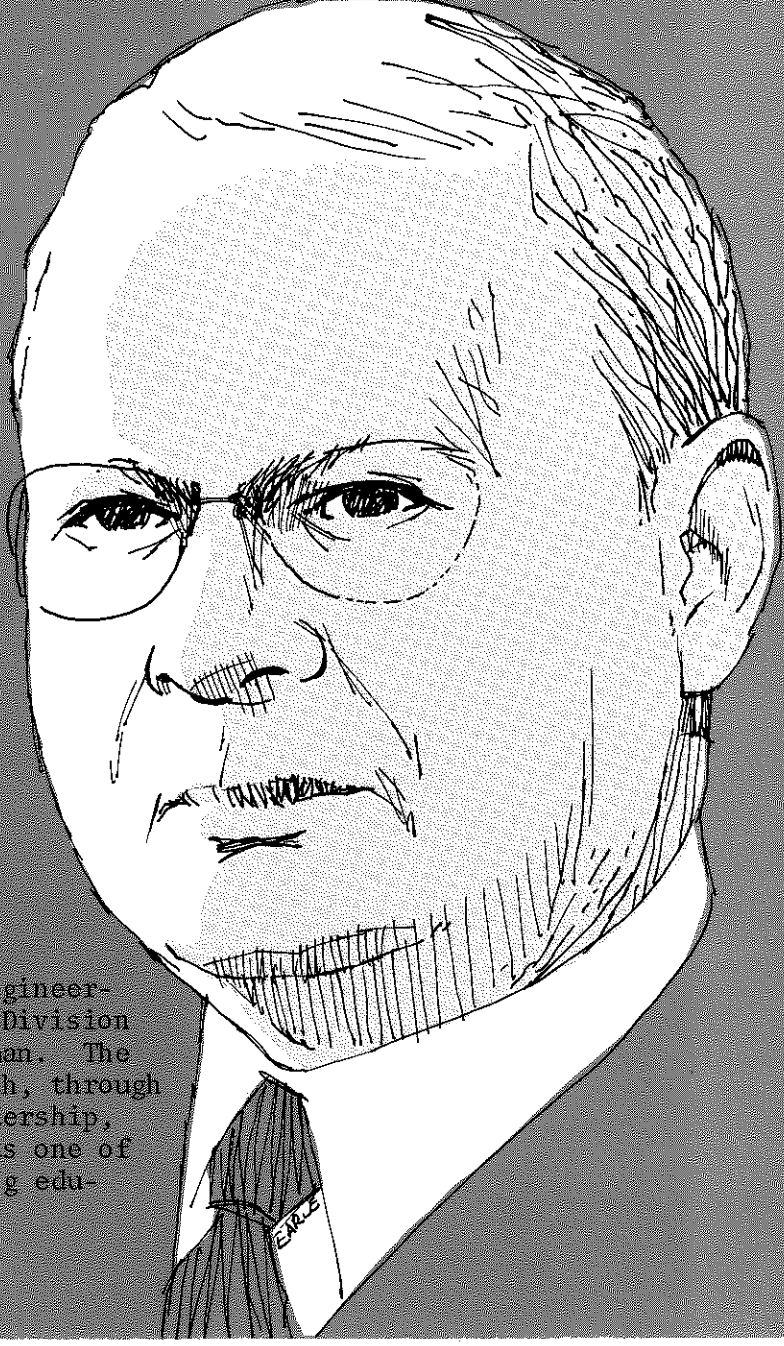
ENGINEERING DESIGN GRAPHICS JOURNAL

WINTER 1974, VOL 38, NO 1, SERIES 113



THOMAS E. FRENCH

Co-founder of the Engineering Design Graphics Division and its first chairman. The late Professor French, through his writing and leadership, must be considered as one of giants of engineering education.

And, for a well-integrated presentation of design and graphics

INTRODUCTION TO ENGINEERING DESIGN AND GRAPHICS

George C. Beakley, Arizona State University;
and Ernest G. Chilton, Stanford University

"The best of the introductory design texts. An excellent balance between the modern and the traditional." Frederick R. Wagner, University of Utah.

Many special features distinguish this text from competitors. For example, *Introduction to Engineering Design and Graphics*

- Emphasizes the importance of engineering to society and human welfare.
- Contains stimulating, *practical* problems to encourage independent thinking.
- Features case studies of typical engineering problems.
- Provides you with a flexible format that you can adapt to your preferred sequence of teaching.

The text is organized into three major, related parts—motivation, design, and graphics. The first part, "The Engineer and Design for Living," defines the role of the engineer in the modern world. In four chapters the authors trace the relationship of the engineer to society in respect to his function as a creator for the benefit of mankind; they discuss design and engineering in nature, and emphasize the importance of aesthetics.

The second part defines "design" as the totality of the engineer's work. The seven chapters of this section explain how the design engineer builds models, experiments, develops ideas, and tests them. The major analytical tools of the engineer are introduced. These first two parts show why students need these tools to become successful designers.

Part three, "Design Graphics," is a step-by-step manual which explains the graphical techniques used by engineers. Numerous clear "how to" sketches emphasize precise graphic communication techniques. This part covers engineering drawing, the use of graphics in problem solving and data presentation, and the development of "true" relations in three dimensional objects.

Eight appendixes offer a wealth of useful tables, graphs, and data. Handy both throughout school years and after, this vast appendix is a compendium of design and graphic supplementary information.

A teacher's manual is available upon adoption of the text.

1973 818 pages $14.50

CONTENTS

Part One: The Engineer and Design for Living. The Challenge. Creative Thinking. Living Designs. Aesthetics and Design. **Part Two: Design.** The Phases of Design. The Design Process. Models. Materials and Processes. Design for Human Satisfaction. Design Economics. Decision Processes. **Part Three: Design Graphics.** Graphic Tools. Sketching and Conceptualization. The Orthographic System. Spatial Relationships of Geometric Elements. Applications and Conventions. Graphic Presentation and Computation. **Appendixes:** Graphics Construction and Symbols. Measurements and Units. Materials and Basic Manufacturing Shapes. Standard Parts Specifications. Anthropometric Tables. Code of Ethics. Murphy's Law and Its Corollaries. PERT. Case Studies. **Index.**

Macmillan Publishing Co., Inc.
100A Brown Street
Riverside, New Jersey 08075

In Canada, Write to Collier-Macmillan Canada, Ltd.,
1125B Leslie Street, Don Mills, Ontario

ENGINEERING DESIGN GRAPHICS JOURNAL

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

Yearly subscription rates:
In U. S., Mexico, and Canada:
ASEE members....................$3.00
Non-members.....................$5.00
All other subscribers............$10.00
Single copy rates:
In U. S., Mexico, and Canada:
ASEE members....................$1.50
Non-members.....................$2.00
All other orders.................$3.50

Back issues are available at single copy rates prepaid and are limited in general to numbers published within the past six years.

Subscription expiration date (last issue) is printed in upper right corner of mailing label, W73 for Winter 1973, S74 for Spring 1974, F75 for Fall 1975, etc.

NOTE
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 ASEE. The editors make a reasonable effort to verify the technical content of the material published; however, final responsibility for the opinions and the technical accuracy of each article rests entirely upon the author.

ENGINEERING DESIGN GRAPHICS JOURNAL OBJECTIVES:

The objectives of the JOURNAL are:

1. To publish articles of interest to teachers of Engineering Graphics, Computer Graphics and allied subjects.
2. To stimulate the preparation of articles and papers on the following topics (but not limited to them):
3. To encourage teachers of Graphics to innovate on, experiment with, and test appropriate techniques and topics to further improve quality of and modernize instruction and courses.

CALENDAR OF MID-YEAR MEETINGS

1973-74 -- New Orleans, Louisiana
1974-75 -- Williamsburg, Virginia

STYLE GUIDE FOR JOURNAL AUTHORS

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

1. All copy is to be typed, double-spaced, on one side only, on white paper, using a black ribbon.
2. Each page of the manuscript is to be consecutively numbered.
3. Two copies of each manuscript are required.
4. Refer to all graphs, diagrams, photographs, or illustrations in your text as Figure 1, Figure 2, etc. Be sure to identify all such material accordingly, either on the front or back of each figure. Your own name should also appear on the back of each. Illustrations cannot be redrawn; they are reproduced directly from submitted material and will be reduced to fit the columnar page. Accordingly, be sure all lines are sharply drawn, all notations are legible, reproduction black is used throughout...and that everything is clean and unfolded. Do not submit illustrations larger than 8-1/2 x 11. If necessary, make 8-1/2 x 11 or smaller photo copies for submisssion.
5. Submit a recent photograph(head to chest) showing your natural pose. Make sure your name is on the reverse side.
6. Please make all changes in your manuscript prior to submitting it. Check carefully to avoid ambiguity, to achieve maximum clarity of expression, and to verify correct spelling throughout. Proffreading will be done by the editorial staff. Galley proofs cannot be submitted to authors for review.
7. Enclose all material unfolded in large size envelope. Use heavy cardboard to prevent bending.
8. Send all material, in one mailing, to:

   James H. Earle, Editor
   Engineering Design Graphics
   Texas A&M University
   College Station, Texas 77843

CALENDAR OF ASEE MEETINGS

1974 -- Rensselaer Polytechnic Institute
1975 -- Colorado State University
1976 -- University of Tennessee

engineering design graphics journal

Published by the Engineering Design Graphics Division, American Society for Engineering Education

WINTER 1974 VOLUME 38 NUMBER 1 SERIES 113

TABLE OF CONTENTS

EDITOR'S PAGE

The Engineering Design Graphics Division is a strong division of many members from various parts of the nation and world. Our Division is also the oldest Division of the American Society for Engineering Education with many fine achievements to its record. The prominence of the E.D.G. Division was gained through many people assuming responsibility and working together.

Your Responsibilities as a member of the Engineering Design Graphics Division can be categorized under four broad headings:
(1) Vote, (2) Serve, (3) Attend Meetings, and (4) Submit Articles. Each of these areas is an important one, but all require progressively greater dedication on the part of the individual.

Soon you will be receiving a ballot to elect officers for 1974-75. Biographical sketches of each of these candidates appeared in the Fall issue of the Journal to assist you in making selections when you are personally unfamiliar with the individuals. The election of the proper man for each position is a very important decision that will bear upon the future of our organization; therefore, it is desirable that we receive as many ballots as possible so those elected will be representive of the Division's membership. Your vote can be cast in a matter of seconds once your ballot is received, thereby fulfilling an important responsibility.

There are numerous positions within our Division that need to be filled by capable, enthusiastic, and responsible people who would like to influence the direction of the Division. We have numerous committees, chairmanships, and offices that are rotated on a regular basis. Many individuals are called upon time and time again to serve in numerous capacities, while others are seldom active. If you are inactive as a member of the Division, you are still wanted by the Division; however if you wish to become active, please notify one of the officers of the Division indicating your particular interest to serve. You will certainly be utilized to your fullest capacities.

The Engineering Design Graphics Division holds annual midyear meetings where its members can meet with fewer distractions than is the case at the annual ASEE meeting where all divisions of the society also meet. The E.D.G. Division offers strong programs at both of these meetings. A responsible member should attempt to attend as many meetings as possible.

Lastly, a responsible member should submit articles to this Journal as a means of expressing his views and also in sharing ideas and techniques that he has successfully applied in his classrooms. This is very beneficial to the readers who are unable to visit firsthand with their colleagues at scheduled meetings. New courses, teaching techniques, methods of organization, and new content areas make excellent reading and serve as valuable guidelines to all of our readers.

In summary, it is fair to say that it is your responsibility to be active in as many of these areas as possible. We think you will find it very gratifying to actively participate in our Division and to assume as many of these responsibilities as time will permit. Voting for a candidate will take only a few seconds, while preparing articles will take more effort. Our Division will be stronger because of any degree of responsibility that you will assume.

Jim Earle

The design process

The five-leg base and pneumatic cylinder adjustments are among the improvements incorporated in this chair series developed by Hans Krieks and Designcraft.

by George T. Finley

Suprchair

Musical chairs is not a game restricted to children. Unfortunately it is all too common in the standard office environment. However, in the office version the problem is not simply a shortage of chairs (there are hundreds of chair-types available) but a shortage of the right kind of seating for the task at hand.

As Joseph Martorano, vice president of marketing for Designcraft puts it: most chairs available today are designed and constructed to support the user in a preconceived, static posture. Since most people work at horizontal surfaces and there have been no realistic adjustments for back support or seat height, Martorano continues, existing chairs do not function as support equipment for serious work tasks, flexibility or varied, dynamic work tasks. This is particularly true, he notes, as modern office procedures rapidly change into new, dynamic environments. Thus, Designcraft, which designs, develops, manufactures and distributes office furniture, had significant indications that a new chair line should be developed.

Designcraft's development of the Suprchair series began with designer Hans Krieks surveying existing chairs in the U.S. and Europe, particularly in Germany and Holland. Krieks found four factors reoccurring, three of which were positive: new concern for the body and proper posture, emphasis on safety, and sophisticated adjustment techniques. The fourth factor was an apparent disregard for aesthetics.

Although Krieks reported back to Designcraft that the specific elements with which he was most impressed were the five-leg (pentapod) base and pneumatic cylinder adjustments, Designcraft was hesitant to pursue these two features at this point because of their sophistication and lack of exposure on the American market. However, as Kurt Grammer, Designcraft's vice president of manufacturing, recalls, additional research including exposure to these concepts at the Hanover Fair convinced the firm of the overwhelming significance of the pentapod base and the efficiency of the pneumatic cylinder.

A project team, including Krieks and Martorano, and headed by Grammer, was immediately formed to develop the new chair series. Other members, all from Designcraft, were: James Agresti, director of engineering; John Fargo, director of materials management; and Fred Navas, director of purchasing. Grammer explains that their 15-month effort involved detailed evaluation, testing and critique of existing seating including interviews with hundreds of office workers. The team reviewed anthropometric data covering the last 75 years and consulted with orthopedic specialists to determine the facts about comfort, fatigue, circulation and other physiological data related to the body in a seated position to perform work tasks.

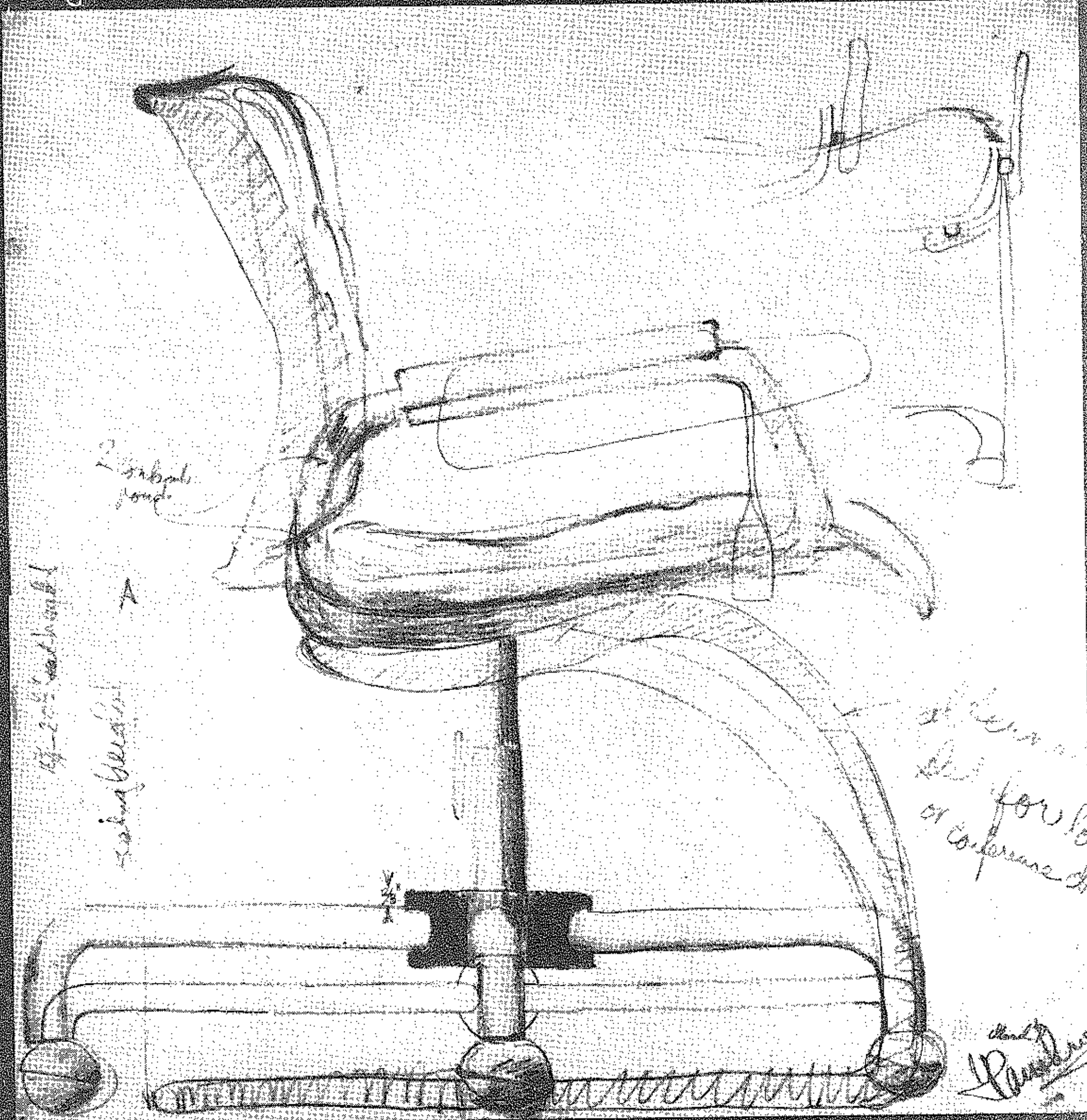
Functional design criteria were established with research into materials and mechanisms that permitted their implementation. And finally, the effort was to package the structures and mechanisms in a manner that provided an aesthetic quality which compromised none of the functional criteria.

The simultaneous activities of the project team and the availability of Designcraft's manufacturing capability led to rapid development of 3D prototypes. according to Martorano. Thus, the design implementation loop was completed with preliminary test marketing.

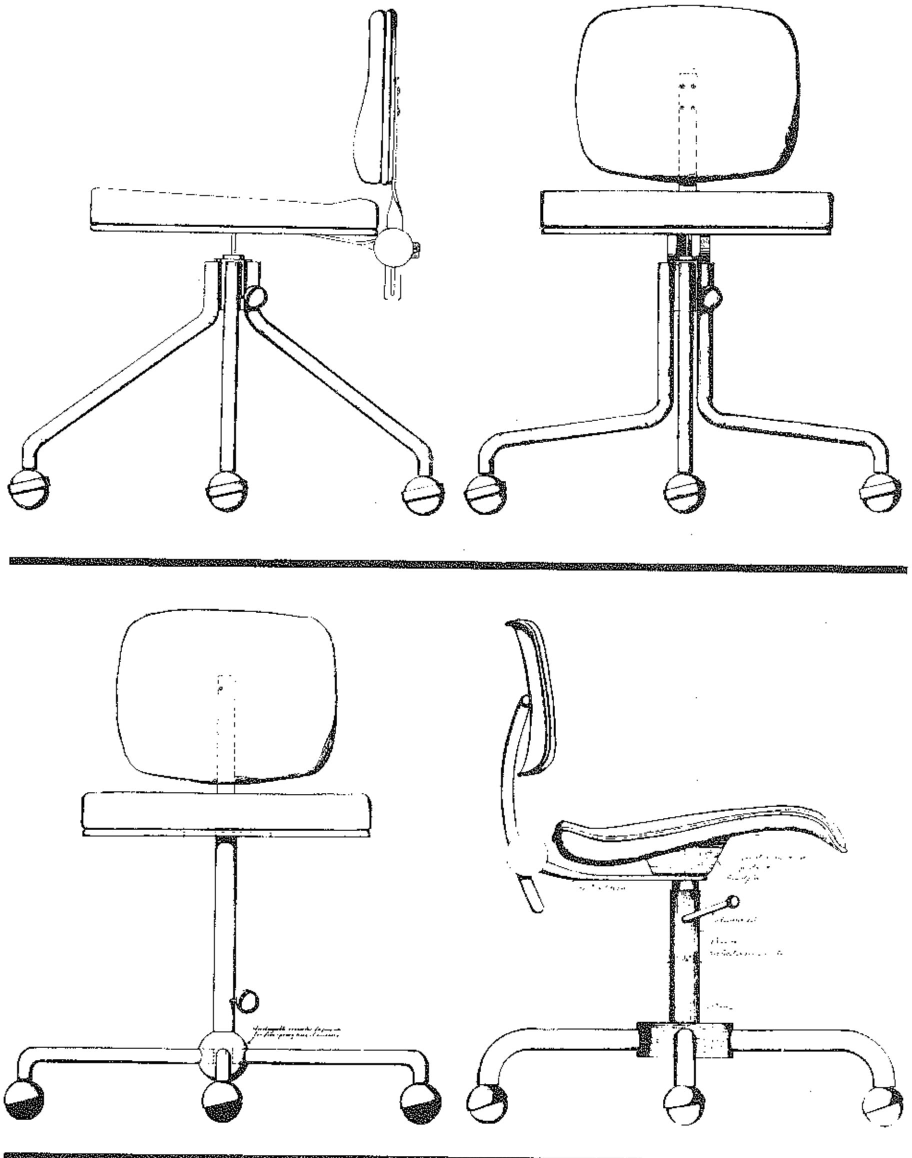
Designcraft's approach to the design was based on the premise that the body has infinite variations in such characteristics as height, weight, dimensions of limbs and resistance to fatigue. As Martorano puts it, there is no "average" person. This is further compounded by variable uses of equipment by the business community and by the individual's varied work tasks. In addition, Martorano notes, more than one person usually uses any given chair and several people will use it during its lifetime of service.

While existing chairs do incorporate adjustments in height, back pressure resistance and back elevation, Designcraft found these are seldom, if ever, used. Martorano points out that most chairs can only be adjusted by tipping the chair or bending beside it to reach controls which require a great deal of physical strength. Thus, Designcraft's research concluded not only the express need for seating which was adjustable, but more precisely, seating which was easily and immediately adjustable—without the user leaving the seated position.

Therefore, two pneumatic cylinders (hermetically sealed inert gas cylinders) were incorporated into the Suprchair. Agresti emphasizes that the cylinders were perfected through five years of product development and were tested to 250,000 cycles of use without substantial wear and without failure (the equivalent of 20 years service).



Hans Krieks' preliminary drawings for the Suprchair (beginning on p. 52) show the development of the pentapod base and the two-piece seat/back culminating in the final design for the work chair (opposite). Bloup (pp. 56–57) is taken from this final drawing.



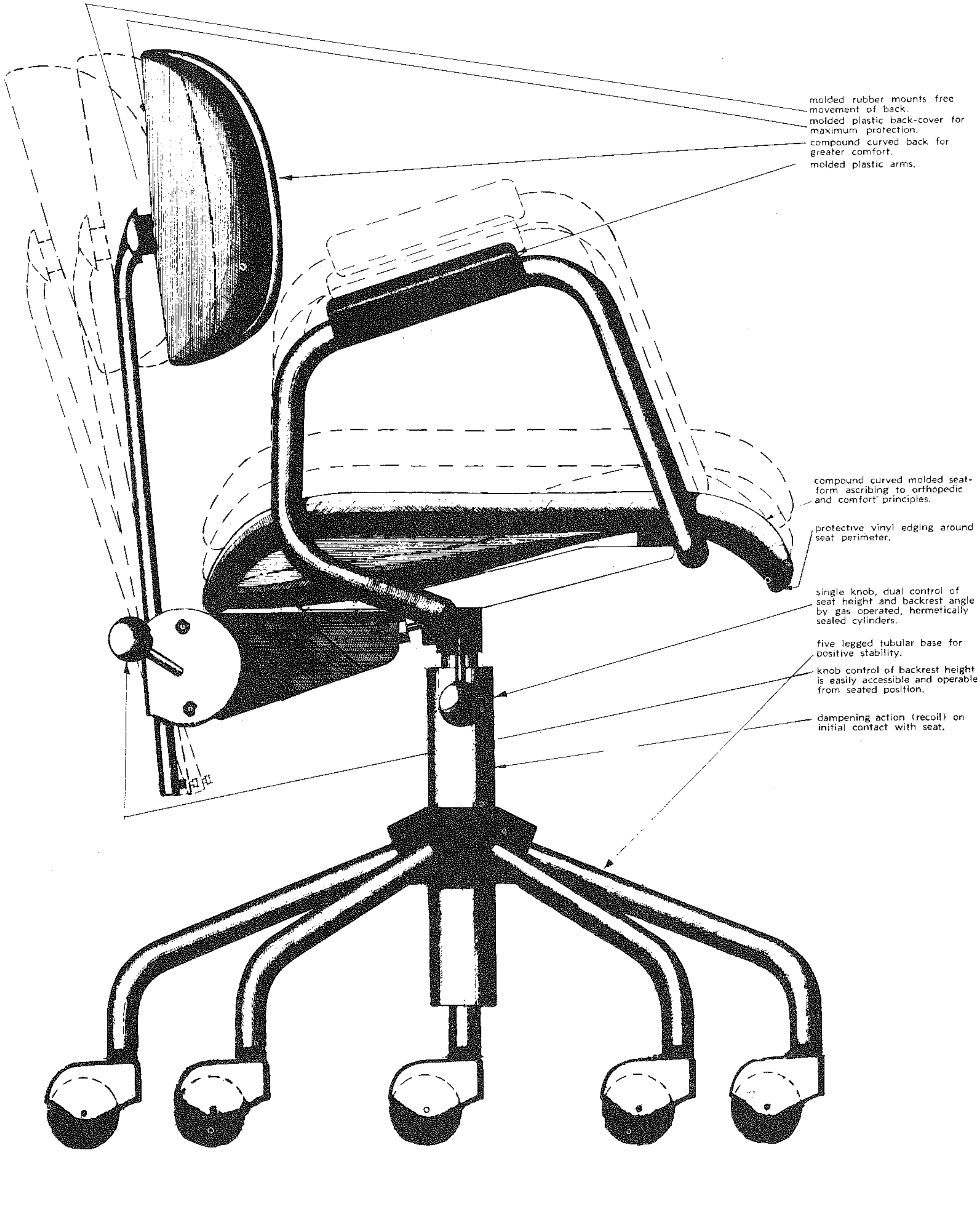
Preliminary designs

The vertical cylinder, which is also the seat support column, allows immediate adjustment of the seat height from a seated position and with little effort. The horizontal cylinder, in the backrest assembly, allows adjustment of the backrest position (forward and back) in the same manner. Both adjustments are controlled by the same lever to the right of the seat. Backrest height is adjustable by a cam-lock device at the rear of the seat, also from a seated position. A double-element, rubber block connector between the backrest panel and backrest bar allows the backrest panel to rotate 30 degrees about the vertical plane, thereby conforming to the posture of the user at work. Agresti points out that an inherent characteristic of the pneumatic cylinder column is free and effortless 360-degree swiveling. The swivel arm chair includes a torsion-tilt mechanism which uses the individual's body weight as the tilting force. Resistance to the torsion-tilt mechanism is adjustable from a seated position by a lever on the left rear of the seat assembly.

Simultaneous development of the chairs facilitated the incorporation of common elements into the entire series, Grammer points out. In addition, all possible attachment devices (for arms, for example) are included on each chair.

The seats and back panels are the same for the work chairs, pedestal chairs and drafting chairs. The seat is a compound curved design of poplar plywood with upholstery over a foam core. It has slightly raised edges, depressed center and cascaded front. This shape, according to Krieks, reduces pressure on the buttocks and backs of the thighs, thereby reducing fatigue and increasing circulation. Backs of these chairs are also a compound curved design to conform to orthopedic principles and are upholstered over a foam core.

The seat/back assembly of the swivel arm chair, side chair and arm chair is a one-piece compound curved shell. The cascade forward edge and canted back are designed in accordance with proper posture principles. The inner portion of this shell consists of four cushions: two on the seat and two on the back. Each cushion contains a pad of different density foam to vary support pressure according to the weight distribution of the user. Attached with a snap-lock fastener, the cushions can be easily replaced as they wear, rather than replacing the entire chair. Their modular


molded rubber mounts free movement of back.
molded plastic back-cover for maximum protection.
compound curved back for greater comfort.
molded plastic arms.
compound curved molded seat-form ascribing to orthopedic and comfort principles.
protective vinyl edging around seat perimeter.
single knob, dual control of seat height and backrest angle by gas operated, hermetically sealed cylinders.
five legged tubular base for positive stability.
knob control of backrest height is easily accessible and operable from seated position.
dampening action (recoil) on initial contact with seat.

MATERIALS AND COMPONENTS

Casters—die-cast hooded casters with ball-bearing mounted wheels of non-marking, hard urethane. The wheel edges are beveled to prevent carpet cutting. Casters are fastened into round tube legs with injection-molded, nylon inserts.
Legs—14 gauge, round, tubular steel—bent into the required configuration, chrome-plated and polished. Round tube allows low-cost fabrication with adjustable tooling.
Cylinder Assembly—support column and hermetically sealed unit with inert nitrogen gas—chrome plated and polished.
Collar Connector—die-cast aluminum. After the legs are welded to the cylinder, the two-piece collar is applied from above and below. Therefore, a mechanical fastening is accomplished in addition to the welds. The open-joint between the two collar pieces assures constant compression on the leg members and thereby additionally prevents any tendency for leg rotation.
Seat Panel Mounting Assembly—provides seat panel fastening and support as well as attachment to cylinder piston. This assembly also contains the cylinder which provides easy and immediate adjustment of seat-back assembly and the cam-lock device which allows easy and immediate adjustment of seat-back height.
Plywood—seat panel and back panel (2 piece—seat-back) ½-in.—5 ply—compound curved—poplar wood.
Foam Core—precut panels of appropriate design. Also available as fire-retardent padding core.
Fabric—available in a wide range of textures and colors; C.O.M.; or fire retardent fabrics, including vinyls.
Arms—14 gauge, round, tubular steel—bent into the required configuration, chrome-plated and polished.
Arm-Rest Pads—injection-molded, fire-retardent ABS.
Seat Edge Trim—extruded vinyl, sewn and stapled to seat assembly. All sewing is done with luggage-quality nylon thread to prevent breaks.
Back Support Bar—14 gauge, oval, tubular steel—chrome-plated and polished. The oval shape is provided to allow maximum friction at contact surfaces of this bar and the cam-lock device.
Back Support Bar—panel attachment—die-cast zinc shape attaches to back panel through double-element rubber block mounts.
Back Panel—Outer Surface—injection-molded, fire-retardant ABS element for protection as well as finish.

FOUR PANEL MODELS

Plywood—one piece seat/back panel—½ in.—5 ply—compound curved—poplar plywood. Spring action of back designed into unit. User's body weight utilizes 2 in. travel spring-action.
Cushions—4 separate cushion panels snap-in/snap-out. This feature allows easy change of cushion due to tear or unusual wear and allows mixed use of fabrics and colors. The 4 cushions are of two different densities to provide proper support as required.
Cushion Attachment—by nylon, snap-block inserts glued and screwed into seat/back panel.

nature also permits various color combinations to be used.

The three base types incorporated into the Suprchair series were designed according to the function of the chairs they support. According to Krieks, safety and stability are greatly increased by the pentapod base which is used on the work chair, drafting chair and swivel arm chair. He explains that the chord distance of the base diameter from point of caster to point of caster is considerably decreased compared to the four-leg base and the resulting closer-spaced support points greatly reduce the possibility of tipping.

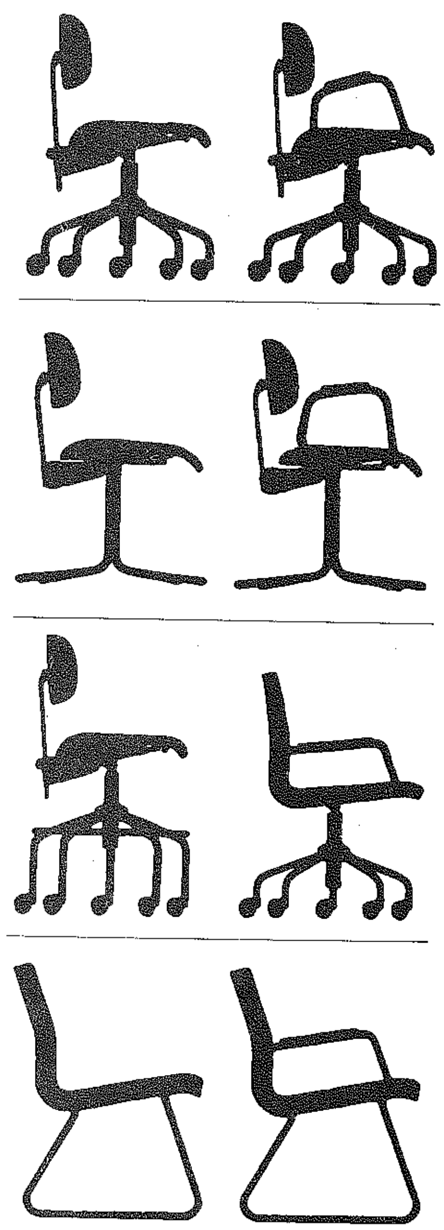
There is also a smaller diameter for the entire base which reduces interference of the chair feet with the user's feet and other office equipment, a factor which is especially significant in the open plan or landscaped office design. Less resistance to rolling and less carpet wear from friction are inherent in the distribution of weight over a fifth contact point.

Although the pedestal chair is intended to be more stationary, and therefore did not warrant a pentapod base, it too has stability as a prime consideration in the base. Since the weight of the chair rests on the four points at the ends of the legs rather than the entire leg, the chair will slide instead of tipping over. The gauge of the tubular steel legs was chosen so that on an uneven floor body weight will flex the three touching legs sufficiently to bring the fourth leg in contact with the floor. For most people the chair will level itself with as much as a one-inch uneven floor.

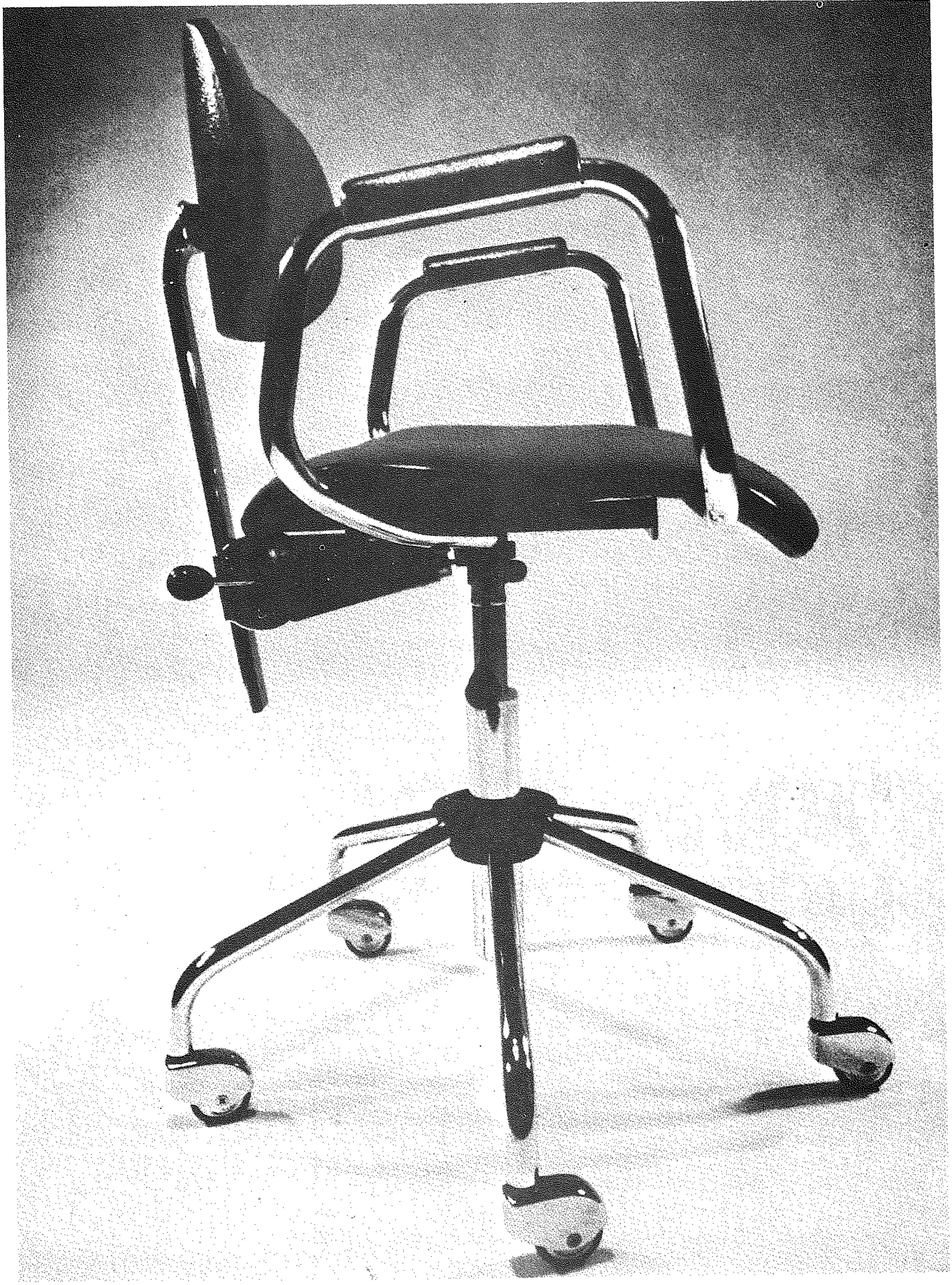
The side chair and arm chair incorporate the third base—the sled. In addition to providing support this continuous tubular configuration serves as a runner enabling the chair to be drawn across a carpeted surface with ease.

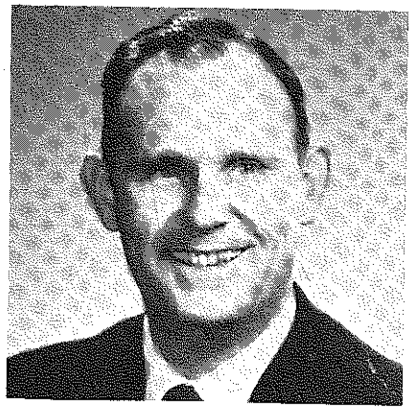
"It's more a gathering of improvements rather than an innovation in itself," Krieks says of the Suprchair. "We were determined to go out on this chair in the same way we did with OES (Designcraft's Open Equipment System)—to work with information about the entity which it was to serve. It's a nice machine—we didn't try to hide any of the mechanical devices but we modified each part so that it had good form in itself. It was really a team effort. There was constant back and forth with the engineers and much more creative design comes from this kind of effort."—*G.T.F.*

Although there are eight chairs in the series, Krieks explains that there are actually two basic chairs which were designed simultaneously. These are the work chair with two-piece seat/back and the swivel arm chair with one-piece seat/back; both use the pentapod base. Six other chairs were derived from these two to fill modified function needs. The work chair with arms, drafting chair (with modified pentapod base), pedestal chair and pedestal chair with arms employ the same seat/back configuration as the work chair; the arm chair and side chair employ the same seat/back configuration as the swivel arm chair, but have a sled base.



Credit: Suprchair logo and photograph, the Collaborative/Eric Porter.





Dr. Charles R. Cozzens
Memphis State University

Ellipse Construction

THE DETERMINATION OF THE PROPER ANGLE OF ELLIPSE TEMPLATE FOR USE IN ORTHOGRAPHIC PROJECTION

By Charles R. Cozzens

Recently I assigned a group of students the task of drawing a trimetric projection of an object which had circles projecting as ellipses on at least one of its surfaces. The students were allowed to use ellipse templates but had had no instruction on selecting the proper guide to use in tracing the ellipse outline. In preparing for the class, I found a method which was new to me and decided to pass it on to others whomight be interested. The method is not purported to be the quickest or easiest, but my students found it interesting and seemed to agree that a thorough understanding of the solution required at least a working knowledge of certain fundamentals of plane and descriptive geometry.

Consider the surface ABC shown in Space I of Figure 1, and suppose we choose to draw the ellipse which would be projected by a circle drawn at point O. Let it be given that the axis AB, AC, and AD in Space I make no special angles with each other, but they are perpendicular respectively to the true length lines, CD, DB, and BC. This arrangement provides for a trimetric projection. Now let it be required to determine the proper template to use to draw the ellipse at O.

Recall that the major axis of an ellipse is true length, equal in magnitude to the diameter of the projected circle, and parallel to any other true length line on the same surface. Then draw 1-2, the major axis of the ellipse, through O parallel to CB. Now recall that the major and minor axis are perpendicular to each other and draw 3-4 through O perpendicular to 1-2. With O as a center and a radius OE equal to the radius of the projected circle, draw the semicircle EF as shown in Space II.

Now, in Space III, draw EG parallel to AB and FG parallel to AC to form the projection of a right angle on surface ABC. From G draw a line parallel to 3-4 to find H on the semicircle. Then connect H and F as indicated. To find K on 1-2 draw a line parallel to HF from J, the intersection of 3-4 and the semicircle. See Space IV. Similarly, to find L on 3-4 draw a line from K parallel to FG.

Realizing that OL is equal to one-half of the minor axis of the ellipse to be drawn, construct another semicircle LM as shown in Space V and from M draw a line parallel to 1-2 to find point N on the original semicircle. Now connect N and O and measure angle P. Finally, select the ellipse template most closely approximating angle P and after properly aligning the guide, draw the ellipse as shown in Space VI.

The results of this procedure may be varified using the more convenient method shown in Figure 2. This method involves measuring the angle P between the edge view of ABC and a line of sight perpendicular to surface BCD.

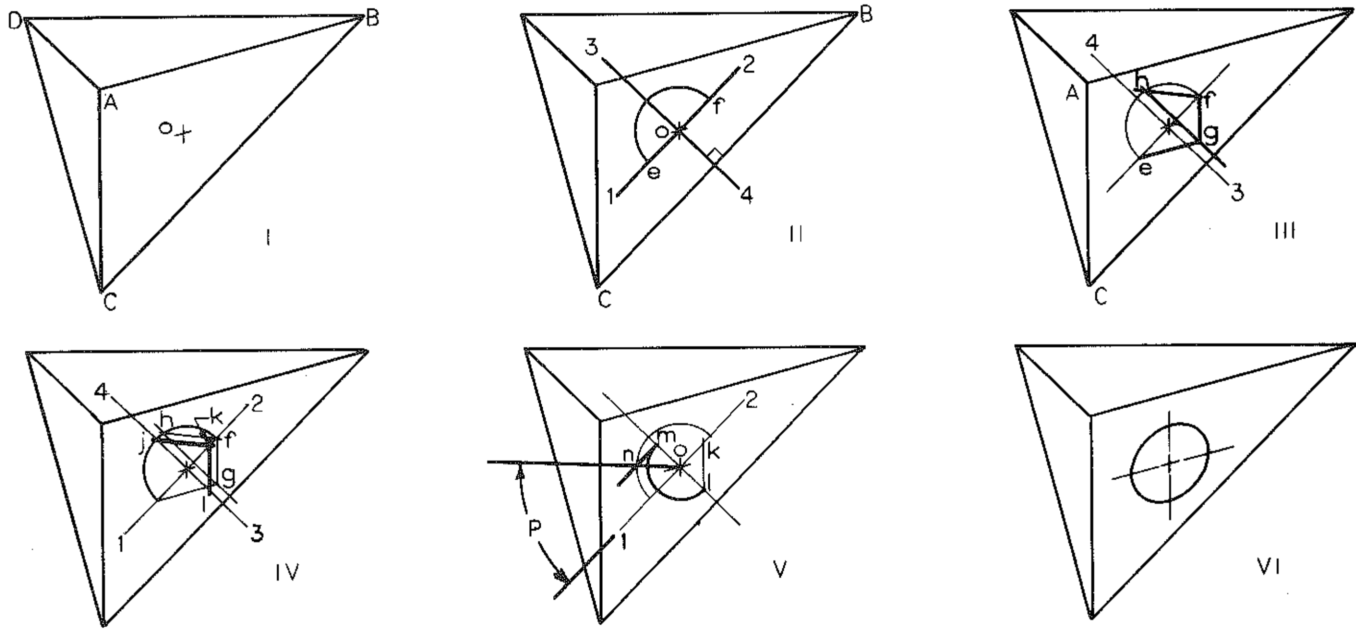


FIGURE 1

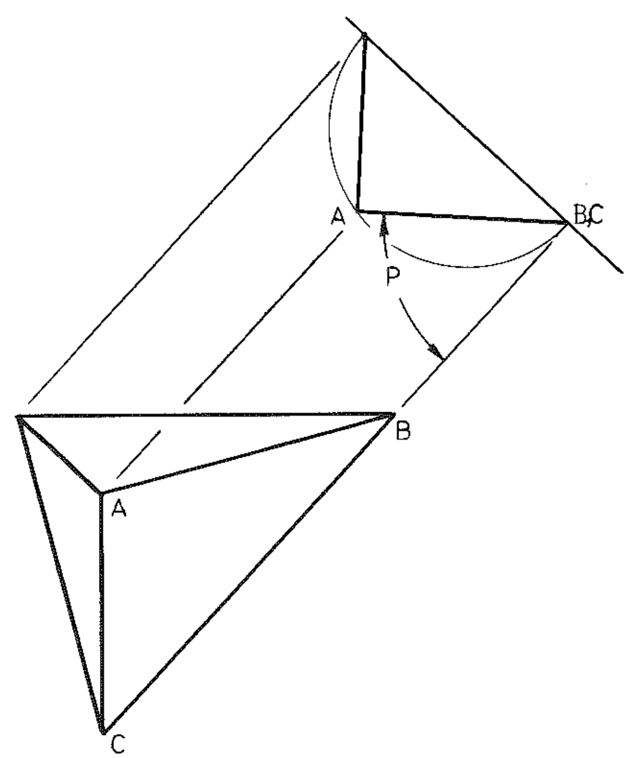


FIGURE 2

Dr. Charles R. Cozzens is in charge of the Engineering Graphics Division, Engineering Technology Department of Memphis State University.

Graphics in the United Kingdom

THE TEACHING OF ENGINEERING DESIGN AND GRAPHICS IN UNIVERSITIES IN THE UNITED KINGDOM WITH SPECIAL REFERENCE TO THE UNIVERSITY OF SWANSEA

by J. F. Watson

Engineering Design and Graphics has, for many years, been part of the undergraduate cirriculum of most Universities in the United Kingdon, however it was the publication of the Feilden Report (Ref.1) some ten years ago which provided the stimulus for the growth of the teaching of Engineering Design and its recognition as a basic discipline in its own right.

While the Feilden Report was specifically related to Design the new teaching approach which resulted has served to bring the important role of the subject of Engineering Drawing into perspective. In many Universities Engineering Drawing, which forms a very important part of Engineering Graphics, was considered as a subject of inferior status taught by lecturers with notparticular experience in this field. Students were only required to reach a minimal standard at the end of the first year and then were not required to become involved with a drawing board and instruments again. This was justified on the pretext that for most engineers it is enough if they can convey information in the form of a series of sketches or general descriptions; they therefore do not need to become competent draughtsmen. The new approach to Engineering Design and Graphics by Universities, although still subject to much discussion, has resulted in the course being considered in much the same light as other basic courses such as mathematics, thermodynamics, fluid mechanics, etc.

It has always been considered that the basic requirements of the undergraduate engineer is for a broad 'science-based' cirriculum. When the rapid advance and present-day extent of scientific and technological knowledge is considered then it is clear that it is only possible to present a fraction of this knowledge to the student within the existing 3 year undergraduate course (and allotted time becomes the restricting parameter in the formulation of the curriculum of any subject). The introduction of a formal Engineering Design and Graphics subject into such a course las posed many problems in deciding the proportion of course time which should be allocated and exactly what the ultimate aims should be.

This article discusses the direction in which the teaching of Engineering Design and Graphics (at Undergraduate and Postgraduate level) has progressed in Universities in the United Kingdom over the last ten years and discusses possible future developments with particular reference to the course operated by the author at the University College of Swansea.

DEFINITIONS

Before entering into such a discussion it is essential to appreciate exactly what the subject of Engineering Design and Graphics includes.

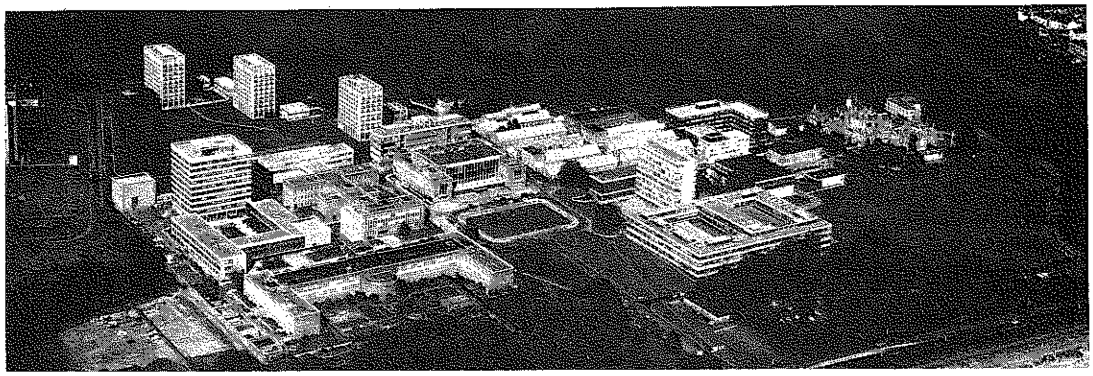
Engineering Graphics is considered as consisting of:-

(i) Graphical methods and analysis techniques
The analysis of data by graphical means includes many extremely powerful techniques and effective instruction is very important. Graphical solutions are in general less abstract than algebraic solutions; hence, the analyst is able to penetrate the problem in greater depth.

(ii) Descriptive Geometry
This is defined as the projection of three dimensional figures onto a two dimensional plane of paper such that lengths, angles, and shapes may be determined.

(iii) Production of Engineering Drawings
In University curricula this is sometimes confused with Descriptive Geometry and it is often considered that once Descriptive Geometry has been learnt the production of engineering drawings has also been mastered. The basic requirement of a set of engineering drawings is to ensure that a component or series of components is manufactured and assembled exactly as the designer intended. The importance of being capable of presenting such information in a clear unambiguous form which will be interpreted correctly on the shop floor cannot be over-emphasized. Inadequacy in this area can prove extremely costly to a firm.

Engineering Design is defined by the Feilden Report (Ref. 1) as "The use of scientific principles, technical information and imagination(together with experience) in the definition of a mechanical structure, machine or system to perform specified functions with maximum economy and efficiency."



It also defined the function of the designer:- "To create a design in as complete a form as possible and then to define this in complete detail in order that the structure machine or system may be manufactured and assembled exactly as the designer intended."

The definition of function indicates the importance in design of design definition and communication.

Engineering Graphics and Design now forms a recognized part of the Undergraduate course in most Universities and there exist many Postgraduate courses where it is interrelated with some specialist topic. Several specialist courses are also in existence which specifically aim at the teaching of Engineering Design.

TEACHING OF ENGINEERING DESIGN AND GRAPHICS AT UNDERGRADUATE LEVEL

The undergraduate course in U.K. Universities is normally a 3 year course with the majority of students being admitted directly from school. The main problem in introducing a specific course in Graphics and Design was that of introducing an expanding course into an already over-crowded syllabus.

Most present day first year courses concentrate during the first half of the year on the teaching of engineering graphics. Graphical methods of analysis usually tend to form part of the syllabus of subjects in which such techniques are generally applied while descriptive geometry and engineering drawing form the major proportion of the basic graphics course. The emphasis is usually placed on draughtsmanship and the ability to produce a well presented engineering drawing that is a work of authority.

In the past many schoolboys have entered the first year of an engineering degree course directly from school with no prior instruction in engineering graphics. More recently they are tending to select a particular career at an earlier age and are taking advantage of the various Graphics courses which are now available to them in schools at both Ordinary and Advanced Levels. Thus, while existing first year degree courses have to assume very little knowledge of all forms of Engineering Graphics, it is considered that in the near future this will not necessarily be the case which may ease the amount of basic groundwork required to be covered.

The second half of the year is where students are normally introduced to the basic concepts of engineering design which is then carried on into the second and final year of the Undergraduate course.

While all Universities realize the importance of design in the undergraduate syllabus the extent to which it is taught the aims of the course and the area of the design/manufacture process to which teaching priority is given varies considerably between Universities.

Fig. 1. illustrates the various steps in the complete design and manufacturing process from initial problem identification to the final manufacture phase which indicates the wide range of activities to be covered by any teaching programme.

Some Universities feel that an Engineering Undergraduate syllabus should still be predominantly scientific in nature and emphasis should be placed on this, simply using design as a workpiece on which to try out the scientific tools learnt. As shown in Fig. 1. this forms an essential part of the design function and generally this type of course is justified on the grounds that industry is more capable of teaching the remainder of the design process.

Most Universities are now responding to the motivation of the Feilden Report and, realising that there is as much a basic requirement to teach the non-scientific aspects of design as the purely scientific, their courses are being suitably remoulded.

Design courses have generally evolved in one of three different ways:-

1. Design teaching based on major "design and make" type projects at both first and second year level with large numbers of students working on one single project.
2. Design teaching based on several small projects each emphasising particular aspects of the design process.
3. Design teaching where emphasis is placed on creativity and the early indoctrination of students into techniques and approaches to design which are formalized and strictly adhered to.

An example of a major "design and make" project was the design and construction of a man-powered aircraft involving approximately 40 second year students at Liverpool University, Ref.2. Experience showed, that while the project was completely successful up to the point where the basic configuration was selected, the subsequent detail design and construction was not.

Although major "design and make" type projects provide a realistic method of teaching design it has been found to be only practicable where there is a small student/staff ratio, preferably as low as six students to each member of staff. Difficulties are encountered in maintaining time schedules in order that manufacture can be completed in the time allocated. Such major projects that have been operated have indicated that in a large group innovation and creative aspects of design tend to be self-motivating. The difficulty arises in getting students to quantify their ideas especially when moving from the creative stage to that of detail design.

Experience has indicated that shorter exercises each emphasising particular aspects of the design process are more effective in the teaching of design at first and second year level.

To teach design as a formal subject with systematic methods of approach before allowing students to tackle any design project is followed in many Universities and has many advantages, the prime one being that students do not get into any "bad habits". The problem is that students tend to look on any formalised method of design as the one they must adopt for every case and become disillusioned when they find that in a real situation it doesn't work out. With this type of course students tend to be encouraged in the early stages of the course to simply be creative and do not pursue the design to any great depth, thus, while many ideas are produced, students do not acquire the same degree of responsibility as in the course involving design and make type exercises.

More recently design courses have evolved which are a combination of all three methods of teaching although a few Universities still operate single major project schemes. The particular combination used by each University depends upon the basic type of degree scheme offered.

POSTGRADUATE AND SPECIAL DESIGN COURSES

Several postgraduate and specialist design courses have become established in recent years. The basic objective of these courses is the creation of an outlook and training of the mind conducive to a successful design engineer rather than in the further acquisition of advanced scientific or technical knowledge.

One example of such a specialist course is that operated by the Engineering Design Centre at Loughborough University, Leicestershire. This centre was established in 1966 and offers a one year postgraduate course leading to a Master of Technology Degree. The work is based upon non-specialised, often innovative, mechanical and electrical engineering and the criterion of success is that the student on completion of the course should be able to lead a small design section in Industry.

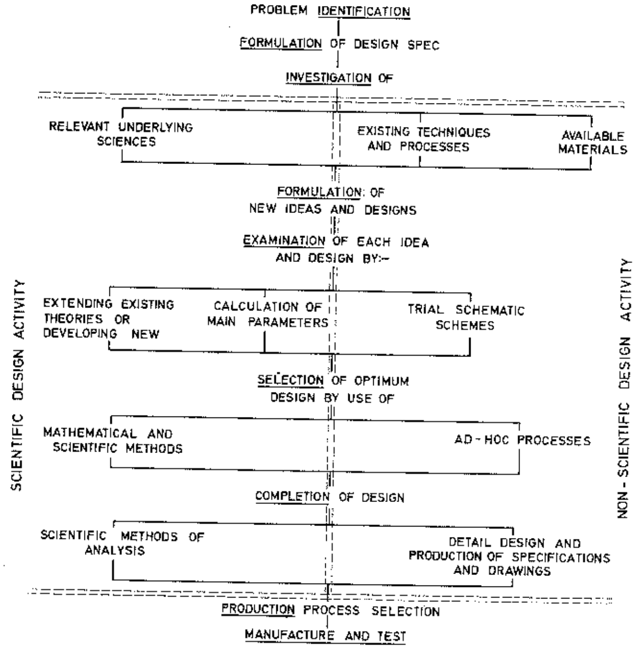


FIG.1 CREATIVE DESIGN WORK

THE DEVELOPMENT OF AN UNDERGRADUATE ENGINEERING DESIGN AND GRAPHICS COURSE IN THE DEPARTMENT OF MECHANICAL ENGINEERING AT UNIVERSITY COLLEGE OF SWANSEA.

The University College of Swansea, which was founded in 1920, is a constituent College of the University of Wales. The Mechanical Engineering Department is contained within the School of Engineering which comprises the departments of Civil, Electrical and Electronic, Mechanical and Industrial Systems Engineering.

Students entering the School of Engineering must be in possession of the General Certificate of Education at Advanced Level in at least three subjects and the degree of B.Sc. General or with Honors may be taken after 3 years of approved study.

Engineering Design and Graphics has been part of the undergraduate engineering curriculum for many years, although prior to 1961 there was no formal recognition of this as a separate subject in its own right. It was introduced simply as an application of the more rigid disciplines such as fluids, elasticity, dynamics, etc. to existing machines and situations.

As the design and graphics course evolved it became increasingly important that a firm intention of the aims of the course was declared and always worked towards, especially in relation to the degree course curriculum as a whole.

The declared intention of the course was to establish in the minds of students an understanding of the process of engineering design from the basic creative aspects to the problems of detail design and production and to establish engineering graphics as a natural and effective method of analysis and communication of thoughts, ideas, and design intent.

It was also recognised that the design course had a very important part to play in linking together(the subject matter of all other dis-

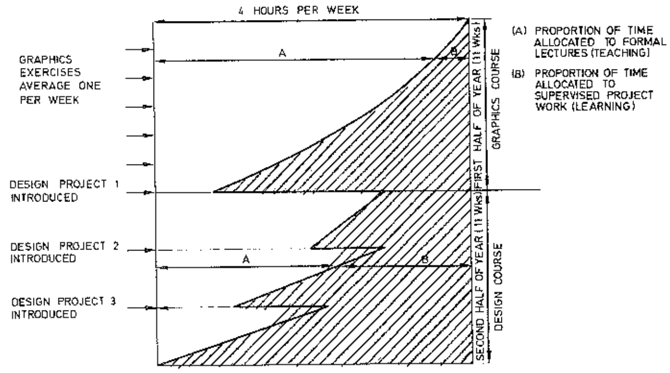


FIG. 2 DIAGRAM ILLUSTRATING HOW TIME ALLOCATED TO FORMAL LECTURES AND SUPERVISED PROJECT WORK IS VARIED DURING THE FIRST YEAR

ciplines) and indicating to students the relevance of this in defining and resolving real engineering problems.

In developing such a course various restraints have to be recognised. Firstly, the allocation of time to the graphics, design activity in terms of both formal lectures and students' own study time and secondly, the requirement for student assessment.

It is also recognised that while graphics is amenable to formal teaching the greater part of a design course should be aimed at creating a situation whereby students learn, more than being formally taught, the teaching aspect of the course concentrating on ensuring that the students learn effectively and efficiently.

This is the basis of all 3 years of the undergraduate design course at Swansea the situation where students learn being created by the careful selection of project work.

FIRST YEAR

The first year of the course is divided into two semesters of approximately 11 weeks. The first semester is allocated entirely to graphics with emphasis being placed on students acquiring good grounding in descriptive geometry and engineering drawing. The total time allocated to the graphics and design course is four hours per week with students being expected to spend a further three hours of their own time each week on unsupervised project work.

It is essential to allow the amount of formal teaching to be varied during the first half of the year - this is achieved simply be allocating a continuous four hour period. In the early part of the year probably only half an hour is used, the remainder being then allocated for supervised project work. This is illustrated diagrammatically in Fig. 2. Formal instruction consists of lectures and demonstrations covering such topics as

Graphical Mathematics

Vector Diagrams

Graphical Analysis Techniques

Drawing Techniques

Projections

Introduction of Cutting Planes

Intersections of Surfaces

Orthographic Projection

Detail Drawings

Assembly Drawings

Projects consists of simple drawing exercises selected such that students are required to apply all of the subject matter of the lectures.

Having acquired the basics of engineering graphics and the subject matter of many separate disciplines, the introduction of students to Engineering Design half way through the first year is very timely. A period of four hours per week is again allocated to the Design course which consists of formal lectures and supervised project work, the extent to which the four hour period is divided between the two varying again throughout the year.

The basic aim of the first year course in design is to expose students to the complete design process from the initial investigation of the problem to the detail component drawings and specification stage.

With such a wide rnage of topics to cover there is a real danger that formal lectures are only able to introduce students to each subject and treat it too superficially. This has been fully recognised and the problem has been overcome by very careful selection of projects which are specifically aimed at requiring the student to extend the subject matter of the lectures just sufficient to solve particular simple problems. It is felt that exposing students to the problems of application in this way and encouraging students to expand on lecture material themselves is more informative than many lectures.

Formal lectures introduce students to such topics as:-

Aspects of Economic Production

Characteristics of Modern Materials

Information retrieval

Standard Components

Design specifications

Systematic design procedures

Three project types are set which are selected to emphasise particularly areas of the design process. Actual problems are changed each year but the three discussed here illustrate the intention of each of the three project types.

Project No. 1.

Design of a shaft, bearings and pully system to transmit a given power at a fixed speed.

Emphasis is placed on:-

Application of simple mechanics and strength of materials.

Production of assembly and Detail drawings.

Selection of production methods.

Selection of Materials.

Location and use of standard components.

For this particular project students are not encouraged to devote too much time to the creative aspect of design by providing them with brief sketches of approximately 8 alternative solutions. They are then required to select the scheme which they consider to be the best and process the design through to the detail stage. This does not inhibit creative thinking, as many students end up by producing further alternative solutions, but it does reduce the amount of time spent by students on generating ideas. In the past it had been found that students liked the creative phase of design and spent too much of the allocated time on this leaving very little time to process the chosen design which ended up being done too superficially.

Each student is required to justify his choice before proceeding with his design - this encourages the student to use his powers of reasoning and brings to the students' attention the fact that with as many as 8 possible schemes to consider he cannot analyse each one in detail, thus there is a need to adopt a "quantifying process" of selection whereby order of value type calculations and qualitative assessments are made to eliminate "non-runners". This is considered to be a very important issue in design teaching.

Project No.2.

Design of an Anti-Back Turning Device for a Gas Circulator in a Nuclear Power Station.

Emphasis is placed on:-

Formulation of a comprehensive design specification.

Use of scientific methods of analysis.

Use of creativity in the generation of possible solutions.

For this project students are only given the basics of the problem and a complete description of the environment in which it has to operate. They are encouraged to produce a comprehensive design specification and to examine all possible methods of solution using creative techniques. The project has considerably more technical content than the first design. While students are required to produce a complete assembly drawing of their final design and materials data detail drawings and production schedules are not asked for. The requirement for the production of an assembly drawing makes the stuent consolidate his creative thinking and makes him more objective in assessing possible solutions.

Project No.3.

Investigation and analysis of existing methods of food containerization with proposals for future requirements.

Emphasis is placed on:-

Information retrieval.

Problem identification.

Formulation of design specification.

Report writing.

Previous projects have firmly stated the problem to be solved. For this project the student is required to identify the problem areas for himself which is often a very important part of the design process.

The project is specifically chosen from topics with which students are very familiar and outside the more scientific area - this encourages the student to think logically and apply common-sense attitudes to the problem and not to simply look for the correct technique or formula to apply.

As may be seen these three project types take the student through the complete design process defined in Fig.1. While the emphasis on each project in order of sequence is opposite to that in the real design situation, from a teaching point of view this is fully justified.

SECOND YEAR

The second year consists basically of Engineering Design and while the course is based almost entirely on project work with specific tutorial periods the subject matter of other disciplines has moved on from basic theories nearer to the application, thus lectures in these topics have a design bias which forms a close link with the project work of the Design Course.

Three basic design project types again are tackled by students, each one again being selected such that students cover the whole process of design shown in Fig.1. The technical content of each project is at a considerably higher level than in the first year and as many subjects as possible are brought into each project. The following are three typical design problems which have recently been used for the three types of project set in the second year.

Project No.1.

Design of a bladed disc assembly for the first stage of an industrial gas turbine.

A fairly rigid specification is set for students to work to with 'life' being the parameter left for the student to maximise. This requires the student to optimise his design in every way and the importance of graphical techniques becomes obvious. Problems in fluid mechanics, stress analysis, dynamics, basic metallurgy and material selection challenge the students' analytical capability. To enable students to cover the amount of work required in the time available they work in groups of three which provides them with an insight into working as a member of a design team.

Project No.2.

Provision of a means of rapidly shutting down a large steam turbine on loss of load.

This is basically a more complex variation on the second Part I project with students generating their own specification and producing alternative solutions for subsequent analysis.

Project No.3.

Analysis of various types of pumps and selection of a particular type for four different specified duties.

While certain aspects of pumping are covered in fluids subject they are made to realise the many problems encountered and is an excellent way of introducing students to information retrieval. They are required to produce a very complete specification for a pump to meet each of the four specified duties. As with the final project of the first year the actual identification of the problem is an important part of this exercise.

THIRD YEAR

The final year of the course is again basically Engineering Design and has two principal objectives:-

(i) To introduce students to design organization, its relationship with other departments of an industrial concern and management problems.

(ii) To consolidate the design project of the first two years by involving students in a fairly major design project working in a small group. (Four or five students).

The first two years of the course have enabled the student to obtain an understanding of the meaning of Engineering Design in its broadest sense and formal lectures on the organization structure and management encompassing all design activities are much more meaningful than if introduced earlier in the course. Topics are introduced as a subject for discussion more than in the form of formal lectures.

Major design projects for the final year are selected from industrial situations and, as far as possible, are a real requirement of an industrial concern. During the first two years it is found preferable to select projects for their suitability as a vehicle for teaching whereas in the final year the main criteria is to involve students in an industrial environment. Students are given only a brief statement of the problem and are required to visit the particular concern and obtain the complete problem directly by consultation with industrialists.

Projects which have been satisfactorily handles by students include:-

Design of a lens grinding machine.

Design of an anti-vibration mounting for surveying equipment.

Design of a means of servicing lampposts.

Design of a versatile vehicle test facility.

CONCLUSIONS

The trend towards a conscious improvement in the teaching of Engineering Design and Graphics at all levels in Universities in the United Kingdom is moving comparatively slowly but progress is being made. In industry where the importance of design is appreciated and the design team accorded proper status, it shows in products which are outstanding, thus it is recognised that every effort to optimise design teaching at all levels should be made.

The present balance between the analytical topics and design/graphics in the present undergraduate course at the University College of Swansea is, we think, about right. Many improvements could be made to the design/graphics course but this would require more time to be allocated and would upset this balance which could result in the scientific-analytical knowledge acquired by the student being inadequate. It is considered that major developments in the future teaching of Engineering Design and Graphics will evolve from the need by industry for engineers with experience in the field of Computer Aided Design(CAD). A recent report published by the Science Research Council(Ref.3) has indicated the potential benefits to industry of a more widespread use of CAD.

A considerable number of Universities are currently involved in major research, concentrating on particular aspects of CAD. Benefits will not be realised unless engineers entering industry are capable of both assessing the potential of CAD in any particular design activity and if applicable implementing its use.

REFERENCES

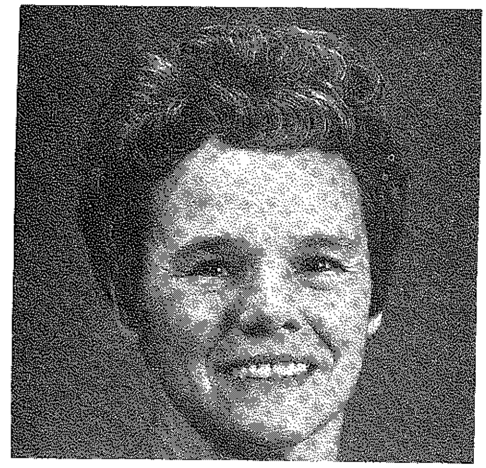
Feilden, G.B.R., "The Feilden Report on Engineering Design". H.M.S.O. 1963

Sherwin, K., "A Major Undergraduate Engineering Design Project". Liverpool University internal communication.

"Report on Research Support for Computer Aided Design". Science Research Council Engineering Board, December 1972.

MEASURE FOR MEASURE—A UNIVERSAL LANGUAGE for INTERNATIONAL STANDARDS

Frances J. Laner
Technical Editor, Technical Information Office
Rocky Flats Division, Dow Chemical U.S.A.
Golden, Colorado



NOTE: Address presented by the author at the Midyear Meeting of the *American Society for Engineering Education, Engineering Design Graphics Division,* in Denver, Colorado, January 17-19, 1973. [Work performed under the U.S. Atomic Energy Commission Contract AT(29-1)1106(RFP-1261).]

Introduction

In these days of chaos, changes, and indecisions, everyone does HIS OR HER OWN THING. My THING will be a part of the program, and I appreciate the opportunity to share it with you. My good fortune is to have two channels through which to communicate—the DOW SPEAKERS BUREAU in which employees share their knowledge with the community; and secondly through the METRIC ASSOCIATION (MA), Inc., in which my membership is as a *Vice President* on the Board and as Rocky Mountain *Region Director* of the 7-state area (the first established MA region). (Figure 1.)

Thirdly, the topic has been a part of my education and work assignments since high school. In addition use was made of metric units as early as 7 years of age, as my parents came from Europe. The *metric* units relate to the universal language to be discussed—simply a language for weights and measures, and the words are the UNITS. Under such a language, a system of units can be set up as standards for exchanges in trade and commerce.

A standard by definition relates to something established by custom, authority, or general agreement. Sometimes, it is an established *practice* simply used by one or more groups, or even one individual. In engineering or design programs, the engineering practice (a way in which things are done technically) leads to adoption of an engineering standard. Generally, this audience would be concerned with *practices* or *standards* adopted to: assure dimensional compatability, qualify the quality of a product, meet methods of testing; or use as a descriptive procedure or standard. For appropriate exchanges in such matters, systems set up may or may not be fully adequate for external communications. Examine the kind of systems already introduced in the world through various practices.

Systems for Weight and Measure

What systems exist, how did they get started, and why are they important in today's world? By name, systems include: The Imperial, The English, The U.S. Customary, The Metric, and The International System of Units. The first three originated in England and are closely related with minor differences. For example, the Imperial (English) System, uses a gallon and a bushel which in the U.S. are smaller than in England by 17 and 3 percent, respectively. The latter two (metric and international) are basically the same system updated and modernized since early origin in France.

Before briefly reviewing some of the history of the commonly called *inch-pound systems* (Imperial and U.S.), emphasis must be given to the initial metric system now known universally as THE INTERNATIONAL SYSTEM OF UNITS. Abbreviated SI after the French name, *Système International d'Unités,* the name was officially adopted in 1960 by the world-making body on international standards. The SI units have been or will be adopted by 95 percent of the world. As noted in the illustrated world map (Figure 2), the remaining countries yet to be committed include:

> The United States; In West Africa: Gambia, Ghana, Liberia, and Sierra Leone; Burma; Muscat and Oman and Southern Yemen; and island areas as Barbados, Nauru, Jamaica, Tonga, and Trinidad.

The SI or modernized metric units offer an advantage since all other units can be derived from the basic seven: The seven basic units have been accurately defined in terms of physical measurements that can be made in a laboratory, except the kilogram (a particular mass preserved in France). The system is simple and coherent and calculations can be performed quickly. With the multiple and submultiple units, the decimal point can be moved from left to right to obtain other values. All multiples are to the base 10 and in accord with generally accepted counting systems in use all over the world. With a unique unit for each physical quantity, a set of symbols and abbreviations eliminates the confusion arising from practices in different disciplines. As compared with the U.S. Customary or English (Imperial), only 3 units need to be learned versus 57 unrelated quantities. The official seven basic units under SI and multiples are noted in Figure 3. (The Practice Guide for use of SI units, E-380-72, may be obtained from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pa. 19103.)

Two supplementary units will be of interest to Engineer designers:

plane angle — radian — rad

solid angle — steradian — sr

Figure 1. Rocky Mountain Region of MA, Inc.

Figure 2. World Map.

Most drawings show the angles in degrees, even those from international sources. However for theoretical calculations, the values in radians (a decimal figure) would probably be used. For example, 180 degrees expressed in π radians equal 3.1416, or 90 degrees ($\pi/2$ radians) equal 1.5708. Most draftsmen would consult the mathematical handbooks for values in radians. Thus, this change may not occur immediately, but it may be of interest to watch the trends.

Engineers, designers, educators—what effects will be produced? In order to transfer to another system, all FOUR-LETTER WORDS will have to be omitted from your vocabularies. Words such as: *inch, foot, yard,* etc. But, it means more—a change in traditional thinking, practices, and a change in the environment. Practices do not change easily, if the environment continues to include old traditional systems. Imagine the frustrations of a jungle creature in an environment foreign to his habits (no offense intended). Adjusting his habits to a world of tall buildings, traffic, crowds of people, etc., would be difficult. (Figure 4.)

Referring again to standard practice categories, the role of measurement units depends upon the specific category. A survey of international recommendations issued through 1969 indicates that 25 percent relate to dimensional specifications; 15 percent to quality; 45 percent to methods of test; and 15 percent to descriptive standards. In the 25 percent group, the units have considerable importance because of size differences. In the latter three, the emphasis would relate primarily to *practices* not formal standards.

Internationally, only 1600 standards in all of these categories have been recommended. Thus only 10 percent of some 20,000 actually exist for use in world trade and commerce.

The situation here should be strongly stressed. Engineers and educators concerned with world and national developments must recognize the urgent need to be represented on world-making bodies selecting and recommending international standards. The International Standard Organization (ISO), the International Electrotechnical Committee (IEC), the American National Standards Institute (ANSI), and many others, as well as various professional, governmental, and trade groups concerned with metrology, have all been active in promoting international agreements. The task appears formidable, but much groundwork has already been undertaken. A complete change overnight in engineering practices

		SI Symbol
Length	metre meter (US)	m
Mass	kilogramme kilogram (US)	kg
Time	second	s
Electric Current	ampere	A
Thermodynamic Temperature	kelvin	K
Luminous Intensity	candela	cd
Amount of Substance	mole	mol

Multiples and Submultiples

Multiplying	Factor	Prefix	SI Symbol
1 000 000 000 000	10^{12}	tera	T
1 000 000 000	10^{9}	giga	G
1 000 000	10^{6}	mega	M
1 000	10^{3}	kilo	k
100	10^{2}	hecto	h
10	10^{1}	deca	da
0.1	10^{-1}	deci	d
0.01	10^{-2}	centi	c
0.001	10^{-3}	milli	m
0.000 001	10^{-6}	micro	μ
0.000 000 001	10^{-9}	nano	n
0.000 000 000 001	10^{-12}	pico	p

Figure 3. Seven Basic Units and Multiples.

would not be possible, but a practical goal to complete *first things first* can be attained.

For example, by starting with *descriptive standards* which include road signs, time clocks, color codes, driving on the left side of the road, etc., a change in environment could be created. Changes should relate to everyday activities, and in these areas, beginnings could include temperature (Fahrenheit versus Celsius), linear measures for heights and distances (meters versus yards), and for weights (kilograms versus pounds). What about time? The whole world recognizes the *second,* defined by so many cycles of radiation

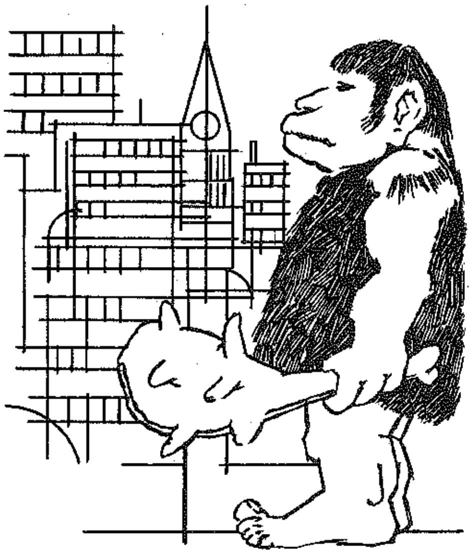


Figure 4. Practices (habits) versus Environment.

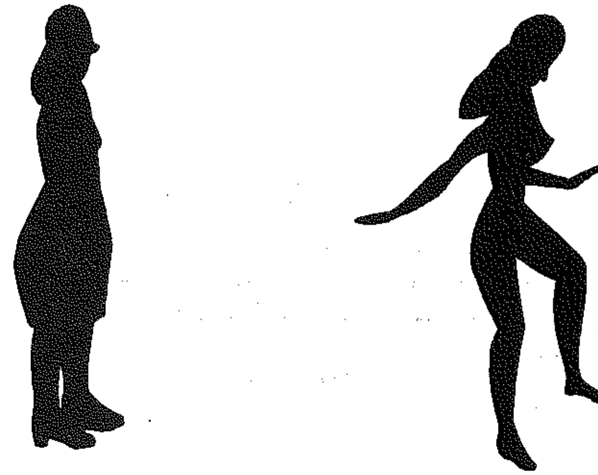


Figure 5. Broad Implications.

Figure 6. New Language for the Shape of Things to Come.

associated with an atomic element. When terms such as days, weeks, months, years, or minutes are used, these are defined simply as *permitted* units for convenience in expression. Many related projects in your discipline areas can relate to the descriptive standards. Perhaps this beginning will lead to a new career for you and stimulate or offer incentive for higher goals, such as working with the committees which draft and evaluate international standards. Publications, posters, flyers for directive purposes, all have a place in creating the environment to THINK AND PRACTICE the SI standards. In teaching, one system of dimensioning should be used in place of dual dimensioning whenever possible.

Specifically, these activities lead to practices which have BROAD implications (Figure 5). And broadly speaking, a change in using four-letter words also means a change in language for the SHAPE of things to come.

Probably this can best be demonstrated by use of a UNIVERSAL standard known in terms of 914–610–914 millimeters (Figure 6), or in your terms by 36–24–36 inches, OOPS that four-letter word!

Not a new shape, but new terminology and a new environment are now required. Not just in America, but for a whole new metric or SI world. For example, what related events have occurred on other continents. In 1965, traditional England announced that by 1975, standards for weight and measure would be changed predominantly to SI or metric units. Most of the Commonwealth countries and Canada immediately followed the course of England. Consider also the formation of the 9 common market countries recently formed to include France, West Germany, Italy, Belgium, the Netherlands, Luxembourg (the original six), and now England, Ireland, and Denmark. The SI NINE could well become the largest trading bloc in the world. With developments in science and industry in Japan, China, Russia, and the Asian groups–all using SI units–should America remain as a lone nonmetric entity?

The U.S. Metric Study Bill

The nation has examined the problems of conversion for some 150 years, but the matter until recently continued to be a low-priority item. After England's announcement in 1965 of changeover, an awareness in Congress increased and in 1968, former President Lyndon Johnson signed into law the U.S. Metric Study Bill (Public Law 90-472). A task force under the National Bureau of Standards was assigned to assess the pros and cons of such a step. A year later, the study was extended to a three-year period. Completed in August 1972, the results were released by the Secretary of the Department of Commerce with recommendations in favor of conversion. The thirteen reports summarizing the findings are now available from the U.S. Government Printing Office, Washington, D.C. 20402 (Coded by SD Catalog Nos. 345, 345-1 . . . 345-12). As far as known, the pro and con debate of the Metric Study represents a *first* in the history of the world in which one issue received a thorough review from various segments of government, industry, education, and the general public. Meetings held regularly in Washington, D.C. during 1970 offered groups, companies, and various individuals a chance to participate in assessment of the questions under study.

Impetus from the study, from favorable reactions in the automotive industry, and from other sectors of the economy, as well as international activities, helped to speed up legislative action. Thus on *August 16, 1972,* the METRIC CONVERSION ACT (S-2483) was passed by the Senate. A similar bill has been introduced to the House (HR-1234) with early action expected. Senators responsible for concerted efforts some years earlier for a metric study bill were C. Pell (D-RI) and George Miller (D-Calif).

The ACT provides for a planned national voluntary program with the target date of 10 years for predominantly metric measurements or SI units in education, trade, commerce, and all sectors of the U.S. economy. To carry on provisions of the ACT, a NATIONAL METRIC CONVERSION BOARD will be established with 11 members (one each from the

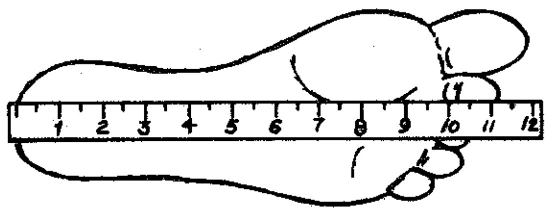


Figure 7. King's Foot as Standard.

House and Senate to be included). Principally, the powers of the Board will be advisory, not compulsory. Consultants and experts on a part-time basis may be employed from across the nation to assist the Board. Within 18 months after appropriations have been made, the Board must submit plans to the President and the Congress on how to achieve change-over in the nation. Immediate attention is recommended in programs for education of the public and toward effective U.S. participation in international standard-making decisions. *The International Standards Act,* not yet passed by Congress, relates specifically to the broad implications of being a part of standards-making committees. Before discussing this aspect, reviewing the post-metric climate and the recent efforts of England since the historic announcement in 1965 to use **SI** units will provide a better understanding of developments.

Historical Summary

Why does the inch-pound environment predominate in the U.S. Historically, the American colonists from England were in a large majority and brought with them the same system as used in their mother country. Thus, the Imperial or English System prevailed, until the nation's government became organized and renamed the system here as the U.S. Customary. Only a few minor differences remain.

Standards and practices for the exchange of goods among countries however began many centuries ago with each culture or civilization developing systems. Space does not permit detailed account of the interesting forms. Body language rather than physical phenomenon was often the basis. For example, the carpenters who built Noah's Ark used a measure of length for the timber or ribs as the distance between their noses and index fingers. Body language was used in earlier times for one of the standards accepted in today's society. Tradition relates the origin of the standard with the Eighth Century in England.

At that time, the European and Asian countries had less uniformity in uses of weights and measures than England. Unity in England was achieved by the West Saxon kings who were the rulers. The first English King was a West Saxon, King Egbert (775-839). The fifth monarch, King Alfred the Great (871-899), along with others had concern for matters of trade and commerce. He was energetic and enterprising, of impressive build (2 meters tall and 230 kilograms in weight), and interested in making improvements for the kingdom. During a day in court, the question of measures for length came up. Anxious to dispose of the matter, he held up his foot to be measured. It came out to exactly 12 equal parts, and a $^1/_{12}$ part was called in Saxon, the YNCH. Since 12 YNCHES equaled one foot, and it was the foot of the ruler, the measurement standard became the ruler of 12 parts (Figure 7). The Roman word equivalent was UNCIAE. The yard also can be traced to the Saxon kings who wore a sash or girdle around the waist. The sash was used as a measuring device and the word *gird* comes from the Saxon meaning waist circumference. Later the translation became *yard* when King Henry I established the yard as the distance from the king's nose to the knuckle of his thumb. Thus through royal edicts and the use of body language, degrees of uniform standardization were achieved beyond what other countries had achieved.

With a lapse of almost a 1000 years since the Imperial System began, changes were occurring elsewhere. One of the outcomes of the French Revolution related to proposals (1790) for initiating a simple coherent system for uniform standards to be used among countries. Consistent with scientific practice, physical phenomena rather than body language became the bases.

The unit of length was to be a portion of the earth's circumference and measures for capacity (volume) and mass were to be derived from the unit of length. Further, larger and smaller parts of each unit could be formed by using multiples and submultiples, or by dividing or multiplying the basic units by 10. Calculations could be performed quickly by a simple shift of the decimal to the right or left. The unit of length was named the meter (metre), derived from the Greek word *metron* meaning measure.

The metric unit of mass, called the gram, was defined as the mass of one centimeter (a cube $^1/_{100}$ of a meter on each side) of water at its temperature of maximum density. The cubic decimeter (a cube $^1/_{10}$ of a meter on each side) was the unit of fluid capacity. Later the term *pinte* in French became popularly known as the *liter* (litre) defined as a cubic decimeter. Because of universal acceptance, its use has continued.

Before 1790, the King of France had written to the King of England asking that he join with France in initiating world action to adopt the metric units for standards. England did not reply to the letter preferring to go it alone with Imperial units. France persisted in her promotion efforts and from 1790 to about 1840 only a few nations followed the trend for metric adoption.

In America, George Washington well aware of overseas developments, stated in his first Annual Message to Congress in January 1790 that . . . *uniformity in the currency, weights, and measures of the United States is an object of great importance, and will, I am persuaded, be duly attended to.* In his second (December 8) and his third (October 25, 1791) messages to Congress, he again repeated his recommendations. Other government officials presented similar recommendations, but Congress was slow to take action. Perhaps one of the reasons related to the times. Most Congressional members represented agricultural pursuits rather than scientific programs and could not foresee the end for metric standards. Or perhaps because no standards had really been agreed upon, no action appeared necessary. Some acts had been passed relating to standards, and the important matter of coinage brought enactment of the ACT OF 1866 (July 28, 1866, 14 Statute 339, HR-596), which legalized the use of the metric system of weights and measures in America. President Abraham Lincoln avowed he would enforce metric standards use before the end of his administration, but was not able to complete his goals.

One must remember also that communications in those days could not be as easily accomplished among countries as it is today, and Congress was cautious in acting on new proposals from the outside. Nevertheless, progress was being made overseas, and in 1875 France invited all interested nations to participate in a meeting to consider standards for international uses, and to establish a permanent body for negotiations and acceptance of standards. Known as the *Treaty of the Meter Convention,* the meeting included some 20 countries of which 17 including the U.S. became signatories. England, Greece, and the Netherlands did not sign with the others. The international body of convention members, the *GENERAL CONFERENCE OF WEIGHTS AND MEASURES,* was set up and meets periodically to ratify improvements or refinements related to metric standards. Under the Treaty, all member nations received prototypes of the meter and kilogram standards, and most of the American states also have been provided with prototypes by the Federal Government.

The English Profile

During my recent visit to England in July 1972, ten days were spent in reviewing the efforts undertaken by the BRITISH METRICATION BOARD. Acting for the *Rocky Mountain Region* of the Metric Association (MA), I presented the Board with a metal sculpture made from pioneering materials of the American West to epitomize their efforts, give recognition to their achievements, and to express appreciation of the MA for their cooperation over the years. Striving to overcome the many obstacles and problems of changeover from a traditional long-term environment of another system, the Board has done some outstanding work in the face of much opposition. Although the problems in America may be similar, recognition must be given to the differences on the two continents to understand future needs. In England, industry took the lead and Her Majesty's Government followed when advised that a majority of the members of the Federation of British Industries favored changeover. Secondly that the initial opposition in 1950 from commerce and industry in England had changed with more and more countries, particularly the Commonwealth groups, moving to adopt changeover. Thus, general government support for the principle and timing of the change was obtained when the final published results of a 1963 survey made by British Standards Institution confirmed favorable industry support. With industry taking the lead and the Government supporting changeover, the educational groups also made plans to keep pace with the changes. With a target date of 1975, and already three-fourths of the way completed, England will achieve the goal for predominate **SI** uses.

In America, industry, government, and education represent three separate entities. As a result, one group may begin activities of changeover without support or endorsement from the other two groups. Although the American National Standards Institute (ANSI) follows the pattern for making standards similar to that of the British Standards group, the U.S. government has not in general given ANSI needed financial and project support as received by the BSI by the British Government. In this area, the INTERNATIONAL STANDARDS ACT has significance and importance, and goes beyond national interest for a changeover. Thus further study is recommended and urged.

Activities related to metrication in England reveal similar steps to those of the U.S. efforts. For example in 1864, a METRIC ACT was passed to permit the use of metric system units in contracts (1866 in America). Later in 1871, a bill in Parliament to make the system compulsory was rejected by the House of Commons by 5 votes. In 1897, a Weights and Measures Act made metric units lawful in trade and commerce. Later, decimalization of the currency also stimulated awareness but action was delayed. In America, U.S. coinage (1875) was set up under metric standards. In spite of these steps, interest waned in both continents and no high priorities were given to changeover in other areas.

Finally, the 1965 announcement to go **SI** in England brought earlier efforts to fruition. Opposition by the various conservative members in Parliament and by the press added to the normal obstacles and frustrations of change, but the dedication of the BRITISH METRICATION BOARD members have admirably surmounted many hurdles. In England, the construction industry was the first to embark on intensive preparation for changeover. Coordination with HER MAJESTY'S GOVERNMENT and the BRITISH STANDARDS INSTITUTION produced effective results. The electrical and engineering industries have made remarkable strides and will easily meet the target date. Much more can be told of the British foothold, but again space limitations prevent discussion.

Engineers, designers, and educators—your experiences and versatility in using various systems give you a foothold also. Transitions probably will be less difficult, as in your work disciplines some knowledge of **SI** units already exists. WHEN to start, HOW soon, and WHAT effects will be produced for complete changeover?

Proposed Actions

After preparing a suitable environment for learning and thinking in **SI** terms, begin to evaluate immediately what needs to be done, a time table, a program, a cost study, and education and training plan. From the experiences of some of the British companies, a crash program for change, simply to change, has been found costly and unnecessary. The three distinct phases, recommended in the *British Metrication for Engineering Management* manual (available from Metrication Board, 22 Kingsway, London WC2B 6LE, England), are: *investigation, programing an action plan,* and *implementation.* Importantly, senior management must be involved and should support the *investigation* phase by proper coordination and authorizations to other levels. All areas of the company activities should be reviewed in order to avoid time loss and unnecessary expense.

Under *programing,* dependent on the company size and activities, an estimate of identifiable costs of change should be made. A time span for completion of changes and evaluation of the benefits should be included.

Implementation will not be a major problem if judicious judgments of *first things first* have been made.

Before these phases are introduced, outline informally to the various units or departments involved why the changes are being considered and present some of the background of the status of changeover in national and international groups. Then for internal use, issue bulletins, charts, publications, up-to-date briefs, names of responsible individuals available to answer questions, and an informal teaching or training class in the fundamental areas of change and the basic units. Later the classes can be expanded to be more comprehensive when plans materialize to a degree that definite changes can be made in machines, inventory, procedures, etc.

Secondly, a coordinator in the specific group area should be appointed to examine the variety of resources that exist within the area, outside the area, and make a study of what has already been done by others. The resource material includes programs carried out for changeover; lists of companies producing metric materials and tools; plans or guides in various discisplines; bibliographies; orientation studies; and case histories of countries involved in changeover. Space limitations do not permit complete details, but resources at the end of text can provide information relevant to changeover. Some of the companies listed have already advanced beyond the three phases. Changes can be initiated to improve old products, to phase out unneeded procedures, obsolete equipment, old inventory items, and to reduce accounting costs—but planning must be done.

Returning to the early uses of body language to set standards in which parts all fit, perhaps an analogy to a song may stress the necessity for components and parts to be standardized (Figure 8) and where to start:

"The headbone is connected to the shoulder bone,

the shoulder bone to the back bone, . . .

ADVISEDLY, *first things first*—measure for measure—not the leg bone to the back bone, ...

RESOURCES

American National Standards Institute, 1430 Broadway Street, New York 10018
"Guide to Impact of Metric Usage . . . ."
"Orientation for Company-Metric Studies (mechanical products)"

American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103

Beloit Tool Corporation, Rockton Road, South Beloit, IL 61080

The British Metrication Board, 22 Kingsway, London WC2B 6LE, England

Caterpillar Tractor Company, East Peoria, IL 61611

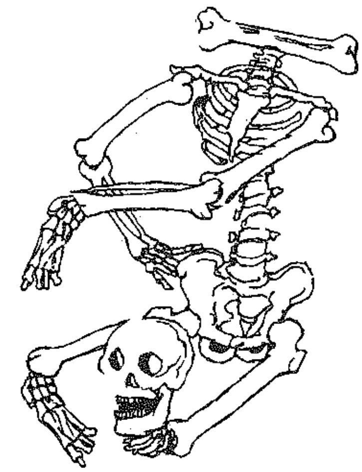


Figure 8. Headbone to _____?

Ford Motor Company, Detroit, MI (Write Lima, Ohio also)

International Business Machines Corporation, Old Orchard Road, Armonk, New York 10504

The Metric Association, Inc., Sugarloaf Star Route, Boulder, CO 80302 or 2004 Ash Street, Waukegan, IL 60085

National Aeronautics and Space Administration, Marshall Space Flight Center, AL 35812

National Bureau of Standards Metric Information Office, Department of Commerce, Washington, D.C. 20234

Frances J. Laner (Miss) –

Referred too often as the *Metric Guru* and *Most-Traveled-One,* the author has been to countries in three-fourths of the world and speaks some five languages.

As a *Technical Editor and Science Writer,* she has continued an active career in technical and scientific publications since high school. Before returning to her native state, Colorado, she held positions in Washington, D.C., with the National Science Teachers Association as *Director of Publications and Press* and also *EDITOR* of the *Science Teacher* journal; and served previously with the U.S. Atomic Energy Commission, the Federal Civil Defense Administration, and the Weather Bureau as *Technical Reports Officer.*

Her background includes BA (journalism) and MS (education) studies at the George Washington University and work in physics (BS) at the Catholic University in Washington, D.C. Current professional activities involve work with the Metric Association, Inc., as *Vice President* on the Board and *Region Director* of the Rocky Mountain 7-state area; with the American Association for the Advancement of Science; the National Science Teachers Association; with the Society for Technical Communication, serving also on the journal staff; and with the Program for the Aged local community project as a Board member. Her teaching and lectures in science and journalism and SI (metric) standards at national and international levels have extended also to the various local community groups, the Adult Tutorial High School Program for students, and elementary students.

THE IMPLEMENTATION OF TRIDM* AT CHICAGO CIRCLE

By F. A. Mosillo

*Computer graphics language developed by Byard Houck at North Carolina State University at Raleigh.

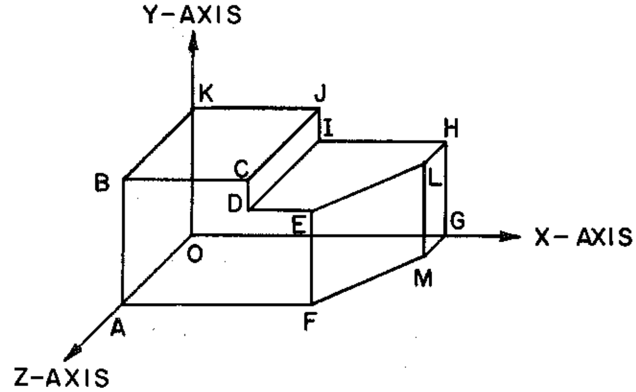


FIGURE 1

Following the 1972 Graphics Summer School in Lubbock, Texas, a few members of the faculty at Chicago Circle studied the possible use of TRIDM in a two quarter hour engineering graphics course. Implementation was begun cautiously due in part to the limited computer knowledge of both faculty and the students at the freshmen level, and also because the content of the course was already too extensive. The conclusion reached was that this program would best be used as a motivational tool in the area of Multiview Drawing. To date, three assignments have been developed that provide experience for the students in three dimensional visualization. The computer outputs are used to verify or correct the students' thoughts in reference to the multiviews they have drawn. These assignments are described herein in the hope that other similar problems can be developed and shared.

Preliminary Assignment

This initial step is a precaution to prevent computer complexities or irregularities from interfering with the primary objective of the student learning the basic principles of multiview drawings.

This assignment shows a pictorial of an object (figure 1) with each corner identified by a letter. A table lists the rectangular coordinates of these corners in the order they are needed for plotting. The students are expected to concurrently sketch the six principal views, to punch up the cards as noted in the table and to process through the computer.

Prior to this point, the student has had no exposure to multiview drawing. Immediately following the start of this assignment the basic principles of multiviews are discussed and the student is asked to draw the six principal views of the object. Being that the computer output and multiview assignment are being developed concurrently, upon receiving the plot, the student then compares it with his drawing and if the results do not agree, the student is to determine which is in error and why. For the majority of students, this assignment is both intriguing, enlighting, and satisfying.

Assignment #2

This assignment is for the student to make a minor alteration of the previous object, with corresponding changes in the data, and present it to the computer for verification. Figure 2 shows one possible solution to this exercise. This exercise:

(1) involves the student in sketching a pictorial;

(2) provides experience in using a mathematical coordinate system (identifying coordinate points in space), thus involving the student in visualizing in three dimension;

(3) requires altering the data listing to trace the object point by point, which further involves the student in the visualization of an object in three dimensions;

(4) enables the student to submit this data to the computer to obtain a plot showing a pictorial and six principal views of the object.

Assignment #3

This third assignment was actually started early in the course to give the student experience in pictorial sketching. The assignment at that time was to "design" a nonsymmetrical structure made up of cubes. Further work on this assignment is to prepare a table as before to define a single cube. A new command is then used to translate and duplicate this cube to the locations defined by the original sketch. The composit is then fixed into a unit by an assembly command and each view of the assembled structure is then located by the student on the plot by a third command. Figure 3 is one result of this exercise.

This exercise involves the student in the visualization of a structure of his own design. He must visualize how the cubes are located with respect to one another, and how and where the principal views are located with respect to each other.

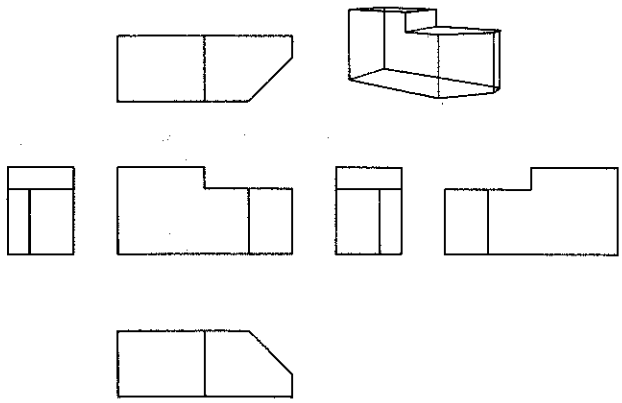


FIGURE 1 RESULTS (FROM THE COMPUTER)

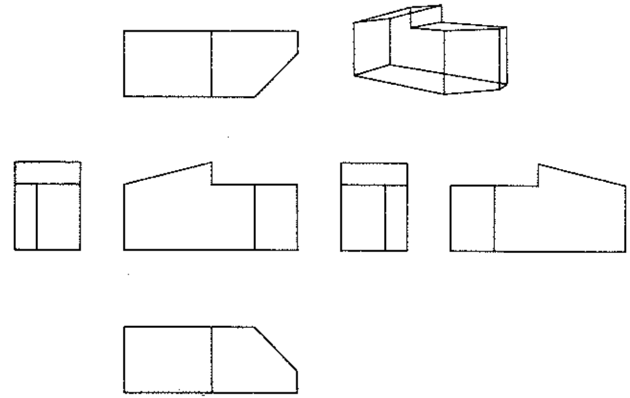
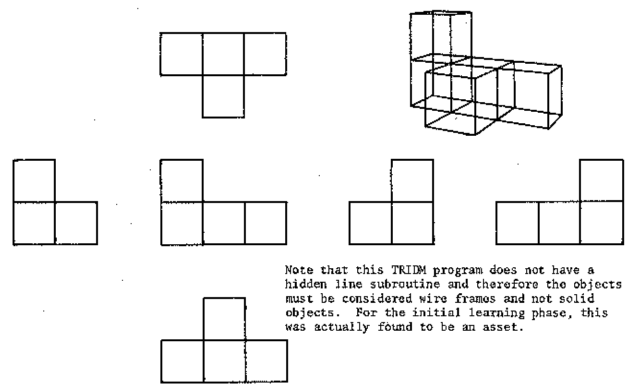


FIGURE 2- FIGURE 1 ALTERATION



Note that this TRIDM program does not have a hidden line subroutine and therefore the objects must be considered wire frames and not solid objects. For the initial learning phase, this was actually found to be an asset.

FIGURE 3- CUBICAL DESIGN

Conclusions

In these assignments the student is expected to know very little about the TRIDM program or computer programming. It is only necessary that he submit a program deck containing standard job control cards and the data cards depicting the points of the object. The final problem requires the student to use three simple commands to position the cubes of the structure and to locate the assembled structure. With this minimal understanding of the computer, it becomes no more than a sophisticated vending machine which provides interest and stimulation for the students. Thus, the major goal of the students achieving a better understanding of the engineer's basic communicative language of orthographic projection is accomplished.

Postscript

Upon returning from the annual ASEE meeting at Ames, Iowa and reviewing notes from the meetings (especially the notes relating to computer graphics) it was concluded that the design graphics division has taken a giant step backwards from the previous year's meeting. The division seems to be in another depression period similar to the one that preceded the design phase of the division. That depression period lasted somewhere in the neighborhood of ten years. Hopefully, it will not be necessary to change the division's name again before its members become active in the mainstream of engineering as was criticized by the last goals report of the ASEE.

The meeting at Ames was completely devoid of the contribution of North Carolina State at the Lubbock meeting at which they gave the TRIDM Graphics Lnaguage Program as a gift to all members of the division. What they gave may not have been considered monumental, but it was at least a start for those wishing to remain in the mainstream of engineering.

This article is presented to show one institution (University of Illinois at Chicago Circle) has done to implement this program to motivate students toward the understanding of multiview projections. This program is in operation as stated herein and is definitely contrary to the premises stated at Ames that "students must have an understanding of engineering drawing and FORTRAN programming before becoming involved with the computer". It is agreed that the instructor would hopefully have these prerequisites.

PT	X	Y	Z	PEN
A	0.0	0.0	1.5	11
B	0.0	2.0	1.5	10
C	2.0	2.0	1.5	10
D	2.0	1.5	1.5	10
E	3.0	1.5	1.5	10
F	3.0	0.0	1.5	10
A	0.0	0.0	1.5	10
O	0.0	0.0	0.0	10
G	4.0	0.0	0.0	10
H	4.0	1.5	0.0	10
I	2.0	1.5	0.0	10
J	2.0	2.0	0.0	10
K	0.0	2.0	0.0	10
O	0.0	0.0	0.0	10
K	0.0	2.0	0.0	11
B	0.0	2.0	1.5	10
C	2.0	2.0	1.5	11
J	2.0	2.0	0.0	10
I	2.0	1.5	0.0	11
D	2.0	1.5	1.5	10
E	3.0	1.5	1.5	11
L	4.0	1.5	0.5	10
M	4.0	0.0	0.5	10
L	4.0	1.5	0.5	11
H	4.0	1.5	0.0	10
G	4.0	0.0	0.0	11
M	4.0	0.0	0.5	10
F	3.0	0.0	1.5	10
O	0.0	0.0	0.0	11
	1-10	11-20	21-30	44-45
	CARD COLUMNS			

Shade & Shadow Theory

Pare's Shade and Shadow of a Solid Object Represented on a Trihedral System

By Manuel F. DeMedeiros

State University of New York at Morrisville

AUXILIARY CUTTING PLANE METHOD

SHADOW ON THE HORIZONTAL BASE PLANE

To find the shadow points on the horizontal base plane, one has only to apply the rules expressed by Dr. Pare' in his article of the Winter 1973 issue of the Journal (See figure 1).

Shadow point 1' is located at the intersection of the projection ray from 1 with its applied to obtain points 2', 3', 4', 5', and 6'. Line 4'-5' is parallel to 4-5, line 5'-6' is parallel to line 5-6, line 11-6' is the shadow of the vertical edge 11-6 and is parallel to line NB.

SHADOW ON THE CYLINDRICAL SURFACE

(a) Analysis

To get the shadow on the cylindrical surface one can think that the light ray AB results from the intersection of two planes, i.e.: one containing Δ AMB and the other containing Δ ANB. On the object, two planes were introduced; one ρ_1 parallel to Δ AMB through line 8-9, and extended to a rectangle; the other ρ_2 parallel to Δ ANB through line 8-10 and also extended to a rectangle. Each one of these planes has an intersection with the cylindrical surface: Line I_1 and line I_2, respectively. Intersections I_1 and I_2 meet at a common point P on the cylindrical surface. Point P is the point where a light ray, parallel to AB through 8, pierces the cylindrical surface. The shadow on the cylindrical surface is well defined by a triangular surface with boundaries 9-10 (directrix), 10-P, and P-9.

(b) Graphical Construction

Intersection I_1 of plane ρ_1 with the cylindrical surface is obtained by a series of planes parallel to Δ MCB. Each cuts plane ρ_1 with a line parallel to MB, and the cylindrical surface along a generatrix parallel to CB. For instance, cutting plane CP_1 gives lines 12-14, and 13-14 respectively on plane ρ_1 and the cylindrical surface. They meet at point 14 which is a point in I_1.

Intersection I_2 of plane ρ_2 with the cylindrical surface is obtained by a series of horizontal cutting planes parallel to Δ NCB. Each cuts ρ_2 with a line parallel to NB and the cylindrical surface along a generatrix parallel to CB. For instance, cutting plane CP_2 gives lines 15-16 and 13-16 (same as 13-14) respectively on plane ρ_2 and cylindrical surface. They will meet at point 16 which is a point in I_2.

Intersection I_1 could also be obtained by this same series of horizontal planes. In this case the line of intersection on ρ_1 would be horizontal, such as 18-19.

GEOMETRICAL TRANSFORMATION METHOD

The shadow of the point P cast on the plane π by the light ray parallel to direction AB, may be thought of as the oblique cylindrical projection of P on the plane π, which is defined as the point of intersection p of π and the parallel to AB drawn through P (Figure 2).

For the cast shadow of a solid object, all shadow lines are parallel and intersect the projection plane at the same angle.

One may also perform this parallel projection considering that any point p is the image of the antecedent point P under the transformation which applies triangles homothetic of Δ ACB. Triangle ACB is established on the spatial diagonal AB, face diagonal AC, and edge CB of light prism.

Triangle ABC is chosen because it is a convenient artifice for our problem: CB is parallel to the generatrix of the cylindrical surface.

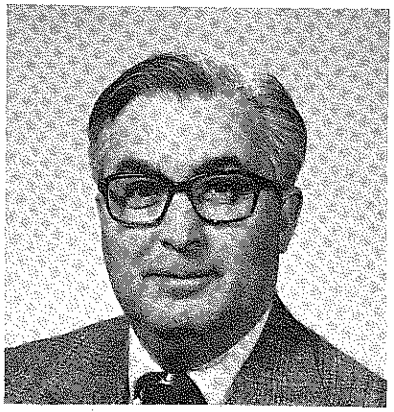
For homothetic triangles corresponding angles are numerically equal, and corresponding sides are parallel and proportional.

In the case of figure 3 we have two situations to consider: a shadow on the cylindrical surface and on the horizontal base.

A SHADOW CAST ON THE CYLINDRICAL SURFACE

(a) Analysis

Point 11" homothetic of vertex C is a point in the directrix of the curved surface; point 11 homothetic of A (antecedent in the transformation) is a point on the shaded line; 11"-11' homothetic of CB is a generatrix of the



curved surface; the image point 11' under transformation (homothetic of point B) is the cast shadow of point 11.

(b) Graphic Construction

To obtain the shadow point of any point on the shaded line, such as 11, construct the triangle 11-11"-11' homothetic to Δ ACB.

A SHADOW CAST ON THE HORIZONTAL BASE PLANE

(a) Analysis

Despite the fact that the same considerations and construction could be made as above, an affine transformation is very fitting here.

(b) Graphic Construction

The axis of affinity E_1 is ascribed to 0-5" parallel to NC, and the light ray is the direction of affinity.

To obtain any shadow point, e.g.: 4', draw from 4 two lines, 4-4' parallel to AB and 4-4" parallel to AC. From the intersection of 4-4" with the axis of affinity E_1 draw line 4"-4' parallel to CB. Its intersection with 4-4" is the image of 4, and as such is the shadow of 4.

As a check on the accuracy in the construction, any line, such as 3-4 and its image 3'-4' will intersect at a double point n-n' located on the axis E_1.

If a line, such as 4-5, is parallel to the axis of affinity, its image is also parallel to the axis of affinity because their intersection is a point at infinity that is an ideal point. Point 6' requires a different axis of affinity E_2.

METHOD OF THE PIERCING POINT OF A LINE

This method is the simpler of the three methods presented, and it seems that it has a general application. It is the fundamental and direct approach to the solution of two intersection problems. (1) The piercing point of a line and a cylindrical surface, and (2) The intersection of a line and a plane surface.

If any plane is passed through the line, and the line of intersection of this plane with either the given plane or the cylindrical surface (according to the case) is found, the piercing point will be the crossing of the given line with the line of intersection. The diffi-

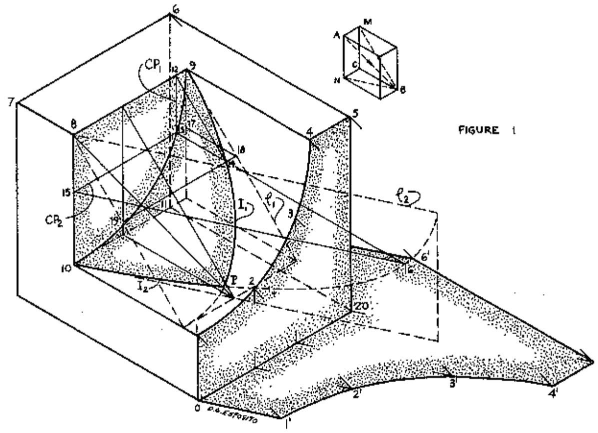


FIGURE 1

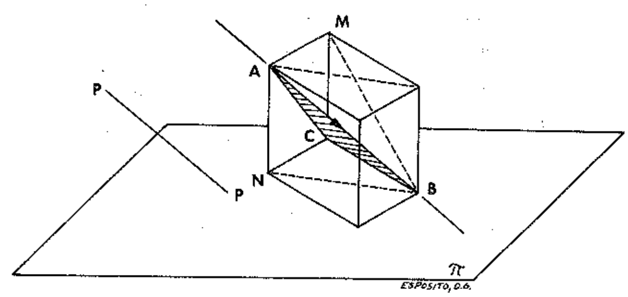


FIGURE 2

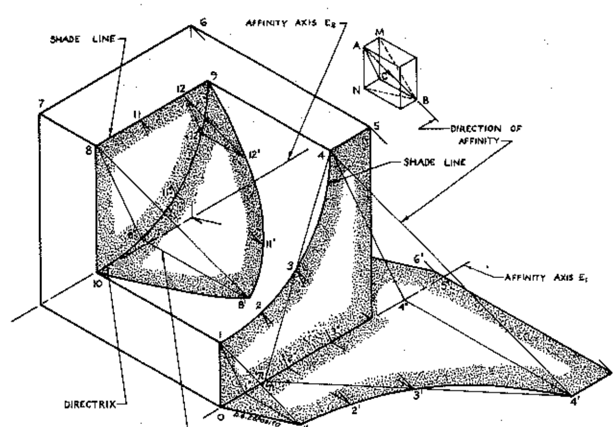


FIGURE 3

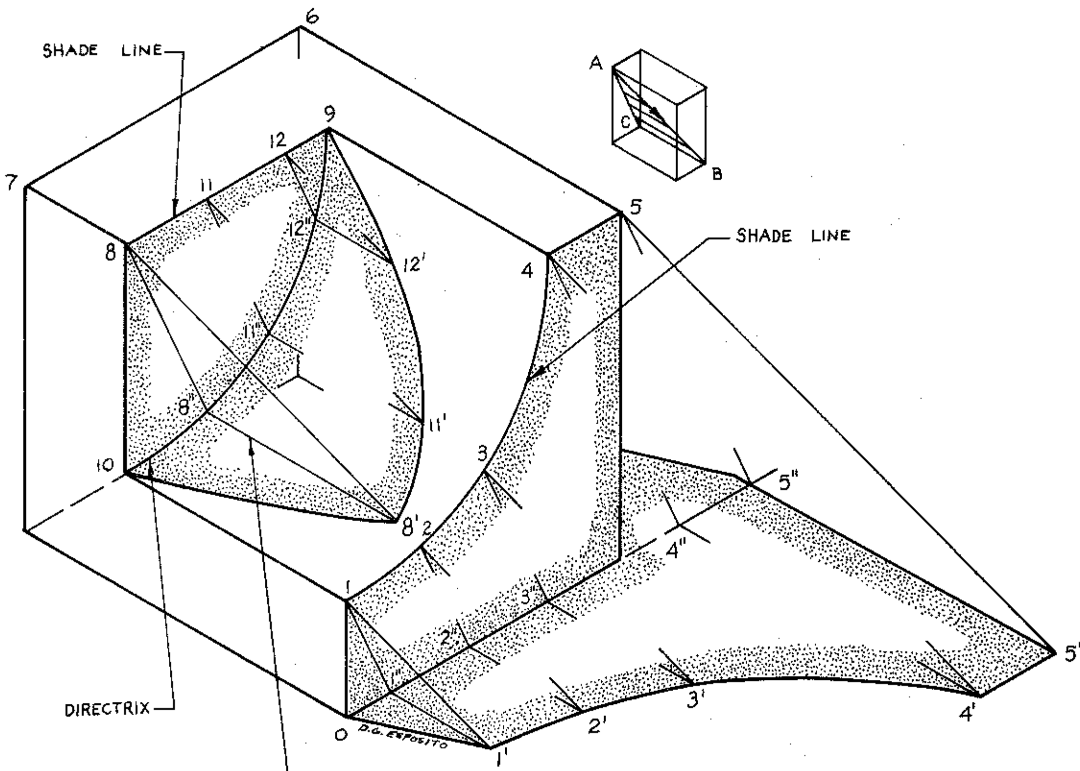


FIGURE 4

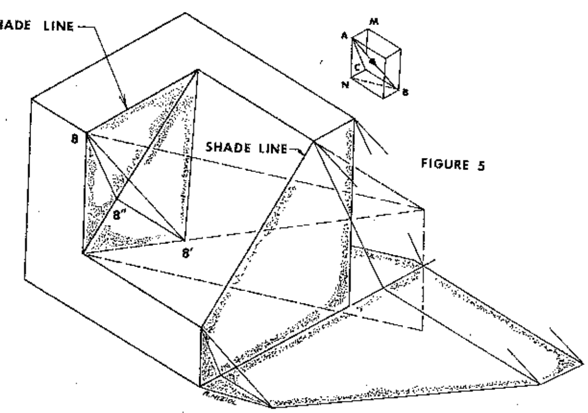


FIGURE 5

culty, if there is one, is circumvented by choosing the apt plane.

SHADOW ON THE CYLINDRICAL SURFACE

(a) Analysis

Each plane parallel to Δ ACB of the light prism, that can be introduced for every point on the shade line, contains the respective light ray and establishes an element parallel to the cylinder axis.

The point of intersection of the element and the respective light ray is the shadow point for the ray. See figure 4.

(b) Graphical Construction

Draw a convenient number of triangles homothetic to Δ ACB as was done for the method of geometrical transformation. As a matter of fact, there is such an analogy between both constructions; they diverge only in the interpretation.

SHADOW ON THE HORIZONTAL BASE PLANE

(a) Analysis & Construction

As before any triangle homothetic to Δ ACB having one vertex on the shade line and the other on the line 0-4" will have the third vertex on the shadow point.

NOTE: As it was already mentioned it seems that this method has a general application and does not require extraneous constructions. One realizes the expeditiousness of the third method by observing figure 5 where an inclined plane takes the place of the cylindrical surface.

The application of this method requires only the drawing of triangle 8-8"-8' homothetic to Δ ACB, while the other method requires an auxiliary plane as a rectangle, etc., etc.

ENGINEERING DESIGN GRAPHICS
BY-LAWS

BY-LAWS
for the
ENGINEERING DESIGN GRAPHICS DIVISION
(1973)

Article I

NAME AND OBJECTIVES

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

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

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

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

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

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

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

e. Maintain a liaison with industry and government.

Article II
MEMBERSHIP

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

Article III
OFFICERS AND DUTIES

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

Chairman	1 year
Vice-Chairman	1 year
Secretary-Treasurer	3 years
Directors	3 years

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

2a. CHAIRMAN

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

He shall preside at all business meetings of the Division and of the executive committee.

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

2a (3) He shall submit the annual budget of the Division to the Executive Director of the Society after consultation with the members of the executive committee.

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

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

2a (6) He shall appoint all by-law committees except the N minating and Elections Committees, designating the chairman except where the chairman is specified by the by-laws.

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

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

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

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

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

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

2b VICE-CHAIRMAN

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

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

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

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

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

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

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

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

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

2b (10) He shall prepare the annual budget for the Division for his term of office as Chairman after consultation with the Chairman of the Division. He shall submit it to the Chairman of the Division for transmission to the Executive Director of the Society.

2b (11) He shall prepare a printed list of committees for his term of office as Chairman for presentation to the Division. Printed copies of the list shall be made available to the executive committee and to all persons in attendance at the annual business meeting.

2c SECRETARY-TREASURER

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

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

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

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

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

2c (6) He shall receive any Division money, except that which is part of the income of the ENGINEERING DESIGN GRAPHICS JOURNAL and under control of the publication committee, and shall place on desposit such money in an account in a suitable repository under the name of the Division.

2c (7) He shall disburse Division funds upon the approval of the Chairman of the Division.

2c (8) He shall submit an annual financial report to the Division at the annual business meeting.

2d DIRECTORS Refer to Articles VI-3 and VIII-3.

Article IV

ELECTION AND SUCCESSION OF OFFICERS

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

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

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

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

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

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

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

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

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

Article V

CONFERENCES

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

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

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

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

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

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

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

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

Article VI

EXECUTIVE COMMITTEE

Section 1 DUTIES

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

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

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

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

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

3a DIRECTORS. Each director shall be elected to serve for a period of three years.

3b Each director and the Vice-Chairman shall be responsible for a group of committees within designated categories. The committee categories shall be:

3b (1) BY-LAW COMMITTEES under the responsibility of the Vice-Chairman.

3b (2) LIASON COMMITTEES under the responsibility of a director.

3b (3) TECHNICAL AND PROFESSIONAL COMMITTEES under the responsibility of a director.

3b (4) PROGRAMS COMMITTEES under the responsibility of a director.

3b (5) PUBLICATIONS COMMITTEE under the responsibility of a director.

3b (6) ZONE ACTIVITIES COMMITTEES under the responsibility of a director.

3c The Director(Publications Committee) shall serve as editor of the ENGINEERING DESIGN GRAPHICS JOURNAL.

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

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

Article VII

COMMITTEES

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

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

The chairman of the nominating committee shall be the senior past chairman, so appointed.

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

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

The chairman of the elections committee shall report the results of the election to the Division at the annual business meeting.

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

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

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

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

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

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

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

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

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

(e) Service to the Engineering Design Graphics Division of ASEE as evidenced:
-by regular attendance at its meetings as an indication of interest in the improvement of teaching--

-service on its committees or an officer with a record of definite achievement--

-contributions to its publications or summer school programs.

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

1d (5) Nomination Form. A nomination form shall be prepared by the Distinguished Service Award Committee which will outline the qualifications and will provide space for a brief outline of a nominee's performance in each category. This form shall accompany the annual request for nominations.

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

Section 2 NON BY-LAW COMMITTEES. Non By-Law committees that are necessary for the adequate functioning of the Division may be designated by either the Division Chairman or by the Executive Committee of the Division. The appropriate director shall, with the approval of the Division Chairman and the Executive Committee, appoint committee chairmen and committee members. Each committee chairman is expected to submita report to the appropriate director well in advance of the Executive Committee meeting at the annual and mid-year conferences.

Article VIII
PUBLICATIONS

Section 1 PUBLICATIONS COMMITTEE. The Publications Committee shall be composed of the Director-Editor(See Art. VI, Sec. 3b(e) and Sec. 3c), the Circulation Manager-Treasurer, and Advertising Manager, and such Assistant Editors as are deemed necessary by the Director-Editor.

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

Section 2 ELECTION OF PUBLICATIONS COMMITTEE.

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

2b The Circulation Manager-Treasurer and the Advertising Manager shall be elected to three year terms in the same manner as presented in Article IV.

2c The elections of the Director-Editor, the Circulation Manager-Treasurer, and the Advertising Manager will be staggered such that one is elected each year in order to provide maximum continuity to the Publicaitons Committee.

2d In the event that either the Circulation Manager-Treasurer or the Advertizing Manager is unable to perform their duties, the provision of Article IV, Section 1g is applicable.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

3c (1) He shall actively solicit and produce advertisements from all appropriate sources.

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

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

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

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

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

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

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

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

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

Article IX
PARLIAMENTARY AUTHORITY

Section 1 The rules contained in Robert's Rules of Order(latest edition) shall govern this Division in all cases to which they are applicable and in which they are not inconsistent with the Constitution and By-Laws of the ASEE, the By-Laws of the Council of Technical Divisions and Committees, or the By-Laws of this Division; in other cases the Constitution and By-Laws of ASEE shall govern.

Article X
AMENDMENTS TO BY-LAWS

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

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

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

a by a majority vote of the Executive Committee.

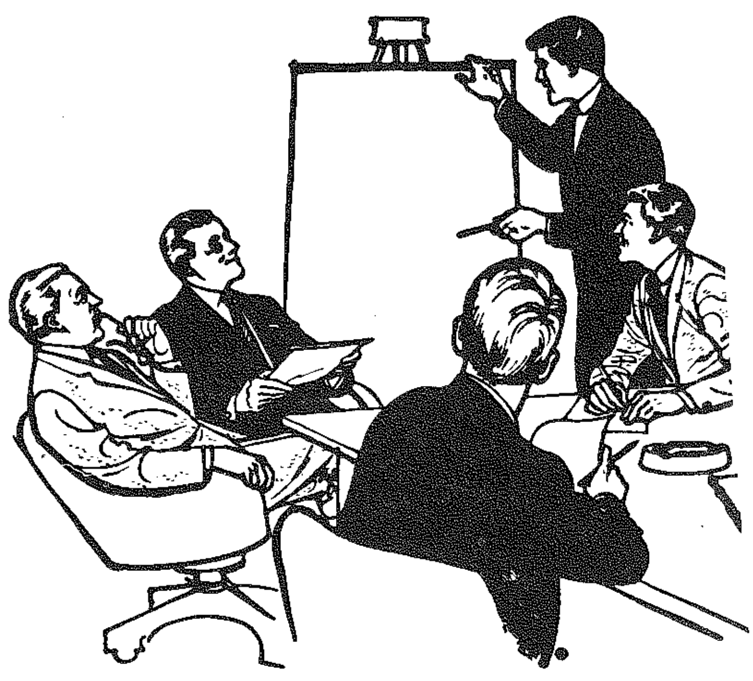
b by petitions to the Chairman signed by not less than fifty(50) individual members of the Division.

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

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

Article XI

Upon the adoption of these By-Laws by this Division, the Executive Committee shall implement the required changes according to the Implementation Report previously approved. This Article shall be eliminated upon completion of the implementation.



Some pictures are not for mother's eyes.

She wouldn't understand.

But a client would. He'd look at every detail. And it better be perfect. Or else.

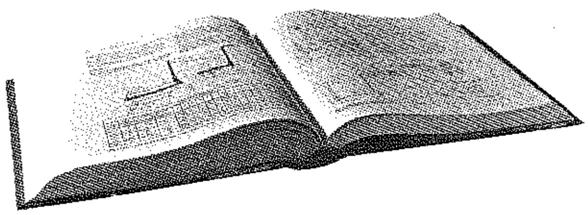
So your students have to know their stuff. With ENGINEERING DESIGN GRAPHICS, SECOND EDITION, they will. Which is probably why more than 150 colleges and universities adopted James Earle's text in its first edition.

The second is even better. For one thing, it places greater emphasis on traditional areas. Like working drawings, data analysis and dimensioning. Many of the illustrations were redrawn too, for more clarity and impact. New problems were added. And even suggestions for supervising student design teams.

However, Earle's second still uses the step method to guide students through the entire design process. It's application of descriptive geometry and graphical principles remains at the freshman level. Suitable for technology and engineering programs.

Eleven companion PROBLEMS BOOKS are also available. Authored by James Earle and seven other members of the engineering graphics department at Texas A & M University. They help keep the course as interesting for you as for your students.

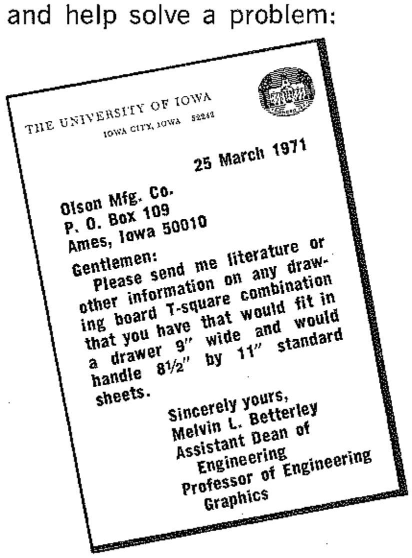
ENGINEERING DESIGN GRAPHICS, SECOND EDITION: Mother could do without it, but not her young engineer-to-be.



College Division
ADDISON-WESLEY PUBLISHING COMPANY, INC.
Department 177
Reading, Massachusetts 01867

tailor-made DRAFTING PACKAGE

Whether you need a conventional Ames Draft-Pak or have a special situation which calls for a "tailor-made" package, we'd like the opportunity to serve you. Here is an example of our ability to come through and help solve a problem:



THE UNIVERSITY OF IOWA
IOWA CITY, IOWA 52242

25 March 1971

Olson Mfg. Co.
P. O. Box 109
Ames, Iowa 50010

Gentlemen:
Please send me literature or other information on any drawing board T-square combination that you have that would fit in a drawer 9" wide and would handle 8½" by 11" standard sheets.

Sincerely yours,
Melvin L. Betterley
Assistant Dean of Engineering
Professor of Engineering Graphics

After devising the Ames Compakt Drafting Kit prepared to Professor Betterley's specifications; here is his reaction after using it in their classroom situation:

"It is with a great deal of pleasure that I can report the Kit is entirely satisfactory. Our students are using it to learn basic concepts in Graphics, and at the same time acquire an acceptable degree of skill which leads them into the art and application of good sketching techniques when expressing ideas graphically. I am sure there are a number of schools today that would find comparable equipment both less expensive and entirely satisfactory."

Sincerely yours,
Melvin L. Betterley
Assistant Dean of Engineering
Professor of Engineering Graphics

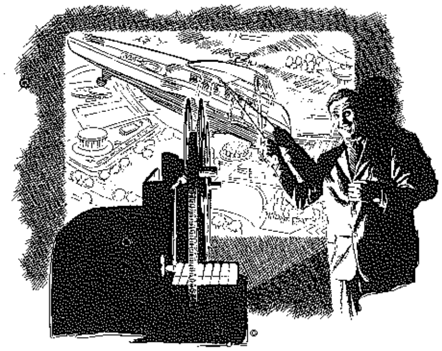
The AMES DRAFT-PAK—available in three popular sizes (9 x 12, 12 x 18, and 18 x 24) and in the standard or executive models.

FREE IMPRINT
We will imprint your university &/or departmental name at no extra charge. Contact us for minimum quantities involved.

- Ames® Lettering Guide
- Visual Aids For Drafting Rooms
- Ames® Draft-Pak
- Ames® Radius Curves for Perspective Drawings
- Ames® Bonded Acrylic Tee Squares
- Ames® Stadia Protractor

Olson Manufacturing Co.
P.O. Box 109 • Ames, Iowa 50010
"Drafting Products by Olson of Ames"

Teaching Techniques



TEACHING TECHNIQUES
(With Your Help, A New Column)

Did you know that the Engineering Design Graphics Division of ASEE had its very own Teaching Techniques Committee? It does, and the committee has made significant contributions to design graphics education since 1965 under the chairmanship of Ernest Schamehorn.

Teaching techniques have been noticeably in the forefront of engineering education for the last several years. Revolutionary changes have occurred in how we teach and the ways in which students learn. Most graphics educators are familiar with the terms: SPI, IPI, CAI, Closed Circuit TV and Authentic Involvement to mention just a few. But how are these methods being implemented in various schools, what are your successes, what are your problems, what aids and devices are employed to supplement and enhance learning? There are probably many new teaching techniques and aids being employed across the country; but because they are not publicized, they receive little recognition and benefit few.

One of the primary objectives of the Journal is to publish articles that stimulate teachers of graphics to innovate, experiment and test topics and techniques to further improve the quality of design graphics instruction. The Journal, therefore, plans to couple its efforts with those of the Teaching Techniques Committee by featuring a regular column on teaching techniques. As many short articles as space permits will appear under this heading each issue. Hopefully, the Journal can serve as a central directory and reference source for teaching techniques being tried or considered throughout its readership.

Want to help the Journal and the Teaching Techniques Committee serve you better? Would you like to toot your horn on what you are doing to improve engineering design graphics education? How about sharing your knowledge? Read Dr. Schamehorn's article that follows.

Garland K. Hilliard
Associate Editor

TEACHING TECHNIQUES COMMITTEE
Dr. Ernest C. Schamehorn, Chairman

After a comprehensive examination of its structure and functions during 1966-67, The Teaching Techniques Committee formulated two principal objectives:

(1) to collect from whatever sources are available and to disseminate to the members of the graphics division information regarding new methods and techniques which will be useful in teaching graphics

(2) to frequently review older techniques of instruction such as chalkboard, film strip, overhead projector, opaque projector, and models

Implementation of the Objectives

In April, 1970, the chairman proposed that the committee implement its objectives by the presentation of a Teaching Techniques Committee Report to members of the graphics division at the annual meeting, and also at the mid-winter meeting if enough material would be available. It was thought by the chairman that the presentation of such a report (or reports) to the division membership would alone meet entirely the two objectives stated above. It was further thought that the issuance of such a report would solve the most perplexing problems the committee has faced since the chairman has first been on this committee in 1965. These problems were (1) how to obtain a wealth of information and (2) how to make it available to the greatest number of interested persons.

The decision was made by the chairman to designate the members of the committee itself as the "experts" most qualified to report on their own teaching techniques and methods, and to be directly responsible to the committee and chairman for furnishing material from their own experiences for the report.

Three outstanding committee reports followed this decision: the 1970 report (June 22), Ohio State University; the 1971 report (June 23), United States Naval Academy; and the 1972 report (June 20), Texas Tech University.

Sample Work of the Committee

What are some of the teaching techniques or activities which members of the Teaching Techniques Committee have been working on or considering?

The committee has given some thought in the past to a national study of teaching techniques in the field of engineering graphics. It felt that a grant or funding for it would be necessary to defray some of the expenses. The committee did not know how to obtain financial assistance for this project and so did not undertake it.

Professor Emeritus Carl Buckman of the University of Arizona conducted a limited geographical survey of the use of teaching techniques in his area and was willing to permit this to be published by the committee. We would like to publish this report or portions of it in a subsequent column in the Journal.

Professor Mervin Weed of Pennsylvania State University proposed "An Experiment in Teaching Through Design" which would have students design plexiglass models which would be used to demonstrate principles of descriptive geometry. The model designs would be presented in working drawing form. The objective would be to have students acquire experience in the design process with projects which would be of direct benefit to the teaching and learning of descriptive geometry in the classroom. A follow-up report on the outcome of this experiment has not yet been received by the committee.

An important adjunct to an established closed circuit television system was acquired in 1970 by the Department of Engineering Graphics at Iowa State University and reported to us by Professors C. Gordon Sanders and Ard Eide. The component installed was called a Telectern which could reflect a variety of visuals (including models) to the zoom lens of the TV camera. This placed the instructor in full control of his presentation as producer, director, cameraman, and video tape recordist. "The potential for this new facility appears to be unlimited."

These are a few of the teaching techniques and approaches devised by members of our committee to help us look for new and sometimes better ways of handling our course work in engineering design graphics.

Need for a New Approach

The June, 1973 committee report fell disappointingly short of the previous three reports and demonstrated that the committee members had "run dry" of material. Only one member had something to report on, Prof. Larry Goss of West Virginia Tech on a teaching aid called the "Goss Box."

The committee would now like to add a third objective: to communicate with all persons teaching graphics by means of a Teaching Techniques column which may be more or less regularly published in the Journal. The purpose will be to keep all of us informed on the latest developments in teaching aids and techniques being tried out and used in our universities, colleges, industries, and high schools. I invite you to send to me a one to two page write-up on some teaching aid or technique which you think will be of interest to the reader. (Perhaps one or two paragraphs may be sufficient.) Your contribution to the column will be appreciated and your name and school will be given in the published column. Furthermore, I would like the option of adding your name to the annual Teaching Techniques Committee roster and including your contribution in the Committee's annual report.

May I take this opportunity to say hello! My name is Ernest Schamehorn, and I am the chairman of the Teaching Techniques Committee.

Will you please, reader, send directly to me your latest teaching technique so we can seek to have it published in one of the next Engineering Design Graphics Journals? Send to:

Dr. Ernest C. Schamehorn
Chairman of Teaching Techniques Committee
Dept. of Physics, Engineering, and Technology
Essex Community College
Baltimore County, Maryland 21237

what's a goss box

LARRY D. GOSS
WEST VIRGINIA INSTITUTE OF TECHNOLOGY

A New Teaching Aid For Orthographic Projection

Teaching aids for helping students to learn the concepts of orthographic projection and the relationships of geometric objects in space are rather plentiful. We are all aware of the three-dimensional models, film strips, slide sets, overhead transparencies, film loops, sound motion pictures, and video tapes that are available to help in teaching the principles of orthographic projection. Most of us have some or all of these teaching aids available now which we are either currently using or which are gathering dust for various and sundry reasons. What is presented here is one more teaching aid to add to the list, but this one is different. It's different for two reasons: (1) it allows a student to see the external principal orthographic views of any object which will fit into the device, in proper projection and alignment complete with indicated reference lines between the views; and (2) it's cheap.

The device is called a "Goss Box." It's not called that for any egocentric reason, but it received the appellation by my colleagues who insisted that they had to call it something and they didn't like calling it an "orthographic projection simulator."

In theory, the device is so simple someone should have thought of it fifty years ago. For all I know, someone probably did. In effect the Goss Box combines some well-known folded path patterns used in binoculars, telescopes, and aerial reconnaissance cameras to erect the desired orthographic images. A drawing of the Model II Goss Box including the light path appears in Figure 1. The device can actually be made any size that is desired, but the original concept scaled it to the following restrictions:

A. It must use the most inexpensive front surface mirrors available with no waste.

B. It must have a final aspect ratio[1] which is compatible with 35mm cameras and television.

C. It must accommodate the largest three-dimensional object possible, within restrictions A and B above.

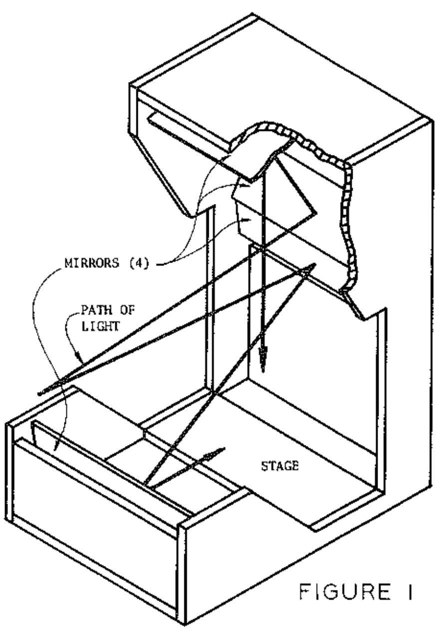


FIGURE I

The resulting design of the Model II Goss Box accommodates any object up to 6 x 6 x 18 inches and gives the viewer (student, teacher, or camera lens[2]) undistorted exterior horizontal and frontal views in their angle projection.[3]

Why use front surface mirrors? To cut down on distortion of the image due to refraction as it passes through the glass. If the image of the object doesn't have to pass through any glass on its way to the observation point, there will be no refraction and therefore no distortion. Regular mirrors will work, but they result in a ghosted image which is undesirable either for television or film work. The front surface mirrors that the Model II Goss Box is designed around are the 10 x 16 inch size listed by Edmund Scientific Corporation of Barrington, New Jersey, which were cut to the proper widths after delivery.

Besides the mirrors, the only other material needed is approximately half of a sheet of 3/4 inch plywood and sufficient screws, glue, sealer, varnish, etc., to put it together. The whole project shouldn't cost over $30 to build, and if you "scrounge" the plywood and use regular mirrors you can make the whole thing for less than $5.[4]

The Goss Box was originally designed for use with a closed circuit television system to introduce the concepts of orthographic projection. It works particularly well also with the fundamental concepts of descriptive geometry. It's most extensive use, however, is by individual students who manipulate models of geometric elements and machine parts on its stage to obtain the views they desire to formulate the concepts completely in their minds. Of course, for the Goss Box to be effective, there must be objects to use in it. These can be real machine elements or objects made out of wood, wire, and cardboard. Over the years, this graphics and design department has collected a number of objects ranging from the head of an automobile engine through string models of double warped surfaces and wooden copies of machine elements to bent pieces of coat hanger wire. All serve their purpose equally well and are kept with the Goss Box in a cabinet on wheels so that regardless of which design room the Goss Box may be used in, all the models are with it and easily accessible by the students.

---

[1]Aspect ratio is the relationship of height to width of a picture. For standard 35mm camera, it is 2:3. For television it is 3:4. The limiting aspect ratio is the 35mm camera and the same Goss Box can be used for television by setting the camera closer to the box.

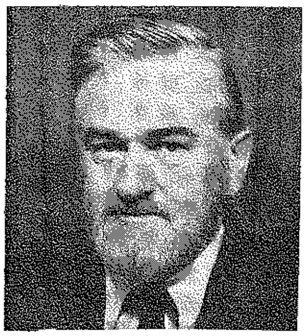
[2]The folded light path within the Model II Goss Box is 6 feet long, which will allow a full aperture image of the two orthographic views with a 50mm lens on a 35mm camera (use a single lens reflex type for accurate framing) or with a 30mm lens on a television camera.

[3]First angle projection can also be achieved with the Goss Box by changing mirror positions and angles.

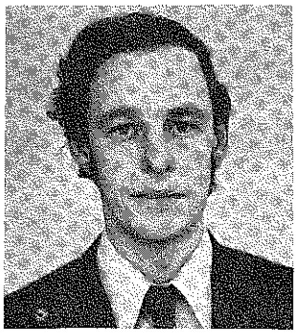
[4]The comments and descriptions of this article have all been for the Model II Goss Box which projects only two of the principal orthographic views. The Model III Goss Box gives the viewer all three principal projections (frontal, horizontal, and right profile). Plans for each model are available from:

Larry D. Goss, Chairman
Department of Graphics and Design
West Virginia Institute of Technology
Montgomery, WV 25136

Please include 50¢ per plan for reproduction and handling.



Prof. Clarke W. Pidgeon



Prof. Don Beattie

Oppenheimer Award

An unusual situation occurred at the 1973 American Society for Engineering Education Annual Conference held at Iowa State University this past summer. The Oppenheimer Award for the outstanding paper presentation at an Engineering Design Graphics Division sponsored session was authored by an individual not present at the conference. The winning paper, entitled "Catch Up in Computer Graphics," was authored by Professor C. W. Pidgeon of the Department of Engineering Drawing, Queen's University in Kingston, Ontario. The paper was presented by Professor Don Beattie of the same University. By being selected as the best of five presentors, Professors Pidgeon and Beattie split the $100 cash award donated by Frank Oppenheimer, and they also received handsome certificates.

Ronald C. Pare'
Awards Committee Chairman

CREATIVE ENGINEERING DESIGN DISPLAY

WANTED: YOUR PARTICIPATION

You and your students are invited to participate in the Seventh Creative Engineering Design Display to be held during the 1974 ASEE Annual Conference at Renssalaer Polytechnic Institute. This display is sponsored by the Engineering Design Graphics Division and needs your support to maintain its role as an important part of the conference. RPI officials are very enthusiastic about the display and have arranged to locate the 1974 display in a wide corridor surrounded by meeting rooms, where projects will receive maximum exposure. Be sure you are represented.

If you have not seen previous Design Displays, you should know that entries have ranged from sets of design and working drawings to a complete design report with models or prototypes. Each school may enter up to seven projects, two freshman and one each from sophomore, junior, senior and graduate levels and one from a cooperative program. Team projects are limited to eight students. Display space limitations are such that each project should be set up for display on a table measuring 30" deep and 36" and 48" wide.

Support for the display has grown greatly and is very encouraging. The James S. Rising award, a cash award, has been established to encourage outstanding designs. Industrial support and cooperation has provided for recognition of schools and individuals winning in each category. Schools will receive plaques for first place winners and all individual winners will receive certificates. These awards, it is hoped, will encourage more students toward creative design, both in the classroom and in their professional careers.

Judging of the display will again be done by individuals from industry, ASEE Division chairman and distinguished educators from various disciplines. This diversity, in the judges background assures objective evaluation of the projects; which involve many different disciplines.

If you have further questions, please write or call Paul DeJong(address below) for additional information or applications. This does not commit you to display but will provide the committee with the information needed to estimate space requirements at Renssalaer.

Paul S. DeJong
Coordinator
Creative Engineering Design Display
Engineering Graphics Department
403 Marston Hall
Iowa State University
Ames, Iowa 50010
Phone: (515) 294-6524

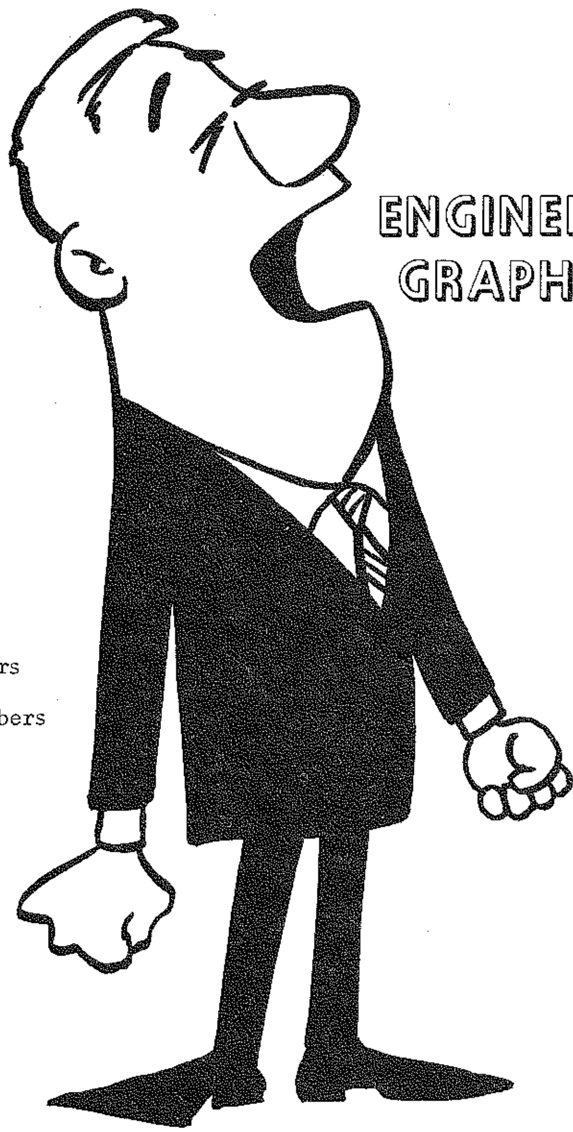
The Committee
Ralph Blanchard, Co-chairman
Borah Kreimer, Co-chairman
Paul DeJong, Display coordinator
Dr. George Sandor, Local arrangements

Engineering Design Graphics Journal

Advertisers

ADDISON-WESLEY PUBLISHERS
BROWN PUBLISHING COMPANY
GRAMERCY CORPORATION
MACMILLAN COMPANY
McGRAW-HILL
OLSON
PULLMAN PUBLISHERS

HELP



ENGINEERING DESIGN
GRAPHICS JOURNAL

SUBSCRIPTION RATES:

$3 Per Year for ASEE Members

$5 Per Year for Non-Members

$10 Per Year for ALL Overseas subscriptions

MULTIPLE YEARS:

$5 For Two Years for ASEE Members

$10 For Five Years for ASEE Members

TREASURER and CIRCULATION MANAGER
C.H. KEARNS
THE OHIO STATE UNIVERSITY
2070 NEIL AVENUE
COLUMBUS, OHIO 43210
PHONE 1-(614)-422-2634

START MY SUBSCRIPTION NOW!

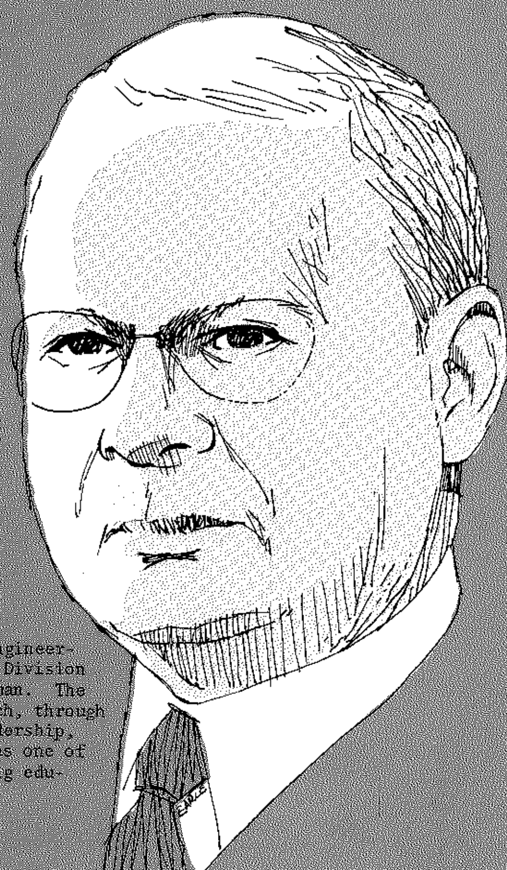
NAME: ______________________________

MAILING ADDRESS: ______________________________

CITY AND STATE: ______________________________

ENGINEERING DESIGN GRAPHICS JOURNAL

WINTER 1974, VOL 38, NO 1, SERIES 113



THOMAS E. FRENCH

Co-founder of the Engineering Design Graphics Division and its first chairman. The late Professor French, through his writing and leadership, must be considered as one of giants of engineering education.

CIRCULATION MANAGER
C.H. KEARNS
THE OHIO STATE UNIVERSITY
2070 NEIL AVENUE
COLUMBUS, OHIO 43210
(Address Correction Requested)

Nonprofit Org.
U.S. Postage
PAID
Bulk Rate
Dubuque, Iowa
Permit No. 477