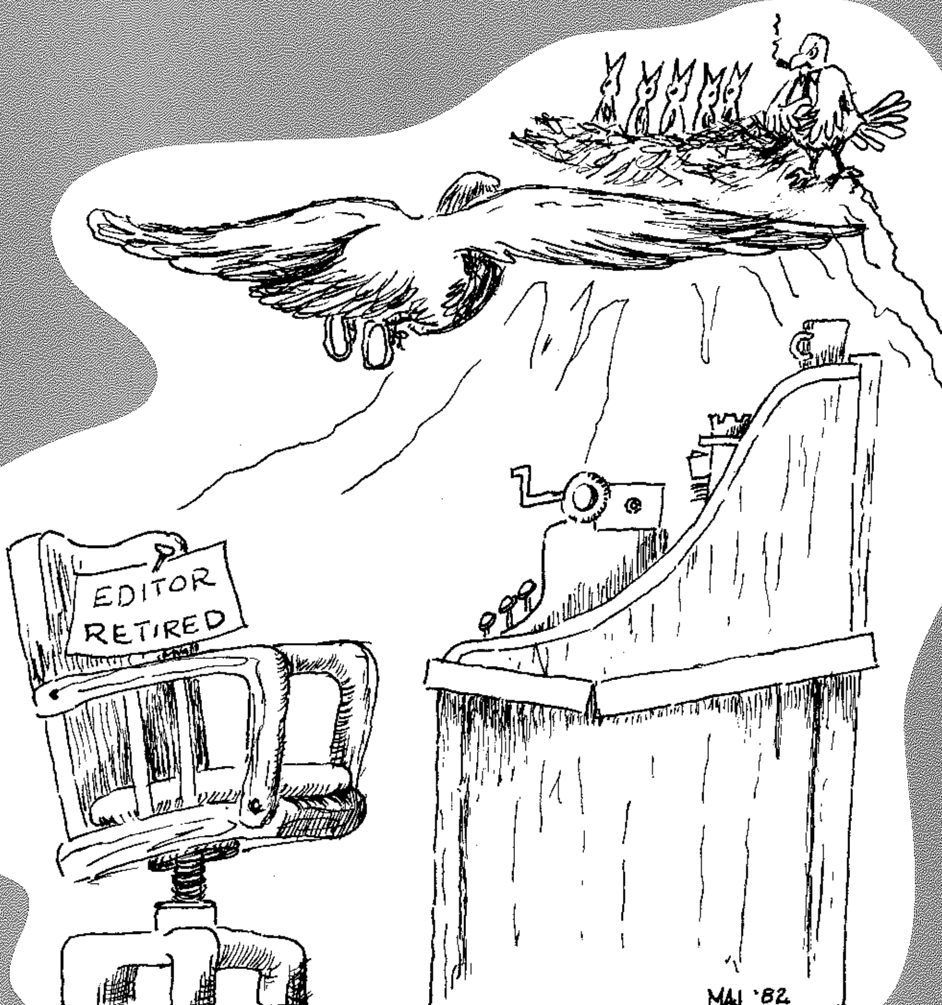
METRIC

ENGINEERING DESIGN GRAPHICS JOURNAL

SPRING 1982 VOLUME 46 NUMBER 2



IN THIS ISSUE

- Midyear Preview
- Annual Meeting Overview
- Slaby Goes to China

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

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ENGINEERING DESIGN GRAPHICS JOURNAL OBJECTIVES:

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

DEADLINES FOR AUTHORS AND ADVERTISERS

The following deadlines for the submission of articles, announcements, or advertising for the three issues of the JOURNAL are:

Fall	September 15
Winter	December 1
Spring	February 15

STYLE GUIDE FOR JOURNAL AUTHORS

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

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

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

3. Two copies of each manuscript are required.

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

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

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

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

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

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

9. Send all material, in one mailing to:

Mary A. Jasper, Editor
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REVIEW OF ARTICLES

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

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

CALENDAR

ASEE ANNUAL CONFERENCES

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

1983 - Rochester Institute of Technology
Rochester, New York

EDGD MIDYEAR CONFERENCES

1982 - California Polytechnic Univ.
Pomona, CA

ENGINEERING DESIGN GRAPHICS JOURNAL

THE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

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Other Features

ANNUAL MEETING

TEXAS A&M UNIVERSITY

College Station, Texas

June 20—24, 1982

"PRODUCTIVITY THROUGH ENGINEERING"

90th Annual Conference of the American Society for Engineering Education

MONDAY, JUNE 21, 1982

1137 **Judging Criteria for Creative Design Display**
7:30-9:45 a.m. MSC 228 Breakfast/Discussion, $6.00

* 1221 **Computer Graphics and Simulation–Novel Approaches**
8:00-9:45 a.m. RT Forum Symposium

1235 **Creative Design Display**
8:00 a.m.-5:00 p.m. RT 2nd Fl. Balc. Display
Engineering Design Graphics Division
Moderator: Robert J. Foster, Pennsylvania State University
Display and judging of student design projects. See Special Events section of this program for further details.

1636 **Implementation of Computer Graphics and CAD Early in Undergraduate Curricula**
3:45-5:30 p.m. RT 308 Symposium
Engineering Design Graphics Division
Co-sponsors: Agricultural Engineering, Computers in Education, Engineering Technology Divisions
Moderator: Ronald E. Barr, University of Texas-Austin
Computer graphics and computer-aided design (CAD) are key tools for increased industrial productivity. This session will present ways in which engineering educators are incorporating computer graphics and CAD into the curriculum as early as the freshman year.

1736 **Engineering Design Graphics Executive Committee Dinner**
6:30-11:00 p.m. MSC 225 Dinner/Business Meeting $13.00

TUESDAY, JUNE 22, 1982

* 2226 **The Computer from Creativity to Design to Product**
8:00-9:45 a.m. RT 502 Panel

2236 **Innovative Teaching Techniques in Graphics and Design**
8:00-9:45 a.m. RT 501 Symposium
Engineering Design Graphics Division
Co-sponsor: Agricultural Engineering Division
Moderator: George Dysinger, Texas A&M University

* 2531 **Educational Research at Texas A&M University**
1:45-3:30 p.m. RT 404 Symposium

* 2549 **Freshman Programs**
1:45-3:30 p.m. ROTC 214 Symposinm

2637 **Minority Engineering Effort: Update**
3:45-5:30 p.m. RT 501 Symposium
Engineering Design Graphics Division
Co-sponsors: Freshman Programs and Women in Engineering Committees
Moderator: Marion Blalock, Purdue University
This panel will address the current status of the minority engineering effort, an historical perspective, current status and what is envisioned in the next decade. The panel will include a student's perspective, a pre-college administrator's perspective, a college level administrator's perspective, a graduate's and industry's perspective, and a national perspective.

2736 **Engineering Design Graphics Division Awards Banquet**
6:00-9:30 p.m. Ramada Inn -B Dinner, $14.00
Engineering Design Graphics Division
Moderator: Jack C. Brown, University of Alabama
Social hour precedes awards presentation and dinner banquet. Open to all members of the Engineering Design Graphics Division.

WEDNESDAY, JUNE 23, 1982

3236 **Graduate Education in Human Factors Engineering**
8:00-9:45 a.m. COLS Symposinm
Engineering Design Graphics Division
Co-sponsors: Design in Engineering Education and Liberal Studies Divisions
Moderator: Francis Jankowski, Wright State University
A presentation of papers on the interaction of human factors with current design problems in industry and focus on the needs for human factors education in engineering.

3436 **Engineering Design Graphics Division Luncheon**
12:00-1:30 p.m. MSC 226 Lnncheon/Business Meeting, $7.25
Engineering Design Graphics Division
Moderator: Jack C. Brown, University of Alabama
Open luncheon and business meeting for all EDGD members.

* NOTE: The Asterisk (*) is used here to denote events which the EDGD is co-sponsoring.

AN EXTENSION OF THE EXPERIMENTS OF KUNIO KONDO AND TARO TAJIMA WITH STEREO VISION WITHOUT OPTICAL AID

DAVID W. BRISSON
BOX 85
REHOBOTH, MA 02769

ABSTRACT

The following paper is an extension of the stereo principles used by Kondo and Tajima in their article in the Journal of Graphic Science of Japan, No. 28, p. 1. These basic ideas are well-known in their simple form as stereograms, and have been adapted as hyperstereograms by Brisson for the American Association for the Advancement of Science Annual Conference in Washington, D.C. in 1978. However, the work of Kondo and Tajima is interesting and well conceived. A particularly interesting aspect of their work concerns the arrays of stereographic elements that they have generated. They have produced the basis of stereo effects from single image construction. This paper is a discussion of some of the possibilites of that aspect.

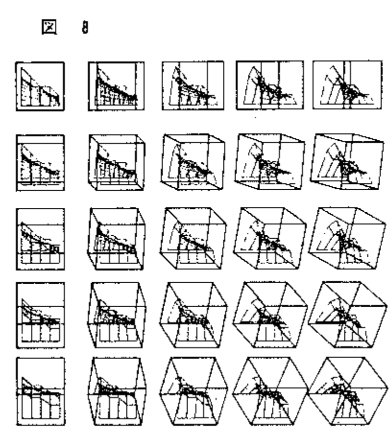

Figure 1

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METHOD

Figure 1 is figure 8 from Kondo and Tajima's article: "Experiment of Stereo Vision Without Optical Aid" from the Journal of Graphic Science of Japan No. 28, p. 1. Figure 2 is an ordinary stereogram of a cube, from an article by Brisson in the Proceedings of the International Conference

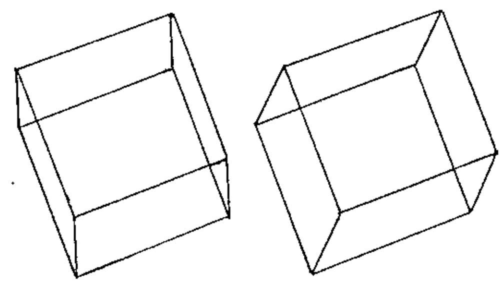

Figure 2

on Descriptive Geometry, Vancouver, 1978. Figure 3 is a drawing by Brisson, demonstrating how to view a stereogram. The method is basically to cross one's eyes in front of the stereogram such that the left image of the cube as projected upon the right eye is superimposed upon the right image of the cube as projected upon the left eye, with the result being the subjective "fusion" of the two images into a little three-dimensional cube floating in front of the paper, between the viewer and the paper. Kondo and Tajima give very fine examples of such stereo images.

Now, one evening several years ago, while on a trip, trying to get to sleep in a strange room in New Brunswick, Canada, I was surprised to observe that the wallpaper appeared to be three-dimensional. I started up out of a semidream-state a little alarmed, and looking carefully at the wall paper, it seemed perfectly ordinary, consisting of a rather ordinary pattern of rosebuds in a geometric array. I started to doze off again and again was alarmed to see the wallpaper become three-dimensional. This t time I considered it more carefully. Apparantly, since each rosebud was identical with every

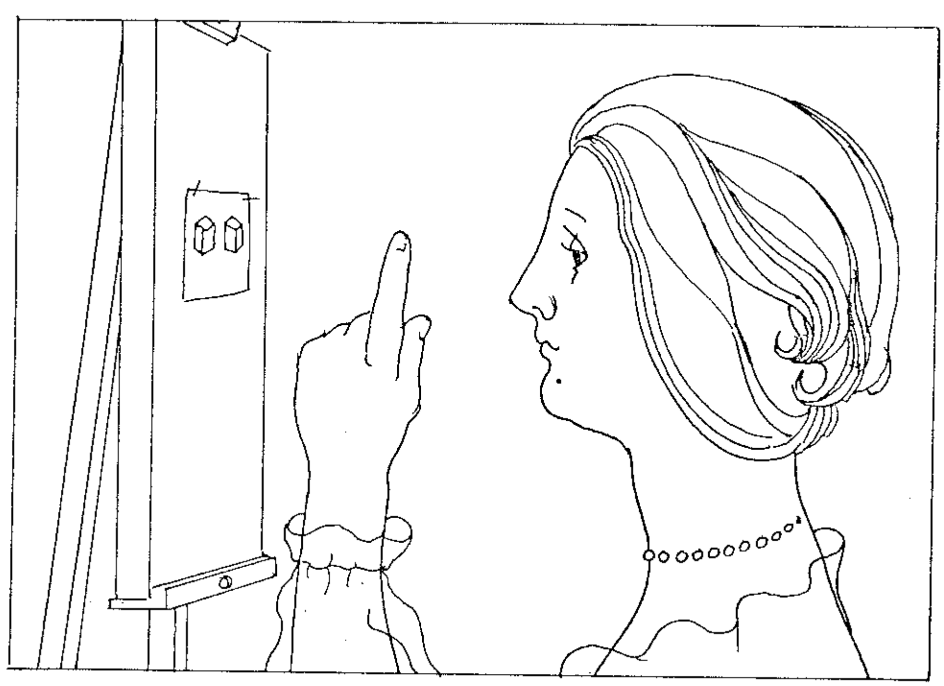

Figure 3

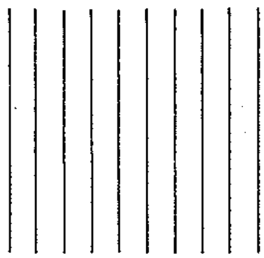

Figure 4

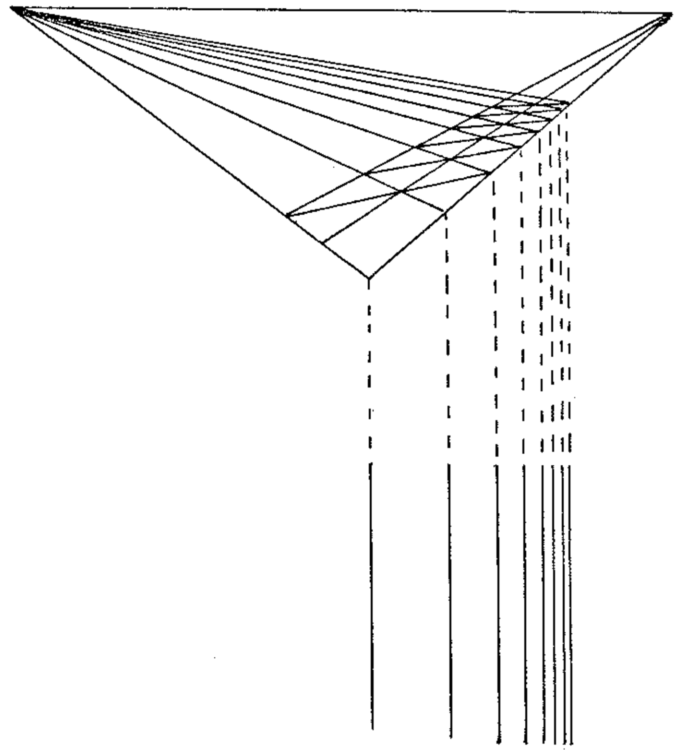

Figure 5

other rosebud, and they were ordered in such a simple array, it was possible to cross my eyes and line up the rosebuds several inches in front of the wall surface. Trying this now on purpose, it was quite easy to do, and sure enough, the array of rosebuds could be made to float in a plane several inches in front of the wall surface. I was then able to settle down to sleep.

Figure 1, of Kondo and Tajima, brought back that experience to mind and it occurred to me to try the same thing with their array. Sure enough, by crossing one's eyes while looking at their single image it is possible to construct in one's mind a whole array of completely three-dimensional little boxes, similar to the rosebuds, but this time a little three-dimensional form as each element.

In relation to this, I had noticed while lying on my couch in my living room at home, that the squares in my paneled ceilings could be m de to appeaar at different leavels made to appear at different levels above me by crossing my eyes, again similar to the rosebuds, thus the reader may be able to see the set of lines in Figure 4 at different levels. The single dot may assist at this. By making the dot "double" optically one can control the distance of the set of lines above the paper.

Now, the most interesting aspect of this is the possibility of constructing fully stereo images with a single image. Certainly Kondo and Tajima's array is one form of this. However, I suggest a more basic structure. Figure 5 shows an array of lines that change their distance from each other by perspective projective methods, as shown in the figure. Now, by viewing these lines as we have viewed the other arrays there are a number of possible fully three-dimensional interpretations. In fact, the first experience is one of confusion. After a little practice, it will be seen that it is possible to view this array in such a way that it appears to be a set of lines in a flat plane that intersects the paper and extends as an angle outward!

It is clear that Kondo and Tajima, by showing their whole array, have opened up the possibility of the single, fully stereo image.

BRIDGING THE GAP --

A SURVEY OF RECENT ENGINEERING GRADUATES FROM TWO UNIVERSITIES

DR. WALTER I. DAVIS
P. O. BOX EG
MISS. STATE, MISS. 39762
(601) 325-3922

The undocumented statement, that universities are five to ten years behind is frequently expressed by industry and others. Regardless of the reliability of this statement, studies that tend to bridge the gap between the universities and the industrial world could contribute to a better relationship between the two. The major purpose of this study was to determine whether or not the engineering student is receiving the engineering background for the field in which he or she will be professionally engaged. The study drew its population from two universities, Auburn University and Mississippi State University, limited to engineers graduating over a five year period from May 1976 to May 1981 in the following curriculum: Mechanical, Industrial, Electrical and Civil Engineering and also Construction Engineering Technology.

In our good state of Mississippi, the question is constantly being asked by the tax paying public as to whether or not they are getting their money's worth out of higher education. The paramount need of the study was to determine if the graphics courses should be altered or remain basically the same. An unending effort to keep the courses relevant to the professional field should exist, and this is difficult without follow-up reports from students that have graduated.

A study of this type must have a population sample and this was fulfilled by drawing randomly 50 names of alumni from Auburn University and 50 from Mississippi State who had graduated from their respective colleges of Engineering during the period May 1976 through May 1981. Since there was such a large population of graduating engineers in this time frame, the study was further limited to the fields of Mechanical, Industrial, Electrical, Civil Engineering and Construction Engineering Technology.

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DESCRIPTIVE CHARACTERISTICS
OF THE RESPONDING
ENGINEERS

Characteristics	Responses of Both Groups	%
1. Year graduated		
1976	8	12.3
1977	10	15.3
1978	9	13.8
1979	14	21.7
1980	13	20.0
1981	11	16.9
TOTAL	65	100.0
2. Field of engineering		
CE	24	36.9
ME	19	29.2
IE	13	20.0
CET	4	06.3
EE	5	07.6
TOTAL	65	100.0
3. Where are you presently employed?		
Industry	50	76.9
Education	1	01.5
Research	1	01.5
Government	9	14.1
Self-employed	2	03.0
Other	2	03.0
TOTAL	65	100.0
4. Are you a licensed professional engineer?		
Yes	6	09.2
No	59	90.8
TOTAL	65	100.0

Characteristics	Responses of Both Groups	%
5. Were any of your graphic courses completed at a junior college?		
Yes	14	21.5
No	51	78.5
TOTAL	65	100.0
6. How many of your graphic courses were completed at Miss. State and Auburn?		
1	20	39.3
2	28	54.9
3	2	03.9
4	1	01.9
TOTAL	51	100.0
7. Has your drafting knowledge been of benefit to your engineering career?		
Yes	56	86.1
No	9	13.9
TOTAL	65	100.0
8. Have you as an engineer, been required to perform drafting assignments by your employer?		
Yes	38	58.4
No	27	41.6
TOTAL	65	100.0

RESPONDENTS' MEAN RATING OF THE OPINIONS
REQUESTED IN SECTION II
OF THE OPINIONNAIRE

The engineering graphic courses would have benefited me more in my field of engineering by;	Mean Of Miss. State Respondent	Mean Of Auburn Respondent	Mean Of Total Group
Additional working drawings related to my proposed engineering field	3.26471	3.77333	3.48437
More computer graphics	3.05882	3.30000	3.17187
Exposure to the reproduction process of graphic representation	3.08824	3.06667	3.07812
Field trips to observe real drafting room situations	2.88235	3.00000	2.93750
More drawing and less lecture	2.82353	3.03333	2.92187
More engineering graphics in general	2.94118	2.86667	2.90625
Adding charts, graphs and diagrams to the instructional content.	3.00000	2.80000	2.90625
Assigning more technical sketches	2.82353	2.83333	2.821812
Using more visual aids such as movies and slides	2.64706	2.73333	2.68750
Spending more time in geometric construction	2.58824	2.63333	2.60937
More emphasis on orthographic projection	2.67647	2.50000	2.59375
Teaching more descriptive geometry	2.67647	2.40000	2.54687
Lettering practice with the use of a Leroy lettering device	2.29412	2.73333	2.50000
Exposure to inking on polyester film (mylar)	2.50000	2.46667	2.48437
More involvement in graphical vectors	2.52941	2.40000	2.46875
Less emphasis on line technique	2.52941	2.36667	2.45312
Including more lettering assignments	2.44118	2.06667	2.26563
More emphasis on axonometric projections	2.20588	2.26667	2.23437
Assigning additional drawings to be done out of the class room	2.29412	2.20000	2.25000
Assignments to be drawn in ink with a technical fountain pen	2.05882	2.23333	2.14062
Less engineering graphics in general	1.97059	1.90000	1.93750
More lecture and less drawing	2.00000	1.86667	1.93750

Because of the wide range locations where the participants were employed and the need to develop a questionnaire that would gather the necessary information while requiring a minimum amount of respondent time, a closed form questionnaire was developed. In order to obtain the necessary data to determine the objectives of the study, examples of the available instruments were studied and ideas and items from them were adapted to this study. After revisions were made, a copy of the questionnaire was submitted to members of the Engineering Graphics staff and the department head for approval.

The questionnaire that was sent consisted of two sections. Section I of the instrument was designed to collect biographical data from each respondent such as year graduated, field of engineering, type of employment, and etc.

Section II asked them to respond to the questions with their opinions. This section of the instrument was a 4 point agreement and disagreement scale with no undecided response listed.

This data collection consisted of two mail-outs, one on February 5, 1982 and the second on February 24, 1982 with the cut-off day being March 19, 1982. These two mail-outs yielded a total return of 65 usable questionnaire, (65%), 31 from Auburn graduates and 34 from Mississippi State graduates.

Section I of the questionnaire brought forth some information that the researcher feels is important to mention, such as: (a) 50 of 65 (75.3%) of the participants are employed in industry, (b) even though many two year community colleges offer graphic courses, only 14 of the 65 participants (24.6%) completed Engineering Graphics courses at a community college level, (c) the need of drafting knowledge for the engineer received an answer of yes from 56 of the 65 participants (86.1%), (d) it would also seem relevant to point out that 38 of 65 participants (58.4%) have been required to perform drafting assignments since engineering employment.

Section II of the questionnaire included 22 opinions or suggestions that could be of benefit to the Engineering Graphics curriculum committees. The three suggestions that had a mean value of 3.0 or above were in the following order:

(a) additional working drawing related to my proposed engineering field

(b) more computer graphics

(c) exposure to the reproduction process of graphic representation

The three lowest ranked suggestions were:

(a) more lecture and less drawing

(b) less Engineering Graphics in general

(c) assignments to be drawn in ink with a technical fountain pen

The very last line of the questionnaire stated that "we would appreciate any comments you would like to make that are not covered by these questions". As always, we received some comments that tickled our ears while others were very constructive and some a little more critical. Listed below are some of the comments;

"Computer Graphics is where it is"

"Need more exposure to plant layout"

"I believe that a good course in practical reading of engineering drawings should be included in <u>any</u> engineering curriculum"

"The use of drafting techniques is not directly related to my job function but would greatly increase my ability to communicate with other engineering fields"

"The course which I took was a good, well rounded course. The best way to improve the course would be to add a follow-up course."

"Give more representation of standard symbols used in industry related drawings"

"Although my current job does not require drafting, my co-op job did. I found the drafting course I took at the university useless. The course should have concentrated on types of drawings useful to a young engineer, in structural, piping, electrical, construction for contractors. This would have better prepared me for the design job"

"I feel that more technical problems and solutions to these problems would help"

"I believe that a strong background in graphics is needed for ME's. My first job was as a design engineer and required 85% board work"

"Need more attention to reading technical plans and drawings related to engineering field"

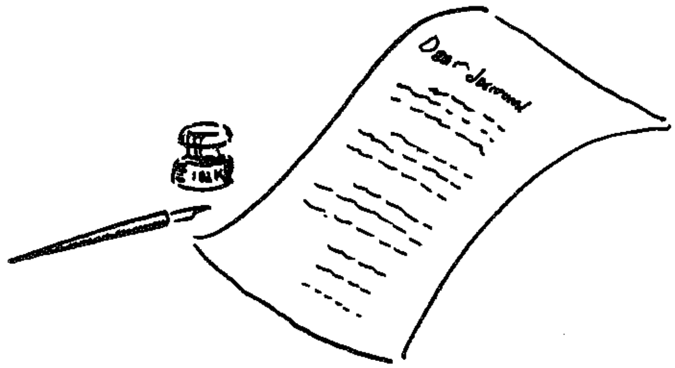
"I thought the Graphics Department was about 10 years behind in drafting methods"

"I felt overall the graphics program was adequate. Practical experience is priceless"

In conclusion, it is felt that the survey was very fruitful and we would like to thank the 65 individuals who responded to the questionnaire and a special thanks for the comments that came as an extra. The fact that 86.1% of the participants believe that drafting knowledge is of value to the employed engineer would seem worth the cost and effort involved in this study. The three top ranked opinions should also suggest that we offer more engineering drawing problems related to particular majors along with more computer graphics and more exposure to the modern reprographic techniques. The lowest ranked opinion should suggest that we talk a little less and allow the student time to draw a little more.

It is hoped that this survey will encourage others in the business of teaching graphics to conduct their own surveys of recent engineering graduates. The data collected is invaluable for curriculum design or modification.

Letters to the Editor



McNeese State University
Lake Charles, LA 70609

Mary A. Jasper, Editor
EDG Journal
Miss. State University
Miss. State, MS 39762

Dear Editor:

I wish to thank Prof. Goss for his comments on my article "Design at the Freshman Level?" (EDG Journal, Fall 1981 Pg. 58-61). It is obvious that he has some expertise with surveys, and that he did some research before developing his conclusions. I won't quarrel with most of them. However, I believe that the primary purposes of the survey and the article were overlooked.

The Content of an engineering course (graphics included) is determined by what those who develop the course believe will be useful to graduate engineers. Naturally we hope that those students who have gone into other fields have benefitted from our courses too, but their evaluations are not our primary concern. I wanted to find out if the graduates of our engineering program thought that what I taught them in graphics was relevant to their engineering practice. I also wanted to know if they thought I was getting the principles across. Responses to specific items and comments by graduates has helped me to improve content and techniques in my course.

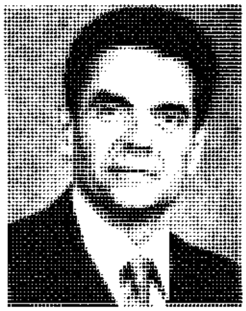
The survey was not done for ABET use. However, the visiting ABET team did have positive comments regarding the required graphics course. Our engineering program received national accreditation in the summer of 1981.

It is to be expected that the value placed on different objectives and how well they have been achieved would not be the same. A comparison of the ratings of various objectives was not intended. A look at the items individually led me to believe that all of the objectives are worthwhile, and that I have additional work to do to improve attainment of some of the objectives.

I wrote the article with the hope that it would encourage readers to take a closer look at their courses for the purpose of improving them. The data obtained in my survey will be of little or no use to any one else. But the listing of objectives in itself is a partial evaluation which may be of use to others. I hope the article accomplished these purposes.

Very truly yours,

/S/ Don Elfert
Associate Professor



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WHAT INDUSTRY SEEKS IN PICTORIAL DOCUMENTATION

I. INDUSTRY AND ENGINEERING GRAPHICS

It has been some 32 years since a Consulting Engineer wrote an article in the Engineering Design Graphics Journal on the relationship of engineering graphics in contracts and its effect on the designer, contractor, owner-client and the public. When Marvin C. Nichols[1],P.E. wrote his article "Engineering Drawing as seen by a Consulting Engineer" in Vol. 14, No. 3, November 1950, none other had been written since the inception of the journal in 1936. In fact there are no headings of Cost, Cost Control, Construction, Construction Control, and Contract Documents to be found in the 1978 Index.[2]

It is conceded however that several articles and texts have been written on the subject of what it costs to produce drawings[3] but none on what effect drawings have on the final cost, quality and profitability of the environment, system, or product design they were intended to communicate. Municipal Governments in Canada and the U.S.A. are being asked to convert to automated line drawing (Computer Graphics) and to justify the conversion in terms of benefits to the contract, contract execution and to the completed design itself. Two municipal engineers known to the author are encountering difficultly with this as no records were maintained as to what the relationship of drawings to construction cost control was. Another public agency bridge engineer is being confronted by his administration's desire to tender contracts for bridges with no drawings. In this light, the author began in 1979 to undertake a pilot study to determine the relationship of pictorial documentation to construction cost control. The results of this study are now being printed in a PhD. Dissertation entitled "Does Pictorial Documentation Improve Construction Cost Control"?[4]

What industry seeks in pictorial documentation based on the findings of that pilot study is presented here. Nineteen engineers, one architectural associate and one production director participated in the study conducted

TABLE 1

LIST OF PARTICIPATING INDIVIDUALS[4]

Case No.	Engineering Profession	Years of Experience	Position
1.	Civil	30	Mgr.Contract Engrg.
2.	Civil	26	Bridge Project Engr.
3.	Civil	25	Asst. Regional Engr.
4.	Civil	28	Special Projects
5.	Civil	24	Director Roads Div.
6.	Civil	32	Senior Project Engr.
7.	Civil	22	Roads Engineer.
8.	-	21	Architectural Assoc.
9.	Civil	21	Project Engineer.
10.	Civil	29	Mgr. Design & Engrg.
11.	Electrical	23	President.
12.	Civil	19	Vice-President.
13.	Civil	27	Engineering Assoc.
14.	Civil	21	Project Manager.
15.	Civil	30	Regional Director.
16.	-	26	Director.
17.	Civil	26	President.
18.	Civil	21	Assist. Chief Engr.
19.	Civil	30	President.
20.	Electrical	16	Capital Projects
21.	Civil	25	Mgr. Toronto Office.

primarily within 100 miles of Toronto, Canada. Data was gathered through 21 interviews of 2 to 3 hours duration and from 24 case studies involving an analysis of the contract documents and cost records for 24 constructed projects. Each pair of case studies took 5 to 7 hours to complete sometimes requiring two office visits. Table.1 lists the 21 participants, with their years of experience and responsibility at the time the study was completed in August, 1981. Table.2 lists the 24 case studies by type, size, complexity, intended and actual constructed cost.

The first step of the pilot study was to determine the present status of a contract, referred to throughout this paper as a Contractual Communication Package (CCP), and its major Components.

To all participants the common TEXT COMPONENTS were:

1. Agreement;
2. General Conditions;
3. Specifications;

and the common PICTORIAL COMPONENTS were:

4. Plan/Profile Sheets;
5. X-Section Sheets;
6. Standard Detail Sheets;
7. Assembly Sheets.

II. PICTORIAL DOCUMENTATION TYPES

Eight of the assumed pictorial types had been used at least once over the years by at least one of the 21 participants. No participant was able to add a ninth type which could form a legal part of a contract or CCP. The eight types can be grouped into three catagories:

1. LINE DRAWINGS
2. PHOTOGRAPHIC
3. MODELS

Figure 1. illustrates the eight types:

1. Automated or Machine Drawings
2. Manual or Hand Drawing
3. Photographic Print
4. Stereo Print
5. Aerial Print
6. Photographic Slide
7. Video Tape
8. Model

Each participant was asked which type they had used and what they knew or thought the advantages and disadvantages were for each of the eight types. The advantages and disadvantages given were based on actual experience or from promotional literature and demonstrations.

TABLE 2.
LIST OF 12 CASE STUDIES OBTAINED (4)

Case Study		Type	Date Built	Similarity No. Size	Complexity	Total	Tendered Cost	Actual Cost	Cost Ratio
1	Owner-Operator	Subdivision	1978	316.9	31.5	348.4	1,592,707	1,426,033B	0.895B
		Services	1980	316.7	31.5	348.2	1,019,033	960,002	0.942
2	Owner-Operator	Road Bridges	1981	45.3	34.5	79.8	2,175,000	2,250,000	1.035
		Over Water	1980	50.0	31.5	81.5	2,300,000	2,300,000	1.000
3	Owner-Operator	R.O.W. Rock	1977	19.3	24.5	43.8	280,000	508,000	1.79
		Stabilization	1979	19.1	21.5	40.6	89,852	92,294	1.03
5	Owner-Operator A	Urban Street	1979	27.2	28.5	55.7	108,858	119,816	1.10
		Renovations	1980	28.3	28.5	56.8	177,721	156,794	0.88
6	Owner-Operator	Road Bridge	1980	29.3	25.0	54.3	1,446,216	1,441.894	0.997
		Renovations	1977	17.5	22.0	39.0	566,759	567,806	1.002
10	Designer	Newspaper	1977	23.3	45.5	68.8	1,143,400	1,717,151	1.024
		Printing Plants	1978	25.2	46.5	71.7	1,345,000	1,380,811	1.027
11	Designer	Hospital	1975	55.3	36.5	91.8	1,749,400	1,867,335	1.067
		Mech/Elect.	1978	68.7	36.5	105.2	3,840,646	3,942,767	1.027
12	Designer A	Warf	1978	10.6	24.5	35.1	73,604	73,250	0.995
		Renovations	1981	30.7	24.5	56.2	1,392,140	1,396,517	1.003
14	Designer	Waste	1980	11.2	24.0	35.2	525,825	524,164	0.997
		Incinerators	1979	12.7	24.0	36.7	605,000	602.441	0.995
15	Contractor	Subdivision	1980	216.9	31.5	248.4	822,147	778,790	0.947
		Services	1980	346.0	36.5	382.5	1,190,777	1,398,293	1.174
17	Contractor	Office	1981	12.2	30.5	42.7	268,027	281,684	1.051
		Renovations	1981	13.4	29.5	42.9	229,937	261,378	1.137
21	Contractor	Underground	1980	125.2	34.5	159.7	6,925,575	7,403,063	1.069
		Tunnel & Piping	1981	170.8	28.5	199.3	4,432,778	4,492,701	1.014

A: Denotes participation in developing methodology format;
B: Denotes a $666,000. claim outstanding, if lost then ratio is 1.314.

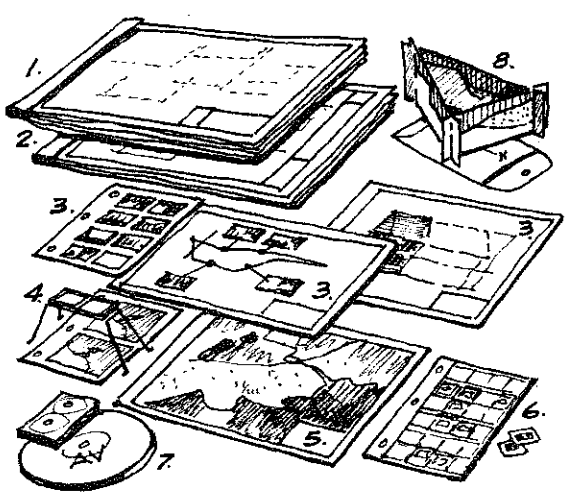

FIG. 1 PICTORIAL TYPES AVAILABLE FOR CONTRACT DOCUMENTATION.

Figure 2. illustrates the range of current use, advantages and disadvantages for each type. It is interesting to note that the percentage of use is not always in the range of known advantages and disadvantages for each type. From this figure it appears that machine drawings, video tapes and models are not used to the extent that they might be.

The participants also provided data that made it possible to plot those aspects of an intended project they wanted communicated in pictorial form. Figure 3. illustrates this demand for documentation

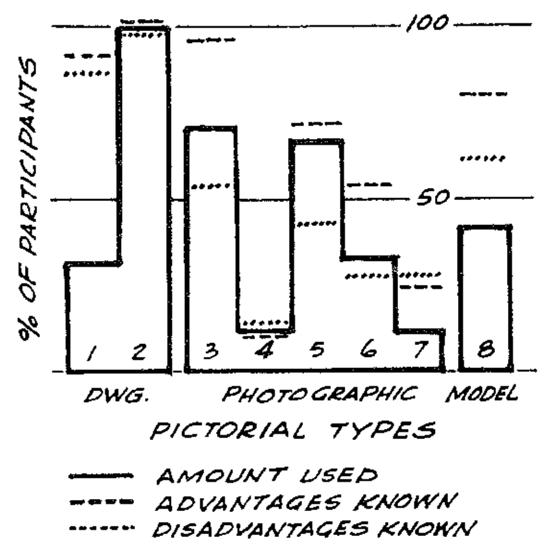

FIG. 2 ATTRIBUTES OF PICTORIAL TYPES CURRENTLY USED IN INDUSTRY.

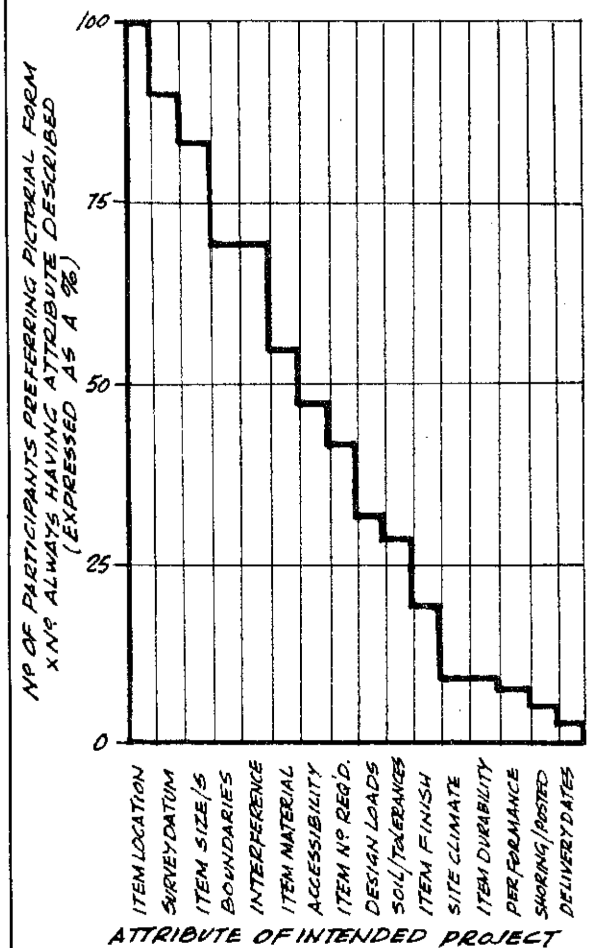

FIG. 3 DEMAND FOR DOCUMENTATION IN PICTORIAL FORM.

in pictorial form. The participants rated ITEM: location, size and shape, material and number required as 1,3,5 and 7 with SITE: survey datum, boundaries, interference and accessibility rated 2,4,4 and 6.

This first part of the study determined two key facts about the state of pictorial documentation today:

1. THE ATTRIBUTES OF EIGHT PICTORIAL TYPES:
2. THE DEMAND FOR DOCUMENTATION IN PICTORIAL FORM.

III. PICTORIAL DOCUMENTATION IN 12 CASE STUDIES

Having established the present status of pictorial documentation in the contractual communication packages of the 21 participants, the second step of the pilot study was to determine the relationship of pictorial documentation to construction cost. The hypothesis being: "does improvement in the pictorial content of contractual communications package improve construction cost control?" Could a certain amount and type of pictorial documentation be prescribed for a specific project that would allow the results in construction cost control to be reasonably predicted.

In order to see if such relationships existed 12 sets of case studies were obtained and analysed. Each case study consisted of two similar projects constructed within a few years of each other and for which the CCP components may have changed. It was hoped that such a change might result in different cost control results that could aid in the identifying of a link or links between the pictorial documentation and project cost control.

The similarity of projects was based on a comparison of the size and complexity of each. Both qualities had pertinent features which were assigned values which resulted in the numerical ratings shown in Table 2. The method of determining the similarity number for a project and its relative merit will be the subject of another paper. One will note that while the project size rating varied from 10.6 to 346.0 the complexity rating remained almost constant varying from 21.5 to 46.5.

Documentation & Complexity Related to No. of Trades

The amount of pictorial documentation used in each of the 24 contract packages was measured on an area basis as only photographs and line drawings were found to be in actual use. This total area of pictorial documentation was then plotted against:

- project size,
  - project complexity,
    - project cost,
      - number of contract items,
        - number of item changes,
          - number of design engineering skills and number of trades employed.

Figure 4. illustrates the comparison of area of pictorial documentation with the number of item changes such as additional, extra and credit items. Again there appears to be no set relationship. The only correlation which did seem apparent was between the area of pictorial documentation and the number of construction trades. This was the same for project complexity when plotted against the number of construction trades. According to this data:

the area of pictorial documentation,
varies proportionately to
the number of trades employed,
which varies proportionately to
the project complexity...

Suggesting a need to relate directly to what each trade would prefer to see communicated in picture form. A survey of what the trades would prefer was not attempted in this study.

The Composition of Pictorial Documentation

The pictorial component was analysed for each of the 24 contract packages and the

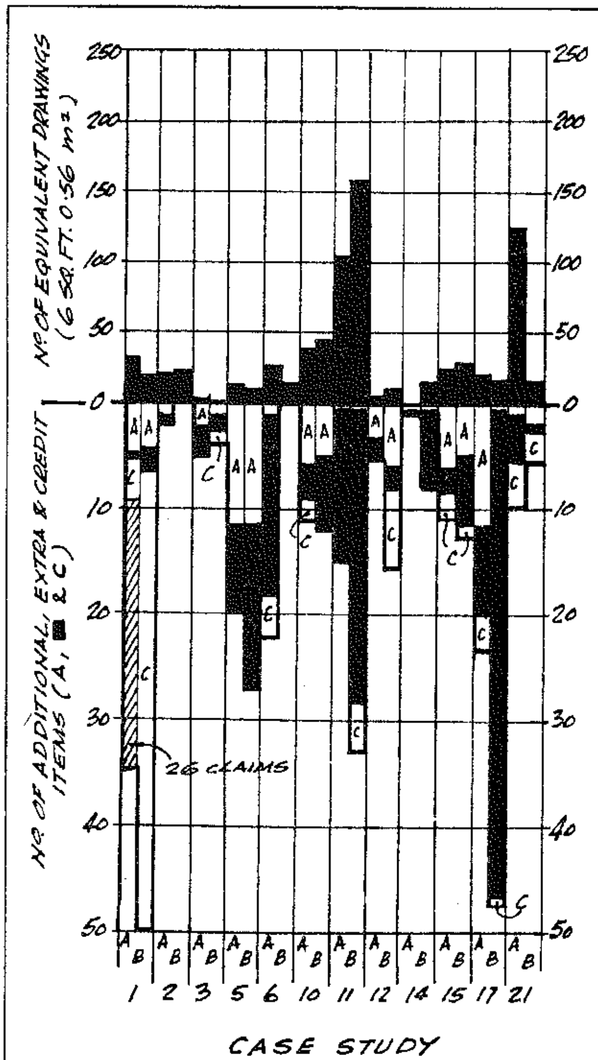

FIG.4 PICTORIAL COMPONENT VS No OF ITEM CHANGES

composition was plotted. Photographic prints were used for both projects in case study No.3 and for one in case study No.12. The only automated or machine line drawings found were those used in topographic base mapping for case studies No.s 1,5,6,15 and 21. From a review of this plot it appeared that there was no set pattern of type or quantity for pictorial documentation.

IV. SECURING "IN-HOUSE" DATA

Several participants had previously done "in-house" reviews of the effectiveness of some of the components of their contractual communication packages. From this pilot study it became apparent that while the users had reviewed and modified portions of their contract packages they had not analysed their recorded data in such a way that would permit them to be able to predict the effect of pictorial documentation on construction control. The 12 case studies indicated that too much or too little pictorial documentation can be both an asset or a detriment to project control and costs. Nothing in this study indicated why. Case study No.3 which used only photographs printed on bond paper of the same size as the specifications seemed to be the most effective and a rewriting of the older specification which had been for line drawings, brought even more drastic control over the resulting cost. A final contradiction, Electrical designers feel that their documentation by use of line drawings is at its best. Electrical foremen on the other hand have stated that they spend up to 4 hours each day searching these drawings for work packages and the appropriate sequences for installation by the tradesmen.

V. CONCLUSIONS

Industry's production managers know what they want to communicate and they also know what they want communicated in pictorial form, however none know just what the most effective pictorial form is for their particular project.
No statistical data exists in construction management and engineering graphics literature which would indicate exactly what the effectiveness of various types of line drawings, photographs and models is.

Based on the previous data perhaps three directions could be suggested for teachers of Engineering Graphics:

1. Industry today needs a new format for its pictorial documentation, one that will present items of work in trade-crew packages arranged in correct sequence for assembly.

2. Industry cannot depend entirely on automated line drawings for future methods of pictorial documentation. Research needs to be done equally on the potential of photography and modelling as they become automated in the next decade.

3. There is a need to expand on the quantitative data obtained in this pilot study. Research can be done with industry to determine the effect of the pictorial documentation in their contractual communication packages.

This is what industry seeks in pictorial documentation. Marvin Nichols concluded his paper 32 years ago with..."it is essential that (students) attain a reasonable proficiency in Engineering Drawing." Today Mr. Nicol's closing remark may be as one consulting engineer participating in the study put it: "we are not using machine drawing, photographic prints, video tape and modelling to their potential because we were not trained in those skills".

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A DISCUSSION OF THE GENERAL SOLUTION IN DESCRIPTIVE GEOMETRY

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Descriptive Geometry may be defined as that branch of Projective Geometry which determines directions-of-sight needed to best describe certain geometric principles. Unless unique directions of sight (projection) are involved, then the principles peculiar to descriptive geometry are not present--only the conventionally adopted six-principal-views-presentation-principles. (Note, however, that the above definition does not exclude the principal-view directions.)

For example, of the directions of projection such that an oblique straight line will appear TL, none will produce a principal view therefore the determination of any or all such directions (as opposed to the projected pictures themselves) is an exercise in descriptive geometry. It is apparent that an infinite number of such directions accomplish TL views. The set of these directions define (or is defined by) a ruled surface (here, a plane) perpendicular to the line, one directrix of the ruled surface being a plane curve and the other directrix being a point within the plane of the curve. If the generatrix's length remains constant, then the plane curve will be represented as a circle with the point directrix as the center. Figure 1. This ruled surface, each element of which represents a direction of projection, represents the general-solution-such that-any-straight-line-appears-TL.

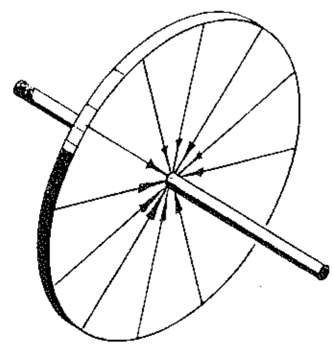

FIG 1

It is a curiosity that this general solution is a special case of the cone--a more general case being such that the point-directrix (apex) lies outside the plane of the circle-directrix (base). This curiosity has significance because, at this writing, all known forms of the general solution in descriptive geometry are some case of the cone. For why this might be, consider the bizarre general-solution-such-that-a-point-appears-as-a-point(!): an unlimited volume defined by the set of all possible elements (representing directions of projection) which might radiate from (or to) the given point. If the elements' lengths

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are limited to be equal, then the volume limit is spherical with the given point as the core. Figure 2. These elements, however, may also be considered as the elements of an infinite number of ruled conical surfaces with their apexes at the core. Figure 3. It is noteworthy that at the extremes the cones reduce to a ruled plane, (A), and a "ruled" straight line, (B). (A) and (B), then, may be considered as special cases of the cone. Figure 1 is an application of (A). An application of (B) is the general-solution-such-that-any-straight-line-appears-as-a-point. Figure 4.

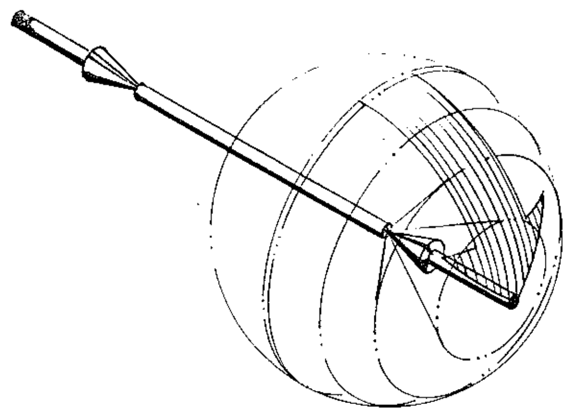

FIG 4

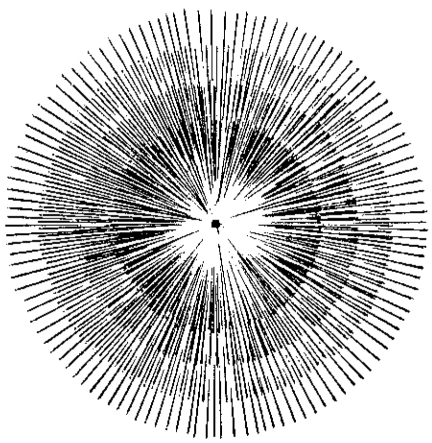

FIG 2

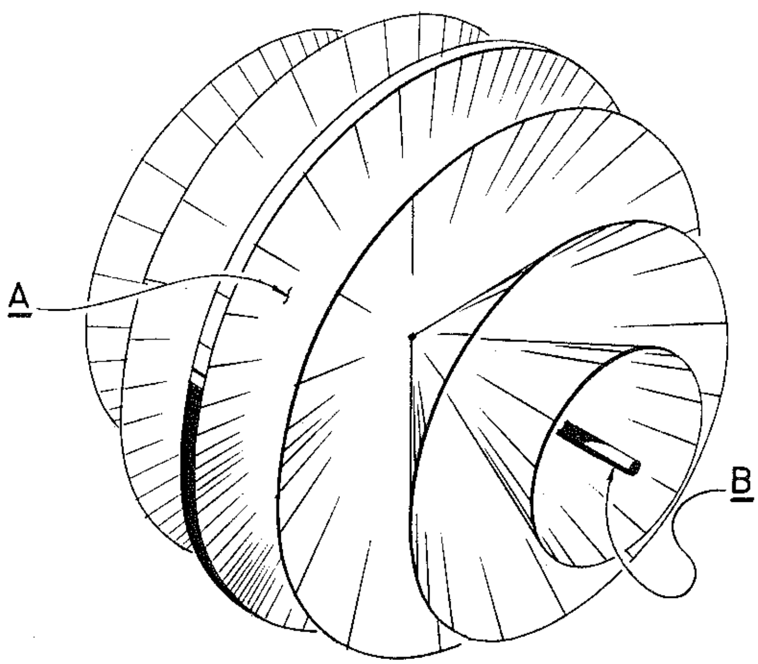

FIG 3

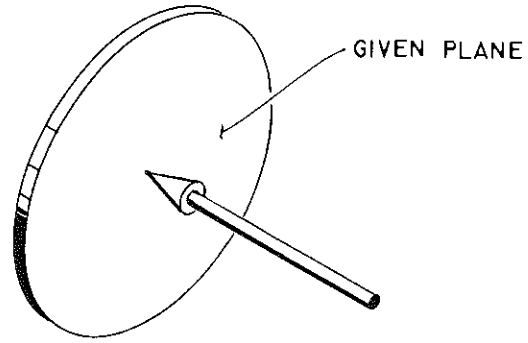

FIG 5

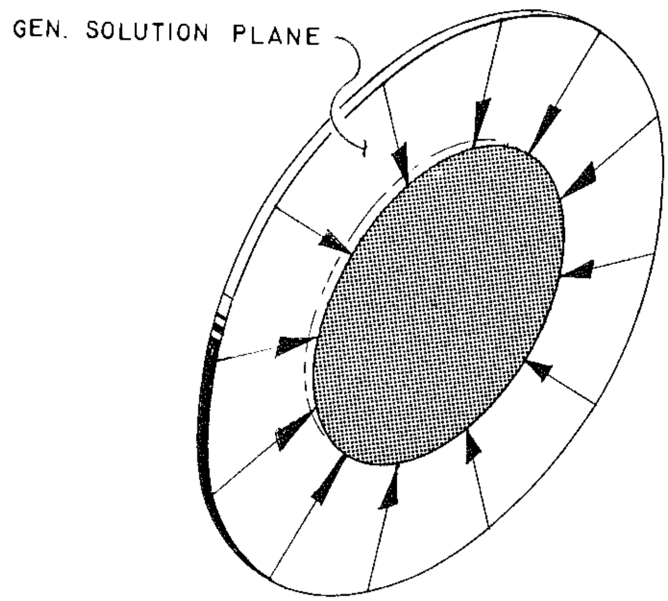

FIG 6

Similarly, the general-solution-such- that- any- plane- appears-Normally (true size) is represented as a (B) type "cone" perpendicular to the given plane. Figure 5. If the angle between the elements and axis of the "cone" is increased from 0° to 90° then the cone becomes a representation of the general-solution- such- that- any-plane-appears-as-a-line (edge), namely, an (A) type ruled surface parallel to (and here, shown coincident with) the given plane. Figure 6.

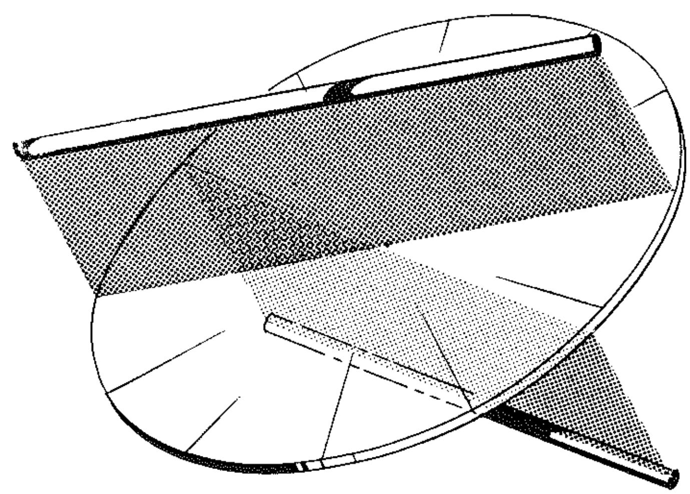

FIG 7

The general-solution-such-that-any-pair- of- straight-lines-appear-parallel is represented as an (A) type surface parallel to both lines. Figure 7.

The general-solution-such-that-any-pair-of-nonparallel-straight-lines-appear-perpendicular is represented as a particular elliptical cone (with a circular base). Figure 8.

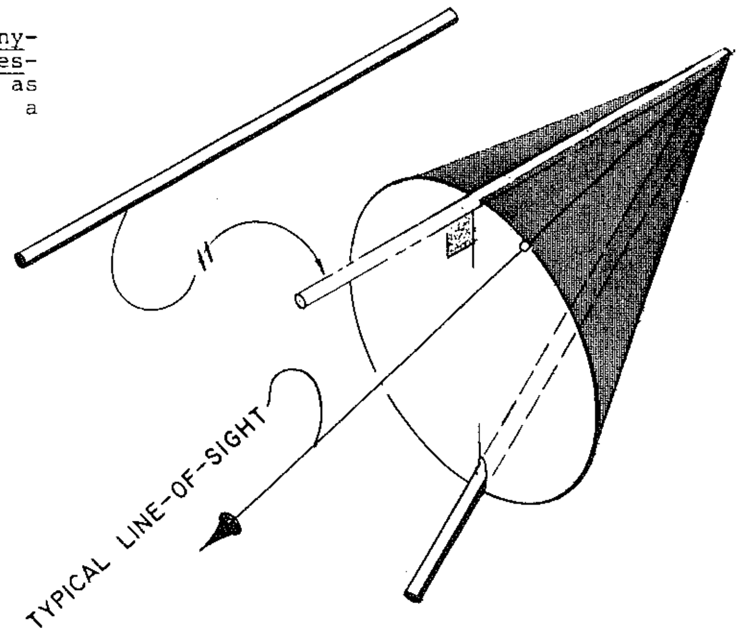

FIG 8

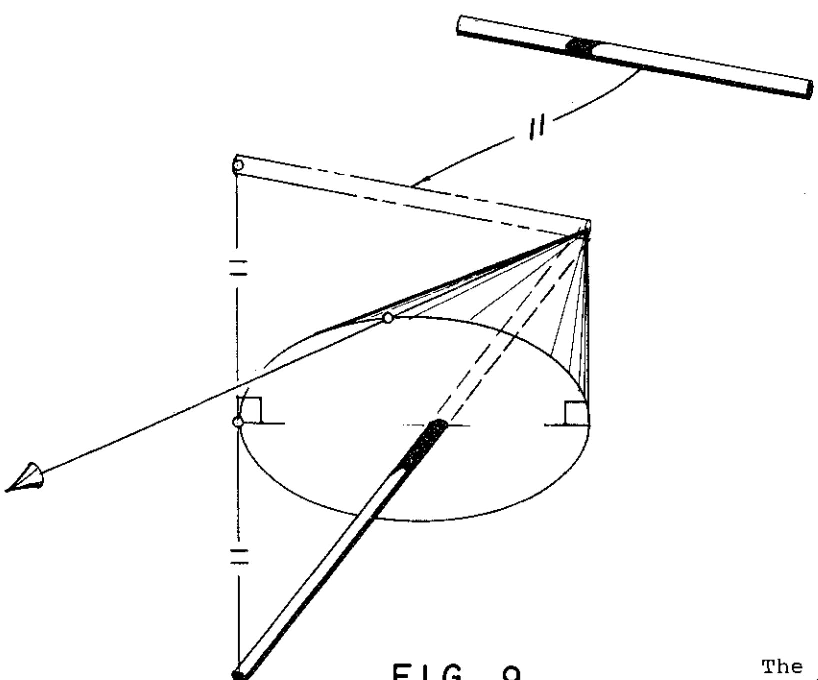

FIG 9

The general-solution-such-that-any-pair-of-straight-lines-appear-equal-in-length (The Rotenberg Solution) is represented as another particular elliptical-cone-with-a-circular-base. This solution originally appeared in the Puzzle Corner (winter '79) and, we believe, marked the initial use and identification of the general solution concept in descriptive geometry. Figure 9. Note that if the given lines are specified as being parallel then the elliptical cone reduces to a special case of the Parallel Lines General Solution.

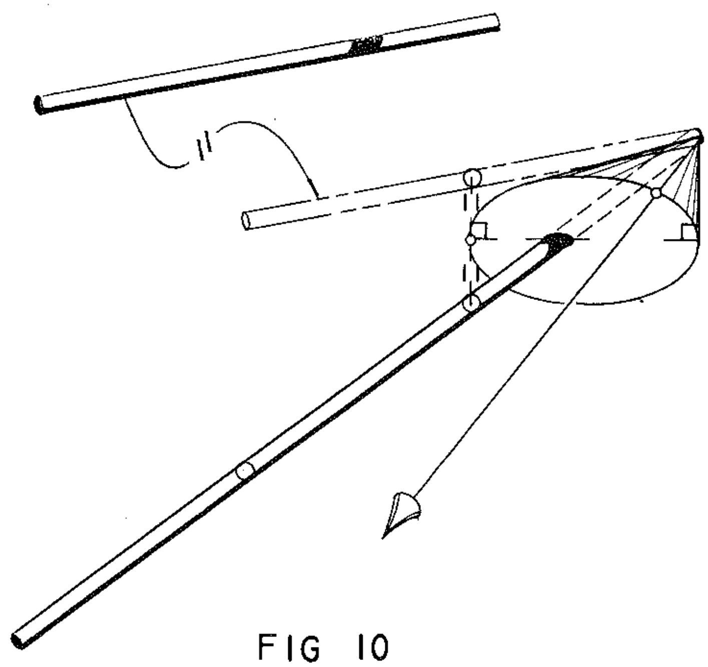

FIG 10

The general-solution-such-that-the-respective- lengths- of- any- pair- of-straight- lines- appears- in-a-specified -ratio also first appeared in the Puzzle Corner (fall '80) and may be represented in two modes (both of which are the-same- particular- elliptical- cone- but-with-different-parallel-circular- bases) depending on how the ratio is expressed, e.g., 2/3 or 1/(3/2). Figures 10 and 11, respectively. The Figure 10 technique was originated by Chi Di Lin of The Anhwei Institute of Technology, the P.R. of China; the Figure 11 technique, by Abe Rotenberg of the University of Melbourne, Australia. Note that Figure 9 is a special case (wherein the specified ratio is 1:1) of this general solution.

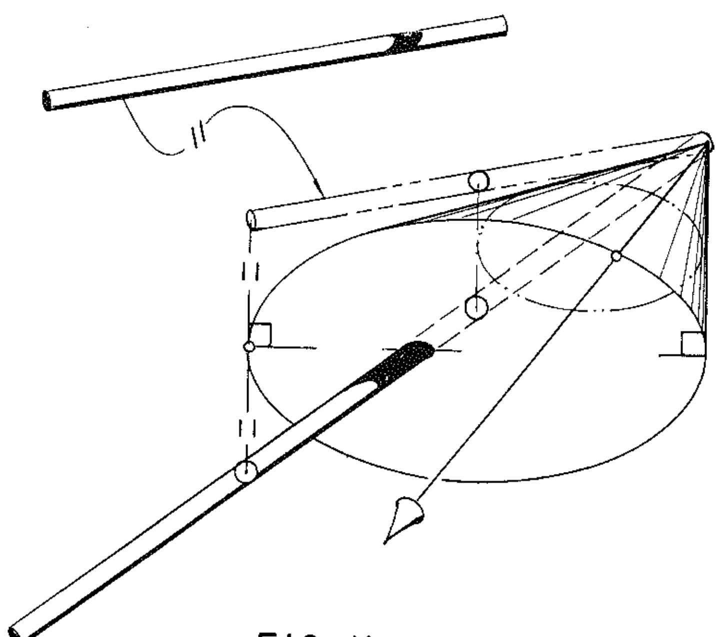

FIG 11

Of the applications of general solutions in descriptive geometry, probably none is more important than is their application to visualization.

For example, is it true or false (and explain the rationale): any pair of non-intersecting straight lines, together with a profile plane, may be viewed in a direction such that the-lines- appear- parallel- and-the-profile plane- appears- as- a- line (edge)? Probably the most common procedure is to recall that the lines may be projected from a side view such that they will appear parallel. Since this accomplishes the desired view the answer is: true. But another approach is to visualize an (A) type surface parallel to both lines (The Parallel Lines General Solution, Figure 7) and recognizing that this unlimited plane must intersect with all principal planes. The point-views of the respective lines-of-intersection (LI's) must show (1) the respective principal planes as lines (edges) and (2) <u>since the respective LI's each must be parallel to at least one ruling element then an LI point-view</u> must also show the given lines as appearing parallel.

This visualization process undoubtedly is more difficult than is the "remembering" process but also it is more meaningful. Suppose, for example, that the question above is again asked, except the profile plane is replaced with an oblique-plane-in-a-general-position. Now the "remembering" process is of little help and visualization-wise this writer, at least, is adrift. But if the general solution plane is now visualized as intersecting with the oblique plane, just as it did with the principal planes, then the answer obviously becomes the same as before, i.e., true.

Suppose the following is posed: Given: a pair of skew lines and an oblique plane in general positions. True or false (and explain the rationale): the given may be viewed in a direction such that the lines-appear-perpendicular-and-the-plane-appears- as-a-line (edge)? If we are limited to "standard" visualizing this is at least, for this writer, a nightmare. But, using general solutions, all one needs to do is visualize a-plane-parallel-to-the-given-plane and which passes through the apex of the visualized Perpendicular

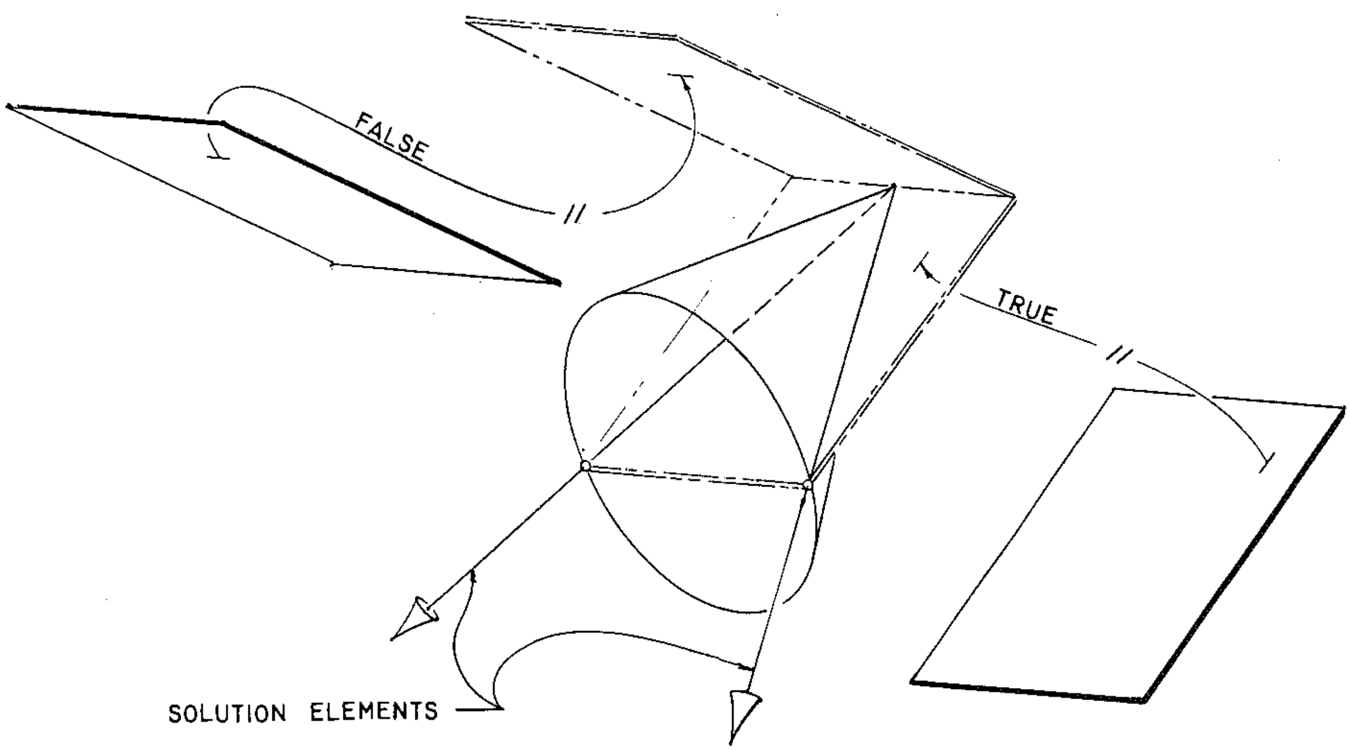

FIG 12

Lines General Solution cone in order to test whether or not it intersects with the cone. If the intersection occurs, then that there are two distinct solutions (LI's) becomes obvious. However, for those planes which pass through the apex yet do not intersect with the cone, then the answer is: false. Figure 12.

Conclusion: It seems the introduction of the General Solution (and the Conditional Invariant) to descript might alter significantly the manner in which it is taught. To this writer descriptive geometry could (and should) become a more abstract and visualizing type of course with less rote operations which mechanically yield solutions and which are, or so it seems to this writer, too often applied to naive and very convenient "engineering" examples. The writer suggests that a new methodology using the "general solution/conditional invariant approach" merits consideration.

LOOKING FOR SOMEONE?

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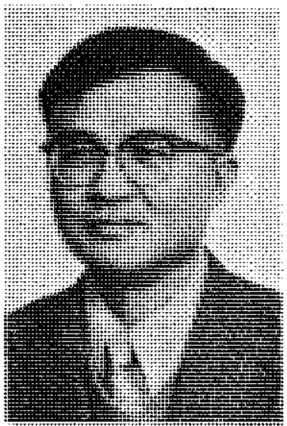
DESIGN PROJECTS FOR INDUSTRY FROM THE STUDENT'S POINT OF VIEW



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INTRODUCTION

Some of my students and I successfully completed, from August 27 1980 through May 8, 1981, four design projects for Pease Industries, Inc. (called hereafter the Corporation) in Cincinnati and Fairfield, OH. The Corporation primarily makes Ever-Strait Doors. The four design projects are as follows:

1. Design of fixtures to hold inserts for Ever-Strait Doors.
2. Design of automated sill assembly.
3. Design of paint hanger dolly.
4. Design of impact test bracket.

Five students in our Die Design class, offered in the first semester 1980-81, were involved in the first design project above as extra work for the class. Four students in our Equipment Design class, offered in the second semeester 1980-81, participated in the remaining three design projects as part of the course work for this class. Since three of these students were involved in the first design project, a total of six different student's overall participated in this evaluation.

TWO QUESTIONS ASKED

After completing the four projects, the six students were asked, in May 1981, to answer the following two questions:

1. What did you learn, in general, from the design project(s) on which we have worked for Pease Industries, Inc. during the first and/or second semester 1980-81?
2. Based on your work experience associated with the Corporation this academic year, what would you suggest for the part of both prospective students and the instructor to complete successfully design projects, (which are now being planned for the future for industries in the Hamilton/Fairfield, Ohio area)?

THINGS LEARNED BY THE STUDENTS

The answers to question 1 above will be summarized below. The following nine items are the things learned by the six students.

1. By successfully completing the four design projects for the Corporation, we gained field experience which will help secure employment after/before graduation.
2. The approach of working as a team to complete a design project is easier and better than a person working alone because the team members can get together and discuss project problems and share ideas about possible solutions.

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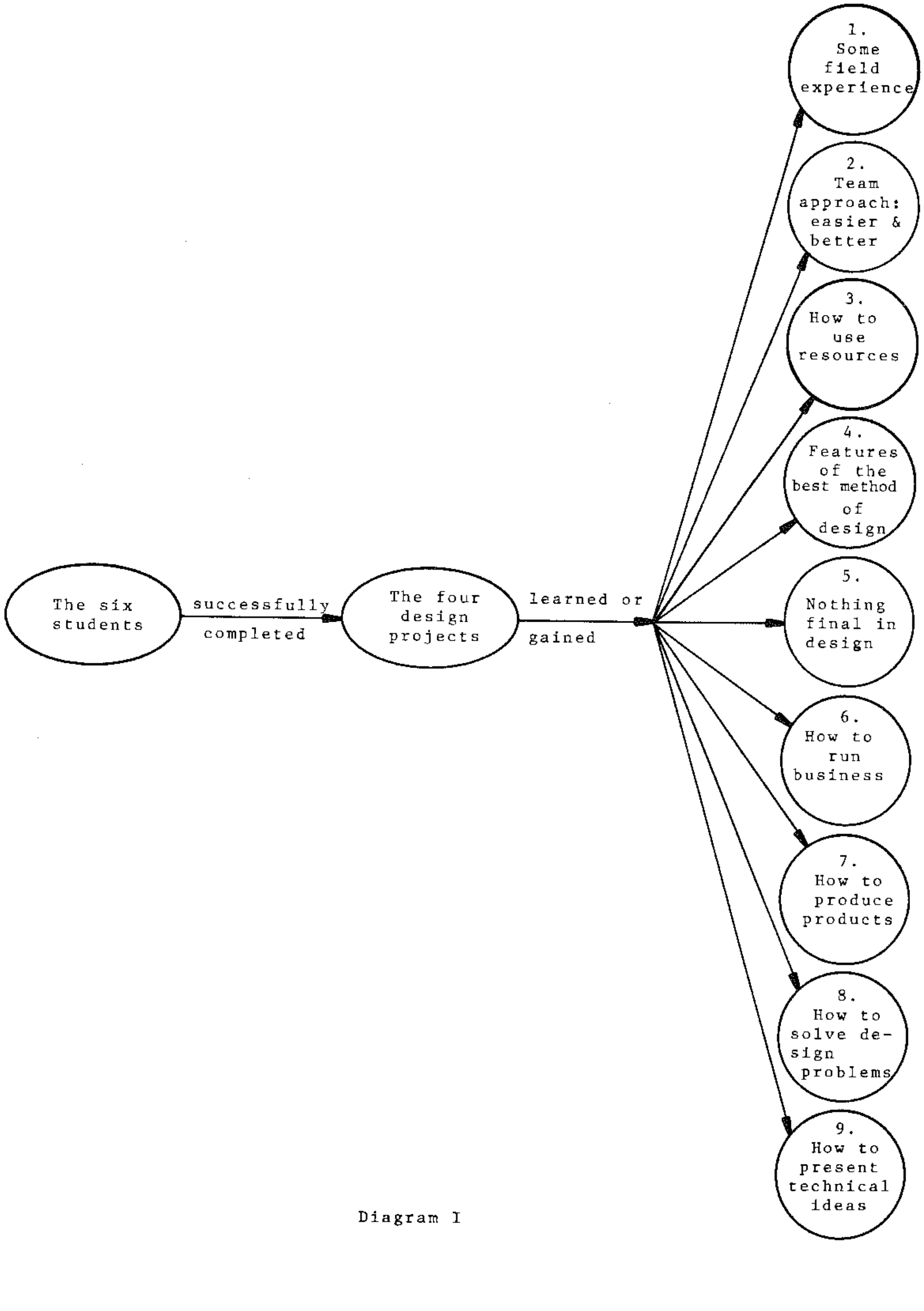

The six students
successfully completed
The four design projects
learned or gained
1. Some field experience
2. Team approach: easier & better
3. How to use resources
4. Features of the best method of design
5. Nothing final in design
6. How to run business
7. How to produce products
8. How to solve design problems
9. How to present technical ideas

Diagram I

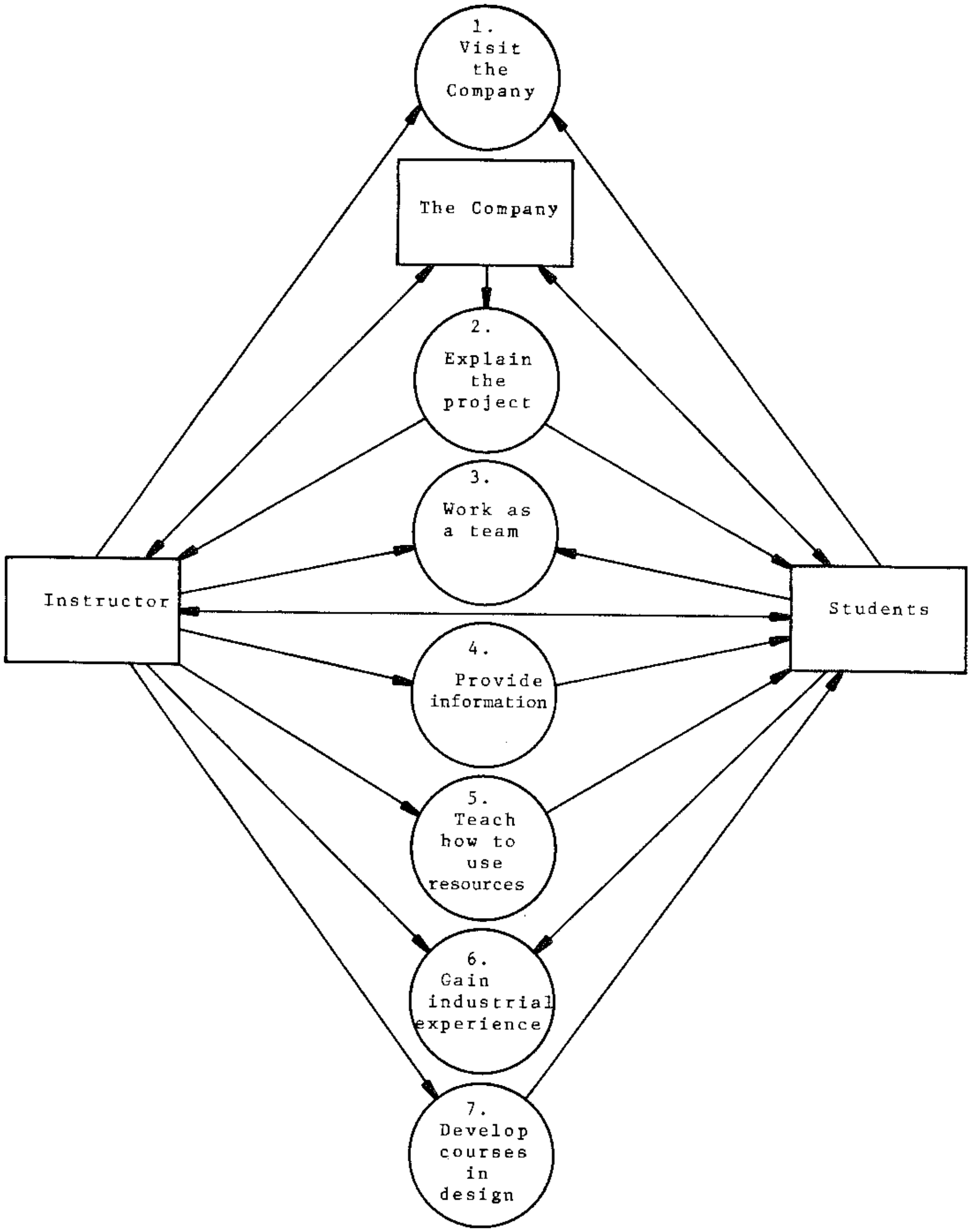

1. Visit the Company
The Company
2. Explain the project
3. Work as a team
Instructor
Students
4. Provide information
5. Teach how to use resources
6. Gain industrial experience
7. Develop courses in design

Diagram II

3. We learned how to use reference books, catalogs, and magazines to get needed information, including information about types of machines such as vibrating feeders, conveyers, and casters.

4. The best method of design is the simplest and cheapest method.

5. Nothing is final in design; changes may have to be made at any time to expedite production.

6. We learned how the Corporation works to run business and got greater insight into the Corporation's needs.

7. We gained greater understanding about producing products through assembly lines.

8. We learned greater self-reliance in solving design problems, lessening our need to ask the instructor for help.

9. We learned how to present technical ideas verbally to other people and to grasp their comments and suggestions.

The above nine things learned by the six students are illustrated in Diagram 1.

GUIDELINES SUGGESTED BY STUDENTS

The answers to question 2, listed under the heading, Two Questions Asked, will be summarized below. The six students suggested the following guidelines to assist both prospective students and the instructor in successfully completing design projects for industry:

1. The prospective students and the instructor should visit the company that is providing the design projects. The company should be toured to see its manufacturing processes and products.

2. The design projects should be explained very clearly to the students and the instructor by a representative of the company so that they know what they are expected to do and how they should go about doing the projects.

3. All of the students and the instructor involved in the projects should work as a team and discuss problems of the projects and share ideas of possible methods of design. The students will also share responsibilities of the design work and make models and drawings, if necessary, to help communicate the ideas of design.

4. The instructor should provide the students with a broad range of information including information about types of machines and equipment available, which will help in completing the projects.

5. Books, catalogs, and magazines pertinent to the projects should be available for use. The instructor should teach the students how to use these resources inoorder to secure information required to complete the projects.

6. Industrial work experience helps students understand and solve the problems of design projects.'

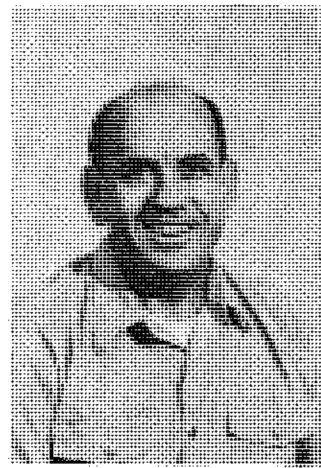
7. Because courses in design help students complete design projects, several courses in design should be developed.

The seven guidelines suggested by the students can be briefly expressed as shown in Diagram II.

CONCLUSION

Six of my students and I successfully completed, from August 1980 through May 1981, four design projects for Pease Industries, Inc., located in Cincinnati and Fairfield, Ohio. In May 1981, the six students maintained that they learned nine things from the projects. Also, they suggested seven guidelines to assist both students and instructor in successfully completing design projects for industry.

FUNICULAR DIAGRAM BEAM ANALYSIS



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The two most common methods of determining tbe shear and moment in a beam are the free-body diagram method and the semigraphical method. An example of each of these methods is shown in Figure 1.

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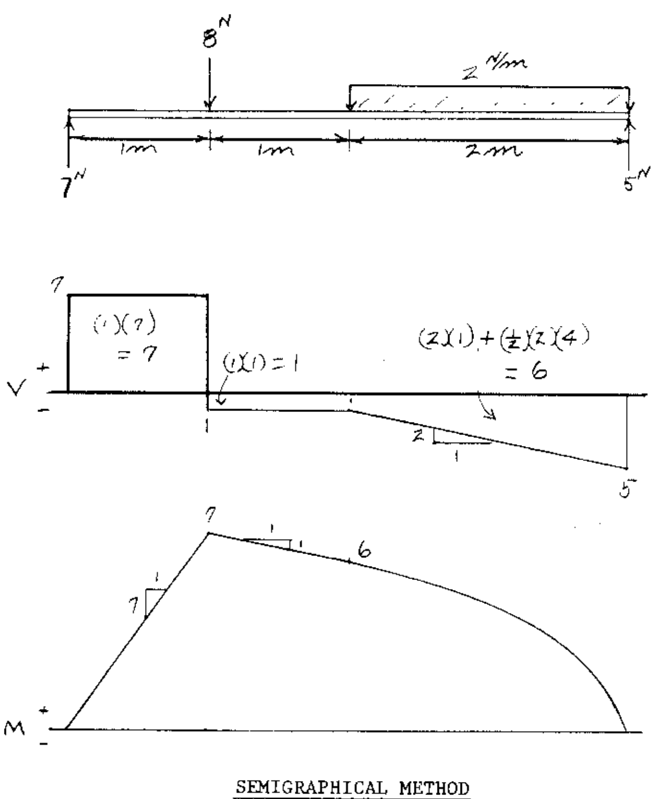
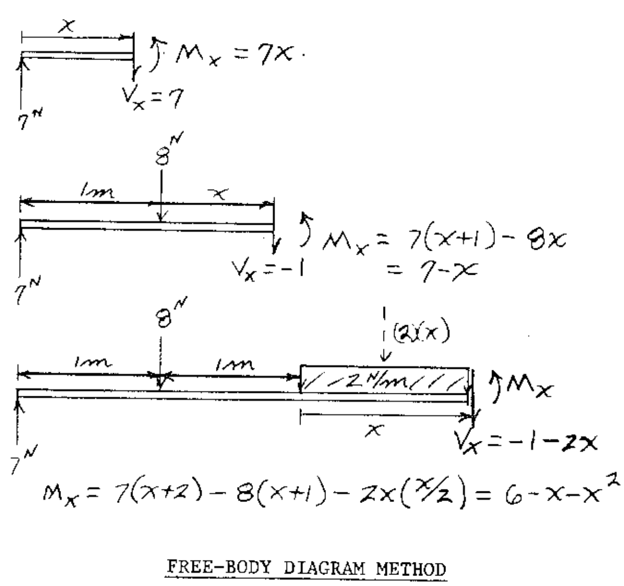
A third method, not commonly used, but yet available, employs the funicular diagram. Both the moment equation for any region in the beam, and the moment diagram for the entire beam can be produced directly and quickly. The rationale and procedure follow.

FIGURE 1





In Figure 2, the free-body (Figure 2a) of a portion of the left region of the beam was drawn first. Next, a vector diagram (Figure 2b) was constructed from which the shear (V_x) was determined. the free-body diagram was then transformed into a funicular diagram (Figure 2c) by resolving all of the forces into components parallel to the "rays" of the modified vector diagram. The funicular diagram then shown that the internal resisting moment (M_x) of the beam at some point "x" is equal to the product (OA)(d) because the sum of the moments about poine "x" of all other force components is zero.

Now the similar geometry of the vector diagram and the funicular diagram can be used. Similar triangles exist in the funicular diagram and the modified vector diagram. In the funicular diagram, tan $\theta = d/x$; and in the modified vector diagram, tan $\theta = V_x/OA$. From these similar triangles, a relationship, and the following sequence can be drawn:

$$\frac{d}{x} = \frac{V_x}{OA} = \frac{7}{OA},\ d = \frac{7x}{OA},\ \text{and since}$$

$$M_x = (OA)(d)\ ;\ M_x = (OA)\left(\frac{7x}{OA}\right) = 7x.$$

Figures 3a, 3b, and 3c establish the same relationship between load, shear, and moment for the middle region of the beam. Figure 3a is the free-body diagram, and Figure 3b is the modified vector diagram which shows that

$$V_x = AB - BC = CA$$
$$= 7 - 8 = -1.$$

The funicular diagram (Figure 3c) again has the forces resolved into components which are parallel to the "rays" of the modified vector diagram. Also, again, the internal resisting moment of the beam (M_x) is equal to the product (OA)(d) because the sum of the moments of all of the other force components about point "x" is equal to zero. However, a more complicated relationship now exists between the geometry of the funicular diagram and that of the modified vector diagram. The funicular diagram shows that

$$d = y_1 - y_2\ ;$$

and that tan $\theta_1 = (y_1/1)$ and tan $\theta_2 = (y_2/x)$. In the modified vector diagram,

$$\tan\theta_1 = \frac{AB}{OA} = \frac{7}{OA} \text{ and } \tan\theta_2 = \frac{AC}{OA} = \frac{1}{OA}.$$

The combination and resolution of these relationships is as follows:

$$\tan\theta_1 = \frac{y_1}{1} = \frac{AB}{OA} = \frac{7}{OA}\ ;\ y_1 = \frac{7}{OA},$$

$$\tan\theta_2 = \frac{y_2}{x} = \frac{V_x}{OA} = \frac{1}{OA}\ ;\ y_2 = \frac{x}{OA},$$

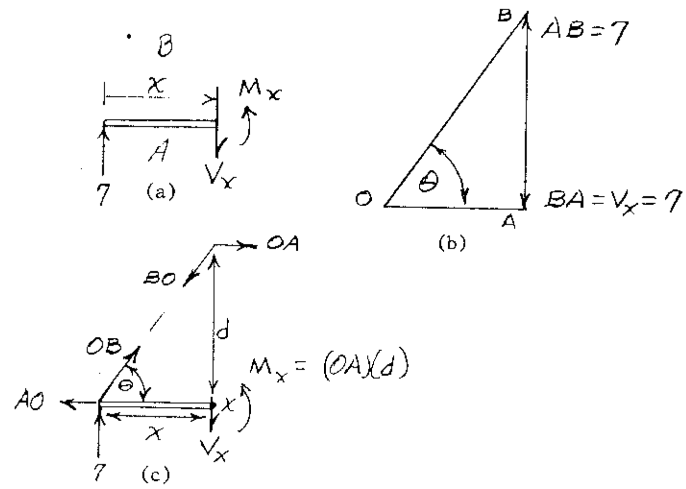


FIGURE 2

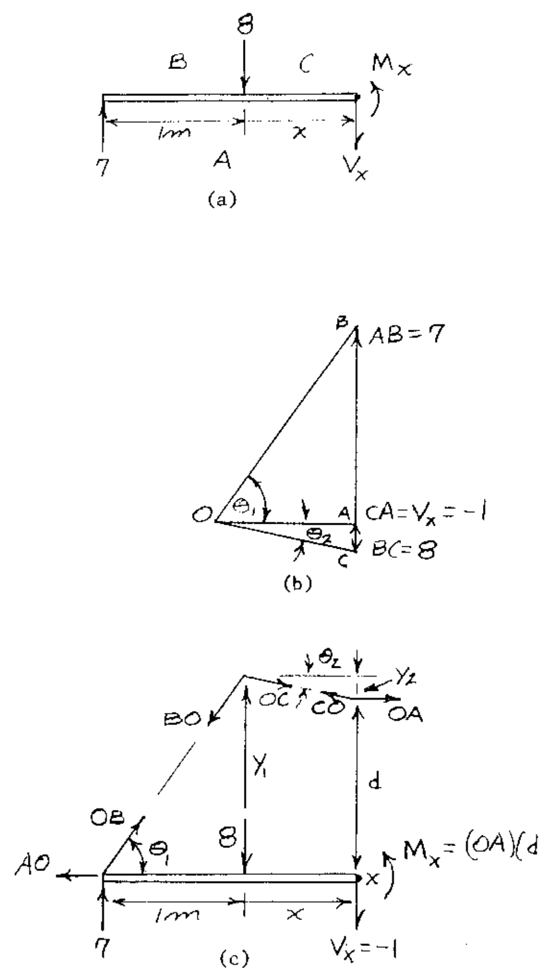


FIGURE 3

$$d = y_1 - y_2 = \frac{7}{OA} - \frac{x}{OA} = \frac{7 - x}{OA},$$

and $M_x = (OA)(d) = (OA)(\frac{7 - x}{OA}) = 7 - x$

The result, ($M_x = 7 - x$) is the equation for the moment in this region of the beam.

In the right region of the beam, all of the figures of Figure 4 apply in the same manner as in the previous two regions. $M_x = (OA)(d)$ still holds but now $d = y_1 - y_2 - y_3$. The geometry of the funicular diagram and the vector diagram is still related through the similar triangles and the moment equation is developed as follows:

$$\tan \theta_1 = \frac{y_1}{1} = \frac{AB}{OA} = \frac{7}{OA} \; ; \; y_1 = \frac{7}{OA}$$

$$\tan \theta_2 = \frac{y_2}{\frac{x}{2} + 1} = \frac{AC}{OA} = \frac{1}{OA} \; ; \quad y_2 = \frac{\frac{x}{2} + 1}{OA}$$

$$\tan \theta_3 = \frac{y_3}{\frac{x}{2}} = \frac{DA}{OA} = \frac{1 + 2x}{OA} \; ; \; y_3 = \frac{\frac{x}{2}(1 + 2x)}{OA}$$

$$d = y_1 - y_2 - y_3$$

$$= (\frac{1}{OA}) [7 - (\frac{x}{2} + 1) - \frac{x}{2}(1 + 2x)]$$

$$= (\frac{1}{OA})(6 - x - x^2)$$

$$M_x = (OA)(d) = (OA)(\frac{1}{OA})(6 - x - x^2)$$

$$= 6 - x - x^2$$

At about this time, a casual scrutiny of the funicular diagram for the right region of the beam (Figure 4c) leads to the conclusion that its shape is very similar to that of the moment diagram (Figure 1). Plotting of addition points for different values of "x" within this region confirms the suspicion. Also, at about this same time, it is realized that the vector diagram is actually an accounting of the accumulated shear as the beam is traversed from left to right.

These two discoveries can now be used to graphically and quickly produce the moment diagram of a beam as is shown in the example below:

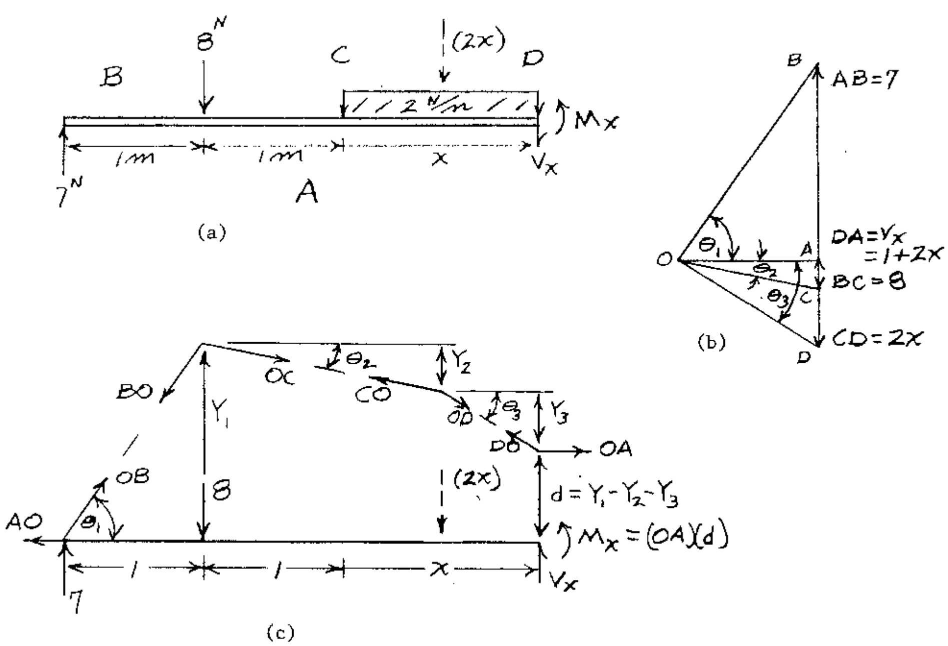


FIGURE 4

Figure 5b is a modified vector diagram which shows the shear for each section of the beam. For example: the shear in the left section of the beam is shown by the vector AB and its value is -3. For the middle section of the beam, the shear is shown by the net value of the vectors -AB + BC and the value is

$$-3 + 7 = +4.$$

The sum of -AB + BC - CD = -2 shows the shear in the right section of the beam; and the fact that the beam is in vertical equilibrium.

Point "O" of the modified vector diagram was chosen so that it is "horizontal from point A" and is also spaced from poin A a distance equal to a unit length of the beam.

With these two constructions correlating the free-body to the funicular diagram, a "funicular-moment" diagram can be drawn.

In Figure 5c, the portion of the moment diagram for the left section of the beam was drawn parallel to the "ray" OB of the modified vector diagram. OB has a slope of -3 on 1 and therefore indicates a moment of -6 at the left support. In the middle portion of the beam, the moment diagram was drawn parallel to "ray" OC which has a slope of 4 on 1, indicating a point of zero moment 1.5m to the right of the left support, and a moment of +2 at the right load. In the right portion of the beam, the moment diagram drawn parallel to "ray" OD closes to zero at the right support.

A summation of the procedural steps is as follows:

a. Draw a free-body diagram of the beam and apply Bow's notation.

b. Construct a vector diagram of the shear as the beam is traversed from left to right.

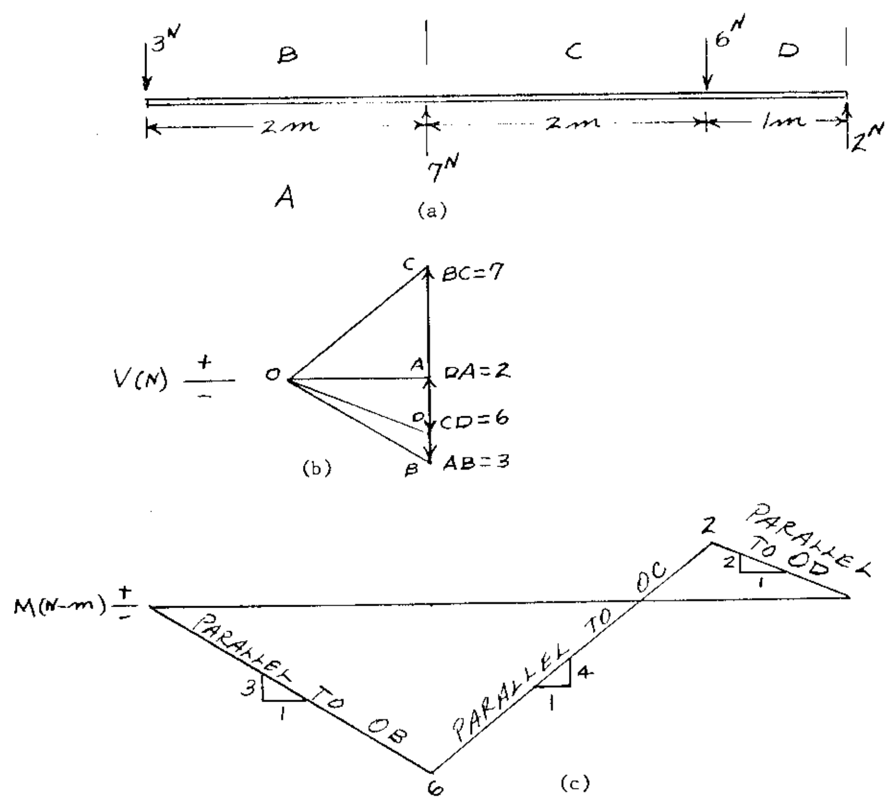


FIGURE 5

c. Modify the vector diagram by establishing a "pole" which is "horizontal" from the origin of the vector diagram and is to the left of the origin a distance equal to a unit length of the beam.

d. Draw the "rays" of the modified vector diagram from the "pole" to the points of the vector diagram.

e. Construct the moment diagram by drawing lines parallel to the "rays" of the modified vector diagram for the corresponding regions of the beam.

The moment equation for any region of the beam can be taken from the geometry of the moment diagram as follows:

(a) For the left portion of the beam:

$$M_x = (x)\left(\frac{-3}{1}\right) = -3x \qquad 0 \le x \le 2$$

(b) For the middle region:

$$M_x = -6 + (x)\left(\frac{-4}{1}\right)$$

$$= -6 + 4x \qquad 0 \le x \le 2$$

$$(M_x = 0 \text{ when } x = 1.5)$$

(c) and for the right portion of the beam:

$$M_x = 2 + (x)\left(\frac{-2}{1}\right)$$

$$= 2 - 2x \qquad 0 \le x \le 1$$

LOOKING FOR SOMEONE?

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A COMPUTER PROGRAM FOR THE SOLUTION OF DESCRIPTIVE GEOMETRY PROBLEMS

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I. INTRODUCTION

Descriptive Geometry is a brance of geometry that studies relationships between figures in an n-dimensional space and their graphical representations on plances. Accordingly, every descriptive geometry problem involves three basic components: a figure ϕ in space, its representation ϕ' on a plane and an apparatus transforming ϕ into ϕ' or, inversely, ϕ' into ϕ. We will consider here only the case $n = 3$ and representations obtained by orthogonal projection combined with linear scaling and thus, the "transforming apparatus" will be defined by the direction(s) of projection with respect to ϕ and the linear scale factor. Depending on which of the three basic components is to be defined, we identify three types of descriptive geometry problems:

Type 1: Given are ϕ and ϕ'. Define the apparatus that transforms ϕ into ϕ'.

Type 2: Given are ϕ and the transforming apparatus. Define ϕ'.

Type 3: Given are two or more representations of ϕ. Define ϕ'.

It is intended to investigate some general methods of solution of each of the three types of problems and attempt to create computer programs to solve them. This paper deals with Type 1 problems only.

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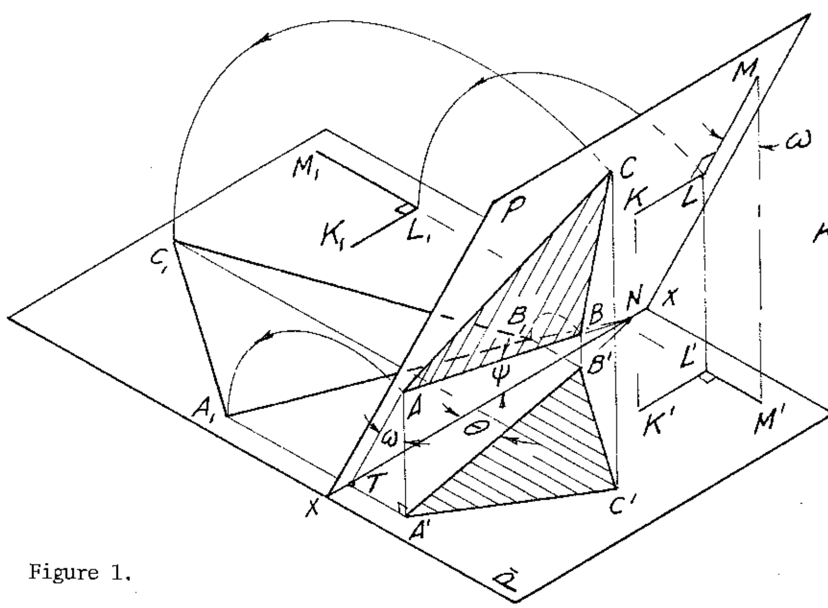

Figure 1.

II. ANALYSIS OF THE PROBLEM.

Let ABC (Figure 1) be an arbitrary triangle in a plane P and A'B'C' its orthogonal projection on a plane P' not parallel to P. Let also KL and LM (KL // P') be a pair of mutually perpendicular lines in the plane P, and K'L' and L'M' their orthogonal projections on P'. Imagine the plane P being rotated about the line XX of intersection of P and P' until the two planes coincide. A_1, B_1, C_1, K_1, L_1 and M_1 are the rotated positions of the points A, B, C, K, L and M respectively. The two triangles, A'B'C' and $A_1B_1C_1$ define a perspective-affine correspondence in the plane P' with XX as its affine axis. The pairs of lines, $K_1L_1 \perp L_1M_1$ and $K'L' \perp L'M'$, define the "principal directions", i.e., two corresponding pairs of mutually perpendicular directions.

Let N be the point of intersection of the two corresponding lines A_1B_1 and A'B', $\angle ANT = \psi$ and $\angle A'NT = \theta$.

$$\text{Then, } \sin\omega = \frac{A'T}{AT} = \frac{A'T / TN}{AT / TN} = \frac{\tan\theta}{\tan\psi},$$

where

ω is the angle between the direction of orthogonal projection and the plane P. We note that the ratio of any two corresponding lines perpendicular to XX equals $\sin\omega$. For this reason, the perspective-affine correspondence may be regarded as a "compression with axis XX and coefficient $\sin\omega$".

Consider now, the following problem: given are two arbitrary triangles, ABC and A'B'C' (Figure 2); it is required to define the direction such that an orthogonal projection of the triangle ABC in this direction is a triangle $A_1B_1C_1$ similar to triangle A'B'C'. The preceding discussion suggests that the problem may be solved by

(a) defining a perspective-affine correspondence which transforms ΔABC into $\Delta A^*B^*C^*$ similar to $\Delta A'B'C'$;

(b) constructing the principal directions of this correspondence;

(c) defining the coefficient of a compression with axis parallel to one of the principal directions.

Since:

1. any two triangles in a plane establish one and only one affine correspondence between two points of this plane;

2. in any affine correspondence there exist two and only two pairs of principal directions.

3. any affine axis XX and a pair of corresponding points A' and A not on it define one and only one perspective-affine correspondence;

4. there exist one and only one compression with a given axis and coefficient of compression,

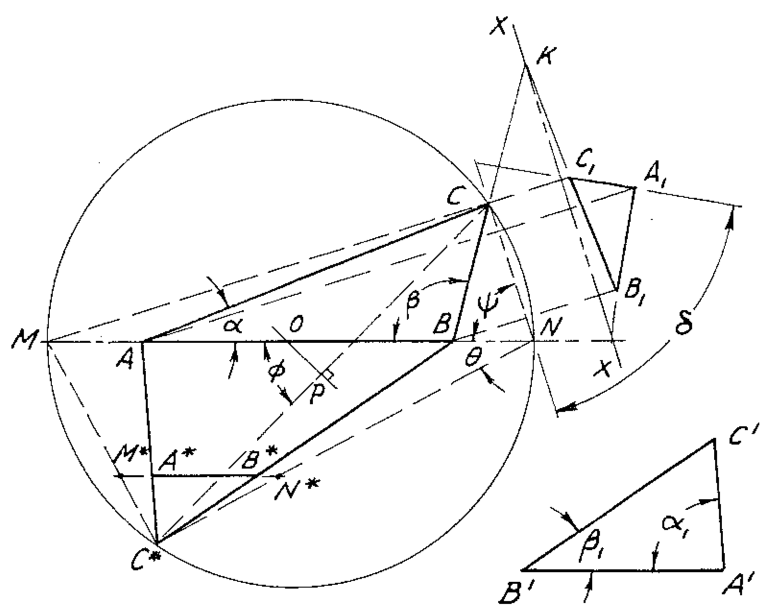

Figure 2.

Type 1 problems have one and only one solution if a pair of corresponding triangles, ABC and A'B'C' is identified in the given figures ϕ and ϕ'.

III. A GRAPHICAL SOLUTION OF THE PROBLEM.

The graphical solution of the problem formulated in Section II is shown in Figure 2 and it consists of the following steps:

(a) Construct Δ ABC* similar to Δ A'B'C'. C and C* may be regarded as a pair of corresponding points in a perspective-affine correspondence with AT as its affine axis.

(b) Construct the two pairs of corresponding principal directions, MC $\perp$ CN and MC* $\perp$ C*N. This may be done by bisecting line CC* with OP $\perp$ CC* and constructing a circle with center O on the line AB and a radius OC.

(c) Construct C*N*=CN and M*N* // AB; - Δ A*B*C* is the "compressed" triangle ABC and the coefficient of the compression is

$$\sin \omega = \frac{M^*C^*}{MC} .$$

Readers wishing to make a model of the two triangles in their relative positions in space, may draw $\Delta A_1B_1C_1$ congruent with Δ A*B*C* so that A_1C_1 forms $\angle \delta = \angle$ NC*A with CN and C_1 is collinear with points M and C and bend the drawing in Figure 2 along the affine axis XX (XX is parallel to CN and passes through a point K of intersection of a pair of corresponding lines, say, BC and B_1C_1) to form a dihedral angle $\psi = \arccos(\tan\theta / \tan\psi)$. In this model, $\Delta A_1B_1C_1$ is an orthogonal projection of ΔABC. The required direction of projection forms an angle $\omega = (\pi/2) - \psi$ with the plane ABC and is in a plane normal to ABC and parallel to line MC.

It should be noted that, in the above construction, it was assumed that $\tan\theta < \tan\psi$. A similar construction, but with the affine axis parallel to CM and compression along C*M, should be performed for the case when $\tan\theta > \tan\psi$.

IV. THE COMPUTER PROGRAM.

A computer program for the solution of Type 1 problems has been written by the author in BASIC. To use the program it is necessary to identify any pair of corresponding triangles, ABC and A'B'C' in the given figures ϕ and ϕ' respectively and to enter the numerical values of α, β and α_1, β_1 - the pairs of corresponding angles. The operator may select an arbitrary set of foreshortening factors which define a single set of orthogonal axonometric axes. The output from the computer is an orthogonal axonometric plot of the ΔABC and an axonometric and a secondary representation (-a "secondary representation" of a line is an axonometric representation of the projection of this line on one of the principal planes, as explained, e.g., in Figure 5) or a line(s) defining the required direction(s) of projection to transform ϕ into ϕ'. In problems with incomplete description of the ΔA'B'C' (e.g., if only one angle or if, say a ratio of the sides of the Δ A'B'C' are given) in general, there exists an infinite number of solutions defined by straight line generators of some conical surface. In this case, the output from the computer is a plot of a set of lines - generators of the conical surface.

The program is based on the following analytical expressions derived from Figures 1 and 2:

$$\sin\omega = \frac{\tan\theta}{\tan\omega} \text{ for } \tan\theta < \tan\psi ,$$

and

$$\sin\omega = \frac{\tan\psi}{\tan\theta} \text{ for } \tan\theta > \tan\psi,$$

where

$$\theta = 0.5 \text{ artan } \left(\frac{\sin\phi}{w+\cos 2\phi}\right),$$

$$\psi = 0.5 \text{ arsin } (w \cdot \sin 2\theta)$$

$$w = \frac{\cot\alpha_1 + \cot\beta_1}{\cot\alpha + \cot\beta}$$

$$\phi = \text{artan } \left(\frac{\cot\alpha + \cot\beta + \cot\alpha_1 + \cot\beta_1}{\cot\alpha \cdot \cot\beta_1 - \cot\alpha_1 \cdot \cot\beta}\right)$$

V. EXAMPLES OF APPLICATION OF THE PROGRAM TO SOLUTION OF DESCRIPTIVE GEOMETRY PROBLEMS.

The program was tested on problems which appeared in the EDG Journal "Puzzle Corner" between Spring 1977 and Spring 1980. Readers who took some interest in the 'Corner may have noticed that most of the "puzzles" offered there are problems easily reducible to Type 1 form. We quote here the reformulated versions of some problems.

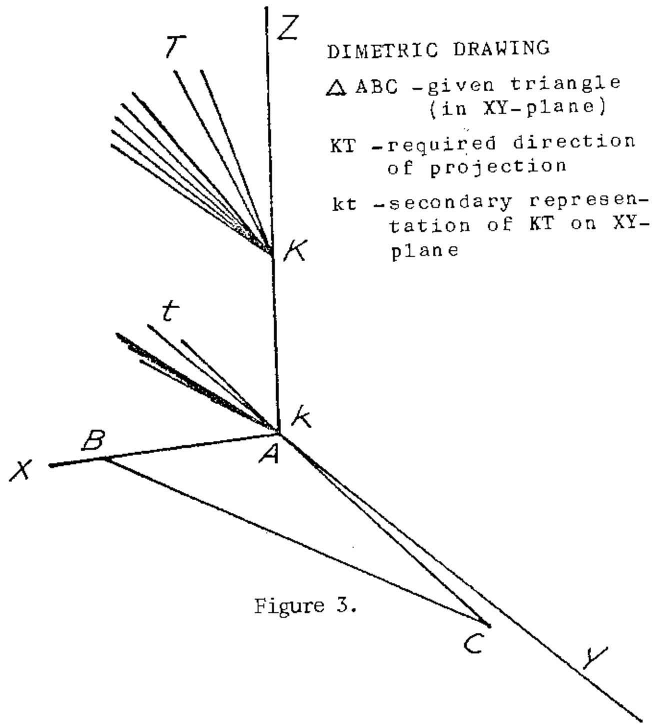

Figure 3.

Example 1 (Spring & Fall 1977 and Fall 1978):

Given are two skew unequal line segments AB and CD; required are the directions of orthogonal projection such that AB and CD appear as two line segments equal in length. This problem will assume a Type 1 form if the word "skew" is replaced by "intersecting", - such replacement does not alter the nature of the pro blem. In this problem, the figure Φ ' is described incompletely and, therefore, in general, the problem has an infinite number of solutions. An example of the computer solution for a particular set of data is shown in Figure 3.

Example 2 ("Perplexahedron", Winter, Spring and Fall, 1979):

Given is the surface of an octahedron formed by eight identical right-angled isosceles triangles as shown in Figure 4; required are two orthogonal projections of the surface in two mutually perpendicular directions. This problem may be easily reduced to Type 1 form if it is noticed that

(a) The given surface has two mutually perpendicular planes of symmetry which divide it into four pairs of triangles of <u>known</u> shape and that

(b) an orthogonal projection of each pair of the triangles in the direction of the axis of symmetry (i.e., the line of intersection of the two

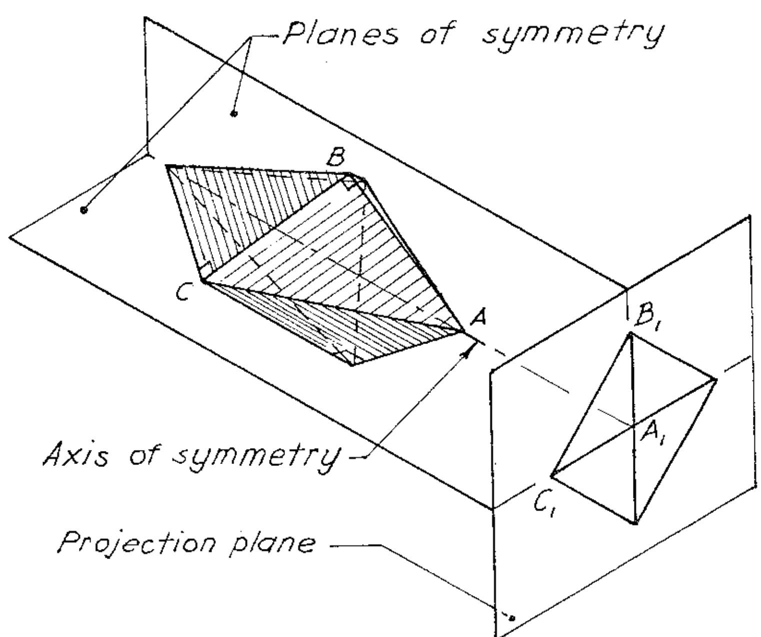

Figure 4.

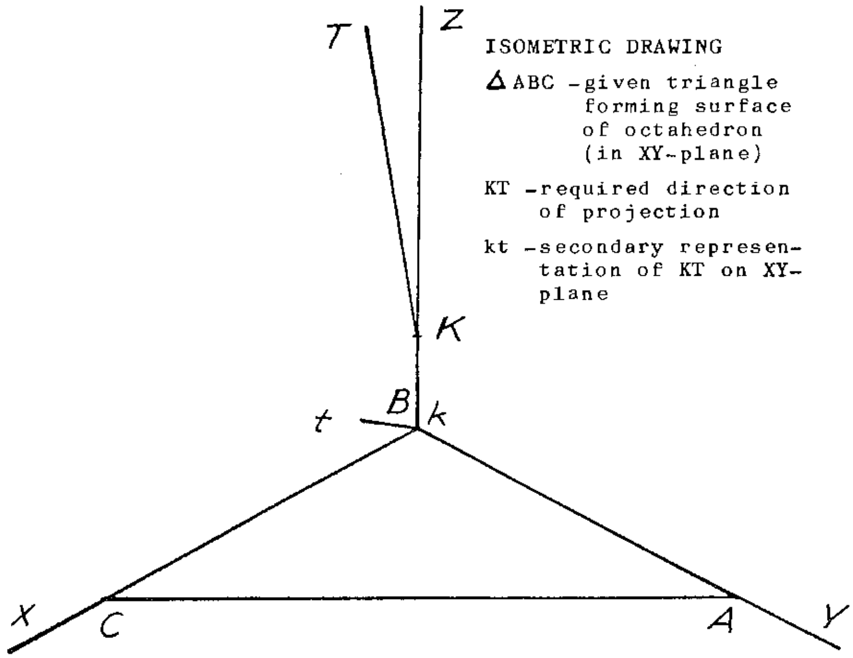

Figure 5.

planes of symmetry) is also a triangle of known shape, - a right-angled isosceles triangle.

The computer output shown in Figure 5, defines the direction of projection (i.e., the direction of the axis of symmetry) relative to △ABC of the given surface. When this direction is known, construction of the two required projections is a trivial problem.

Readers should have no difficulty in recognizing that the "equal-angle" (Fall, 1979) and the current "specified-ratio-of-the-two-skew-lines" (Spring, 1980) problems, are both of Type 1 form and may be solved using the program, or, if preferred, the graphical construction described in Section 3 of this paper.

ENGINEERING GRAPHICS IS ALIVE AND WELL IN THE PEOPLES' REPUBLIC OF CHINA

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My "Class" at the South China Institute of Technology
--Steve Slaby

On March 3, 1981, I received a letter from Professor Zhu Fu-Xi inviting me to present a series of lectures on Theoretical Descriptive Geometry, focusing on Four Dimensional Descriptive Geometry, at the South China Institute of Technology in Canton. I wondered what stimulated the invitation and learned that Prof. Zhu and his colleagues were familiar with my book "Fundamentals of Three-Dimensional Descriptive Geometry" (published by John Wiley, publishers, in 1977) and knew about another book I had co-authored (with C.E.S. Lindgren, on "Four-Dimensional Descriptive Geometry") published by McGraw-Hill in 1968. Through a series of exchanges and correspondence between Prof. Zhu and me, my wife and I found ourselves on Pan Am Flight #1 heading towards Hong Kong via Tokyo Airport on December 13, 1981. From Hong Kong we travelled by a Chinese train to the city of Guangzhau (Canton) in the People's Republic of China - a trip of about three and a half hours..

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The next day began with a series of meetings to get acquainted with the people at the South China Institute of Technology (SCIT) and a magnificent Chinese banquet in the evening (Cantonese food is exceptional).

The general schedule for my stay in China can be summarized as follows:

	Morning Sessions	Afternoon Sessions
Dec. 14	Introduction/Orientation	
15		3 hr. discussion - the recent situation and developments in Theoretical Graphics.
16.	3 hrs - 4-D Descriptive Geometry	
17	3 hrs - 4-D Descriptive Geometry	3 hrs - Introduction to Engineering Graphics Education and Research in the U.S.A. including developments in Computer Graphcis and Computer-aided Design.
18	3 hrs - 4-D Descriptive Geometry	
19	Trip to Seven-Star Crags, 100 kilometers from Canton	
20	Sightseeing - Parks and Historic areas in and around Canton	
21	3 hrs - 4-D Descriptive Geometry	
22	Visit to Fushon and People's Farm Commune	
23	Fly to Beijing (Peking)	Visit Summer Palace
24	See to Great Wall, the White Cloud Gate and Ming Tombs	
25	3 hrs - 4-D Descriptive Geometry	3 hrs - Discussion in Engineering Design Graphics Division, ASEE.
26	3 hrs - 4-D Descriptive Geometry	3 hrs - Discussion - Engineering Education in the U.S.A. with a focus on Princeton University
27	Fly back to Canton	
28	Leave Canton for Hong Kong	

The South China Institute of Technology * is a polytechnic institute which was established in 1952 by combining a number of engineering colleges of the universities in South China, including Sun Yat-Sen and Ling-Nan Universities. Presently the South China Institute of Technology is one of the key institutions of higher learning in South China which comes under the domain of the Ministry of Education of the People's Republic of China, as do all educational institutions.

* I thank Professor Zhu Fu-Xi for all the information he supplied me on the South China Institute of Technology and the Chinese Society for Engineering Graphics.

In 1981 there were 8777 undergraduate students at the Institute in addition to 100 post-graduate students and over 2200 teachers, including 79 professors, 155 associate professors, 1103 instructors and 866 lecturer/assistants, and 2300 staff and workers.

The campus of the Institute is located in a suburb (Shipai) of Canton on about 400 acres of land. The Institute has a Computer Center, 158 laboratories, a closed-circuit television system for 600 students, a video studio and a library with over 700,000 volumes.

The South China Institute of Technology presently is made up of the following academic departments and specialties:

1. First Mechanical Engineering Department

   Machine-building Technology and Automation
   Automobile Technology

2. Second Mechanical Engineering Department

   Casting
   Forging
   Welding
   Metallography and Heat Treatment

3. Civil Engineering Department

   Building Structural Engineering
   Irrigation and Water-power Engineering

4. Ship Building Department

   Naval Architecture
   Naval Internal Combustion Engines

5. Radio Engineering Department

   Radio Technology
   Electrical Vacuum Technology

6. Architecture Department

   Architecture - Design

7. Electric Power Department

   Electrical Machinery
   Electric Power Systems and Automation

8. Automatization Department

   Automatic Control
   Industrial Automatization
   Ships and Dockyards Electrification and Automatization
   Chemical Engineering Automatization and Instruments

9. Computer Engineering and Science Department

   Computer Hardware
   Computer Software

10. Chemical Machinery Department

    Chemical Machinery
    Polymer Materials Processing Machinery
    Light Industrial Machinery
    Corrosion and Protection

11. Organic Polymer Material Science and Technology Department

    Polymer Engineering
    Rubber Products

12. Inorganic Material Science and Technology Department

    Inorganic Non-Metallic Material
    Gelaton Materials
    Radia Ceramic Material and Devices

13. First Chemical Engineering Department

    Chemical Engineering
    Inorganic Chemical Engineering
    Basic Organic Chemical Engineering

14. Second Chemical Engineering Department

    Pulp and Paper-Making
    Sugar Refining
    Chemical Cellulose
    Microbiological Engineering

15. Physics Department

    Semi-conductor Physics and Devices
    Applied Physics

16. Mathematics and Mechanics Department

    Applied Mathematics
    Applied Mechanics

17. Chemical Department

    Chemistry

18. Management Engineering Department (in preparation)

19. Interdepartmental Departments

    Marxism-Leninsm and Natural Dialectics
    Electricity and Electronics
    Engineering Graphics
    Foreign Languages
    Physical Culture
    Correspondence School
    Machine Building Program
    Building Construction Program

20. Research Institute

    Radio and Automatic Control
    Material Science
    Chemical Engineering

21. Centers

    Architectural Design Center
    Computer Center
    Foreign Text Books Center

22. Workshop

    Machinery Plant
    Radio Factory
    Chemical Industrial Machinery Plant
    Rubber Products Factory
    Printing House

The academic degrees awarded by the South China Institute of Technology include the Bachelor of Science, Master of Science and Doctor of Science degrees. Admission to the Institute is by competitive examination, which is designed by the Ministry of Education. This examination is given each summer at the same time in all of the provinces in China.

The undergraduate program is 4 years in length while postgraduate study ranges from 2 to 4 years. Tuition and related costs (room and health services) are free. Student financial aid for board is based on the earnings of the parents of the students and range from zero to twenty-one yuens per month. After graduation, every student is assigned a job by the government.

The Chairman of the Department of Engineering Graphics at the South China Institute of Technology is Professor Zhu Fu-Xi. In addition the department has three vice-chairmen (Prof. Liao De-Lui, Associate Professors Li Long, Ye Bing-jun, and lecturer Jiang Hou-Xiang). The faculty of this deparment includes 3 full professors, 7 associate professors, 32 lecturers and 11 assistants. One-third of the faculty are women!

The following courses of study are offered to approximately 2000 freshmen representing all engineering departments at the Institute:

1. "Descriptive Geometry and Mechanical Drawing" in 150 periods for Machine Building and Ship Building Departments

2. "Descriptive Geometry and Architectural Drawing" in 120 periods for Civil Engineering Department

3. "Engineering Drawing" in 80-100 periods for Chemical Engineering, Electronics, and other Departments.

The department conducts a Teacher-Training Program which includes the following areas of study

1) Descriptive Geometry
2) Mechanical Drawing
3) Fundamental Mathematics for Engineering Graphics
4) Axonometric Projection
5) Perspective
6) Shade and Shadow
7) Computer Graphics
8) Nomography
9) Special Engineering Drawings

The curriculum of the Engineering Graphics Teacher Program, which is a 4-year program, covers the following topics (this list also indicates the number of periods devoted to each area of study):

Subjects	Periods
Politics	186
Physical Culture	100
English	242
Analytic Geometry and Calculus	271
Physics	159
Descriptive Geometry	92
Mechanical Engineering Drawing	151
Mechanics	228
Machine Design	165
Electricity and Electronic	131
Metallography and Heat Treatment	63
Tolerance and Measurements	45
Metal Cutting and Tools	90
Fundamentals of Machine Building	40
Machine Building Technology	96
Metal-Cutting Lathe	60
Axonmetry, Perspective, Shade and Shadows	60
Technical Sketching	42
Fundamental Mathematics for Engineering Graphics	96
Programming Language	64
Computer Graphics	108
Nomography	20
Architectural Drawing	30
Ship Building Drawing	30
Electronic Drawing	20
Chemical Engineering Drawing	20
Graduation Design or Thesis	8 weeks

Two major research projects are underway which are being conducted under the auspices of the Department of Engineering Graphics:

1. The application of computer graphics in building construction engineering.

2. The application of computer graphics in ship propeller design.

Also work is being done on setting up a 4-year undergraduate program of Engineering Graphics, starting in 1983 and a 3-year postgraduate program to begin in 1984. In addition faculty members are involved in their individual research projects.

The Academic program begins with the Fall Term in September of each year (after a 7-week summer vacation) while the Spring Term starts in February after a 4-week winter vacation.

The strength of Engineering Graphics in China is also demonstrated by the Chinese Society for Engineering Graphics and the local Engineering Graphics societies under it which have been set up in 23 provinces, municipalities, and autonomous regions. The Chinese Society for Engineering Graphics was founded in May, 1980 as an academic organization for those engaged in Engineering Graphics science and practice, and it is a member of the China Association for Science and Technology.

The purpose of the Society is to promote the science and practice of Engineering Graphics and to strengthen the solidarity and cooperation among the members so as to make an active contribution to the four modernizations of China.

The objectives of the Society are:

a. To organize academic interchange activities on the science and practice of Engineering Graphics.

b. To encourage the members to make suggestions on the development of China's construction.

c. To carry out the international academic interchanges and to develop friendly contacts with foreign societies and colleagues for Engineering Graphics.

d. To provide Engineering Graphics education in various spheres and different levels for those engaged in Engineering Graphics work.

e. To popularize the knowledge of Engineering Graphics among the people.

f. To compile and publish transactions and popular publications on Engineering Graphics.

For developing academic activities and to promote their implementation the following seven divisions have been set up:

a. Division of Theoretical Graphics

b. Division of Applied Graphics

c. Division of Computer Graphics

d. Division of Graphic Techniques

e. Division of Engineering Graphics Education

f. Division of Graphic Standardizations

g. Division of History and Development of Engineering Graphics

The first National Congress of the China Society for Engineering Graphics was held in Wuhan in May 1980. At the meeting, 71 directors were elected to constitute the first Board of Directors, from which an Executive Committee was formed by 19 directors. The Chairman, Vice-Chairman and Secretary-General of the Board of Directors are as follows:

Chairman: Zhao Zuetian, Professor, Huazhong Institute of Technology

Vice-Chairmen:

Zhu Fu-Xi, Professor, South China Institute of Technology

Zhu Yuwan, Professor, Chiaotung University of South-west China

Zhang Jiuyuan, Professor, East China Institute of Textile Engineering

Chen Jiannan, Associate Professor Beijing Institute of Aeronautics and Astronautics

Yu Tinghe, Engineer, Deputy Director of Standardization Research Institute of the First Ministry of Machine Building

Tang Zhaoping, Associate Professor, Huazhong Institute of Technology

Secretary-General: Tang Zhaoping

Led by the Board, there are four working committies:

1) Academic Activities Committee
2) Popularization Committee
3) Organization Committee
4) Compilation Committee

The main office of the Society is located in the Huazhong Institute of Technology, Wuhan.

The China Society for Engineering Graphics publishes the "Journal of Engineering Graphics" and the "Engineering Graphics News" on a periodic basis.

While at the South China Institute of Technology, I presented my lectures in English (very slowly) to over 100 teachers of Engineering Graphics and Descriptive Geometry. I was kept very busy lecturing almost every day in the morning and conducting seminars in the afternoon, except for several day trips. The Seven-Star Crags are located about 100 kilometers from Canton and are unbelievably beautiful natural wonders. We were then taken to the city of Fushan to see one of the first Bio-gas stations constructed in China which produces over 500 kilowatt hours of electricity per day using two diesel-electric generators run on methane gas. The source of raw materials for the Bio-gas plant came from the city in the form of human waste. The City of Fushan is the ceramics "capital" of China where the main ceramics production facilities are located.

We left Canton for Peking (Beijing) on December 23, 1981, where we spent four days, two of which were devoted to lectures and seminars in Theoretical Graphics and Four Dimensional Descriptive Geometry as well as gneeral discussions on computer graphics and comptuer-sided design, areas which are at tracting much attention in China. In addition, I was requested to discuss the character of engineering education in the United States and specifically engineering education at Princeton. These lectures and seminars were conducted under the auspices of the Peking Engineering Graphics society and took place at the Beijing Institute of Aeronautics and Astonautics with 100-150 teachers participating.

On the Great Wall -- Steve and Karen Slaby

Two days were spent visiting historic/cultural sites including the Great Wall, where we spent the day of Christmas Eve. A marvel of engineering and building construction extending over 3000 miles in length, constructed over a period of about 1500 years. We visited the Temple of Harvest, the Ming tombs as well as the Forbidden City and Mao-Tse Tung's mausoleum. All were marvellous experiences from which one derives a deep appreciation of the richness of the Chinese culture and the long history of the Chinese people. On Christmas Day, following a full day of lectures and seminars, we were feted with a Peking Roast Duck banquet at one of the restaurants known for its preparation of roast duck.

The Cultural Revolution, judging from conversations I had in Canton and Peking was a traumatic experience, expecially for the Chinese intelligentsia and the academic community. The universities were closed down for a number of years and academics were sent to the rural areas with no resources to depend upon, resulting in a survival mode of living which was very costly in terms of human hardships and intellectual development. After the cultural revolution the universities and institutions of higher learning were reconstituted and fairly rapidly became dynamic institutions. The hunger for knowledge in China today is awesome and after over 35 years of isolation the people are eager to reestablish contacts at all levels and as quickly as possible. In my opinion the future of China looks bright but not without major problems ensuing. There is a tremendous drive towards "modernization" and technological development in China is a prime goal as well as being looked upon as a prime mover towards this modernization of Chinese Society. The impact of rapid technological growth in China, however, can result in major destabilizations in Chinese society, especially if "appropriate technologies" are not further developed and adapted to the indigenous conditions and culture.

Bring somewhat cognisant of Chinese history I trust that the proverbial patience and wisdom of the Chinese people will result in proper choices and decisions concerning what technologies are appropriate and which ones are not - resulting in modernization with a "human" face.

My overall impression of the Chinese people with whom I came into contact during my short visit, is that they are a very warm, hospitable people with immense talents and creativity and tenacity. From my observations I came to the conclusion that in spite of their forced isolation from the west (and vice-versa) for over 35 years - the work that is being done in Engineering Graphics and Descriptive Geometry, especially at the higher and theoretical levels, equals and in many cases surpasses much of the work done in these areas in the United States.

I strongly urge that a faculty exchange program be established between the Engineering Graphics and Descriptive Geometry people in China and the United States. As a first step towards this exchange program I am in the process of inviting two professors from the South China Institute of Technology to come to Princeton University for one or two semesters as Visiting Professors. I encourage other colleagues to do the same and we will all benefit from these exchanges and our fields of Engineering Graphics and Descriptive Geometry will be enhanced by this "cross-fertilization".

I proposed to Professor Zhu Fu-Xi and his colleagues in Peking that the Second Internatinal Conference on Descriptive Geometry be held in China in 1984. The response was overwhelming and initiatives in China and the United States have commenced towards this goal.

I look forward to the enthusiastic support of the members of the Engineering Design Graphics Division, ASEE, for these initiatives and also look forward to the Second International Conference on Descriptive Geometry in China becoming a reality.

PUZZLE CORNER

ROBERT P. "PAT" KELSO
DEPARTMENT OF INDUSTRIAL ENGRG
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RUSTON, LA 71272

<u>LATEST PUZZLE</u>
(Continued <u>from Winter '81</u> issue)

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

DETERMINE: The center of the <u>smallest</u>* sphere which is tangent <u>to all of</u> the given lines.

* Because there may exist more than one solution to the old puzzle, we are now asking for the SMALLEST sphere.

Mail solutions before July 15, 1982 to:

Robert P. Kelso
ENGINEERING DESIGN GRAPHICS JOURNAL
c/o Dept. of Ind. Engrg. and Computer Science
Louisiana Tech University
Ruston, LA 71272

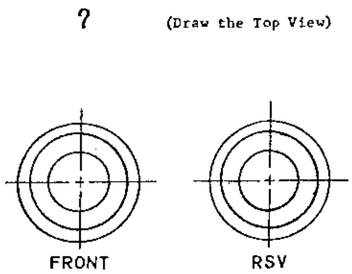


FIGURE I

Old Business

#1. In re the winter '81, "Find: A" problem, the difference between the solutions of Chi Di Lin of the Anhwei Institute of Technology, the P.R. of China, and of Abe Rotenberg of the University of Melbourne, Australia, is that Chi Di Lin's solution is calculated; Abe's is graphical.

#2. As it appeared in the spring '80 issue the 'Corner's solution to the "angle-appearing-true-size" puzzle is wrong. Abe Rotenberg's Conditional Invariant solution (four ruled surfaces) is the only correct solution at this writing. See Puzzle Corner, fall '81.

#3. From the fall '80 issue: Given Fig. 1, (a) does a solution exist and (b) if so, is there a limit to the number of concentric circles for which solutions continue to exist? Chi Di Lin gives us the ultimate answer. (a) yes, (b) no. Fig. 2. His graphics are a thing of beauty!

'From our file of maddening questions. . .

Why are there 360° in a circle -- as opposed to, say 361° or 370°?????

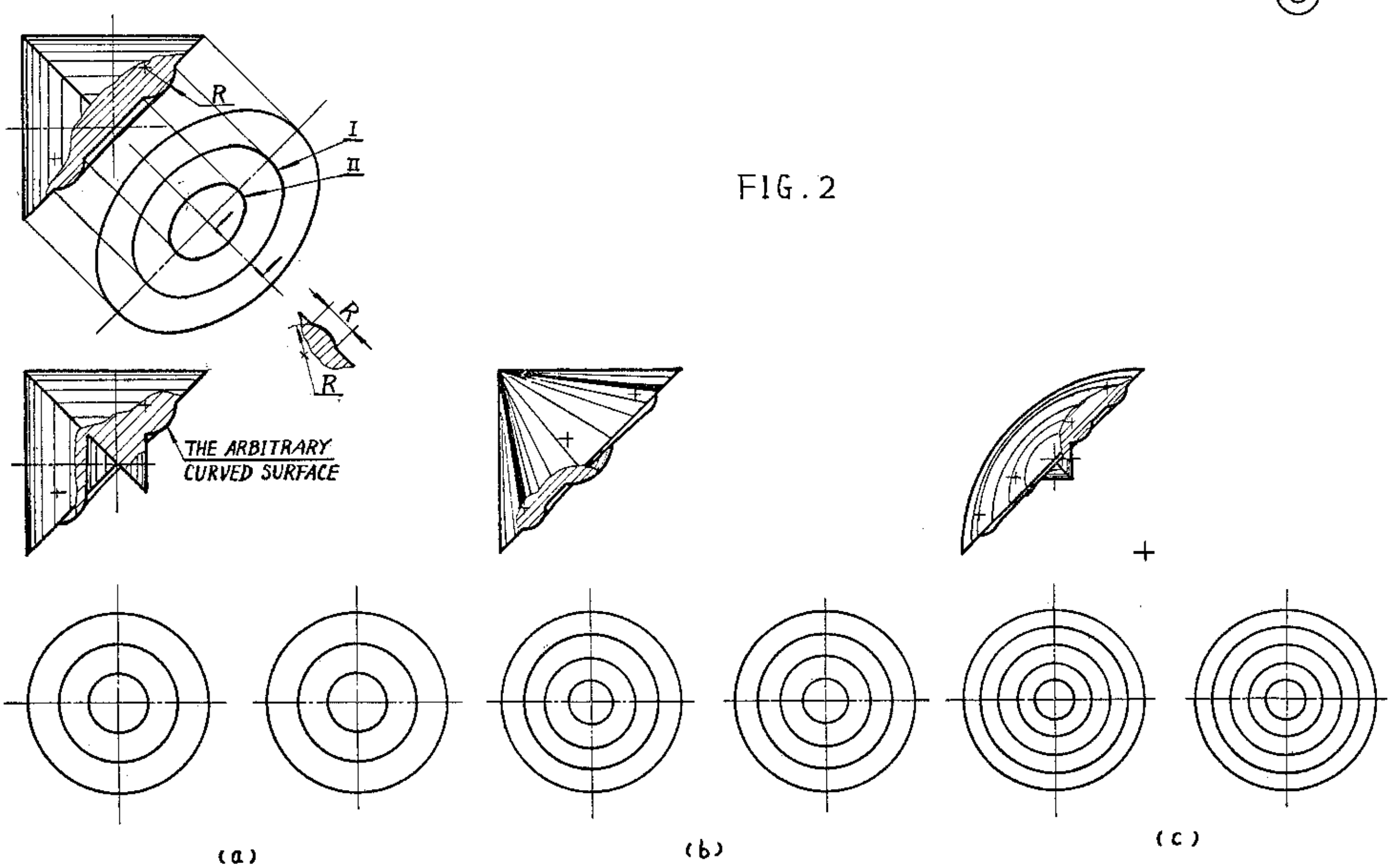


FIG. 2

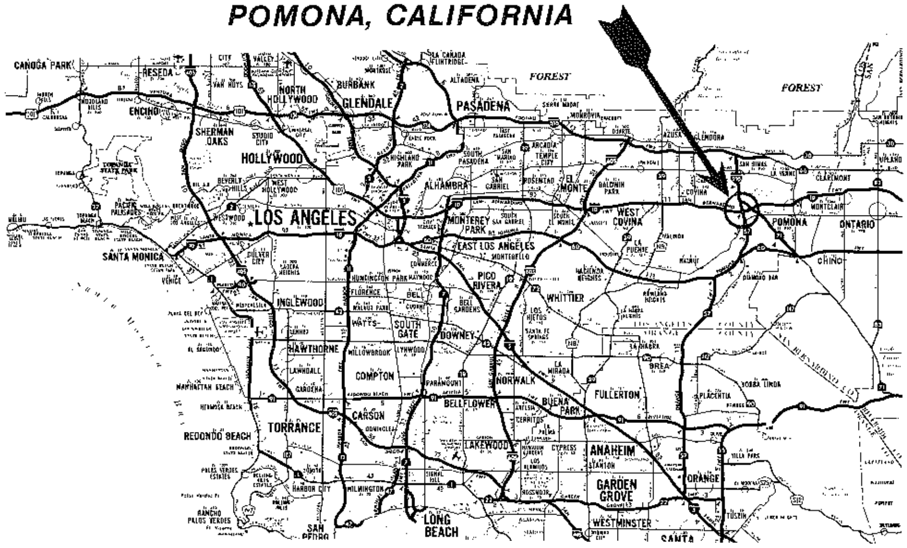
Announcing... CAL POLY 83

EDGD MID-YEAR MEETING
JANUARY 1983
CALIFORNIA STATE POLYTECHNIC UNIVERSITY
POMONA, CALIFORNIA

FLY INTO ONTARIO

OR

LOS ANGELES



TIMOTHY FERRIS

EXCESSIVE
FAITH
IN THEORY
is like living alone in a house
with the
curtains drawn.

EXCESSIVE
FAITH
IN RAW DATA
can turn the mind
into an abandoned house,
wind gusting
through its gaping windows.

G Weber

METRIC

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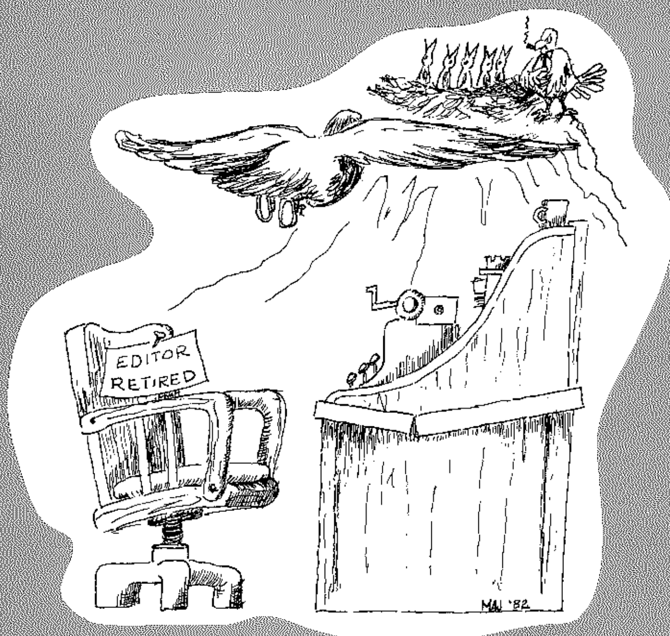
SPRING 1982 VOLUME 46 NUMBER 2



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- Midyear Preview
- Annual Meeting Overview
- Slaby Goes to China

AND MORE!

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