.

Following the workshop, the papers and written commentary will be consolidated with the open commentary from the workshop into a report which will be issued by the Engineering Design Graphics Division. This report will be discussed at meetings of the Division and Sectional and Annual Conferences of ASEE. The report will be available for dissemination to individuals, institutions, and associations who are interested in applying modular instructional methods to Engineering Graphics teaching.

THIS IS A CALL FOR ALL INTERESTED INDIVIDUALS TO SUBMIT PAPERS BY Dec. 1, 1977 TO:

Dr. Amogene F. DeVaney, Director
Study on Instructional Modules
Box 447, Amarillo College
Amarillo, Texas 79178

The Division of Engineering Design Graphics
American Society for Engineering Education

has bestowed upon

Percy H. Hill

its highest honor

THE DISTINGUISHED SERVICE AWARD

for his outstanding interest and devotion to his students, his colleagues, the Division, and to engineering education in general.

Percy H. Hill, Professor of Engineering Design at Tufts University, received his B.S. degree in Mechanical Engineering from Rensselaer Polytechnic Institute and his S.M. degree from Harvard University. During World War II he served in the United States Navy in the Pacific Theater of War as a Communications Department Head.

Professor Hill was appointed to the faculty of the Engineering Drawing Department of Tufts University in 1948. Since 1954 he has served as head of the department, being appointed its permanent chairman in 1955. During his tenure as chairman the name of the department was changed to relate to its offerings in engineering education. Through his efforts the department received a Ford Foundation Grant which led to the offering of a Master of Science degree in Engineering Design. Today the department also offers the Bachelor of Science degree and is involved in a Ph.D. degree-granting program. The various programs of the department enroll 1000 students each year.

Professor Hill has served Tufts University in many areas since his original appointment. For five years he was the director of an engineering curriculum for General Electric; he served as chairman of the Faculty Board for the University's Experimental College; he was the director and principal investigator for biodental engineering research, and was recently appointed by the President of Tufts University to establish an all-university course on Decision and Policy Making.

Since 1951, Professor Hill has served industry as an engineering consultant in such areas as product development design methods and human factors in design. Engineering education was also the beneficial recipient of his expertise since he served as a curriculum consultant to a number of colleges and universities in engineering design education. He is registered as a professional engineer in Massachusetts and New Hampshire.

Professor Hill has been a member of ASEE and the Engineering Design Graphics Division since 1948. He has served the Division on many committees and has held many offices including that of Vice-Chairman, and Chairman, 1971-72. In 1967, he organized and served as chairman of the Engineering Graphics and Design Summer School.

Professor Hill has written several texts and workbooks on Descriptive Geometry, Engineering Graphics and Creative Engineering Design. His book entitled "The Science of Engineering Design" is mentioned as a reference in the Encyclopedia for Higher Education. He has also written many articles for professional publications including Engineering Design Graphics Journal, The Journal of Dental Research, Machine Design, Mechanical Engineering, Journal of Engineering Education and others.

Professor Hill is a member of the American Association of University Professors, the American Society of Mechanical Engineers, the American Association for Dental Research, the International Association for Dental Research, Tau Beta Pi, Sigma Xi, Creative Education Foundation, and the Human Factors Society. The Tufts University Senior Yearbook of 1965 was dedicated to him. Other honors include the 1968 Frank Oppenheimer Award, Who's Who in American Education, Engineers of Distinction - Engineers Joint Council, and Who's Who in Massachusetts.

For his achievements and leadership in engineering education, the Division is proud to bestow upon Percy Holmes Hill its 1977 Distinguished Service Award.

Presented this day June 28, 1977

at the Annual ASEE Conference, University of North Dakota

Clarence E. Hall
Chairman

Robert J. Foster
Secretary-Treasurer

ENGINEERING DESIGN GRAPHICS DIVISION
19 28
ASEE

Distinguished Service Award

Percy H. Hill

Checking the membership directory, I found that I joined ASEE and the Division (then Engineering Drawing) just a few years ago, in fact 1948. Charlotte and I began attending meetings at the University of Tennessee, then Kentucky, and Iowa and I soon found myself unhappy with things as they were. I am afraid I soon developed into a maverick and was known as one who made waves and rocked the boat. I want to thank you for forgiving my nature by presenting me this award. I am a New England Yankee, and if you know our breed, we are short on words but long on sentiment. Please accept my sincere thanks for this honor.

Another trait of the New England Yankee is when he has something to say, he must say it. I have something to say: The Division has come a long way over my almost 30 years of active membership and has fought off many attacks by senior departments and curriculum committees. I believe our most successful offense in recent years was the 1967 Engineering Graphics & Design Summer School at Michigan State. This was followed by the Computer Graphics Summer School in 1972 at the U.S. Naval Academy. The next summer school planned for 1978 at Vancouver should strengthen our position.

I firmly believe that our strength as educators lies in engineering design instruction and strongly recommend your consideration of the following areas of inquiry:

(a) Research into techniques of teaching design.

(b) Human factors in engineering design.

(c) Design for the handicapped.

(d) Design for the elderly.

(e) Application to consumer product liability.

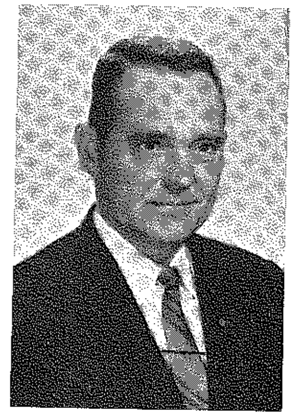
(f) Design of systems involving alternate energy sources.

It seems to me quite appropriate for us to involve our students in these areas at the freshman level. Graphics can and should be the vehicle by which any and all of these areas can be taught.

With the acceptance of this Award, it does not mean that I plan to retire and move to New Hampshire and fish. I do plan to fish, but you will hear from me again and again as an active member of the Division.

I am most grateful to the Division for this Award and my special thanks to Borah Kreimer for his efforts in my behalf in preparing the award citation and being here to present it to me.

Candidates for Office



VICE CHAIRMAN
(1978-79)

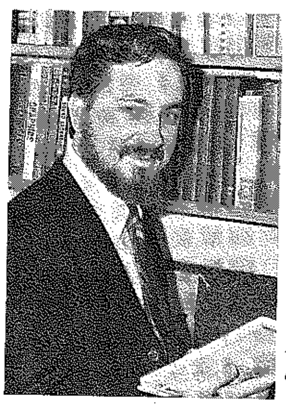
Leon M. Billow
U.S. Naval Academy

Lee joined the USNA faculty in 1958 and has been Coordinator of Graphics there for the past fourteen years. Prior to 1958 he had seventeen years experience as a machinist, design draftsman, industrial engineer, and public works engineer. In 1970 Lee became an active member of ASEE and the EDG Division. He has served on the Membership Committee, as Co-Chairman of the Banquets and Luncheons Committee, and as a judge for the Oppenheimer Award on four different occasions. He was also Chairman of the Committee for Commercial Exhibits at three mid-year meetings, and Coordinator of Judges for the Creative Engineering Design Display from 1975-1977. He is currently completing his third year as Advertising Manager for the JOURNAL.

W. Hunter Eubanks
Mississippi State U

Hunter joined the Engineering Faculty at Mississippi State University in 1947. He has been professor and head of the Engineering Graphics Department since 1960. He has attended most of the sectional, midwinter, and annual meetings of ASEE since joining in 1950. He participated in the first NSF-sponsored Graphics Conference held at the University of Detroit in 1959, and in the Design Summer School held at Michigan State in 1967. He has served on several Division Committees and as Director of Zones since 1975.

He is a past secretary, vice-chairman, and chairman of the Southeastern Section Design Graphics Division. A registered professional engineer and a member of the NSPE, Hunter has had industrial experience in engineering estimating, airbase planning, and construction.



DIRECTOR
TECHNICAL & PROFESSIONAL
ACTIVITIES
(1978-81)

William J. Crochetiere
Tufts University

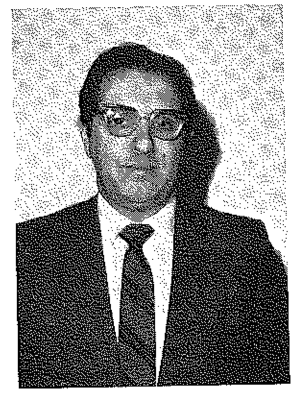
Bill is an Associate Professor of Engineering Design at Tufts University, and is registered as a professional Engineer in Massachusetts, and Maine. His training includes a certificate of apprenticeship in drafting from the General Electric Co., Associate and Bachelor degrees from Tufts, and M.S. and Ph.D. degrees from Case Institute of Technology (now Case-Western Reserve University). A recipient of the Frank Oppenheimer Award in 1970, Bill has published over 25 professional papers on Engineering Design, and Bio-medical Engineering.

Larry D. Goss
Indiana State ,
Evansville

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

Larry has been a member of ASEE since 1966, concentrating his interest on computer graphics, human factors, and teaching techniques. He has conducted twelve effective teaching institutes for ERM Division and received the Dow Award in 1971. He has industrial experience in computer graphics program development and lighting systems design for marine, aircraft, and theatre applications.

Once again the nominations committee has presented a slate from which it will be difficult to choose. Every candidate is not only a fine graphician but also a fine person and worthy of the office. Gentlemen, I am sure the entire division will join in expressing our gratitude for your service. Regardless of the outcome of the election, we will all look forward to our future association and your future contributions to the division's development and growth.



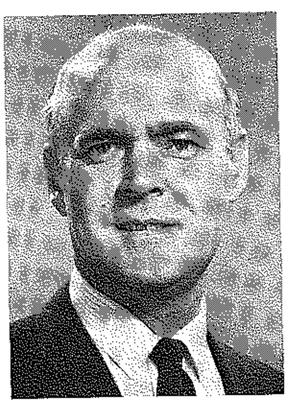
JOURNAL
ADVERTISING MANAGER
(1978-81)

Menno DiLiberto
Ohio University

Menno is Professor and Chairman of the Engineering Graphics Department at Ohio University. He has been a member of ASEE and EDGD since 1965 and just finished his second year as chairman of the Creative Engineering Design Display. Prior to his entering the teaching field he spent 13 years in industry with various organizations as a design draftsman. He is deeply interested in freshmen students and the important part guidance and counseling play in helping them decide their future.

Francis A. Mosillo
University of Illinois
at Chicago Circle

Francis is a graduate of Illinois Institute of Technology. He has twenty-one years of teaching experience there, in addition to experience in industry and university administration. He has published papers on design graphics and computer graphics, as well as a text-work book covering engineering drawing, descriptive geometry, design, and computer graphics. He has been a member of the ASEE ans EDGD since 1955 and is currently srving as chairman of the Division's Computer Graphics Committee and its Zone II Committee.



DIRECTOR
ZONE ACTIVITIES
(1978-81)

George E. Pankratz
University of Toledo

George is Professor and Coordinator of Engineering Graphics. A graduate of Toledo with an MSME from Michigan and an Ohio PE license, he has taught since 1946, and also has worked part-time and summers with a mechanical engineering design consultant and with the local electrical power utility. He has attended all but four of the annual conferences of ASEE since 1956, and is a member of the Industrial Relations Committee of the EDG Division. He is a past chairman of the Ohio Association for Engineering Graphics.

William A. Earl
New York State
College of Ceramics
Alfred University

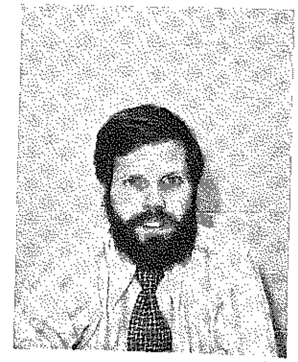
Bill received both his Bachelors and Masters Degrees from Alfred University. He joined the Research staff at the College of Ceramics in 1959 and took over the teaching of graphics in 1961.

He has had Industrial experience with General Motors and as a private consultant and Industrial Designer.

He has been active member of the Graphics Division of ASEE since 1962 and has served on several Division committees since then.

Robert J. Beil
Vanderbilt University

Phillip H. Sherrod
Vanderbilt University



One Year with the Graphics System – an Educational Experience

Introduction

This article presents the experience of use of a CRT terminal, a teletype terminal, hardcopy and grapics tablet through the first year of the installation of the system as an educational center at Vanderbilt University. The system was connected to a Xerox Sigma 7 so that it did not stand alone with its own small computer. It was an extremely small part of the vast number of time-sharing units on the campus. The system was located in a building used mainly for engineering research, and hence, its extensive use for research can be easily explained. The system was used extensively nearly every day, including many days on the weekend, by undergraduates learning the techniques of graphic analysis, graduate students compiling and analyzing major portions of their theses, and other members of the University for analyses of their research. The following sections present overviews of these uses.

Undergraduate Usage

Students used the system in two courses. One was a module, Introduction to Computer Graphics, and the other was the laboratory, Strength and Structure of Engineering Materials. Essentially, the module promoted learning of the following techniques:

a) using the teletype to construct graphic images on the screen - either by using programs generated by the student or by using software already available.

b) storing of data in files

c) using the graphic tablet to generate data or images to the CRT screen and to files

d) programming to recall file data for display and alteration

The following excerpts from assignment instructions to students illustrate a,b, c, and d.

The authors have presented a brief and interesting summary of Computer Graphics capabilities available at Vanderbilt University. These capabilities are amply illustrated in a variety of graphical output figures.

From the title, one might assume that educational aspects of the Computer Graphics courses offered would be emphasized. This is not the case. Even though reference is occasionally made to class hours offered and the availability of the computing system to students, specific information on time required in learning to efficiently use the available facilities is not included. However, persons considering the establishment of computer graphics courses and students considering enrolling in these types of courses will still find the contents of the article beneficial.

John B. Crittenden
Division of Engineering Fundamentals
Virginia Polytechnic Institute and
State University

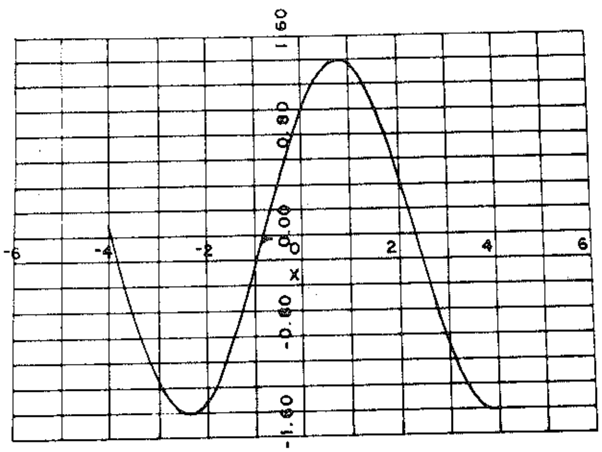


Figure 1: Y=SIN(X) + COS(X), RANGE= -4,4.

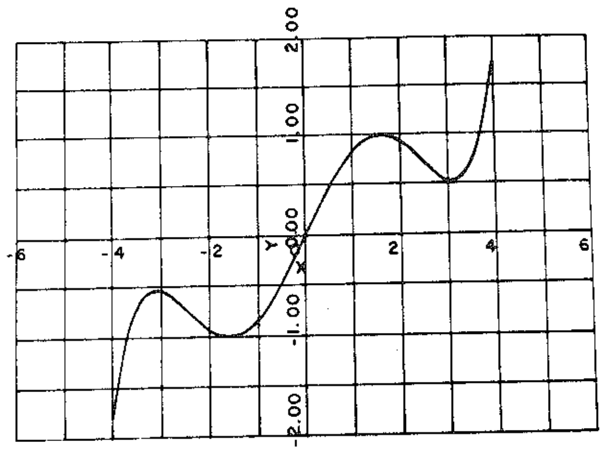


Figure 2: $Y=X - X^3/6 + X^5/120$, RANGE= -4,4.

A) "You most likely remember from high school courses that drawing y=sin(x) + cos(x) by addition of ordinates was a difficult and sometimes frustrating experience. Here, with the aid of the Tektronix 4013 CRT and software developed by Phillip Sherrod of the Vanderbilt University Computer Center, such problems can be completed graphically with ease by using FUNPLOT. Use the following commands to convince yourself:

```
!FUNPLOT.USERLIB

?Y=SIN(x)+COS(x)

?RANGE=-4,4

?AXIS=1

?GRID=3

?PLOT
```

After your final pressing of the return button, the screen should be cleared and the function plotted along with axis, scale and grid." [The hardcopy of the plot obtained by the student is shown in Figure 1.]

"FUNPLOT is an effective program to use in the design process. Questions you might ask yourself during design are:

a) Am I satisfied with the design (approximation)?

b) Would I be willing to pay the price for a better design (better approximation)?

So, let's try something that you are familiar with from calculus. The Taylor's expansion for sin(x) is:

$$\sin(x) = x - x^3/3! - x^5/5! - x^7/7! + \cdots$$

Start out with the first two terms of the expansion and after plotting ask yourself if you are satisfied with the plot as an approximation to sin(x). Hopefully, you are using the range -4,4. If you are not satisfied, proceed to plot the first three terms as an approximation. Continue the process until you are satisfied. Then realize that in building electronic circuits to approximate functions with increasing accuracy cost also increases. Would you as a consumer pay much more (say fifty dollars) for the better approximation given by the last term you choose?" [Figures 2 and 3 are two plots obtained following the above instructions.]

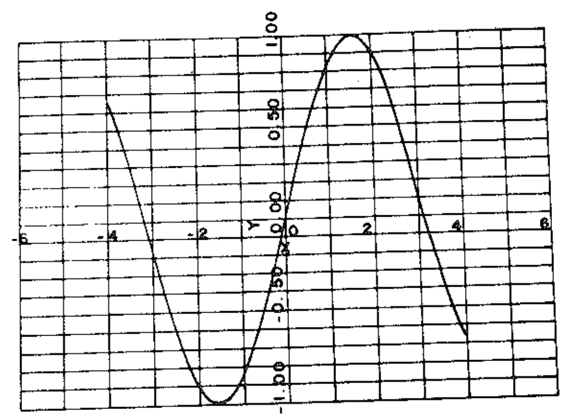


Figure 3: $Y=X - X^3/6 + X^5/120 - X^7/5040 + X^9/362,880$, RANGE= -4,4.

"What criteria did you use to express satisfaction with the approximation of the Taylor's series to sin(x)? How close does the first root to the left (minus side) of zero of the approximation agree with -3.14159? Error estimates which are not discussed here are generally used for comparison. Just to emphasize the point, change the plotting range to -15,15 and plot the approximation. Surprised? You should not be, for you know from calculus that the approximation you used is good for only small values of x. What range of x do you feel comfortable in saying that the approximation is good? And, how do you justify your conclusion?" [Figure 4, obtained by using the preceding instruction, is the final plot in the sequence which is an elementary exercise in design.]

Once the student experiences how easily he can draw graphs on the CRT using existing software, he does not need further encouragement to try plotting functions which he has generated. Figures 5 and 6 are illustrations of student-generated plots.

Students can immediately be creative by using the cursor mode of the terminal and the software DRAW, also developed by Phillip Sherrod. Straight lines can be generated from point to point. Graphic figures constructed in this manner by students are shown in Figures 7 and 8.

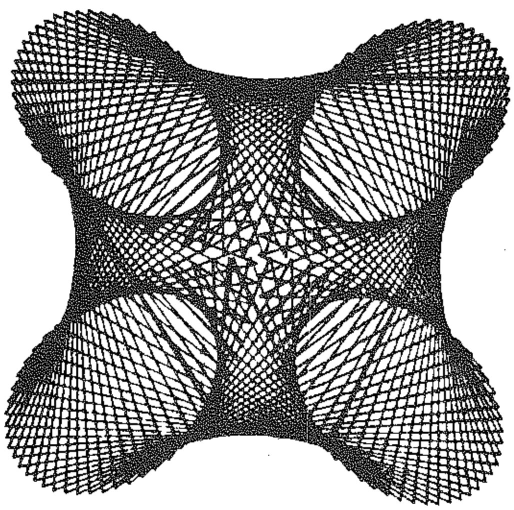


Figure 5: R= SIN(2A) , RANGE= 1,1000.

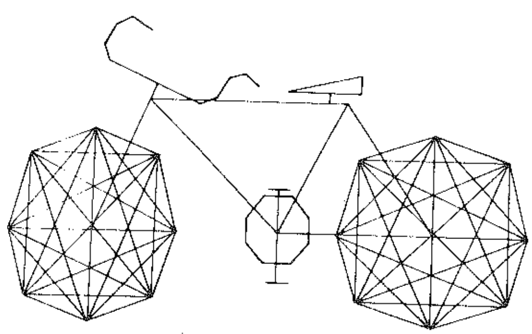


Figure 7: Plot using DRAW program.

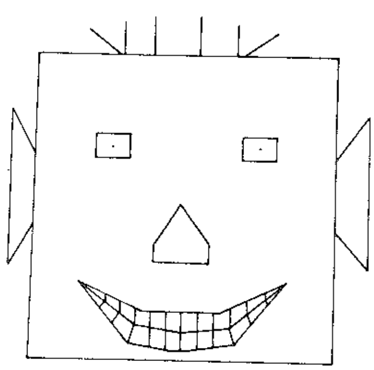


Figure 8: Plot using DRAW program.

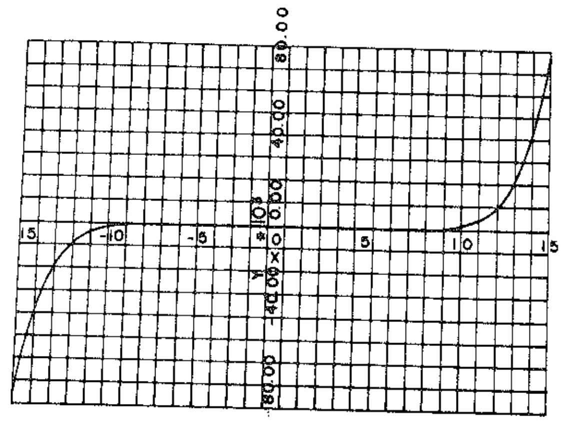


Figure 4: $Y= X - X^3/16 + X^5/120 - X^7 5040 + X^9/362,800$, RANGE= -15,15.

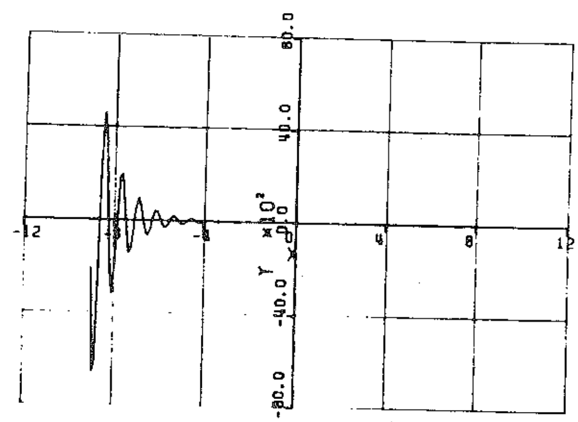


Figure 6: $Y= e^{-X} SIN(8X)$, RANGE= -9,11.

Students were given a program using CALCOMP routines which drew the front, top, and oblique views of an object. They were then asked to write a program that drew the side view and obtain a hard copy. One result is shown in Figure 9. The student programmed the four views to appear simultaneously on the screen.

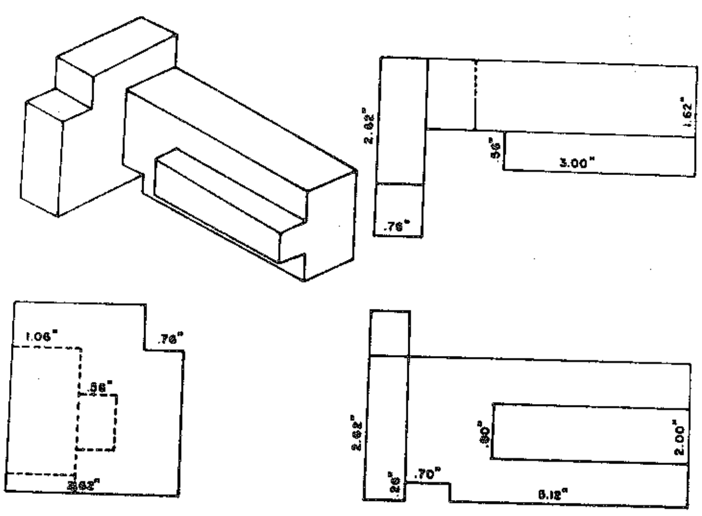


Figure 9: Plot using CALCOMP and PLOT 10 routines.

B) Students learned how to construct labelled axes and plot functions on the terminal screen using CALCOMP and PLOT 10 (TEKTRONIX) routines. The technique used required some knowledge of FORTRAN and file manipulation. Students were introduced to both in three two hour instructional periods. Figures 10 and 11 show the result of the instruction.

C and D) Students were shown how to use the graphics tablet to transmit x,y coordinates of a point from a figure of interest, which had been placed on the tablet, to a file. They were instructed how to write programs which would produce screen displays in coordination with the transmitted points from the tablet. Figure 12 shows the production of five rectangles on the screen. Only the five lower left points of the rectangles correspond to transmitted points from the graphic tablet. A program using CALCOMP routines drew each rectangle after the transmission of one point from the graphic tablet. Figure 13 shows the result of operating the tablet in conjunction with the terminal screen while using a continuous display tracing mode of operation. Any files produced by transmission of coordinates from the graphic tablet could be used as date files for picture reproduction or other purposes.

All of the preceding instructional material is presented to Freshmen students in nine two hour sessions. Students who complete the extensive work required feel that it is a worthwhile though challenging experience.

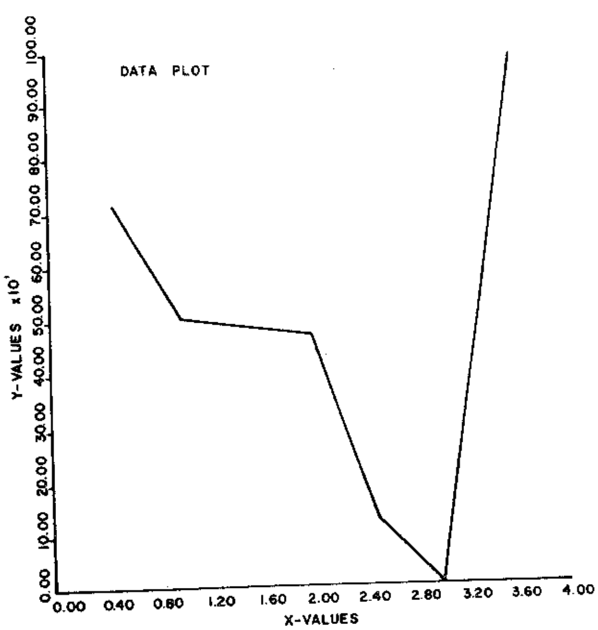


Figure 10: Plot using CALCOMP and PLOT 10 routines.

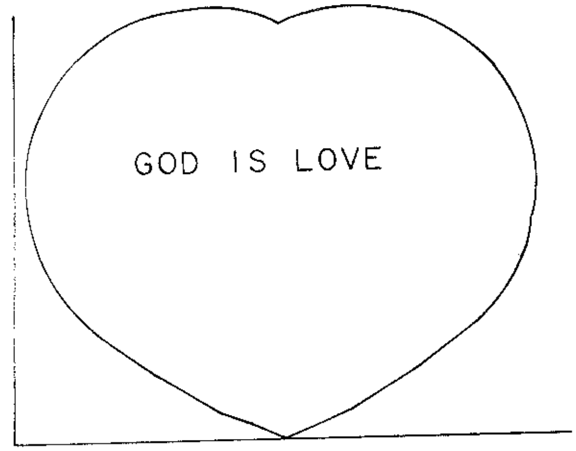


Figure 11: Plot using CALCOMP and PLOT 10 routines.

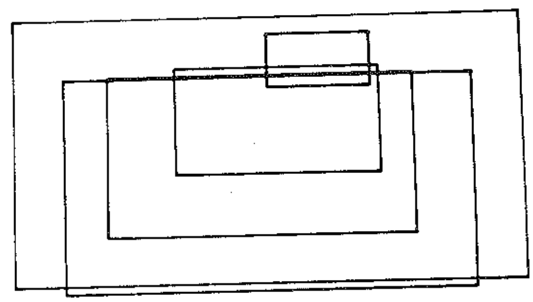


Figure 12: Plot using CALCOMP rectangle routine and graphic tablet.

Figure 13: Plot using continuous transmission of points from the graphics tablet to the terminal screen.

Upperclass students enrolled in a laboratory concerning strength of materials were taught to use the CRT to display data, display a straight line fit to the data, and, after entering data obtained from a strain rosette finally resulted in Mohr's circle appearing on the CRT, were asked to find the maximum normal stress indicated by the circle. This added innovation resulted in increased student interest, as demonstrated by more comprehensive reporting than in previous semesters. Examples of results of analysis are shown in Figures 14 and 15.

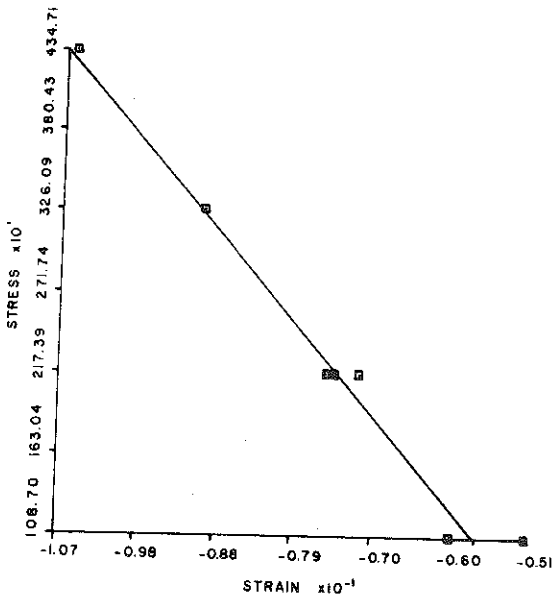


Figure 14: Leastsquares fit to data.

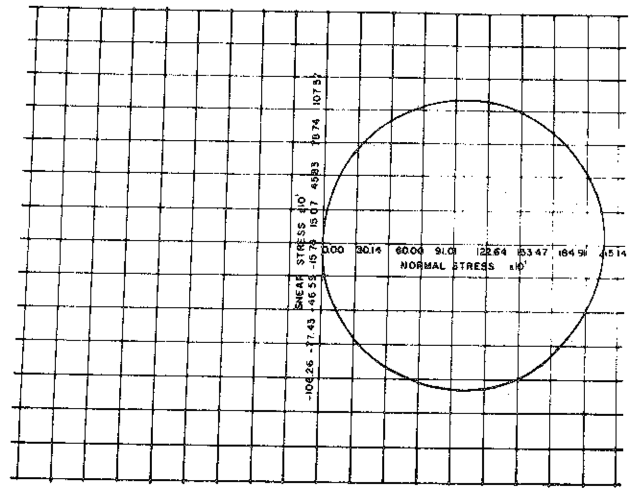


Figure 15: Mohr's Circle plot.

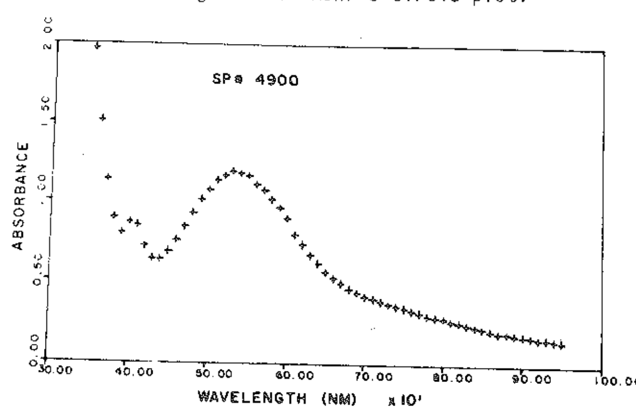


Figure 16: Glass research plot.

Graduate Usage

Nearly all graduate students seeking quality graphic displays to be included in theses used CALCOMP copies as final copies. Since the turnaround time is long for returned CALCOMP copies, students use the CRT for review to ascertain if their displays are suitable or even to determine if graphic display indicates the need for more research. A display used in glass research is shown in Figure 16.

The use of digitizing equipment has been most helpful in interferometic studies of crack displacement profiles in transparent polymers. In this fracture mechanics study crack surface profiles were obtained in cracked polymethylmethacrylate. Topographical maps of the cracked region were obtained by directing monochromatic sodium vapor light onto the crack surface and photographing the resulting fringe pattern. The displacement at any position along the crack can be found by the relation:

$d = (n-1/2)\frac{}{2}$ n=1,2,3....(dark fringe)

where is the wavelength of the light and n is the order of the fringe at the location in question.

The resulting photographs of the destructive interference patterns are digitized to provide the x, y coordinates of each fringe. The order of the fringe determines the z coordinate. (See Figure 17.) Computer programs written specifically for the analysis of these patterns, when coupled with the digitizing unit, allowed rapid determination of crack surface profiles. A representative fringe pattern is shown in Figure 18. The resulting profiles for various loads are shown in Figure 19. Determination of such displacement profiles

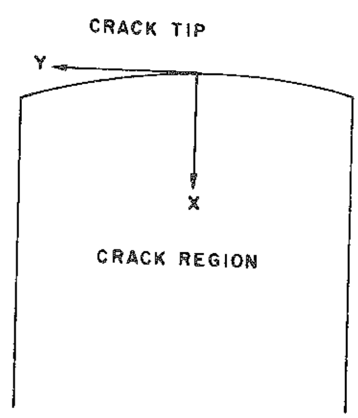


Figure 17: Axis reference.

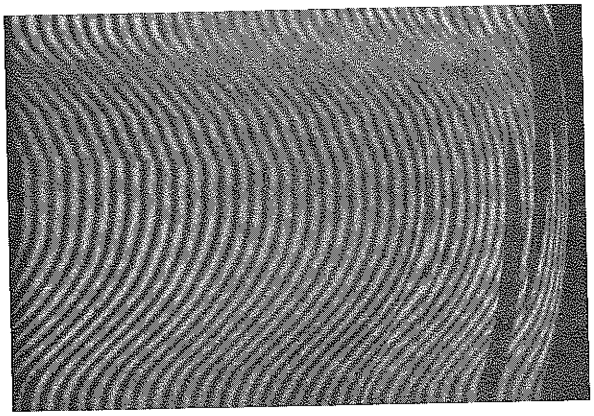


Figure 18: Fringe pattern.

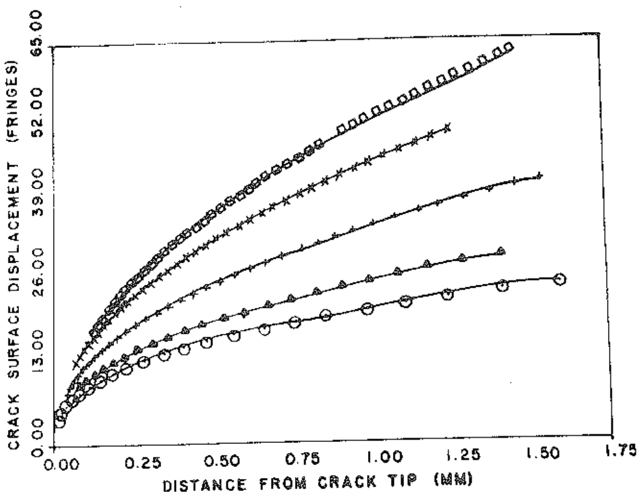


Figure 19: Profiles

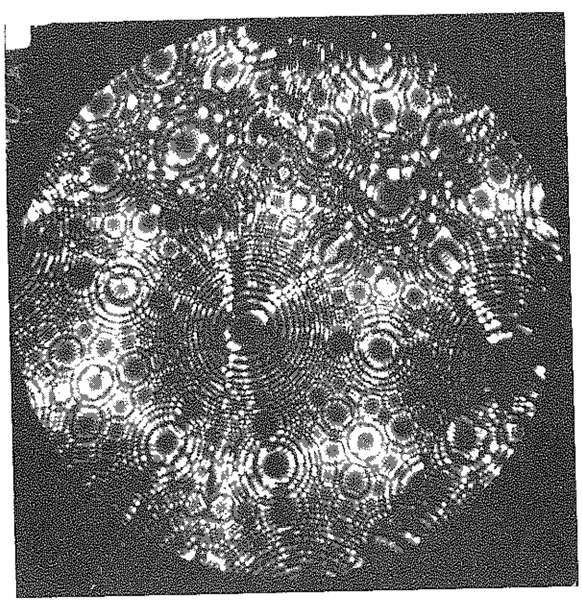


Figure 20: Field ion micrograph.

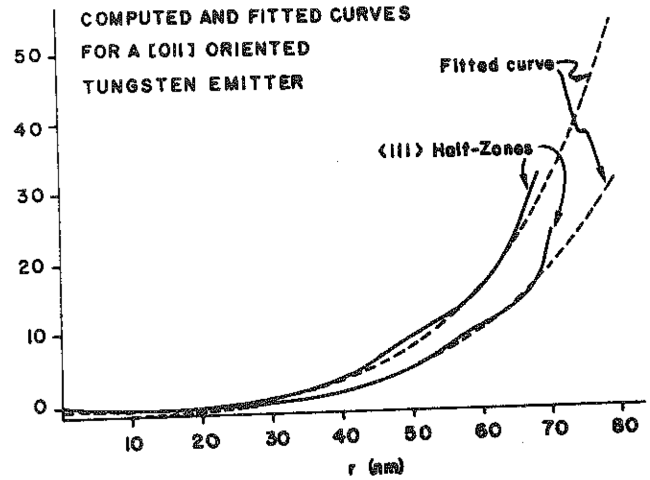


Figure 21: Field ion data plot.

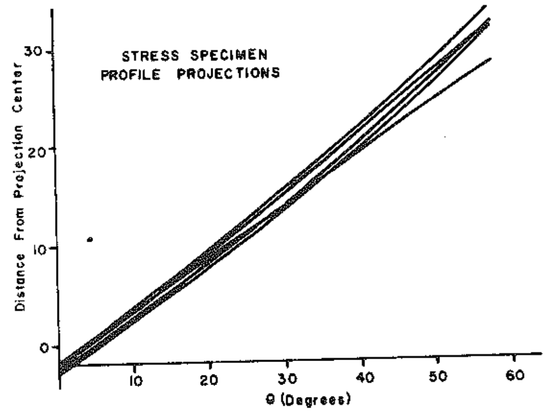
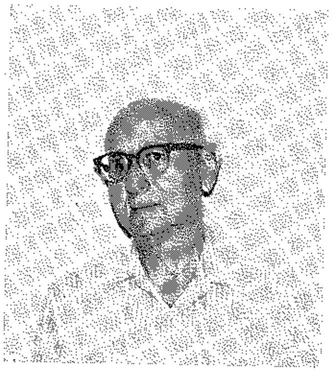


Figure 22: Field ion data plot.

allows better use of fracture mechanics in the study of flawed materials. These figures were provided by Dr. James Wayne Jones and Dr. Paul Packman, Vanderbilt University.

Finally, work done by Dr. Harvill Eaton, Louisiana State University, and Dr. Robert J. Bayuzick, Vanderbilt University utilized the graphic tablet to write on a file the coordinates of points in a field ion micrograph. Information gained following the digitizing of points and subsequent analysis of several micrographs will give information concerning the shape of a field ion sample, the geometric shape of a fracture in the sample, or, perhaps descriptions of other physical characteristics. Figure 20 is a micrograph that has been used for such an analysis. Figures 21 and 22 are plots using the data transmitted from the tablet.



Irwin Wladaver, Ret.
Formerly Department of Mechanical Engineering
New York University

Géométry Cotée, Gaspard Monge, and the Modern System

The task I have set for myself is to present one or two basic elements of each of the first two systems named in the title. I then propose to illustrate how each system can be applied to solve a simple problem. For reasons that ought to be obvious, I don't dare to attempt a hard one. I have arbitrarily selected a dihedral angle problem, that is, the angle formed by two distinct, nonparallel planes.

My first stunning discovery was that géométrie cotée was formally introduced before Gaspard Monge was born. According to Adrian Giombini, of the National Engineering School of Mexico, author of a Spanish textbook, "Geometria Descriptiva y Ejercios," P. Bauché was the man who had the honor of "establishing the fundamental bases of a system called in Spanish, 'dibujo de los planos de nivel'," which I would translate freely as "drawing by means of horizontal planes". Bauché was a Parisian Frenchman who lived from 1700 to 1773; he introduced the basis of the system known in French as "géométrie cotée" in 1738. Gaspard Monge was born in 1746 and died impoverished and in political disgrace in 1818; he introduced the Mongean system, sometimes called the "classical" system (and also called by other names) in 1763, when he was nineteen. Oh, those teen-agers! As an aside I should mention that under his picture at the entrance to the Library of the École Polytechnique in Paris hangs a small sign that reads: "Pas de Cracher" - no spitting. It's just a coincidence, I dare say.

Giombini goes on to say that there "was a great analogy evident in Bauché's and Monge's procedures". Yes, it's "obvious", but it takes close and long study to find the obvious.

For assistance with géométrie cotée, I turned to the ever-generous and genial Professor Claude DeGuise, who was our host at the 1977 Montreal Meeting. He sent me a copy of "Géométrie Cotée", by Georges Landreau and "corrigé" by Claude DeGuise. I now translate from that French text (the abbreviation p.o.p. is mine):

> "If we take our plane of projection (p.o.p.) sheet of paper, a point "a" on the sheet is the projection of a point A in space, situated on a perpendicular to the sheet into "a" and in order to know the exact location of A, it is sufficient to write beside "a" the "cote" of A, that is to say, the distance of the point A from the p.o.p. as in Figure 1.

+b(4)

+a(3)

+d(2)

+c(-7)

Fig. 1

Algebraic cotes are used: positive cotes for points located above the plane and negative cotes for points below the plane. (Pronounce "cote" more like the English "cut" than "coat" I.W.) The highest point in Figure 1 is B, four units above the p.o.p.; the lowest is C, seven units below the p.o.p."

A few preliminary ideas should help us understand how to solve for dihedral angles by one of the methods in géométrie cotée. The word "rabattement" occurs frequently in French texts. My dictionary defines it as "a pulling down". In a very real sense it is. But I'm going to use "rotation" for the noun and "rotate" for the verb, entirely accurate in the cases I've chosen. The word "trace" means the intersection of a plane with the p.o.p. just as the projection of a point to the p.o.p. is a trace, such a trace being the result of the projection from a point in space to the p.o.p. You'll read about plane traces if you don't quit too soon.

Géométrie cotée is economical: most of the elementary problems are dealt with in a single view because the three dimensions are available in s single view, two in the actual drawing and the third by the indexing (the cotes). Occasionally the cotes are given without the letters, or vice versa, but only when no ambiguity results. So much for the definitions and the propaganda. Let's go to work.

Let the first problem be to rotate (rabattre) the point a (10) about the horizontal axis (charnière) into the plane of the horizontal axis m(4)n(4), Figure 2.

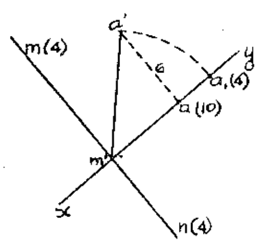


Fig. 2

"Rotating about the axis mn, the point "a" describes a circular arc in a vertical plane through a and perpendicular to mn. Project m to m' on xy, xy being the trace of the vertical plane in which point a rotates. The radius of the arc of rotation is the true length of the distance from m' to a, according to the scale of the drawing. With m'(4) and a(10), the difference of their cotes must be taken into account to get the correct radius of rotation. 10 - 4 = 6 gives us the distance of six units on the line through a and perpendicular to xy to form the triangle aa'm'. With m' as center, rotate a' to a_1(4) on xy. Point a_1(4) is the result of the required rotation into the horizontal plane of m(4)n(4). (Translation and some paraphrasing are from the same textbook and illustrations stolen from the same. All mistakes are mine.)

The next introductory problem, also "borrowed" from the same Landreau-DeGuise text, requires us to draw the bisector of an angle. Quoting again: "We know that an angle in space may be projected on a plane of projection to appear to be any angle whatsoever from 0° to 180°, depending on the orientation of the angle in space. We must agree, then, that the bisector of an angle in space does not necessarily have projective properties, that is, the bisector of an angle in space does not generally project as a bisector of the projection of that angle.

"Let it be required to find the bisector of the angle a(4)o(6)b(2), Figure 3. The procedure will be to rotate the angle on to the horizontal plane of cote 2.

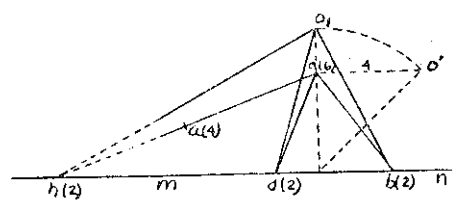


Fig. 3

"Produce the line o(6)a(4) to the level of cote 2, by proportion, and name that point h(2); draw the axis mn through the points b(2) and h(2). Next rotate point o(6) about mn, taking into consideration that the difference of the cotes of o and mn is 6 - 2=4, to get o'. The rotation will give o_1 and the true size of AOB, which is represented by ho_1b. Now bisect the angle at o_1 and o_1d is the required bisector of the angle in rotated, true size position. Of course the final step is to project the bisector back to the original view; that step gives us od, the required projection of the bisector of the angle illustrated in Figure 3. It hardly needs saying that the point d does not move since it lies on the axis of rotation.

Our readers should find Dr. Wladaver's article both informative and entertaining. In his own inimitable prose, he touches here upon a very interesting subject and some apparently little-known historical facts about the development of descriptive geometry. It is particularly interesting to study the visualization problem encountered in dealing with "cote" geometry. One cannot help but wonder if similar problems were experienced by their (Bauché's and Monge's) contemporaries.

Paul S. DeJong
Iowa State University

The dihedral angle which I selected to demonstrate is not the only procedure by which géométrie cotée solves such a problem. I simply took the method that looked easy, or should I say easier, than some other.

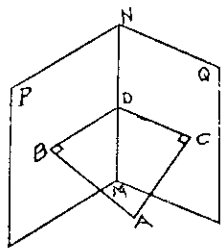


Fig. 4

In Figure 4 we may see a sketch of the familiar proposition that if from a point A a perpendicular is dropped to each of two nonparallel planes, the angle formed at A by the two perpendiculars is equal to the supplement of the angle formed by the two planes. No elaboration is needed.

A plane is given by a horizontal line (trace) and the slope. We are acquainted with strike and dip. Let it be our problem to find the angle between planes D and D_1. Plane D has a slope of 30° and plane D_1 has a slope of 50°. See Figure 5.

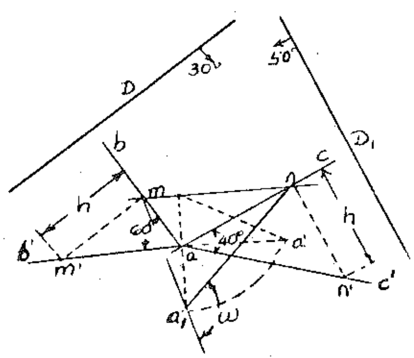


Fig. 5

From any point a, drop a perpendicular ab toward D with a 60° inclination. Toward D_1 drop a perpendicular ac with inclination of 40°. Next, pass a vertical plane through ab and revolve the plane containing ab into the horizontal plane of point a; this gives ab' at 60° with ab. Do similarly with a vertical plane through ac at arrive at ac', which will be at an angle of 40° with ac.

The next step is critical: Select any convenient length h. Use length h from ab and also from ac to find m' and n', respectively, both being length h from ab and ac but lying on ab' and ac'. Now project m' and n' back to m on ab and n on ac; mn proves to be a horizontal line, naturally, because m and n are both the same h distance (cote) below point a.

Point a is now rotated about mn as axis, with aa' having as one leg of the triangle cote h; the hypotenuse is the radius of the rotation of a' into a_1. And now we have at a_1 the angle ma_1n in true size, whose supplement is the measure of the dihedral angle omega between planes D and D_1 as required. Note the economy of notation.

The textbook that I used calls this "the indirect method". The authors go on to say that "the direct method" is more adaptable when certain constructions must be made within the dihedral angle itself.

I hope I have not given the impression that géométrie cotée is as relatively simple in all its manifestations as the dihedral angle problem. In fact, I'll try to conceal my ignorance of more complicated problems by leaving géométrie cotée and turning to the Mongean system, sometimes called "the plane trace" method and sometimes called other things. In its day, it ranked with thermodynamics and fluid mechanics as a graveyard of aspiring engineering students. Difficult though it may have seemed, it was a most elegant subject and remains so to those few who know it. I don't know whether France has dropped it; I'm inclined to doubt it. Anyway, I promised (or threatened) to do a dihedral angle problem. There is nothing much about the procedure that you don't already know, for I selected what might be sneeringly called a non-typical solution. Actually, it's typical enough because it's taken directly out of Monge's text material. I did over some of the sketches because the pages of the Monge-Brisson textbook are yellow and fragile, with lines almost obliterated.

The "trace" of a plane is its intersection with one of the planes of projection. The four quadrants (eight octants, if you please) are available but we are going to use only the first quadrant (Q-1). Monge's illustrations are nearly invariably in Q-1, and he know the system pretty well. Visualization is easier, I think, in Q-1.

In Figure 6, you may see how a randomly selected plane, not parallel to a p.o.p. of course, intersect the vertical and the horizontal planes of projection in its traces. The name of the plane is R. VR is its vertical trace and HR is its horizontal trace. Easy enough.

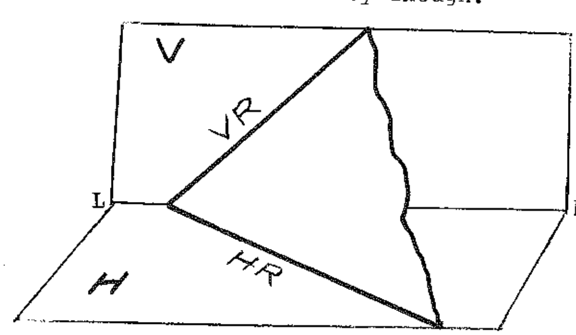


Fig. 6: VR and HR are the traces of Plane R within the limits of Quadrant 1.

CHANGE IN NAME OF THE SOCIETY: At the annual meeting held at Washington University, St. Louis, Missouri, June 20-23, 1946, the name of the Society for the Promotion of Engineering Education was changed to the American Society for Engineering Education, ASEE.

The third Summer School of the Engineering Drawing Division was held at the time of this meeting. The proceedings of this school was printed in book form, and a copy was distributed to each of the 135 persons attending. It is known as the Proceedings of the Summer School for Drawing Teachers, and was made available by the McGraw-Hill Book Company. A copy may be found in many departments and libraries across the country. The Preface to this 639-page volume, as well as its table of contents, follows.

PREFACE

The Summer School for engineering drawing teachers was organized under the auspices of the Drawing Division of the American Society for Engineering Education. Professor Justus Rising, Chairman of the Division, initiated the program with the approval of the Division and the Council of A.S.E.E. at its annual meeting in June 1944 at Cincinnati, Ohio. The school was originally scheduled for June 1945, but was postponed until June, 1946 because of the war time ban on conventions.

A committee of twenty-two present and past officers of the Drawing Division planned the summer school; Dean A.A. Potter, who secured appropriations from the Society for about one-third of the operating budget; Dean Langsdorf, who made available the facilities of Washington University; Professor Hoelscher of the University of Illinois, Chairman of the Summer School faculty; Professor Bockhorst of Washington University, Secretary for the summer school; the late Professor McCully of Carnegie Institute of Technology, Publicity Director and Editor of the Proceedings.

The school was held concurrently with the annual meeting. The preconvention sessions on Tuesday, June 18, and Wednesday, June 19, were devoted to organizing the school and the presentation of the first major theme, namely- the relationship between engineering drawing as taught in our colleges and its use in industry. The convention sessions were devoted to interdepartmental relationships between the drawing departments and the degree granting departments. The post-convention sessions from Monday, June 24, through Friday, June 28, were devoted to a study of teaching methods, techniques, equipment, etc.

The Chairman of the Faculty was responsible for selecting the speakers and organizing the pre-convention and post-convention sessions while the Chairman of the Drawing Division was responsible for the Convention sessions. Both men are indebted to many members of the Drawing Division for suggestions concerning available speakers.

The program of the Summer School was supplemented by four exhibits: (1) Foreign drawings from twenty countries; (2) Student work from forty-nine schools; (3) Course outlines for one hundred seventy-nine courses; and (4) Visual aids by ten different schools. None of this material can be presented in these proceedings.

The proceedings published herein represent only the papers and discussion and are presented in substantially the same order as given except Section I which consists of Professor Rising's opening paper and addresses made at dinner and luncheon meetings. Section II represents the pre-convention program; Section III the convention papers and Sections IV through XI the post-convention sessions. The appendices consist of committee reports, roster of attendance, and other items of interest.

The publication of these proceedings has been made possible through the generosity of the McGraw-Hill Book Company who assumed all costs of publication without guarantee of sales by the Drawing Division. We hereby acknowledge our indebtedness to them.

In the plan originally set up, the late Prof. Harry M. McCully was designated to edit the manuscript for this publication. This he did in very excellent fashion. Then in the process of manufacturing, somewhere along the line the entire manuscript was lost. Unfortunately, duplicate copies were not available and Professor McCully undertook to reassemble the material and had almost completed the task when he was overtaken by illness which resulted in his death on November 29, 1947. The illustrations, which the publisher had returned to him, could not be located.

At the request of the McGraw-Hill Book Company Professors Justus Rising and R.P. Hoelscher were asked to complete the task.

In finishing this work it was not possible to replace some of the illustrations since originals were used with the first manuscript and they could not be replaced. Professor McCully had also secured many additional photographs which would have added to the inter3st of the present volume. Because of the lack of time no attempt has been made to replace these. Our apologies go to those who supplied personal photographs. In re-editing this work, no attempt has been made to unify the style of the various authors except in minor details. The discussion of the various papers was abbreviated where the remarks were not pertinent to the subject as sometimes happened in long continued discussion of an impromptu character.

The Drawing Division of A.S.E.E. is deeply indebted to Dean A.S. Langsdorf of Washington University who made the school possible by underwriting the expense involved and to Professor R.W. Bockhorst of Washington University who was the secretary of the school and handled the many details necessary for housing the members of the school and providing other facilities for their use.

R.P. Hoelscher
Justus Rising
June, 1949

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Method of Constructing Various Types of Examinations--Presented by R. F. Schuck
Discussion by M. R. Graney, R. P. Hoelscher, J. N. Arnold, H. P. Skamser, and S. S. Radford.

Determining Validity and Reliability of Examinations--Presented by C. V. Mann
Discussion by J. N. Arnold.

SECTION 7: ORGANIZATION AND ADMINISTRATION OF THE DRAWING DEPARTMENT

Grading Methods, Standards, and Records--Presented by R. O. Loving
Discussion by J. J. Heimerich, F. M. Warner, M. R. Graney, J. M. Russ, R. T. Northrup, H. C. Spencer, F. R. Hughes, N. D. Thomas, F. H. Thompson, and R. R. Worsencroft.

Granting College Credit for Previous Drafting Experience--Presented by O. A. Olson
Discussion by F. A. Heacock, R. P. Hoelscher, J. Gerardi, F. W. Slantz, A. L. Thomas, C. E. Rowe, R. T. Northrup, H. B. Howe, J. L. Hill, Jr., H. P. Skamser, S. P. Owen, and M. R. Graney.

Methods of Keeping the Staff abreast of the Times--Presented by W. E. Street
Discussion by H. H. Fenwick, H. L. Henry, R. P. Hoelscher, A. B. Wood, H. C. Spencer, J. L. Hill, Jr., J. N. Arnold, and R. R. Irwin.

SECTION 8: PHYSICAL PLANT AND EQUIPMENT

Physical Plant and Equipment for the Instructional Drafting Room--Presented by Justus Rising
Discussion by W. W. Preston and A. L. Thomas.

The Use of Photographic Reproduction Processes in Drafting--Presented by R. E. Farnham
Discussion by L. E. Nollau.

SECTION 9: AUDIO-VISUAL TEACHING MATERIALS

Projection Methods and Materials for Visual Aids--Presented by I. C. Boerlin
Discussion by L. O. Johnson

Non-Projection Methods and Materials for Visual Aids--Presented by W. W. Turner
Discussion by S. S. Radford, J. L. Hill, Jr., and F. A. J. Becker.

Models for Teaching Drawing and Descriptive Geometry--Presented by C. E. Rowe
Discussion by N. D. Thomas.

SECTION 10: COURSES IN ADVANCED GRAPHICS

Aircraft Drafting--Presented by D. W. Dutton
Discusssion by J. C. Klotz, J. Gerardi, R. T. Northrup, S. S. Radford, and B. L. Brown.

Nomography at the Undergraduate Level--Presented by D. P. Adams
Discussion by W. H. Burrows.

Uses of Pictorial Drawing--Presented by C. H. Springer
Discussion by R. T. Northrup.

Special Equipment and Teaching Methods for Production Illustration--Presented by O. W. Potter

Need for Graduate Study in Graphics--Presented by A. B. Mays
Discussion by E. L. Williams and C. H. Ransdell.

New Horizons in the Field of Graphics--Presented by A. S. Levens
Discussion by J. T. Rule, W. H. Roever, T. C. Brown, F. M. Porter, and J. J. Devine.

Courses in Advanced Descriptive Geometry--Presented by F. M. Warner
Discussion by W. H. Roever.

SECTION 11: COMMITTEE REPORTS

What Training in Graphics DoesIndustry Require of College Men?--Report of Committee No. 1, W. W. Preston, Chairman

Elementary Drawing Course Content--Report of Committee No. 2, A. B. Wood, Chairman

Descriptive Geometry Course Content--Report of Committee No. 3, C. L. Bratton, Chairman

Teaching Methods--Report of Committee No. 4, J. J. Hill, Jr., Chairman

Organization nad Administration of Drawing Departments--Report of Committee No. 5, R. S. Paffenbarger, Chairman

Examinations--Report of Committee No. 6, B. C. Kent, Chairman

Audio-Visual Aids--Report of Committee No. 7, G. H. Brock, Chairman

Advanced Graphics--Report of Committee No. 8, J. T. Rule, Chairman

The summer school was a huge success. The program thoroughly covered all matters of interest to a teacher of Engineering Drawing and and Descriptive Geometry - from administrative organization and physical equipment to course content and methods of teaching.

Emphasis was given to the necessity of enlarging, beyond the freshman level, the services offered by the Departments of Engineering Drawing. Professor Al Levens gave a techcical review of the work done at the University of California, where descriptive geometry proved valuable in the solution of certain problems arising in the design of prosthetic devices. Professor Frank Warner of University of Washington stressed the value of further training in graphics through its application to advanced engineering problems. Professors Douglas Adams and John Rule of Massachusetts Institute of Technology reviewed the application of the graphic medium to nomography and gave a tentative outline of a course of study in graphics covering four years.

VISUAL AIDS.

Teaching Aids have always been very valuable in the presentation of graphics courses. The object in their use is for the student to learn more, remember longer, increase interest, and save time by reducing chalkboard work. Starting with the old lantern slides 3 1/4" x 4", then 2" x 2" and film strips, and more recently, movies, all are known as text film and have been very helpful. Exhibit material when properly used can be extremely helpful. When models are used they are sometimes presented to large classes by projection methods.

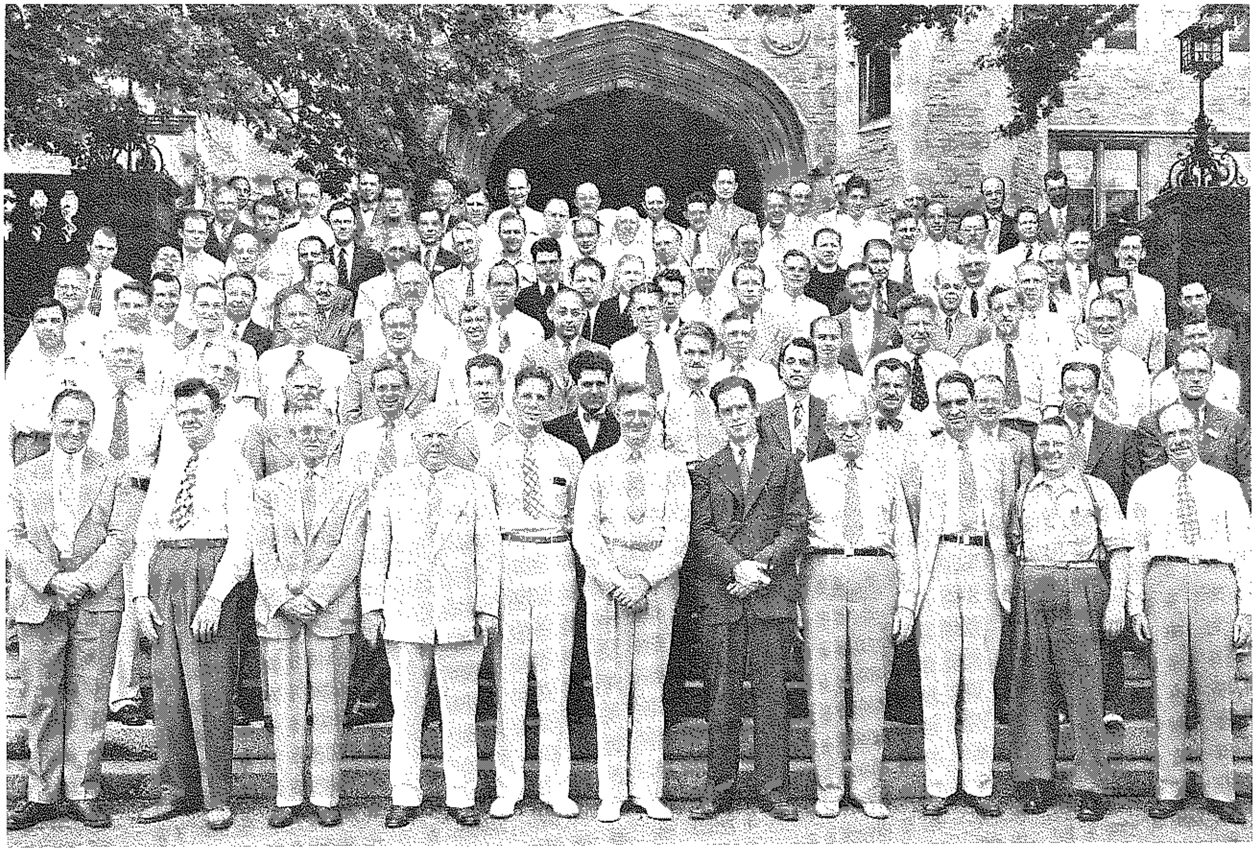
One of the finest collections of models was owned by Professor C. E. Rowe of the University of Texas. Professor Rowe made a hobby of model building, and the results of his efforts were published in a bulletin by the University.

The modern and speedy way of presenting visual material, particularly in step-by-step solutions, is with the overhead projector-using transparent overlays.

MID-WINTER MEETINGS.

The 1940's saw the development of our midwinter meetings. Sectional meetings of the ASEE started earlier, but following our 1946 Summer School we began holding our own Drawing Division gatherings.

The first midwinter meeting of record of the Drawing Division of ASEE was held at the Brooklyn Polytechnic Institute, Brooklyn, New York on Saturday, February 1, 1947. There were



DRAWING DIVISION SUMMER SCHOOL
AMERICAN SOCIETY FOR ENGINEERING EDUCATION
WASHINGTON UNIVERSITY - ST. LOUIS, MO. JUNE 1946

(READ FROM LEFT TO RIGHT)

ROW 1. RUSS, AAKHUS, HIGBEE, McCULLY, HILL, HOELSCHER, BOCKHORST, J. RISING, RULE, NORTHRUP, PAFFENBARGER.

ROW 2. MANN, WARNER, ROWE, GERARDI, LARSON, HRACHOVSKY, MAGNUSON, LOVING, CAMBRE, ADAMS, HOWES, STREET.

ROW 3. BULLEN, PRESTON, VIDETO, RADFORD, STONE, JENKINS, J. S. RISING, N. THOMAS, WORSENCROFT, EUVRARD, LEE, ALLEN, BOERLIN, CHRISTMAN.

ROW 4. WILLEY, OWEN, T. C. BROWN, SPENCER, KENT, JOHNSON, BECKER, LEX, BROCK, HEACOCK, HOWE, WHENMAN, SHOOK, MACHOVINA.

ROW 5. IRWIN, BETTENCOURT, ROBERTSON, VIERCK, HUGHES, A. L. THOMAS, FREDERICK, FENWICK, ORTH, OLSON, DAINES, TURNER, WEBB, BUCK.

ROW 6. RIEBETH, RANSDELL, DEVINE, VOJTA, HEINKE, ENBURG, KNEBLE, GORMAN, VRANA, DIXON, THOMPSON, HALES.

ROW 7. BRATTIN, HEBRANK, SISSON, PALMERLEE, RUSSELL, GRISWOLD, SHIGLEY, BRUNO, SWANNER, H. HARRIS, McGUIRE.

ROW 8. WOOD, POTTER, HOPPE, FULLER, CHAPP, CLEARY, CLEMENT, M. HARRIS, B. L. BROWN, BRAGG, FARNHAM, STEWART, McTYRE.

close to 50 in attendance and Chairman John Rule presided.

The morning session featured a talk by Dr. Otto Klitgord of the Institute of Applied Arts and Sciences in Brooklyn on "The Technical Institute Movement". It was followed by committee reports and a discussion of Engineering Science and Management Defense Training Courses (ESMDT).

The afternoon session featured a paper by Steven A. Coons of the Chance Vought Aircraft Corporation, titled "The Application of Graphical Methods to Aircraft Design".

The theme for the annual meeting at the University of Minnesota in June was chosen as "Emphasis on Graphical Methods and Graphical Research".

ADVANCED CREDITS COMMITTEE.

At the St. Louis meeting a committee was appointed to prepare unit examinations on subjects treated in basic drawing courses. The tests were primarily seen as a means to establish credits in drawing for transfer students or use in testing on a specific subject.

The committee consisted of the following members:

W. M. Christman, University of Wisconsin
Maurice Graney, Purdue University
Randolph Hoelscher, University of Illinois
John M. Russ, University of Iowa
Ralph S. Paffenbarger, Ohio State University

The committee decided on objective tests of multiple choice type. With financial aid from the Measurement and Guidance Project in Engineering Education New York, New York, tests were set up covering the following subjects.

1. Use of Instruments and Applied Geometry
2. Three-View Drawing
3. Reading views (Missing Lines)
4. Sections and Conventions
5. Auxiliary Views
6. Elementary Dimensioning
7. Screw Threads and Threaded Fastenings
8. Advanced Dimensioning
9. Working Drawings
10. Isometric Drawing
11. Oblique Drawing
12. Perspective Drawing
13. Charts, Graphs and Diagrams
14. Intersections
15. Developments

After the validation of these tests they were made available through The Educational Testing Service, Princeton University, Princeton, New Jersey. These were available through the years 1947, 1948 and 1949.

ANNUAL MEETING OF ASEE
MINNEAPOLIS, MINNESOTA - June 17-21, 1947

The Engineering Drawing Division had four very excellent papers presented at their sessions at this meeting. They were:

1. "Analytical Procedure in Aircraft Design" - R.W. Holmes, Curtis-Wright Corp., Columbus, Ohio.

2. "Descriptive Geometry of Crystallography" - H. T. Evans, M. I. T.

3. "Method of Presenting Dimensioning" - Paul Machovina, Ohio State University.

4. "Decimal System-Its use in Aeronautical Industries" - P.J. Hayes Jr., American Air Lines.

Professor Frank Heacock of Princeton University was elected to serve as chairman of the Engineering Drawing Division at this meeting and presided over the mid-winter meeting held during the Holiday season December 27, 1947 in the Horace H. Rackham Foundation Building, Detroit, Michigan.

ASEE ANNUAL MEETING
AUSTIN, TEXAS, June 14-18, 1948

At the annual meeting of ASEE at the University of Texas, the Engineering Drawing Division had a most interesting program with Frank Heacock presiding.

First Session: Joint with Machine Design of Mechanical Engineering Division.

Papers presented:

1. Some Relations between Descriptive Geometry, Mechanics and Mathematics- W.H. Taylor, Univ. of Alabama.

2. Preparing the Beginning Engineering Drawing Student in Drawing for His Later Work in Machine Design - H.N. Tyson, Calif. Inst. of Technology.

3. Standard Parts and Practices - A.W. Luce, Pratt, Institute.

4. Modern Dimensioning Practices - S.B. Elrod, Purdue University.

Second Session: Teaching Clinic on Engineering Drawing and Descriptive Geometry - W. H. McNeill, University of Texas, presiding.

1. Blackboard demonstration of teaching engineering drawing - H. C. Spencer, Ill. Inst. of Technology.

2. Objectives of an Engineering Drawing Course - R. P. Hoelscher, Univ. of Ill.

3. Methods of Stimulating Students Interest in Engineering Drawing and Descriptive Geometry - F.G. Higbee, State Univ. of Iowa.

4. Development of the Students Ability to Think and Analyze in Space - F.M. Warner, University of Washington.

5. Importance and Place of Pictorial Methods in a Course in Engineering Drawing- John Rule, M.I.T.

6. Grading Students Drawing - J. Gerardi, Univ. of Detroit.

7. Preparation of Quizzes and Examinations - R.S. Paffenbarger, Ohio State University.

Third Session:

1. Visual Aids and Models for Engineering Drawing and Descriptive Geometry - C.E. Rowe, University of Texas.

2. An Adaptable Teaching Model for Orthographic Views - P.M. Mason, Texas A&M.

3. A rating Scale for Grading Engineering Drawings - E.G. Kirkpatrick, Purdue Univ.

H. C. Spencer of Illinois Institute of Technology was elected chairman of the Drawing Division for the year 1949.

REVISION OF ASA Z14 STANDARDS FOR DRAWINGS & DRAFTING PRACTICE.

Active work on the reorganization of Sectional Committee ASA Z14, sponsored jointly by the ASME and ASEE got under way at a meeting of the Sectional Committee with forty-four (44) representatives of colleges and industries on March 30, 1948.

It was decided to form an Executive Committee and the following persons were named as well as the officers to direct the activities. They were:

R. F. V. Stanton, American Machine & Foundry Co., Chairman (ASME).

R. P. Hoelscher, Univ. of Ill., Vice Chairman (ASEE).

R. S. Paffenbarger, Ohio State Univ., Secretary (ASEE).

J. M. Barnes, Drafting Division Philadelphia Electric Co. (member at large).

W. A. Bischoff, Standards Engr., Bell Telephone Lab (ASA Telephone Group).

W. A. Siler, Delco-Remy Div., General Motors Corp. (SAE).

H. L. Keller, Mer. Com'l Eng., Ohio Crank Shaft Co. (ASME).

C. A. Ward, Senior Naval Architect, Gibs & Cox, Inc. (Soc. Naval Arch.).

This committee was authorized to extend to industries and National Societies not presently represented. They met monthly and when Mr. Stanton, the chairman, resigned from the committee he was replaced by Clifford Springer of the University of Illinois (ASEE). Randolph Hoelscher was made Chairman, Springer-Vice Chairman, and Paffenbarger - Secretary.

The ASME and ASA changed the designation of the committee to ASA Y14 instead of Z14.

It was decided to publish the eventual revision in separate sections. Upon completion of a section that the individual committee had agreed upon, it was submitted for Sectional Committee approval and then sent to sponsors and ASA. Completed sections were published and sold by the ASME 29 W. 39th St., New York, New York.

In a year's time, or on March 10, 1949, the Executive Committee had set up the following subcommittees.

1. Size and Format
2. Line Conventions, Lettering, and Sectioning.
3. Projections
4. Pictorial Presentation
5. Dimensioning & Placing Tolerances on Drawings
6. Screw Threads
7. Gears, Splines, and Serrations
8. Castings
9. Forgings
10. Metal Stampings
11. Plastics
12. Die Casting
13. Springs - Round and Flat
14. Structural Drafting
15. Air Frames Standard
16. Tool and Gage Drawing
17. Notes

Many of these sub-committees went right to work and in the years time many had their standard submitted for approval. Effort was being made to include unification of the standard to be developed with the British, Canadian, and others.

1949 MEETINGS.

The mid-year meeting of the Division of Engineering Drawing was held at Ohio State University in Columbus, Ohio, January 28-29, 1949. It was held in conjunction with the 75th anniversary celebration of the University.

Professor Fred Higbee of the State University of Iowa gave this lecture on "The History of Drawing" in University Hall auditorium to all freshman engineering students as well as those of our own group the day before our sessions started.

Henry C. Spencer, Chairman of the Division, presided over the meetings which included a business luncheon and banquet with Professor Samuel Renshaw, the speaker on "The Visual Third Dimension".

Others on the program were Col. L. E. Schick, U. S. Military Academy on "Military Graphics"; Harry W. Stertzbach, Engr. Consultant, Buckeye Steel Castings Co. on "Development of Railroad Rolling Stock Specialities"; James A. Flint, Research & Development, Jeffrey Co., on "Development of Conveying and Mining Machinery"; and, Glenn R. Logue, Chief Engr. Bridges, Ohio Highway Dept. on "Trends in the Design of Highway Bridges".

ANNUAL MEETING OF ASEE

RENSSLAER POLYTECHNIC INSTITUTE., TROY,

NEW YORK - JUNE 20-24, 1949.

In addition to the business luncheon and annual banquet, papers presented in various sessions were:

First Session:

1. Ellipse Guides - J. G. McGuire, Texas A&M.

2. Foreign Drafting Practices - T. C. Brown, North Carolina State College.

3. S. A. E. Drafting Standards - J. H. Hunt, General Motors Corp.

4. Y14 Progress Report - R. P. Hoelscher, University of Illinois.

5. General Discussion

Second Session:

1. Visualization - Mary Blade, The Cooper Union.

2. Welding Symbols - Allen C. Craig, General Electric Co.

3. Logic of Multiview Approach in Descriptive Geometry - B. L. Wellman, Wooster Polytechnic Institute.

4. General Discussion

New officers elected at this meeting are as follows:

Chairman - O. W. Potter, University of Minnesota.

Secretary - C. H. Springer, University of Illinois.

Member Exec. Comm. - 5 yrs. - Cerowe University of Texas.

T Square Page - W. J. Luzadder, Purdue University.

Editor of Journal - T. T. Aakhus, University of Nebraska.

Jobs

FACULTY ASSOCIATE OR INSTRUCTOR IN ENGINEERING, 1977-78. Teach courses in engineering drawing and graphics, descriptive geometry, introduction to engineering, and elementary engineering design. Preference given to those admitted to a graduate engineering degree program at ASU. First application deadline May 16, 1977; second deadline July 15, 1977.

Application, three letters of professional reference, resume and transcripts to Dr. George C. Beakley, Director, Engineering Core, Arizona State University, Tempe, AZ (85281). (602)965-3421. Equal Opportunity/Affirmative Action Employer who complies with Title IX of the Educational Amendment of 1972.

The University of Wisconsin - Milwaukee is seeking a Lecturer in engineering design and graphics. Areas of concentration: design techniques, graphics, and descriptive geometry. Secondary areas possible: computer graphics and/or manufacturing processes. Qualifications: M. S. in engineering or technology with industrial design experience. Send resume to Prof. Earl Ratledge, Systems Design, University of Wisconsin - Milwaukee, Milwaukee WI, 53012. UWM is an affirmative action/equal opportunity employer.

Faculty position open in the area of engineering graphics for the Fall 1977 semester. Additional interest in computer graphics, industrial design, architectural drawing, and extension conferences and short courses are also desirable. For more information, contact the Chairman of the Mechanical Engineering and Aerospace Engineering Department, University of Missouri-Columbia, Columbia, Mo, 65201. The University is an equal opportunity/affirmative action employer.

The Engineering Design Graphics Department of Texas A&M University is seeking applicants for an assistant or associate professorship. Duties will include the teaching of engineering graphics and descriptive geometry to freshman engineering students. Applicants should be competent in and able to teach specialty courses such as computer graphics, electronic drafting, pipe and vessel drafting, nomography, etc.

It is preferred that applicants have a doctor's degree with at least one degree in a field of engineering. Salary is open based upon the qualifications of the applicant. Texas A&M is an equal opportunity, affirmative action employer.

Graduate Assistantships and part-time teaching positions are also available in the Engineering Design Graphics Department.

Contact James H. Earle, Engineering Design Graphics Department, Texas A&M University, College Station, Texas. Phone (713)845-1633.

William G. Stinson
Department of Engineering Drawing
Queen's University
Kingston, Canada

USE of the STEREOGRAPHIC NET in structural geology problems involving rotation

As I pointed out in an earlier introductory article on the use of stereographic nets (see pages 20-25, E.D.G. Journal, Winter 1976), such nets when used in structural geology are the stereographic projection of the lower half of a sphere having N-S axes and E-W line lying in the horizontal plane of projection. The spherical surface is represented by its great circle intersection with the plane of projection and by the projections of the lower half of a family of meridian circles established every two degrees and by the projection of the lower half of small circles located every two degrees and lying in planes perpendicular to the N-S axis (like parallels of latitude). See Fig. 1: A Stereographic Net.

Rotation About Horizontal Axes

If we imagine the hemispherical bowl represented by such a stereo-net to be filled with a mating solid hemisphere of clear plastic that is made to rotate about the N-S axis of the 'bowl', every point on the surface of the solid hemisphere will move along or parallel to one of the vertical small circles all of which have their centres on the N-S axis. These small circles project on the stereographic net as circular arcs which divide and are divided by the meridian circles into 2-degree segments.

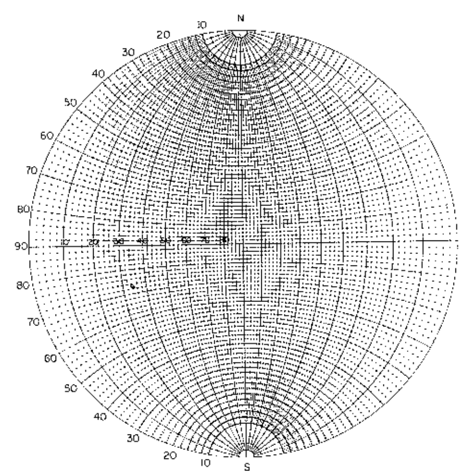


Figure 1: A stereographic net

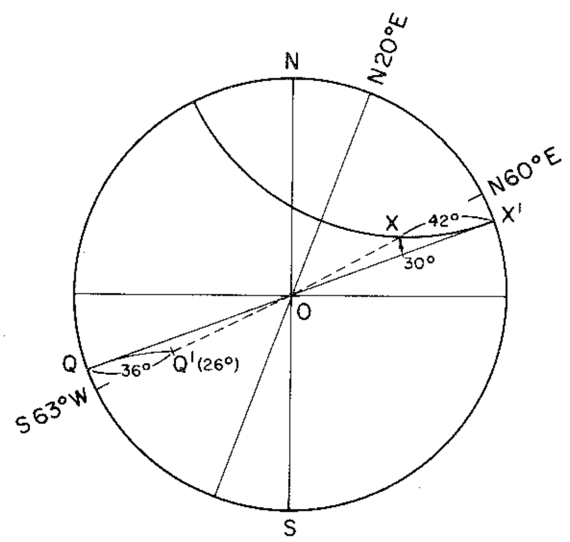


Figure 4: Rotation of a line to a position about the horizontal

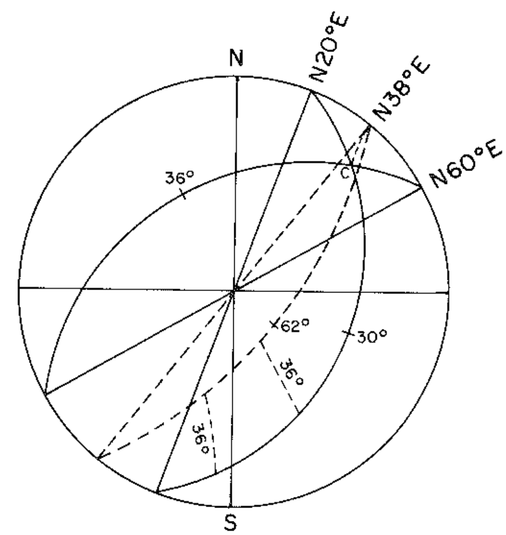


Figure 5: Solution of a 2-tilt problem

Solution

Refer to Fig. 5. On a tracing paper overlay mark the stereonet N-point, and the strike lines and great-circles of intersection of planes having the same strike and dip as the 2 sets of beds. Both sets of beds must be rotated until the younger set are horizontal. This means that the axis for this rotation must be horizontal and bearing N60°E and that the rotation must be 36° clockwise looking N60°E (this reverses the process that tilted the younger beds). This 'reverse tilting' as applied to the older beds would carry every point of the great circle representing them through a similar 36° rotation. This is simplified by performing this rotation for two representative points, finding their new positions, and then establishing the common great circle on which they lie. This immediately gives the strike and dip of the older beds before the second tilting. The operation may be somewhat simplified by taking the intersection point, C, as an additional point. The new position of C automatically establishes one end of the strike line for the previous position of the older beds, and the strike can be determined (N38°E). The great circle may now be readily drawn through the other 2 points and the dip of 62° south-easterly read directly from stereonet.

Rotation About An Inclined Axis

Because of the nature of the stereonet, i. e. the projected small circles are all circles on the surface of the sphere that have their centres on the horizontal N-S axis, it is convenient to arrange the steps in a problem-solution so that rotations are always performed about a horizontal axis. In order to achieve this the solution requiring rotation about an inclined axis will normally involve several rotations and reverse rotations.

In the case of rotations involving planes, a process that would be fairly complicated can be greatly simplified by changing the way a plane is represented. Up to this point we have confined ourselves to defining the attitude or direction of a plane on the stereonet by its great circle intersection with the hemisphere and by its strike (horizontal) lines passing through the centre of the sphere. While this representation is particularly useful for intersection determinations and angular measurements it is cumbersome for solutions involving multiple rotations. The direction of applane may be equally well-defined by the direction of a line perpendicular to it or, more specifically, by the point where the normal to the plane through the centre of the sphere intersects the surface of the sphere. This point, called the pole of the plane adequately defines the direction of the plane and provides a greatly simplified problem-solution, especially when rotation is involved, even though it contributes little to the visualization of the problem details. Normally the position of the pole of the plane is described by the plunge and bearing of the line perpendicular to the plane. See Fig. 6, in which orthographic views of a hemisphere illustrate the relation between the strike and dip of the plane and the location of the pole.

Example 2 may now be solved using polar representations for the planes. We need only to recall that for rotation of an inclined plane to a horizontal position the axis of rotation must be parallel to the horizontal or strike lines of the plane and to realize that when a plane is horizontal the line to its pole is vertical.

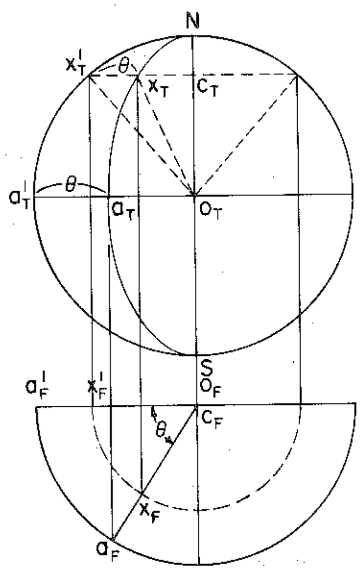


Figure 2: Rotation about N-S axis

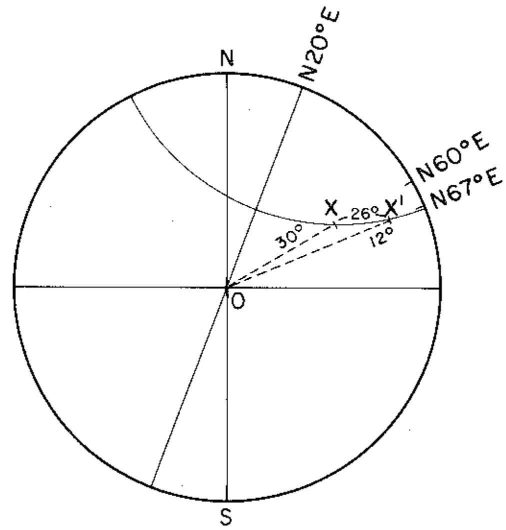


Figure 3: Rotation of a line about a horizontal axis

For example, as shown in the orthographic projections of Fig. 2, a line OX in the solid hemisphere of plastic would be carried about with its end-point X travelling about the vertical small circle having centre C and with the line itself sweeping out the surface of a cone. Note that a plane containing OX and having a N-S strike (i. e. N-S horizontal lines) would be carried about with each point of its great circle intersection with the hemisphere moving along its own small circle arc through an angle equal to the angle of rotation. On the stereonet this angle could be counted out in degrees along any small circle. Fig. 2 illustrates line OX and plane NAS being rotated through θ degrees to positions OX' and NA'S respectively.

If it is required to rotate any configuration about a horizontal axis other than the N-S axis, the north point and the direction of the required axis are marked on an overlay of tracing paper which is then rotated about the vertical axis of the hemisphere until the required axis coincides with the N-S axis of the stereonet. The required rotation is then performed for all components of the configuration, using the small circles of the stereonet. The overlay is then rotated back about the vertical axis to return the North point and specified horizontal axis back to their proper locations and the new positions of the various points, lines, etc. would be clearly established.

Example 1

(a) A line plunging at 30° in a direction N60°E is rotated about a horizontal axis bearing N20°E through 26° clockwise (looking N20°E). What will the new plunge and bearing of the line be?

(b) What will the new plunge and bearing be if the clockwise rotation is 78°?

Solution

(a) Refer to Fig. 3. On a tracing paper overlay mark the N-point of the stereonet, the N20°E axis, and the line OX plunging at 30° in a direction N60°E. Then rotate the overlay until the N20°E axis on the overlay coincides with the N-S axis of the stereonet. The small circle of rotation of X about this axis can now be identified, and the clockwise angle of 26° can be counted out along it to locate the new position of X, X' as shown in Fig. 3. By rotating the overlay until X' lies in the plane of the E-W vertical circle the plunge of OX' can be determined as 12°. By rotating the N-point of the overlay back to the N-point of the stereonet the bearing of OX' can be read off.

(b) Refer to Fig. 4. If the clockwise rotation of OX were increased to a total of 78° then after a 42° rotation OX would be horizontal. In rotating OX the remaining 36° OX would move up out of the hemisphere and beyond the limits of our stereographic net. This remaining rotation can only be handled by using the reverse extension of OX' which I will call OQ and Q must move down into the hemisphere 36° to give position Q', with a plunge of 26° and a bearing of S63°E.

Example 2

A geological map indicates two sets of dipping sedimentary beds, a younger set dipping at 36° north-westerly and having a strike of N60°E.

Determine the strike and dip of the older set of beds before the tilting of the younger set occurred.

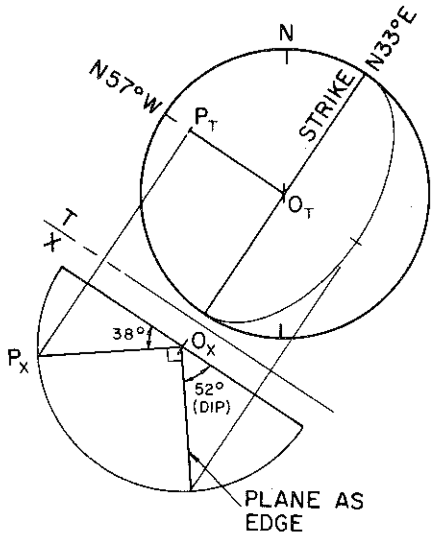


Figure 6: Pole of plane is P

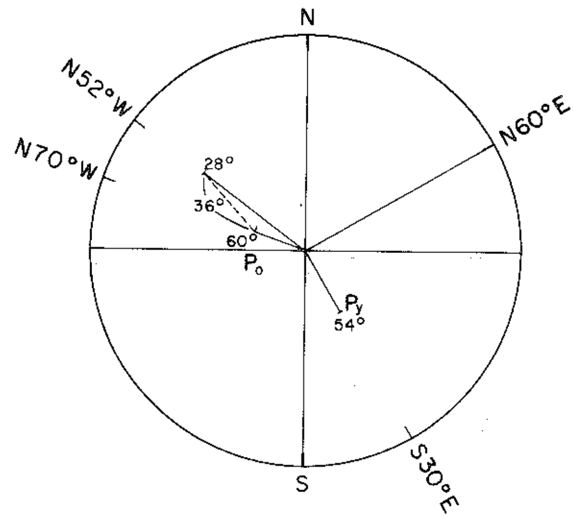


Figure 7: Solution of 2-tilt problem using poles

Refer to Fig. 7. Using an overlay mark on P_y for the younger set of beds using a plunge of 54^o and a bearing of $S30^o$ and P_o for the older set of beds using a plunge of 60^o and a bearing $N70^oW$. To reverse the tilting of the younger beds requires a clockwise (looking $N60^oE$) rotation of 36^o. Such a rotation moves P_y directly below the centre and P_o 36^o along its small circle to give a new plunge and bearing of 28^o $N52^oW$. Converting this polar direction to strike and dip yields a strike of $N38^oE$ and a dip of 62^o south-easterly, as before.

Example 3

Using an axis of rotation OA which plunges at 24^o in a direction $S47^oW$, rotate point P, located at a plunge of 35^o in a direction $S9^oW$, through an angle of 40^o counterclockwise (looking down along OA).

Solution

Refer to Fig. 8. Mark on a tracing paper overlay the stereonet North point, the bearing of OA ($S47^oW$) and the bearing of OP ($S9^oW$). Rotate the overlay until the $S47^oW$ bearing lies above the E-W great circle of the stereonet and locate A at a plunge of 24^o. Similarly locate P at a plunge of 36^o. Now rotate the overlay until the horizontal axis OB, perpendicular to OA, corresponds with the N-S axis of the stereonet and OA once again lies in the plane of the E-W great circle. Rotate OA up through 24^o until it is horizontal and A occupies A' on the rim of the hemisphere. At the same time P must be rotated in the same direction through 24^o along its small circle to position P'. Now the overlay must be rotated about the vertical axis of the hemisphere until A' corresponds with N of the stereonet. OP' may now be rotated counter-clockwise about OA' through 40^o to position OP'' along the appropriate small circle. All that remains now is to rotate the overlay to make OB coincide with the N-S axis of the stereonet and to place A' in the plane of the vertical E-W great circle and return A' to its original position A at the same time rotating P'' 24^o in the same direction to position P'''.

The bearing of OP''' and its plunge may now be read off to give the new position of **P** at a plunge of 55^o and a bearing of $S26^oW$.

Rotational Fault Problem

The technique of the previous example may be applied to a problem involving a rotational or picotal fault, i.e. a fault where the rotational or 'scissor' component of the motion is appreciable. In such a case the attitude or orientation of the beds in the displaced block will be changed, or in other words the strike and dip of the beds interrupted by a pivotal fault will be different on the two sides of the fault plane. In addition when two masses or bodies separated by a common plane undergo a relative motion that is rotational the axis of rotation must be perpendicular to the plane of the separation, in this case the fault plane. Refer to Fig. 9.

Example 4

A rotational fault that strikes $N10^oE$ and dips 50^o easterly cuts through a series of beds having a $N83^oE$ strike and a 32^o north westerly dip. It is estimated that the hanging wall (upper block) has tilted downward toward the north through 26^o. Find the strike and dip of the beds in this block.

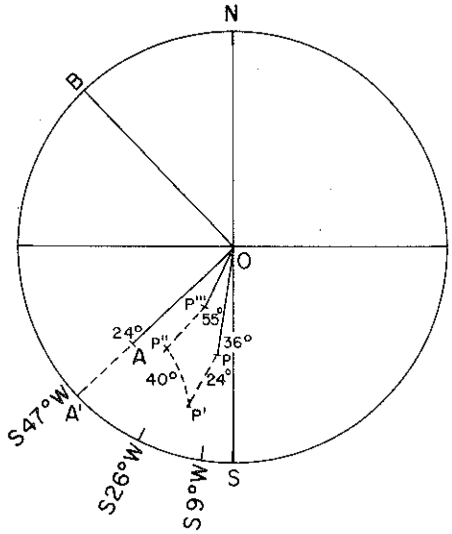


Figure 8: Rotation of a line about an inclined axis

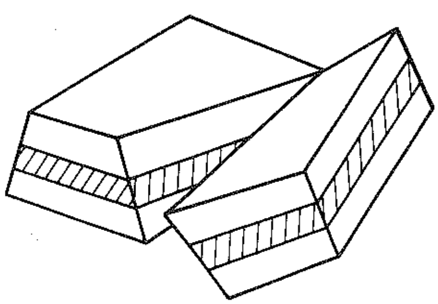


Figure 9: A pivotal fault

Solution

Refer to Fig. 10. The pole of the fault plane P_F is located at a plunge of 40° in a direction N80°W. The pole of the series of beds is located at a plunge of 58° in a direction S7°E. When looking down toward the pole of the fault plane and tilting of the upper block could be described as a clockwise rotation.

On a tracing paper overlay mark the N-point of the stereonet, P_F, the pole of the fault plane, and P_B, the pole of the beds. Since the tilting motion is actually a rotation about an axis perpendicular to the fault plane, the line OP_F may be used as the axis of rotation. This inclined line must first be rotated about a horizontal axis, bearing N10°E, through 40° to the horizontal position OP'_F. Of course pole P_B must be rotated about the same axis through 40° in the same direction to P'_B so that the relative position of P_F and P_B is not changed.

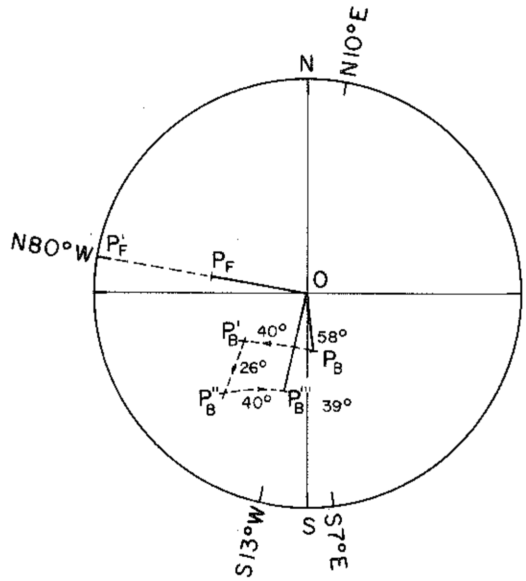


Figure 10: Pivotal fault problem

Then line OP'_F is rotated to coincide with the N-S axis of the stereonet and P'_B, the pole of beds in the upper block may be tilted or rotated clockwise through 26° to position P''_B. Now all that remains to complete the solution is rotate OP'_F back into the plane of the vertical E-W great circle and reverse the original 40° rotation to return P_F to its proper position and P_B to its tilted position at P'''_B. The position of the pole of the beds may now be located at a plunge of 39° in a direction S13°W, and the altitude of the beds described by a strike of N77°W and a dip of 61° northerly.

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COMPUTER-AIDED DETERMINATION of INTERSECTION LINES for surfaces of revolution having parallel axes

This article presents material which should be of considerable educational value to the readership of the EDG JOURNAL. It describes, through a well-developed example, how the computer can do things normally requiring tedious graphical constructions. The computer handles these details efficiently and accurately.

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Machine-part design frequently involves intersecting surfaces of revolution with parallel axes. A method is presented below for computer-aided construction of an intersection line of the latter type, including the determination of visibility.

The basic assumption is that the surface contours are irregular curves, continuous or discontinuous, with or without rectilinear segments.

The procedure consists of three stages:
(1) Scanning of the drawing.
(2) Determination of the intersection line.
(3) Plotting of its projections.

The scanning operation consists of translating the graphical data in the drawing into information suitable for discretized processing with the aid of any digital computer. The so-called "Silhouette" unit used in the present experiments (an optical-electronic device manufactured in the Lithuanian SSR), scans the ordinates of a pair of plotted curves at short intervals and produces perforated-tape information fed directly to the computer.

The procedure is illustrated in Fig. 1. The necessary graphical information is shown in Fig. 2 and is seen to be confined to the pair of contours; the axes are omitted, and only their location and spacing are indicated in the margin. The drawing, on standard-size computer paper is rolled on a drum and presented sidewise to the scanning head, as shown in the magnified section, Fig. 3. Extra-large drawings may be photographed to scale on standard film and scanned with the aid of a special attachment.

The device scans the curves with respect to the lower axis at equal intervals $\underline{u}$, which may range from 0.1 to 1.5 mm. Denoting the readings (ordinates) at abscissa $h_j(=j\cdot u)$ by r_j and Y_j respectively, and the spacing of the axes by G, it is seen from Fig. 3 that the ordinate of a point of the upper curve with respect to the upper axis is $R_j=Y_j-G$.

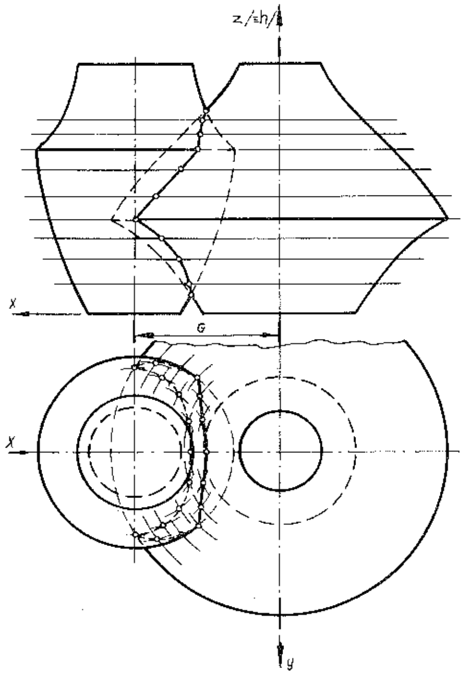


Figure 1

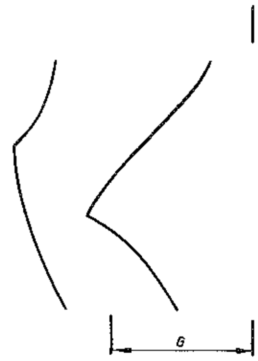


Figure 2

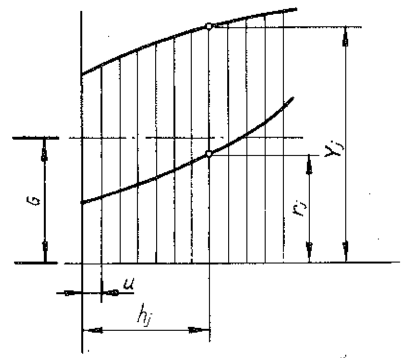


Figure 3

In our example, the intersection line is normally constructed with the aid of auxiliary planes (perpendicular to the axes of revolution), which are chosen on visual considerations in accordance with the configuration involved, and which intersect the surfaces in circles having radii R_j and r_j, determined by the device. The steps are programmed with the aid of an approximation algorithm A_{app}, described in an earlier paper [1] (see Appendix). This algorithm permits judicious subdivision of a curve into a finite number of segments whose deflections relative to their chords lie within a given limit, and also detects discontinuities, if any.

In the problem in question, both surfaces have to be approximated simultaneously, beginning with h_o and concluding with h_m, as follows ($R_o+r_o=R_m+r_m=G$):

(1) Take the first step on curve 1 and determine a possible subdivision point.

(2) Ditto for curve 2.

(3) Compare the abscissae of the resulting points, and take the lesser of the two.

(4) Determine the corresponding R_j and r_j.

(5) Store the three values, which are the initial data for the next step.

The extended algorithm as above is denoted by A'_{app}.

The points thus found are logical locations for the auxiliary planes. The radii of the corresponding circles of intersection are known, and their common points, determining the desired intersection in Fig. 4, are given by:

$$x = \frac{G^2 + r^2 - R^2}{2G}$$

$$y = \pm\sqrt{r^2 - x^2}$$

in turn yielding the angles

$$\varphi = \text{arc cos}\,\frac{G-x}{R}$$

$$\vartheta = -\,\text{arc cos}\,\frac{x}{r}$$

the minus sign indicating that the angles are laid off in opposite directions.

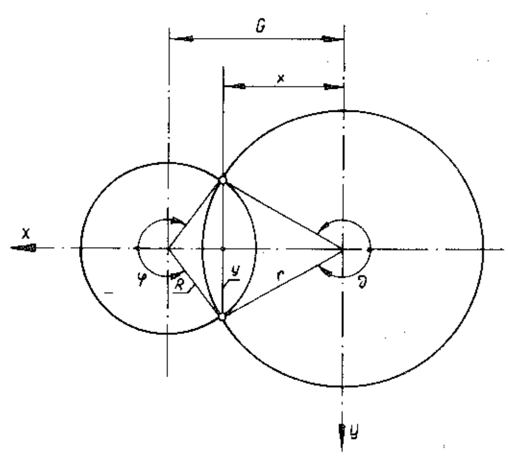


Figure 4

[1] J. Charit, "Computer-Aided Construction of the Line of Intersection of Surfaces of Revolution with Arbitrary Generating Contours", Litovskii Mekhanicheskii Sbornik, Vilnius 1968, vol. 2(3). (In Russian).

The sequence of steps for determining and ordering the intersection-line data is denoted by A_{int}.

The set of data stored in the memory - three dimensional Cartesian, and cylindrical, coordinates of the sought points with respect to the axes of revolution - may be printed out as follows, the subscripts denoting the serial numbers of the auxiliary planes:

Auxiliary plane No.	Altitude h	H	x	y	R	φ	r	∂

where $H_j = \sum_{j=o}^{j} h_j$

The points are sufficiently close together to be joined in rectilinear segments; where necessary, smoothness can be ensured by means of appropriate subprograms.

The data may be fed directly from the memory to a programmed plotter, thereby achieving complete automatization of the process.

Projective presentation may be effected on the basis of one of the surfaces. The elevation is conveniently plotted as x=f(H), with the two branches coincident and the projection visible. The plan is plotted as x=f(y). Since it is obviously symmetrical, one half of the view suffices.

Visibility in the plan is determined in a reverse sequence (i. e. from h_m to h_0), with each interval between two consecutive auxiliary planes examined as illustrated below.

In our problem, the first interval ($h_m - h_{m-1}$) is visible. The radii are then compared as follows:

(1) If $R_{j-1} > R_j$ and $r_{j-1} \geq r_j$, or $R_{j-1} \geq R_j$ and $r_{j-1} > r_j$, the segment in question is visible.

(2) If $R_{j-1} = R_j$ and $r_{j-1} = r_j$, visibility remains as before (the segment reduces to a point in the projection).

(3) If $R_{j-1} < R_j$ and/or $r_{j-1} < r_j$, the section is hidden.

R_j and/or r_j are characterized as local maxima (R'_{max}, r'_{max}) and all subsequent radii (R_{j-i}, r_{j-i}) are compared with them. So long as at least one of the compared radii is less than its local maximal counterpart, the segments remain hidden. When $R_{j-i} > R_{max}$ or $r_{j-i} > r_{max}$, these radii become the new maxima for comparison (R''_{max}, r''_{max}) and the procedure is continued.

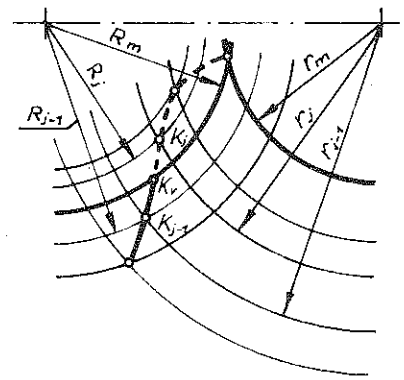


Figure 5

The point of transition from concealment to visibility, K_V, generally falls between two consecutive points (Fig. 5) and is to be included in the set of the intersection line. It is obtainable with sufficient accuracy on the assumption that the three points (K_j, K_v, K_{j-1}) are interrelated as the cooresponding differences of R_j, R^i_{max}, R_{j-1}, or their r-counterparts, as the case may be. Where both radii are operative, the solution is ambiguous (K_v and K'_v), and the sought point is the one nearest the visible end of the segment ($x^i_{j-1} - x^i_v \to$ min, y^i_v = min). The sequence of steps for determining the visibility is denoted A_v.

In conclusion, the main operations may be summarized in the accompanying block diagram:

SCANNING	A'_{app} . A_{int}	A_v. PLOTTING

Appendix

APPROXIMATION OF SURFACE

The given contour or profile of the surface, plotted on a strip of drawing paper or photographed by cinecamera, is scanned by a "Silhouette" unit, with the scanning speed adjusted in accordance with the sought degree of accuracy. An example of an initial contour is shown in Fig. 6 (horizontal straight line - axis of revolution of surface). The output of the "Silhouette", obtained in punched tape for direct feeding to a computer, comprises the ordinates y in intervals u(u=0. 1, 0. 2, 0. 8, 1. 4mm, etc.). These ordinates are the radii of revolution of discrete points on the surface, R_i.

The next step is the approximation proper. The contour is subdivided, in accordance with the desired degree of accuracy, into a finite number of segments, which are replaced by their chords. By this means the surface is approximated by an aggregation of coaxial

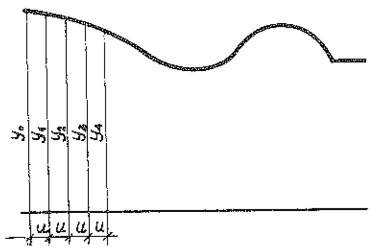


Figure 6

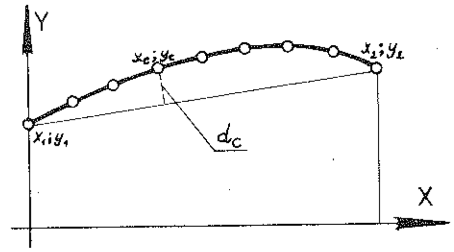


Figure 7

circular cones, cylinders and planar rings. The term "desired degree of accuracy" means the maximum permissible deflection (ξ) of the segment relative to its chord. According to Fig. 7, the equation of the chord is:

$$kx - y + y_1 = 0$$

where

$$k = \frac{y_2 - y_1}{x_2}$$

Denoting

$$\mu = -\frac{1}{\sqrt{k^2+1}}$$

we have for the controlled point (x_c, y_c):

$$d_c = \left|\mu(kx_c - y_c + y_1)\right|$$

On basis of this expression, we construct the approximation algorithm using a variable frame of reference (Fig. 8) in which the x-axis is coincident with or parallel to the axis of revolution and the y-axis slides parallel to itself, passing successively through the endpoints of the chords.

Given n points (1, 2, 3, ... , i-1, i, i+1, . . . , n) on the contour, we consider the section beginning with point i (ordinate R_{j-1}). The procedure is as follows:

(1) Connect point i with point i+t (t=2, 3, . . . n-1).
(2) Calculate the deflections of all intermediate points i+s (s=1, 2, . . . t-1),

$$d_{i+s} = \left|\frac{1}{\sqrt{k_i^2+1}}\,(k_i\, s\cdot u - y_{i-s} + y_i)\right|$$

where

$$k_i = \frac{y_{i-t} - y_i}{t\cdot u},$$

and compare them with the permissible deflection:

(a) If for all the intermediate points $d_{i+s} < \xi$, then try a longer chord by advancing t by one, thus moving the chord terminal point to the next point along the curve. Repeat steps (1) and (2) for this new chord.

(b) If for at least one of the intermediate points $d_{i+s} \geq \xi$, then the attempted chord is too long. Proceed to Step 3.

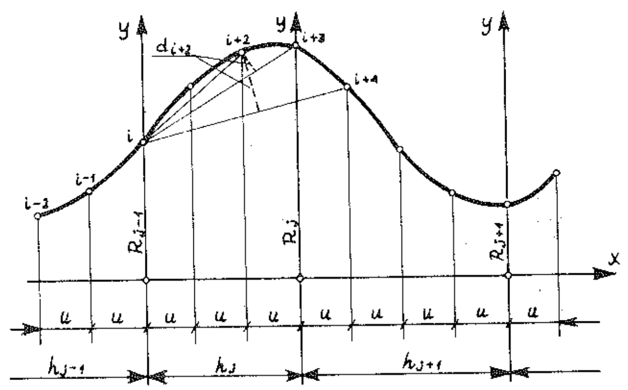


Figure 8

(3) The longest acceptable chord is one increment shorter than the last one attempted. Therefore, replace the section between i and i+t-1 by its chord. The corresponding zone of the surface is thus approximated by a circular cone or cylinder j with altitude $h_j = (t-1)\cdot u$, and base radius $R_j = y_{i+t-1}$.

(4) With i+t-1 as initial point for the next approximated section j+1, repeat the procedure beginning with Step 1.

Thus, m zones are obtained with corresponding h_j and R_j, which are stored in the memory.

ANALYSIS OF PERSPECTIVES

* This is a translation of Chapter IX in F. Hohenberg's Konstruktive Geometric in der Technik ,Springer-Verlag, New York, 1966. The preface of this book was presented in the Spring 1976 issue of the Journal. The present chapter was translated by Mr. Tim Brown, a PhD candidate in the German Dept. at the University of Massachusetts who has a science background. This project was under the supervision of Prof. Klaus E. Kroner of UMass and is being funded by the Journal in the interest of acquainting its readers with some of the theoretical work being done in the graphics area in other countries.

FOREWORD

Hohenberg's book, from which the following was translated, approaches the solutions to descriptive geometry problems from a more theoretical point of view than one is accustomed to in American literature. His explanations of spatial relationships make challenging reading material and are most likely too advanced for the average undergraduate student.

In deciding which portion of the book should be translated, the chapter on perspectives was chosen as probably meeting the broadest interest among the readers of the Journal.

Klaus E. Kroner

Inspection of perspective illustrations.

If one views a perspective picture with one eye from a point O, used as the visual center, then one can gain a correct geometrical impression of the depicted object. Usually, however, one will view the figure with both eyes and , in general , neither eye will be located exactly at O since geometrical divergences result from the natural visual impression. If one considers a line AB in space and its projection A^cB^c from O, then the visual angle $\measuredangle AOB = \measuredangle A^cOB^c$ is immediately apparent; its size is dependent on the length and position of AB. In a ladder parallel to the picture plane (Π), the rungs follow in even intervals also in the picture, while the eye perceives the more distant rungs at a smaller angle than the close ones. Even so, it is in proportion to the rungs of a lattice parallel to Π . A facade appears in the front perspective in true shape, whereas the eye perceives window-widths and heights as becoming smaller the further the ray of vision deviates from the main line of sight. A sphere generally does not appear in a perspective figure as a circle, but the visual rays which touch the sphere form a cone of rotation, and artists represent a sphere as a circle. Spheres which are equidistant from Π appear in the perspective figure as larger and more distorted the further they are located from the main line of sight. In the graphic representation of a frontal row of columns, the more distant columns appear as wider parallel bands than the closer ones.

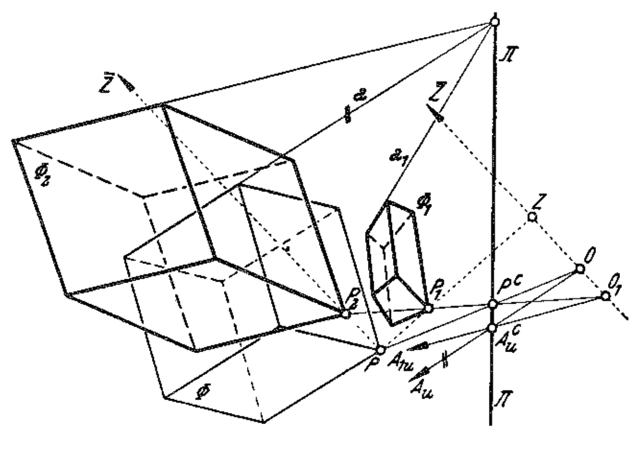


Fig. 1. View from O_1

Photographs are usually viewed from too great a distance; pictures usually hang too high on the wall. What does it mean geometrically, when a perspective figure located in the picture plane is not viewed from the visual center O but from a point O_1 ? Fig. 1 shows a side view. The eye at point O_1 interprets a point P^c in Π as the image of some point P_1 on O_1P^c . What kind of connection exists between the solid figure Φ of the point P and the solid figure Φ of the point P_1 ? In Fig. 1, Φ is assumed to be a cube. In architectural drawings it is justifiable that the drawing a^c of a straight line a from Φ looking from O_1 is interpreted as a figure of a straight line. This line a_1 lies in the plane $O_1 a^c$. Any line a from Φ corresponds to a line a_1 from Φ_1; it follows then that a spatial collineation exists between Φ and Φ_1. The points of the visual ray O_1P^c correspond to those of the visual ray OP^c, that is to say that each visual ray from O_1 corresponds to one from O. If one assigns the point O to Φ and the point O_1 to Φ_1, then O and O_1 conform to one another in the collineation.

If this is to be a perspective collineation then the center Z must lie on OO_1. The plane of collineation can only be Π since the corresponding visual-rays cut across Π. If one assumes that Z is on OO_1, then the cube depicted in Fig. 1 becomes a hexahedron Φ_1. If one gives Z all possible positions on OO_1 and if one then generates all possible perspective collineations (especially lengthening) on the developing views Φ_1 from the center O_1, then a group of solid views Φ_1 is produced. It can be shown that no other solid figures Φ_1 are imaginable. This ambiguity is reduced if one recognizes the vanishing point in perspective figures, which will always be possible with architectural drawings. If A^c_u is the vanishing point of all lines a parallel to OA^c_u then all a^c, when viewed from O_1, are to be interpreted as images of line a_1 with the direction $O_1 A^c_u$. If one recognizes in the drawing at least three vanishing points, X^c_u, Y^c_u, Z^c_u, (which do not lie on a single line), then these vanishing points are interpreted, even in the view from O_1, as distant points, namely the distant points of $O_1X^c_u$, $O_1Y^c_u$, $O_1Z^c_u$. The relationship between Φ_1 and Φ becomes an affinity. The center of this affinity (distant point of the affine rays) can only be the distant point $\overline{Z}$ on OO_1. The perspective affine solid figure Φ_2 (Fig. 1) yields to Φ which can still be exposed to all extensions with the center O_1.

Whoever impartially views a picture from too great a distance and recognizes a vanishing point in it, gets the impression of an affinely transformed solid figure. In reality, the original visual impression is quickly corrected because our previous experiences help us to properly interpret the visual impression and to assess the spatial position and size of objects. One can recognize how far such influences permeate for if one continually wears "reverse glasses" which exchange up and down on the retina, everything looks "normal" again after a few days.

Curved Perspectives.

If one views a larger facade from the front, then the horizontal lines both left and right seem to lean towards the horizon. The vertical lines seem to run together from above and below. That follows, as we have seen, from the reduction in size of the visual angle. In the attempt to express this graphically many different methods have been suggested which are supposed to replace the perspective with a better representation. One can imagine that the visual rays which come out from O are intersected by a "Visual sphere", χ, whose center lies at O and further that in some way this sphere is projected on the picture plane Π. We call the generated figure a curved perspective since solid lines were generally represented by curves in the suggested methods and these turn their concave sides towards the main point in Π. By means of the points of a line in space the lines of sight cut χ so as to form the locus of a great circle whose length is proportional to the sight angle under which the line from O appears. If one then wants to reproduce the sight angle as realistically as possible in Π, then the task arises to reproduce χ as exactly as possible on Π.[1] Distortions in it are unavoidable since a sphere cannot be congruently developed on a plane.

The same problem, that is to say the projection of the spheroid globe or a part of the globe on to a flat map, is to be found in every attempt at map making---with a difference: the map depicts the globe as seen from without but the curved projection depicts the visual sphere as seen from inside, like a stellar map. If one holds onto the usual perspective of mapmaking where all spatial points to include the points of χ, are projected from O onto Π, one attains a gnomic projection. While O and the perspective picture lie on the same side of Π, the gnomic map lies on the other side.

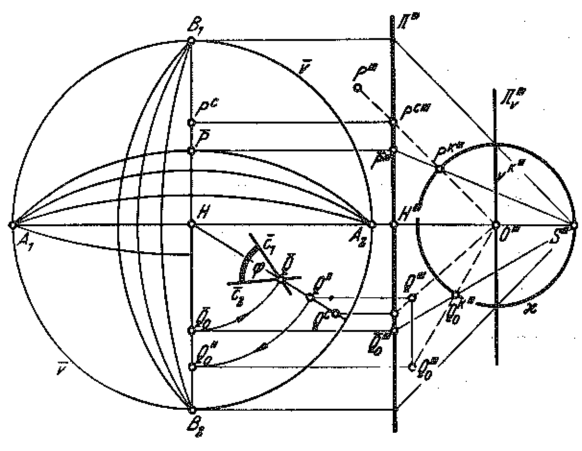


Fig. 2. Stereographic Perspective

One example of a curved perspective is the "stereographic perspective". S would be that point on χ which is most distant from Π (Fig. 2, right side elevation). A point in space P is projected from O towards χ at point P^k, then P^k is projected from S towards Π at point $\overline{P}$. $\overline{P}$ is called the "picture point" of P. In Fig. 2, P lies in the profile plane. Another point in space Q, given through the vertical projection Q'' on Π and profile Q, is first turned in the profile plane towards Q_o. From Q_o comes $\overline{Q}_o$ and through reverse rotation it determines $\overline{Q}$. For every point R on the vanishing plane Π_v, $\overline{R}$ lies on the intersecting circle v^k of χ with Π_v. $\overline{R}$ lies on the circle $\overline{v}$ = (H; HS). Within this circle lie the "picture points" of all points in space which lie in the profile left of Π_v. In contrast, the usual perspective pictures of these points fill the entire plane Π. The projection of χ from S to Π is a stereographic projection.[2] It possesses interesting characteristics (Fig. 3). A circle c_1^k on χ which goes through S appears as an intersecting line c_1 of its plane with Π. If a point P^k moves along c_1^k towards S, then $\overline{P}$ moves along $\overline{c}_1$ towards infinity and the tangent of S to c_1^k is parallel to $\overline{c}_1$. Two circles c_1^k and c_2^k on χ, which intersect in S and a further point of χ, appear therefore as two lines $\overline{c}_1$ and $\overline{c}_2$ through $\overline{Q}$ which enclose the same angle as the tangents in S on c_1^k and c_2^k. However, c_1^k and c_2^k intersect Q^k with the same angle as in S and therefore the angle of intersection φ of c_1^k and c_2^k with Q^k appears in true size as the angle φ of $\overline{c}_1$ and $\overline{c}_2$ with Q. Any two curves s_1^k and s_2^k on χ which intersect in Q^k and there touch c_1^k and c_2^k respectively appear subsequently as two curves $\overline{s}_1$ and $\overline{s}_2$ in Π which are touched in $\overline{Q}$ by $\overline{c}_1$ and $\overline{c}_2$ respectively and which intersect in the same angle. If s_1^k and s_2^k are major arcs of χ, then they are projected from O by visual planes and it follows that: In stereographic projections the angle formed by two intersecting visual planes appears in true size.

Let c^k be a circle on χ which does not go through S. χ will be touched by a cone of rotation, the vertex of which is C, along the length of c^k; SC intersects Π in C. In a projection from S on Π the cone-generating elements appear as straight lines through $\overline{C}$. The right angle which is formed by the intersection of c^k and the cone-generating elements appears as a right angle in Π. Therefore, the circle $\overline{c}$ on the picture plane projected from c^k must be intersected at right angles by all lines going through $\overline{C}$, it is then a circle with a center at C. If, for example, a sphere γ can be represented in a stereographic perspective then χ would be intersected by a tangent cone from O on γ like a circle c^k and this appears as circle $\overline{c}$. Therefore, the outline of a sphere in stereographic perspective is a circle.

A great circle g^k on χ is related to a line in space g and appears as circle $\overline{g}$ in stereographic perspective. g^k intersects Π_v in the end points of a diameter of v^k, hence $\overline{g}$ and $\overline{v}$ intersect in the end points of a diameter of $\overline{v}$. χ is touched along the length g^k by a cylinder of rotation. The perpendicular in S directed to O_g intersects Π at the midpoint of $\overline{g}$.

A kind of curved perspective can be seen in every attempt at map making. Artists have often depicted lines as curved (for example,

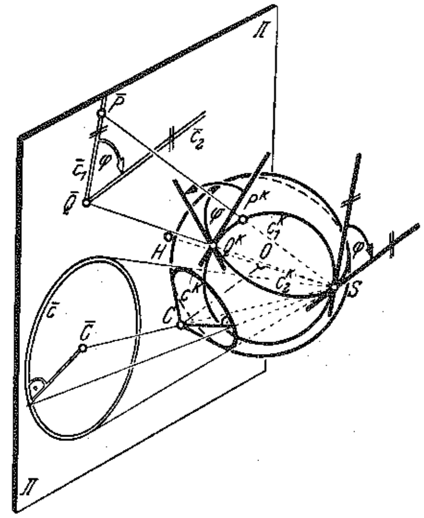


Fig. 3. Stereographic Perspective

A. Dürer, Scheldetor in Antwerp, Albertina in Vienna). One also finds such curves in architecture itself (for example, Parthenon, Athens). However, the need for a change in a perspective drawing is seldom perceived because our eye is just as used to viewing paintings, drawings, and photographs in perspective as East Asians are used to their slanting lines.

Other Graphic Means of Representation.

a) Panorama: The unidirectional view does not suffice for a panoramic view from a single viewing point, but the eye at O must turn from side to side. Then one can intersect the visual rays with a vertical cylinder of rotation whose axis goes through O. Fig. 4 depicts a portion of the cylindrical plane Π. The axis of Π is vertical, and on it lie O and the outline O^1 of O on the horizontal ground-plane Γ. A line OP intersects Π in two points but only that point of intersection which lies on the same side of O as P will be considered as the projection point P^z of P. The ellipse g^x is the figure of a line g in the general case since the plane O_g intersects Π in an ellipse. The panorama can be developed into a long rectangle. One views it segmentally on the cylinder or on the development. Sometimes one also puts together several photographs taken from O at regularly spaced intervals. If these photos are lined up one after another, then the edges must be hidden by hanging tree branches or other irregular forms. If the panorama is taken by means of an "all-round-camera" which turns about a vertical axis, then no edges will appear. In such a picture non-vertical lines appear curved.

b) Planetarium: If the side to side movement of the eye does not suffice to survey the object, then one can transfer it to the inside of a visual sphere around O and view it segmentally from O. For example, the starry sky in a planetarium is depicted in this manner.

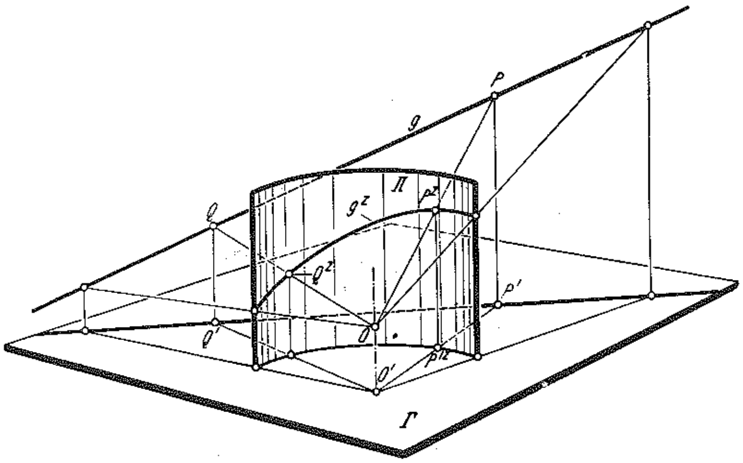


Fig. 4. Panorama

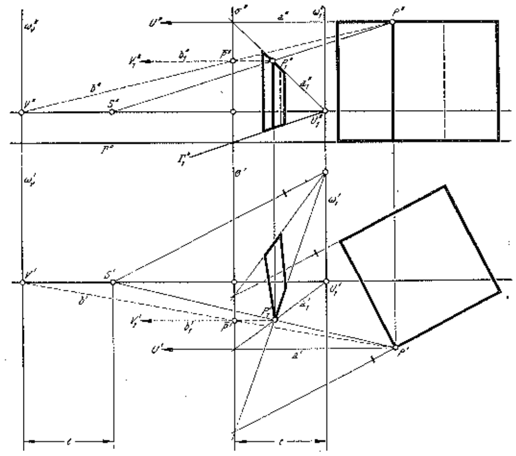


Fig. 5. Relief Perspective

c) Arch and dome painting, scene projection: Here the visual rays are intersected by the surface of a dome or arch. The drawing surface is frequently a cylinder of rotation, elliptical cylinder, or a sphere. The eye is not on the axis of the cylinder or the center of the sphere but rather at the place where it is assumed that the viewer will stand. Painters, especially in the art of the Baroque, have artistically extended columns and other architectural structures into the dome with amazing skill and attained startling effects. On many modern stages, slides are projected by means of one or two projectors, which simulate the background of the stage set on a "curved horizon". Usually the "curved horizon" is a standing elliptical cylinder; sometimes a half-dome is set up for it. The slides must be drawn in such a way that the projected background appears free of distortion when viewed from a central point in the audience. [3]

d) Relief, Theaterperspective: If an object is subjected to a spatial perspective affinity or collineation, then one can conceive of the affinely or collinearly transformed object as a spatial picture of the original object. In Fig. 5 the horizontal and vertical projections are pulled apart so that S' does not coincide with S'', likewise V' and V'', U' and U'' do not coincide. By means of the perspective spatial collineation the horizontal plane Γ is transformed into the plane Γ_1. For each point P_1, which is not on the same side of σ as S, there is a corresponding point P, which lies between the plane of collination σ and the base plane. The width t of the layer between σ and ω_1 is called the depth of relief. Fig. 5 shows the construction of a "Relief"; that is to say the collinear drawing of a cube.

Point $\overline{P}$ is the normal view of the relief point P_1 on the plane σ and at the same time $\overline{P}$ is the orthographic view of the spatial point P from V onto σ. One sees that: The orthographic projection of an object from V onto σ is also the normal view of the relief on σ. Such a relief often has the function of depicting an object of great depth in a space of more limited depth. One finds reliefs on coins and also as decoration on walls, doors, columns, and so forth. One gets the proper impression if one views the relief from the turned center of collineation or respectively from the direction of the affine rays. The distortions of the relief become apparent when viewed from another point and especially when viewed with both eyes. Therefore, free standing human figures in reliefs should not result in full collinear or affine distortion. Sharply illuminated reliefs behave unnaturally (trees throw shadows on mountains) and therefore reliefs are best begun in places without sunlight.

Similar questions arise with stage perspectives. There an effect of great depth is attempted on a stage with limited depth. The side walls converge at the rear and the ceiling is not horizontal but slants down toward the rear.

e) Stereoscropes, Anaglyphs, and Plastic Film: Stereoscopic reproduction was explained earlier. In the stereoscope each eye is presented with its own picture while the other picture is separated by a dividing screen. Anaglyphs attain the same effect by coloring the left picture red and the right picture green. Then a pair of glasses is placed in front of the eyes, and left lens of which is green and the right red. Red light rays come from the red picture, which cannot pass through the green lens and therefore the left eye perceives the left picture as black, similarly the right eye perceives the right picture as black. In a short time the object will be clearly perceived as plastic. [5] Complicated technical and medical objects are presented plastically through stereoscopic photography and anaglyphic pictures. In addition, stereoscopic x-ray photographs as well as stereoscopic photographs taken with electron and optical microscopes are being produced. One can plastically clarify the inner structure of an organism, the assembly of complicated machines, the excavation blue print of a mine survey or etc., by making several stereoscopic photographs with very short exposure times on the same photographic plate and taking away an outer layer of the object after each photograph. The result is a spatial view in which one can see into the inside of the object whose outer parts act as if they were transparent. Such binocular microscope photographs help in the inspection of surfaces and illumination of the minute characteristics of raw materials.

The stereo-comparer and other important geodetic instruments have also developed from the stereoscope.

Plastic film is a similar case. Each eye is offered its own picture and by use of colored glasses each eye only perceives one picture. Another method makes use of polarized light.

As explained earlier, the spatially perceived object experiences a spatial affinity if the eyes are shifted in a parallel manner. If at the same time the viewing distance is changed, but the direction of OO_1 kept constant, then the spatially-viewed object undergoes a spatial collineation. Practically speaking it is important that the spatial impression also remains preserved when the line OO_1 changes its direction (within certain limitations). Since visual rays viewed at related picture points are in general skew, then the spatial impression is no longer to be explained geometrically but is in the physiological and psychological realm. Above all, the old notion that depth perception is solely dependent on biocular vision is not valid. Not only do momentary perceptions function in each visual scene, but also all earlier experiences. The toddler reaches for the moon even though he sees it with both eyes. On the other hand, one-eyed people also need to spatially orient themselves. The same is true for herbivorous animals and for fish, whose eyes are placed on the side of the head and receive from their right and left eyes two completely different optical images.

f) Scaled-down Models: One cannot force the "real" impression which an object causes to appear in a picture, but one can approximate it. A scaled-down model, like one put together by architects to assess the aesthetic effect of a planned structure, has the advantage that the viewer is able to look at the model from different angles. Of course one should also be able to reduce the distance between the viewer's eyes according to the scale of the model. Since this is not possible, then it is suggested to view the scaled-down model from different sides with only one eye which should be brought as close as possible to the model. Models of larger building projects work the best, since for the most part they are viewed from above under similar conditions as with the actual building. The architectural effect of interior spaces cannot be satisfactorily reproduced.

g) Movies of Models: Scaled-down models can be filmed, and through photographic tricks, which make the vision of the proportionately reduced person possible, the film makes the structure appear like the normal size building in which it seems that the viewer can wander around. Excellent pictorial effects can be obtained if the model of the structure and its surroundings is advantageously lighted, and is exact in both form and color; if during filming the camera is handled in such a way that the film reproduces the viewers movements well with respect to space and time; and finally if the film is viewed during its showing from approximately a point in the viewing room which coincides with the optical mid-point of the camera. If one of these conditions is not met, then the impression is just as displeasing as that of an inexpertly drawn perspective. Model films succeed best with meaningful interior spaces, for instance in churches. The field of applications for movies is severely limited by the high cost of model construction and movie production. Model-films have been used for a long time in the presentation of feature films in film studios. Film-photographs of models made in Hollywood are very skillfully blended into feature scenes from all parts of the earth and ages of man.

h) Life-size models (Prototypes) placed at the future location of a monument or building, which are supposed to give the final impression of the aesthetic effect of a project, are only erected in special cases because of high cost.

1. "Analytical Treatment in U. Graf", Jahresbericht der Deutschen Mathematikervereinigun, 50 (1940), 35-53.

2. This was already known to Hipparch as a mapmaking technique. A transverse map is formed in Figure 2 only when the figure is drawn on the backside of Π .

3. cf. U. Graf, Z. angew. Math. Mechan. 18 (1938), 237 and 20 (1940), 50, as well as Z VDI 82 (1938) , 1429.

4. Concerning the construction of reliefs according to Staugil and de la Gournerie cf. E. Müller and E. Kruppa, Lehrbuch der Darstellenden Geometrie, 5th Edition, pp371-76. Viena: Springer, 1948.

5. There are machines which can produce stereoscopic pictures from paired normal outlines. Cf. T. Hildebrandt, Stereobilder zeichende Geräte. Baden-Baden: Verlag für Angewandte Wissenschaften, 1959.

Public Law 94-168
94th Congress, H. R. 8674
December 23, 1975

An Act

To declare a national policy of coordinating the increasing use of the metric system in the United States, and to establish a United States Metric Board to coordinate the voluntary conversion to the metric system.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "Metric Conversion Act of 1975". Metric Conversion Act of 1975. 15 USC 205a note.

SEC. 2. The Congress finds as follows: 15 USC 205a.

(1) The United States was an original signatory party to the 1875 Treaty of the Meter (20 Stat. 709), which established the General Conference of Weights and Measures, the International Committee of Weights and Measures and the International Bureau of Weights and Measures.

(2) Although the use of metric measurement standards in the United States has been authorized by law since 1866 (Act of July 28, 1866; 14 Stat. 339), this Nation today is the only industrially developed nation which has not established a national policy of committing itself and taking steps to facilitate conversion to the metric system.

SEC. 3. It is therefore declared that the policy of the United States shall be to coordinate and plan the increasing use of the metric system in the United States and to establish a United States Metric Board to coordinate the voluntary conversion to the metric system. 15 USC 205b.

SEC. 4. As used in this Act, the term— Definitions. 15 USC 205c.

(1) "Board" means the United States Metric Board, established under section 5 of this Act;

(2) "engineering standard" means a standard which prescribes (A) a concise set of conditions and requirements that must be satisfied by a material, product, process, procedure, convention, or test method; and (B) the physical, functional, performance and/or conformance characteristics thereof;

(3) "international standard or recommendation" means an engineering standard or recommendation which is (A) formulated and promulgated by an international organization and (B) recommended for adoption by individual nations as a national standard; and

(4) "metric system of measurement" means the International System of Units as established by the General Conference of Weights and Measures in 1960 and as interpreted or modified for the United States by the Secretary of Commerce.

SEC. 5. (a) There is established, in accordance with this section, an independent instrumentality to be known as a United States Metric Board. United States Metric Board. Establishment. 15 USC 205d.

(b) The Board shall consist of 17 individuals, as follows: Membership.

(1) the Chairman, a qualified individual who shall be appointed by the President, by and with the advice and consent of the Senate;

(2) sixteen members who shall be appointed by the President, by and with the advice and consent of the Senate, on the following basis—

(A) one to be selected from lists of qualified individuals recommended by engineers and organizations representative of engineering interests;

(B) one to be selected from lists of qualified individuals recommended by scientists, the scientific and technical community, and organizations representative of scientists and technicians;

(C) one to be selected from a list of qualified individuals recommended by the National Association of Manufacturers or its successor;

(D) one to be selected from lists of qualified individuals recommended by the United States Chamber of Commerce, or its successor, retailers, and other commercial organizations;

(E) two to be selected from lists of qualified individuals recommended by the American Federation of Labor and Congress of Industrial organizations or its successor, who are representative of workers directly affected by metric conversion, and by other organizations representing labor;

(F) one to be selected from a list of qualified individuals recommended by the National Governors Conference, the National Council of State Legislatures, and organizations representative of State and local government;

(G) two to be selected from lists of qualified individuals recommended by organizations representative of small business;

(H) one to be selected from lists of qualified individuals representative of the construction industry;

(I) one to be selected from a list of qualified individuals recommended by the National Conference on Weights and Measures and standards making organizations;

(J) one to be selected from lists of qualified individuals recommended by educators, the educational community, and organizations representative of educational interests; and

(K) four at-large members to represent consumers and other interests deemed suitable by the President and who shall be qualified individuals.

Term of office.

As used in this subsection, each "list" shall include the names of at least three individuals for each applicable vacancy. The terms of office of the members of the Board first taking office shall expire as designated by the President at the time of nomination; five at the end of the 2d year; five at the end of the 4th year; and six at the end of the 6th year. The term of office of the Chairman of such Board shall be 6 years. Members, including the Chairman, may be appointed to an additional term of 6 years, in the same manner as the original appointment. Successors to members of such Board shall be appointed in the same manner as the original members and shall have terms of office expiring 6 years from the date of expiration of the terms for which their predecessors were appointed. Any individual appointed to fill a vacancy occurring prior to the expiration of any term of office shall be appointed for the remainder of that term. Beginning 45 days after the date of incorporation of the Board, six members of such Board shall constitute a quorum for the transaction of any function of the Board.

Quorum.

(c) Unless otherwise provided by the Congress, the Board shall have no compulsory powers.

(d) The Board shall cease to exist when the Congress, by law, determines that its mission has been accomplished.

Policy implementation. 15 USC 205e.

SEC. 6. It shall be the function of the Board to devise and carry out a broad program of planning, coordination, and public education, consistent with other national policy and interests, with the aim of implementing the policy set forth in this Act. In carrying out this program, the Board shall—

(1) consult with and take into account the interests, views, and conversion costs of United States commerce and industry, including small business; science; engineering; labor; education; consumers; government agencies at the Federal, State, and local level; nationally recognized standards developing and coordinating organizations; metric conversion planning and coordinating groups; and such other individuals or groups as are considered appropriate by the Board to the carrying out of the purposes of this Act. The Board shall take into account activities underway in the private and public sectors, so as not to duplicate unnecessarily such activities;

(2) provide for appropriate procedures whereby various groups, under the auspices of the Board, may formulate, and recommend or suggest, to the Board specific programs for coordinating conversion in each industry and segment thereof and specific dimensions and configurations in the metric system and in other measurements for general use. Such programs, dimensions, and configurations shall be consistent with (A) the needs, interests, and capabilities of manufacturers (large and small), suppliers, labor, consumers, educators, and other interested groups, and (B) the national interest;

Comments and hearings.

(3) publicize, in an appropriate manner, proposed programs and provide an opportunity for interested groups or individuals to submit comments on such programs. At the request of interested parties, the Board, in its discretion, may hold hearings with regard to such programs. Such comments and hearings may be considered by the Board;

(4) encourage activities of standardization organizations to develop or revise, as rapidly as practicable, engineering standards on a metric measurement basis, and to take advantage of opportunities to promote (A) rationalization or simplification of relationships, (B) improvements of design, (C) reduction of size

variations, (D) increases in economy, and (E) where feasible, the efficient use of energy and the conservation of natural resources;

(5) encourage the retention, in new metric language standards, of those United States engineering designs, practices, and conventions that are internationally accepted or that embody superior technology;

Consultation and cooperation.

(6) consult and cooperate with foreign governments, and intergovernmental organizations, in collaboration with the Department of State, and, through appropriate member bodies, with private international organizations, which are or become concerned with the encouragement and coordination of increased use of metric measurement units or engineering standards based on such units, or both. Such consultation shall include efforts, where appropriate, to gain international recognition for metric standards proposed by the United States, and, during the United States conversion, to encourage retention of equivalent customary units, usually by way of dual dimensions, in international standards or recommendations;

Public information and education programs.

(7) assist the public through information and education programs, to become familiar with the meaning and applicability of metric terms and measures in daily life. Such programs shall include—

(A) public information programs conducted by the Board, through the use of newspapers, magazines, radio, television, and other media, and through talks before appropriate citizens' groups, and trade and public organizations;

(B) counseling and consultation by the Secretary of Health, Education, and Welfare; the Secretary of Labor; the Administrator of the Small Business Administration; and the Director of the National Science Foundation, with educational associations, State and local educational agencies, labor education committees, apprentice training committees, and other interested groups, in order to assure (i) that the metric system of measurement is included in the curriculum of the Nation's educational institutions, and (ii) that teachers and other appropriate personnel are properly trained to teach the metric system of measurement;

(C) consultation by the Secretary of Commerce with the National Conference of Weights and Measures in order to assure that State and local weights and measures officials are (i) appropriately involved in metric conversion activities and (ii) assisted in their efforts to bring about timely amendments to weights and measures laws; and

(D) such other public information activities, by any Federal agency in support of this Act, as relate to the mission of such agency;

(8) collect, analyze, and publish information about the extent of usage of metric measurements; evaluate the costs and benefits of metric usage; and make efforts to minimize any adverse effects resulting from increasing metric usage;

Surveys. Recommendations to Congress and President.

(9) conduct research, including appropriate surveys; publish the results of such research; and recommend to the Congress and to the President such action as may be appropriate to deal with any unresolved problems, issues, and questions associated with metric conversion, or usage, such problems, issues, and questions may include, but are not limited to, the impact on workers (such as costs of tools and training) and on different occupations and industries, possible increased costs to consumers, the impact on society and the economy, effects on small business, the impact on the international trade position of the United States, the appropriateness of and methods for using procurement by the Federal Government as a means to effect conversion to the metric system, the proper conversion or transition period in particular sectors of society, and consequences for national defense;

Report to Congress and President.

(10) submit annually to the Congress and to the President a report on its activities. Each such report shall include a status report on the conversion process as well as projections for the conversion process. Such report may include recommendations covering any legislation or executive action needed to implement the the programs of conversion accepted by the Board. The Board may also submit such other reports and recommendations as it deems necessary; and

Report to Congress and President.

(11) submit to the Congress and to the President, not later than 1 year after the date of enactment of the Act making appropriations for carrying out this Act, a report on the need to provide an effective structural mechanism for converting customary units to metric units in statutes, regulations, and other laws at all levels of government, on a coordinated and timely basis, in response to voluntary conversion programs adopted and implemented by various sectors of society under the auspices and with the approval of the Board. If the Board determines that such a need exists, such report shall include recommendations as to appropriate and effective means for establishing and implementing such a mechanism.

Committees, establishment. 15 USC 205f.

SEC. 7. In carrying out its duties under this Act, the Board may—

(1) establish an Executive Committee, and such other committees as it deems desirable;

(2) establish such committees and advisory panels as it deems necessary to work with the various sectors of the Nation's economy and with Federal and State governmental agencies in the development and implementation of detailed conversion plans for those sectors. The Board may reimburse, to the extent authorized by law, the members of such committees;

Hearings.

(3) conduct hearings at such times and places as it deems appropriate;

Contracts.

(4) enter into contracts, in accordance with the Federal Property and Administrative Services Act of 1949, as amended (40 U.S.C. 471 et seq.), with Federal or State agencies, private firms, institutions, and individuals for the conduct of research or surveys, the preparation of reports, and other activities necessary to the discharge of its duties;

(5) delegate to the Executive Director such authority as it deems advisable; and

(6) perform such other acts as may be necessary to carry out the duties prescribed by this Act.

Gifts and bequests. 15 USC 205g.

SEC. 8. (a) The Board may accept, hold, administer, and utilize gifts, donations, and bequests of property, both real and personal, and personal services, for the purpose of aiding or facilitating the work of the Board. Gifts and bequests of money, and the proceeds from the sale of any other property received as gifts or bequests, shall be deposited in the Treasury in a separate fund and shall be disbursed upon order of the Board.

(b) For purpose of Federal income, estate, and gift taxation, property accepted under subsection (a) of this section shall be considered as a gift or bequest to or for the use of the United States.

(c) Upon the request of the Board, the Secretary of the Treasury may invest and reinvest, in securities of the United States, any moneys contained in the fund authorized in subsection (a) of this section. Income accruing from such securities, and from any other property accepted to the credit of such fund, shall be disbursed upon the order of the Board.

Unexpended funds.

(d) Funds not expended by the Board as of the date when it ceases to exist, in accordance with section 5(d) of this Act, shall revert to the Treasury of the United States as of such date.

Compensation. 15 USC 205h.

SEC. 9. Members of the Board who are not in the regular full-time employ of the United States shall, while attending meetings or conferences of the Board or while otherwise engaged in the business of the Board, be entitled to receive compensation at a rate not to exceed the daily rate currently being paid grade 18 of the General Schedule (under section 5332 of title 5, United States Code), including traveltime. While so serving, on the business of the Board away from their homes or regular places of business, members of the Board may be allowed travel expenses, including per diem in lieu of subsistence, as authorized by section 5703 of title 5, United States Code, for persons employed intermittently in the Government service. Payments under this section shall not render members of the Board employees or officials of the United States for any purpose. Members of the Board who are in the employ of the United States shall be entitled to travel expenses when traveling on the business of the Board.

5 USC 5332 note. Travel expenses.

Executive Director, appointment. 15 USC 205i.

SEC. 10. (a) The Board shall appoint a qualified individual to serve as the Executive Director of the Board at the pleasure of the Board. The Executive Director, subject to the direction of the Board, shall be responsible to the Board and shall carry out the metric conversion program, pursuant to the provisions of this Act and the policies established by the Board.

(b) The Executive Director of the Board shall serve full time and be subject to the provisions of chapter 51 and subchapter III of chapter 53 of title 5, United States Code. The annual salary of the Executive Director shall not exceed level III of the Executive Schedule under section 5314 of such title.

5 USC 5101 et seq. 5 USC 5331.

(c) The Board may appoint and fix the compensation of such staff personnel as may be necessary to carry out the provisions of this Act in accordance with the provisions of chapter 51 and subchapter III of chapter 53 of title 5, United States Code.

Experts and consultants.

(d) The Board may (1) employ experts and consultants or organizations thereof, as authorized by section 3109 of title 5, United States Code; (2) compensate individuals so employed at rates not in excess of the rate currently being paid grade 18 of the General Schedule under section 5332 of such title, including traveltime; and (3) may allow such individuals, while away from their homes or regular places of business, travel expenses (including per diem in lieu of subsistence) as authorized by section 5703 of such title 5 for persons in the Government service employed intermittently: *Provided, however*, That contracts for such temporary employment may be renewed annually.

Financial and administrative services. 15 USC 205j.

SEC. 11. Financial and administrative services, including those related to budgeting, accounting, financial reporting, personnel, and procurement, and such other staff services as may be needed by the Board, may be obtained by the Board from the Secretary of Commerce or other appropriate sources in the Federal Government. Payment for such services shall be made by the Board, in advance or by reimbursement, from funds of the Board in such amounts as may be agreed upon by the Chairman of the Board and by the source of the services being rendered.

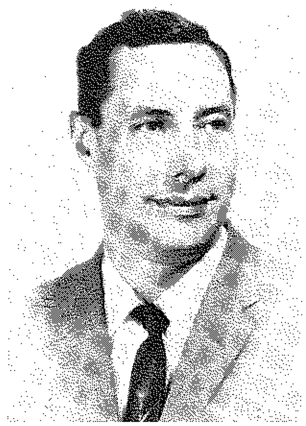
Appropriation authorization. 15 USC 205k.

SEC. 12. There are authorized to be appropriated such sums as may be necessary to carry out the provisions of this Act. Appropriations to carry out the provisions of this Act may remain available for obligation and expenditure for such period or periods as may be specified in the Acts making such appropriations.

Approved December 23, 1975.

LEGISLATIVE HISTORY:

HOUSE REPORT No. 94-369 (Comm. on Science and Technology).
SENATE REPORT No. 94-500 (Comm. on Commerce).
CONGRESSIONAL RECORD, Vol. 121 (1975):
Sept. 5, considered and passed House.
Dec. 8, considered and passed Senate, amended, in lieu of S. 100.
Dec. 11, House concurred in Senate amendment.
WEEKLY COMPILATION OF PRESIDENTIAL DOCUMENTS, Vol. 11, No. 52:
Dec. 23, Presidential statement.



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CONTOURING

For years the accumulation of data followed by time consuming interpolating and plotting the data for a contour plot has required many man hours.

With the advent of the computer and digital plotter the effort and time have been reduced drastically. It must still be remembered that sufficient accurate data must be collected before a plot is made. Also no plotter can "eyeball" a contour line based on the general trend of the surrounding surface. As the sophistication of the algorithm increases so does the plotting time. Frequently the highest contour line becomes an n-sided polygon because of the lack of data and the plot is in question. The draftsman frequently would omit the line or sketch a nice ellipse and no question would be raised.

Commerical packages are not only expensive, but also run very slowly and frequently are written in assembly language. For these reasons a subroutine in Fortran language featuring linear interpolation was written to allow students to have first hand experience in contouring using not only a familiar language but also reasonably small amounts of expensive computer time.

The logic was written for a Zip mode 718 Flatbed Calcomp plotter on line with an 1130 IBM 16K computer. Any computer with an ASA Fortran compiler and at least 16K should be sufficient.

A four pen option allows pens of different colors or widths to be used. Contour lines may be periodically annotated. Border scales are optional.

The flow of logic has been written so as to cause the computations to be performed while the plotter is moving thus saving much time.

Most of the arguments are fed through the CALL list. However, the large altitude array is placed in the COMMON area to save linking time.

The Example in Fig. I was chosen to show how the logic functions using a VERY difficult mathematical surface. Too often an example is selected to make the program look more effective than it really is. In Fig. 1, values of Z, contours, are plotted for the equation

$$Z = \sin(X) + 0.5*\sin(X*Y) + \sin(X/2.) + 0.5*\cos(Y/1.5)$$

Note that in the creation of the Z array from the X and Y vectors only the Z array is fed to the package. The Z (I,J)th value is related to the Ith value of X and the Jth value of Y. The separate SCLES subroutine may be used to relate X and Y.

Where a grid square is intersected by a contour line on all four sides, all possible lines connecting the points are drawn. It is easier to cover the unwanted line with correction fluid using an erasing shield than to add a line as is necessary in other packages.

For CONTOUR only Calcomp PLOT is needed. For SCLES routine the AXIS and associated Calcomp routines are needed. When using a single-pen plotter, the calls to and the logic for NUMPN should be omitted.

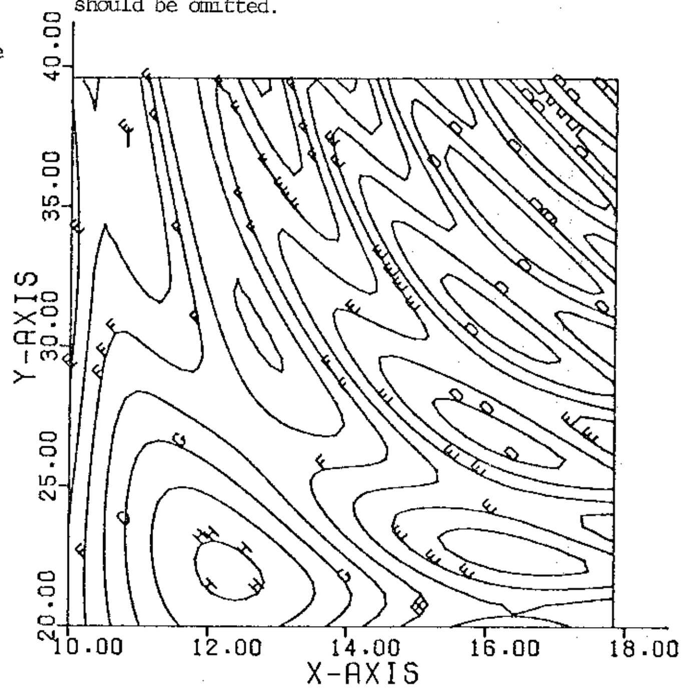

Figure 1

Figure 2

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PAGE   1

// JOB

LOG DRIVE   CART SPEC   CART AVAIL   PHY DRIVE
  0000        0009        0009         0000

V2 M07   ACTUAL 16K   CONFIG 16K

// FOR
*ONEWORDINTEGERS
*LISTALL
      SUBROUTINE CONTR(TMIN,TMAX,TDEL,IZ,JZ,SCALI,SCALJ,KK,FREQ,IACC,SIZ
     *E,ANG,N,BORDR)
      DIMENSION BRDR(2)
      COMMONT(50,50)
      DATA BRDR/'YES','NO'/
C KK=0 WILL NOT TEST FOR A NEAR PLATEAU,KK=1 WILL TEST BUT RUNS SLOWER...
C IF IZ IS NEGATIVE WILL GIVE A THREE COLOR PLOT...
C JZ NEGATIVE  GIVES SYMBOLS, PLUS NO SYMBOLS,
C FREQ=FREQUENCY OF SYMBOLS...
      I=IABS(IZ)
      J= IABS(JZ)
      IM1=I-1
      JM1=J-1
      DO 100 II=1,IM1
      DO 100JJ=1,JM1
      ICONT=0
      TT=TMIN
400   CALLREVRS(JM1,JJ,II,K)
      IF(KK)900,3000,900
900   IF((ABS(T(II,K)-T(II+1,K))+ABS(T(II,K)-T(II,K+1))+ABS(T(II+1,K)-T(
     $II+1,K+1))+ABS  (T(II,K+1)-T(II+1,K+1)))-.002*ABS(T(II,K)+T(II+1,K
     $)+
     $T(II+1,K)+T(II,K+1)+T(II,K+1))/4.)1,3,3
3000  IF(TT-T(II,K))700,700,601
601   IF(TT-T(II+1,K))700,700,602
602   IF(TT-T(II+1,K+1))700,700,603
603   IF(TT-T(II,K+1))700,700,100
700   IF(TT-T(II+1,K))701,300,300
701   IF(TT-T(II+1,K+1))702,300,300
702   IF(TT-T      (II,K+1))703,300,300
703   IF(TT-T(II,K))9,300,300
300   CALLENTRY(TT,T(II,K),T(II,K+1),T(II+1,K+1),T(II+1,K),R1,R2,R3,R4)
C DRAWS LOGIC...
      ICNT=0
      X=(II-1)*SC ALI
      Y=(K-1)*SCALJ
      X1=II*SCALI
      Y1=K*SCALJ
      IPN=3
      IF(R1-.1E20)1,2,1
1     IF(IZ)31,200,200
31    CALLNUMPN(TT,TMIN,TMAX,TDEL)
200   CALL PLOT(X,Y+R1*SCALJ,IPN)
      IF(JZ)21,20,20
21    CALL SYMBL(ICONT,FREQ,0,IACC,SIZE,ANG,N)
20    ICNT=ICNT+1

PAGE   2

      IPN=2
2     IF(R2-.1E20)3,4,3
3     IF(IZ)32,500,500
32    CALLNUMPN(TT,TMIN,TMAX,TDEL)
500   CALLPLOT(X+R2*SCALI,Y1,IPN)
      IF(JZ)36,  30,30
36    CALL SYMBL(ICONT,FREQ,1,IACC,SIZE,ANG,N)
30    IPN=2
      ICNT=ICNT+1
4     IF(R3-.1E20)6,5,6
6     IF(IZ)33,40,40
33    CALLNUMPN(TT,TMIN,TMAX,TDEL)
40    CALLPLOT(X1,Y+R3*SCALJ,IPN)
      IPN=2
      ICNT=ICNT+1
5     IF(R4-.1E20)8,9,8
8     IF(IZ)34,41,41
34    CALLNUMPN(TT,TMIN,TMAX,TDEL)
41    CALL PLOT(X+R4*SCALI,Y,IPN)
      ICNT=ICNT+1
      IF(ICNT-4)9,10,9
10    IF(IZ)35,42,42
35    CALLNUMPN(TT,TMIN,TMAX,TDEL)
42    IF(T(II,K)-T(II,K+1))9,44,9
44    IF(T(II,K+1)-T(II+1,K+1))9,45,9
45    IF(T(II+1,K+1)-T(II+1,K))9,43,9
43    CALLPLOT(X1,Y1,2)
9     CONTINUE
      TT=TT+TDEL
      ICONT=ICONT+1
      IF(TT-TMAX)400,400,100
100   CONTINUE
      IF(BORDR-BRDR(1))50,51,50
51    CALLPLOT(IM1*SCALI,0.,3)
      CALL NUPEN(1)
      CALLPLOT(IM1*SCALI,JM1*SCALJ,2)
      CALLPLOT(0.,JM1*SCALJ,2)
      CALLPLOT(0.,0.,2)
      CALLPLOT(IM1*SCALI,0.,2)
50    CALLPLOT(IM1*SCALI+1.,0.,3)
      RETURN
      END
VARIABLE ALLOCATIONS
   T(RC)=7FFE-6C78  BRDR(R )=0002-0000  TT(R )=0004  R1(R )=0006  R2(R )=0008  R3(R )=000A
  R4(R )=000C          X(R )=000E        Y(R )=0010  X1(R )=0012  Y1(R )=0014    I(I )=0028
   J(I )=0029       IM1(I )=002A       JM1(I )=002B  II(I )=002C  JJ(I )=002D ICONT(I )=002E
   K(I )=002F      ICNT(I )=0030       IPN(I )=0031

STATEMENT ALLOCATIONS
 400  =00BB  900  =00C5  3000 =0180  601  =018E  602  =019C  603  =01AA  700  =01B8  701  =01C6  702  =01D4  703  =01E2
 300  =01F0  1    =0262  31   =0266  200  =026C  21   =027D  20   =0286  2    =0290  3    =0297  32   =029B  500  =02A1
 36   =02B2  30   =02B8  4    =02C5  6    =02CC  33   =02D0  40   =02D6  5    =02ED  8    =02F4  34   =02F8  41   =02FE
 10   =0317  35   =031B  42   =0321  44   =033A  45   =0353  43   =036C  9    =0371  100  =0384  51   =039F  50   =03DE

FEATURES SUPPORTED
 ONE WORD INTEGERS
```

Guide to Subroutine CONTR., shown in Fig. 2.

CALL CONTRO (TMIN, TMAX, TDEL, IZ, JZ, SCALI, SCALJ, KK, FREQ, IACC, SIZE, ANG, N, BORDR)

TMIN: Real value of smallest expected contour value.

TMAX: Real value of largest expected contour value.

TDEL: Real value of contours interval.

IZ and JZ: Integer value of the size of the array to be plotted.

T(50,50) maximum on a 16K unit.

SCALI and SCALIJ: Real value in inches along the x and y axis representing a unit change in subscripts IZ and JZ.

KK: Integer value; Zero usually.

FREQ: Real value which controls how often contour is labeled. (FREQ = 1. is most frequent)

IACC: Integer value; Zero suggested.

SIZE: Real value for height (inches) for alphabetic contour label.

ANG: Real value for angle (degrees) from +X measured counterclockwise for alphabetic label.

N: Integer value; zero suggested.

BORDR: Real value alphabetic YES or NO to print or suppress border.

Special features: If IZ is negative plot will be in four colors. Lower 25% of contour lines for Pen 1 and etc.

If JZ is negative the plot will be annotated using letter A for TMIN, B for TMIN +2*TDEL and etc.

IACC and N are included here and in SYMBL, so if numeric labels are desired the logic can be added easily.

In certain problems a large plateau area may have small undulations giving rise to unwanted loops in this area. Under these conditions selects a value for KK other than zero. Running time increases substantially as a result however.

Subroutine REVRS scans the area left to right and reverses the Y direction every other time to speed the plot.

Subroutine ENTRY and AOVRB calculate the entry points for the contour lines with each grid square.

Subroutine NUMPN calculates proper pen to be used to draw the contour line. (And annotation)

Subroutine SYMBL calculates proper integer equivalents for alphabetic label. The border if requested is drawn last and the pen moves to the right off the plot.

```
      SUBROUTINESCLES(I,J,SCALI,SCALJ,NUMB,AX,NXX,XMIN,XDEL,AY,NYY,YMIN
     *,YDEL)
C NUMB IS THE NUMBER OF SCALES 2 OR 4
C AX AND AY ARE THE ALPHAMERIC ARRAYS CONTAINING THE AXIS TITLES
C  NX AND NY ARE THE NUMBER OF ALPHABETIC CHARACTERS IN EACH TITLE,
C   XMIN XDEL ARE THE FIRST VALUE ALONG THE SCALE AND THE INCREMENT PER INCH.
      IM1=I-1
      JM1=J-1
      NX=NXX
      NY=NYY
      K=0
      A=0
      B=0
5     CALL AXIS (0.,A,AX,-NX,IM1*SCALI*1.1,0.,XMIN,XDEL)
      CALL AXIS(B,0.,AY,NY,JM1*SCALJ*1.1,90.,YMIN,YDEL)
      IF(K)4,3,4
3     IF(NUMB-2)1,4,1
1     A=JM1*SCALJ
      B=IM1*SCALI
      NX=-NX
      NY=-NY
      K=K+1
      GOTO5
4     RETURN
      END
      SUBROUTINESYMBL(ICONT,FREQ,CODE,IACC,SIZE,ANG,N)
      INTEGER CODE
      DATA IVERT,IHORZ/2*1/
      IF(CODE)3,4,3
4     IF(IVERT-IFIX(FREQ))6,11,6
11    IVERT=1
      GOTO10
6     IVERT=IVERT+1
      RETURN
3     IF(IHORZ-IFIX(FREQ))60,110,60
110   IHORZ=1
      GOTO10
60    IHORZ=IHORZ+1
      RETURN
10    SMB=ICONT/2.
      IF(ABS(SMB)-IFIX(SMB))2,2,1
2     CALLWHERE(X,Y,Z)
      IF(SMB-9)20,21,21
20    ISMB=SMB+18
      GOTO30
21    IF(SMB-18)22,23,23
22    ISMB=SMB+25
      GOTO30
23    ISMB=SMB+33
30    CALLSYMB(X,Y,SIZE/Z,ISMB,ANG,-1)
      CALLPLOT(X,Y,3)
1     RETURN
      END
      SUBROUTINE NUMPN(T,TMIN,TMAX,TDEL)
      DATA FIRST,NUPN/0.,1/
      IF(FIRST)3,4,3
4     SLOPE=4./(TMAX-TDEL-TMIN)
      B=1.-SLOPE*TMIN
3     FIRST=1
      NOPN=NUPN
      NUPN=T*SLOPE+B
      IF(NUPN-5)8,7,8
7     NUPN=4
8     CONTINUE
      IF(NUPN-NOPN)5,6,5
5     CALLNUPEN(NUPN)
6     RETURN
      END
      SUBROUTINE AOVRB(T2,T1,T,RATIO)
      DEN=T2-T1
      IF(ABS(T2-T1)-.1E-3)1,2,2
1     DEN=SIGN(.1E-3,T2-T1)
2     RATIO=(T-T1)/DEN
      IF(RATIO)4,3,3
4     RATIO=.1E20
3     IF(RATIO-1.)5,5,6
6     RATIO=.1E20
5     RETURN
      END
      SUBROUTINE REVRS(JM1,JJ,II,K)
      IF(II/2-FLOAT(II)/2.)1,2,1
1     K=JJ
      GOTO3
2     K=JM1-JJ+1
3     RETURN
      END
```

```
      SUBROUTINE ENTRY(T,T1,T2,T3,T4,R1,R2,R3,R4)
      CALL AOVRB(T2,T1,T,R1)
      CALLAOVRB(T3,T2,T,R2)
      CALLAOVRB(T3,T4,T,R3)
      CALLAOVRB(T4,T1,T,R4)
      RETURN
      END
```

Figure 3

Guide to Subroutine SCLES, Figure 3.

CALL SCLES (IZ, JZ, SCALI, SCALJ, NUMB, AX, NX, XMIN, XDEL, AY, NY, YMIN, YDEL)

NUMB: Integer value; If NUMB = 2 scales are drawn on left and bottom. If NUMB = 4 scales are on all sides.

AX(AY): Real alphabetic label on X(Y) axis.

NX(NY): Number of characters in AX(AY).

XMIN(YMIN): Starting value on X(Y) axis.

XDEL(YDEL): Increment between labels on X(Y) axis. Other values same as in CONTR.

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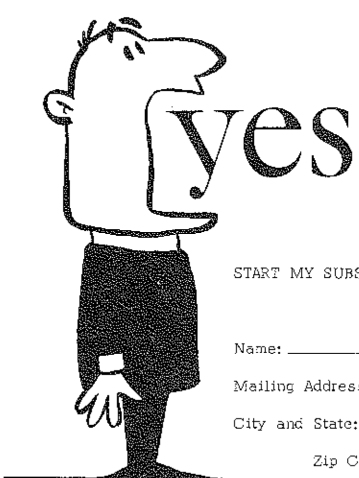

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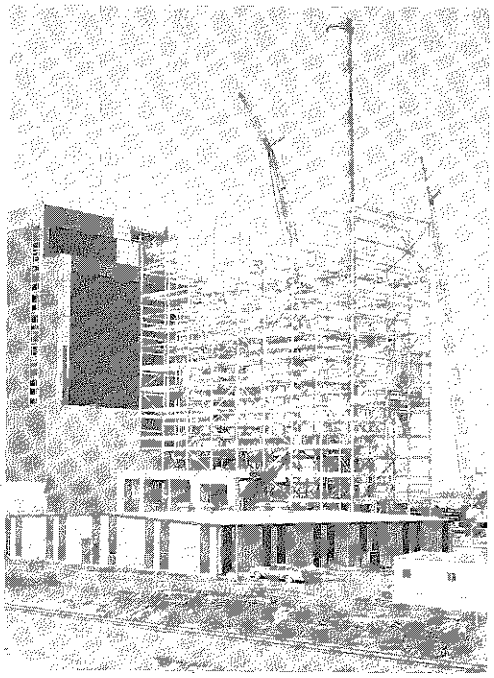

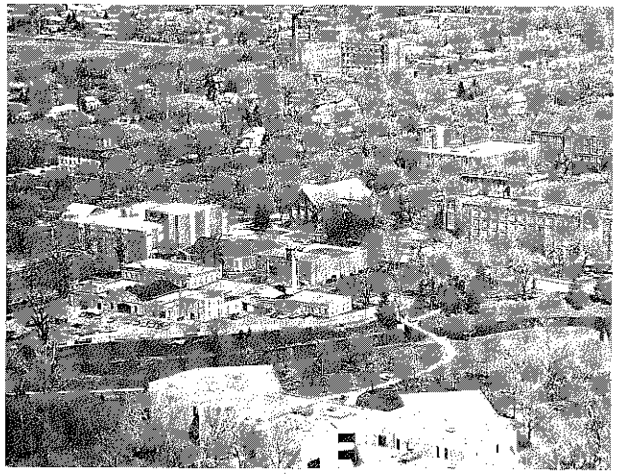

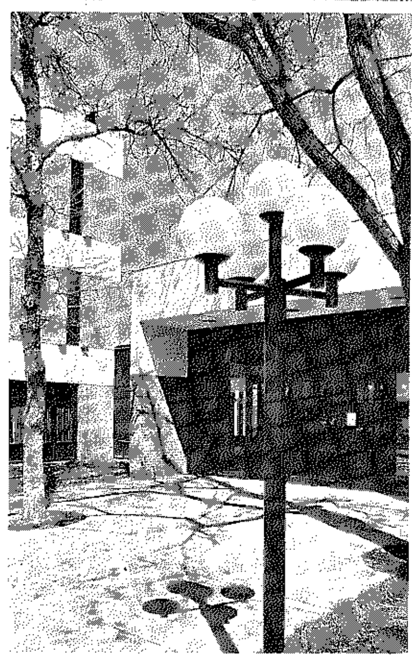

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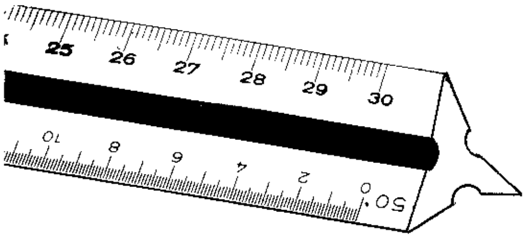

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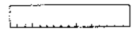

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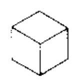

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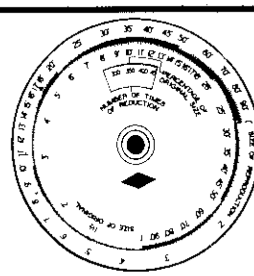

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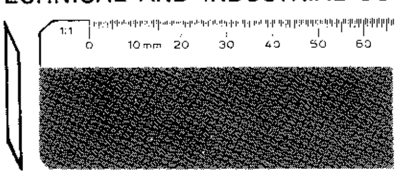

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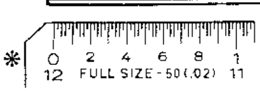

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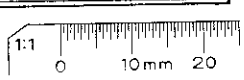

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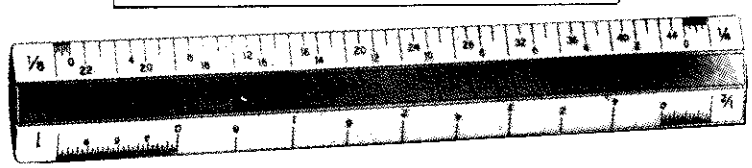

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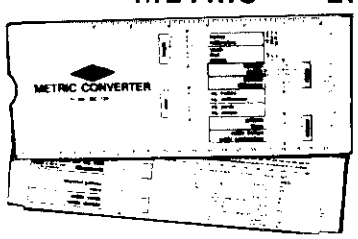

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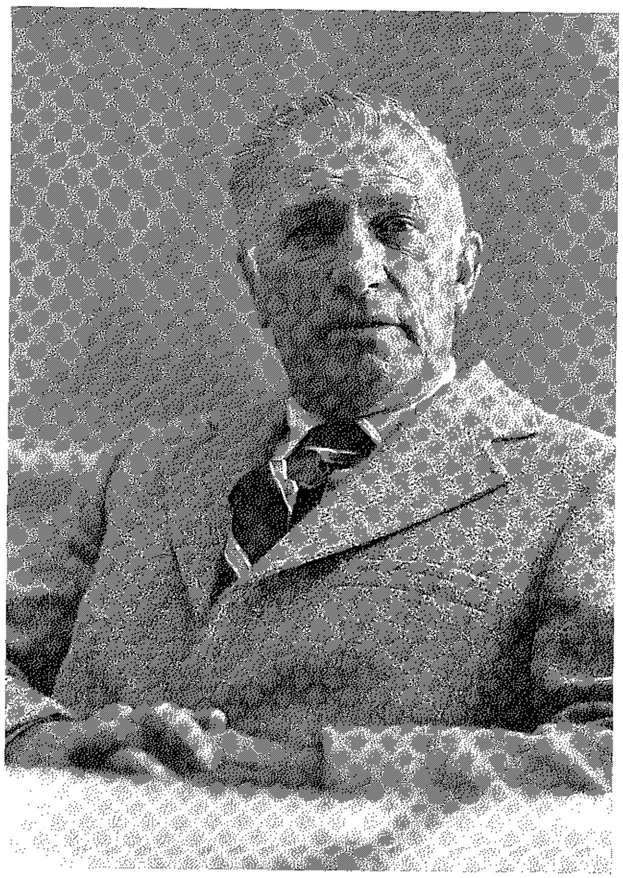

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