THE ENGINEERING DESIGN GRAPHICS

Journal

AUTUMN 1985 VOLUME 49 NUMBER 3

ENGINEERING DESIGN GRAPHICS DIVISION

AMERICAN SOCIETY FOR ENGINEERING EDUCATION

in this issue:

- division by-laws
- elections
- distinguished service award
- midyear meeting
- features on

  multi-dimensional descript
  development of warped surfaces
  computer aided drawing
  analog solutions
  non-orthodirectional projection
  history of graphics

VOLUME 49 NUMBER 3

ISSN 0046-2012

PUBLICATION BOARD

CALENDAR OF EVENTS

ASEE ANNUAL CONFERENCES

- 1986 CINCINNATI hosted by The University of Cincinnati
- 1987 RENO hosted by the university of Nevada at Reno
- 1988 PORTLAND hosted by Portland State University

EDGD MIDYEAR MEETINGS

- 1986 AUSTIN hosted by the University of Texas at Austin
- 1987 LOUISVILLE hosted bu the University of Louisville
- 1988 EVANSVILLE hosted by the University of Southern Indiana
- 1989 TUSCALOOSA hosted by the University of Alabama

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

SUBSCRIPTION RATES

YEARLY RATES		SINGLE COPY RATES	
US, Canada, Mexico		US, Canada, Mexico	
ASEE/EDGD Member	$1.50	ASEE/EDGD Member	$1.00
ASEE Member	$3.00	ASEE MEMBER	$1.50
Non-Member	$5.00	Non-Member	$2.00
Foreign Subscribers	$15.00	Foreign Subscribers	$5.00

All fees are payable to the Engineering Design Graphics Journal at: The Engineering Design Graphics Journal, Department of Engineering Graphics, The Ohio State University, 2070 Neil Avenue, Columbus, OH 43210. Back issues are available at single copy rates (prepaid) from the circulation manager and are limited in general to numbers published within the past six years. Subscription expiration date appears in the upper right corner of the mailing label as follows: ASEE/EDGD member is the same month/year as ASEE dues e.g. 6/86; all others last issue paid e.g. W86 for Winter 1986. Claims for missing issues must be submitted to the Circulation Manager within a six-month period following the month of publication: February for Winter, May for Spring, and November for Autumn.

OBJECTIVES OF THE JOURNAL

The objectives of The Journal are:

1. To publish articles of interest to teachers and practitioners of Engineering Graphics, Computer Graphics, and subjects allied to the fundamentals of engineering graphics education and graphic technology.
2. To stimulate the preparation of articles and papers on topics of interest to its membership.
3. To encourage teachers of graphics to experiment with and test appropriate teaching techniques and topics to further improve the quality and modernization of instruction and courses.
4. To encourage research, development, and refinement of theory and application of engineering graphics for understanding and practice.

DEADLINES FOR AUTHORS and ADVERTISERS

The following are deadlines for submission of articles, announcements, and advertising: FALL-September 15; WINTER-December 1; SPRING-February 1.

STYLE GUIDE FOR JOURNAL AUTHORS

1. All copy is to be typed, double spaced, on one side only using white paper with black ribbon in standard English. Dot matrix copy is acceptable if high quality.
2. All pages of the manuscript are to be numbered consecutively.
3. SIX copies of each manuscript are required.
4. Refer to all graphics, diagrams, photographs, or illustrations in your text as Figure 1, Table 1, etc. Be sure to identify all material. Illustrations cannot be redrawn. Accordingly, be sure that all linework is black and sharply drawn and that text is large enough to be legible when reduced to 4.25" in width. Good quality photocopies of sharply drawn illustrations are acceptable.
5. Submit a recent, glossy black and white photograph (head to chest). Make sure that your name and address is on the back. Photographs, illustrations or other submitted materials cannot be returned without postage prepaid.
6. The editorial staff will edit manuscripts for publication after return from the board of review. Galley proofs cannot be returned for author approval. Authors are encouraged to seek editorial comment from their collegues before submission.
7. Enclose all material, unfolded, in a large envelope. Use heavy cardboard to prevent bending.
8. All articles shall be written using Metric-SI units. Common measurements will be accepted at the descretion of the editorial staff.
9. Send all material in one mailing to:

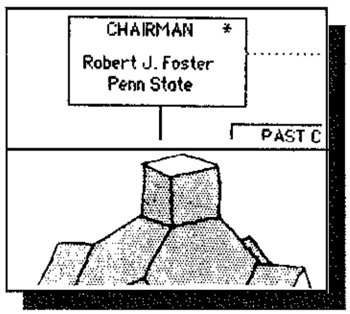
Jon M. Duff
Editor, EDGJ
355 Knoy Hall of Technology
Purdue University
West Lafayette, IN 47907

REVIEW OF ARTICLES

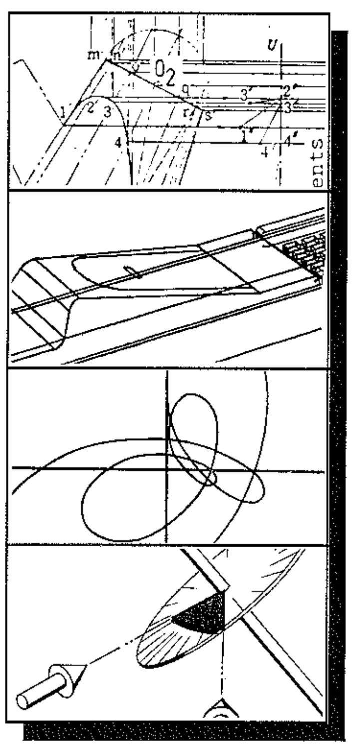
All articles are submitted to the EDGJ Board of Review for blind review. This board represents national authority on graphic technology, engineering education, and technical specialties within engineering and technology. Authors will be notified as to the results of the review. Manuscripts may be accepted as submitted, accepted with provisions, or not accepted for publication.

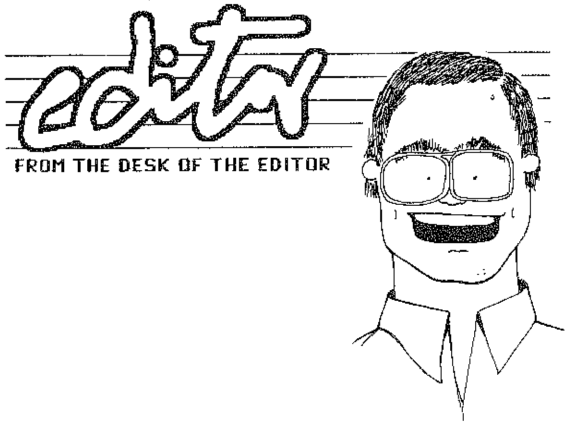
THE ENGINEERING DESIGN GRAPHICS
Journal
AUTUMN 1985 VOLUME 49 NUMBER 3
ENGINEERING DESIGN GRAPHICS DIVISION
AMERICAN SOCIETY FOR ENGINEERING EDUCATION

DEPARTMENTS



FEATURES





He was an American boy with his hands on the wheel, of a dream that was made of American steel...

The lyrics seem to play over and over, partly because of ***Iococca: An Autobiography***, partly because of my memories of a 1955 Ford Victoria (two-tone black and white with a green interior), and partly because of thinking of what we dream for our ourselves as educators. The 1985 ASEE National Meeting in Atlanta pointed to the dynamic yet heterogeneous makeup of our society and the strengths and weaknesses because of it.

How can we teach the same subject and yet teach widely differing subject matter in widely differing ways? Introductory graphics for engineering and technology students runs the gamut from traditional graphic technology to graphics programming, to visualization and quick-sketch techniques. Strange, there is no unified graphics curriculum in a profession who's accreditation is rigidly controlled. We do not present a unified front and receive an appropriate response.

See Letters to the Editor on Page 21

Five or six years ago, to an audience I can't recall, I warned that those individuals who were surfacing as "friends of graphics" were in fact enamored not by the importance of the subject matter, but by the new electronic technology. I warned that these people would be the first to turn when the glow of the new technology had waned. I think we are starting to see that right now.

Events of recent months have pointed out just how vulernable teachers of graphics are, especially if they are not involved in a degree-granting program. Even with such a program, the pecking order remains engineering first, engineering technology second, and the other technologies (read that graphics) last. It points out that there is no long-term professional future in teaching graphics as a service course to engineering and technology.

What are our dreams? Do we have a vision greater than just meeting our classes this term and finishing that current project?

EDGJ

Graphics Students Today

Has it ever seemed to you that spatial abilities of the incoming freshmen have somehow dropped? Data from the **Educational Testing Service** released this summer makes a startling comment on this. Comparing the scores on the spatial perception part of the **SAT**, they have found that on this part of the test the average college freshman now scores the same as **high school freshmen** did in 1962. Of course there are still highly qualified students entering engineering and technology but the pool of college-bound students has widened, meaning the pool of students that we see in our graphics courses has also widened. It is not suprising that the attrition rate is so high, and difficulty in visualization so common.

Add to this another factor--**reading level**. The vast majority of college freshmen read at below the 12th grade level, many as low as the 9th. But tests of reading level on many of the well-known texts reveal reading levels as high as the 17th grade level. We have been criticized for writing for each other and it appears to be true. Johnny can't read the graphics texts, and won't, until they are written for students.

chairman

A MESSAGE FROM THE CHAIRMAN

ROBERT J. FOSTER
Chairman, Engineering Design Graphics Division

Our Division begins a new academic year. It is a pleasure and honor to work this year as your chairman. The task has been made easier with the excellent guidance given me during the year just concluded by **Garland Hilliard**, outgoing Chairman. He stressed communication among members, and rightly so. In the same vein I hope to keep all officers well informed so that with teamwork we may have a constructive year.

Within these paragraphs it might be well to review the Division's activities at the June conference in Atlanta. Also, it could be helpful to look at needs and concerns of the Division as noted by this one observer. In this way, the membership may have a sharper focus on the mission of the division.

The conference in Atlanta had as its theme "Computer-Aided Engineering." Our Division responded with a session "Computer Graphics in Freshman Engineering Education" and another session "Computer-Aided Graphics and Design." These two solid events and others were well received. In addition, the Division sponsored the annual Creative Engineering Design Display (CEDD) under the leadership of **Gerry Voland**. He also organized for the first time a competition sponsored by the National Institute for Occupational Safety and Health (NIOSH). Winners of the CEDD were from Villanova University. The winner of the NIOSH competition was from Texas A&M University. Maintaining and expanding these important activities will be the priority of **Tom Baker** who succeeds Gerry Voland. Our Thanks go to Gerry for his two years of effort.

The awards for the CEDD/NIOSH winners were made at the annual awards banquet. Also of great interest was the announcement of the recipient of the Distinguished Service award, **Klaus Kroner**, who has given considerable service for many, many years.

The Executive Committee in its deliberations received and discussed reports from the various officers and members. It is heartening to see how seriously people discuss issues, even when they don't always agree. It is safe to say that in all cases the good of the Division was at the forefront of discussion. The recently elected officers participated also: **Barry Crittenden** as Secretary/Treasurer, **Rollie Jennison** as Vice Chairman, and re-elected **Jon Duff** as Director of Publications. The core of a hard working group is in place for the year to come.

The membership at large was informed at the Business Luncheon of news coming out of the Executive Committee meeting. Special mention was made of the Mid-Year Meeting to be at Purdue November 24-26. **Mike Khonsari** and **Pete Miller** are involved in working to make this a fine meeting. Also, a fresh new brochure is being readied to describe activities of the Division. Additionally, a third international conference is being planned for Vienna, Austria in 1988. This should be popular indeed! Closer and nearer is the '86 Annual Conference in Cincinnati with **Frank Croft** as the EDGD program chairman. Your active participation can help both you and the Society. It is those who get <u>involved</u> in an activity that derive the most satisfaction from that activity. This truism holds for most aspects of life, not suprisingly.

Can we assume from the comments so far that we can be content and complacent about the strength and health of our Division? Are ther problems? One wishes there were indeed no problems or concerns. However, any organization has its challenges and the EDGD is no exception.

Internally, there is the problem of weak committees which remain inactive year after year. Thought should be given to either strengthening such committees, making them inactive, or dissolving them. A committee which exists only on paper and has no activity is in a sense dishonest.

Continued on p. 22

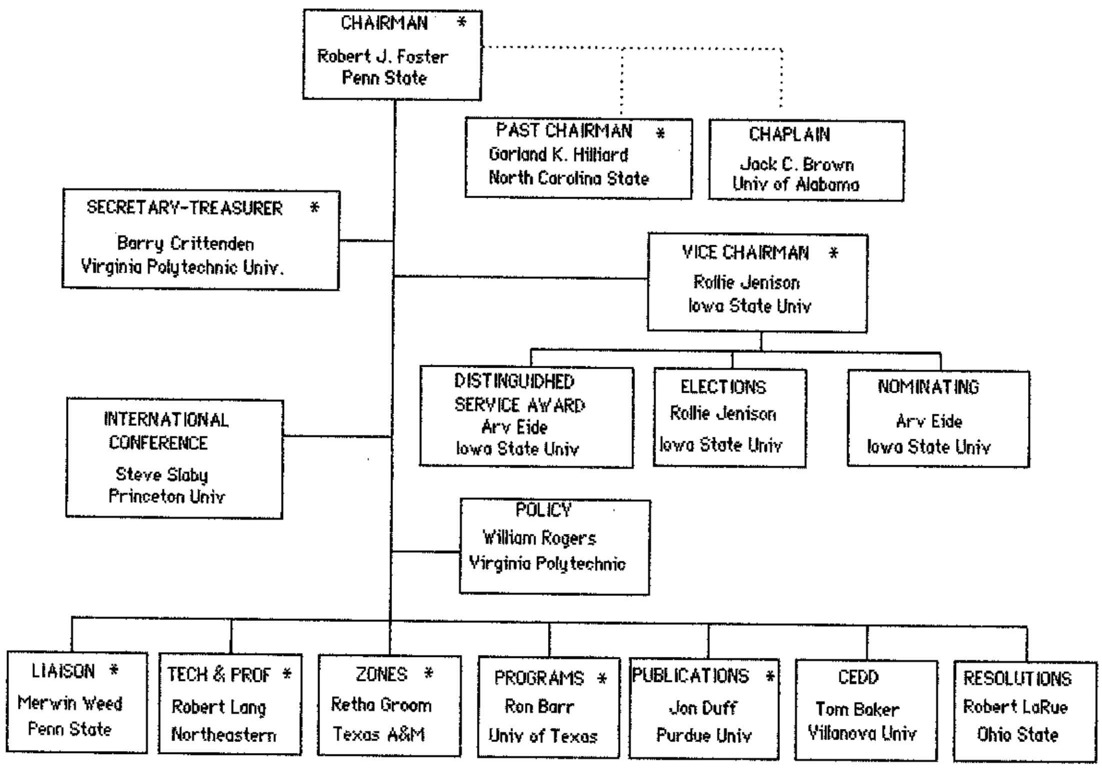
division

NEWS OF THE ENGINEERING DESIGN GRAPHICS DIVISION

ENGINEERING DESIGN GRAPHICS DIVISION

American Society for Engineering Education

Organization Chart 1985-1986



Liaison

Ed Relations
E.D. Galbraith
Cal State Poly

Membership
Garland Hilliard
N.C State

Frosh Programs
L.L. Northrup
Iowa State

Ind Relations
Charles White
Purdue

Intl Relations
Clarence Hall
Louisiana State

Tech & Prof

Computer Graphics
Robert Wilke
Ohio State

Eng Design Educ
Rollie Jennison
Iowa State

Teaching Techniques
Jon Jenson
Marquette

Theoretical Graphics
Ming Land
Appalachian State

Programs

1985 Mid-Year
Purdue Univ.
Mike Khonsari
Prgm Chmn

1985 Annual
Cincinnati, OH
Frank Croft
Prgm Chmn

1986 Mid-Year
Austin, TX

Publications

Technical Editor
______
______

Division Editor
______
______

Board of Review:
______
______
______
______
______
______
______
______
______

Circulation Mgr
Clyde Kearns
Ohio State

* Executive Committee Member

ASEE/EDGD MEMBERSHIP

Membership in our Division comes with that of our parent Society, The American Society for Engineering Education. We encourage you to join ASEE and associate with EDGD to promote engineering and technical graphics as a field of study; if you are a member, encourage others to join.

AMERICAN SOCIETY FOR ENGINEERING EDUCATION
Suite 200, Eleven Dupont Circle, Washington, D.C. 20036
(202) 293-7080

INDIVIDUAL MEMBERSHIP APPLICATION

Date ____________

I, ______________________ (signature), hereby apply for membership in the American Society for Engineering Education and enclose ________ as my annual membership dues for the year. $16.00 and $5.00 of this amount are for a year's subscription to *Engineering Education* and *Engineering Education News* respectively. The undersigned member of ASEE stands as my sponsor. (If ASEE sponsor is not readily available, application may be submitted to ASEE Headquarters for continuing action.)

______________________ (print name of sponsor)   ______________________ (signature of sponsor)

Please complete the application form below, hand-lettering or typing all entries. Enter one letter or number per block, leaving a blank box for normal separation of words. Use standard abbreviations where possible.

MAILING ADDRESS

Name (title, first, middle, last)	
Institution (if applicable to mailing address)	
Street Address and/or Department (if applicable)	
City (if served by U.S. Post Office)	State / Zip
City & Country (International Applicants only)	

PROFESSIONAL DATA (As it will appear in ASEE's Individual Member Directory)

Professional Position	
Institution/Company Name	
City (if served by U.S. Post Office)	State / Zip
City & Country (International Applicants only)	
Telephone (Include Area Code)	

DIVISION/COMMITTEE MEMBERSHIP

An individual ASEE member may become a member of six (6) divisions/committees. Three (3) non dues paying affiliations are allowed. If a member desires to join more than three (3) groups, the additional ones must be dues paying. Payment for dues paying affiliations must accompany this application. A listing of ASEE divisions/committees and their respective dues are listed on the back.

☐ Please check if you have chosen dues paying division/committee affiliations.

Enter your divisions/committees in order of preference

Date of Birth (Month) (Year)

In order for ASEE to qualify as a society member in the American Association of Engineering Societies, we must verify that 50% of our members are either Professional Engineers or have degrees from ABET/ECPD accredited institutions. Will you please help us by marking the appropriate box below and returning this sheet with your dues payment.

☐ Professional Engineer ☐ Degree from accredited institution ☐ Neither

FOR ASEE USE ONLY	Institution Code	Section Code	Country Code
84			

(OVER PLEASE)

MEMBER DUES

☐ $40 will supply one full year of membership for REGULAR MEMBERS.

☐ $15 will supply one full year of membership for STUDENT MEMBERS. Student members must be full-time students at one of the educational institutional members of the society. Verification of student status MUST accompany application and subsequent renewal notices.

Send check for new member dues to **ASEE, Eleven Dupont Circle, Suite 200, Washington, D.C. 20036.** If an individual desires special mail service, or wishes to affiliate with dues paying divisions/committees, the extra costs MUST be added to new dues payment.

OPTIONAL MAILING SERVICES

First Class Mail (U.S., Canada & Mexico)	Journal: $13.50 ☐	Newsletter: $6.50 ☐
Air Mail (All Countries except U.S., Canada & Mexico)	Journal: $42.00 ☐	Newsletter: $20.00 ☐

NOTE. ASEE publications will be sent via second class mail unless otherwise stipulated. Payment for the above optional mail services must accompany this application.

ASEE DIVISIONS AND CONSTITUENT COMMITTEES

Code		
DIVISIONS		
10	Aerospace	
11	Agricultural Engineering	
12	Architectural Engineering	
13	Chemical Engineering	
*14	Civil Engineering (Construction, Hydraulics, Sanitary, Soil Mechanics, Structural Surveying, Transportation)	$2.00
*15	Continuing Professional Development	$5.00
16	Cooperative Education	
*17	Educational Research & Methods	$1.00
*18	Electrical Engineering	$1.00
*19	Engineering Economy	$2.00
*20	Engineering Design Graphics	$1.50
21	Graduate Studies	
*22	Industrial Engineering	$2.00
*23	Liberal Education (Economics, English, History, Languages, Psychology, Specify Other)	$2.00
*24	Computers in Education	$5.00
*25	Materials (Mineral Engineering)	$2.00
26	Mathematics	
*27	Mechanical Engineering (Machine Design, Thermodynamics, Power)	$2.00
*28	Mechanics	$2.00
*30	Nuclear Engineering	$2.00
31	Physics	
32	Relations with Industry	
*33	Engineering Technology	$5.00
34	Environmental Engineering	
35	Instrumentation	
*36	Engineering Libraries	$1.00
37	International	
*50	Biomedical Engineering	$2.00
52	Ocean and Marine Engineering	
54	Energy Conversion & Conservation	
56	Engineering and Public Policy	
*57	Engineering Management	$1.00
58	Design in Engineering Education (DEED)	
59	Information Systems	
61	Experimentation and Laboratory Oriented Studies (DELOS)	
COMMITTEES		
55	Engineering Acoustics	
*60	Construction Engineering	$2.00
62	Women in Engineering	
64	Manufacturing	
65	Minorities in Engineering	
67	Freshman Programs	

***Include division/committees dues with payment**

BYLAWS for the ENGINEERING DESIGN GRAPHICS DIVISION of the AMERICAN SOCIETY FOR ENGINEERING EDUCATION (1984)

There have been several changes to the By-Laws of our Division in the past several years. The up-to-date version is presented here.

Article 1
NAME AND OBJECTIVES

Section 1. The name of this Division of the American Society for Engineering Education shall be the Engineering Design Graphics Division.

Section 2. The purpose of this Division shall be to promote the science and practice of graphical representation, communication, design, and analysis

Section 3. The objectives of the Division shall be to:

a. Provide leadership and guidance for those engaged in the teaching of conceptual design and graphical analysis and their use in industry.

b. Investigate matters relating to engineering graphics and to inform the membership of current developments.

c. Encourage the early participation of engineering students in the areas of graphics and design.

d. Promote, stimulate, and provide opportunities for the professional interchange of ideas among the membership.

e. Maintain a liaison with industry and government.

Article II
MEMBERSHIP

The membership of this Division shall consist of all those members of the American Society for Engineering Education who have indicated Engineering Design Graphics as an area of interest and paid Division dues for the year.

Article III
OFFICERS AND DUTIES

Section 1. The Division shall have the following officers whose terms of office shall be as indicated:

Chairman	1 year
Vice-Chairman	1 year
Secretary-Treasurer	3 years
Directors (5)	3 years

Section 2. The duties of each officer of the Division shall be those usually associated with his respective office including the following:

2a. CHAIRMAN

2a(1). He shall be Chairman of the Division and of the executive committee and ex officio member of all other committees of the Division. He shall preside at all business meetings of the Division and of the executive committee.

2a(2). He shall be the senior member of the Division on the executive board of the ASEE Council for Professional and Technical Education.

2a(3). He shall review the annual budget of the Division as prepared by the Secretary-Treasurer [See ART. III, Sec. 2c(6)]. The Vice-Chairman shall be consulted during this review. If necessary, adjustments in the budget will be made and discussed with the Secretary-Treasurer. When finalized, the budget shall be presented by the Chairman to the Executive Committee for final approval or revision. Upon approval the budget shall be submitted to the Executive Director of the Society. (ASEE).

2a(4). He shall prepare a written report, including budget expenditures, of his term of office and furnish copies to the Division Secretary-Treasurer.

2a(5). He shall keep the Vice-Chairman informed of all activities of the Division and, at the end of his term, transmit other pertinent material to maintain continuity.

2a(6). He shall appoint all bylaw committees except the Nominating and Elections Committees, designating the chairman except where the chairman is specified by the bylaws.

2a(7). He shall appoint the chairman and, at his discretion, other members of committees not specified by the bylaws but considered necessary for the adequate administration and operation of the Division, and assign such committees to the Vice-Chairman or appropriate Director for administrative control.

2a(8). He shall review and approve the composition of all committees.

2a(9). He shall assure the effective operation of the Division by revoking the appointment of any appointee who is not, in his judgement and the judgement of the appropriate Director, satisfactorily performing the duties of the position to which the appointee was designated.

2a(10). He shall, with the advice and consent of the Executive Committee, request the resignation of any officer of the Division who is not adequately fulfilling the obligation of that officer's elected office, and shall appoint another member of the Division to serve in that office for the remainder of that term.

2a(11). He shall be responsible for all meetings of the Division and the Executive Committee.

2a(12). He shall arrange for each new member of the Society, who has indicated an interest in the Division, to receive a card, or letter, of welcome. Information concerning the Division and its activities should be included.

2a(13). He shall be responsible for the functioning and performance of the Policy Committee whose duties and composition are defined in ART. VII, Sec. 1c.

2b. VICE-CHAIRMAN

2b(1). He shall serve as the Vice-Chairman of the Division for the year following his election.

2b(2). He shall assume the chairmanship of the Division for the year following his term as Vice-Chairman.

2b(3). In the event that the Chairman is unable to perform the duties of his office, the Vice-Chairman shall assume the office of Chairman.

2b(4). He shall preside over business meetings of the Division and the executive committee in the absence of the chairman.

2b(5). He shall be the junior member of the Division on the executive board of the ASEE Council for Professional and Technical Education.

2b(6). He shall assist the Chairman in the operation of the Division.

2b(7). He shall, through the Chairman, keep informed on the current problems and operations of the Division so that he may maintain continuity of the activities of the Division.

2b(8). He shall appoint the nominating committee and the elections committee subject to the approval by the executive committee at its annual business meeting.

2b(9). He shall be the chairman of the election committee. He shall, with the aid of the other members of the elections committee, count the election ballots and submit a confidential report of the results of the election to the Chairman of the Division.

2b(10). He shall prepare a printed list of committees for his term of office as Chairman for presentation to the Division. Printed copies of the list shall be made available to the executive committee and to all persons in attendance at the annual business meeting.

2b(11). He shall be responsible for the functioning and performance of the following Bylaws Committees: Nominating, Elections, and Distinguished Service Award. The duties and composition of these committees are defined in ART. VII, Sec. 1.

2c. SECRETARY-TREASURER

2c(1). He shall be Secretary-Treasurer of the Division and of the executive committee.

2c(2). He shall keep complete records of all meetings of the Division and of the executive committee within sixty (60) days following each meeting or group of meetings and shall furnish copies of the minutes to all members of the executive committee and their proxies. He shall distribute to all the members of the Division who are in attendance at the annual business meeting in June copies of the minutes of the previous annual and mid-year business meetings.

2c(3). He shall receive and preserve copies of all reports and papers presented at the meetings of the division and of the executive committee.

2c(4). He shall receive and transmit to the Engineering Library of the University of Illinois at Urbana, Illinois 61801, such items as may be properly deposited there.

2c(5). He shall supply to the officers of the Division up-to-date copies of these Bylaws with all amendments, within sixty (60) days following the annual conference of the Society, provided that changes were made.

2c(6). He shall prepare an annual budget and submit it to the Division Chairman for review prior to its presentation to the executive committee for final approval or revision.

2c(7). He shall receive any Division money, except that which is part of the income of the ENGINEERING DESIGN GRAPHICS JOURNAL and under control of the publication committee, and shall place on deposit such money in an account in a suitable repository under the name of the Division.

2c(8). He shall disburse Division funds upon the approval of the Chairman of the Division.

2d. DIRECTORS

2d(1). There shall be five Directors each elected to serve for a period of three years. No more than two (2) Directors shall be elected in any calendar year. Each Director shall be responsible for all committees in one of the following categories:

A. Liaison
B. Professional and Technical
C. Programs
D. Publications
E. Zones Activities

2d(2). GENERAL DUTIES OF DIRECTORS

Directors are responsible for establishing functions and guidelines for the operations of each of their assigned committees. Each year, prior to the Annual Conference, they shall recommend to the incoming Chairman the names of suggested committee Chairmen and members of committees under the Director's direction. A Director whose term of office is ending should consult with his elected replacement as to committee composition. Actual appointments should not be made until approved by the Executive Committee and the Division Chairman as designated in ART. III, Sec. 2a(8). Directors shall maintain contact with the chairmen of their assigned committees to insure the enactment of the committees' functions. Directors are responsible for the presentation of reports on the activities of their assigned committees at the Executive Committee meetings during the Annual and Mid-Year Conferences. Directors may recommend the creation of new committees (or the discontinuance of committees that have fulfilled their function) within the category under their jurisdiction. Recommended actions must be approved by the Executive Committee and Division Chairman. Directors shall be responsible for notifying the Division Chairman of the unsatisfactory performance of any individual under their jurisdiction which could invoke the provisions of Article III, Secs. 2a(9) and (10).

2d(3). SPECIFIC DUTIES OF DIRECTORS

2d(3a). DIRECTOR: LIASION COMMITTEES

2d(3b). DIRECTOR: PROFESSIONAL AND TECHNICAL COMMITTEES

The Director is responsible for the functioning and performance of all professional and technical committees as defined in ART. VII, Sec. 2a(2).

2d(3c). DIRECTOR: PROGRAMS

The Director is responsible for the programs of all Conference sessions during his term of office. The Director shall be responsible for issuing a call for papers to be presented at each Conference. The Director shall maintain a Manual of Procedures to aid the Program Chairmen in planning the Conference for which they are responsible, as well as keeping the Program Chairman informed of all pertinent information regarding that Conference including papers submitted, requests to participate, theme and general guidelines. The

Director will approve all proposed programs before submitting them for the approval of the Division Chairman and Executive Committee. He is responsible for insuring that all Program Committees are properly functioning and maintaining their time schedule.

2d(3d). DIRECTOR: PUBLICATIONS

The Director shall also serve as Editor of the ENGINEERING DESIGN GRAPHICS JOURNAL. He is responsible for the effective performance of all members of the Publications Committee.

2d(3e). DIRECTOR: ZONE ACTIVITIES

The Director shall encourage and suggest activities by maintaining contact with all Zone Chairmen to inform them of special activities being accomplished in other Zones as reported to the Director by those Chairmen.

Article IV ELECTIONS AND SUCCESSION OF OFFICERS

Section 1. Elected personnel shall be nominated and elected according to the following procedures:

1a. A slate of two candidates, for each officer to be elected, shall be prepared by the nominating committee. An eligible candidate must be a member of the ASEE and the Division who has expressed a willingness to accept nomination and to serve if elected to the office to be filled. The slate shall be published in the Fall issue of the ENGINEERING DESIGN GRAPHICS JOURNAL.

1b. A candidate for an elective position may be nominated by a written petition addressed to the Chairman of the nominating committee bearing ten (10) signatures of members of the Division and accompanied by a statement from the candidate affirming his willingness to serve if elected. The names of candidates so nominated shall be added to the slate as prepared by the Secretary-Treasurer under 1d below.

1c. The nomination period shall close on January 31. A petition for nomination received after January 31 cannot be accepted.

1d. Not later than February 15, and returnable before March 15, the Secretary-Treasurer shall mail to each member of record (as provided by the ASEE Executive Director) of the Division an election ballot bearing the slate submitted by the nominating committee together with additional names presented by petition. A candidate receiving the largest number of votes for the office sought shall be declared elected. Included in the mailing shall be an envelope for the return of the ballot. The envelope shall bear the name and address of the chairman of the elections committee (Vice-Chairman of the Division).

1e. The holder of an elective position whose term extends beyond the current year shall not be eligible for nomination to another office or position.

1f. Assumption of office by newly elected personnel shall be concurrent with that of the offices of the American Society for Engineering Education.

1g. If any elected person is unable to perform the duties of his office, these duties shall be assumed by a member of the Division appointed by the Chairman with the approval of the executive committee, for the remainder of the term.

1h. In the event that both the Chairman and Vice-Chairman are unable to assume their offices, the executive committee shall elect a Chairman from its membership.

Artice V CONFERENCES

Section 1. ANNUAL CONFERENCE. There shall be an annual conference of the Division to be held concurrently with the annual conference of the Society, and it shall include the annual Division dinner meeting, one or more conference sessions, and a luncheon business meeting. The annual conference shall be planned to include areas of interest to instructors in technical education as well as those instructing at junior and senior levels and employers of graduates. Joint meetings with other Divisions and Constituent Committees of the Society are to be encouraged.

1a. PROGRAM FOR ANNUAL CONFERENCE. The program for the annual conference shall be considered by the executive committee at the mid-year conference of the Division. The Chairman shall present the annual conference program to the members of the Division at the mid-year luncheon business meeting along with items of business. Written reports of committees shall be received and distributed.

1a(1). The Chairman shall transmit the program for the annual conference to the Executive Director of the Society. The tentative draft of the program shall be submitted when requested by the Society subject to modifications enacted by the Executive Committee at the mid-year conference. The program for the annual conference shall be published in the ENGINEERING DESIGN GRAPHICS JOURNAL as a record for the Division.

Section 2. MID-YEAR CONFERENCE. There shall be a mid-year conference to be held on an appropriate date each year between November 1 and January 31, and shall include a Division mid-year dinner meeting, one or more conferences, and a luncheon business meeting. The Executive Committee will be responsible for selecting sites for conferences.

2a. PROGRAM FOR MID-YEAR CONFERENCE. The program for the mid-year conference shall be considered by the Executive Committee at the annual conference of the Division. The Chairman shall present the mid-year conference program to members of the Division at the annual luncheon business meeting. The program for the mid-year conference shall be published in the ENGINEERING DESIGN GRAPHICS JOURNAL as a record for the Division.

Section 3. Periodic Summer Schools shall be held at the direction of the Executive Committee.

Section 4. Division members are urged to plan group meetings of engineering design graphics instructors in connection with sectional conferences of ASEE, and are urged to make those meetings of interest to instructors in technical education and of junior and senior college levels with a view of including such instructors as members of the Division.

Section 5. Members of the Society and other interested persons are eligible to attend all open conferences and meetings of the Division.

Article VI EXECUTIVE COMMITTEE

Section 1. DUTIES

1a. The Division shall have an executive committee whose duty shall be to administer the affairs of the Division and report to the Division at the mid-year and annual conferences.

1b. The Executive Committee shall convene for a meeting prior to the annual and mid-year business meetings in order to receive and discuss written reports from the Division's committees and to conduct such other business as required.

1c. The Executive Committee shall schedule and arrange for annual conferences, mid-year conferences and summer schools. It shall administer such other activities as may be desirable for the promotion of the objectives of the Division, including the appointment of special committees.

Section 2. OFFICERS. The officers of the Executive Committee shall be the officers of the Division.

Section 3. MEMBERS. The members of the Executive Committee shall be the officer of the Division and the immediate past Chairman.

Section 4. PROXIES. A member of the Executive Committee who cannot attend a meeting may appoint a proxy. If he fails to do so, the Chairman of the Division may appoint a proxy for him. Proxies must be members of the Division.

Section 5. The Chairman of the Division may invite guests to the Executive Committee meeting if he feels that it is in the interest and to the benefit of the Division. Any members, or other interested person having a contribution to make to the Division should submit his thoughts in writing to the Chairman at least thirty (30) days before a scheduled meeting of the Executive Committee so that he may be invited if his presence is deemed to be desirable by the Chairman.

Article VII
COMMITTEES

Section 1. BYLAW COMMITTEES. Each chairman of a Bylaw committee is expected to submit a report to the Vice-Chairman of the Division well in advance of the Executive Committee meeting at the annual and the mid-year conferences. The Vice-Chairman will consolidate the reports of his committee chairmen into a single report submitted to the Division Chairman. The report should be available for study, by members of the Executive Committee, prior to the meeting of the Executive Committee so that controversial or other critical issues may be intelligently discussed and action taken at the Executive Committee meeting.

1a. NOMINATING COMMITTEE. A nominating committee shall be recommended by the incoming Vice-Chairman to be confirmed by the Executive Committee at its annual meeting in June. The nominating committee shall consist of five members three of whom shall be the most recent past chairmen of the Division and two other qualified members. To be qualified, the member must not hold a Division office at the time committee action is taken. The chairman of the nominating committee shall be the senior past chairman, so appointed.

1b. ELECTIONS COMMITTEE. The elections committee for the following year shall consist of the Vice-Chairman in office and two members of the Division appointed by the Vice-Chairman. The appointments shall be subject to approval of the Executive Committee. The Vice-Chairman shall be the chairman of the elections committee.

1b(1). The chairman of the elections committee shall transmit the results of the election to the Chairman of the Division. The Chairman of the Division shall then inform each candidate (including those not elected) of the results of the election for his office and shall transmit the names of the newly elected officers to the editor of the ENGINEERING DESIGN GRAPHICS JOURNAL for publication in the Spring issue of the Journal. The chairman of the elections committee shall report the results of the election to the Division at the annual business meeting.

1c. POLICY COMMITTEE. A policy committee shall be recommended by the incoming Chairman to be confirmed by the Executive Committee at its annual meeting in June. The policy committee shall be composed of three or more members, three of whom shall be past chairmen of the Division. The policy committee shall consider all matters of policy for the Division that are assigned to it and make recommendations to the Division and the Executive Committee. The committee shall act for the Division to approve or disapprove American National Standards Institute (ANSI) Drafting Standards submitted to it by the ASEE as sponsor in accordance with the policy of the Society.

1d. DISTINGUISHED SERVICE AWARD COMMITTEE. The distinguished service award committee shall be composed of the three immediate past chairmen of the Division. The senior past chairman shall serve as chairman of the committee. The committee shall consider as possible recipients of the Distinguished Service Award those nominees thought to be worthy of the award because of distinguished service to the engineering profession, the Division, and to education. Since this award is recognized, also, as one of the outstanding awards of the Society and the person receiving it is honored at the annual dinner of the Society as a person of considerable professional stature, the committee need not select a recipient in any year that none of the nominees fully meet the requirements set forth herein by the Division. The award shall be based upon the following:

1d(1). To recognize and encourage outstanding contributions to the teaching of students of engineering design graphics, descriptive geometry, computer graphics, and other courses within the interests of the Engineering Design Graphics Division.

1d(2). The Award. The award shall consist of a certificate presented at the annual dinner of the Engineering Design Graphics Division of ASEE.

1d(3). Requirements. In order to receive the distinguished Service Award, a person must have made a clearly discernible contribution to the art and science of teaching courses in a recognized field of graphics in several of the following ways of which item (e) shall not be omitted:

(a) Success as a teacher must be established both as to competence in a subject matter and ability to inspire students to high achievement.

(b) Improvement of the tools of, and conditions for, teaching. Evidence of such achievement may consist of subject matter (textbooks, etc.), courses or curricula, diagrams and models, laboratory and other teaching equipment, and other similar activities.

(c) Improvements of teaching through activities, including the development of teachers in a department or in other schools, testing or guidance programs, promotion of cooperation with other types of educational institutions or industry, development of testing and guidance programs, and the coordination of fields of subject matter.

(d) Scholarly contributions to literature, significant honors, etc.

(e) Service to the Engineering Design Graphics Division of ASEE as evidenced:

- by regular attendance at its meetings as an indication of interest in the improvement of teaching--
- service on its committees or an officer with a record of definite achievement--
- contribution to its publications or summer school programs.

1d(4). Nominations. nominations may be made by any member or group of members of the Division except members of this Awards Committee.

1d(5). Nomination Form. A nomination form shall be prepared by the distinguished Service Award Committee which will outline the qualifications and will provide space for a brief outline of a nominee's performance in each category. This form shall accompany the election ballot (See ART. IV, Sec. 1d).

1d(6). The report of this committee shall be made at the appropriate time and place.

1d(7). Nominees from the previous three years may also be considered for the award by this committee. A list of the names of these individuals, and all supporting information, shall be passed on to the incoming chairman of the committee by the outgoing chairman of the committee.

Section 2. NON-BYLAW COMMITTEES. Non-Bylaw committees shall be assigned to one of the following described categories under the supervision of the appropriate Director. They may be designated by the division Chairman or by the Executive committee when such a committee is deemed necessary for the proper functionig of the Division. Some special purpose committees may be assigned under the control of the Chairman or Vice-Chairman.

2a(1). LIAISON. Committees in this category are those whose purpose is to provide a connection between the Engineering Design Graphics Division and other related or interested groups both within and without the American Society for Engineering Education.

2a(2). PROFESSIONAL AND TECHNICAL. The purpose of committees within this category is the advancement of knowledge in the many areas encompassed by the Engineering Design Graphics Division.

2a(3). PROGRAM. Committees in this category are responsible for planning and implementation of on-going programs of the Division. There shall be an Ad Hoc Program Committee for each Annual and Mid-Year Conference, and it shall be responsible for all conference sessions sponsored totally or jointly by the Division during that conference. Each program committee shall be appointed at the conference occurring approximately 1-1/2 years prior to the conference for which it is responsible, and shall cease to exist following the conference for which it was formed. A Program Committee shall generally consist of the Division Vice-Chairman, the Director: Programs, a Program Chairman, and at least one other person closely allied with, or especially qualified to represent and act as liaison for, the institution or area in which the particular conference is to be held. This person could also be the Program Chairman.

2a(5). ZONE ACTIVITIES. Committees in this category are to increase and promote Section and local activities of Division members within the various Zones. There shall be a committee from each of the Sections in the particular Zone.

Section 3. COMMITTEE CHAIRMEN. Committee chairmen are responsible for following the guidelines established by their Director and for keeping the appropriate Director informed of the activities of their committee. The chairman directs the activities of the committee members within the constraints of those guidelines, and he may suggest to the appropriate Director such additional activities as he deems necessary for the committee's proper functioning. Each chairman shall prepare and submit reports to the appropriate Director in time for the reports required of the Directors to be prepared. Required reports are interim for presentation at Mid-Year Conference and annual for presentation at the Annual Conference.

3a. PROGRAM CHAIRMAN. Each Program Chairman shall submit proposed programs to his Director for approval. The Director will in turn submit the proposal to the Division Chairman and Executive Committee for their approval. Program Chairmen for an Annual Conference and the Division Chairman shall attend the ASEE planning meeting for that particular conference. The Program Chairman shall, with the assistance of his committee, determine the number, type, and specifics of all technical events, including participants and session moderators. Although it is the Director's responsibility to pass on to the Program chairman all available papers, abstracts, program suggestions and other pertinent information that he has, it shall be the responsibility of the Program Chairman to select and schedule the actual events and participants after the program has been approved by the Director: Programs and the Executive Committee. He shall notify all participants of their selection and forward appropriate forms and information to them and make related arrangements requested by the National Headquarters or the committee.

The Program Chairman shall also be responsible for preparing feature articles or announcements publicizing the program in the appropriate Journal(s) and in other ways assist in the proper advertising and promotion of the program.

Article VIII PUBLICATIONS

Section 1. PUBLICATIONS COMMITTEE. The Publications Committee shall be composed of the Director-Editor [See ART. III, Sec. 2d(3d)], the Circulation Manager-Treasurer, the Advertising Manager, and such Assistant Editors as are deemed necessary by the Director-Editor.

1a. The Publications Committee shall be responsible for the timely publication of the ENGINEERING DESIGN GRAPHICS JOURNAL, and any other Division publications, as authorized or directed by the Executive Committee. A minimum of three issues of the JOURNAL shall be published each year.

Section 2. ELECTION OF PUBLICATIONS COMMITTEE

2a. The election of the Director-Editor is covered in Article IV.

2b. The CIRCULATION MANAGER-TREASURER shall be appointed by the Director of Publications subject to the approval of the Executive Committee. The term of appointment shall be indefinite and continue for so long as: is mutually agreeable with the appointee, the supporting institution, and the Director of Publications; the responsibilities of the office are properly served. The appointment may be terminated by resignation or death, by request from the supporting institution, or for cause by action of the Executive Committee. A recommendation to terminate the appointment may be made to the Executive Committee by the Director of Publications or may be initiated by the Executive Committee after suitable notification to the Director of Publications. Termination, for whatever reason, shall consider the best interests of the division and be handled in such a manner as to insure continuity of the operations of this office.

2c. The Advertising Manager shall be elected to a three-year term in the same manner as presented in Article IV.

2d. The elections of the Director-Editor and the Advertising Manager will be staggered in order to provide maximum continuity to the Publications Committee.

2e. In the event that the Advertising Manager is unable to perform his duties, the provision of Article IV, Section 1g is applicable.

Section 3. DUTIES. The duties of the members of the Publication Committee shall be as follows:

3a. DIRECTOR-EDITOR. He shall be Chairman of the Publications Committee and Editor of the ENGINEERING DESIGN GRAPHICS JOURNAL.

3a(1). He shall have the responsibility of soliciting, selecting, and editing all articles published in the ENGINEERING DESIGN GRAPHICS JOURNAL.

3a(2). He shall cooperate with the Editor of the ENGINEERING EDUCATION JOURNAL as to articles referred to the ENGINEERING DESIGN GRAPHICS JOURNAL for publication and as to articles referred to the ENGINEERING EDUCATION JOURNAL for publication.

3a(3). He shall make such arrangements and agreements as are necessary for the publication of the ENGINEERING DESIGN GRAPHICS JOURNAL.

3a(4). He shall report on all matters pertaining to the ENGINEERING DESIGN GRAPHICS JOURNAL to the Executive Committee at all its meetings.

3a(5). He shall appoint such Assistant Editors as he feels are required to assist him in his duties, subject to the approval of the Executive Committee.

3b. CIRCULATION MANAGER-TREASURER. He shall be responsible to the Director-Editor for all matters pertaining to the circulation and finances of the ENGINEERING DESIGN GRAPHICS JOURNAL.

3b(1). He shall solicit subscriptions from members and from other sources and shall submit lists of such subscribers to the Director-Editor.

3b(2). He shall assist the Director-Editor in any way requested to expedite the mailing of the ENGINEERING DESIGN GRAPHICS JOURNAL.

3b(3). He shall handle all monies for the ENGINEERING DESIGN GRAPHICS JOURNAL in a standard bookkeeping form and deposit such monies in an account in a suitable repository under the name of the ENGINEERING DESIGN GRAPHICS JOURNAL.

3b(4). He shall receive all advertising fees from the Advertising Manager for deposit in the account above.

3b(5). He shall pay all costs connected with the publication of the ENGINEERING DESIGN GRAPHICS JOURNAL as submitted by the Director-Editor.

3b(6). He shall submit reports on the status of all his activities to the Director-Editor prior to the mid-year and annual meetings of the Executive Committee.

3b(7). He shall present the financial records for an annual audit by an audit committee designated by the Division Chairman.

3b(8). He shall, at the end of his term and the accompanying audit, transmit to his successor all financial records, together with all monies in the ENGINEERING DESIGN GRAPHICS JOURNAL account.

3c. ADVERTISING MANAGER. The Advertising Manager shall be responsible to the Director-Editor for all matters pertaining to advertising in the ENGINEERING DESIGN GRAPHICS JOURNAL.

3c(1). He shall actively solicit and procure advertisments from all appropriate sources.

3c(2). He shall conduct all business matters with advertisers.

3c(3). He shall submit all bills for advertising according to the current rates.

3c(4). He shall promptly transmit such monies received to the Circulation Manager-Treasurer.

3c(5). He shall maintain logs of advertising accounts, contracts, accounts receivable, and recommendations for advertising policy changes.

3c(6). He shall submit reports on the status of all his activities to the Director-Editor prior to the mid-year and annual meetings of the Executive Committee.

3d. ASSISTANT EDITORS. Their duties shall be assigned by the Director-Editor.

Section 4. ADVERTISING RATES. The Publications Committee shall fix advertising rates subject to the approval of the Executive Committee.

Section 5. SUBSCRIPTION RATES. The Publications Committee shall fix subscription rates subject to the approval of the Executive Committee.

Section 6. FINANCES. The Publications Committee will conduct an annual Financial review of the Journal and other publications financed from Journal funds and prepare an operating budget for the coming year. In addition to the operating fund, an emergency contingency fund of sufficient amount to finance Division publications for one year will, financial solvency permitting, be maintained in an insured financial institution in the name of the publication. Funds in excess of the operating budget and emergency contingency fund may, by action of the Executive Committee or at the discretion of the Publications Committee, be transferred to the Secretary-Treasurer for deposit in the Division fund to be used for any purpose the Executive Committee may approve. Available Division funds may, upon application of the Publications Committee to and subsequent approval of the Executive Committee, be transferred to the Circulation Manager-Treasurer, Publications Committee, to meet existing or anticipated deficits in operating funds or to finance special or unusual "one-time" projects. No separate account will be maintained by the Secretary-Treasurer of funds received from the Publications Committee, nor will funds made available to the Publication Committee by the Secretary-Treasurer be limited to amounts previously deposited.

Article IX
PARLIAMENTARY AUTHORITY

Section 1. The rules contained in Robert's Rules of Order (latest edition) shall govern this division in all cases to which they are applicable and in which they are not inconsistent with the Constitution and Bylaws of the ASEE, the Bylaws of this Division; in other cases the Constitution and Bylaws of ASEE shall govern.

Article X
AMENDMENTS TO BYLAWS

Section 1. These Bylaws may be amended at any annual business meeting of this Division by a two-thirds majority vote of the members of the Division who are present.

Continued on p. 22

CALL FOR PAPERS

COMPUTER GRAPHICS AND CAD:
IMPLICATIONS FOR ENGINEERING EDUCATION

The Engineering Design Graphics Division of ASEE invites papers for possible presentation at the 1986-87 midyear meeting hosted by the University of Texas at Austin,

January 6-9, 1987

Possible topics include:

- Engineering Computer Graphics
- Computer-Aided Design (CAD)
- Automated Drafting
- Microcomputer Graphics
- Freshman Design Projects
- Color Graphics Applications
- Hardware and Software Systems
- Computational Geometry
- CAD Degree Programs, 2 and 4 Year
- Graphics Programming Exercises
- Software Exchange

Submit the title of the paper and a 500 word abstract to the meeting program chairman.

General Chairman

Ronald E. Barr
Mechanical Engineering Department
University of Texas at Austin
Austin, TX 78712
(512) 471-3008

Program Chairman

Ronald C. Pare
Mechanical Engineering Technology
University of Houston
Houston, TX 77004
(713) 749-4652

New Journal

It's always nice to note the birth of a new addition to the literature of graphics and graphic education. REPRESENTATION: The Journal of Graphic Education has released its second issue and it provides an interesting outlet for the architectural and design education people who are graphically inclined. The content is essentially on concept or ideation drawing and though not specifically engineering oriented, it still makes for good reading. The editorial board is widely representative geographically with Kirby Lockard (Drawing as a means to Architecture) serving as managing editor. If you would be interested in a subscription contact:

Journal of Graphic Education
2901 E. Mabel, Tucson, AZ 85716

NOTICE OF AVAILABILITY OF "FREEWARE"

For copies of a listing of freeware available for MS-DOS computers contact :

Bob Soden
3300 Stanton Street
Springfield, IL 62703

Send $3.00 for a listing (on diskette) of over 150 free programs or bring blank DS DD disks to the software exchange session at the ASEE national meeting in Cincinatti in June.

EDGD SPRING ELECTIONS

Three offices are up for election in Spring, 1986. You will receive an official ballot in the mail for your vote. Make sure you take the time to evaluate the fine slate of candidates and cast your vote!
Here are the offices and the candidates.

Vice Chairman	Director of Programs	Director of Liaison
Ronald E. Barr Associate Professor University of Texas/Austin	**Josann Duane** Associate Professor Ohio State University	**James Leach** Assistant Professor Auburn University
Merwin Weed Associate Professor Penn State University	**Jerry V. Smith** Associate Professor Purdue University	**Billy H. Wood** Teaching Specialist University of Texas/ Austin

1985 DISTINGUISHED SERVICE AWARD

PAGE 19

ASEE OFFERS COMPUTER DISCOUNTS!!

ASEE has expanded its program to assist engineering faculty buy personal computers hardware and software. Companies featured are:

- **Zenith** models Z-100 and Z-150 (40% off)
- **AutoCAD** (35% off)
- **Texas Instruments** TI Professional (30-35% off)
- **Heath** low profile kit computer (38% off)

Interested? Contact ASEE headquarters to verify membership and receive forms.

ADDRESSES AT ANAHEIM

Two addresses of interest to engineers will keynote the Winter Design Engineering Show and Conference at Anaheim, December 11-13, 1985.

John J. Clancey, president of McDonnell Douglas Manufacturing and Engineering Co. will speak on "The Increasing Role of Engineers in Corporate Decision Making", and **Robert S. Ozaki**, School of Business and Economics, Cal State University, will discuss "A Proposed Industrial Policy Relating to Government and Private Sector."

The conference is sponsored by the Design Engineering Division of ASME and features 11 sessions devoted to **CAD/CAM/CAE**. The show features 200 exhibitors from all areas of design engineering. List of speakers and their topics can be obtained from: Show manager, Winter National Design Engineering Show, 99 Summer Street, Stamford, CT 06905. (203) 984-8287.

1985 ASEE/EDGD MIDYEAR
November 25-26, 1985
Hosted by PURDUE UNIVERSITY

NORTH CAROLINA STATE UNIVERSITY HONORS TWO

The Department of Occupational Education in the School of Education honored two long-time graphics teachers with **THE ORTHOGONAL MEDAL**, a recognition of their dedication to the advancement of knowledge in the graphical knowledge. The medal was cast with the likenesses of four individuals who historically serve as models for the development of Graphic Science as a field of study: Euclid, Da Vinci, Monge', and Jefferson.

Robert H. Hammond who taught graphics at The Military Academy and North Carolina State University and the author of several texts in the field, and Warren J. Luzadder, former professor of engineering graphics at Purdue University and noted author each received the medal. Both are Professors Emertiti of their respective universities.

At the presentation, Professor Luzadder addressed the gathering as the 1985 Distinguished Lecturer in in Graphic Communications at The North Carolina State University.

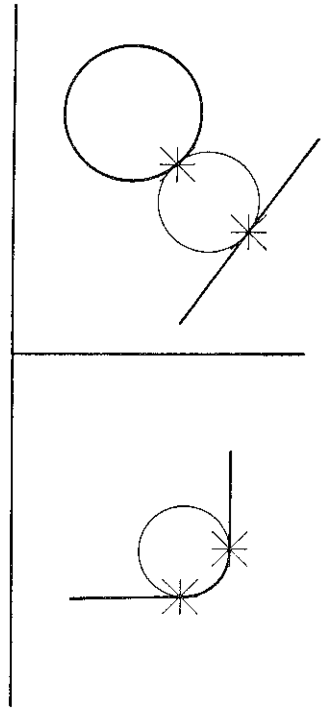
IN PASSING

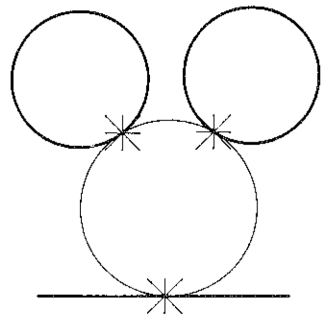
Thoedore T. Aakhus, 88, retired professor of Engineering Mechanics at the University of Nebraska-Lincoln, Died January 28, 1985, at his home in Lincoln. The late Professor Aakhus taught at the University of Nebraska from 1926 until his retirement in 1964. As Professor Emeritus, he continued to teach evening classes until 1972.

He was a former Chairman and Vice-Chairman of the Engineering Drawing Division (earlier name of EDGD) of the American Society for Engineering Education and the former editor for a number of years of the Journal of Engineering Drawing (earlier name of the EDGJ). In 1963 he received the Distinguished Service Award from the Division. The membership of the EDGD mourns his passing.

software exchange

The 1986 Annual Conference will again present an opportunity to units within **ASEE** to exchange information by providing a forum for computer software exchange. The exchange will be organized as poster demonstrations with presenters displaying their software. All software will be public domain and presenters must sign a release. Contact **Frank Croft** at Ohio State





review

A REVIEW OF NEW PRODUCTS AND MATERIALS

Fundamentals of CAD

Gary R. Bertoline
Delmar Publishers Inc, 1985

Fundamentals of CAD by Gary Bertoline offers a solid introduction to computer-aided drafting. The text progresses gradually from a general discussion of CAD topics to specific techniques for creating drawings with a computer. To avoid being system-specific, the discussion of CAD commands is based on generic terms. Therefore, the emphasis is on CAD capabilitiees and procedures that are transferrable to almost any system. The text is intended to supplement system-specific manuals for instructional use. It would be appropriate for teaching CAD "on paper" without the use of computer hardware.

The content of the text can be divided into two categories--CAD topics and CAD drawing functions. The sections on general CAD topics include the definition, advantages, development, and components of CAD. Descriptions of various hardware devices and how they are used to input, output, and store data are also covered. In addition, current and future applications of CAD are discussed.

.....an excellent supplement to an introductory CAD course

The portion of the text devoted to creating drawings covers the basic functions of computer systems. Each function is introduced through examples and diagrams. Some of the functions included are creating and editing geometry, manipulating images, dimensioning, and inserting text. After each drawing is introduced, it is followed by a step-by-step procedure of how to implement the task with the computer.

The text is well-organized and written in a language which is appropriate for an introductory level text. As CAD terms are introduced into the discussion they are explained and listed at the end of the chapter in a glossary format. The entire alphabetized glossary is included at the back of the text. Each chapter includes objectives and review questions to aid instruction and the drawing sections are prefaced with a list of prerequisite knowledge that must be mastered before attempting the next set of commands. These sections also include drawing exercises in addition to review questions. Another plus is the appendix which includes a listing and description of CAD systems, a vendor questionnaire to assist in purchasing decisions, and a listing of CAD periodicals and conferences. Overall, the text would serve as an excellent supplement to an introductory CAD course.

Reviewed by Judy A. Watson, Purdue University

THE DIVISION OF
ENGINEERING DESIGN GRAPHICS

AMERICAN SOCIETY FOR
ENGINEERING EDUCATION

bestows upon

KLAUS E. KRONER

its highest honor

THE DISTINGUISHED SERVICE AWARD

Klaus E. Kroner has been an untiring staunch supporter of the Division. His work in metrication includes service as chairman of the Division's metrication committee as well as the presentation of numerous papers on the subject.

Klaus worked on the 1967 Division Summer School which resulted in the establishment of engineering design education at the freshman level. Also, he was one of the first to recognize the importance of computer graphics and introduced this subject at The University of Massachusetts. He was involved in the planning of computer graphics workshops presented at this university.

For his dedicated service to the Division and engineering education, his devotion to students and colleagues, and as an expression of admiration and respect by his professional peers, the Division proudly presents this award.

Presented on this day June 18, 1985

at the Annual Conference, Atlanta, Georgia

Garland K. Hilliard

Chairman

1985 EDGD/NIOSH COMPETITION

Awarded at Atlanta, Georgia June 18, 1985

FIRST PLACE: SAFETY ENGINEERING PROGRAM
INDUSTRIAL ENGINEERING DEPT.
TEXAS A&M UNIVERSITY

"Engineering Control of Asbestos Fiber Hazards During Debagging and Bag Disposal Operations"

DESIGNERS: Karen Carter, John Frey. Wayne Gremillion, Darren Martin, Jan Simon

FACULTY ADVISORS: Richard Konzen, Harry Suggs

1985 EDGD CREATIVE ENGINEERING DESIGN DISPLAY

Awarded at Atlanta, Georgia June 17-19, 1985

FRESHMAN AWARD: VILLANOVA UNIVERSITY

"The Dream Retrieval System"

DESIGNERS: Michele Davis, Darlene DeMatte, John DiLullo, Charles Flynn

INSTRUCTOR: Thomas R, Baker

SENIOR AWARD: VILLANOVA UNIVERSITY

"Design of a Lifting and Rotational Mechanism for a Wheelchair"

DESIGNERS: Don Dinella, Chris McDonnell, Steve Sharbaugh, Carolyn Zima

INSTRUCTOR: Kenneth A. Kroos

Message continued from page 5

Externally, the Division needs greater interaction with other divisions of ASEE sharing common interests. Groups such as the Engineering Technology Division, Design in Engineering Education Division, and Freshman Programs have something to offer us, and we them. How to effect interaction is the challenge. What suggestions do you have? Let us know!

Size-wise, the Division is reasonably healthy. While at one time EDGD was the largest within ASEE, that time is lost in history. Membership is now about 550 persons, a reasonable size, though far below such groups as Computers in Education(1059) and Relations with Industry (1681). We need always to be active in seeking new members.

Fresh blood is vital to a vigorous division. Sometimes we end up talking to just ourselves. The most recent business luncheon, for example, saw only 27 attendees. One can recall fairly recent years when over 100 participated. What does this trend say to us?

Let it not be said that we are no longer relevent to engineering education, that other divisions have assumed our responsibilities and functions. Engineering graphics is still a unique emphasis within education and industry. The ways to express the graphics evolve with time. Certainly the computer-generated format for drawings is a valid format. Our division has heeded the challenge of computer expression well, but again, complacency can be fatal. It might be useful, for example, to include computer garphics within the Creative Engineering Design Display.

The Division has a strong past. This past can serve as a springboard to carry our traditions into the future in fresh formats with new members, all serving the ultimate product, our students

Looking forward to a good year,

Robert J. Foster
Chairman

EDGJ

Letters TO THE EDITOR

Editor's response on p. 22

I have just finished reading the current issue of the Journal. I fail to get excited over the difficulty of fitting ellipse templates onto a perspective grid. They do not need to be fitted so carefully except in the case of a large cylinder which might need to have outside fittings plotted accurately and even these could be "fudged" in many cases.

I don't believe the ellipsicom could be used at all on an illustration containing dozens of ellipses......

The author seems to think that buying, storing, and paying for a set of templates is an unnecessary problem. A set of templates is the busiest piece of equipment in a drafting room.

-H.W. Blakeslee
Orlando, Florida

I am puzzled by the "Editor's Note" (EDGJ, Spring 1985, p.19) on Professor Moore's paper ***Ellipse in Perspective.***

1. The note implies existence of two kinds of elliptical curves, orthogonal and perspective, <u>differing in their properties.</u> The properties of an ellipse do not depend on the method by which it was obtained.

2. The note claims that the method described in Moore's paper <u>approximates</u> a perspective ellipse. In fact, the paper describes an <u>exact</u> method of construction.......

3. The note refers to the perspective ellipse, which is not a symmetrical ellipse. In fact <u>every</u> ellipse is symmetrical; it has two planes of symmetry and also an axis of symmetry.

-Abe Rotenberg
Parkville, Australia

This is to express admiration for Charlie Moore of Northern Arizona University and his paper ***Putting The Ellipse in Perspective*** (EDGJ; Spring, 1985) Judging from the Editor's note, the Journal and Charlie may have different approaches to perspective. The following is in defense of Charlie's approach:

i. The <u>orthographic projection</u> of an oblique ellipse -in-space may be accomplished by projecting its rectangular envelope on to a plane of projection where its image will be come a rhomboid and then by duly constructing the ellipse using any of a variety of methods. Or by projecting points from the ellipse-in-space onto the plane of projection.

ii. The <u>perspective projection</u> of an oblique ellipse-in-space may be accomplished by projecting its rectangular envelope onto a surface of projection where its image will become a trapezium--but only if the surface of projection is a plane. If the surface of projection is taken to be a sphere, that is if the projection is taken to be "what the eye really sees," then the image will be beheld from the station point as a rhomboid and the ellipse in space will be beheld as an ellipse in projection. Or, the ellipse may be found by plotting, not projecting, the points of tangency on the trapezium, thereby defining a discrete ellipse, or by placing an ellipse as accurately as possible within the trapezium by trial and error using a template. Charlie's paper, for the first time to my knowledge, eliminates guesswork. Or, finally, by projecting points on to the plane of projection.

The Journal's interpretation of Charlie's paper as an attempt to fit an orthogonal ellipse into the perspective envelop differs from my own and the suggestion that its is more accurate to project individual points than to project the envelope is not necessarily the foregone conclusion which seems to be implied.

It is acknowledged that a perspective projection of an ellipse-in-space on to a plane of projection will be distorted with respect to that which the eye really sees, and therefore should not appear as an ellipse at all--no matter how it is done, be it by projecting points or by projecting the envelope. This being so, the question becomes: which is the most accurate way to perspectively project the least distorted ellipse--or, rather, to perspectively project an ellipse-in-space into the least distortion? It would seem that in order to achieve the accuracy method mentioned in the Editor's Note, Charlie's true ellipse (a distortion of planar perspective projection but a truer image of that which the eye sees) might be preferred over the projection of points, a true planar perspective projection but with greater distortion that that which the eye sees. I say truer "image" because the constructed ellipse will not be the same size ellipse as the eye sees, but at least both will be true ellipses whereas the projection of points will not.

-Pat Kelso
Ruston, Louisiana

Surely we choose the most accurate and reproducable method for producing graphics. Most circles in perspective are delineated by using ellipse guides. The point is, concessions have to be made to fit a symmetrical ellipse into a non-symmetrical perspective envelope. These concessions increase the further out in the cone of vision you go. Remove the circle far enough from the central vision line and an ellipse will not work, period. Possibly the confusion, for Abe Rotenberg at least, would have been removed by a more judicious use of terms. I suggest: *Use "**circle in perspective**" rather than "ellipse" when talking about perspective; use "**ellipse**" when talking about either a true conic section or the non-normal view of a circle in orthographic.*

-Editor

EDGJ

Bylaws continued from p. 14

Section 2. These Bylaws may also be amended by a letter ballot of the members of this Division as recorded in the office of the American Society for Engineering Education, mailed by the Secretary-Treasurer of the Division; the amendment being approved if two-thirds of the ballots returned within thirty (30) days are favorable.

Section 3. Proposed amendments may be submitted in only four ways as follows:

a. By a majority vote of the Executive Committee.

b. By petitions to the Chairman signed by not less than fifty (50) individual members of the Division.

c. By recommendation to the Division Chairman by the Constitution and Bylaws Committee of the Society through its executive director.

d. By unanimous vote of the policy committee of the Division.

EDGJ

Mid-Year

ASEE/EDGD MID-YEAR MEETING

American Society for Engineering Education
Engineering Design Graphics Division
Mid-Year Meeting
Purdue University
West Lafayette, Indiana
November 24-26, 1985

Schedule of Events

Sunday, November 24

1:00 pm	Hotel Check-In
3:00 pm-6:00 pm	Computer Workshop
4:00 pm	Conference Registration
6:00 pm	Executive Committee Dinner and Meeting Moderator-**Robert Foster**
8:00 pm	Hospitality Hour All registrants and spouses invited

Monday, November 25

8:00 am	Conference Registration
8:15 am	Introduction and Welcome Moderator-**Peter Miller** Keynote-**Dean George McNelly** School of Technology Purdue University
SESSION 1	Moderator-**Edward Galbraith**, California Polytechnic, Pamona
8:30 am	"Kaleidoscope: A Graphic Art and Design System", **J. Ingber**, Iowa State University
8:50 am	"Developing a CAI Package for Engineering Graphics", **L.Nasman**, The Ohio State University
9:10 am	"CAT:Computer-Aided Teaching",**D. Annarino**, Purdue University
9:30 am	"Three-Dimensional Graphics Modeling", **R. Barr & D.Juricic**, The University of Texas at Austin
9:50 am	Coffee/Refreshment Break
SESSION 2	Moderator-
10:15 am	"Interactive 3-D Geometric Modeling with Vectors and Viewpoints", **K.Helmlinger & L. Northup**, Iowa State University
10:35 am	"Interactive Computer Graphics in Teaching Aircraft and Spacecraft Structural Analyses Courses", **N.Sarigual**, The Ohio State University
10:55 am	"Computer Graphics: A Way to Teach CNC Programming With or Without CNC Machine Tools", **T. Fujii & R. Speckert**, Miami University

11:15 am	"Computer Aided Design of Electro-Magnetic Valves for Mechanical Systems", **R. Sharma & P. Patel**, Western Michigan University
11:35 am	Lunch on your own
SESSION 3	Moderator-
1:00 pm	"A Study of Journal Bearing Dynamics Using Motion Picture 3-D Graphics", **D. Brewe**, Propulsion Laboratory, NASA Lewis
1:20 pm	"Present and Future Trends on the Use of Computer Graphics in Engineering Education", **V. Anand**, Clemson University
1:40 pm	"The Impact of Computer Graphics on Instruction in Engineering Graphics", **J. Jensen**, Marquette University
2:00 pm	"The Application of Computer Graphics to Engineering", **M. Aziz**, Clemson University
2:20 pm	"Cognitive Processing and the Teaching of Engineering Graphics", **D. Bowers**, Arizona State University
2:40 pm-6:00 pm	Workshops and free time
6:00 pm	Cocktail Hour
7:00 pm	Annual Mid-Year Conference Banquet

Tuesday, November 26

SESSION 4	
8:30 am	Moderator-**Mike Khonsari**, The Ohio State University Panel Discussion-"Engineering Graphics Today, In 1990 and the Year 2000" Moderator: **Edwin Boyer**, The Ohio State University Participants: **R.E.Barr**, University of Texas at Austin **B.Crittenden**, V.P.I. State University **J.T.Demel**, The Ohio State University **J.S.Dobrovolny**, University of Illinois **A.Eide**, Iowa State University **R.J.Foster**, Penn State Univ. **J.Smith**, Purdue University
9:50 am	Coffee/Refreshment Break
SESSION 5	Moderator-**Frank Croft**, The Ohio State University
10:15 am	"Descriptive Geometry On the Computer", **M. Waldron, L. Smith & R. Hang**, The Ohio State University
10:35 am	"Justifying CAD in Engineering Technology", **B.Harding**, Purdue University
10:55 am	"Total CAD Integration in Existing E.T. Programs", **M. Stewart**, University of Arkansas at Little Rock
11:15 am	"Introduction to Computer-Aided-Drafting at IPFW", **K. Perry**, Indiana University-Purdue University at Fort Wayne
11:45 am	Business Luncheon Moderator- **Robert Foster**
SESSION 6	Moderator-
1:40 pm	"The Introduction of Computer Graphics into Our Mechanical Drafting Program at the University of Alabama", **J. Weiss**, The University of Alabama
2:00 pm	"Furniture Graphics: An Unique Answer to an Unique Need", **J. Freeman**, North Carolina State University
2:20 pm	"Design Analysis in the Freshman Engineering Problems Course", **L. Genalo**, Iowa State Univ.
2:40 pm	"Visualization: Can 2-D CAD Do a 3-D Job?", **W. Ross**, North Carolina State University
3:00 pm	"Large Molecule Display and Analysis Using an Engineering Graphics Software", **J. Duane, L. Rellick & E. Gross**, The Ohio State University
3:20 pm	Conference Adjournment and Departure

VOLUME 49 NUMBER 3

papers

REVIEWED TECHNICAL PAPERS

1984北京

INTERNATIONAL CONFERENCE

HYPERGRAPHICS

Harriet E. Brisson
Professor
Rhode Island College
Providence, Rhode Island
United States of America

"Hypergraphics" is a term which was coined by my husband, David Brisson, to describe graphics that transcend traditional means. It is a term that combines the meaning of hyper (above, super, extra, beyond) with the meaning of graphics (writing, drawing, printing) to define a concept of work that extends beyond the traditional methods of image-making. In very specific terms, it is related to mathematics of n-dimensional descriptive geometry, but in the broad sense in which it is defined above, any system of thought, technical process or philosophical attitude that extends existing methods of visualization would fall into the category of hypergraphics.

Over the past several years an increasingly large group of artists, scientists, mathematicians and engineers have gathered to participate in symposia and exhibitions devoted to the examination of the latest findings and creations in this area of concern. They started with a talk given by David Brisson at Harvard University in 1975. The following year Toshihiro Katayama of the Carpenter Center at Harvard organized an exhibition called Virtual Realities consisting of the work of the Spanish painter Jose Iturralde, who is investigating impossible geometries in two-dimensions, David Brisson's four-dimensional anaglyphs and projections and my tensegrity figures of close-packing forms. Computer generated films made by Thomas Banchoff and Charles Strauss of Brown University were included in this exhibition as well.

This exhibition stimulated an interest on the part of artists, mathematicians, and scientists to collaborate on a variety of projects which evolved into five more exhibitions: in 1977 the Hypergraphics Exhibition and Symposium III: Visualizing the Impossible Through Art and Technology at Princeton University, in 1980 "Hypergraphics III" Exhibition at Newport Art Museum in Newport, Rhode Island and in 1981 the "Hypergraphics V" Exhibition and Conference at Rhode Island College.

The convergence of science and art is viable, one in which artists and scientists are able to interact while preserving the integrity of their own methods and attitudes. It transcends verbal language in that communication is possible through visualization of concepts. Historically visualization has played a major role in the development of scientific thought. However, recently visualization has been increasingly excluded from scientific exploration and similar tendency has occurred in art which has become very specialized and insular, separating itself from mathematical formulations and scientific thought. Such separation is unhealthy for both the arts and the sciences. The new field of Hypergraphics seeks to counter that trend by bringing together computer graphics, perceptual psychology and modern geometry to develop new ways of understanding complex multidimensional relationships.

I have been an active participant in all of the Hypergraphics programs and am continuing to do so, since my husband's death in 1982, with the presentation here at this International Conference of Engineering and Computer Graphics and by curating a Hypergraphics Exhibition at the Rhode Island School of Design's Woods-Gerry Gallery scheduled for October 1984.

I am an artist; not a mathematician. The formal structure of my sculpture has for many years had as its base geometric concepts. However, it was an intuitive use of mathematical ideas rather than one founded on a study of geometry. Nearly twenty years ago I made a representation of a hypercube, quite by chance and quite unaware that it was a hypercube until recently when I saw a reproduction of Theo Van Doesburg's "A New Dimension Penetrates Our Scientific and Plastic Consciousness" from De Stijl, VII 79-84 (1927) pp 21-22.(1) My cubic form comprises seven cubes and is close in concept to "Eight Cubes Which Can Be Folded So As to Form a Hypercube" from H.P. Manning, Geometry of Four Dimensions, New York, 1914, p. 240. (2)

However, this form was not arrived at purely by chance as I have been systematically truncating cubes in much the same way as had Wentzel Jannitzer, a Nurenberg goldsmith who presented a set of perspective engravings of variations on the theme of regular polyhedra in Perspectiva Corporum Regularia (1568). As a result of exploring the cube through truncation and building a model of the way in which the five Platonic Solids are related to one another, I became interested in space-filling forms. These were built as discontinuous-compression tensegrity structures using plexiglass, aluminum tubes and nylon cord. There are no rigid joints in any of the structures. They are held in position entirely by the geometrical configuration of the relationship of compression members to each other pulled together in a perfectly balanced manner by tension members. The octet truss composed of octahedra and tetrahedra, a space-filling form so often used architecturally to span large surfaces without suporting members, as well as the close-packing of truncated octahedra found in crystal formations were both familiar to me. Further research revealed several others which were adaptable to tensegrity construction.

Robert Williams in Natural Structures states that "there is evidence that identical polyhedra can pack to fill some kind of space, whether it be curved, finite or hyperspace" according to H.S.M. Coxeter in "Regular Honeycombs in Elliptic Space", Proc. London Math. Soc.(3). v.4, pp471-501. Williams continues, "In three-dimensional Euclidean space, however, not all packings of identical polyhedra will fill space, but every ployhedra in combination with assorted non-related polyhedra can satisfy spacefilling requirements".(3)

Tensegrity spacefilling forms may include the following:

(1) Truncated Octahedra
(2) Great rhombicuboctahedra, octagonal prisms
(3) Small rhombicuboctahedra, cubes, tetrahedra
(4) Cuboctahedra, cubes, small rhombicuboctahedra
(5) Great rhombicuboctahedra, truncated, octahedra, cuboctahedra
(6) Truncated octahedra, cubes, great rhombicuboctahedra
(7) Truncated tetrahedra, truncated octahedra, cuboctahedra
(8) Octahedra, cuboctahedra

(9) Rhombic dodecahedra, truncated close-packing octahedra, cubes

The primary motivation for making these forms was my interest in their geometry; however, I was concerned with the aesthetic and visual impact of these forms as well. I continued my research of space-filling polyhedra and discovered a close-packing which I have not seen published in any of the literature on the subject. It is a space-filling composed of truncated close-packing octahedra, rhombic dodecahedra and cubes. Not only is it an interesting form, but I feel it to be a very beautiful one both visually and conceptually.

Out of this work grew the "Infinity Box" containing neon tubes in the shape of a great rhombicuboctahedron and six octagonal prisms. The single unit becomes an infinite structure inside the mirrored cube and is visually evocative as well as producing a sense of mystery and ambiguity, highly ordered, an infinite repetition of a single unit filling space completely.

Unfortunately, this piece could be viewed only through its single one-way front surface. I wanted the viewer to be able to walk around an infinite space-filling form. Actually, I would like to make one large enough for people to walk around IN, so that they could more fully experience an infinite space-filling form. However, since that was impossible then, I built a second neon piece with one-way mirrors on the four vertical surfaces of the cube, making it possible to see into the box through all of its sides. The form is a truncated octahedron repeated infinitely by the mirrored surfaces in all directions: up, down, sideways and backwards. The mirrored surfaces appear solid when behind the form, but transparent in front of the form. It becomes a "Magic Box" which has sides that are opaque from one view, but dissolve when the stronger light behind them turns them into "glass" through which the infinite structure can be seen. I believe that the element of mystery is essential to art and the knowledge of geometric form makes it possible to produce this kind of magic more completely than would a random grouping of neon tubes in the same kind of space.

the convergence of science and art is viable....

In 1976 David Brisson discovered an interesting relationship between his work with n-dimensional geometry and my work, when analyzing my space-filling forms and his work with the hyper-Schwarz-surface. The following is taken from an unpublished paper which he wrote at the time. The hyper-Schwarz-surface is a periodic hypersurface that is the four-dimensional analog of the Schwarz-surface, a periodic minimal surface named after its discoverer, the German mathematician Karl Hermann Amadus Schwarz (1843-1921).

The Schwarz-surface can most easily be visualized as described by the physicist Alan Schoen. Imagine a jungle-gym made of soft, hollow thin rubber tubes. Next imagine them being slowly inflated. At a certain point the space inside the tubing is exactly the same as that outside the tubing. In fact, it is somewhat meaningless to identify an inside or outside to the space, unless you happen to be in the structure. In that case, you could wander around on the surface forever and only be able to investigate one-half of the total space, because the surface divides three-dimensions exactly in half. Yet the surface is variable, formed of "bubbles" that interlock and that is why it is called periodic. Further, the surface is the smallest possible that can so divide the space and is thus called minimal. A pecularity of the minimal surface is that although it is clearly "curved", it is a special surface said to have zero curvature, for curvature along one axis is equal to curvature along the axis at a right angle to the first axis.

The hyper-Schwarz-surface is arrived at in a similar way in four-dimensions, although considerably more complicated to visualize. Basically one starts with a four-dimensional jungle gym such as an oblique projection of ten of the sixteen hypercubes that fit around a point in four-dimensions. Instead of the lines being tubing, the surfaces must be considered to be the faces of each cube in the structure and constructed of double rubber sheets; the whole structure then inflated. the end result is essentially a minimal "space" or hypersurface that is of zero curvature, not Euclidean, that divides hyperspace into two identical halves again consisting of periodic interloced four-dimensional "bubbles". The model presented here is, of course, three-dimensional; only a "real" four-dimensional jungle gym would make it a hyper-Schwarz-surface. Perhaps a simpler way of understanding the hyper-Schwarz-surface is to start with a model which is a close approximation of the Schwarz-surface. With a little imagination it will be seen that another one just like it can fit right next to it. (Figure 1).

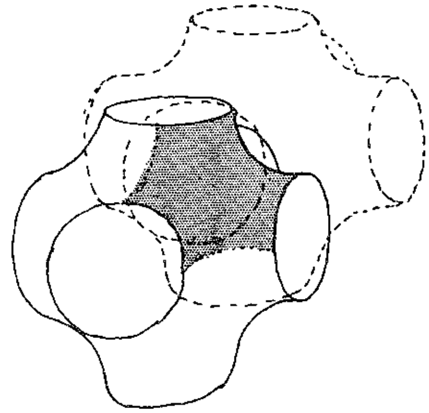


FIGURE 1

Suppose this unit is slowly moved to the right or to the left and as this is done, it is inflated or deflated so that it becomes puffed out or shrunken inward. This is continued until a puffed out octahedron is produced on one end of a continum and a shrunken cuboctahedron is produced at the other end. These can be fitted together to completely fill space and this is true of any given interval to either the right or the left of the hyper-Schwarz-surface in the middle of the continum. Thus, as the figure is moved in one direction, it is actually describing both sets at the same time. Starting with the puffy octanedron and inflating it, then deflating, it will pass through all of the stages until it arrives at the octahedron again. This kinetic structure just described is a unit of the hyper-Schwarz-surface. It has the property of being able to be nestled next to another unit in the same way as were the two units of the Schwarz-surface.

The practical significance of the hyper-Schwarz-surface would appear to rest in structural analysis, for it serves as a periodic index to all of the possible configurations of the close-packing of three-dimensional solids that can be related consistently to a cubic lattice. Especially significant is its function as an index of three-dimensional close-packing. Consider the notation of a mathematical approximation. A triangle is the simplest possible approximation of a circle. The square is a closer approximation of the circle, the regular n-sided polygon is an even closer approximation of the circle. In fact, the circle may be considered to be the limit of regular polygons. Similarly, the tetrahedron and cube are different approximations of a sphere. There is always a connected set of faces in any close-packing, such as in my tensegrity structures, that is an approximation of one of the surfaces generated by the Schwarz-surface as it modifies its form to describe the unit of the hyper-Schwarz-surface. Consequently, within each close-packing configuration there is an approximation of a three-dimensional cross-section of the unit of the hyper-Schwarz-surface.

This collection of planes always forms two volumes that completely enclose each other, even at the extreme case of the octet truss which may be understood to be a collection of tetrahedra connected by their edges to surround an isolated octahedron. Why it is not considered the other way around will be realized when it is recognized that every such lattice exists in three-dimensional space that may be described by a point with three lines passing through it at right angles to each other. Each one of these close-packings must conform to the structure of that space, and there must always be a way of dividing such a system by a relationship of six of the close-packing units to a seventh unit that connects them, or some composite form of the same structure. Figure 2 shows this relationship for the octet truss. Note the six tetrahedra connected to a seventh in the center and note where the octahedron may fit. The shaded areas show which surfaces will touch each other when the two forms are fitted together.

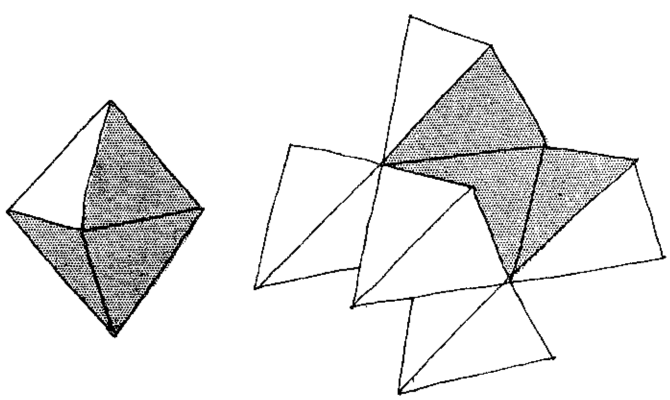


FIGURE 2

The close-packings are grouped in three categories (A) the group that aproximates the Schwarz-surface, (B) the group in-between the Schwarz-surface and the final type of surface, (C) the close-packing of octahedra and cuboctahedra. All of these figures are in the Appendix.

Quite recently, I constructed the Schwarz-surface out of eight units which were formed by pressing clay on plaster of Paris molds. These surfaces were fired to high temperature in a wood-burning kiln. I have made a second set of those eight forms and displayed them on a wall to show the network of the Schwarz-surface when unfolded. The intent here was to make a visually pleasing or aesthetic statement utilizing clay, the discipline that I have most thoroughly researched, and firing it in a wood-burning kiln to catch the fly-ash on the surface of the clay. This produces true uneven coloration and matt to gloss by the vitrification of the clay. I wanted to integrate this random texture and color with the highly structured geometry of the Schwarz-surface. This has been a major concern to me for some time.

Initially I believed that random patterns were totally the result of chance relationships, but I have since realized that they are the result of a set of events which have as real a mathematical definition as close-packing structures. The difficulty lies in understanding these mathematical relationships with the same clarity as that of the more obviously ordered geometry of the close-packings. It must be understood that the random patterns are dependent upon several variables: form, surface coating, firing technique and fuel, all of which are instrumental in producing random patterns due to various phenomena occurring in a specific predetermined sequence. It is necessary to determine the set of events that produce the desired effect, through testing, in order to duplicate the results with a high degree of predictability. The variation on the surfaces demonstrates the parameters of the particular set of events, i.e. the clay, wood as fuel for firing to high temperature and so forth. They are the result of mathematical relations which are just as subject to law as those used to produce close-packing structures, but they are not as easily grasped.

During the process of making these forms, I found that this minimal surface is extremely strong, never breaking in the forming process, the drying or firing of it. I have drawn the conclusion that since it is a minimal surface, having equal curvature along axes at right angles to one another, its strength is increased greatly due to the stress on the form being equalized throughout the surface. If this is the case, then other minimal surfaces should be investigated as well, for it can be a significant discovery for the clay industry as a whole, as well as for the individual potter. I am presently in the process of carrying out this exploration in my research of form.

In conclusion, I believe that the basic quality which sets my work apart from other sculpture of the past and the present is my concern with transcending sculpture conceived of as an object. The common aesthetic element shared by all of my work is that it uses segments of infinite structures that transcend the classical "object" of sculpture: all can extend infinitely in three-dimensions. In each case, I have given the viewer a sample unit, the objective is to extend the viewer's concern to infinity. I believe that it truly brings together geometric concepts, scientific technology and visual imagery in a very exciting form.

For those interested in the work and ideas of the others who have participated in the Hypergraphics Exhibitions and Conferences, you will find that the book edited by David Brisson contains articles by many of those who took part in these events. Its title is Hypergraphics: Visualizing Complex Relationships in Art, Science and Technology. It was one of the American Association for the Advancement of Science Selected Symposia Series of 1978 and was published by Westview Press, Inc.

References:

Brisson, David, ed., Hypergraphics: Visualizing Complex Relationships in Art, Science and Technology, Westview Press, 5500 Central Ave., Boulder, Colorado, 1978

Critchlow, Keith, Order in Space, A Design Source Book, A Studio Book, Viking Press, Inc., 625 Madison Avenue, New York, N.Y. 1969.

Coxeter, H. S. M., Regular Polytopes, Dover Publications, Inc., 180 Varick Street, New York, N.Y. 1973

Fuller, R. Buckminster, Synergetics, Macmillan Publishing Co. Inc., 866 Third Ave, New York, N.Y. 1975

Holden, A. and Singer, P., Crystals and Crystal Growing, Anchor Books, Doubleday and Co. Inc., Garden City, N.Y. 1960

Henderson, Linda Dalrymple, The Fourth Dimension and Non-Euclidean Geometry in Modern Art, Princeton University Press, 41 Williams Street, Princeton, N.J. 1983

Williams, Robert, Natural Structure, Toward a Form Language, Eudaemon Press, Box 236, Moorpark, California, 1972

(1) Linda D. Henderson, The Fourth Dimension and Non-Euclidean Geometry in Modern Art, Princeton University Press, Princeton, J.J. 1983, plate 107

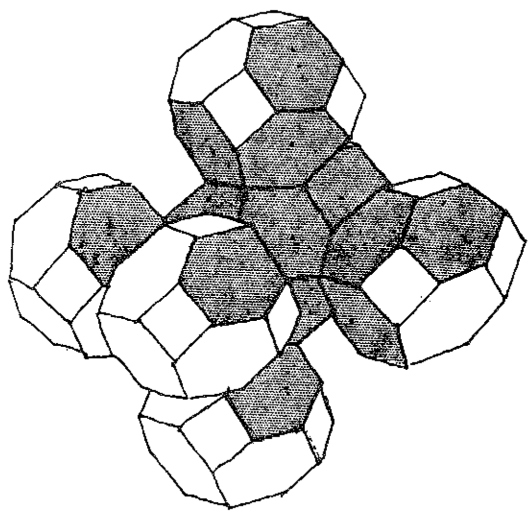
(2) Ibid., plate 5

(3) Robert Williams, Natural Structure, Toward a Form Language, Eudaemon Press, Moorpark, CA 1972, p.164.

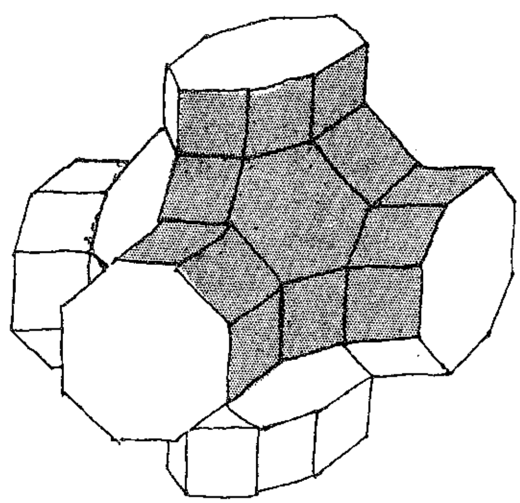
APPENDIX

Group (A)

Truncated Octahedra

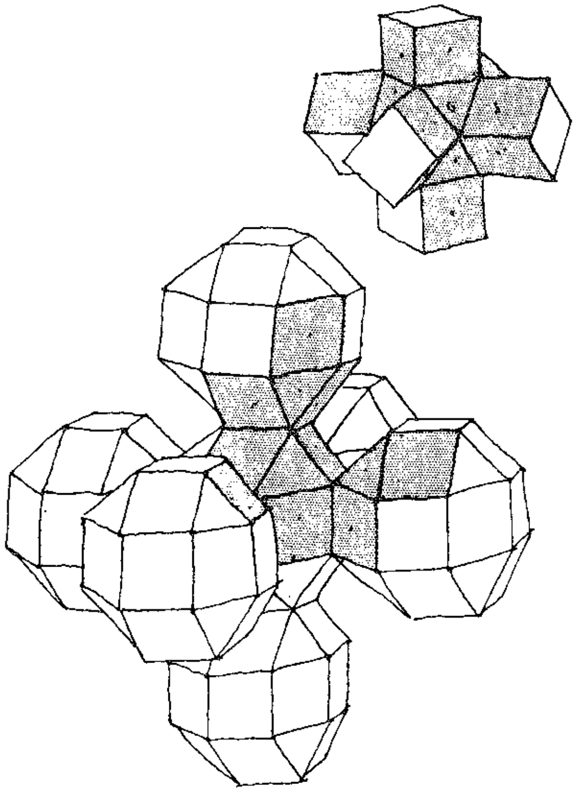


Great Rhombicuboctahedra, octagonal prisms

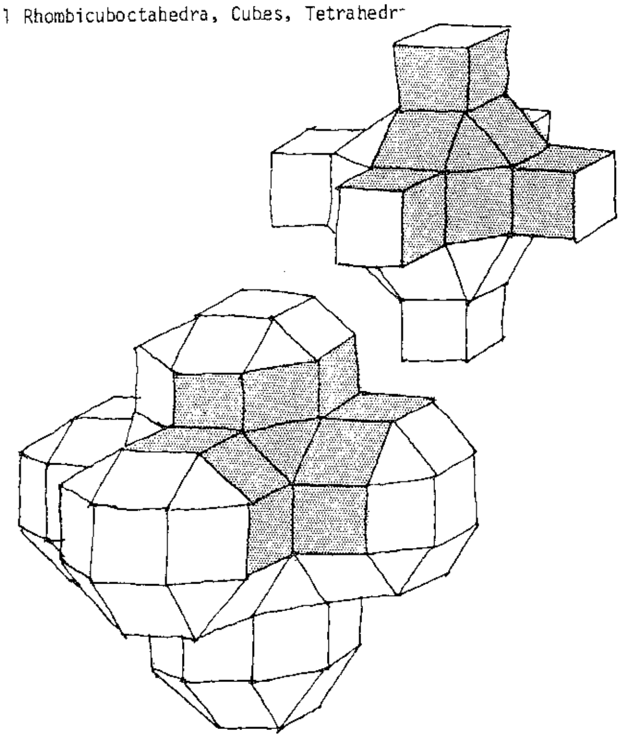


Group (B)

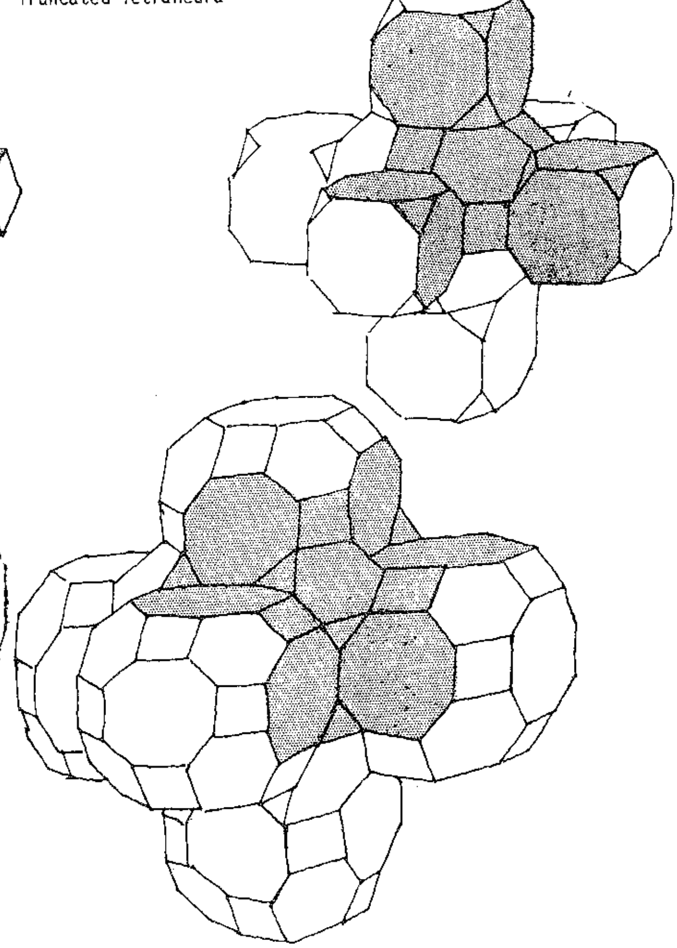
Cuboctahedra, Cubes, Small Rhombicuboctahedra



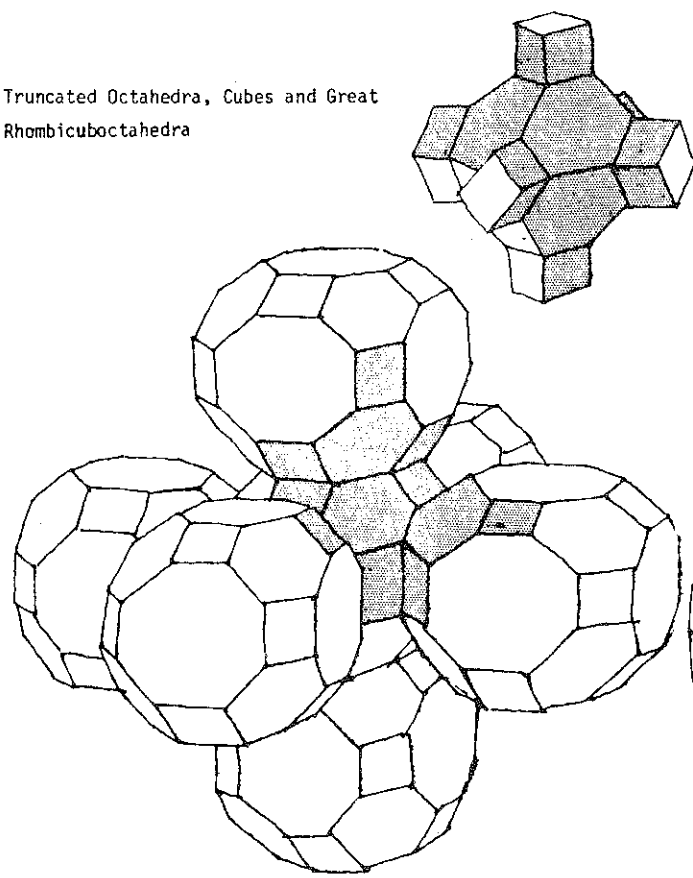
Small Rhombicuboctahedra, Cubes, Tetrahedr-



Great Rhombicuboctahedra, Truncated Cubes, Truncated Tetrahedra

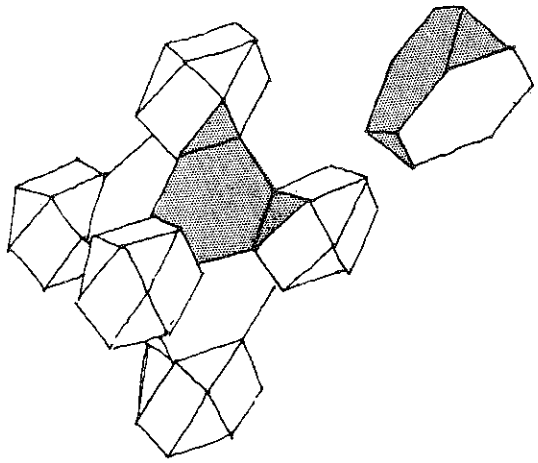


Truncated Octahedra, Cubes and Great Rhombicuboctahedra

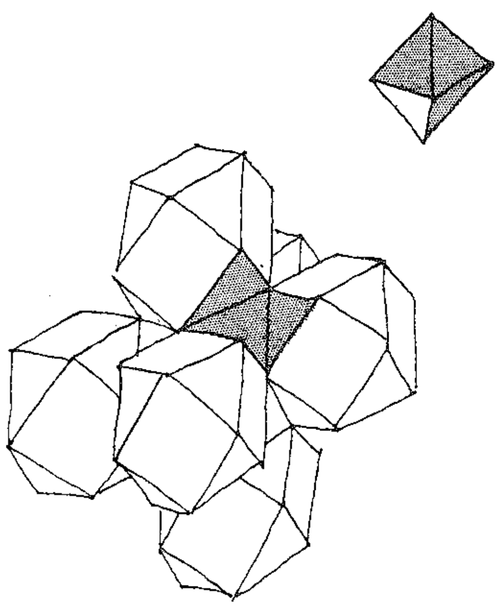


Group (C)

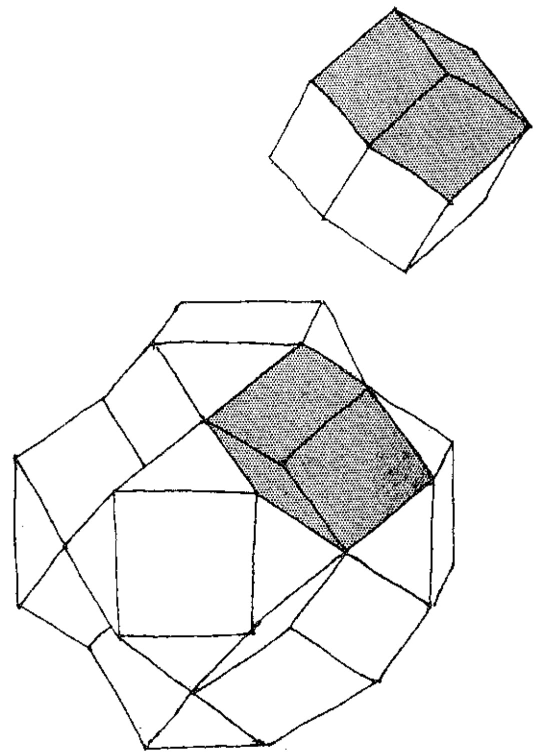
Truncated Tetrahedra, Truncated Octahedra, Cuboctahedra



Octahedra, Cuboctahedra



Rhombic Dodecahedra, Truncated Close-packing Octahedra and Cubes



1984北京

INTERNATIONAL CONFERENCE

GENERALIZED METHOD FOR MULTI-DIMENSIONAL DESCRIPTIVE GEOMETRY

By

C. Ernesto and S. Lindgren

Universidade Federal Do Rio De JaNeiro/Superior War College

Rio De Janeiro, Brasil

ABSTRACT

In the first half of the 20th century, several attempts were made to devise a method of graphical representation of geometric figures embedded within multi-dimensional Euclidean hyper-spaces, an effort parallel to that accomplished in analytic geometry through direct extension of the Cartesian method. Even though some progress was made, the resulting proposed methods proved to be cumbersome in addition to presenting certain difficulties in relating the methods for each of the scalating number of dimensions of the hyper-spaces.

This paper presents a concise discussion of a generalized Mongean-type method, developed as a result of research done in four-dimensional descriptive geometry. It shows that the basic difficulty and that proved to be the most probable cause of the failure of earlier attempts to generalization, resides in the necessity of properly and exactly defining the system of reference to be used at the dimensionality of the hyper-space in consideration. It shows also that the method of representation at a given dimension (n) contains the system of reference and the method for the dimension (n-1) and so on. Consequently, one needs to work only at the level of the representation itself, being unnecessary to pre-define the relation among the basic geometric elements at a given dimension. In fact, those properties are perceived through analysis of the graphic representations. This scalating relation among the systems of reference and methods of representaton at successive dimensions, in addition to the advantage above mentioned, also makes it possible direct generation of representations through computer-aided graphics. This means that existing software is sufficient for the construction of the projections of geometric forms at any desired dimension and identification of their characteristics and properties.

FROM ONE TO n-DIMENSIONS

A usual format to indicate the possibility of extension from one to two to three to four to n-dimensions has been, in the field of the analytic geometry, to add one more variable in the equation of the geometric element from which one starts the reasoning. Thus, the equation of the straight line $ax+by+c=0$ is used to obtain $ax+by+cz+d=C$ (plane), $ax+by+cz+du+e-0$ (3 D space), $ax+by+cz+du+ew+f=0$ (4-D space) and so on. This format readily permits one to observe some basic characteristics of relations and properties among and of geometric elements and geometric forms at a given n-space as well as the number and arrangement of the system of reference used.

A second manner to achieve the conception for spaces with higher than three dimensions is to describe each geometric form as a projection of a form of higher dimensions or as a view of this form as it is frontly observed. Thus, a point is said to be the projection of a line on a plane or the front view of that line; a line is the projection of a plane on a 2-D space or on a 3-D space or the front view of that plane; a plane is the projection of a 3-D space on a 3-D space or on a 4-D space or the front view of that space; and so on. One is induced, in this form of abstraction, to conceive spaces of higher dimensions, gaining in detail as one combines several of the geometric forms to be admitted as the process is repeated.

Thus, one would be able to conceive certain relations among point, line, plane and three-dimensional space as these forms are considered to be projections or views of geometric elements and forms embedded within a four-dimensional space. This process is, no doubt, useful in the development of the synthetic geometry and is the one to which some privileged individuals, as reported in several publications in the area, appeal in order to manage to describe the arrangements of geometric forms of higher dimension which they are capable of imagining.

Conception of higher dimensions . . . . a projection of a form of higher dimensions

A third approach was proposed by this author through the application of the principle of geometric duality after a basic Euclidean postulate was extended in order to relate geometric elements in defining three-dimensional space. The proposal evolved after noticing that in Euclid's Elements, the sequence obtained is as follows:

a. Two points determine a line to which they belong.
b. Three points not of the same line determine a plane.
c. Two lines belonging to the same plane determine a point.
d. Two planes determine a line to which they belong. It is possible to extend these Euclidean postulations and notions to state:
e. Four points not belonging to the same plane, determine a three-dimensional space to which they belong.
f. Two planes determine a three-dimensional space to which they belong.

It appears to be evident that it could be speculated that Euclid himself would consider such extensions if he had included as a geometric element the three-dimensional space into which point, line and plane, objects of his considerations, are embedded. As it happens Euclid dealt in terms of a solid, that body which has "length, breadth and depth".

It follows, from the last postulate above that point, line, plane and three-dimensional space are embedded within a four-dimensional space. This line of reasoning, with slight differences as to the order of proposition of the postulates obtained was presented by Lindgren and Slaby (1968). What is desirable to notice is that this third format leading to the consideration of a Euclidean four-dimensional space can be extended to higher dimensions, as is evidenced when each new space is considered as a geometric element and grouped with the geometric elements of lower dimension. Thus, point, line, plane, three-dimensional space and four-dimensional space, as geometric elements, are simultaneously embedded with a five-dimensional space.

At each dimension, the several possible combinations of the elements yield the propositions that would be basic for the development of the related synthetic geometry.

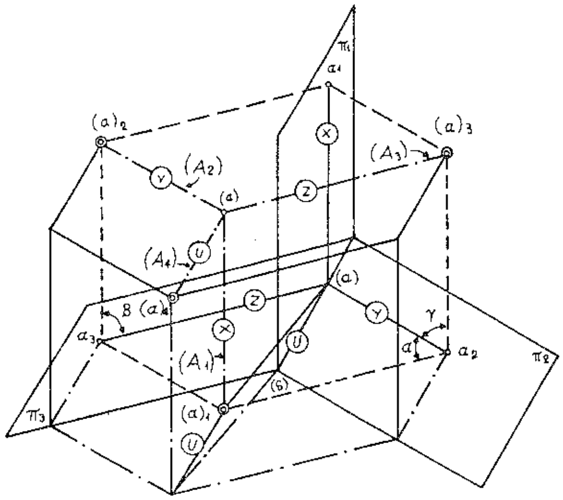
The next focus in this process would be to develop manners of objectively representing the relations among elements and among geometric forms obtained through associations of the elements. One of those manners, as firstly described, is through appropriate extension of the analytic geometry method of higher dimensions.

An alternative way is the extension of the Mongean-type method of representation proposed by Maurin (1948) and Lindgren (1955) and described in Lindgren and Slavy (1968) for the four-dimensional descriptive geometry. This extension is the central theme of the present paper.

4-D DESCRIPTIVE GEOMETRY: MONGEAN-TYPE METHOD

The method evolved from the following steps*:

1. proper identification of the system of reference consisting of four mutually perpendicular 3-D spaces which intersect along six planes, two by two perpendicular at a point; each line is the intersection of the 3-D space taken three by three.
2. a point in 4-D space is referred to these elements, first projecting it in each 3-D space and next obtaining the projections of these projections on the planes; it can be observed that the system of reference thus considered and the process applied in the representation, involves four independent systems of reference used in three-dimensional descriptive geometry, their association being established by a common plane. (Figure 1).



(a) : point in 4-D space
$(a)_1$, $(a)_2$, $(a)_3$, $(a)_4$: projections of (a) on $\Sigma_1, \Sigma_2, \Sigma_3, \Sigma_4$
a_1, a_2, a_3 : projections of $(a)_1, (a)_2, (a)_3$ on π_1, π_2, π_3
$(a)-(a)_1$: distance from (a) to Σ_1
$(a)-(a)_2$: distance from (a) to Σ_2
$(a)-(a)_3$: distance from (a) to Σ_3
$(a)-(a)_4$: distance from (a) to Σ_4

FIGURE 1

3. Considering that the distance from the point in 4-D space to one of the 3-D spaces of the system of reference is measured along a line which is parallel to the intersection of the other three 3-D spaces, as these spaces are rotated about their common line until superimposed, the final representation is obtained as indicated in Figure 2.

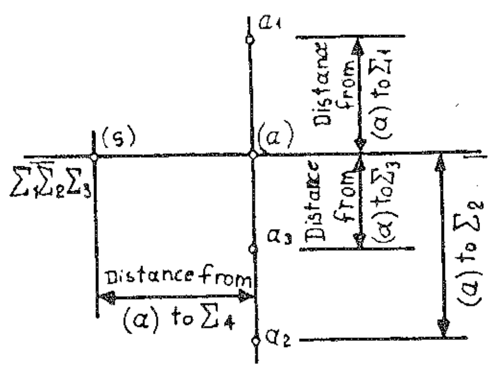


FIGURE 2

POINTS IN HIGHER-DIMENSIONAL SPACES

Once the representation of the point is obtained, the representation of the other elements naturally follow. What appeals to the imagination is that it appears that the proper extension of the system of reference would yield similar results for the representations of geometric elements embedded into higher-dimensional spaces. This is so and, for example, the system of reference for a 5-D descriptive geometry would be five 4-D spaces belonging to a line. Since the distance from the point in 5-D space is measured on a line parallel to that common line, the superimposition of the 4-D spaces would yield a representation similar to the one shown in Figure 2 where it would appear one more projection. Consequently, it can be concluded that the projections of an element in n-space contains or is composed of projections of the same element when embedded however in (n-1) - space. In fact, as it can be observed in Figure 2, the projections of a point in n-space is composed of (n-1) projections of (n-1) point in (n-1), (n-1) - spaces. (In Figure 2, the projections of the point in 4-D space is composed of 3 projections of 3 points embedded in three 3-D spaces).

GENERALIZED PROJECTIONS OF 2D, 3D, 4D,...,nD - SPACES

The most striking feature of the possibilities suggested above is the easily obtained projections of any n-dimensional space in such a way that from it one can arrive at the projections of any space of lower dimensionality. The process used to achieve this is systematic in its construction, which means that it can be simply programmed for computer-aided descriptive geometry constructions.

Lindgren and Slaby (1968) have shown that the projections of a plane embedded in a 3-D space which in turn is embedded in 4-D space are obtained directly from the relations among points and lines of the 3-D space, in respect to all conditions of belonging, parallelism and perpendicularity as expressed in the projectons. This is repeated in Figure 3.

The reader is invited to verify the conditions of belonging, by exercising in higher-dimensions the constructions corresponding to the consideration of a line (B) in Figure 4, whose projection where drawn AFTER the representation was completed. In other words, the projections of line (b) ought to contain the projection a_2 and a_3, being B_3 parallel to the reference line and B_2 parallel to 2.

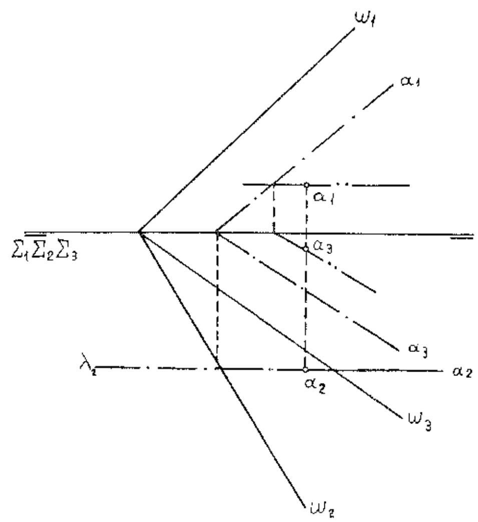


FIGURE 3

CONCLUSIONS

From the studies carried out in the last 30 years with the Mongean-type method for four-dimensional descriptive geometry and experiments at higher dimensions, among other things we can state that:

a. the method is extendable to any dimension desired;

b. all conditions of belonging among the geometric elements, as represented in projections are systematically maintained;

c. propositions relating to geometric forms and to synthetic geometry can be derived directly from the projections;

d. The above possibility is perhaps the most important consequence of the method since it has been customary to derive a method of graphical representation based on the propositions stated in synthetic geometry; the steps are thus reversed.

e. The systematic relations and maintainance of graphical properties makes the generalized method suitable to computer-aided n-dimensional descriptive geometry.

BIBLIOGRAPHY

LINDGREN, C. Ernesto S., "Geometria Descritiva na Quarta Dimensao", Universidade Federal do Rio de Janeiro, 1955.

LINDGREN, C. Ernesto S., SLABY, Steve M. FOUR-DIMENSIONAL DESCRIPTIVE McGraw - Hill Book Co., New York, 1968, translated into Chinese by Xie Shen-Jian, Ging-hua University Publishing House, Beiking, 1982.

MAURIN, Jacques, Geometrie Descriptive a Quatre Dimensions Gauthier - Villars, Paris, 1948.

EDGJ

INTERNATIONAL CONFERENCE

DEVELOPMENT BY TRIANGULATION AND CONSTRUCTION OF WARPED SURFACES

Kenjiro SUZUKI, Tatsuhiko AIZAWA and Hiroshi ISODA
Department of Graphics, College of Arts and Sciences,
Univeristy of Tokyo
3-8-1 Komaba, Meguro-ku, Tokyo 153, Japan

INTRODUCTION

Curved surfaces are classified into single-curved, warped, and double-curved surfaces. Of these surfaces, only the single-curved can be developed theoretically. Practicably, however, warped surfaces are sometimes developed approximately by triangulation (in which, the warped surfaces are assumed to be made up of a large number of triangular strips). Odaka pointed out that the area of the development by triangulation is larger than the surface area of the original warped surface(1).

Warped surfaces are always developed by triangulation on flat planes. Therefore, the surfaces constructed by rolling the developments without folding become single-curved surfaces, which are different from the original warped surfaces (fig. 1).

The degree of approximation in these procedures, i.e., the development and construction of warped surfaces, is not exactly clear.

In this paper, we report the results of the estimation of the degree of approximation in the development by triangulation and construction of warped surfaces. Comparison has been made between the warped surfaces and the single-curved surfaces whose restriction conditions are similar to each other.

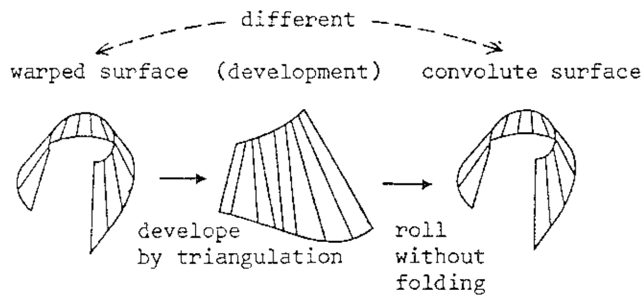


Fig. 1. Development by triangulation and construction of warped surface

WARPED TRANSITION SURFACES

Fig. 2 shows a 4-branched warped transition piece connecting the lower large circle O_1 with the upper small circle O_2, and its approximate development by triangulation. Assume that we can make a surface which passes through the circles O_1 and O_2. Therefore, it is necessary that the development of the warped surface is similar to that of the convolute surface, for the development by triangulation and construction is of practical use.

Fig. 3 shows the developments of the warped surfaces and those of the convolute surfaces for various angle of axis and axial length. These figures have been drawn by using an X-Y plotter and a computer. The locations of the elements are different between the warped surfaces and convolute surfaces, especially for small axial length and large angle of axis. The external shapes of the developments are, however, similar to each other.

In order to compare the developments quantitatively, the areas of the developments have been numerically calculated. Fig. 4 shows the area of the development of the warped surface ($S_{W.D.}$) and that of the convolute surface (S_O) as a function of the number of divisions (N) for a typical 4-branched warped transition.

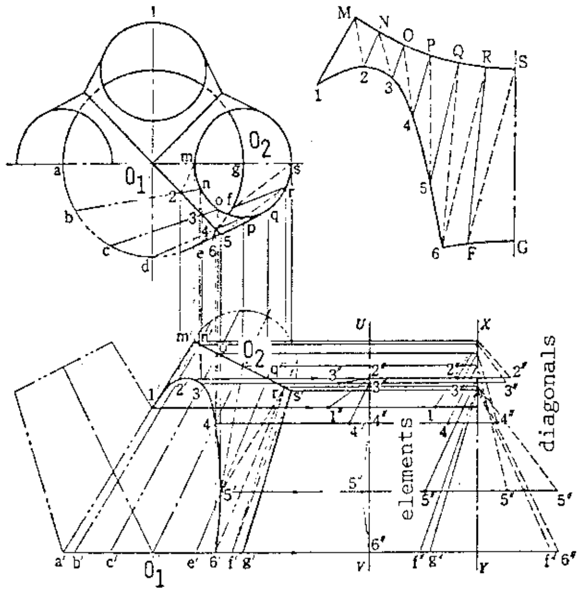


Fig.2. 4-branched warped transition and its development[2)]

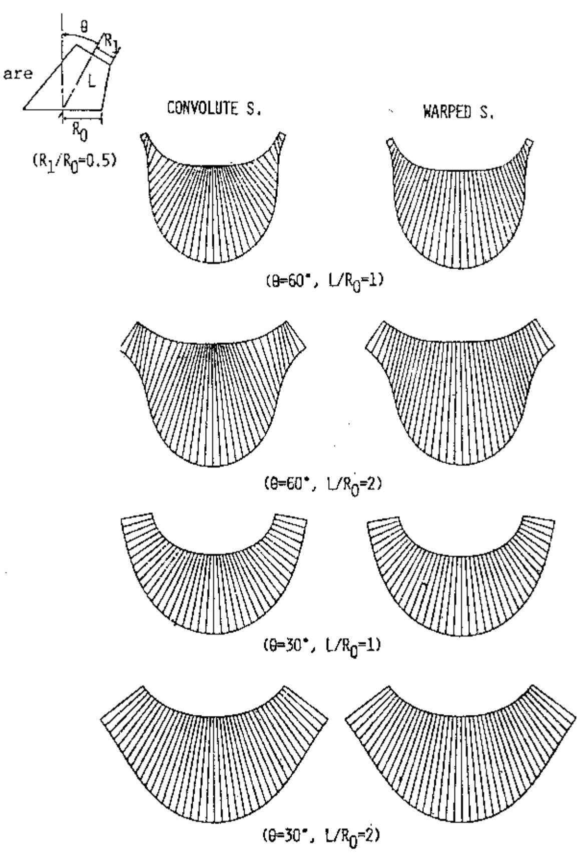


Fig. 3. Developments of warped transition and convolute surface

The area of the development of the warped surface is larger than that of the convolute surface for every N. For large N, the areas $S_{W.D.}$ and S_0 coverage to different values. Fig. 5 shows the area ratio $(S_{W.D.} - S_0)/S_0$ as a function of the angle of axis with the normalized axial length as a parameter. These values have been calculated for sufficient large N (=200). In this figure, are also plotted the area ratio $(S_{W.D.} - S_{W.})/S_{W.}$, where S_W is the surface area of the warped surface, and has been calculated by dividing the quadrilaterals made up to two adjacent elements into a large number of subdivisions. As the angle of axis increases or the axial length decreases, the area ratios increase.

As shown in fig. 5,

$$S_{W.D.} > S_0 >> S_W,$$

$$(S_{W.D.} - S_0)/S_0 \sim O[10^{-4}],$$

and $$(S_{W.D.} - S_W)/S_W \sim O[10^{-3}],$$

in the parameter range $L/R_0 \geq 2$, o 40º

It should be noted here that the triangulation makes the area of the development larger than the surface area of the original warped surface and it approaches to that of the development of the convolute surface. These results show that it is possible to construct convolute-like surfaces by rolling the developments of the 4-branches warped transitions.

Similar results have been obtained for 2-branches warped transitions.

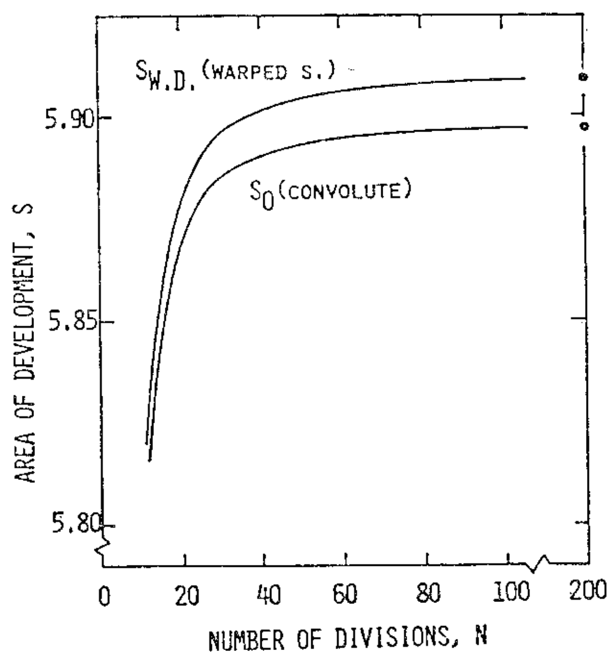


Fig. 4. Area of developments

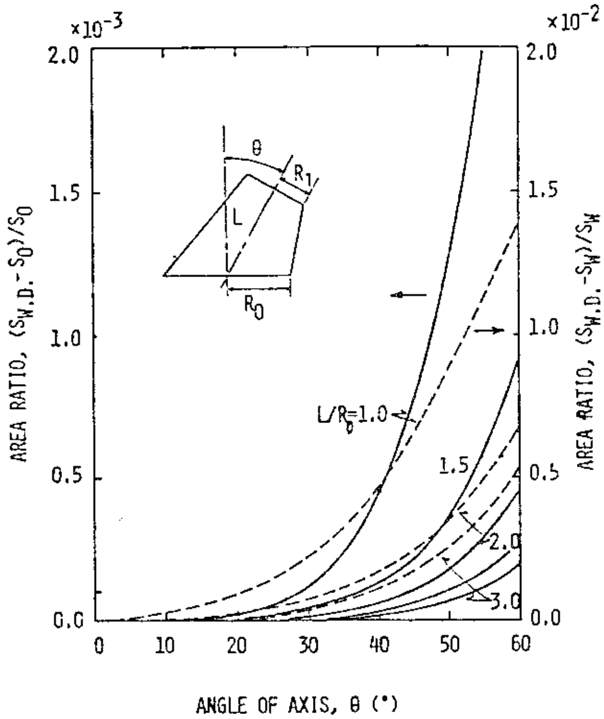
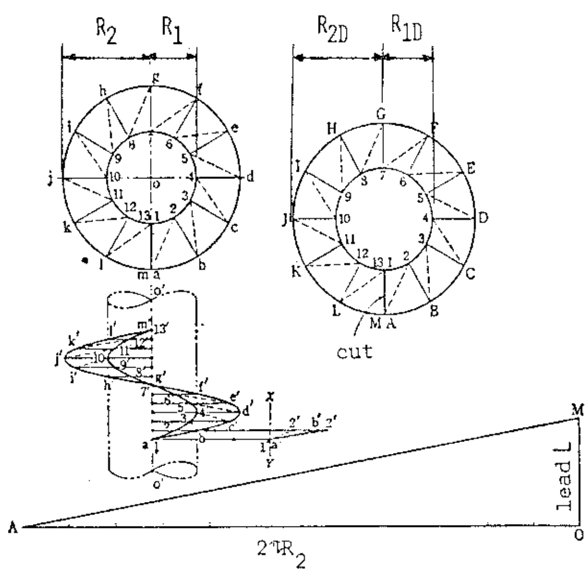


Fig. 5. Area ratio between warped surface and convolute surface



$R_{2D}=AM/2\pi$, $R_{1D}=R_{2D}-(R_2-R_1)$

Fig. 6. Right helicoid and its development[2)]

HELICOIDS

Fig. 6 shows a right helicoid which has an inner helix of lead L. Fig. 6 also shows the development by triangulation and the approximate development proposed by Hara[2)], in which, the development is approximated to be made up of concentric circles whose outer and inner-radii are AM/2 and $AM/2+(R_2-R_1)$, respectively. Assuming that we can construct a surface which passes through the inner helix of the helicoid by rolling the development without folding, the surface constructed should become a single-curved surface which passes through the inner helix. Since any of the helical convolute surfaces whose directrices are the helices of lead L and of radius less than R_1 can pass through the inner helix, there are infinite numbers of single-curved surfaces that pass through the inner helix. In these surfaces, the helical convolute surface whose direcrix is the inner helix of the helicoid is most similar to the original helicoid. It should be noted here that there are no single-curved surfaces that pass through the inner and outer helices simultaneously. Therefore, it is necessary that the development of the helicoid is similar to that of the helical convolute surface, for the development by triangulation and construction of the helicoid is of practical use.

Fig. 7 shows the developments of the helicoids and the helical convolute surfaces whose directrices are identical to those of the helicoids. Although the locations of the elements are different between the helicoids and the helical convolute surfaces, the external shapes of the developments are very similar to each other for small L/R_1. For large L/R_1, the developments are, however, completely different.

In order to compare the developments quantitatively, the area of the development of the helicoid (S) and that of the helical convolute surface (S_0) have been numerically calculated. Fig. 8 shows the area ratio $(S_0-S)/S_0$ as a function of the normalized lead with the normalized radius of the outer limiting cylinder as a parameter. When the lead or the radius of the outer limiting cylinder increases, the area ratio increases. As shown in Fig. 8, the area ratio $(S_0-S)/S_0$ is less than 10^{-3} in the parameter range $R_2L/R_1^2 \leq 3$. Paper-craft models constructed from the developments show that we can make convolute-like surfaces by rolling the developments of the helicoids smoothly in this parameter range. It is, however, impossible to construct a surface similar to the original helicoid for large R_2L/R_1^2.

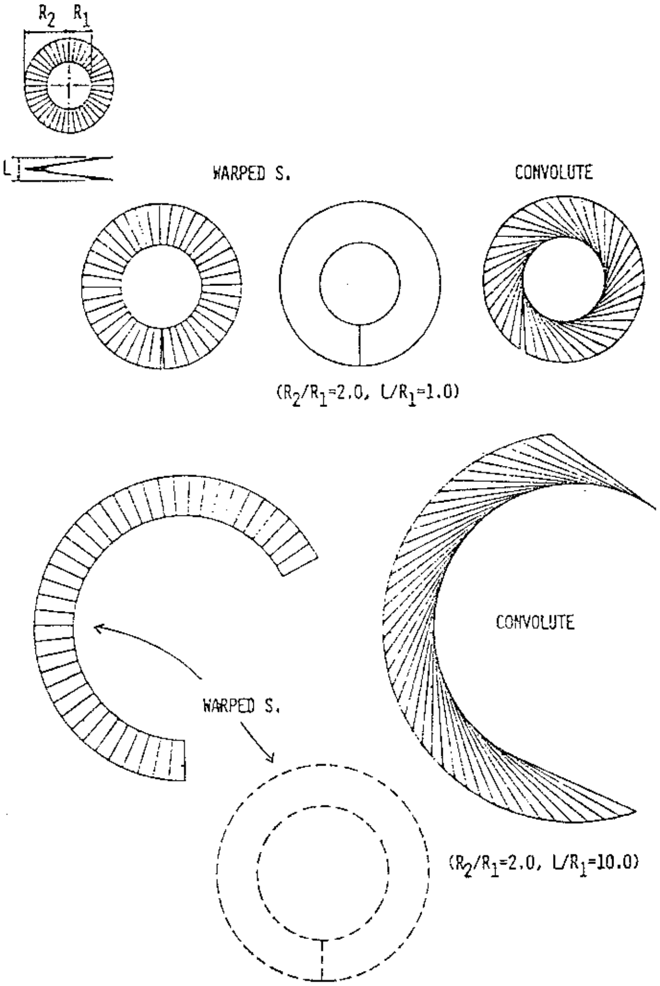


Fig. 7. Developments of right helicoid and helical convolute surface.

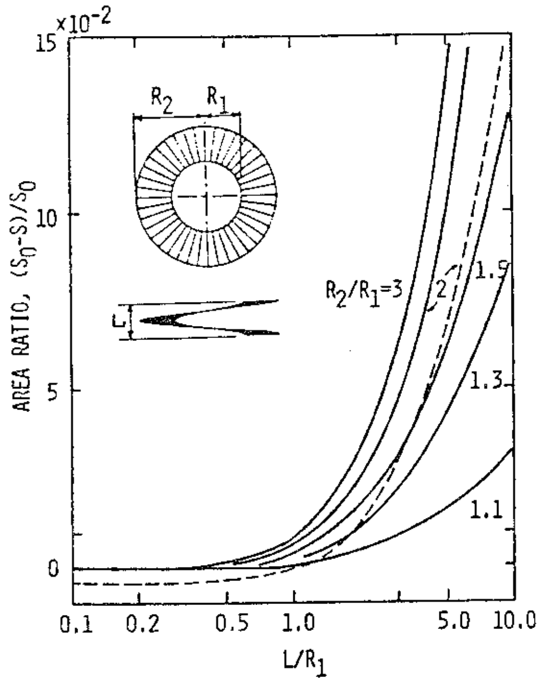


Fig. 8. Area ratio between right helicoid and helical convolute surface
———— S :Triangulation
------ S :Approximation

It should be noted here that we can construct a convolute-like surface by rolling the development of the helicoid for any R_1, R_2 and L. The lead or the radius of the limiting cylinder of the surface is, however, completely different from the original helicoid for large $R_2 x L/R_1^2$.

CONCLUSIONS

Since the warped surfaces are always developed by triangulation on flat planes, the surfaces constructed by rolling the developments without folding become single-curved surfaces. We studied the degree of approximation in these processes, i.e., the development by triangulation and the construction of warped surfaces. Comparison has been made between the warped surfaces and the convolute surfaces whose restriction conditions are similar to each other. The principal results are as follows:

Warped Transition Surfaces

In the parameter range in usual design, the area of the development of a 4-branched warped transition becomes nearly equal to that of the convolute surface whose directrices are identical to those of the warped transition ($(S_{W.D.}-S_0)/S_0<10^{-4}$, $S_{W.D.}$: area of the development of the warped transition, S_0: area of the development of the convolute surface). It shows that it is possible to construct convolute-like surfaces by rolling the developments of the warped transitions without folding.

Similar results are obtained for 2-branched warped transitions.

Continued on p. 43

ENGINEERING GRAPHICS INSTRUCTION USING APPLIED COMPUTER AIDED DRAWING: STATUS REPORT

by

William A. Ross
North Carolina State University

INTRODUCTION

The evolution of microprocessor technology and resulting developments in computer graphics are rapidly expanding the field of engineering graphics and merging it with design and manufacturing. The unique ability to create, modify, manipulate and 'simulate' three-dimensional models of objects with computer graphics allows the creation of new instructional methods for assisting engineering graphics students in developing their visual and spatial thinking. To put the importance of enhancing clear visual and spatial thinking in a better perspective, two mathematicians, Senechal and Fleck have observed that "both the natural world and the world created by technology abound with geometrical forms that must be both seen and understood by anyone who wants to deal intelligently with these worlds. Yet, ignorance of the elementary properties of spatial geometry is profound. We teach our students a great deal about triangles but almost nothing about the tetrahedron, a principal building block in constructions from the atomic structure of metals to the supports of giant bridges."[3]

"The importance of three-dimensional structures and forms increases as our culture becomes more complex. But college students find themselves handicapped in calculus, chemistry, engineering, and art courses because they have had little experience with three-dimensionsl shapes. The book, blackboard, television screen, video game, and artist's canvas all present two-dimensional abstractions that can, of course, be represented on a drafting board or a computer monitor. But representations, no matter how excellent, have little meaning unless they call forth from the imagination previous experience with objects."[3]

If we are to assume that one of the major roles of engineering graphics education is to promote clear, logical visual-spatial thinking, then there are two key questions which must not be overlooked as we frantically scramble to develop computer based graphics instruction. First, What should we teach? Should we teach two-dimensional, three-dimensional or both systems of computer aided drawing? To what extent should programming be introduced to freshman and sophomore students? Second, How should we teach? What methods and techniques can best be used to deliver instruction? In order to insure effective planning and professionally sound development of computer based instruction these two issues must be continually addressed.

PLANNING

A long range plan[2] was initiated in 1982 by Engineering Graphics Faculty at North Carolina State University to develop and incorporate interactive applied computer aided drawing instruction for engineering graphics students. The central phase of this plan consists of developing and implementing an experimental course followed by establishing a formal undergraduate course in applied computer aided drawing. The focus of this paper is to highlight the rationale, methods and instructional techniques underlying our approach to instruction of engineering graphics using computer aided drawing.

IMPLEMENTATION

The Graphic Communications Program, formerly Engineering Graphics, installed its first CAD/D system in 1983. Following a year of inservice faculty training and curriculum development, an experimental course was offered in the Fall of 1984 for 12 students. The only prerequisite required was successful completion of GC 101, Engineering Graphics I, a required course for all engineering students. Since its initial offering as an experimental course, GC 200, Applied Computer Aided Drawing has been officially approved by the University and 2 sections of this new course are being offered for the Fall 1985 semester with a total enrollment of 36 students. To accomodate the increased enrollment, 2 additional systems have been acquired and a 4th system is currently pending approval.

Instruction and student lab exercises are currently being conducted on MTU-140 microcomputers from Micro Technology Unlimited, a locally manfactured computer designed and built by N. C. State graduates, (Figure 1.). Each system is equipped with a Houston Instruments DP-11 Digitizing Pad and a special Data Mover Board with a Motorola 68000 microprocessor. Although currently functioning as stand alone units, the systems are configured for future networking. For hard copy output, each system has a dot matrix printer attached for graphics or text dumps and is connected through a multiplexer switch to a central Houston Instruments DMP-29 Plotter.

The software used for this course is IHS-CAD, a 3-dimensionally based drafting and design modeling

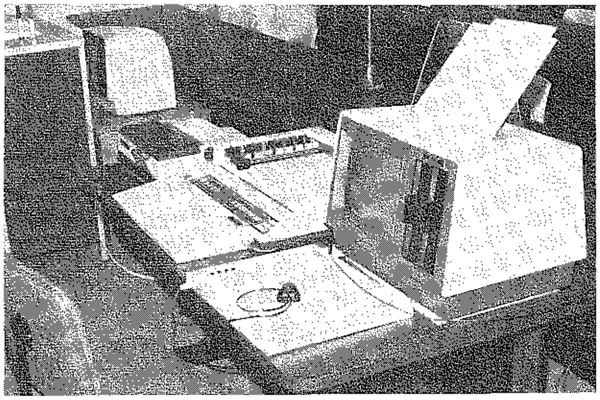


Figure 1. Portable CAD Workstation

package, from B. H. Thrasher & Associates. IHS-CAD is a menu driven, interactive graphics package designed to simulate Computer-Vision CADDS-4 software. Although not as sophisticated as its industrial counterpart, IHS-CAD offers a flexible and powerful merger of 2-D drafting and 3-D design/modeling capabilities, at the wire-frame level, for instructional purposes. Examples of student projects produced with this software package are illustrated in Figure 2. We feel that students exiting this course will have a much clearer understanding of how to make practical and correct use of engineering graphics through any integrated computer aided drafting and design system. Though the course is designed to take a non-programming applications approach, the system includes built-in graphics libraries for students possessing more advanced programming skills.

During the 1984-85 academic year, course lectures have been held on the 4th floor of our building while students did their lab exercises on the 5th floor. In order to "mobilize" instruction, each CAD system has been installed on a rolling Micromaster cart by Inmac, for transport in and out of elevators. As a temporary solution to lack of laboratory space, we have found that a portable "CAD on wheels" system works quite well.

With increased enrollment, a special facility has been made available to support the course for the coming academic year. All student labs will be conducted in a climate controlled room designed for housing and remote hookup of computer equipment. Lectures will be conducted in a room adjacent to the lab. For each lecture and demonstration, a CAD system can be rolled into the classroom and connected to an Electrohome video projector so that large numbers of students can clearly see all screen displays and actions while the instructor interacts with the CAD system as a teaching tool.

THE ISSUE OF WHAT AND HOW TO TEACH

In order to develop computer based instruction for engineering graphics, there are two fundamentally related questions or issues which we have previously stated. First, "What should we teach?" and second but equally important, "How should we teach it?".

What should be taught? Should we teach two-dimensional computer graphics, three-dimensional computer graphics or both? The answer to this question should be obvious to any engineering graphics educator who has ever worked with freshman level engineering students having no prior drafting or industrial work experience. If the student with a mental block to visualization is unable to rely on his intuitive sense of geometric shapes, then learning the concepts of multiview projection and the systematic visualization of complex drawings can be extremely frustrating, for both student and instructor. In this three-dimensional world we should not rely on two-dimensional CAD software alone to 'help' students learn about three-dimensional objects. Using two-dimensional computer graphics exclusively to teach three-dimensional concepts is similar to teaching plane geometry and expecting students to be able to solve solid geometry problems. CAD software which allows three-dimensional interaction directly between student and object exposes the student to one of the most powerful visualization tools available. Two-dimensional CAD systems are also highly useful, provided the user is already a trained and competent visual thinker. To the extent possible within this one course, we are attempting to promote the appropriate use of both two and three-dimensional computer graphics.

How should we teach? It has become our contention that a new technology demands the examination of established teaching methods (ie; chalk talk, overhead transparencies, slides, video tapes, the Goss Box[4], 3-D models, etc.) and the evolution of new methods and techniques for delivering concepts and standards. Our approach has been to experiment with integrating existing methods, see Figure 3., by "using the computer to teach" while "teaching to use the computer". Using an Electrohome video projector and curved projection screen and a special white gridded board, Figure 4., we are developing new teaching techniques which were not possible with other teaching methods. As illustrated in Figure 3., the video projector can be swiveled to project images on either the curved screen or onto the white gridded board. As shown in the illustration the instructor can then utilize chalk talk methods while using the CAD system to generate any required multiview or pictorial required. The relatively new technique of integrating lectures with

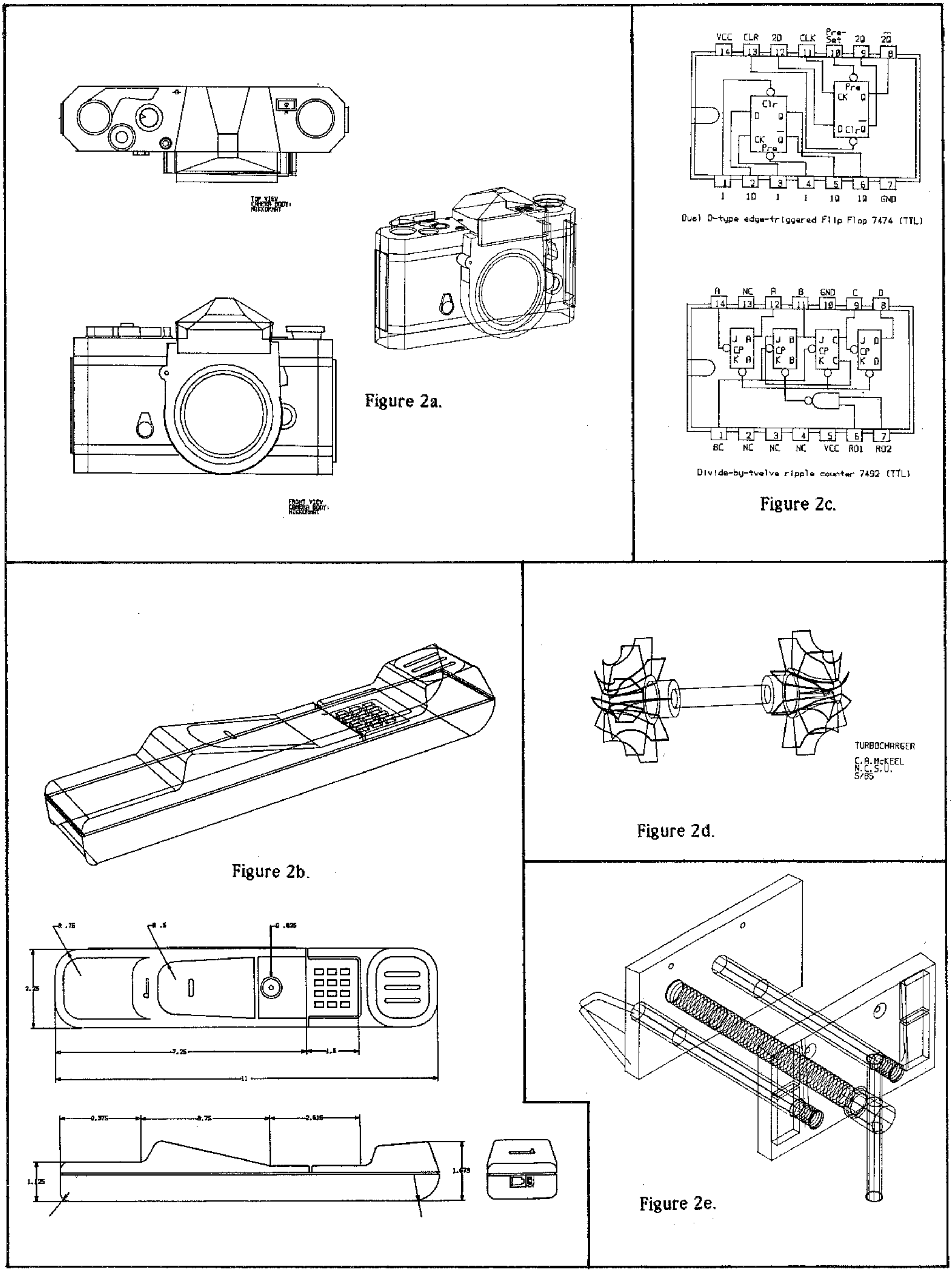


Figure 2. Sample Plots from Student Projects

hardware and applications software have proven to be particularly helpful when demonstrating the construction or editing of three-dimensional objects during lectures to large numbers of students. Everyone, including the instructor, gets a close examination of the applications software and its graphic capabilities and limitations.

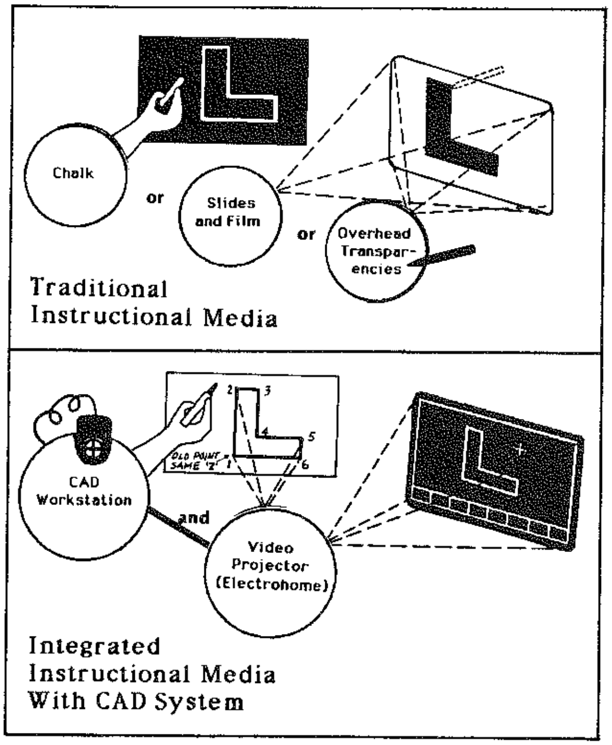


Figure 3. Integration of Traditional Instructional Methods with a CAD Workstation

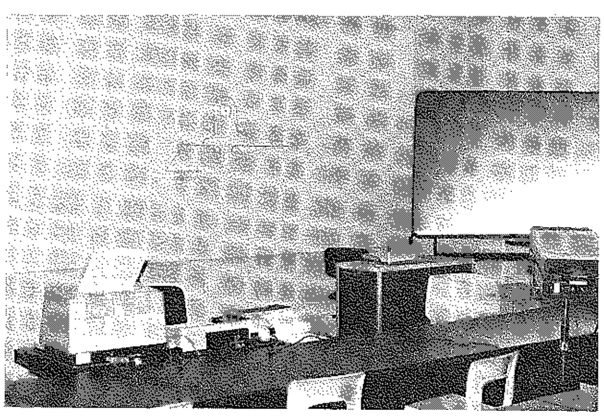


Figure 4. Equipment Configuration for CAD Classroom

CONCLUSION

Integrating the computer into engineering graphics education is a well established need. How this is to be done is a subject of much debate and concern to an expanding professional cadre of graphics educators. There are many issues to be dealt with; to name a few, the emergence of 32 bit technology and networking; the extent and level of knowledge of algorithms and graphics programming required; the growing complexity and speed of canned graphics software; a lack of standardized methods; the ethics and propriety of using public and private source code. From our experience in using a packaged CAD system, it is difficult to avoid becoming entrenched with existing hardware and software and very easy to develop a mindset for instruction based on these limits. To this extent, engineering graphics students should always be given clear albeit generic exposure to the organization of CAD/D software, algorithms and hardware. If this can be done effectively, the available hours for engineering graphics instruction (a valuable commodity), can be used to concentrate on the intelligent creation and application of two and three-dimensional computer graphics. The complex and labor intensive task of learning to write useful source code for computer graphics software might be handled best in advanced coursework, after the student has personal experience with its use. The growing sophistication and complexity of computer graphics hardware and software appear to support this approach.

Again, I will assume that one of the major roles of engineering graphics education is to facilitate and promote clear, logical visual-spatial thinking for students who have little or no prior experience in this area. If it is possible to do this effectively in a one semester course, we should concentrate our efforts in the sound development of instructional methods utilizing applied three-dimensional software. Acceptance of this evolving responsibility should continually alert us to ask two very important questions. What should we teach? How should we teach it? The need to share our ideas and efforts at the national level remains essential.

REFERENCES

1. Leitner, Wells N., "New Programs, University of Missouri-Rolla Computer Aided Drafting", Engineering Design Graphics Journal, Vol. 48, No. 3, Autumn 1984.

2. Ross, William A., "Development of Interactive Computer Aided Drawing Instruction: A Long Range Plan for Engineering Graphics at North Carolina State University", Engineering Design Graphics Journal, Vol. 48, No. 1, Winter 1984.

3. Senechal, Marjorie & Fleck, George, "Two-Dimensional Math In a Three-Dimensional World", Education Week, February 6, 1985.

4. Waldron, Manjula B. & Lalitha, P. S., "Multisensory Learning and Orthographic Projection: A Comparative Study", Engineering Design Graphics Journal, Vol. 49, No. 1, Winter 1985.

Warped continued from p. 38

Helicoids

In the parameter range $R_2L/R_1^2 < 3$ (R_1: radius of the inner limiting cylinder of the helicoid, R_2: radius of the outer limiting cylinder, L: lead), the area of the development of the helicoid becomes nearly equal to that of the helical convolute surface whose directrix is the inner helix of the helicoid (S_0-$S/S_0 < 10^{-3}$, S: area of the development of the helicoid, S_0: area of the development of the helical convolute surface). It shows that it is impossible to construct convolute-like surfaces by rolling the developments of the helicoids wihtout folding in this parameter range. It is, however, impossible to construct surfaces similar to the original helicoids for large $R_2 x L/R_1^2$.

Acknowledgements

The authors wish to express their thanks to Prof. Hara for many discussions.

REFERENCES

1. S. Odaka: J. Graphic Science, Jpn. 18 (1977) 1. 19 (1977) 1. 20 (1988) 1.

2. M. Hara: "Developments for sheet-metal working (in Japanese)", Shoko-do (1971).

VOLUME 49 NUMBER 3

Analog
ELECTRONIC IMPLEMENTATION

GRAPHICAL SOLUTIONS OF MATHEMATICAL FUNCTIONS: THE ANALOG APPROACH

by

N. M. Karayanakis
Austin Peay State University

INTRODUCTION

Often, those who wish the iconical representation of a mathematical function are torn between plotting by hand or using some sort of a digital machine. The first is usually out of the question and the second calls for the availability of specialized equipment, specialized techniques, or both. While the advent of microcomputer systems have inspired some excellent work on the plotting of two-dimensional functions (Kolomyjec, 1983), the generation and control of digital software is still a somewhat formidable task. Using analog or hybrid computation techniques is a viable alternative to digital methods. Once a problem is stated in mathematical terms, it can also be mechanized in terms of an electronic analogy. This mechanization is a simple process, whose details are shown in many good textbooks like those by Jackson (1960) or Korn and Korn (1972).

HOW IT IS DONE

Before we show some actual examples of mathematical function plotting, let us describe the most important building block: the analog sine-cosine or sinusoidal generator. Shown in Figure 1, the generator consists of one inverting operational amplifier (inverter) A1 and two integrating amplifiers (integrators), designated as A2 and A3. If the reader has no access to an analog computer, where integrators and inverters are available as patchcord-connected subunits, it is easy to make them with a few dollars' worth of parts from the local electronic parts store. For information on the actual construction of these devices, the reader is referred to Lenk (1976), Hughes (1981) and Seippel (1983). Readers without an electronics background will be brought up to speed after reading the book by Hoenig and Payne (1973).

The sinusoidal generator of Figure 1 is the electronic realization of the equation

$$x + a^{2} = \emptyset \qquad (1)$$

whose solution is

$$X = C_1 \cos(at) + C_2 \sin(at) \qquad (2)$$

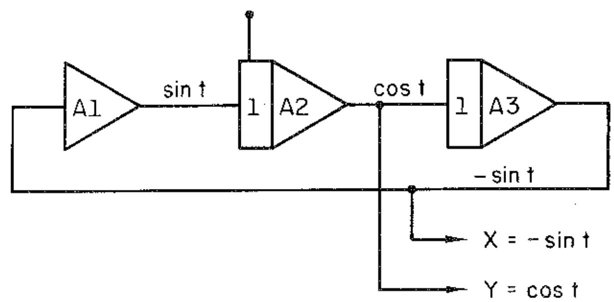


FIGURE 1

Equation (2) is a linear combination, where the C-coefficients are arbitrary constants. The sinusoidal generator consists of three operational amplifiers (op amps). Amplifier A1 is an inverter, that is, it yields an output which has a sign opposite to that of the input. Both amplifiers A2 and A3 are integrators which produce the time integral of their input. The sinusoidal generator needs an initial condition input voltage which can be applied on either integrator.

Inputing an initial-condition signal on A2 will result in amplifiers A1, A2 and A3 yielding sin t, cos t and -sin t, respectively. Inputing an initial condition signal on A3 will result in A1, A2 and A3 yielding -cos t, sin t and cos t, respectively. This occurs because only the cosine can have nonzero initial conditions. The magnitude of the argument (at) of the sinusoidal function for sin (at) can be adjusted with potentiometers placed at the inputs of integrators A2 and A3. Then, the output (solution) will have an argument whose t-values correspond to the potentiometer setting.

using analog or hybrid computational techniques is a viable alternative to digital methods....

It should be noted that the sinusoidal oscillator of Figure 1 is a classical design which can be improved in terms of stability and precision. It is offered here as a working example of this type of device. As will be shown in the following examples, we can condition the output of a single oscillator with some peripheral op amp components or combine the outputs of two oscillators for the purpose of obtaining the plots of mathematical functions which contain nonlinear terms.

SO, LET'S DRAW A CIRCLE

The circle can be represented in polar form by the system of parametric equations:

$$X = r \cos t \qquad (3)$$

$$Y = r \sin t \qquad (4)$$

In Cartesian form, the equation is:

$$X^2 + Y^2 = r^2 \qquad (5)$$

Electronic implementation of Equation (5) calls for an initial condition voltage applied on A2. This voltage represents the radius of the circle. The equations of Figure 1 have been chosen to best illustrate the motions of the X-Y plotter. Here X and Y are of opposite signs, and the plotter pen will move clockwise. When X and Y are of the same sign, the plotter pen will move counter-clockwise. This becomes apparent after inspecting the system of Equations (3) and (4). At $t = 0$, $X = 0$ and $Y > 0$. Also, X becomes negative with an increase in t while Y decreases, which occurs as a counter-clockwise plotter movement through the second quadrant, which begins with $X = 0$ and $Y = r$. Using potentiometers to introduce various initial conditions (radii) will yield concentric circles of various diameters.

As a matter of interest to people operating graphic output devices, the generation of circles goes beyond the academic utility of the example. A sinusoidal generator used in the above described manner can be used to check plotter accuracy and repeatability, which is known as the 'circle test'.

HOW ABOUT A CYCLOID?

A cycloid can be described as the path of a point located within a circle of radius (a) at a distance (b) from the circle's center when the circle rolls along a horizontal surface. The generalized cycloid can be described by the following system of parametric equations:

$$X = at - b \sin t \qquad (6)$$

$$Y = a - b \cos t \qquad (7)$$

The electronic mechanization for the realization of Equations (6) and (7) is shown in Figure 2. Figure 3 shows a typical plotter output for this problem.

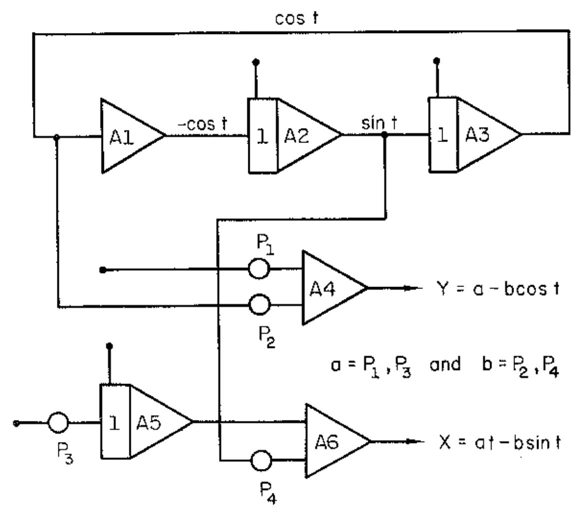


FIGURE 2

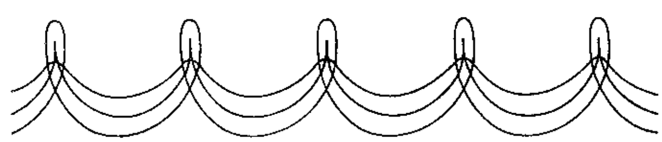


FIGURE 3

HAVE YOU HEARD OF THE LIMACON OF PASCAL?

The Limacon of Pascal can be described as the trace of a point fixed within a circle rolling upon a fixed circle of equal radius. The generalized Limacon of Pascal can be described by the following system of equations:

$$X = 4a \cos t - K \cos 2t \quad (8)$$

$$Y = 4a \cos t - K \sin 2t \quad (9)$$

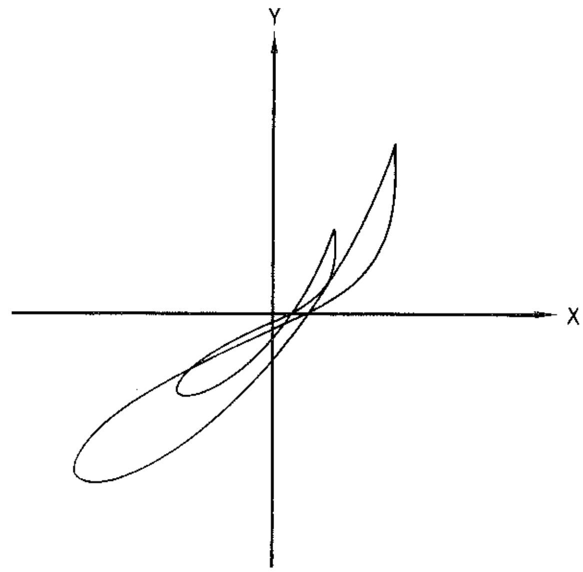


FIGURE 5

The mechanization of the above system is shown in Figure 4. Let us now consider some variations on this theme. Given 2a = K, a cusp will be generated, as shown in Figure 5. A double point will appear if 2a < K, as shown in Figure 6, and an indentation will be observed if 2a > K, as shown in Figure 7. Here, we used an initial condition voltage of 2V for the small figures and 6V for the larger ones.

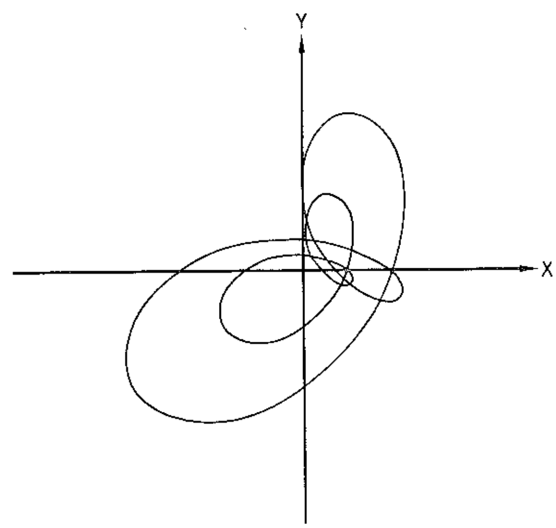


FIGURE 6

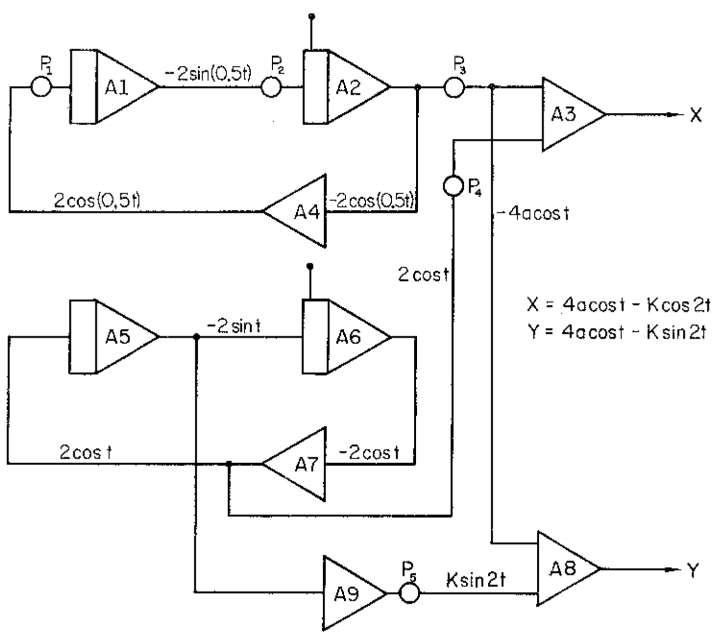


FIGURE 4

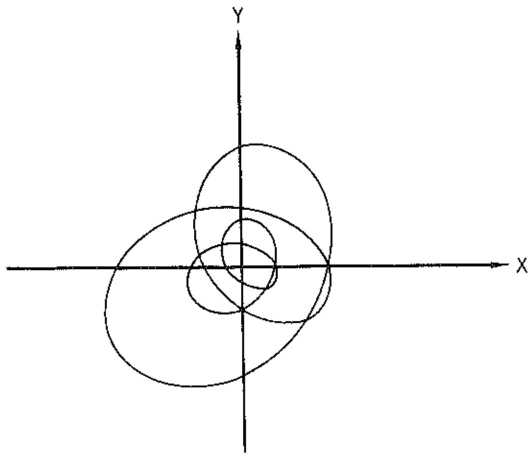


FIGURE 7

SOME CONCLUSIONS

We have come to the end of a brief presentation on a simple method which enables the plotting of mathematical functions without the aid of digital hardware. Using the electronic analog approach to plot functions offers many advantages over the digital route, as evidenced by the flexibility of implementation and ease of problem solving. Given accurate electronic components, the analog method is, for all practical purposes, as accurate as the digital.

Given the availability of an X-Y plotter, the electronic analog approach requires but a few components, like op amp integrated circuits, resistors, capacitors and the like. The components may be purchased at a very low cost by the student and breadboarded over and over again in solving different problems of mathematical function plotting. Essentially, the approach exploited here represents an ideal vehicle for making practical sense of various branches of mathematics and technology and for fulfilling the illusive goal of integration of electronics, mathematics and graphic technology.

REFERENCES

Hoenig, S. A. and Payne, F. L. How to Build and Use Electronic Devices Without Frustration, Panic, Mountains of Money, or an Engineering Degree. Boston: Little, Brown, 1973.

Hughes, F. W. Operational Amplifier Handbook. Englewood Cliffs, NJ: Prentice-Hall, 1981.

Jackson, A. S. Analog Computation . New York: McGraw-Hill, 1960.

Kolomyjec, W. J., Plot-a-Function, Engineering Design Graphics Journal, 47 (3), 1983, 45-48.

Korn, G. A. and Korn, T. M. Electronic Analog and Hybrid Computers, 2nd ed. New York: McGraw-Hill, 1972.

Lenk, J. D. Manual for Operational Amplifier Users. Reston, VA: Reston, 1976.

Seippel, R. Operational Amplifiers. Reston, VA. Reston, 1983.

EDGJ

Professor Karayanakis is currently an Associate Professor in the Division of Technologies at The University of North Florida.

Classroom

TEACHING THE SUBJECT MATTER

CAD INSTRUCTION: THE "BUDDY" SYSTEM

by

Judy A. Watson

Purdue University

Many schools today are faced with the challenge of adding CAD courses to their curriculum. As soon as CAD courses are initiated, the demand quickly surpassese the enrollment capacity. A major concern is how to serve large number of students without sacrificing hands-on experience. The Technical Graphics Department at Purdue, opted to use a "buddy" system as a means of increasing class size.

DESCRIPTION OF "BUDDY" SYSTEM

The "buddy" system, as the name implies, pairs students into teams for learning purposes. Two students work jointly on all exercises and projects assigned throughout the semester. The instructor remains responsible for lectures and lab assistance, while the two partners rely on each other for mastering skills and meeting objectives during the lab portion of the class. Buddies can be assigned randomly, selected by each other or assigned according to predetermined criteria. The "buddy" system has roots in both education and industry. In education, it is the basis for peer teaching and study groups. Likewise, industry often relies on project teams or groups to perform specific tasks.

RATIONALE FOR SELECTING THE "BUDDY" SYSTEM

In the fall of 1984, a CAD course was added to the curriculum of the Purdue Technical Graphics Department. The hardware available consisted of eight Computervision work stations. At the time, three faculty members were trained and available to teach a maximum of five sections. In order to economically utilize faculty and equipment, a class size greater than eight per section was necessary. The "buddy" system was initally considered for administrative purposes. It allowed class size to be doubled without affecting the number of sections offered. In addition, this option was in accordance with course goals which specified that the lab portion would be supervised by the instructor and include as much "hands-on" experience as possible.

The departmental preference was to have scheduled labs with faculty supervision. This was due to the fact that the course was intended to be introductory and for entry level students. Therefore, increasing enrollment by setting up an open lab format was not desirable. In addition, there was a lack of trained monitors since the system was so new. Other ways to increase enrollment required limiting hands-on terminal time. This was rejected based on the departmental policy of offering courses which were application oriented. Once it was decided to adopt the "buddy" system approach, both the advantages and shortcomings were considered in preparation for the semester.

ADVANTAGES OF THE SYSTEM

Some of the positive results anticipated were as follows: First, it was hoped that the feelings of anxiety and isolation often experienced by first-time users could be lessened. Second, students would benefit from peer teaching as team members interacted to solve lab exercises. As partners collaborated on problems, they could direct questions and explanation to each other before consulting the insturctor. In addition, alternate approaches could be discussed by team members while constructing drawings. Since it is often difficult to share problem-solving differences in computer courses, this could offer a unique opportunity. Third, working as a team could offer subtle lessons in communication and cooperation skills which could later serve the student on the job.

LIMITATIONS OF THE SYSTEM

An effort was also made to trouble-shoot problems that might arise due to implementing the "buddy" system. A major concern was that one partner would dominate the station. To avoid this, one partner would work the keyboard and the other the graphics tablet. Also, partners would have to switch these responsibilities on a regular basis. Another concern was that the learning pace might vary greatly between partners. To avoid one partner falling behind, the class pace would be geared to the average student so that the slower student could stay longer for further work if necessary. Another option was to provide some out-of-class lab hours for students who needed additional time for mastery of concepts. This extra lab time would be minimal and scheduled prior to tests. To avoid problems due to differences in operational skill levels, the majority of the testing would not be on the system. Evaluation would consist of two written tests and one performance test on the system.

STUDENT REACTION TO THE SYSTEM

At the end of the semester, students were given the opportunity to evaluate the "buddy" experience. Sixty-three students responded to the questionnaire. Over 90% of the participants thought that the team experience made learning less isolated, and that each partner had equal access to the station. The student response supported our preliminary expectations and planning. The questions and results are as follows:

Continued on p. 64

QUESTIONS	RESPONSES SD	D	A	SA
1. The team system aided learning.	0	5	39	19
2. The team made learning less isolated.	0	5	41	17
3. I was more intimidated working as a team.	17	38	5	2*
4. I asked fewer questions of the instructor working as a team.	7	14	36	6
5. I was less nervous working as a team.	0	17	34	11*
6. The team isolated me more from the rest of the class.	7	32	18	6
7. Overall, working as a team was a good experience.	1	5	41	16
8. My partner dominated the station.	18	40	1	3*
9. The team system limited my progress.	11	31	13	8
10. In general, I did not like the team experience.	18	36	6	3
11. Each partner got equal use of the station.	18	40	1	3*
12. I was less prepared for the test because of sharing terminal time.	15	30	12	6

TABLE 1

* Answer omitted by one participant.

NON-ORTHODIRECTIONAL, ORTHOGRAPHIC PROJECTION

By
David Sanders
Robert Kelso
Louisiana Tech University

BACKGROUND

Descriptive Geometry is often poorly defined if it is defined at all. This seems to be due to it being equated with "projective geometry operations." This paper defines Descriptive Geometry as:

The Science (art?) of determining the direction of viewing an object such that a particular geometry of an object appears in the most descriptive manner.

Once the descriptive geometry solution, for example the direction of sight, has been determined, then it becomes an exercise in projective geometry to produce an image onto a two-dimensional plane as viewed in the solution direction. The projective geometry technique which is employed is orthographic projection. Orthographic projection (Ortho meaning perpendicular and Graphic meaning to draw) is defined as a projection perpendicular to a plane of projection. Two such orthographic views projected in directions orthogonal (perpendicular) to one another accommodate the three dimensions of space, thereby defining in space the location of given geometric entities (points, lines, planes). Once these two orthodirectional orthographic views have been established, additional auxiliary projective geometry operations may be executed in order to produce the solution image. These auxiliary orthographic projections, by convention, have in the past also maintained an orthodirectional relationship between adjacent directions of projection to the extent that this orthodirectional relationship has too often and erroneously become implicitly associated with the term orthographic itself.

However, this orthodirectional relationship is not necessarily required except in the initial and location-defining adjacent orthographic views! In these location-defining views, the three dimensions of space may be found only in an orthodirectional manner.

For example, if adjacent top and front views are used to define the locations of the end points of a line, then the three dimensions of space are represented by the customary height, width, and depth directions, and each dimension is seen true in at least one of the two adjacent views. Once the location of the geometric entity is defined in space however, it is no longer essential that additional adjacent orthographic views also be orthodirectional.

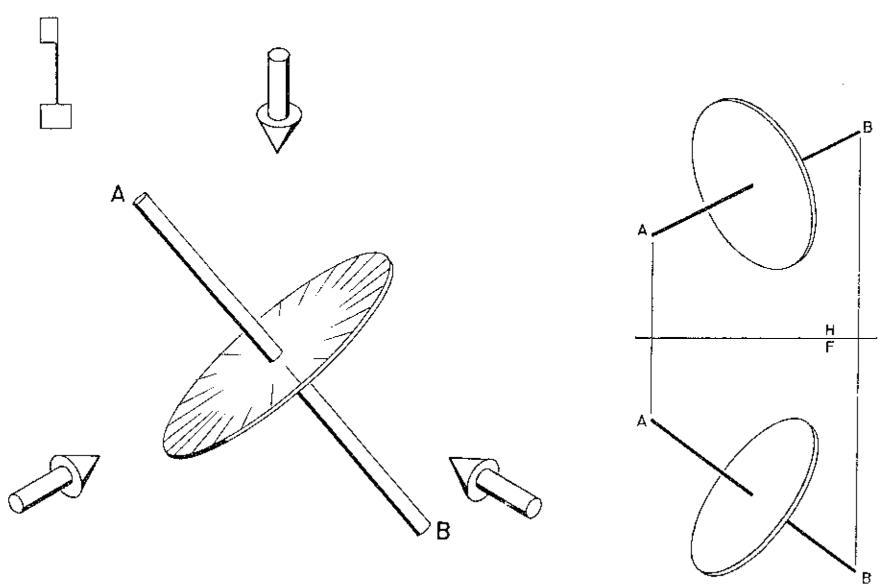
This phenomenon was first demonstrated to me by a Louisiana Tech student, David M. Sanders, with whom I have the priviledge of co-authoring this paper. It should be noted that his discovbery of this technique was completely intuitive.

Graphics
THEORETICAL APPROACHES

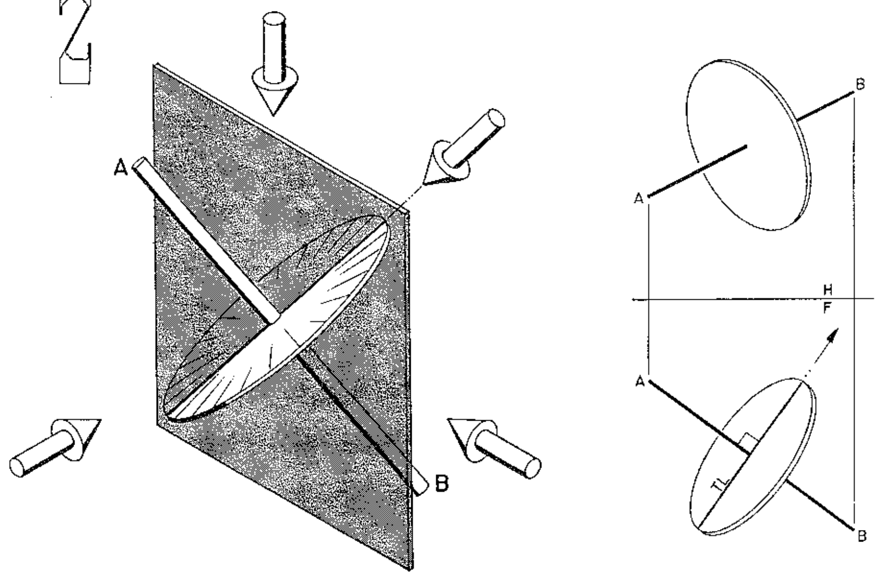
NON-ORTHODIRECTIONAL ORTHOGRAPHIC PROJECTION

In order to explain the phenomenon of Non-Orthographic Orthographic Projective Geometry, general solutions are employed.

Figure 1 is a pictorial and two standard orthodirectional orthographic views of a line in space. The descriptive geometry general solution such that the line appears true length is a ruled plane surface perpendicular to the given line, one directrix of the ruled surface being a plane curve, here shown as a circle, and the other directrix being a point, here the circle center, within the plane of the curve. Although it is unnecessary for it to do so, here the point directrix coincides with the piercing point of the given line with the plane. In this general solution plane, each ruling element represents a Descriptive geometry solution (direction of view) such that the line appears true length.



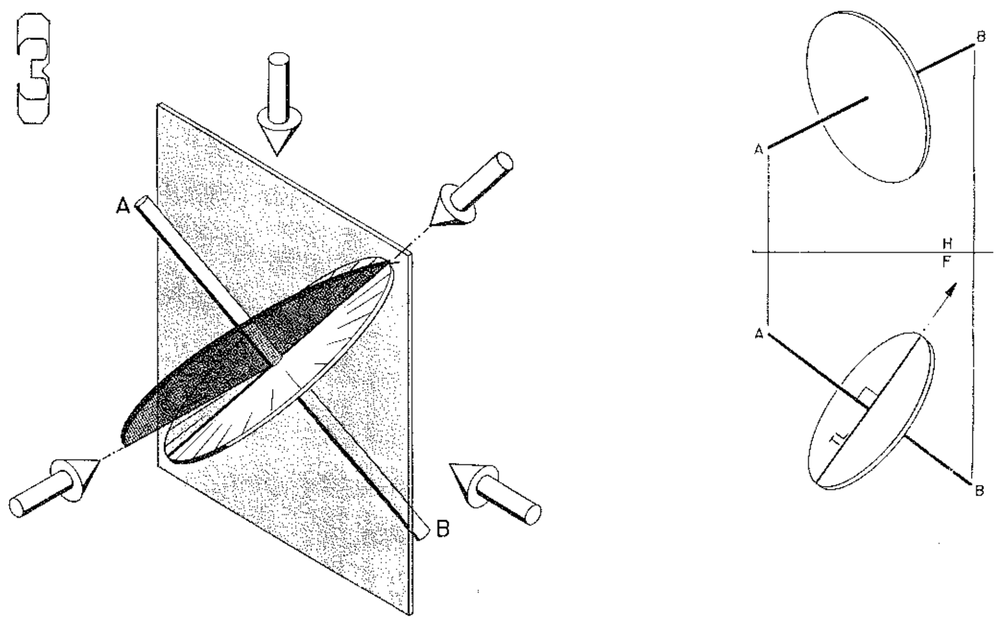
2

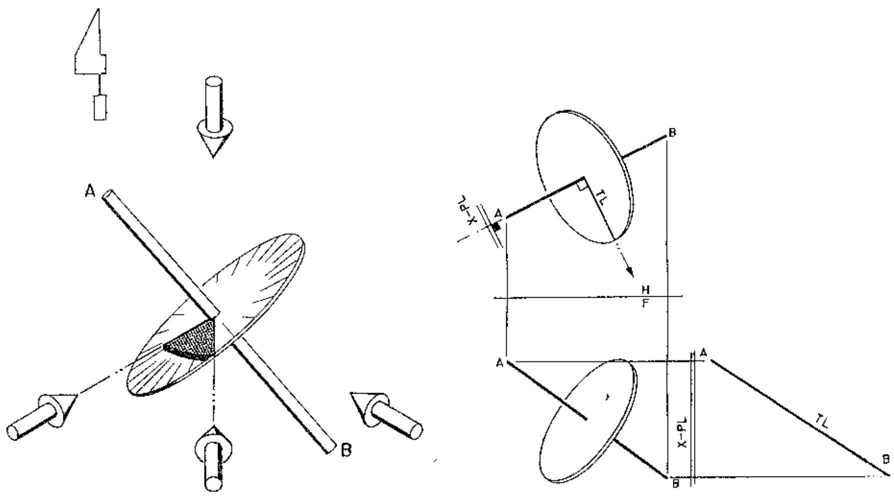


By standard orthodirectional methods, the descriptive geometry solution of a true length view as projected from the front view is the line of intersection between a frontal plane passed through the point directrix and the general solution plane (see Figure 2). Figure 3 shows the orthodirectional relationship between the front view sight direction and the true length sight direction.

Another descriptive geometry solution showing a true length view projected from the front view however, may be achieved by projecting in a direction parallel with, say, the horizontal plane (see Figure 4). This solution direction is the line of intersection between a horizontal plane through the point directrix and the general solution plane. Note that it is achieved by a projection from the object at an angle other than 90° to the front view direction of projection, making it a non-orthodirectional view. Further note that this direction of view will also be parallel to a vertical reference plane (X-PL) perpendicular to the top view projection of the given line. Figure 5 is a pictorial showing the location of the X-PL reference plane. The open, double type lines are used in the orthographic projections to depict the edge views of X-PL so as not to confuse them with a princxipal plane or the other standard orthodirectional reference planes.

3




4
A
B
X-PL
TL
H
F
A
B
X-PL
A
TL
B
B

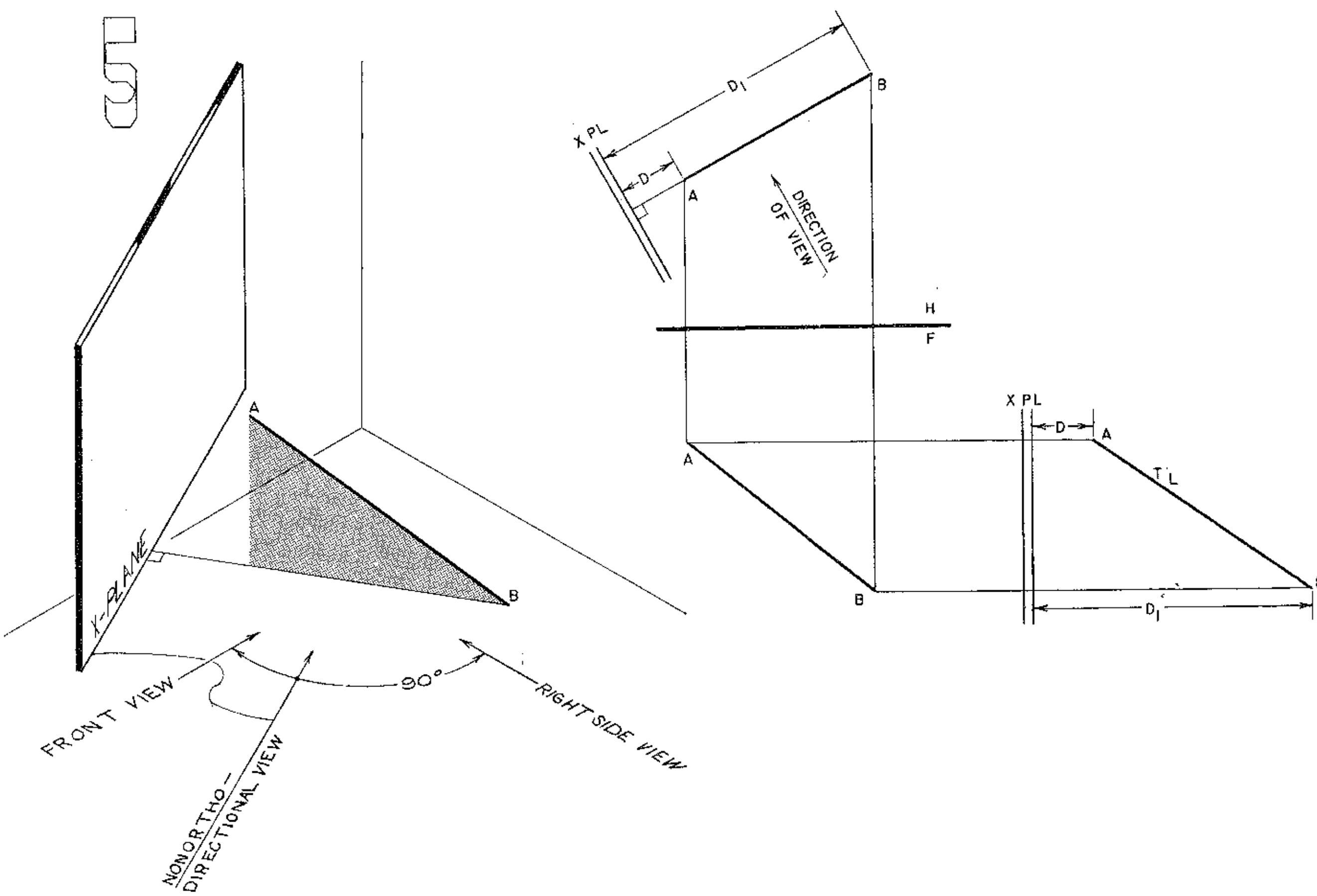
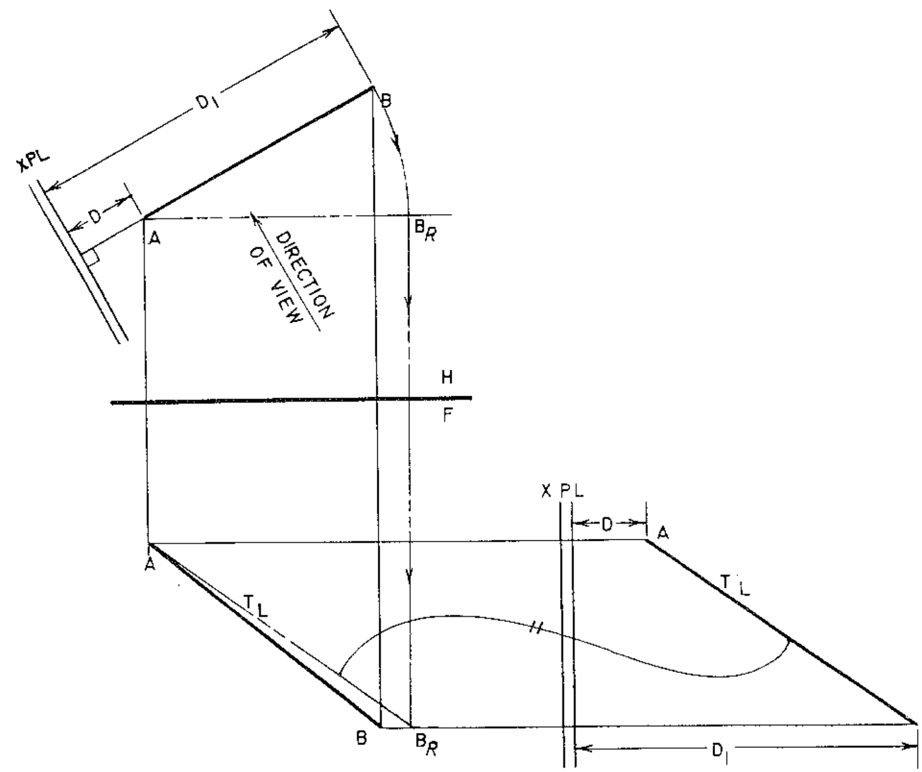

5
X-PLANE
A
B
FRONT VIEW
90°
RIGHT SIDE VIEW
NONORTHO-
DIRECTIONAL VIEW
X PL
D
D1
B
A
DIRECTION
OF VIEW
H
F
X PL
D
A
TL
A
B
B
D1

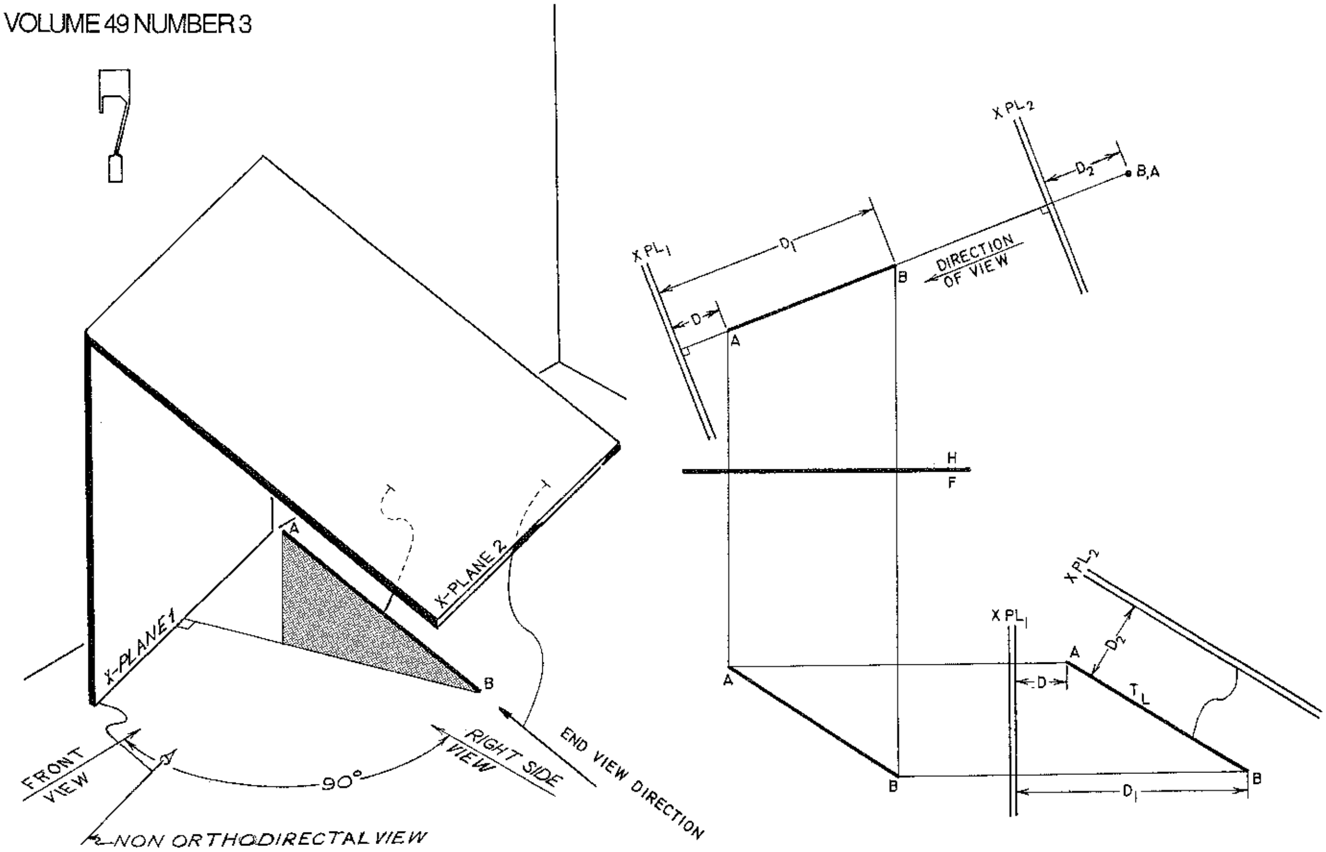
Figure 6 shows the true length determined by rotation and serves to verify the solution by non-orthodirectional projection. Figure 7 is a pictorial and an orthographic projection of the solution for the end view of a line. The line of intersection between X-PL_1 and X-PL_2 is a horizontal line. From the top view, a non-orthodirectional projection is made parallel to the given (non-true length) line until it is projected as a point. This direction of viewing will also be parallel to X-PL_2.

Figure 8 is a pictorial and an orthographic projection of a solution for the edge view of a plane. Note that the view rotation is in a direction to the right of the front and goes over 180°. That is, it represents a projection which not only passes over the right side view, but passes over the rear view as well until it stops in a direction perpendicular to the line A-B, and, just as with orthodirectional projection, the end view of a line on the plane gives a solution view.

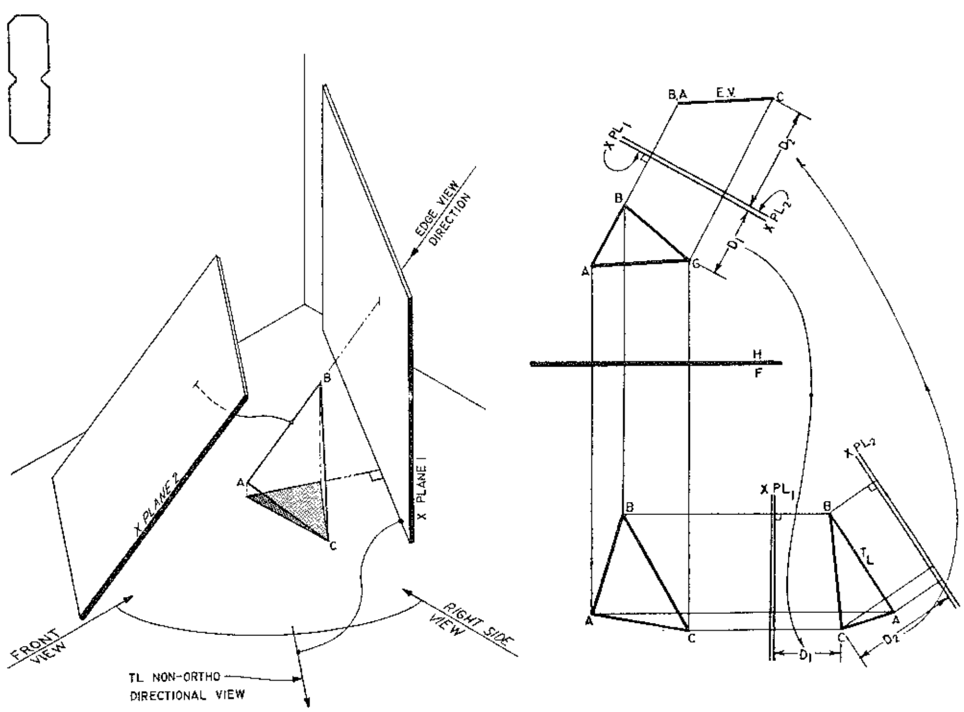
6



7


X-PLANE 1
X-PLANE 2
A
B
FRONT VIEW
90°
RIGHT SIDE VIEW
END VIEW DIRECTION
NON ORTHODIRECTAL VIEW
X PL1
X PL2
D1
D2
D
B,A
DIRECTION OF VIEW
H
F
TL

8


EDGE VIEW DIRECTION
X PLANE 2
X PLANE 1
A
B
C
FRONT VIEW
RIGHT SIDE VIEW
TL NON-ORTHO DIRECTIONAL VIEW
B,A
E.V.
X PL1
X PL2
D1
D2
H
F
TL

9

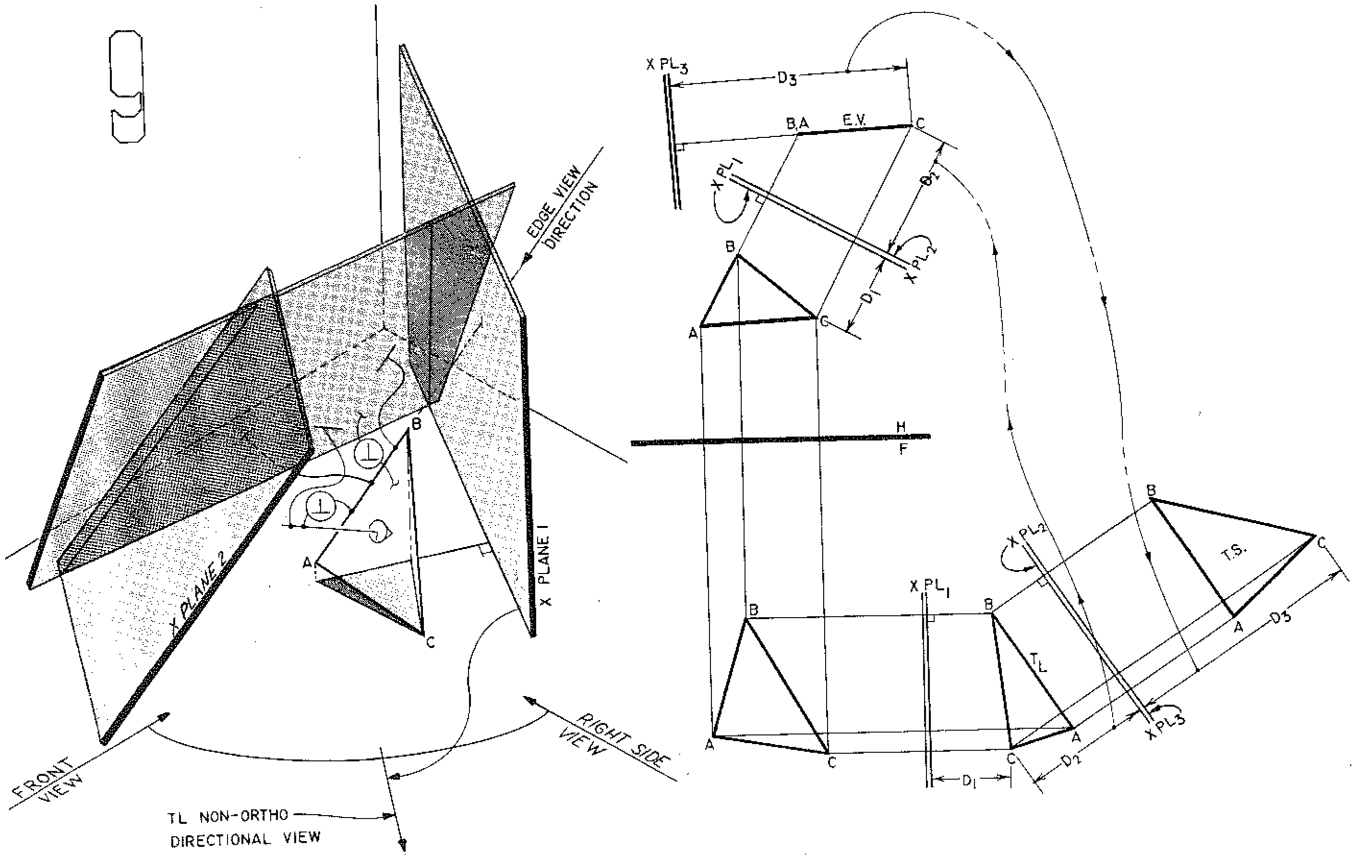
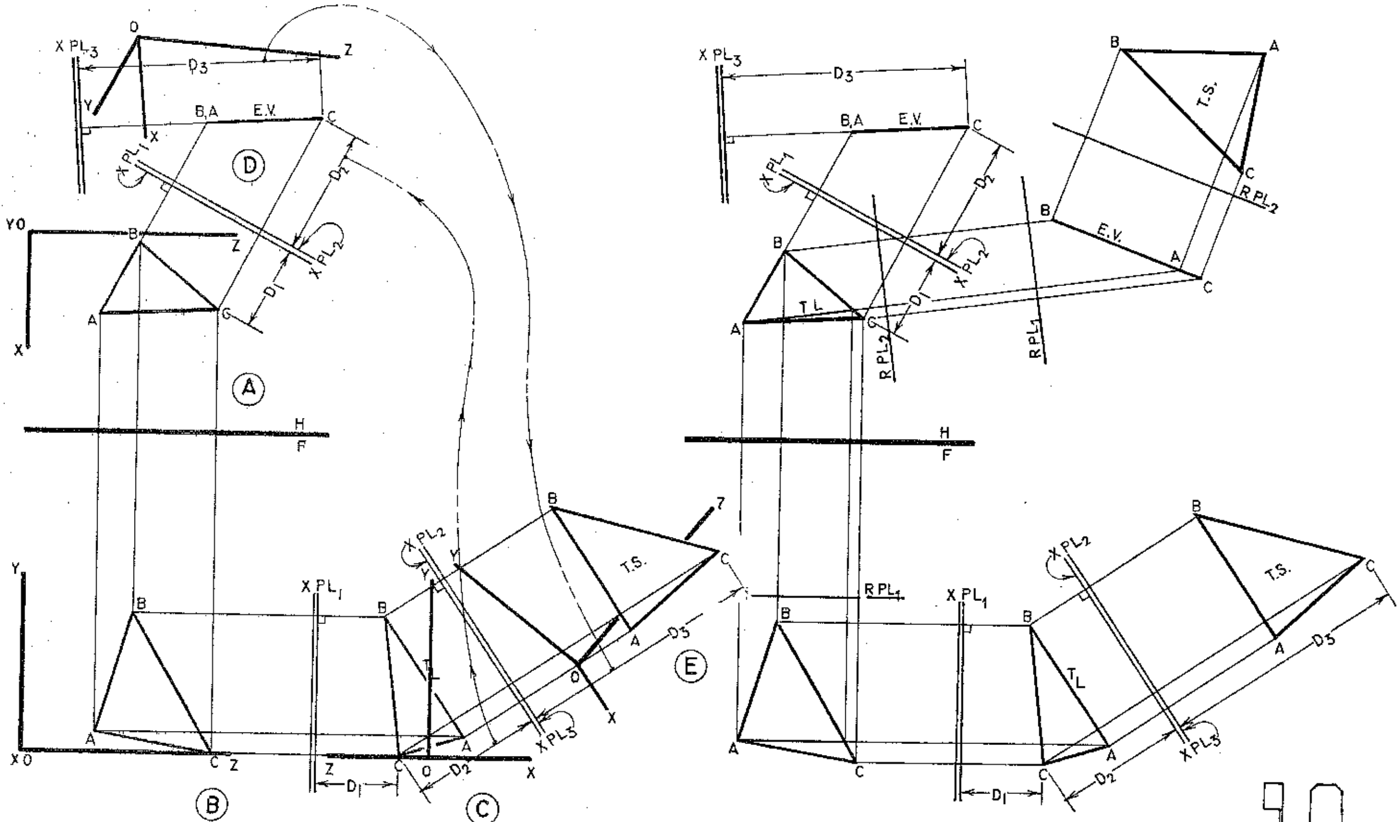


Figure 9 is a pictorial view and an orthographic projection for the normal (true size) view of a plane. A non-orthodirectional projection is made in a direction perpendicular to the true length view of line A-B, until the plane is seen true size. When this occurs, the direction of projection will be perpendicular to line A-B and also parallel to X-PL_3 which is perpendicular to the edge view of the given plane and parallel to line A-B.

Figure 10 is a pictorial showing the X-Y-Z axes in the various views and also an orthodirectional verification of the non-orthodirectional solutions.

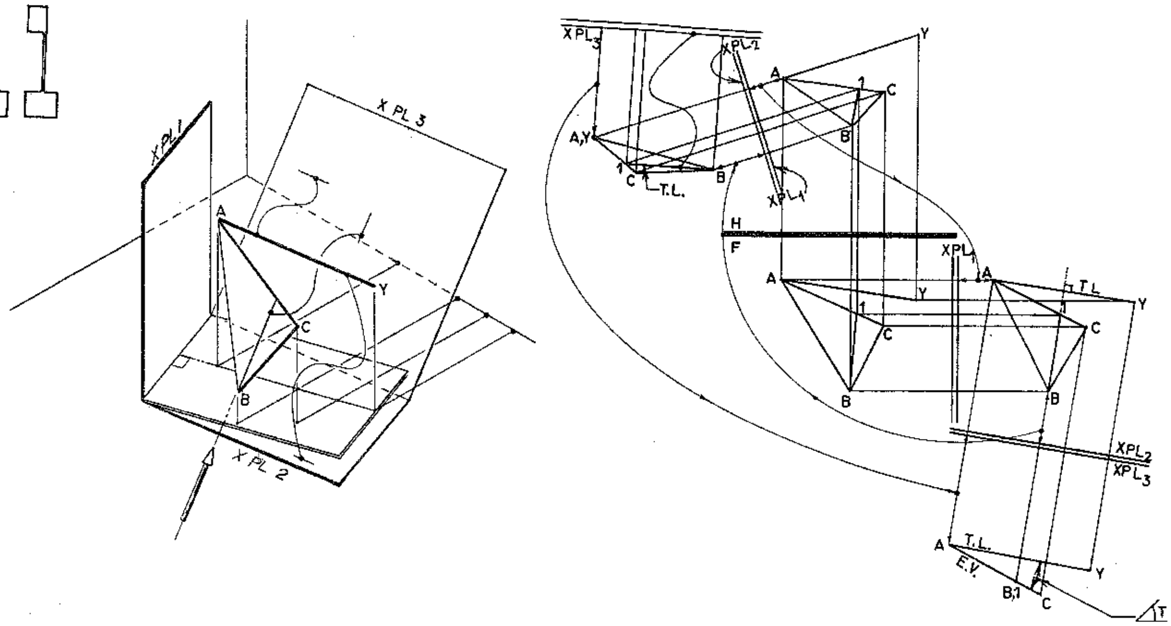
Figure 11 is a pictorial and an orthographic projection of the solution for the true angle between an oblique line A-Y and an oblique plane A-B-C, both in general positions. The first step is to project a non-orthodirectional view to the right of the front view and parallel with the horizontal plane until the line A-Y is projected true length. In this view, then draw ("paint" as I tell my classes) line 1-B on the plane such that it appears perpendicular to line A-Y. Since the line A-Y is true length in this view, this makes the "painted" line perpendicular to line A-Y in space. A view showing the end view of the "painted" line will then show the plane as an edge and line A-Y as true length, the solution view.

Figure 12 is a pictorial and an orthographic projection of the solution for the shortest frontal line connecting two skew lines in general positions. A plane, A-B-Y containing line A-B and which is also parallel to line C-D is constructed. Line A-Y is made to be a frontal line. It is known from spatial geometry that the solution line will always be perpendicular to line A-Y.


X PL3
D3
B,A
E.V.
D
Y O
X PL1
X PL2
D2
D1
A
H
F
B
C
X O
Z
T.S.
T.L.
R PL1
R PL2
E

10

11


X PL 1
X PL 3
X PL 2
XPL3
XPL2
XPL1
A,Y
T.L.
H
F
E.V.
B,1

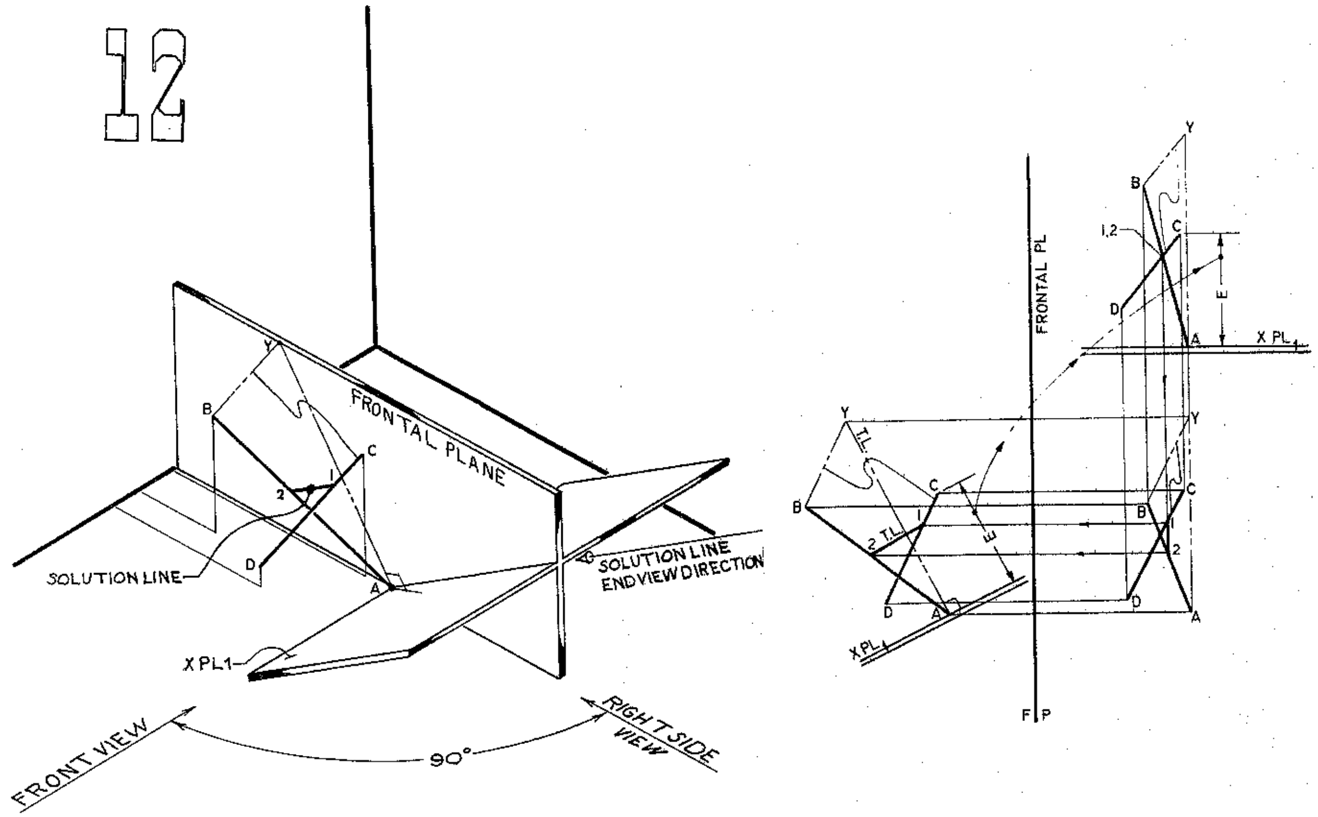


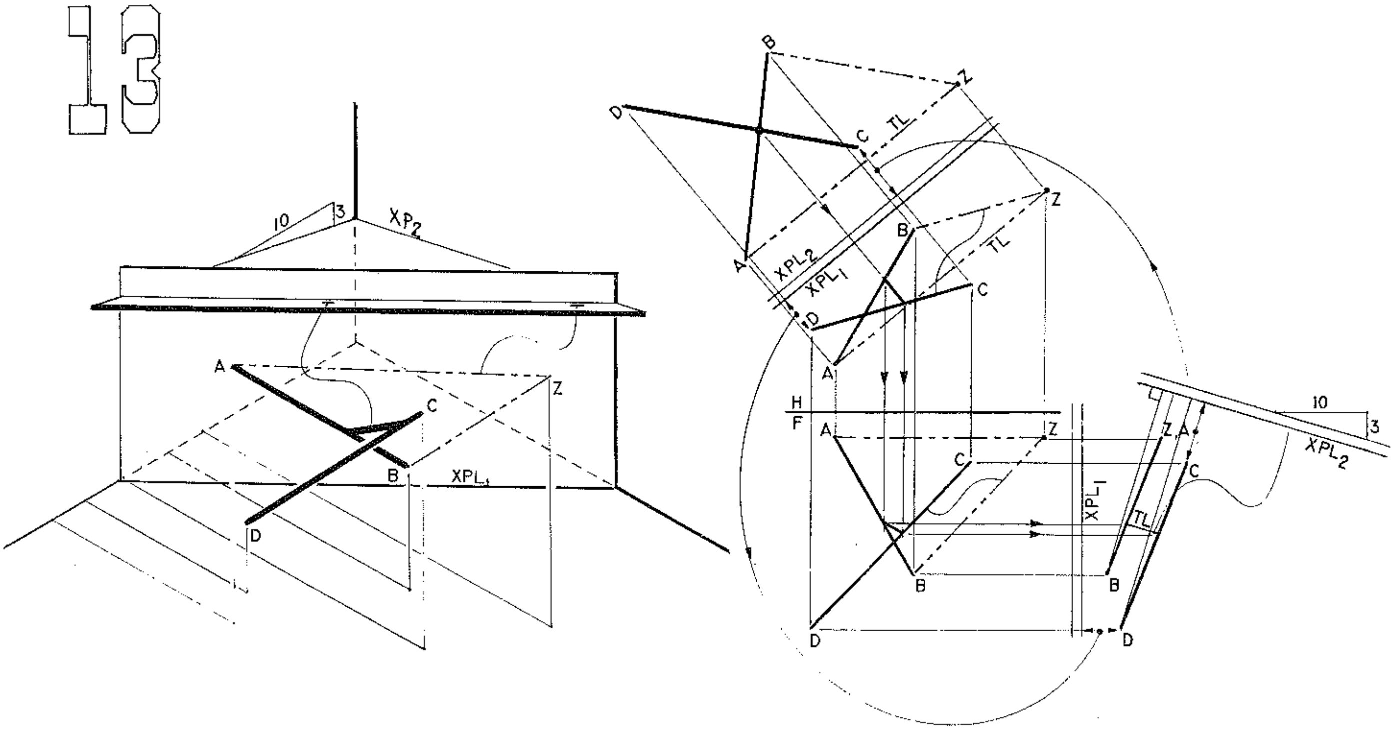
FIG 13

From the profile view a view is projected parallel to the frontal plane until the end view of the solution line 1-2 is achieved. In that view, line A-Y will appear true length and perpendicular to an X-PL_1 parallel to the solution line. X-PL_1 is therefore, constructed perpendicular to line A-Y in the front view and measurements perpendicular from this plane are transferred to the non-orthodirectional view to establish the location of all points in that view.

Figure 13 is a pictorial and an orthographic projection of the solution for the shortest line of 30% grade connecting two skew lines in general positions. A non-orthodirectional view is projected to the right of the front view such that the two given lines appear parallel. To achieve this, a plane A-B-Z containing line A-B and parallel to line C-D is constructed. Line A-Z is made a horizontal line. Since a view in the direction of the true length line A-Z will show the given lines to appear parallel, a vertical reference plane X-PL_1 is established parallel to line A-Z in the top view, and measurements from that plane to points in the top view are transferred to the non-orthodirectional view to the right of the front view. It si known that in this latter view, where the given lines appear parallel, the solution line will appear true length and will be seen to form a 30% grade with the horizontal plane. An X-PL_2 is then constructed with the specified grade of 30% in this view.

Next, a non-orthodirectional view is constructed in a direction perpendicular to the true length top view of line A-Z until the solution line appears as a point. This is achieved by transferring measurements from X-PL_2 in the view to the right of the front view to this new view. Once the end view of the solution is established, it is then projected back into the other views.

13



14

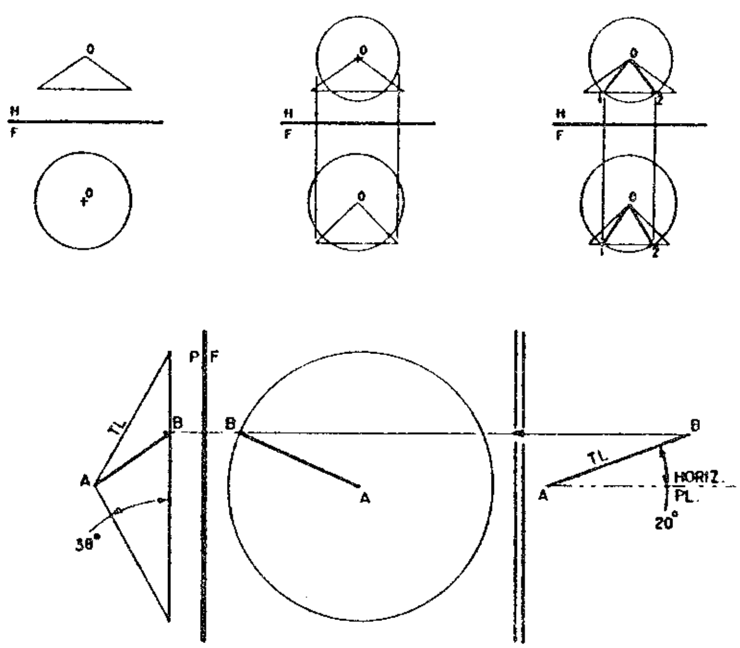


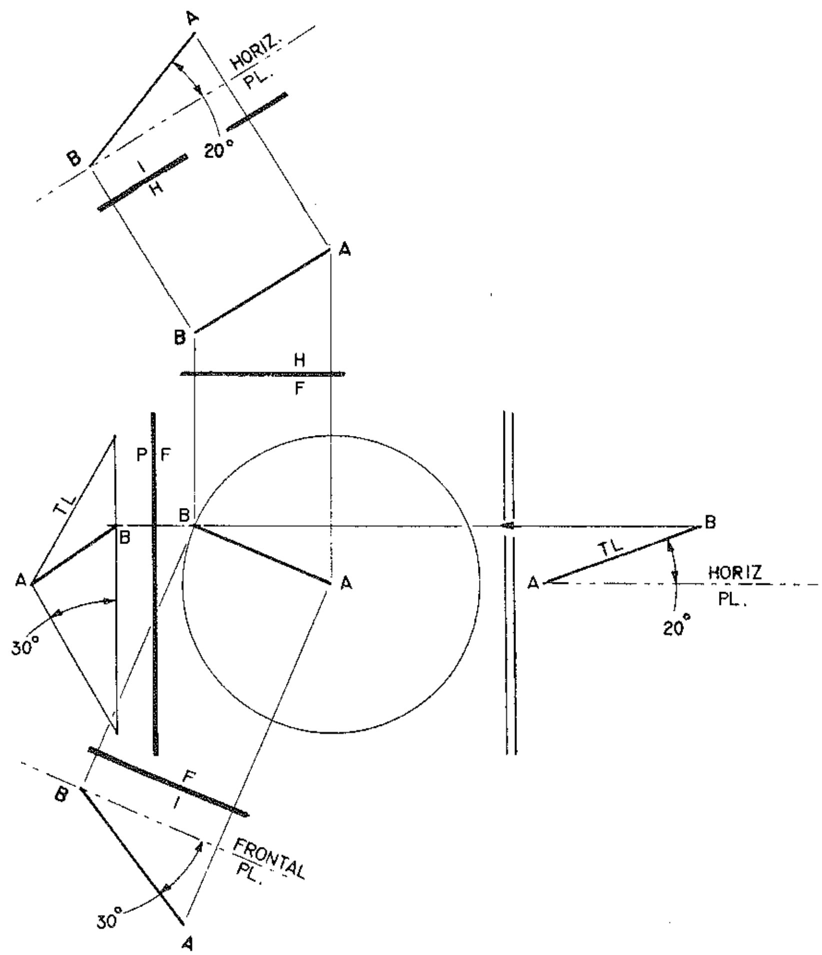
Figure 14 is two orthographic solutions for constructing a line which forms specified angles with the frontal and horizontal planes, The top illustration shows the steps as used in the classical orthodirectional solution using only the two principal views. The bottom illustration shows another solution to the same problem. As in the first solution, the first step is to construct the general solution cone for all lines containing point A and which form an angle of 30° with the frontal plane. Next a non-orthodirectional view is projected to the right of the front view and parallel with the horizontal plane and until line A-B is seen true length. In that view, the true angle with the horizontal plane will be seen and point B located. Point B is then projected back into the other views. Figure 15 is an orthodirectional verification of the non-orthodirectional solutions.

CONCLUSIONS

Perhaps an appropriate question to ask is, " What good is it all?" If it were standard to use only the non-orthodirectional projection and someone invented the orthodirectional projection with its more easily expressed rote type rules, then it must be concluded that a "breakthrough" had been accomplished. Since a non-orthodirectional projection offers no advantage over the orthodirectional projection the reverse cannot be claimed. However, it is suggested that the development of the non-orthodirectional method does render a service by giving more insightful appreciation for the mechanics of the orthodirectional method.

EDGJ

15



Roots
HISTORICAL BASIS OF GRAPHICS

HISTORY OF GRAPHICS

BY

Daniel L. Ryan
Engineering Graphics Program
Clemson University

ABSTRACT

The idea for this article came to this writer during a recent visit to the British Museum of Egyptology located in Cambridge, England. I was touring the Computer-Aided Design Centre in Cambridge and mentioned that a special interest of mine was the history of engineering graphics. My host at the CAD Centre suggested that I spen a day at the museum. Several days later, I was still fascinated by the amount of graphics contained in the displays, and at the same time, annoyed that I had not made this connection--between Egyptian antiquities and graphic history--during my first visit there in the summer of 1980.

Those Egyptian illustrations and descriptions which remain outline the history of engineering graphics and how it has influenced modern engineering practice. Graphics has been a part of man's history since the earliest recorded times. Early man painted on the walls of caves while modern man uses photographs, video tape, or electronic storage media. Both saw and recorded by whatever means were available to them. Humans have always created pictures of mental images or concepts. Because these mental images were soon forgotten, they were "written down." This writing process took the form of life size drawings at first, but because wall drawing took considerable time and skill to create, a smaller type of picture drawing became popular. This smaller form was developed by the Egyptians and others into a script-like form. In this form of picture drawing a combination of small pictures and symbols were used to describe such things as road and temple construction, and important events of the day.

THE HISTORY OF GRAPHICS

The history of engineering graphics extends from classical antiquity to modern times. The exact history of graphics is hard to trace as a continuous process. There are many exmples in archeological records but the actual graphics are simply not availabe for study. This is particularily true when we go back beyond the invention of paper. The road back is fairly smooth until paper or papyrus "disappears." Earlier than this time the documentation of graphics history depends on images carved on temple walls or pressed into clay tablets. And earlier that that, natural formations such as cave walls are all that are available for study.

If we limit our search to papyrus, the graphic images of Egypt follow those of Babylonia where the earliest records of technical graphics are found. Egyptian origins have been investigated with established success. English archeologists and French explorers such as Monge are given much of the credit for finding the keys that unlocked the mysteries of the graphics used by early Egyptians.

For the purposes of my investigation, I considered the classical antiquity of graphics to include three main periods: Early Egyptian, Greek, and Roman. A developmental procedure will be used for each time period.

THE EGYPTIAN PERIOD

The graphic system used in early Egypt was believed to have been invented by the god Toth, who instructed the Nile people in its use (Figure 1). It is found fully developed on the most ancient monuments and continued to be used until the Middle Ages (Figure 2).

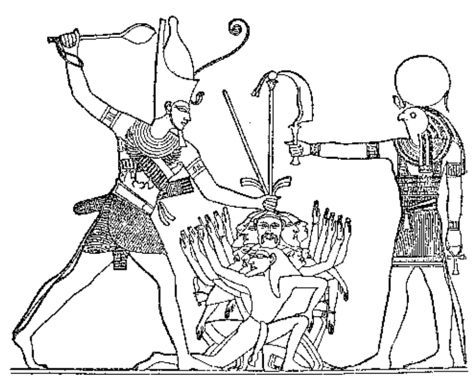


Figure 1 Toth hands the graphic system to the Pharoah who instructs the people in its use.

The individual symbols of Figure 3 illustrate a graphic system, one of several types of ancient hieroglyphics. This Egyptian form differed from Mexican, Babylonian, and Chinese picture writing in that it was never simplified and conventionalized into modern script. It was remarkable because it retained the most primitive form of picture writing. The Egyptians used phonetic signs, ideograms and determinatives. For example, verbs of motion were determined by a pair of legs. The prevailing orthography required that each word be written by means of its ideogram. As in all ancient forms of graphics except the Assyro-Babylonian cuneiform, only consonants were used. The vowels were left to the reader. Then, at a very early period, another form of graphics called "hieratic" came into use for graphics on papyrus.

Most of the techniques used in modern computer graphics havetheir roots in ancient graphic methods

It is interesting to note that 5000 years later a form of computer-aided graphics called PLATO uses similar picture representations. Picture formations similar to those invented by the Egyptians are used today to help elementary school children learn how to read.

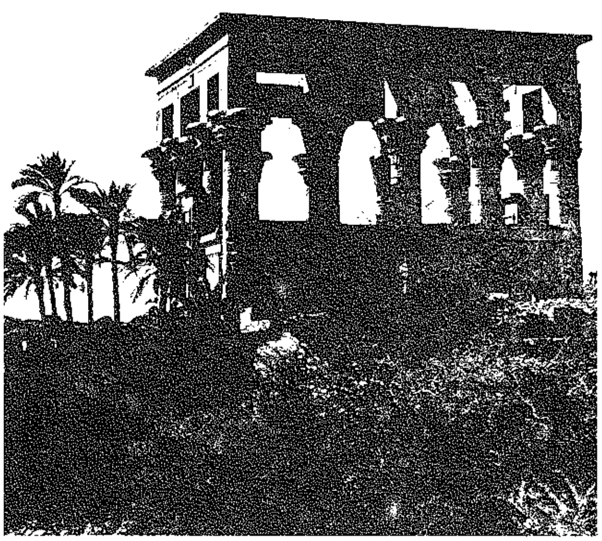


Figure 2 Temple at Philae.

THE GREEK PERIOD

It was in Greece that ancient graphics reached its highest state of historical development. The fragments from Tiryns and Cnossus in Crete show that the Mycenaean Age introduced much of the graphics developed by the Egyptians (Figure 4).

In later periods color was introduced in graphic imagery. Examples of the use of color can be found on vases and in the remains of buildings and monuments. The introduction of color placed graphics, along with sculpture and architecture, among the important contributions to Greek civilization. There are accounts of Corinthian and Sicyonian graphic artists who drew outlines and indicated details by the use of several smaller lines.

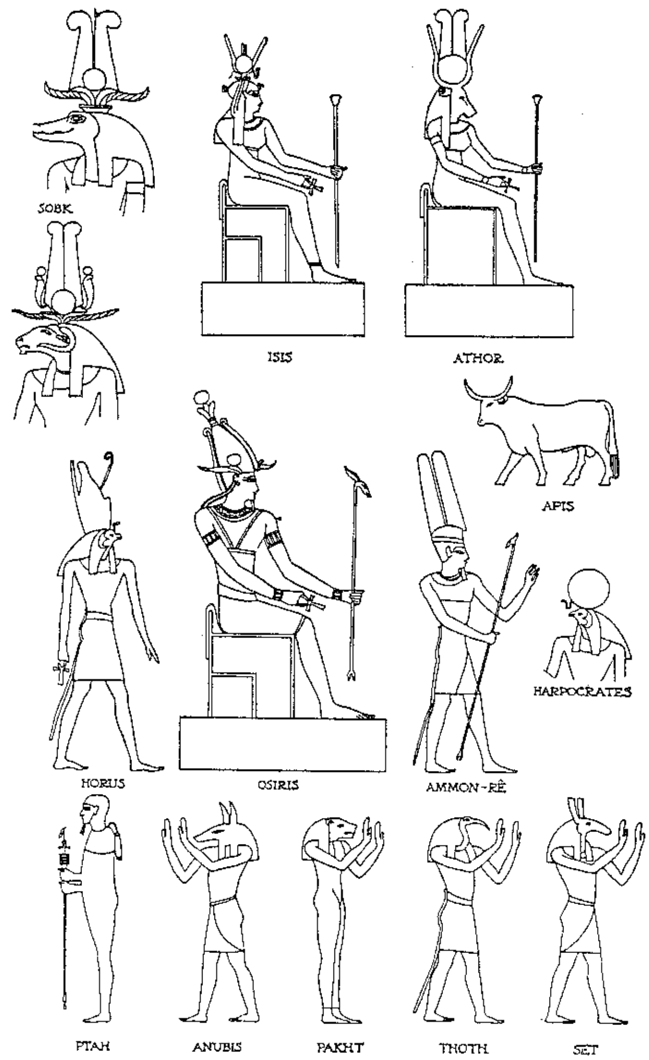


Figure 3 Individual graphic symbols.

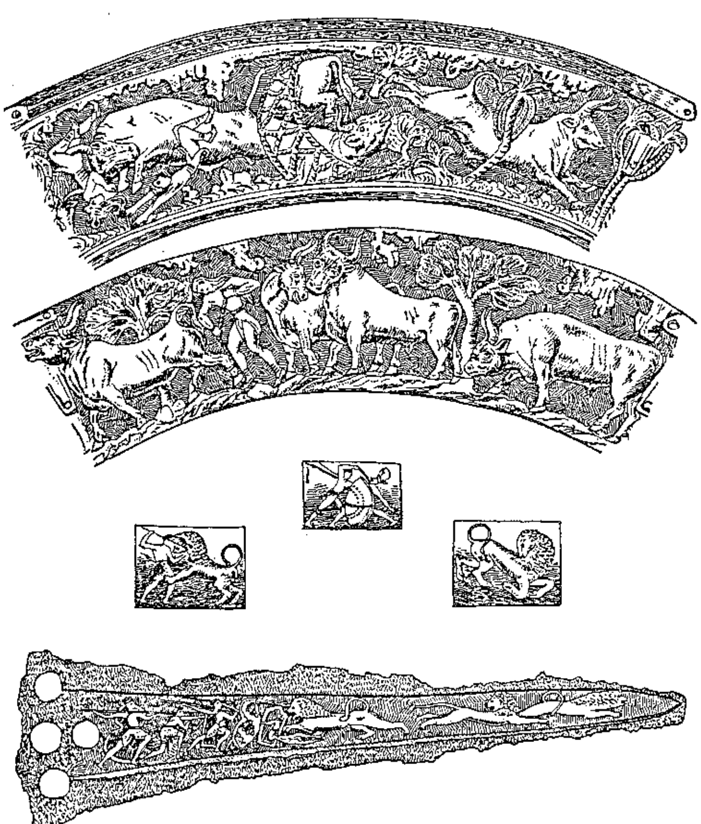


Figure 4 Early Greek graphics.

Cimon of Cleonae introduced correct drawing in profile with the concept of perspective and view points. This advance in graphics is connected directly with Polygnotus of Thasos, whose public works included the portico at Athens and Lesche at Delphi. The most important advance was based on Cimon's theory and Agatharchus's application of perspective and shading. Agatharchus wrote a book on this application, which lead Anaxagoras and Democritus to develop and state the laws of perspective drawing.

Therefore, within a hundred years the Greeks discovered and perfected a new graphic technique which was beyond all that the Egyptians had achieved in 3000 years. We use today many of the techniques discovered by the Greeks. The use of the ICON technique (a symbol used to represent a command on a computer menu) can be traced to Polygnotus. Most of the techniques used in modern computer graphics have their roots in ancient graphical methods.

The next Greeks to advance the use of graphics were those from the Hellenistic age. The conquests of Alexander had opened the rest of the world to Greek rule, thought, life and graphic skills. At the same time it ended the old city-state ideas of Athens. This change in the center of focus for graphics was one of export and import, the export of Greek ideas and the import of Asian graphic techniques. The

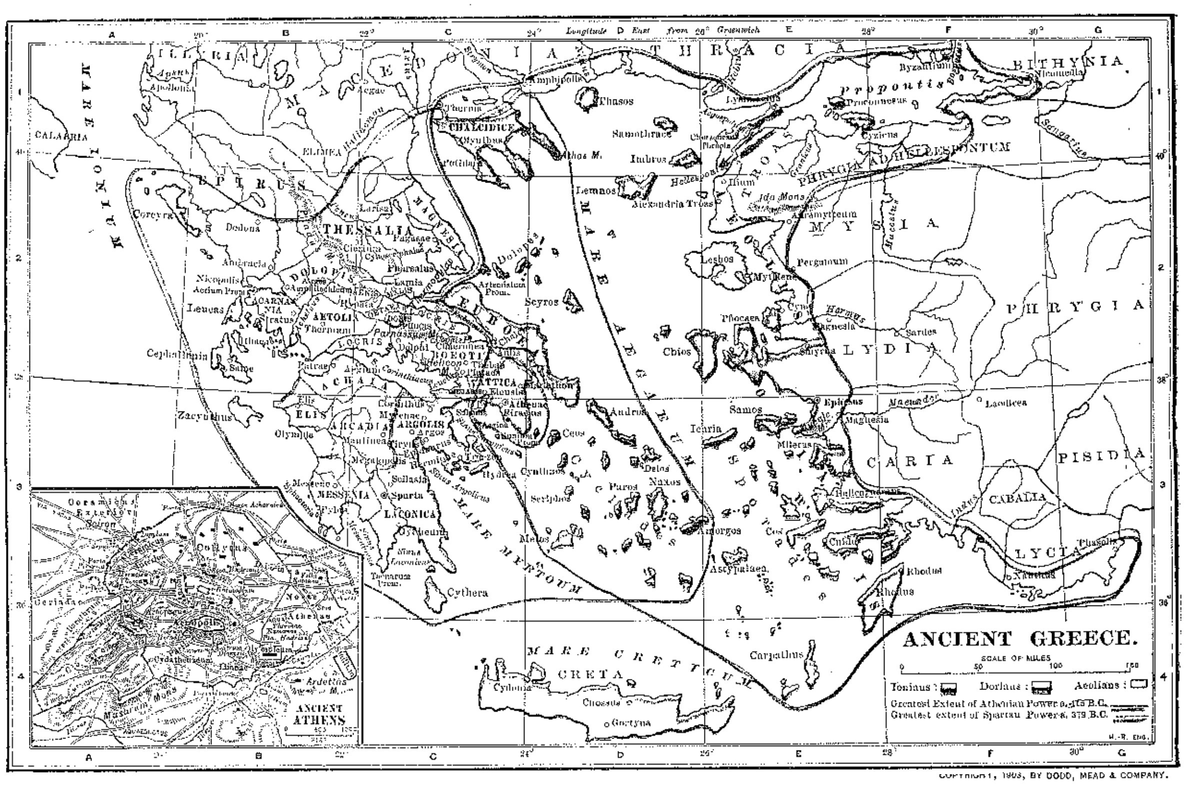


Figure 5 Influence of Greek graphics at the time of Alexander.

earlier Greek graphic artists depicted the needs of the city-state, while these later Greeks were filled with the wonders of Alexander's conqueats (Figure 5). The use of graphics here was for recording those conquests and for the construction of many public monuments. In addition, the Hellenistic Age showed two tendencies for graphics. One was for the rendering of scenes and the other was for portraiture. Both attained excellence during this period. The walls of Pompeii furnish examples of this technique, and of special value are the portraits discovered in Falum, Egypt, where this portrait skill was exported to cover the faces of mummies.

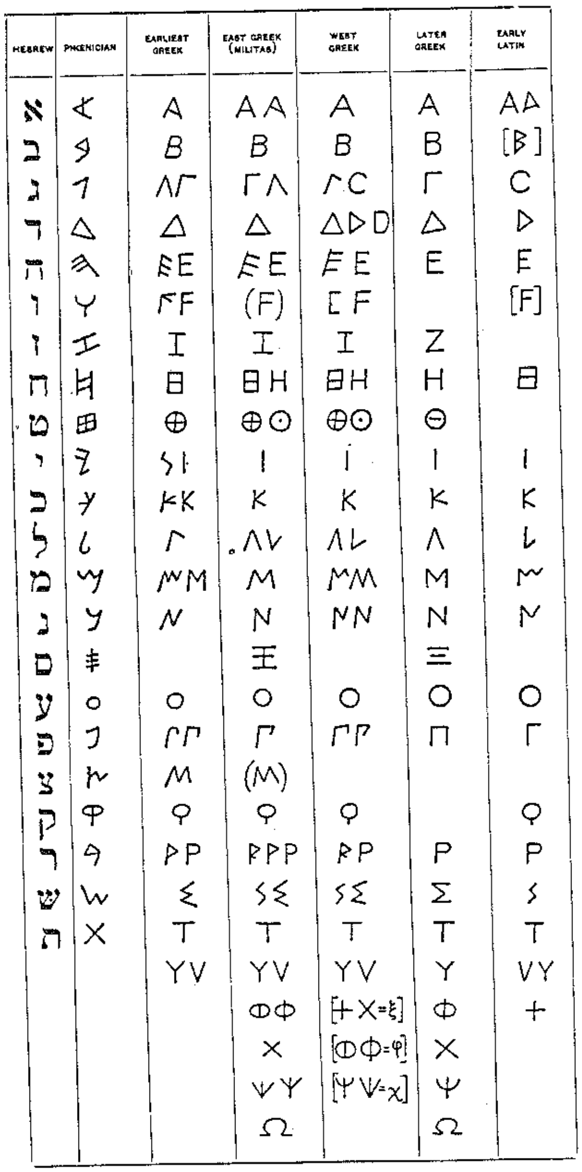


Figure 6 Example of Roman assimilation of graphic skills.

The Roman period of Greek graphics is perhaps the most useful in term of historical study. Greek graphics, in part, is still available because of a wholesale plundering of the Greek Empire by the Romal legions. Afterward, graphic plans were used to construct Roman temples, palaces and villas. This, coupled with the Roman passion for record keeping, made it an age of copies. Much of the graphic examples from Greece were produced during this period. The Greeks were also the first civilization to write and produce books in great numbers. Because of this, many manuscripts have been discovered which include the signatures of graphic artists and the records of how the graphic techniques were mastered. While such recorded evidence has been found, it is difficult to determine the number of persons at that time who were skilled in graphics. Perhaps fewer than five percent of the population could produce technical graphics.

One reason for this was the attitude of the Greeks themselves toward graphic artists during that period. In general, while the graphic productions were highly valued, the person who produced them was of little interest. This was due to the low esteem in which the artisan was held: he was not a soldier or an athlete. Because of this, graphic skills nearly died out during the Dark Ages.

THE ROMAN PERIOD

Although modern historians have found little proof that the Romans advanced the use of graphics, they did develop a distinctly nationalistic style during their late Republic and Empire. Largely under the hands of prisoners captured from the campaigns against Greek cities, the Roman graphic style began. From the Hellenistic Greek period the Romans copied the best features, inventing modifications that have been used through this day (Figure 6). The Roman period of graphic history lasted until the time of Augustus where the century and a half that followed was known as "the golden age of graphics." The decline of graphics begane before the time of Septimus and was complete in the time of Constantine save what was needed for practical construction.

EDGJ

Daniel L. Ryan has written a complete history of graphic communication in his latest book entitled "Modern Graphic Communication," available from Prentice-Hall Inc., Englewood Cliffs, NJ 07632.

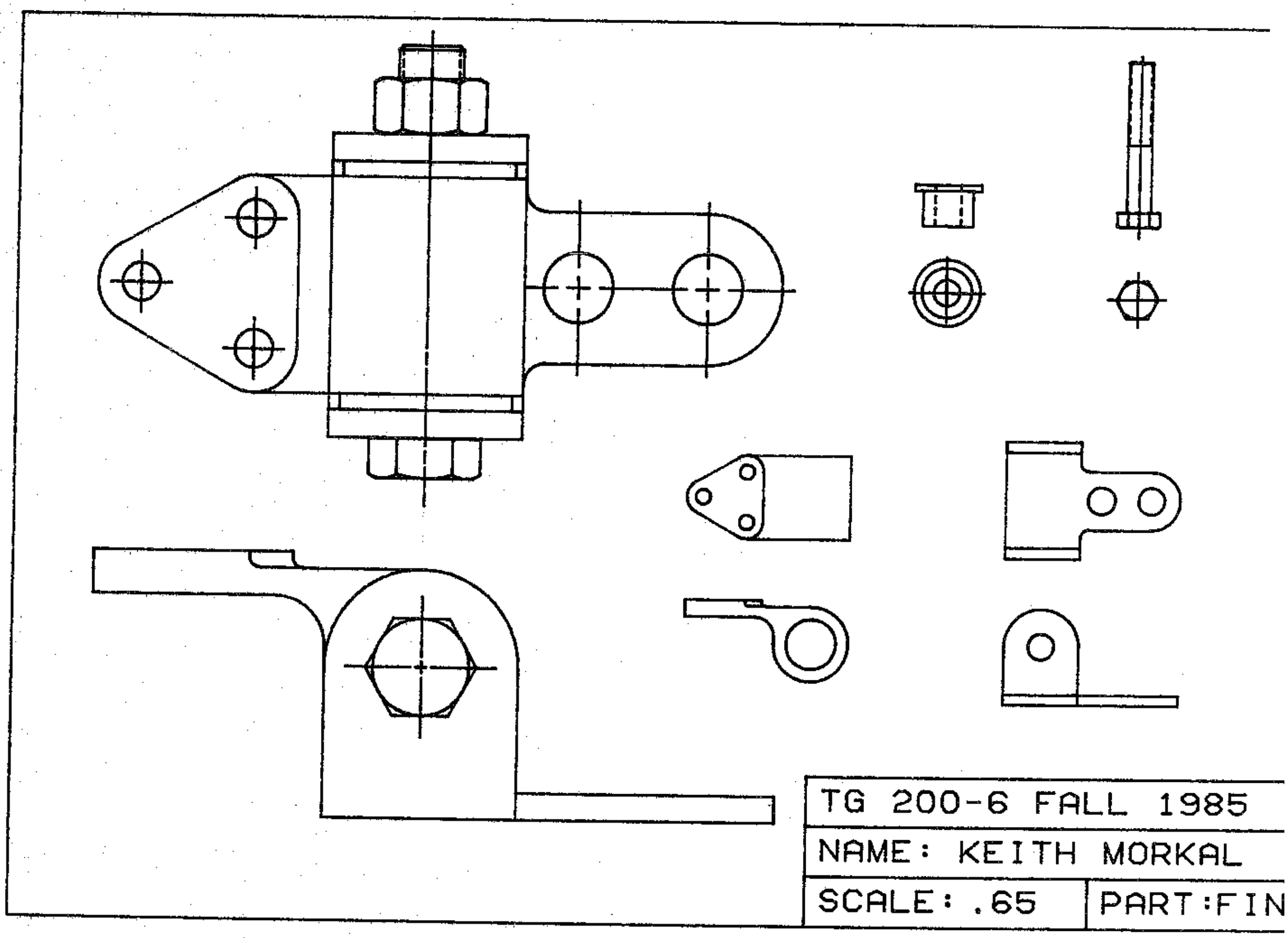
Buddy continued from p. 49

SUMMARY

After the pilot course, the hardware for the introductory course was changed to Apple IIE's. This was due to advance courses being added to the curriculum and increasing the utilization of the larger system. Even though the number of work stations increased slightly, the "buddy" system has remained intact. The only format change has been the addition of one full day of open lab for students who need additional time to complete assignments.

In retrospect, the experience was positive for the department, the participating faculty and the students. The "buddy" strategy met both administrative and course goals. In addition, the participating faculty agreed that all reservations were eliminated after the pilot semester. Likewise, students worked well together and benefited from peer assistance.

EDGJ



MICHIGAN TECHNOLOGICAL UNIVERSITY

Houghton, Michigan 49931

The Department of Mechanical Engineering- Engineering Mechanics has tenure-track positions in the following areas:

Energy Thermo-Fluids	background in thermodynamics, fluid mechanics, heat transfer, and combustion
Mechanical Design	background in CAD/CAM, computer graphics, kinematics, mechanisms
Dynamic Systems	background in experimental methods, data analysis, noise and vibrations, controls
Solid Mechanics	background in composits, non-linear material, non-destructive evaluation
Industrial Engineering	background in robotics, operations research, facilities planning

Responsibilities include undergraduate and graduate instruction and development of funded research. Preference given to U.S. citizens and permanent residents.

Send resume and names of three references to

Dr. Harold W. Lord, Chairman ME-EM Department
Michigan Technological University
Houghton, MI 49931

MTU is an Affirmative Action/ Equal Opportunity Employer

Circulation Manager
The Engineering Design Graphics Journal
Department of Engineering Graphics
The Ohio State University
2070 Neil Avenue Columbus, OH 43210

NON PROFIT ORGANIZATION
U.S. POSTAGE PAID
BULK RATE PERMIT NO. 477
DUBUQUE, IOWA