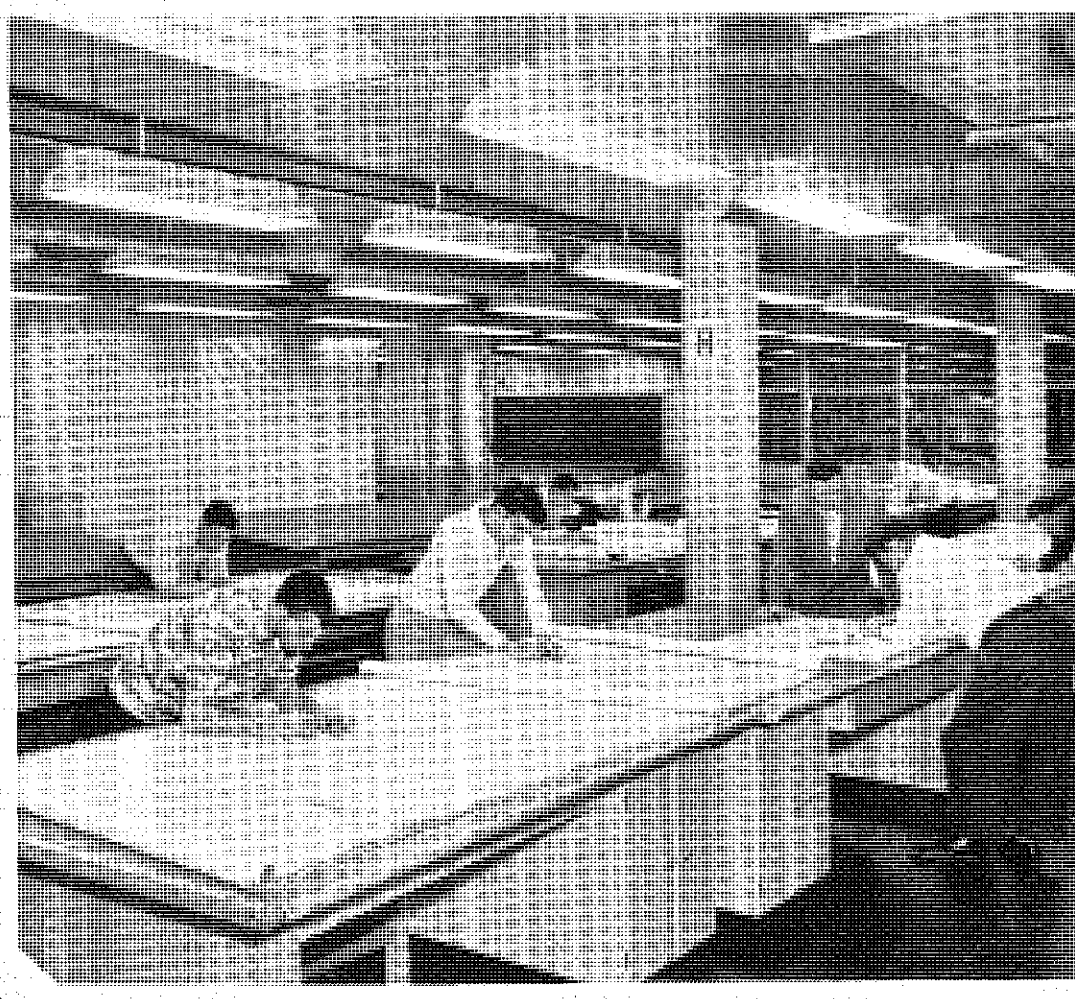
The Journal of Engineering Graphics



February (Winter) 1966 Vol. 30, No. 1, Series 88

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The Journal of Engineering Graphics

February (Winter) 1966 Volume 30, Number 1, Series 88

Published for teachers and others interested in Engineering Graphics. It is published three times per year -- Fall (November), Winter (February), and Spring (May). The subscription rates are $2.00 per year in the United States (single copies 75 cents). Foreign rates upon request.

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A LOOK IN THE MIRROR

Membership alone in the Engineering Graphics Division, ASEE, will not assure one of becoming an outstanding teacher of engineering graphics. One cannot be educated by whetting the tools and never using them. The member who avails himself of the opportunities provided by exchanging ideas should soon distinguish himself as an unusual teacher and the rewards will be in proportion to meaningful and constructive participation in Divisional activities.

Attendance in any Divisional conference may include several general objectives:

To renew acquaintances as well as make new contacts with faculty members of other universities and engineering schools and discuss developments, experiences, and problems with them.

To participate in the general activities of the Division.

To inspect new texts, instruments, new methods, and new ways of stimulating student and faculty interest in effective use of engineering graphics as an agent of design and communication of design to others.

The engineering graphics teacher has the best opportunity for introducing engineering subjects to the student and has a chance to have a lasting, stimulating, and motivating influence on him. He has an opportunity for teaching the student how to combine science and art in engineering communication. He has an ideal chance to help the student integrate engineering knowledge. The student must be taught the principles of research and evaluation of his findings to avoid a state of static living among mankind.

Too many students are encouraged down narrow ruts which they sometimes do not get out of. The student should be prepared for more than a special small nitch in life. His progress in life is due to changes in responsibility, job experiences, and perhaps a little to fate or circumstances. He will be unprepared for living a full life if he is hemmed in by narrow ideas caused by teachers who place thumb screws on the lid of new ideas and new ways of doing things.

Facts serve as a starting point for doing things a new way. Undiscovered facts and conditions make present ways of life backward and obsolete. Research and study for improvement brings freshness to a subject. Through research we can prove that present knowledge is only tentative.

We have given much attention to "what to teach" but we could do well to give more attention to "how to teach." Good instruction cannot be replaced. The impact of the teacher is a definite influence upon effective instruction. A good teacher is more than a common practitioner. He must add new material to his knowledge. A successful student must integrate knowledge, abilities, and techniques of the numerous subjects which he has studied. He must be prepared to go out on his own throughout the remainder of his life. He must learn to live as well as make a living.

The student should be our most important consideration. His educational development demands our careful consideration in making decisions for time available, the subject taught, and the character of the teacher who teaches him. We must fit the courses taught to the needs and capacity of the student. Engineering graphics should be taught as a systematic procedure for organizing productive ideas and expressing them in an accurate, unmistakable manner.

Knowledge is the cutting edge of progress. Any educational exposure in school should be a shortcut to actual experience. Every man is a debtor to his profession. How much do you owe your professional associates? Our participation in this Division should tend to pay somewhat this debt to our profession as engineering teachers. We can only do our best in this respect.

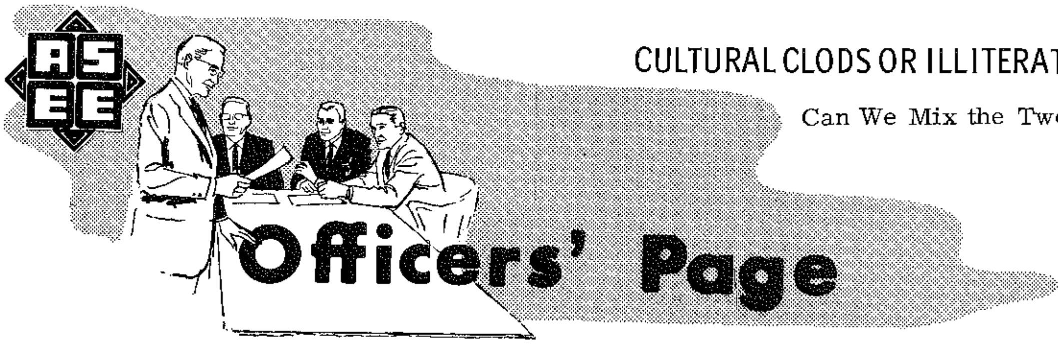
E. D. B.

A CALL FOR DIVISIONAL PAPERS

Professor Steve M. Slaby, the Engineering Graphics Divisional Representative on the ASEE Journal of Engineering Education Editorial Committee, urgently requests papers from the Engineering Graphics Division members for possible publication in the Journal of Engineering Education.

It is recommended that writers consult the Journal of Engineering Education - INFORMATION FOR AUTHORS - before writing.

Please send your papers to Professor Steve M. Slaby, Princeton University, Princeton, New Jersey.



CULTURAL CLODS OR ILLITERATE TECHNICIANS?

Can We Mix the Two?

We in the engineering profession little realize what cultural clods we are until we consider all the necessary humanities credits lacking in our undergraduate degree requirements. Our colleagues in other schools may be unaware of their own cultural illiteracy. Is it not our duty to tell them, loud and clear, and offer our help in overcoming the deficiencies in their curricula before it is too late?

A story is told of an eminent philosopher who, while traveling in a foreign country, was being ferried across a swift stream by a native boatman. Attempting conversation, the philosopher tried several languages and found the boatman understood only the provincial dialect of the area. "Such a pity," remarked the philosopher, "A third of your life is gone." The philosopher continued by asking the boatman if he had read certain writings of his countrymen. Upon learning that the boatman could not read, the philosopher exclaimed, "Two-thirds of your life is gone!" Suddenly, a shift in the wind and an erratic current upset the boat and both men were in the water. "Can you swim?" shouted the boatman. "No!" spluttered the philosopher, "No, I cannot swim!" "Then the whole of your life is gone," replied the boatman as he swam for the shore.

Not long ago an old friend, a successful practitioner of one of the traditional "scholarly" professions stopped by with his family for an overnight visit. After the usual exchange of family amenities, my friend complained of car trouble, a "loss of power" he had noticed for the last hundred miles or so, and asked if I could recommend a garage. It being late Saturday afternoon, my wife, possibly motivated by the thought that our guests (and their six children) might be delayed an additional day, enthusiastically suggested that we (meaning me) have a look at the car. My friend hesitated insisting that there was a serious malfunction which would undoubtedly be time-consuming and expensive to remedy . . . perhaps even a new engine would be required. But he did humor my wife by starting the engine while I raised the hood and looked in knowingly. Performance was obviously less than optimum, but this was to be expected with one spark plug wire disconnected! I had the engine turned off, connected the loose wire to the spark plug, enunciated a few appropriate technically sounding magic words like "distributor," "spark," "cylinder," and "missing," and directed my friend to, "Try it now!" Of course, I basked in the undeserved aura of "mechanical genius" for the rest of the weekend.

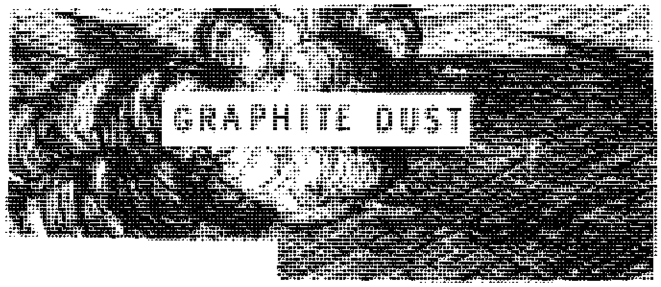
My learned friend, with more humanities degrees to his credit than a dog has fleas, is almost totally unprepared to cope with the mid-twentieth century technical environment in which he lives. Yet his entire way of life is dependent upon the efficient functioning of an amazingly complex array of electro-mechanical-hydraulic equipment contained in attractive packages labeled automobile (two of these), telephone, television, washer, drier, air conditioner, stereo hi-fi, tape recorder, ad infinitum. He willingly spends the major portion of his income to surround himself with these manifestations of engineering achievement, lives in happy ignorance of their inner workings, and trustingly pays and eighth grade dropout mechanic more in an hour than his services are worth in a week for questionable maintenance.

A great hue and cry has been lately heard throughout the land demanding more time in engineering curricula for formal studies in the social-cultural-humanities area, and it is not disputed that due attention to man's social, cultural, and artistic expressions is necessary in a professional curriculum. However, due attention to man's social, cultural, and artistic expressions is necessary in any professional curriculum, and man's engineering achievements are not only an integral and inescapable part of our culture, but have been the major single factor in determining the course our culture has taken.

Do the schools preparing their students to wear the cloth, wield the scalpel, plead at the bar, compete in business, lead the symphony, or daub the canvas offer courses in elementary engineering subjects? Where does the doctor first learn representational drawing and mechanics? Where does the musician first encounter harmonics and the physics of sound? Where does the artist become aware of precise perspective and the physics of light? Would not the businessman profit from a study of graphical mathematics? There is no doubt that the minister must be ready at a moment's notice to do everything mechanical, electrical, and hydraulic from making temporary repairs on the pipe organ, to replacing a fuse in the movie projector, to cleaning a clogged drain in the church kitchen.

Perhaps there has been no opportunity for non-engineering students to pursue liberally oriented general interest engineering courses either as part of a core curriculum or as elective courses? Perhaps the engineering schools should offer such courses? Perhaps a good place to start would be in the engineering graphics department?

WmBR
20 Oct 65



DID YOU KNOW:

That back issues of the Journal of Engineering Graphics may be secured by writing to James H. Earle, Circulation Manager and Treasurer, at Texas A & M University, College Station, Texas, 77840 and enclosing 50 cents per copy with your order to defray mailing expenses?

That Dr. Luisa Bonfiglioli has been appointed Visiting Post-Doctoral Research Fellow to the Department of Graphics and Engineering Drawing for the 1965-1966 academic year? Dr. Bonfiglioli will be doing research in theoretical graphics and in descriptive geometry of higher spaces.

Dr. Bonfiglioli received her Ph.D. in Mathematics from the University of Ferrara. She is a member of the faculty of the Technion - Israel Institute of Technology and has been Head of the Department of Descriptive Geometry at the Technion since 1962. She is a member of the Society Italiana di Fotogrammetria e Topographa, the Hahevra Israelit le-Photogrammetry and the Mathematical Association of Israel.

Dr. Bonfiglioli has published widely in the fields of nomography, photogrammetry, descriptive geometry, and grapho-mathematics. She also is the inventor of a number of significant graphic calculating devices. Her work while she is in Princeton will include, in addition to her research and writing, the presentation of special lectures and seminars in her field.

Dr. Bonfiglioli's appointment to the Department of Graphics and Engineering Drawing at Princeton represents a continuing effort by the Engineering Graphics Department to encourage and enlarge the field of theoretical graphics in this country.

EDITOR'S NOTE: An article by Dr. Luisa Bonfiglioli appears in this issue.

Charvoz-Carsen Corporation has a new line of easy-carrying T-squares. Known as the Charvoz Safe-T-Lock T-Square, these unusual T-squares separate into two parts which lie flat against each other in a convenient waterproof zippered carrying sheath. The usual projecting head of carried T-squares is eliminated. To use, the head is simply slipped on, and a patented locking device guarantees perfect alignment regardless of the number of times the square is assembled.

The square is a high-quality unit. Plastic edges along the hardwood blade are slightly recessed for inking, and to prevent slipping of the set T-square Top and bottom of the blade are sealed to prevent opening.

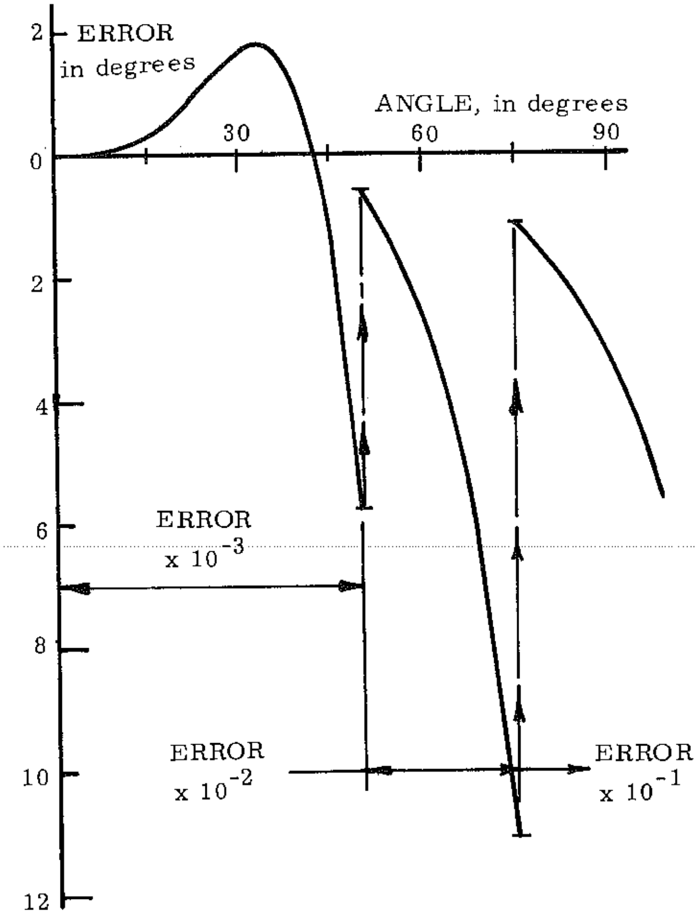
Designed primarily for the student or engineer who carries his T-square to various locations, these units offer the additional advantage of reduced storage space.

Charvoz Safe-T-Lock models are available with blade lengths of 18", 24", 30", 36" and 42". The T-squares are reasonably priced and delivery is from stock.

TRISECTION REMAINS A PROBLEM!

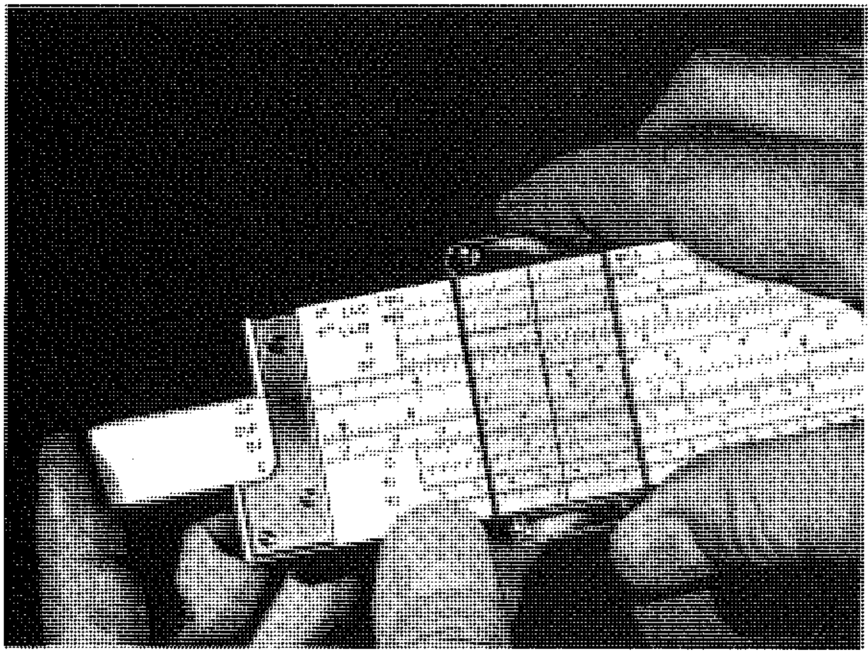
by
H. McCUTCHEN AND K. E. BOTKIN
Purdue University

On page 30 of the winter, 1964-65, edition of the Journal of Engineering Graphics was an article dealing with the trisection of an arbitrary angle. The statements in the article lead us to believe the construction steps outlined would, in fact, produce a precise graphical solution to this age-old problem. The construction outlined looked pretty good until we programmed the modern-day checker, the computer, into evaluating the calculated results.



The resulting error between the constructed and the theoretical is represented by the following figure. As an example of interpreting this figure for an angle of 75°, the construction produces an angle of 25° - .11° + which equals 24.89° -. This representation of the error is a graphical approximation from a digital calculated program.

DRAFTING TRENDS



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LETTERS TO THE EDITOR

Dear Editor:

This morning in the mail I received from a publisher a set of work sheets in engineering graphics addressed to the Journal in my care.

Apparently this material is for review and a possible write-up in the JEG "book review" column. Do you think we should attempt to add such a column to the Journal?

Several questions should be considered if we do:

1. Who would act as reviewer?
2. Should there be a regular book editor added to the Journal staff or should the privilege be passed around to a group of part-time or one-time reviewers?
3. Who among us is capable of an "impartial" book review?
4. If the chips are down, who would risk panning a friend and colleague's new book?

I really think a book review, discussing one or two new graphics texts, in each issue of the JEG would be an excellent feature . . . but such a column might stir up either a hornet's nest or turn out to be a can of worms . . . !

What do you think?

William B. Rogers
U.S. Military Academy
West Point, New York

EDITOR'S NOTE: What do our readers think of this idea? We would like to hear from you.

Continued on page 38

INFORMATION FOR AUTHORS

Manuscripts

Articles or papers may be descriptive, theoretical, documentary, tutorial in nature, or they may be reviews. Editorial considerations suggest most papers should be 2000 to 4500 words in length. The topic should receive professional treatment in depth. One or two copies of the manuscript should be submitted. Articles should be typewritten and double-spaced with typing only on one side of each sheet. Pages should be numbered to avoid omissions. References, footnotes and illustrations should be listed on separate sheets and not inserted within the text.

Illustrations

Line drawings may be prepared in pencil or India ink with mechanical lettering. If mechanical lettering is not available, freehand lettering should be placed on a separate overlay sheet. Photocopies (same size or reduced) of the original line drawings are accepted if they are clean, clear and sharp in contrast. Illustration width limitations are, (1) single column, 4-1/8 inches, and (2) double column, 9 inches. Height limitation is 11-3/4 inches for either column width. When illustrations are reduced 20%, all lettering must be large enough to remain clear and legible. Photographs should be 8 x 10 glossy prints. Figure numbers and captions should be listed on a separate sheet. If there could be any doubt about the positioning of the illustration, identify its top with a blue pencilled note in the margin. Figure numbers should be lightly written on the back of each illustration. If the illustration is prepared on translucent material a blue pencilled note might be made in the lower margin on the face of the illustration.

Correspondence

Your candid observations via brief communications are welcomed. Your observations; criticism of, or comments on, previously published articles; or other timely notices of interest to the members of the Engineering Graphics Division are welcomed. Please indicate whether submitted correspondence may be published.

Writing Style

Spelling and capitalization should follow Webster's Seventh New Collegiate Dictionary, which also offers guidance in punctuation. For more detailed information of the editorial style, see United States Government Printing Office Style Manual, 1959.

If you have further questions -- write to the Editor.

Earl D. Black, Editor
The Journal of Engineering Graphics
General Motors Institute
Flint, Michigan 48502

INCIDENTALLY

The Divisional Membership Committee reports that the representative of the ASEE Board of Directors said that the constitution of the society means what it says with reference to "--- or other persons interested in engineering education." He felt that we are free to invite into the Division any teachers, pre-college as well as college, who were preparing students to become engineers.

Professor J. Earle, Texas A & M University, agreed to prepare a brochure to help increase subscriptions to the Journal. It was felt that interest in the Division so generated will result in new members. Since that time the Division chairman has made fifty dollars available to Professor Earle to partially defray the expense of this work.

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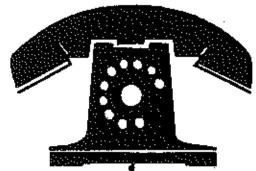
COMMUNICATION NEEDS IN ENGINEERING EDUCATION

by

J. Stuart Johnson, Dean
College of Engineering
Wayne State University
Detroit, Michigan



To the engineer, more specifically the one whose basic interests are in things electrical, the word "communications" denotes those technological devices and systems which have been developed as technical aids to the transmission and reception of information. To the non-engineer, particularly those persons whose interest is immediately directed toward the proper interpretation of the information transmitted and received, the word implies something quite apart from the device or system. In fact to him the device may be nothing more than a pencil and paper and may, for that matter, have no components at all other than those physiological.

I happen to be in both camps. I was raised in a family in which education, English, and communication in the non-technological sense represented the professional activity of the head of the household. I majored in electrical engineering and thus subsequently came to recognize the other interpretations as well. I feel, therefore, that I may be in a somewhat unique position as it relates to the theme of communication needs.

We recognize the importance of clarity of transmission of information and have repeatedly pointed out the shortcomings in the area of effective communication possessed by and admittedly existing in engineering graduates of this and preceding generations. We have evidenced, quite properly, much concern over this deficiency but may, perhaps, have left the impression that the weakness is greater today than yesterday. I subscribe thoroughly to this concern but hasten to the defense of our educational system in stating my firm belief that the weakness is not as great today as yesterday, but like so many other things in our rapidly moving, and I should say rapidly accelerating, technological society, the importance of this area of communication to progress, both personal and sociological, is far greater.

Not only must we communicate more complex ideas, but we no longer have the time for repeated clarification and further, our communication media themselves have expanded both in quantity, scope, and rapidity so that we communicate more things more rapidly and to more people. Thus while the deficiency has, I believe, lessened, this lessening has not kept pace with the increased need so that the problem itself on a net basis has become and is becoming increasingly more acute.

Presented at 27th Annual Meeting, Michigan Section, American Society for Engineering Education, East Lansing, Michigan.

We are aware of the communication problems currently existing in industry. Similar problems confront the educator who has made communication the prime focal point of his talents and professional efforts.

In the past we have traditionally spoken of the three languages through which an engineer communicates: first, graphics, a drawing or picture; second, the language of mathematics, which may be considered as related to the picture in one sense in that it represents a shorthand method of communicating. Indeed mathematics is a medium which eliminates the need for long and complex groupings of words to explain the situation and provides a convenient and effective means of idea manipulation. And third, is the native tongue both spoken and written. No one, I believe, challenges these as the three basic languages with which the engineer works. However, today we also have other media of communication; namely, those of the common language concept and the language of the computer. While these themselves undoubtedly represent a degree of combination of the three originally conceived basic languages of communication, they represent very distinct and essentially new sets of reasoning processes through which ideas and information can be transmitted, received, and interpreted.

I shall attempt to indicate the manner in which engineering colleges today, recognizing the problem, attempt to solve this problem in the course of the formal engineering educational program. I hope to point out the direction being taken, certain fundamental problems existing, and perhaps introduce some new ideas which might supplement present methods of solution in certain instances.

With reference to the problem relating to the development of communication proficiency, no one challenges or questions the need to communicate effectively. Just as one is against sin and for motherhood, he will subscribe wholeheartedly to the principle that information acquired is of little value unless it can be properly disseminated and understood. There is a very decided difference, however, in individual evaluation of one's own ability to project his ideas or glean all the information contained in a transmission of thoughts directed toward him.

Thus the matter of self-evaluation and the area of motivation, though not too distantly related, enter the picture strongly. The vast majority of students in our engineering colleges today and the graduate engineer in practice, have for approximately the first 18 years of their lives, been exposed to the English language. Two-thirds of this time they have been under formal tutelage in the subject prior to their admission to a university. While the home environment of the individual has much to do with his response to and performance under formal tutelage, nevertheless the 12-year formal exposure to correct and effective usage of the mother-tongue should, with the exception of the extent of his personal vocabulary, have produced in him an effective communicator considering the term "communicator" to refer to both ends of the system. Following the pre-college education, training, and exposure, the student, at least in his freshman year, receives further such formal training. Subsequently, he is called upon in his various courses, both professional and non-technical, to present his ideas in the form of examinations, term papers, and reports as well as short talks. In turn he reports on his understanding, interpretation, and evaluation of the utterances, vocal and written, of others.

From the point of view of attention to the problem and opportunity afforded, I feel the universities are performing a very creditable service. I have omitted the word "effectively" and purposely substituted "creditably." We have failed, miserably in some instances, to infect the student with an awareness of the true importance of what is being presented in his various courses regardless of subject area. Perhaps we ourselves are not good communicators. We have failed correspondingly to inject into the student the motivation to perfect himself in the art of information transmission and reception. And we have failed somehow in many instances to understand ourselves where, why, and how we have failed the student and thereby not fulfilling our responsibility to industry in its broadest sense.

The instructors responsible for communication training - and I use the word training instead of education, since it certainly involves an art - may be divided roughly into two categories. There are those whose professional efforts are directed specifically at the communication field, and there are the teachers who teach other subjects both within the circle of engineering educators and in the supporting fields. The faculty members in the second category are often prone to depend upon the professional communication expert to solve the problem and feel that their own responsibility lies only in the small professional area designated by the subject of the course being taught. Thus, they will grade a report or term paper on the basis of its subject matter content, perhaps marking some errors in grammar and suggested improvements in the communication technique but basically deploring the student's exhibited weakness in this area. Somehow these teachers continue to promote the idea of accuracy in the use of the mathematical language, perhaps since it has been by tradition more closely related to their professional programs, but take a much less active part in and responsibility for the correction of communication techniques.

Certain instructors are quite conscientious in their efforts in the direction of good communication techniques while others frequently, unfortunately because they themselves do not know better, neglect almost completely this phase of their responsibility. Some institutions, through periodic checks, attempt to keep the student aware of the importance of the problem or at least keep him continually alert to the academic dangers of failure to live up to his communication potential, in an effort to create automatic observance of the principles of good communication. In this latter connection several procedures are followed by different schools throughout the country.

Some institutions require a junior proficiency examination to be taken by the student in the period near his transfer from lower to upper division activities. Performance on this examination will determine whether or not the student may be required to take certain remedial non-credit work before being certified as proficient in the art. While this has definite merits, it is certainly an artificial one-time hurdle requiring for any degree of permanent benefit the continued support of the faculty beyond this point. Other institutions may require an examination the semester prior to certification for the degree.

Failure to perform properly on this examination may prevent, or at least delay, the awarding of a degree. Other schools through arrangement with the campus communication clinic, variously named, may require instructors to submit random reports and term papers throughout the entire upper division enrollment of the student, such work to be checked by the clinic for communication weaknesses. When a weakness is observed in such degree as has been pre-determined to be critical, the student may be required again to take an examination and based on his test performance, perhaps to take remedial work. In each of the procedures mentioned above, numerous flaws exist. For example in the use of the latter of the three, it has been my personal experience that students who have been called in as a result of observed weaknesses in reports, communication-wise, and required to take such an examination, have usually passed the examination quite satisfactorily to the extent of 90 per cent of the persons so involved. This is a very definite indication that the student can perform if he so desires and if he can be persuaded to feel that this is an important phase of the report or paper he is preparing. I do not believe that the remaining 10 per cent, considering that this represents only a percentage of those in whom weaknesses were specifically observed, represents any significant basic deficiency in the overall student ability.

All this evidence points up the fact, I believe, that the student somehow has developed the idea that a course is passed merely for the sake of getting a satisfactory grade in that course. Having so passed it, he can forget the material and proceed to the next course. Thus, we are confronted by the danger of excessive fragmentation of subject matter into small, from the student's point of view, apparently isolated pockets of knowledge.

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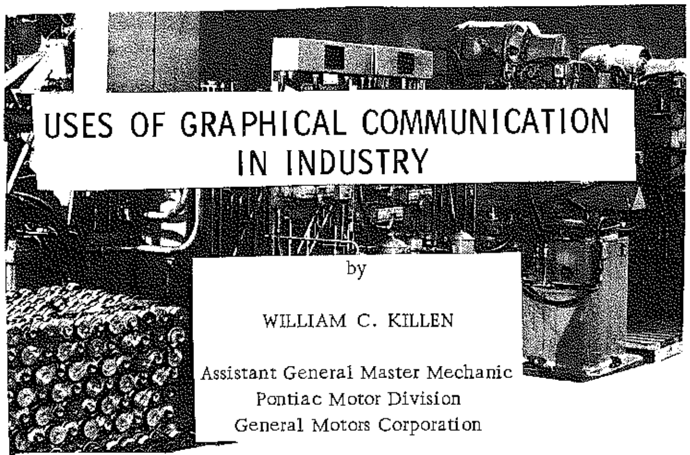

USES OF GRAPHICAL COMMUNICATION IN INDUSTRY

by

WILLIAM C. KILLEN

Assistant General Master Mechanic
Pontiac Motor Division
General Motors Corporation

EDITOR'S NOTE:

Instructional departments at General Motors Institute occasionally call upon General Motors plant personnel to talk to students on selected topics. Mr. William C. Killen, Assistant General Master Mechanic, Pontiac Motor Division, General Motors Corporation was asked to talk to the beginning Graphics for Engineers classes on the topic, "Uses of Graphical Communication in Industry." This talk was tape recorded and transcribed.

It is with pleasure that we are permitted to publish this talk.

The graphical language is very, very important, in engineering education. You freshmen have been transplanted, so to speak, into a foreign country. By virtue of being transplanted into this foreign country, you must learn to speak the language, regardless of how you may feel about "drafting." Mechanical drawing, the language of an engineer, is graphical in nature, and it must necessarily be so. Through the use of graphical language, engineers speak to one another and convey their ideas. It would be very difficult for me to sit and talk to any of you and explain verbally what an automobile is, and if you had never seen an automobile before, expect you to come up with the same idea that I have.

I know, by virtue of the fact that you are in an engineering college, that most of you are mechanically inclined. I suspect that all of you are familiar enough with a cylinder block to know how it looks. I would like to have you take a piece of paper now and very briefly, in your very best English composition, explain what a cylinder block is, and describe it in enough detail that someone could take your description and manufacture it. While you are doing this, I will hang up a blueprint. (The detail of an engine block covers a drawing area of about four by sixteen feet.)

You can see that this is a cylinder block drawing. From this drawing many people do many things towards the manufacture of this part. Are you ready to turn your description over to the machine shop now? I am sure that not one of you got past the first sentence, for I am trying to point out to you that it would be impossible. It is impossible for an engineer to convey his design thoughts completely by any method other than graphical communication.

What is the graphical language? The graphical language, as far as we are concerned, is composed of lines, symbols, definitions, notes, specifications, etc., all of which you see on this drawing. Over the the years there have been many things added to the graphical language that formerly were not used. For example, surface finish specifications have been added recently. Prior to this the terms such as "must be smooth" or "grind," were used. These terms, of course, meant many things to many people. What was "smooth" to one may not have been smooth to another. Therefore the graphical language has evolved itself into a more exact science than what it was in the past.

Engineering drawings help in forming a concrete mental picture of engineering thinking. It is impossible for you to look into my mind or for me to look into yours and try to determine what you are thinking or designing. It is difficult for you to explain to me what you are thinking, merely by telling me so.

Industry has become much larger over the years. In former years when "the plant" was a small shop, or when Henry Ford was chief engineer, chief mechanic, chief machinist, chief purchasing agent and a few other jobs, there was not this difficulty of having drawings to convey the idea from one person to another. One man had the idea, and he was the only person to whom it meant anything. The other folks did his bidding, so it wasn't important that he convey his engineering image to others. Over the years, as the industry became larger and expanded, there had to be a method of communication. This communication has evolved into the graphical language.

When you started kindergarten and the first and second grade, you were involved in learning the alphabet, in learning how to read and to write. The same thing is true in engineering, and it is just as important that you learn how to "read and write" the graphical language. If you fail, you will have just as much difficulty in being an engineer as you would have difficulty in earning your living if you did not know how to read and write English.

I can't impress upon you too strongly that it is important for you to talk the language of the people with whom you are going to work. You should understand it fully, and be able to read a print. I don't mean just after an hour or two of study; I mean be able to read it much the same as scanning a page of reading material in a book, so that you can be around a drawing board with people on your level or above you, and read the drawing with the same speed and with the same intelligence as they do.

These drawings convey ideas from one person to another using the graphical language. They convey a set of specifications that must be adhered to so that the final product will not only go together, but will meet the specifications on durability and reliability that are supposed to be built into it, and are intended to be built into it by the engineering staff.

One thing that you must not overlook, too, whether you are making a drawing or receiving one, is that a drawing, as such, is a legal document and it does have a standing in court. It is important that if you, as the designer, make a drawing to communicate your ideas, be certain that it does convey your ideas accurately. It is important, so that (1) you will get what you want as an engineer and tell folks what you want; (2) when someone makes what you have said on the paper, and you see it in its concrete form, it somewhat resembles what you wanted. So many times people who make a drawing are amazed to see lying on the bench what they thought they drew

I don't know whether or not you are familiar with the term "government work," but "government work" in the plant is the part that is made for a farm implement or a tractor, a hot rod, or a washing machine, or whatever. If one of the gentlemen from "upstairs," who has several more stripes than you do, comes down with a sketch and says, "I need this by tonight, would you make this for me?" Certainly you will make it for him.

Here you get into the area where these folks are not as attuned to this graphical language as I hope you gentlemen are when you graduate. Their sketches leave a lot to be desired. So many times at the end of the day when you deliver this farm implement, tractor part, hot rod part, or whatever it might be, to the gentleman that drew the sketch, he is amazed at what happened. This leads to what is called "rework" - that is, taking the part and making it now conform to what he had in mind at the time. He may take it in his hand and say, "Now I don't mean for it to be quite as long here, nor the hole to be quite as large, or to be there. Could we do this?" Then we start over. You can see that it is important that on the first go around you pass on to other folks what you are talking about, exactly how you want it - not almost, not approximately, but accurately. If the engineering group made a drawing that was "almost" the size of the piston, and it "almost" fit when the cylinder block came down the line, there would be more than an "almost" lot of trouble.

Engineering drawing is a science where accuracy of result is emphasized. The drawings, as such, are a record of engineering thinking - past and present. A drawing such as you find in your work in school and on the job normally has in one corner a list of engineering changes. These are historical records of what has happened over the months, weeks, years, whatever it might be to this particular part. They tell how it has changed, how it has evolved in its engineering shape and form. But it all boils down to one thing: you as an engineer must know how to talk and write. When you talk about "writing" it means making a drawing in the graphical language because it is the predominent way that engineers have of talking to one another intelligently.

Now engineers do talk to one another, I have seen them talk to one another at meetings and try to describe what they are going to do. But I sometimes wonder how intelligible their words were, because after having come away from some of these engineering meetings, I am still at a loss as to what went on. (I am sure that they are too.)

Various people in the plant use these engineering drawings as a so-called thesis expressed by the graphical language. This blueprint is a thesis describing a cylinder block using the graphical language. These prints mean many things to many people. For example, one of the groups that receives this drawing is the production group. The production group looks upon this drawing as the part that they are to make exactly as the drawing shows. That is probably a lot of theory; sometimes the parts don't come out exactly as the drawing says they are supposed to, but within limitations which are set up on the drawings and by the use of good judgment. The parts are made by production in this manner.

The Standards Department in a plant has the task of setting up the time standards, and the plant layout. They set standards of how long it should take to do a particular operation. They necessarily must have the specifications that pertain to that particular operation so that they will know, using their past experience, how much time to allow for the various operations. Sometimes the Standards Department has the responsibility of designing and building hooks and other moving equipment to transport the product from one operation to another, or from one department to another. They would have to use a drawing to determine how the part is to be grasped and moved from one station to another.

The Purchasing Department, of course, gets copies of all the prints. The Purchasing Department looks at a print somewhat differently from some of the other areas which receive these prints. They'll receive prints of parts that they are to purchase completed, that is, a part that will not be manufactured at their particular plant but is to be purchased from some outside vendor. For example, they may buy a battery, or a starting motor, or something along that line; but there must be a drawing which sets up the specifications so that these outside vendors can bid competitively. We don't want one company to bid on a starting motor, with 100 amp capacity and another to bid on 150 amps and then to try to compare these two quotes. It would not be fair to the outside vendor and, of course, the Engineering Department would have no idea what is to go in the car. These specifications are adhered to, and bid on by all the outside companies that are contacted by purchasing. Purchasing also must get other types of material in supply, such as bar stock, castings, forgings, etc. The drawings are used to that end. It isn't necessary in many instances that the people in the Purchasing Department be as capable of reading a drawing as an engineer, but at least they have a use for the prints and have a nodding knowledge of graphical communication.

The "Reliability" group, as the Inspection Departments are now referred to in General Motors, makes great use of these drawings. These drawings set up the boundary line, the specifications to

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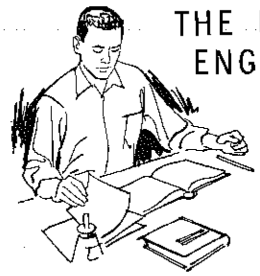

THE USE OF GRAPHICS IN ENGINEERING ANALYSIS

by

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Graphic techniques can be an important and useful tool in the area of engineering analysis. Any quantity, regardless of its units, which can be represented as a vector can be represented as a straight line, hence any number of quantities, with like units, having defined relationships can be represented by a system of graphic (vector) polygons. There will be one polygon per defined relation (or equation) and each polygon will be joined to a neighboring polygon by a line representing that vector quantity which is found in those equations which the polygons represent. This last statement is best illustrated by a graphic solution which yields the amplitude and phase angle associated with the steady state response of a dynamic system subjected to a sinusoidal forcing function. The system investigated consists of two masses, two springs, and two viscous dampers as shown in Figure 1. The differential equations for the motion of the two masses are written and the form of the steady state response (or displacement) is assumed. When the assumed steady state response equation is substituted into the differential equations of motion the result is a system of equations which may be represented as vector polygons, thus the solution of an otherwise lengthy and difficult problem in engineering analysis is reduced to a graphic solution as is illustrated in Figures 2 and 3. The determination of the desired quantities, which in this example are amplitudes and phase angles, reduces to a matter of scaling a graphic polygon. The details of the solution follow:

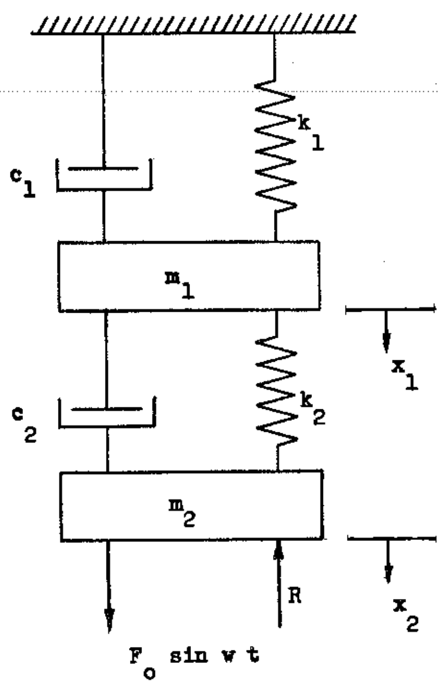

Figure 1

Consider the two degree of freedom system represented by Figure 1. Where

k_1, k_2 are spring constants

c_1, c_2 are damping constants

m_1, m_2 are masses

F_o is the amplitude of a sinusodial shaking force

R is a constant force

t is time

If we assume $x_2 > x_1$, then the equations of motion are

$$m_2 \ddot{x}_2 + c_2 \dot{x}_2 + k_2 x_2 = F_o \sin w t - R + k_2 x_1 + c_2 \dot{x}_1 \quad (1)$$

and

$$m_1 \ddot{x}_1 + (c_1 + c_2) \dot{x}_1 + (k_1 + k_2) x_1 = k_2 x_2 + c_2 \dot{x}_2 \quad (2)$$

let

$$c_1 + c_2 = c_3$$

$$k_1 + k_2 = k_3$$

and assume the steady state response to be of the form

$$x_1 = A_1 \sin (w t - \phi_1) \quad (3)$$

$$x_2 = A_2 \sin (w t - \phi_2) \quad (4)$$

EDITOR'S NOTE:

This paper was submitted under the title, "A Graphical Solution for the Steady State Response of a Two Degree of Freedom Dynamic System Subjected to a Sinusoidal Forcing Function."

where A_1, A_2, ϕ_1, and ϕ_2 are to be determined. Substitution of the preceding equations into the equations of motion yields, for mass 1

$$m_1 A_1 w^2 \sin(wt - \phi_1) - c_3 A_1 w \cos(wt - \phi_1) - k_3 A_1 \sin(wt - \phi_1) + k_2 A_2 \sin(wt - \phi_2) + c_2 A_2 w \cos(wt - \phi_2) = 0 \quad (5)$$

and for mass 2

$$m_2 A_2 w^2 \sin(wt - \phi_2) - c_2 A_2 w \cos(wt - \phi_2) - k_2 A_2 \sin(wt - \phi_2) + F_o \sin wt - R + k_2 A_1 \sin(wt - \phi_1) + c_2 A_1 w \cos(wt - \phi_1) = 0 \quad (6)$$

These equations may be illustrated graphically as per Figure 2.

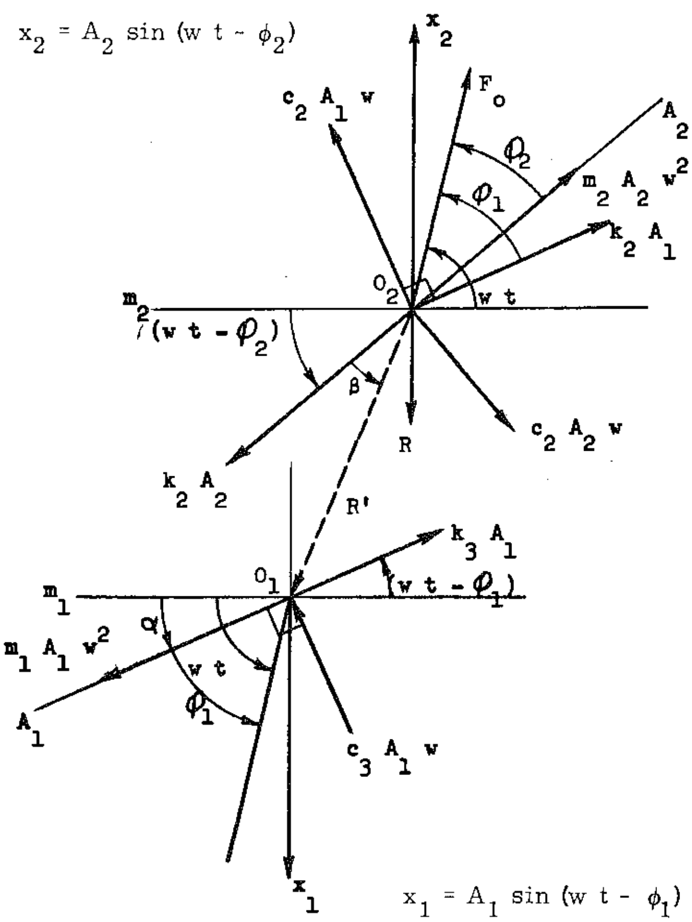

Figure 2

Note that there are two origins, each corresponding to the coordinates x_1 and x_2. The angle α is arbitrary and A_1, A_2, ϕ_1 and ϕ_2 are unknown at this point; however, equations 5 and 6 are satisfied.

We now divide both equations 5 and 6 by A_1; this is equivalent to scaling the preceding figure by the factor $\frac{1}{A}$. A closed force polygon may now be drawn to scale as per Figure 3 by the following steps:

Step	Procedure
1	The vectors, whose lengths are represented by the values m_1, w^2, $c_3 w$, k_3, are drawn first. The angle α is arbitrary and 0_1 is one origin.
2	$\frac{R'}{A_1}$ is drawn to close the polygon at 0_1.
3	β is defined by $$\arc\tan\beta = \frac{c_2 w}{k_2} \quad (7)$$
4	Draw the two vectors whose lengths will represent the values $c_2 \frac{A_2}{A_1} w$ and $k_2 \frac{A_2}{A_1}$
5	Scale the drawing for the value of $c_2 \frac{A_2}{A_1} w$ and calculate $\frac{A_2}{A_1}$. The point 0_2 is the other origin.
6	Draw the vectors whose lengths are represented by the values $c_2 w$, k_2 and $m_2 \frac{A_2}{A_1} w^2$, with $m_2 \frac{A_2}{A_1} w^2$, parallel to $k_2 \frac{A_2}{A_1}$.
7	Draw a vertical line through 0_2 which represents the direction of $\frac{R}{A_1}$ To close the polygon, we make use of the fact that the relative length of the two remaining vectors are in the ratio of $$\frac{\frac{R}{A_1}}{\frac{F_o}{A_1}} = \frac{R}{F_o} = \frac{\text{length of } \frac{R}{A_1}}{\text{length of } \frac{F_o}{A_1}} \quad (8)$$
8	After the polygon has been closed, scale the vector $\frac{F_o}{A_1}$ and calculate A_1. From the ratio of $\frac{A_2}{A_1}$ yielded by step 5, we may also calculate A_2.

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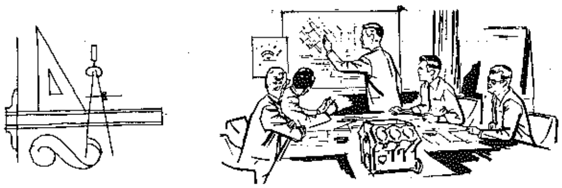

OPINIONS OF EDUCATORS AND ENGINEERS ON THE IMPORTANCE OF ENGINEERING GRAPHICS TOPICS

by

ERNEST C. SCHAMEHORN

Department of Education
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February 1965

This paper summarizes a comprehensive national study of engineering graphics content conducted in 1962-1963. The study was undertaken to learn what content should be offered in graphics courses and how much time should be allotted to the graphics education of the engineer in view of the changing needs of industry and engineering education. This study is the first to make direct comparisons of the opinions of several principal population groups concerned with graphics instruction. It therefore provides a much wider base for curriculum planning than has been the case with previous studies in this field. The extremely high percentage of returns of 83 per cent on a detailed ten-page questionnaire suggests the importance which the respondents placed on this study.

The study includes the viewpoints of nine groups: (1) Mechanical, (2) Civil, (3) Electrical, and (4) Chemical Engineering Educators, (5) Engineering Graphics Educators, (6) Manufacturing and Production, (7) Research and Development, (8) Architectural and Structural, and (9) Operations and Maintenance Engineers holding engineering degrees.

The data suggests that a common program of engineering graphics should be offered to students in the Mechanical, Civil, Electrical, and Chemical Engineering Curricula. The data obtained shows that a minimum program of engineering graphics courses should include six semester hours. Primary emphasis should be given to Engineering Drawing topics, and important emphases should be given to Descriptive Geometry topics and to the solving of comprehensive problems which require applications of descriptive geometry, projective geometry methods, and creativity.

The purposes of this study were to procure data upon which comparisons of the principal groups participating in the study could be made as to the relative importance which they would place upon areas, subjects, and topics of the graphics curriculum, and to accumulate the data for a total content and corresponding time recommendation for each group and combinations of the groups. The overall objective was to assess the current thinking of the principal groups of persons affected by the graphics courses in the engineering curriculum so that the results would provide a better basis for a graphics program than would a study of only engineers, or only engineering educators.

Method of Research

The survey method was used for this study. The heads of mechanical, civil, electrical, chemical, and engineering graphics departments of selected institutions accredited by the Engineers' Council for Professional Development for at least one engineering curriculum were asked to participate in this study or to recommend faculty representatives for their respective departments. A questionnaire was sent to each designated representative which asked him to indicate the degree of emphasis and the amount of time which should be given to each of 56 items of content. The percentage return for the five groups was 86 per cent. The five groups of engineering educators included 250 participants from 97 institutions located in fifty states, the District of Columbia, and Puerto Rico.

Engineering supervisors and managerial personnel of selected small, medium, and large industries and government agencies offering diversified products and services were asked to recommend for participation in the study engineers whose activities were in the functional areas of manufacturing and production, research and development, architectural and structural, and operations and maintenance. A questionnaire sent to each designated representative asked him to indicate the degree of emphasis and the amount of time which should be given to each of 56 items of content. The percentage return for the four groups was 80 per cent. The four groups of practicing engineers included 234 participants from 87 industries and government agencies located in 43 states and the District of Columbia.

Summary and Conclusions

Statistical treatment of the data revealed significant differences in the emphasis and time which the practicing engineers recommend. The practicing engineer groups include between 44 and 53 of the 56 listed items in engineering graphics courses. The accumulated total hours for the 44-53 topics vary between 300 and 500 hours (or 3.5 semesters to 5 semesters, based on an average time of 93 hours per semester). The Engineering Graphics Educators Group includes 37 topics at 270 hours (or three semesters). The Mechanical and the Civil Engineering Educators Groups include between 27 and 30 of the topics at 200 hours (or two semesters). The Electrical and the Chemical Engineering Educators Groups include between 11 and 15 of the topics at 90 hours (or one semester).

The practicing engineers consider three of the six primary areas of content defined in the study to be important. They indicate that Engineering

Drawing is the most important, followed by Problem Solving and Applications, and Descriptive Geometry. The areas of Special Types of Drawings and Graphical Representation, Analysis, and Computations are given a limited importance, and the area of Modern Graphical Approaches a very slight importance.

The engineering graphics educators consider four primary areas to be important. They indicate that Descriptive Geometry is the most important of the four, and that Engineering Drawing is only slightly more important than the other two areas. They rate Graphical Representation, Analysis and Computations content and Problem Solving and Applications content as being of nearly equal importance.

The engineering educators from degree-granting departments indicate that Descriptive Geometry is important, Engineering Drawing is of limited importance, and except for three topics -- Projective Geometry in Solution of Graphics Problems, Applications of Descriptive Geometry to Various Engineering Problem Areas, and Charts and Graphs -- none of the content in the other four primary areas should be included in engineering graphics courses.

The practicing engineers consider five of the six secondary areas defined in the study to be important. They indicate that the two most important areas are Basic Skills, and Size Representation (dimensioning). The Multi-View Projection (visualization) and the Working Drawings Areas also are considered important. The area of Pictorial Drawing is considered to be of limited importance. The area of Modern Graphical Approaches is given even less importance.

The engineering graphics educators attach a relatively strong importance to four of the six secondary areas. They indicate that Multi-View Projection is by far the most important, with Surfaces, Basic Skills, and Size Representation content following in order. They attach limited importance to the area of Working Drawings.

The engineering educators from degree-granting departments consider two secondary areas to be important: Multi-View Projection and Basic Skills. They indicate the two areas Surfaces and Pictorial Drawings are of limited importance and the two areas of Working Drawings and Size Representation are of slight importance.

The practicing engineers place a significantly greater importance on the following topics than do the engineering educators: Layout Drawings and Design Sketches, Checking a Drawing, Welding Representation, Structural Drawing, and Electrical Diagrams.

The practicing engineers place a substantially greater importance on the following topics than do the engineering graphics educators: Lettering, Geometric Constructions, Reading a Drawing, Piping Drawing, Architectural Drawing, and Electrical Diagrams.

The practicing engineers place a substantially greater importance on the following topics than do the engineering educators from degree-granting departments: Limits and Tolerances, Geometrical and Positional Tolerancing, Working Drawings, Comprehensive Problems, Applications of Descriptive Geometry to Various Engineering Problem Areas, and Mechanisms.

The opinions expressed by each of the nine groups in this study indicate the basic question regarding the place of engineering graphics courses in the engineering curriculum is not whether such courses should be in the curriculum, but rather to what extent they are to be included in the curriculum.

Recommendations

It is recommended that consideration of the findings of this study be a major factor in the revision of the mechanical, civil, electrical, and chemical engineering curricula. The findings also should be of interest to the employers of engineers who are concerned with the development of engineering graphics courses which will insure that the graduate engineer will possess the necessary knowledge and skill in engineering graphics to perform engineering assignments adequately.

Based on the findings of this study, it is recommended that a minimum program of engineering graphics for mechanical, civil, electrical, and chemical engineering students consist of three 2-semester hour courses, or two 3-semester hour courses (total of 6 semester hours of credit), or the equivalent in quarter hours. It is recommended that the total time breakdown be as follows: Engineering Drawing Area -- 60 per cent, Descriptive Geometry Area -- 17 per cent, Problem Solving and Applications Area -- 15 per cent, Graphical Representation Area -- 6 per cent, and Modern Graphical Approaches Area -- 2 per cent.

It is recommended that a minimum program of engineering graphics for mechanical, civil, electrical, and chemical engineering students provide the following items of content:

A. Engineering Drawing Area.

1. Freehand Sketching
2. Lettering
3. Use of Instruments
4. Drawing Techniques
5. Geometric Constructions
6. Orthographic Projection
7. Axonometric Projection
8. Oblique Drawing
9. Perspective Drawing
10. Primary Auxiliary Views

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AXONOMETRIC PICTURE AND STEREOSCOPIC MODEL FOR FOUR-DIMENSIONAL EUCLIDEAN GEOMETRY

By

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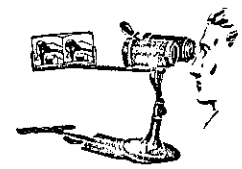

1. Introduction

The 4-Dimensional Geometry is an important branch of Geometry but the study of it is handicapped by the difficulty of imagining it in an intuitive manner.

The main aim of this article is to develop constructions and drawings similar, as far as possible, to the usual axonometric picture of bodies to which we are accustomed.

All the theoretical constructions are performed according to the "Method of Parallel Projection for Geometry of Four Dimensions" (1), and we will use them without explanations or proofs.

2. The System of Reference and Axonometric Picture of a Point

The system is composed of four axes x, y, z, t whose locations are always: z-Vertical, t-Horizontal, x and y inclined towards z at 120° angles. The axes start from a point 0, origin of the coordinates. See Figure 1.

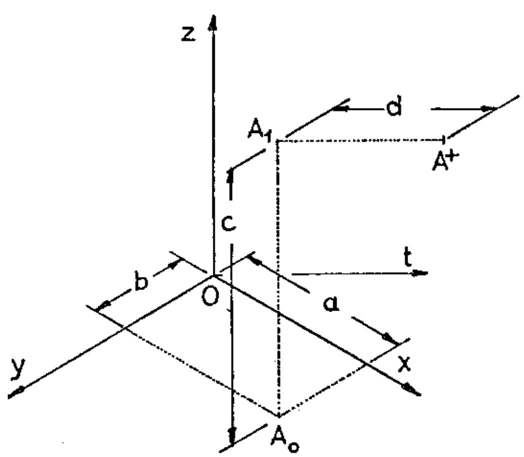

Figure 1

Let A, whose coordinates are a, b, c, d, be a point of the 4-Dimensional Space D_4. Locate a point A_o of the plane xy whose coordinates are a and b; this point is called 0-P (Zero-Projection) of A. Through A_o draw a line parallel to z and along it plot a segment A_0A_1 whose length is c. The point A_1 is called the Isometric-Projection of A (I-P) because it would be the normal isometric projection of A if this were a point of the 3-Dimensional Space D_3. Now, through A_1 draw a line parallel to t and along it plot a segment A_1A^* whose length is d. The point A* is the Axonometric Picture of A.

3. Axonometric Picture of a Line Segment and a Plane

Let AB be a line segment of the 4-Dimensional Space D_4 whose ends have coordinates a, b, c, d and e, f, g, h. Draw the Axonometric Picture A*, B* of A and B as explained in section 2, and connect them by means of the line segment A*B*. This is the required Axonometric Picture of AB. See Figure 2.

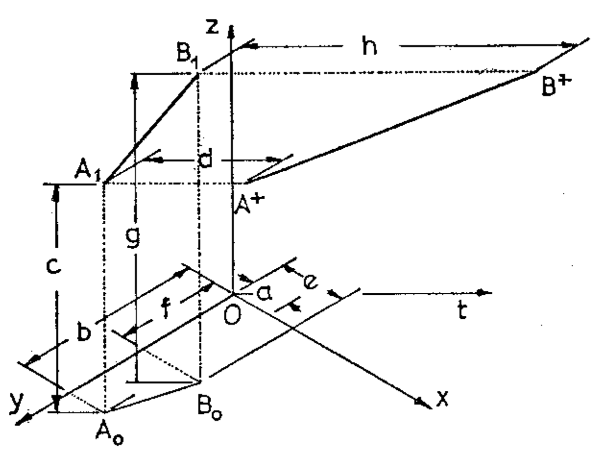

Figure 2

Let L, M, N be three non-collinear points which determine a plane α. See Figure 3. Draw the Axonometric Picture L*, M*, N* of L, M, N according to their coordinates and connect them in sequence.

(1) Luisa Bonfiglioli. Parallel Projection for Geometry of Four Dimensions. (In printing.)

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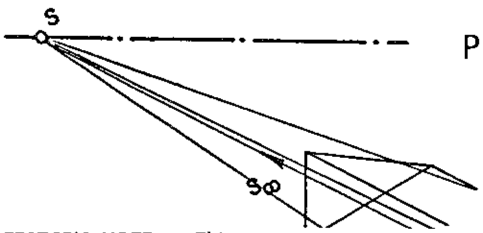
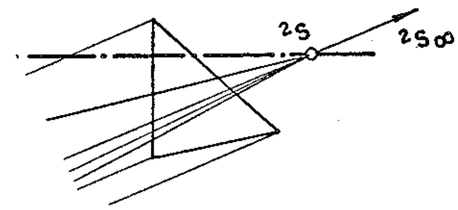


PECULIAR LINES AND PLANES



by

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EDITOR'S NOTE: This paper is on the Relationship Between Orthographic and Central Projections Established by Projective Geometry.

FOREWORD.

We are rediscovering laws, principles and methods which have been known for quite a long period of time. The principles have been partly rejected, partly merely forgotten because of no immediate practical utility. The methods have been remodelled (i.e., simplified or "improved") with no contribution to progress in graphical science.

However, in the natural evolution of events in engineering and science, history repeats itself periodically. A law, a principle, or a method rejected yesterday may be successfully reinstated tomorrow.

The number of enthusiastic participants in projective geometry is increasing from year to year. Many dedicated men are endeavouring to refine the existing methods and techniques of representation by projection; some of them are trying to establish a material link between projective and descriptive geometries; they pertain mainly to the younger generation, a few being in possession of Ph.D. degrees in Mathematics. This is rather encouraging, even if those men are inventing "old" facts unaware of their existence.

This exposition[1] I hope will be of assistance to anyone interested in the extension of descriptive geometry and the related constructions in engineering design into the field of projective geometry, and especially to those who are still groping their way in the dark.

METHODS OF PROJECTION

In graphical science (engineering graphics) we are simplifying constructions by methods of descriptive geometry, representing objects in space by projection into one, two, three, or more projection planes. We are using several centers of projection which may be ideal (i.e., at infinity), or finite. Thus we differentiate between orthographic, oblique, and central projections. In order to refine or simplify the original Mongean concepts of descriptive geometry, we have introduced a device called the "direct method" to better explain orthographic projection; which implies observers, quasi-transparent projection planes, third quadrant, deletion of traces of lines and planes in the principal projection planes, etc. This latter approach is positively inadequate thereby leading to discrepancies between orthographic and perspective, or axonometric projections, making the pictorial visualization difficult.

PROJECTIVE GEOMETRY, AXIS OF HOMOLOGY

Projective geometry is all geometry; orthographic projection is just a small, but extensively developed part of projective geometry.

Desargues, the Newton of graphical science, was not aware of the Monge system of orthographic projection; but Monge was thoroughly acquainted with the concepts of projective geometry existing in his epoch. An Einstein of graphical science has yet to make his introduction; however anyone[2] able to operate in terms of four-dimensional projective-descriptive geometry, is approaching the noble goal of the modern graphical science.

Every method of projection can be derived from the general concept of central projection.

In every projection we may determine a peculiar Line I linking the respective method of projection with projective geometry. It is the line of invariant points (i.e., points with identical projections) called axis of homology; it relates mutually the object and its projections in the scheme of the selected projection planes. This concept is illustrated in Figure 1.

In four-dimensional descriptive geometry we operate with plane of homology as the intersection of two three-dimensional spaces.

In affine and collinear transformations in space, we also encounter a plane of homology containing all axes of homology pertaining to various cross-sections of objects with some sort of intrinsinc symmetry.

In orthographics projection, the axis of homology is called the axis of affinity. In the selected scheme of two projection planes, perpendicular to each other, it is the line of intersection of a planar geometric configuration with the plane of identity. The plane of identity is a plane bisecting the right angle between the second and fourth quadrants and passing through the intersection of the selected projection planes.[3] For the sake of simplification, we will refer to this line as the x-axis.

It is obvious that the axis of homology exists in any representation with two centers of projection and two projection planes which may be orthogonal or oblique to each other, thus permitting the creation of an artificial, but very useful device, namely the plane of identity.

There is another auxiliary device whose applicability is of no lesser importance. It is the plane

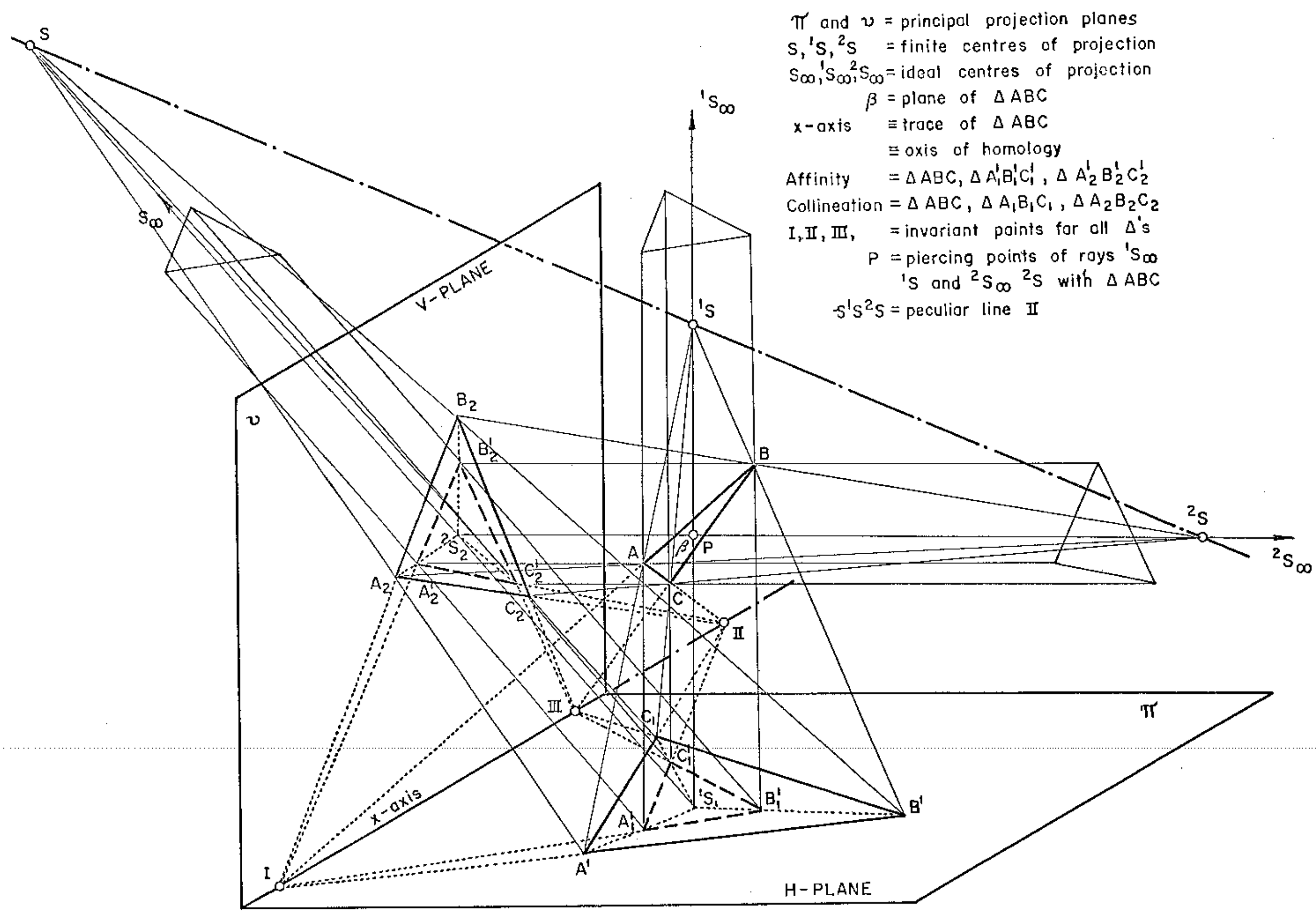


FIG. I

RELATIONSHIPS:
COLLINEATION AND AFFINITY
PARALLEL AND CENTRAL PROJECTIONS

of symmetry bisecting the angle between projection planes, passing through the first and third quadrants, and through the line of intersection of the selected (i.e., principal) projection planes. Another straight line, the peculiar Line II is related with the plane of symmetry. This is the projection perpendicular to the plane of identity (or parallel to the plane of symmetry). This concept will be depicted in Figure 2.

Planes of identity and symmetry are indispensable in constructions of solutions in Higher Descriptive Geometry, which is more closely associated with Projective Geometry.

In central projection the axis of homology becomes the axis of collineation, but the relationship between the object and its projections remains unchanged: the axis of collineation may again be the intersection of the plane of a geometric figure in space with the plane of identity whose location depends on the selection of the respective projection planes (orthogonal or oblique) and the centers of projection.

Remark: In the original terms of projective geometry (Desargues, Pascal, Brianchon), when dealing with triangular configurations located either in two colocal (i.e., in a plane), or two non-colocal (i.e., in two intersecting planes in space), the axis of homology may be identified with "Desargues' line."

The relationship between central projection, orthographic projection and projective geometry

π and ν = principal projection planes
${}^1S_\infty$, ${}^2S_\infty$ = centres of parallel projection
σ = plane of symmetry
τ = plane of identity
S_∞ = centre of projection for parallel rays $\perp$ plane τ
Q = point in τ ($Q_1 \equiv Q_2$)
R = point in σ
a' = peculiar line III

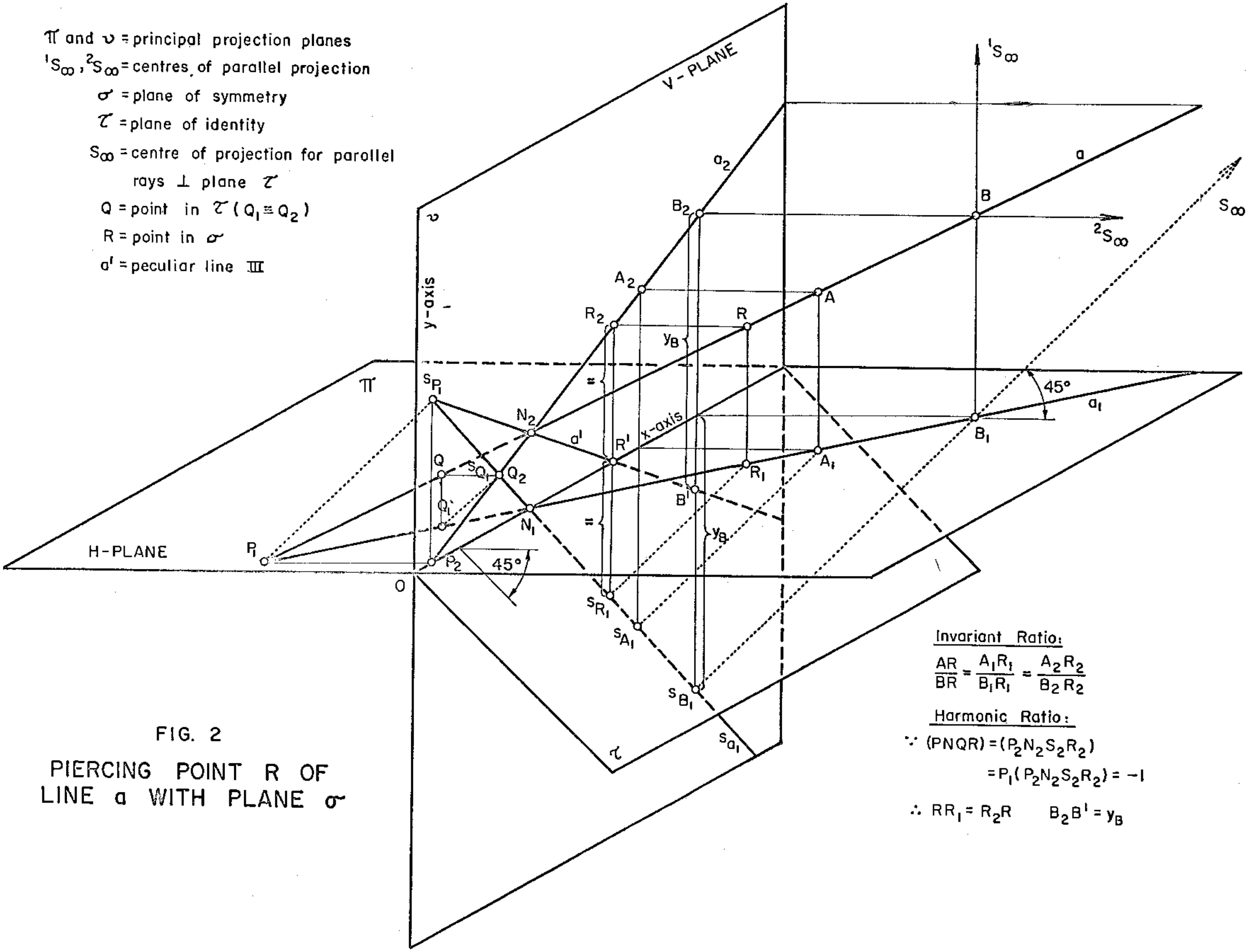


FIG. 2

PIERCING POINT R OF LINE a WITH PLANE σ

Invariant Ratio:

$$\frac{AR}{BR} = \frac{A_1R_1}{B_1R_1} = \frac{A_2R_2}{B_2R_2}$$

Harmonic Ratio:

$$\because (PNQR) = (P_2N_2S_2R_2) = P_1(P_2N_2S_2R_2) = -1$$

$$\therefore RR_1 = R_2R \qquad B_2B' = y_B$$

continued on page 48

A Technical One Year Drawing Course For College Preparatory Students; A Proposal By the Educational Relations Committee

THE CHANGING CURRICULUM

Engineering colleges are eminently concerned with the educational process of their prospective clientele; namely, the high school student. We are all totally aware of the vastly increased emphasis on education especially in engineering, the sciences, and mathematics precipitated by Sputnik and sustained by the challenges of the space age.

Curricula committees for the past eight years have expended more effort formulating courses in new mathematics, new physics, new chemistry and other disciplines than in the previous half century. New knowledge is continually being organized and appended to the present supply The role of the educational institution, be it an elementary school whose charges are struggling to learn the multiplication table or a graduate school solving problems of nuclear composition, is to somehow appraise the new concepts and techniques and fit them into the curriculum at their optimum level with due regard for comprehension, assimilation and sequence.

While the graduate schools explore the thresholds of new knowledge, the undergraduate college finds itself teaching material previously in the realm of the graduate school. In a like manner some of the traditional material taught in the first year of college is now taught in the last year of the high school. The college preparatory student who has had some experience with the calculus in high school is now more apt to be the rule rather than the exception.

And so the body of knowledge which makes up that which we call the Engineering Sciences and Mathematics gets pushed down the ladder to a continually lower level resulting in sixth graders solving arithmetic problems in binary numbers with the following class period devoted to a French lesson. The result of all this brings under study the time spent on the curriculum for the so-called traditional subjects. New material cannot be effectively taught unless sufficient time is allowed. No lengthening of the school day or school year is foreseen, however, and so careful scrutiny must be made of those subjects which are considered not to be as important in the new scheme of things as in the past.

THE ROLE OF THE ENGINEER AND ITS EFFECT ON ENGINEERING GRAPHICS

Engineering Graphics is such a subject under the impartial eye of the evaluating committees. Traditionally the graduate engineer has frequently been employed on the drawing board or closely associated with it as he started his professional career. While this may be relatively true of the present day mechanical engineering graduate it is markedly less apt to be the case with graduates of the other engineering disciplines. Production of drawings, while still conceived and defined by the engineer, is now the responsibility of the draftsman or designer.

Seemingly the engineers worth is such that his time is better spent in engineering analysis which closely resembles the textbook problems solved in the classroom than in the communicative, descriptive activities of industry which relate to the engineering drawing experience of the student while in college.

This changing role of the engineer in industry impinges directly and quickly on the college curriculum that produces him and materially changes that curriculum.

Engineering drawing or engineering graphics departments in the last decade have felt the results of this change by having their allotted time for teaching reduced by as much as fifty per cent!

It is significant to note here that while everyone, industry and educators alike, subscribes to the need of disciplines involving spatial conceptions and relations in this era which we call the space age, the argument tends to run toward the minimization of purely drafting time by the college student.

College graphics curricula have always been heavily devoted to the communicative aspects of engineering drawing; that is, the multi-view, pictorial, dimensioning, etc., techniques utilized by the draftsman. During the last decade a large emphasis has been placed on what is called "Graphical Analysis" consisting of graphical mathematics, vector analysis, nomography and similar studies which tend to be more analytical in nature or be graphical counterparts of mathematical methods.

During the last five years, the predominant emphasis in the teaching of engineering graphics has been in the area of engineering design. Since engineering graphics is taught in the first year exclusively in nearly all schools any design work done by the student would realistically fall in an area categorized as introduction to design.

One fact should be clearly understood. There is no one college engineering graphics program. Rather there are countless variations depending on the quality and probable professional level of the students, the geographic area of the school with its indigenous industrial emphases, and the collective opinion of the professional departments of an engineering college in addition to that of the graphics department itself. Throughout the wide variations in the courses, however, one could expect to find a sizeable area of common ground. The underlying base of multi-view drawings and projective systems would certainly be necessary and utilized by anyone involved in graphical techniques. Without doubt these areas would discernably be pre-eminent.

THE EDUCATIONAL RELATIONS COMMITTEE

The Educational Relations Committee of the Engineering Graphics Division of the American Society for Engineering Education has been actively studying the high school-college relationship with the intent of advising and guiding the high school technical drawing teacher in his professional work. Characteristically it must be a close and personal relationship since the output of the high school teacher is the input of the college freshman teacher with little else to supplement the high school learning experience. Subject matter taught in the college is very dependent upon the general high school background of the class with college faculties generally agreeing that inadequate preparation is an unnecessary retardant to a present-day course in engineering graphics.

Students arrive at the college classroom with backgrounds in technical drawing ranging from no experience at all to four or more years and extensive coverage of topical material. Students with good backgrounds are apt to find the course much easier especially in the area of engineering drawing while for those without preparation the discipline is an entirely new experience. With such a heterogeneous body to teach, the college instructor must assume the class has no knowledge of his subject and proceed to teach a course starting with the barest fundamentals. This is obviously a disturbing factor to the college instructor who is attempting to teach more sophisticated aspects of his subject but is encumbered by his students' lack of adequate preparation in fundamentals.

It is this random approach to teaching technical drawing at the high school level that has prompted us, the Educational Relations Committee to set for ourselves the task of determining a course of study, one year in length, for the college preparatory student intending to enter an engineering school.

We hope that the report will accomplish at least two goals: first, to demonstrate by our efforts, our concern for the high school teacher and his problems; to encourage him and help promote technical drawing as a significant discipline in the high school curriculum; secondly to offer the high school teacher a guide to channel his teaching and students' efforts into the most orderly and efficient utilization of teaching-learning time.

The Educational Relations Committee consists of approximately twelve professors of engineering graphics representing an equal number of colleges and universities throughout the United States. Each member is interested and concerned with the educational process at the high school level. The opinion of each member has been determined not only by his experience as a teacher at the college level but by extensive communication and involvement with the high school teacher. Some of the professional activities of the membership include acting as counselors and advisors to organized societies of high school drawing teachers, experience as high school teachers, writing and publishing articles and textbooks for the secondary level, teaching at summer institutes for high school personnel, and actively participating in association activities of high school drawing teachers.

THE PROPOSED COURSE

The course as we propose it would be the following:

Title: A pre-engineering course in technical drawing.

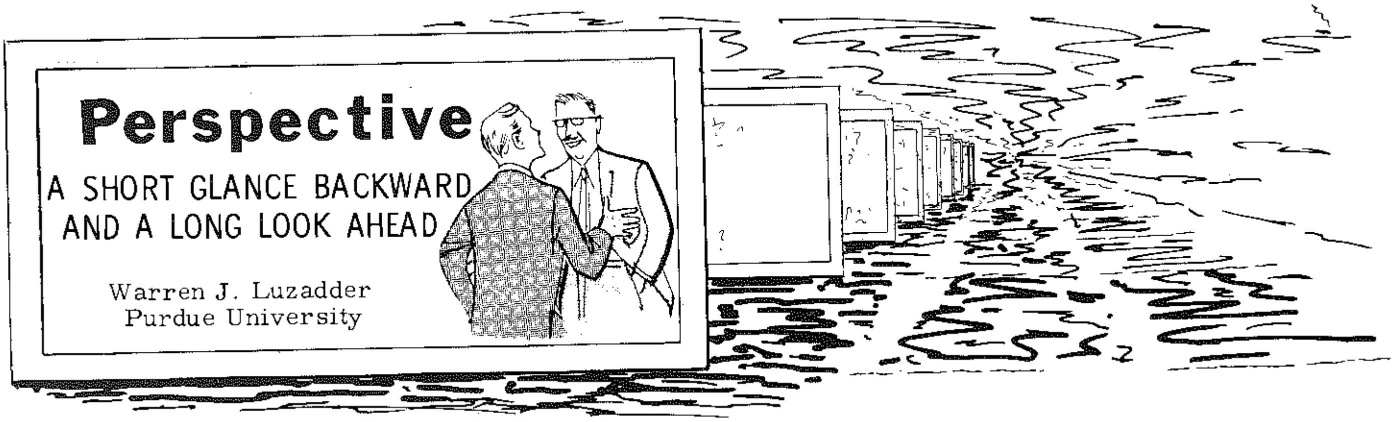
Time: One school year preferably the 11th or 12th, five periods per week for thirty-six weeks, forty-five minutes per period.

Homework: Very little, limited to reading and sketching.

COURSE CONTENT

Topic	Time, Periods
1. Use and Care of Instruments	3
2. Lettering	7
3. Geometric Constructions	11
4. Orthographic Projection, Principal Views	26
5. Freehand Sketching	15
6. Sections and Conventions	14
7. Auxiliary Views, Primary and Secondary	15
8. Isometric Drawing	13
9. Oblique Pictorial Drawing	10
10. Shop Processes	8
11. Threads and Fasteners	10
12. Dimensioning	17
13. Working Drawings, Including Assemblies	17
Testing	14
Total	180

continued on page 55



Perspective

A SHORT GLANCE BACKWARD AND A LONG LOOK AHEAD

Warren J. Luzadder
Purdue University

In a recent copy of our Journal an article appeared bearing the title "At the Forks of the Road." Under this topic the writer stated rightly that the Division had arrived at a point along a winding road where a decision must be made whether or not our Select membership should travel straight ahead along the main artery or accept into our group fellow travelers who may find their work along a branch road that leads, as does the main road, to a common goal.

The decision should be an easy one for our fellowship for there is only one right decision if we are to properly serve our Society and the American people. Remembering that our graphic science, in its many forms, is useful to the draftsman, technician, technologist, stylist, machine operator, and salesman as well as the engineer, we should provide an all encompassing membership for interested teachers. In the final analysis the persons in all of these groups are aids to our engineers who have the overall responsibility for seeing to it that our American Society enjoys the full benefits of science and technology. Our parent society recognized some responsibility for the training of aids to engineers when it created the Technical Institute Council. Are we to do anything less, particularly when we have within our field areas that are applicable to an even wider range of occupations within our technological society?

Seated among you at the fork of the highways, one is tempted to reminisce in taking a glance backwards along the road. It is indeed difficult to look back through the misty haze of memory and not ramble along endlessly about the highlights of the past and the exceptional men who guided the division through the early years. T. E. French and Fred Higbee were assisted in their leadership by C. L. Brattin, H. C. T. Eggers, R. E. Farnham, F. E. Giesecke, G. J. Hood, C. V. Mann, O. W. Potter, Justus Rising, John Russ, Carl Svensen, F. W. Slantz, F. M. Warner and others. Some from this era who are in active retirement but still known by most of us are R. P. Hoelscher, H. C. Spencer and C. H. Springer.

Several times over the past years these leaders were forced to make decisions at points where the road forked but these dedicated men in their wisdom made the right decision for their time. We of the present have leaders just as dedicated and with just as much wisdom. More than a few have investigated the branching roads to show us the many directions that our graphic science may take in satisfying the needs of the latter years of the twentieth century. It is now up to us to open up our minds to the future that now appears to be brighter than it has been in several decades. Our only real problem is the recruitment of capable, broadly trained, and dedicated young men who will become the classroom teachers and leaders of the future.

Looking down the branching roads that are ahead one sees the breaking of the bonds that have held all of us to the traditional courses for beginning engineering students. We have hobbled ourselves along the last miles of the road that we have been traveling by thinking that the only courses we could offer were the traditional courses for engineers. When these were curtailed we sat on our hands and howled. Our howls and sobs have led our campus colleagues to believe wrongly that our capabilities were very limited.

Along the roads ahead we can offer courses to young men and young women in technical institutes and schools of technology who want to assist the engineers of the future as draftsmen, designers, technical illustrators, and so forth; young people who need the types of courses and who should want to teach. On the home campus, the writer of this article derives considerable satisfaction from teaching students in the associate degree program for technical illustration - the only group of students required to take a course in descriptive geometry.

Ahead along another branch road is the opportunity for team teaching in upper level courses. Courses based on creativity and design where sketching is needed to record the thoughts of active young minds and graphical methods offer the quickest means for the solution to some problems. In these courses, where motivation is high and the need is recognized, an application of descriptive geometry can offer a welcome challenge to a highly motivated student. With team teaching we are infiltrating and integrating the classrooms of our colleagues. In so doing we can say silently to ourselves that if you cannot lick them -- then join them.

If one decides to travel along another route that breaks away just beyond the forks, he must do so with imagination, faith and courage. This route, staked out originally by our own Steve Coons, steadily lengthens as research improves

continued on page 38

SOME COMMENTS ON THE GOALS REPORT

by

EUGENE G. PARE
Professor, Department of Mechanical Engineering
Washington State University

The Preliminary Report of the Goals Committee provides some substantial guidelines for the future development of engineering education to assure a more competent engineering profession.

It is disappointing, however, that the report apparently does not take full recognition of the significant advancements at the pre-college schools, advancements that should stimulate some major changes or deletions in our beginning college requirements in chemistry, physics, and mathematics.

It is disappointing that this report seems more concerned with the curricula content and administration, that usually undergoes a natural evolutionary development, and seems unconcerned with the more pressing need for an improvement in the quality of instruction. Of course we all realize that we are accidentally favored with some excellent teachers, but it is somewhat inconsistent that this society, dedicated to education, seems unconcerned with the gaping void in the training of engineers for the profession of teaching. An exception to this criticism can perhaps be found in the Engineering Graphics Division of ASEE which seems dedicated to the improvement of instruction. By means of its extensive committee structure, its own quality journal, its regular annual and mid-year conventions, as well as its frequent summer schools, this division is able to keep its members informed of the latest innovations in course content and instructional techniques. As evidenced by the NSF sponsored Reinhard report and several recent design-oriented textbooks and manuals, the graphics area has been a leader in the effort to strengthen the creative-design stem of engineering education which the Goals Report so strongly endorses.

The report seems concerned with our ability to attract and retain greater numbers of quality students and suggests that an improved freshman orientation to engineering is desirable. Yet our report writers are years behind if they are not aware that in many colleges the graphics courses have already been significantly altered to provide a stimulating orientation to engineering concepts as well as to develop the visualization proficiency so essential to creative design and effective engineering communication.

With just a little more of the student's valuable time and an occasional helping hand from degree-granting departments and the report writer, the educator in the field of engineering graphics will continue to meet the challenge of his changing, but indispensable role.

"GRAPHICS EXTRACTS"

EDITOR'S NOTE:

The following "graphics" extracts are from the "Preliminary Report of the 'Goals' Committee" released at the Clearwater meeting of the ECPD on October 5, 1965. Edited by E. W. Jacunski, University of Florida.

From Chapter II - General Introduction - page 11:

"Skill in the use of the scientific method (or methods) for solving problems is essential in engineering. Skills in communication -- verbal, graphical and mathematical -- are important. The requisite knowledge and skills are gained from formal educational programs, from on-the-job experience (more frequently now thanformerly), and from off-the-job, life-long learning. The neophyte must not only become a scholar but must remain one."

From Chapter III - Undergraduate and First Degree Education - page 22:

"Engineering graduates, as well as many representatives of management, industry, and government strongly recommended formal training in written, oral, and graphical communications, and reported extensive use of such skills in their own careers. Replies show that management regards both older and newer engineering graduates as weak in oral reporting. Neither group was thought to be strong in liberal (or general) education, although recent graduates were much more likely to be viewed as adequate."

page 24:

"Engineering managers report that recent graduates are stronger in mathematics, physical sciences, theoretical principles, and generally more willing to consider new ideas than earlier graduates. However, earlier graduates were viewed as stronger in engineering design, engineering graphics, and the ability to solve practical problems."

"Reports of the Institutional and Organizational Study Committees stressed that increased importance should be given to the general area of engineering design. This view seems to stem from a concern that emphasis on mathematics, science, and general education may result in the deletion of distinctive engineering features, or at least their relegation to a minor role. A need was expressed in these reports for a creative engineering design experience, rather than routine experiences that stress details at the expense of comprehensive understanding."

page 25:

"The Goals Committee does not imply that such courses as rhetoric, and composition, are unimportant but suggests stimulating the teaching of these courses in high school, as has been done for mathematics and physical science in some high schools, to prepare students better for college level study. Non-credit remedial course should be provided for students who do not have the necessary proficiency in these areas upon entering college."

"There are far too few engineering courses at the freshman level to stimulate the entering student and motivate him to continue toward an engineering career. Many feel that one course in engineering graphics does not fill this need. Much experimentation is in progress, and much more is needed to develop freshman courses which will have substance and which will provide motivation of the student in the freshman year."

page 34:

"Skills in communication -- verbal, graphical and mathematical -- are gained from formal educational programs, from on-the-job experience and, perhaps most important, through off-the-job lifelong learning. Every effort should be made to give the student experience in written and oral expression in all of his courses, for only through continuous practice throughout the college program can the needed improvement be realized. All engineering languages should be utilized -- verbal (oral and written), pictorial and symbolic. Isolated courses offered at the freshman level that are little more than minor extensions of high school courses are ineffective by comparison with the continuous attention recommended here. The use of graphics as a tool of analysis, of creative thought, and as a pictorial language should be encouraged. The student must be expected to attain and maintain an acceptable performance level in writing, speaking and drawing."

From Appendix B - Resolution Adopted by Liberal Studies Division of the American Society for Engineering Education, June 24, 1965 - page 86:

"That engineering curricula recognize communication (speech, composition, report writing) as supporting disciplines analogous to graphics on the one hand and mathematics on the other, and provide for these disciplines a place commensurate with their value in the training of engineers and in the development of articulate human beings."

From Appendix F - Summary of the Report on Evaluation of Engineering Education - page 111:

"An insistence upon the development of a high level of performance in the oral, written, and graphical communication of ideas."

The engineer may have graduated from the drafting board, but engineering graphics remains a basic function of communication in engineering design and development.

AMERICAN SOCIETY FOR ENGINEERING EDUCATION
ENGINEERING GRAPHICS DIVISION

1965 Mid-Year Meeting

EDITOR'S NOTE: This Program is printed here at the request of the Engineering Graphics Division Executive Committee as a record of activities.

Theme: Facets of Engineering Graphics

Thursday, October 21

6:30 p.m. — Executive Committee Dinner and Meeting (For committee members and invited gnests)
Galaxy Room

7:30-9:00 p.m. — Social Hour
Red Cedar Room

8:30 p.m. — Special Films: Computer Oriented Engineering Graphics Developments
Kellogg Center Auditorium
Presiding: Prof. Albert L. Hoag, University of Washington

Friday, October 22

8:30-11:30 a.m. — General Session
Kellogg Center Auditorium

Presidiug: Col. Robert H. Hammond
Past Chairman
Engineering Graphics Division

Greetings
Dr. John D. Ryder, Dean
College of Engineering, Michigan State University

Paul M. Reinhard, Associate Dean
College of Engineering, University of Detroit

Presentations

About Scales	Mr. Sandor T. Halasz City College of New York
Four-Dimensional Projection	Mr. C. Ernesto S. Lindgren U. S. Steel Corporation
Coffee Break Big Ten Room	
Creativity and Design	Prof. Percy Hill, Chairman Engineering Graphics Tufts University

12:00-1:30 p.m. — Luncheon and Business Meeting
Centennial Room

Presiding: Prof. Howard Porsch, Chairman
Engineering Graphics Division

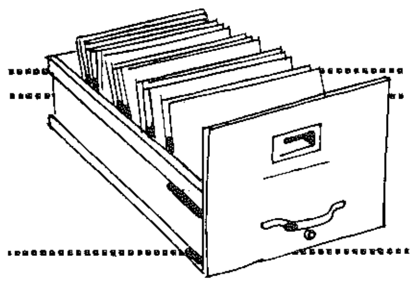
1:30 p.m. — Group Picture
Front Steps, Kellogg Center

2:00-4:00 p.m. — Concurrent Discussion Sessions

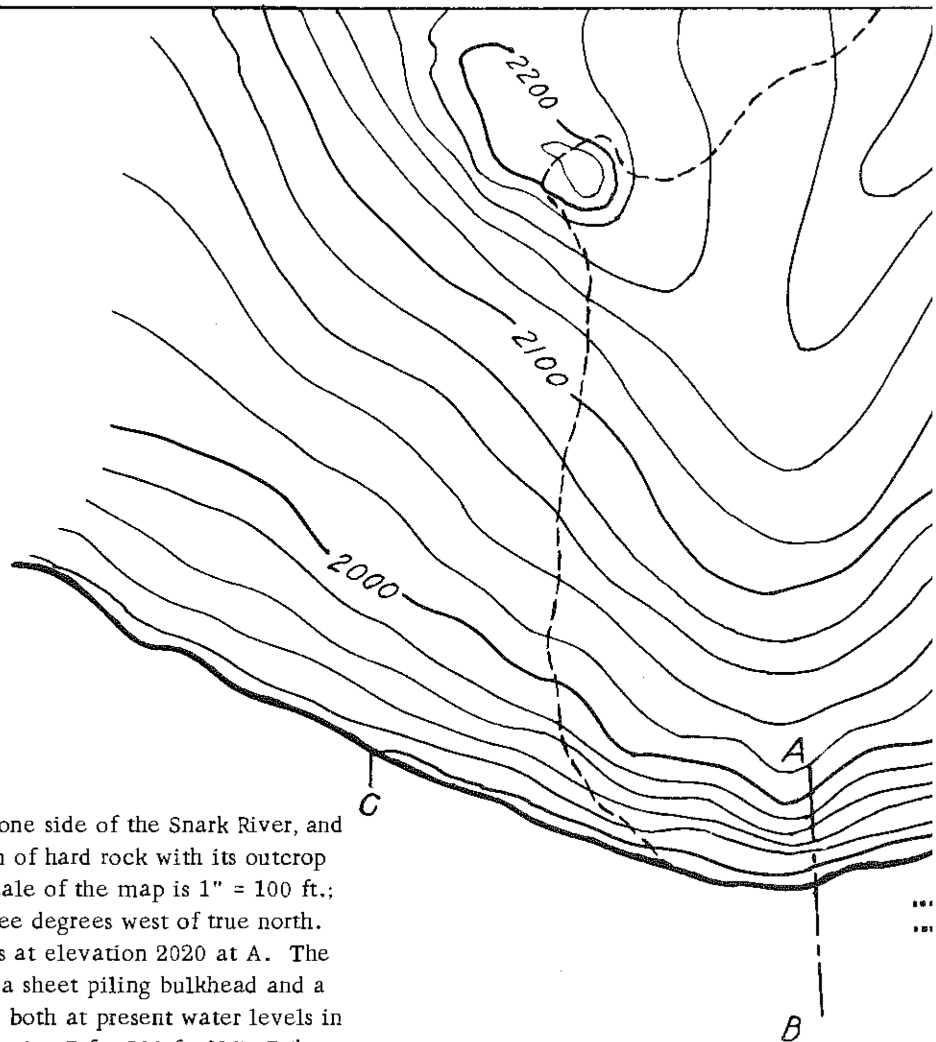
Course Content
Room 101

Presiding: Prof. Jerry S. Dobrovolny, Head
General Engineering, University of Illinois

file to file



TUNNEL DESIGN



TUNNEL DESIGN

The given contour map represents a dam site on one side of the Snark River, and its adjacent area. The site is underlaid by a stratum of hard rock with its outcrop on the surface indicated by the dotted lines. The scale of the map is 1" = 100 ft.; the top of the map is north with a declination of three degrees west of true north.

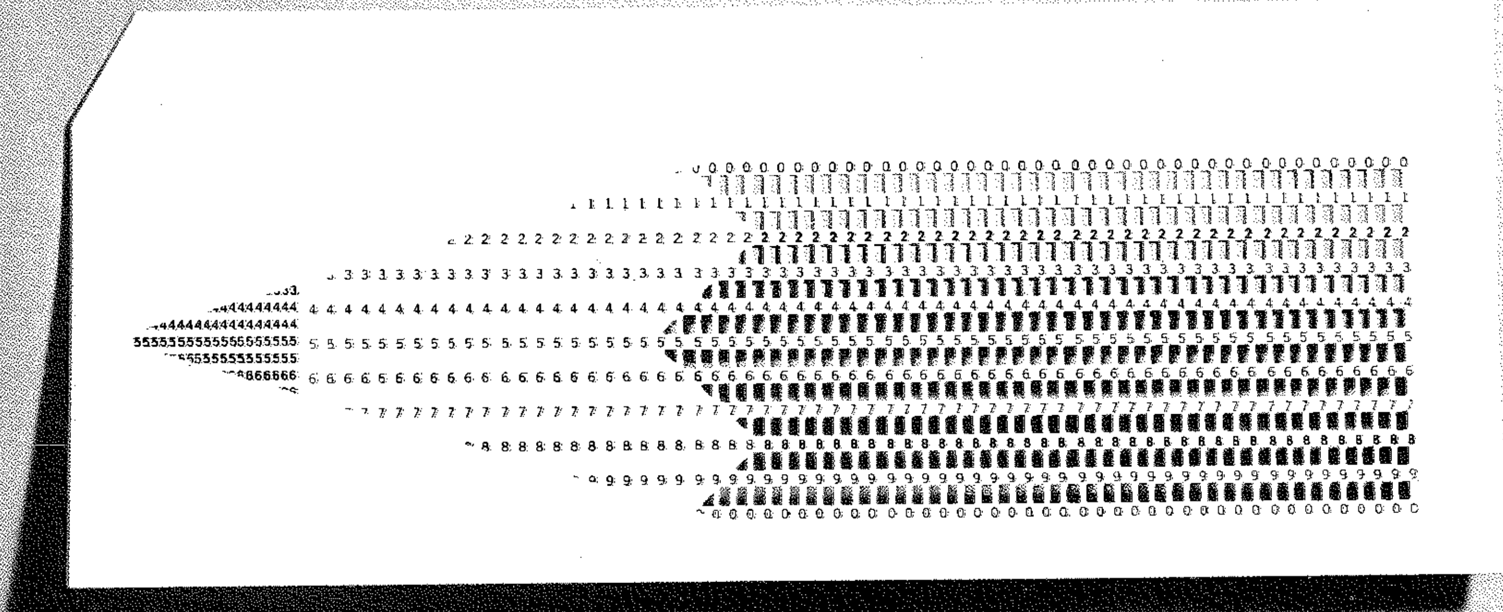
The dam, represented by its center line AB, starts at elevation 2020 at A. The site is to be dewatered for construction by means of a sheet piling bulkhead and a diversion tunnel which runs between points C and D, both at present water levels in the river. One leg of the tunnel is to proceed from point C for 200 ft. N 70 E (horizontal distance); thence in a general easterly direction until it turns southerly to intersect the river again at point D.

The tunnel is to have a uniform grade throughout its length, not to exceed seven per cent; it is to have a minimum earth overlay of 30 ft. at all places except for approximately 100 feet at each end; changes in direction of the alignment are to be angles as much greater than 90° as possible; and the length is to be as short as possible, consistent with the foregoing requirements.

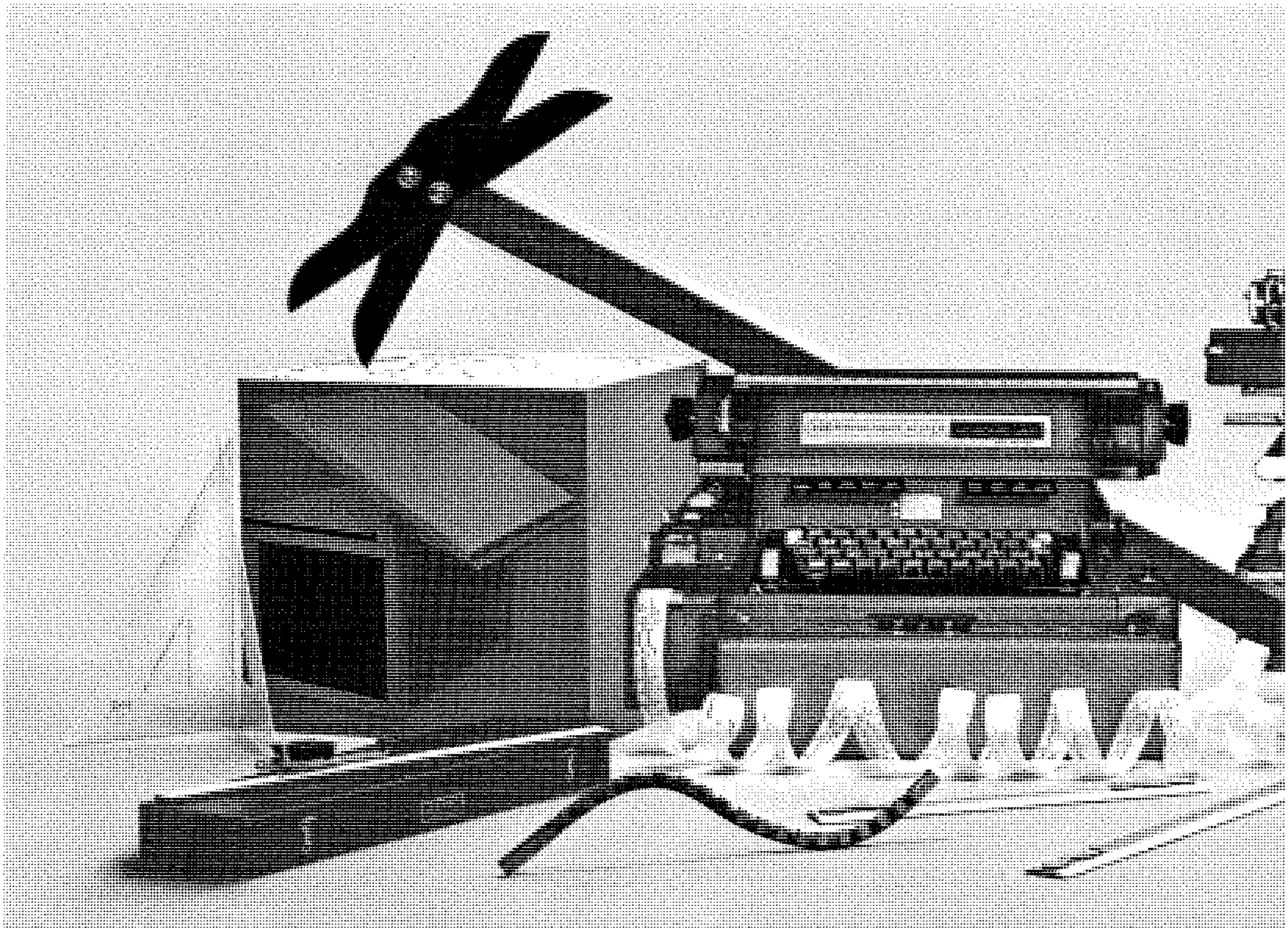
Required:-

1. Indicate by an arrow, the direction of flow of the river, and show the approximate location of the bulkhead, by a line MN.
2. Draw the tunnel center line on the map, marking on it, the 100 ft. station points, horizontal measurements. (C = Sta. 0+00), and bearing of each straight section.
3. Draw on the grid provided a profile along the center line of the tunnel, showing the topography profile, and the tunnel center-line profile. Determine from this, the grade of the tunnel and letter it on the profile line. Profile to be complete with elevations and station points.
4. Determine station points at which the tunnel enters and leaves the stratum of hard rock, and the true distance through the stratum. Indicate these points on the profile at their proper stations.
5. Letter a title on the sheet giving the pertinent information.

This problem was submitted by Professor R. R. Worsencroft
Department of Drawing and Descriptive Geometry
University of Wisconsin



the end of the pencil?



in the meantime, while you're waiting for computerized drafting...

Don't throw away your pens and pencils, T-squares and drafting machines just yet.

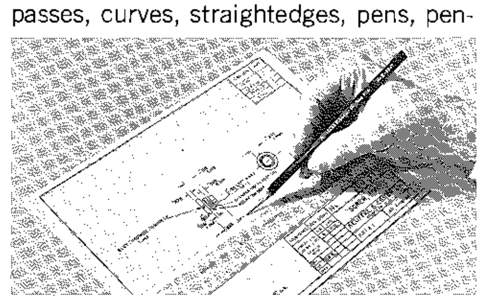
It's true, some day electronic brains will be well enough instructed (programmed) to handle the majority of engineering and architectural drafting tasks. But this technology is in its infancy.

Strangely enough, the computer is better equipped today to handle complex, far-out design problems than it is to take on day-to-day drafting. For example, a computer can draw the complex mathematical contours of a space glider a lot more efficiently than the side view of a toggle switch. Today's drafting room can make much better use of some of the new semi-automated techniques now being introduced. The use of punch-tape systems, and microfilm techniques, for example.

So where does this leave you?

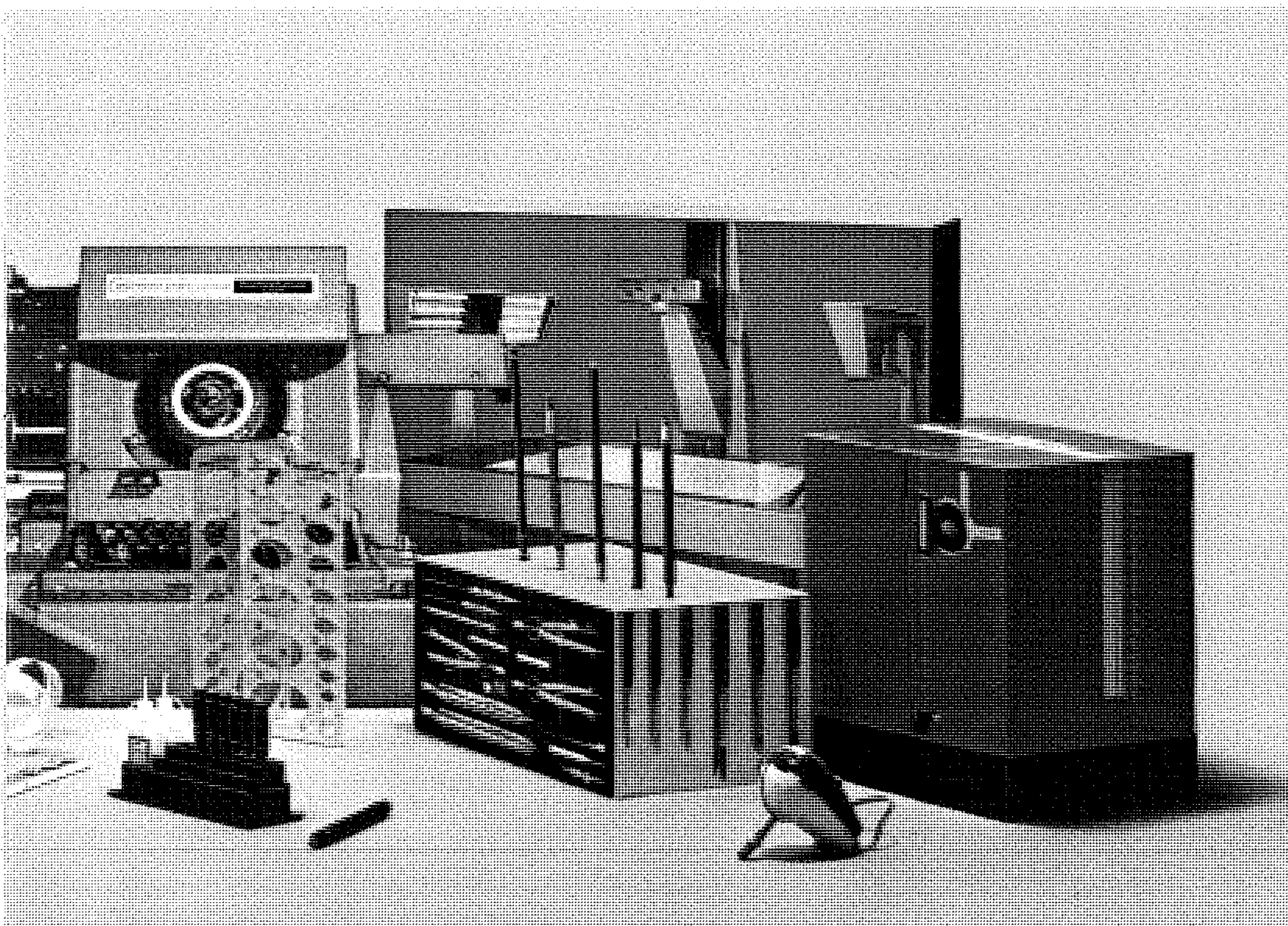
Let's start with the manual techniques which have stood the test of time. They'll be around for a long while to come. As you know, K&E provides almost everything you can use in this area. And we're trying to improve our line all the time.

The nuts and bolts of the K&E drafting line include the T-squares, scales, compasses, curves, straightedges, pens, pen-



cils, styluses, scribers, cutters, erasers and drafting tables. Developments here come both in the form of refinements, such as plastic/graphite blend pencils especially made for work on film, and the development of new tools for new K&E-developed techniques like scribing and Cut 'N' Strip®.

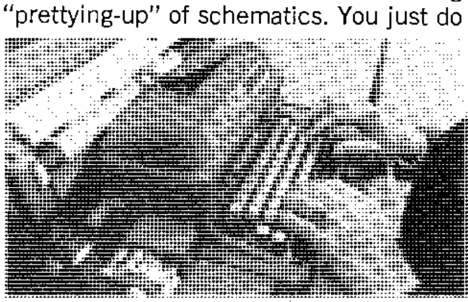
A step up in manual methods is the often-copied, never-duplicated Leroy® con-



trolled lettering and symbol equipment. Improvements come here, too. In such things as new templates, the perpetual-point pencil and the quarter-mile-drawing Reservoir Pen that lets you letter longer before refilling.

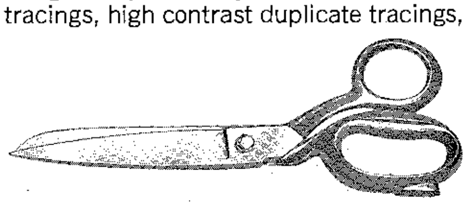
Up another step are manual drafting machines. Of which PARAGON AUTO-FLOW® stands alone for faster, more accurate work.

And finally at the semi-automatic stage, is a system such as PHOTO-DRAFT . . . equipment that produces precise, detailed schematics ten times faster than a draftsman could. No laborious time-consuming "prettying-up" of schematics. You just do



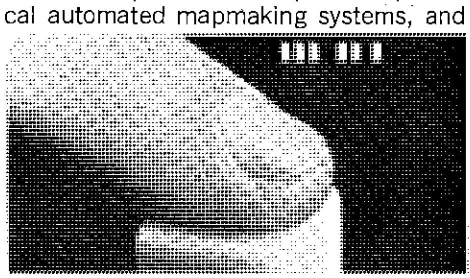
a rough sketch. A clerk or secretary "types" the finished schematic.

Making drafting go faster and easier takes many forms at K&E. Forms like the MICRO-MASTER® 35/105mm camera-projector system. Microfilm becomes more than an efficient filing system. It becomes a versatile drafting tool . . . permitting such things as quick, easy restorations of old tracings, high contrast duplicate tracings,



and scissors drafting (which has cut untold hours from the industrial re-drawing workload). And K&E offers total systems of microfilm supplies and equipment, of course.

How about the fully automated drafting systems? As they say, we're working on it. K&E has experience in depth with practical automated mapmaking systems, and



we are now applying that experience in our R&D programs.

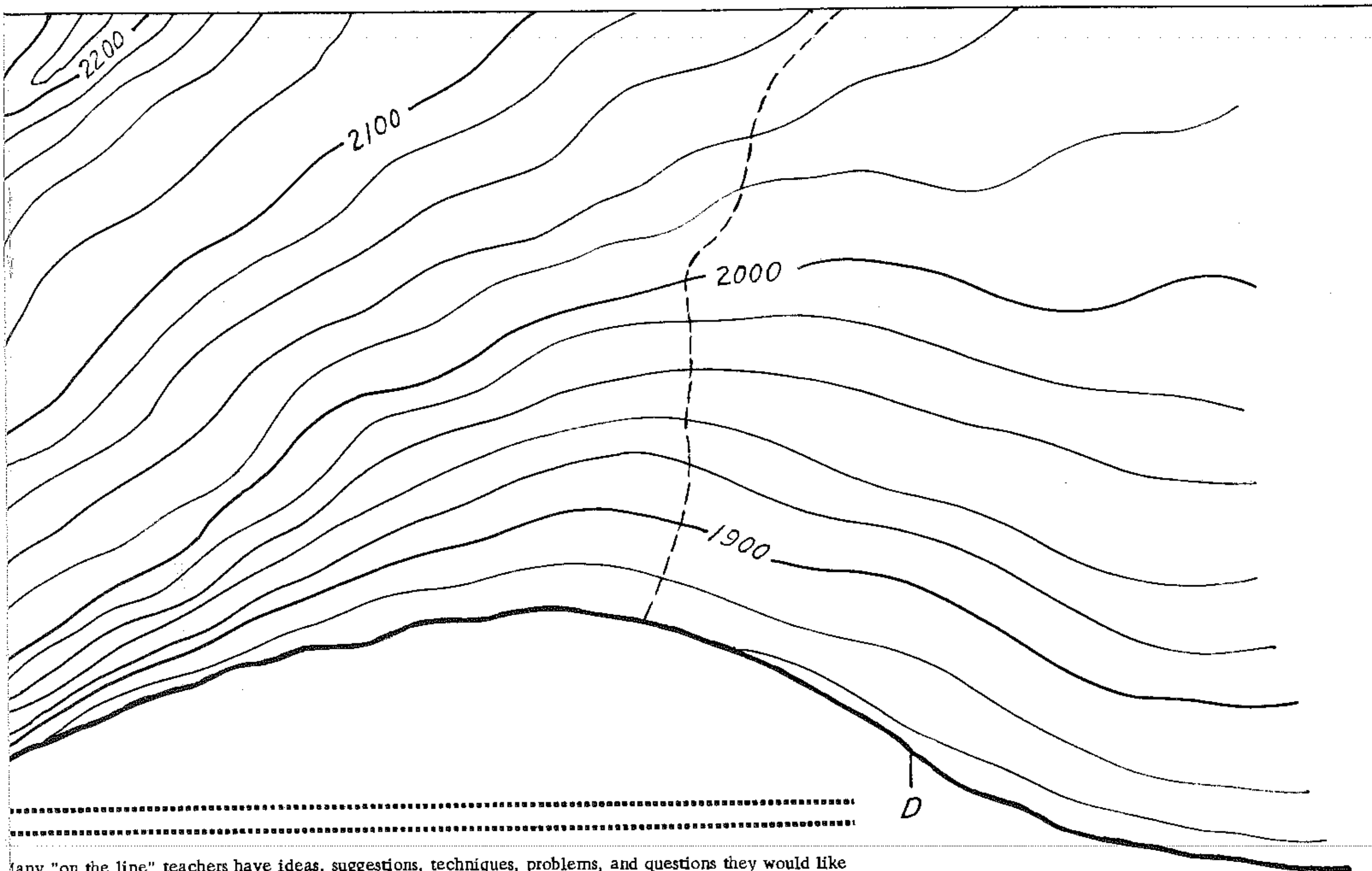
When, some time in the next decade, computer-controlled drafting becomes completely workable for general purpose drafting, K&E will bring such a system to you.

But in the meantime, while you're waiting for these advanced systems, you've got work to do today.

And we've got the stuff to do it with. Today.

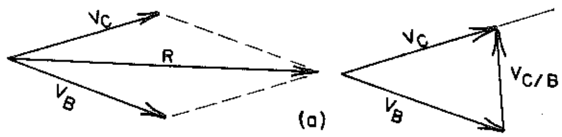
CREATIVE PRODUCTS
FOR THE CREATIVE ENGINEER
KEUFFEL & ESSER CO.


NEW COMPANY RULES
1
Office employees will daily sweep the floors, dust the furniture, shelves and showcases.
2
Each draftsman will bring in a bucket of water and a scuttle of coal for the day's business.
3
Draftsmen will each day fill lamps, clean chimneys, trim wicks. Wash the windows once a week.
4
Make your pens carefully. You may whittle nibs to your individual taste.
5
This office will open at 7 A.M. and close at 8 P.M. daily, except on the Sabbath, on which day it will remain closed.
6
Men employees will be given an evening off each week for courting purposes, or two evenings a week if they go regularly to church.
7
Every employee should lay aside from each pay a goodly sum of his earnings for his benefits during his declining years, so that he will not become a burden upon the charity of his betters.
8
Any employee who smokes Spanish cigars, uses liquor in any form, gets shaved at a barber shop, or frequents pool or public halls, will give me good reason to suspect his worth, intentions, integrity and honesty.
9
The employee who has performed his labors faithfully and without fault for a period of five years in my service, who has been thrifty and attentive to his religious duties, and is looked upon by his fellow men as a substantial and law abiding citizen, will be given an increase of five cents per day in his pay, providing a just return of profits from the business permits it.
[Company rules of an engineering office in Morgantown, West Virginia, circa 1860.]



!any "on the line" teachers have ideas, suggestions, techniques, problems, and questions they would like ɔ share with the society. "FILE TO FILE" provides the place for exchange of professional information. f you have an item for exchange, submit it to "FILE TO FILE," E. D. Black, General Motors Institute, lint, Michigan.

A SOLUTION FOR THREE UNKNOWN FORCES



JOHN P. OLIVER, P.E.
Professor of Engineering Graphics
Texas A&M University

A simple solution for a three-member non-coplanar concurrent force system may be made by substitution where the known force is vertical or horizontal. This solution was suggested by a Mr. Frank W. Steinle, graduate student in Aerospace Engineering, some years ago. It is from his suggestion that the following mathematical and graphical solution has been developed.

It is true that this problem is a special case since in general the load may have any line of action. But the occurrence of a horizontal or vertical load is of sufficient frequency as to make this solution of value. This solution may be used when the known force projects as a point in one of the principal views. For any other loading condition, the general solution is much simpler. The solution here is for a structure supporting a vertical load so that the plan view shows the load as a point.

In brief outline, the method is as follows: Project the system on a horizontal plane thus eliminating the known force which appears as a point. Substitute for one of the horizontal projections any reasonable value and solve for the other two horizontal projections. With the runs of the forces known, solve for their space values. By $\Sigma V = 0$, solve for the load, P, which will create these magnitudes; then, by ratio, correct for the given load.

For example, take the force system shown in Fig. 1. For sake of ease in handling, the space dimensions are given as horizontal and vertical angles.

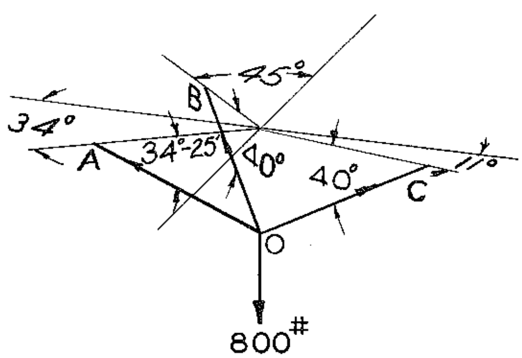


FIG. 1

Following the above outline, project the system on a horizontal plane (Fig. 2.). The three unknowns are OCH, OBH, and OAH. The known load of 800 lb. appears as a point and falls out of the equation. Now, assume any reasonable value for one of these unknowns, say OCH. Let OCH = 300 lb.

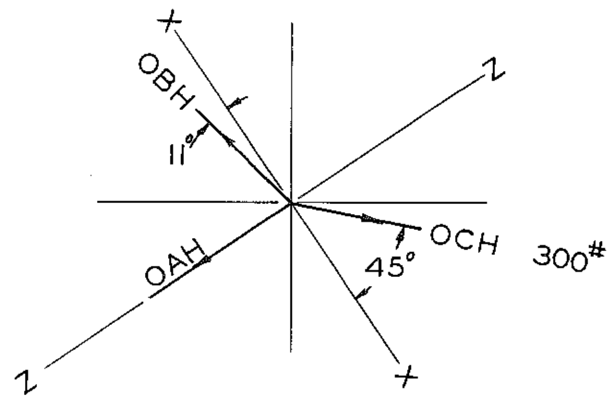


FIG. 2

Revolve the X and Z axes clockwise through 56° so that the Z - axis coincides with OAH.

Σ Fx = 0

$-\text{OBH} \cos 11^{\circ} + \text{OCH} \cos 45^{\circ} = 0$

OBH = 216 lb.

Σ Fz = 0

$+\text{AOH} + \text{OBH SIN } 11^{\circ} - \text{OCH SIN } 45^{\circ} = 0$

AOH = 170.8 lb.

Dividing by the cosine of the vertical angle in each case:

OA = OAH/COS $34^{\circ}25'$

= 207 lb.

OB = OBH/COS 40°

= 282 lb.

OC = OCH/COS 40°

= 392 lb.

$\Sigma V = 0$

$$+ 207 \sin 34^{\circ}25' + 282 \sin 40^{\circ} + 392 \sin 40^{\circ} - P = 0$$

$$+ 117 \quad + 182 \quad + 252 \quad - P = 0$$

$$P = 551 \text{ lb.}$$

P is the load which will create the stresses in OA, OB, and OC which have been calculated.

But the given load P = 800 lb.

Therefore by ratio $\frac{800}{551}$

$$OA = 207 \frac{800}{551}$$

$$= 300 \text{ lb.}$$

$$OB = 282 \frac{800}{551}$$

$$= 410 \text{ lb.}$$

$$OC = 392 \frac{800}{551}$$

$$= 568 \text{ lb.}$$

The graphical solution follows the mathematical step by step. Project the system onto top and front planes, Fig. 3(a). In the top view, the load 800 lb. appears as a point. Draw top view of stress diagram Fig. 3(b) assuming any value for OCH. By parallels, draw in OBH and OAH.

continued on page 58

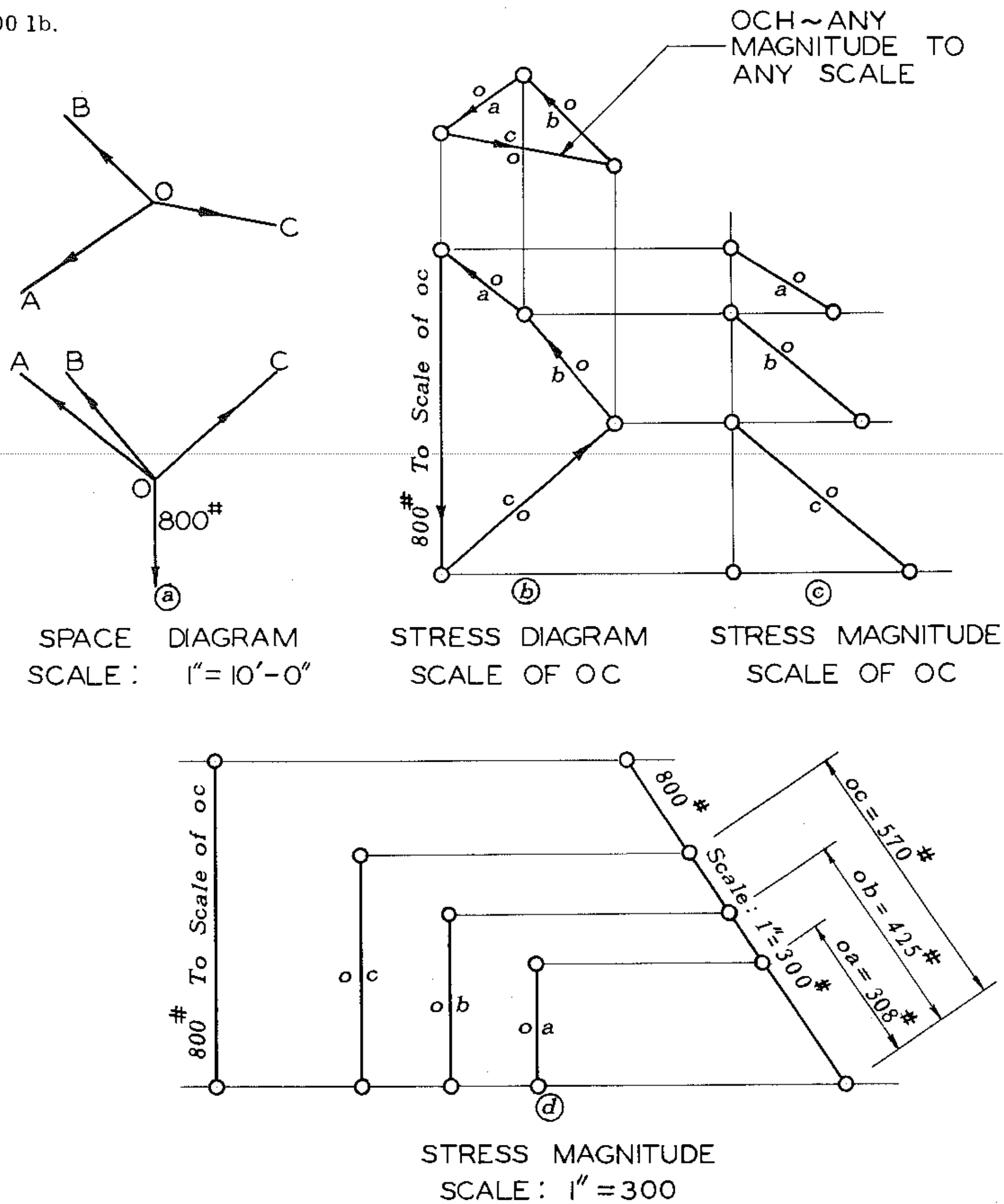


FIG. 3

LETTERS TO THE EDITOR
Continued from Page 9

Dear Editor:

I know that you are going to chide me again about not writing an article for the JOURNAL. One should write only when one has something to say. Up until last week I had nothing in mind, but since I have attended the ECPD meeting at Clearwater earlier this month and listened in on the Preliminary Report on the Goals of Education Committee, I have been doing a lot of thinking and can come up with some sensible suggestions in the near future. I presume you have also heard about the report and happily note that Graphics has been given a place in the engineering core thathas been suggested. It is a question now of how it will fit in and what its coverage will, or should be. That is a decision that lies before us in the next two or three years. Since Graphics has been recognized as a pre-engineering subject, it is now time for all graphics people who have been slapped down and mutilated to raise their voices once more and redevelop their graphics roles in their schools. It is going to take courage and this courage has to be inspired.

Cordially,

E. W. Jacunski
Vice-Chairman

Dear Editor:

Many of our colleagues in the Graphics Division are going downhill in their respective institutions due to either a lack of leadership or a misunderstanding of the role of graphics in present day education. It is the responsibility of the division to supply this leadership and the most effective way is through a vigorous summer school where those attending can play an active role.

I am very much in favor of a summer school in 1967 devoted to instruction in the teaching of engineering design through active involvement of attendees in workshops devoted to case studies and design projects. I shall be pleased to serve in any capacity in the planning of this session for I have several ideas related to the effective teaching of design to educators.

Please pass my feelings on to Howard Porsch and I will discuss the summer school idea with you further in October.

Sincerely,

Percy H. Hill, Chairman
Department of Engineering
Graphics and Design

Editor's Note:

Professor Hill has accepted the chairmanship of the Committee on The Engineering Graphics Division Summer School to be held at Michigan State University in June, 1967. Please send him your ideas.

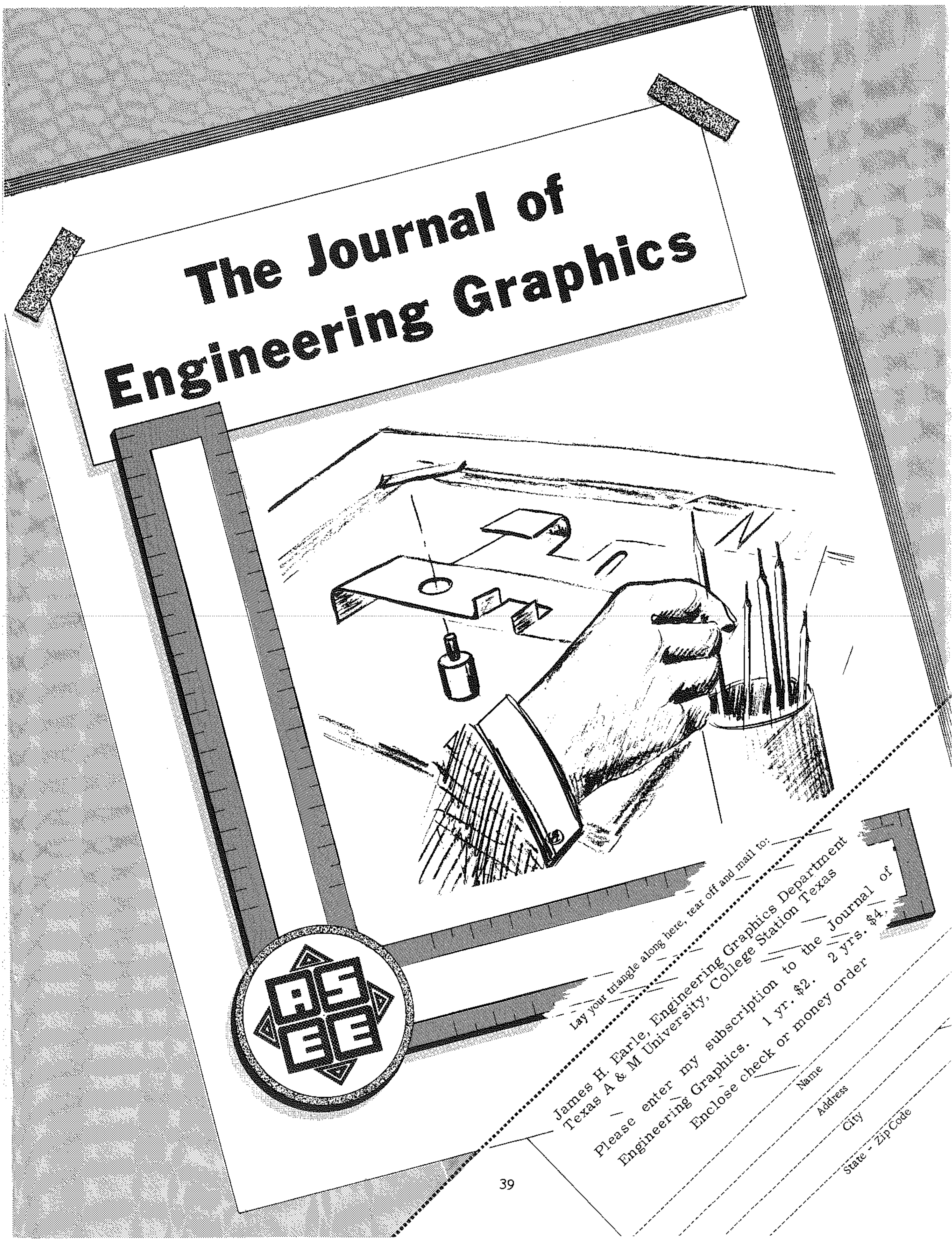
PERSPECTIVE Continued From Page 24

and reveals the vast potentials of computer produced graphics. Computer-plotter systems have become widely accepted for the production of graphs, orthographic views and perspective drawings. Now that recent advancements have made it possible for a computer to understand and interpret a drawing, the computer has become a new means for preparing a graphical representation of a proposal with a minimum of effort expended in making known the designers' intentions. By going through the motions of drawing with a light pen on the screen of a CRT tube while using appropriate push buttons, one may draw lines, circles, and curves for desired shapes, move views around, enlarge them, and produce a pictorial representation. DAC-1 developed for use at General Motors, provides for graphical input and output through a high-speed computer to make possible a working partnership between man and computer.

With engineers doing design work on graphic input/output Cathod-ray tube (CRT) consoles, connected directly to a shared computer, we are justified in insisting that our students not only be well grounded in the basic fundamentals of engineering drawing but in descriptive geometry as well. We can say to our colleagues that if our undergraduates and graduates are to use graphics as a computer language for rapid interchange of information between man and computer, they must be given more courses in graphics than in the past. Conventional computer programming, requiring a detailed ritual of calculations that hopefully might yield a required solution to a design problem, has been relegated to the past. Engineers are again making drawings, some completely dimensioned, using a computer.

No one can clearly visualize what lies ahead but our young teachers should be encouraged to investigate the potentials of computer graphics and to give some thought as to what changes must be made in the teaching of graphics in the immediate future. At the writers school several courses are being readied to satisfy new needs. Among these courses is one to teach methods for programming of graphic display devices. The APT language will be used by the student for programming automatic drafting machines, digital plotters, CRT display devices, and numerical controlled machine tools of the continuous-path contouring type.

This writer has wandered far from the assignment of our editor which was to write about the past. The past -- it is enjoyable to talk about when surrounded by old friends of a like age but it is not as exciting to write about as the present and future, particularly when the future holds forth new approaches and new responsibilities for our Division of Engineering Graphics.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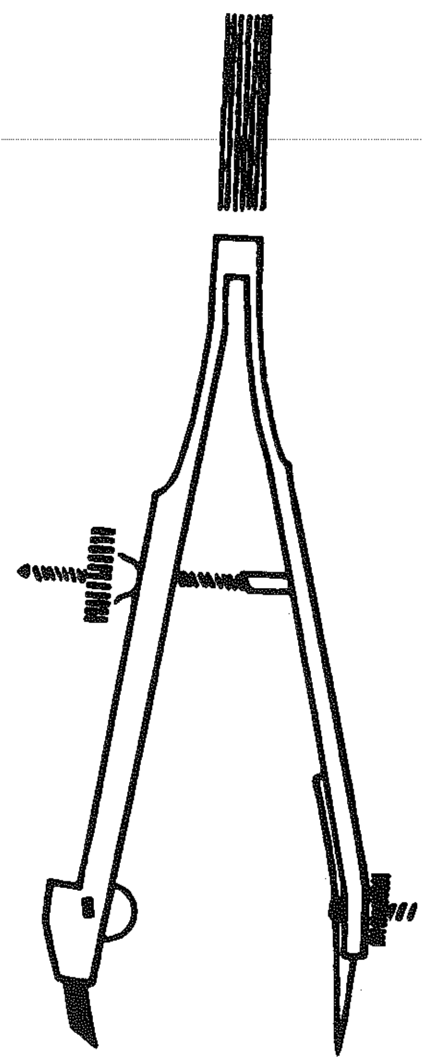


Continued From Page 12

We must somehow inject the idea of interrelation into our numerous courses and create a motivation on the part of the student beyond that based on the passing of a course for the sake of clearing a hurdle. All of us enrolled for courses in our undergraduate days which we took with reluctance, with resentment, and with self-satisfied relief when the course was completed. Students today are no different. Our own awareness of the current problem is the result of our own past experience and present need and as in so many other things, we must somehow get across to the student the idea of profiting by the experience of others rather than always suffering through his own. As teachers and/or parents you are well aware that this achievement is an extremely difficult thing to do.

There is a fourth pattern that is followed by some institutions and which, regardless of any other corrective applied, must be followed by all if the problem is to be substantially reduced in its severity. Each individual instructor in every single course scheduled following the formal communications courses themselves, must accept the seriousness of the problem. We must acknowledge the existing need and must make it our own personal responsibility to consider that the course assignments presented by the student for evaluation must be evaluated in their entirety and not merely upon the single technological or philosophical point relating to the subject matter of the course concerned. We attempt to show the student that his profession relates to the whole of society. Should we not be consistent in recognizing the need for total evaluation in our grading? Students will resent being criticized and downgraded on their English in a report relating, for example, to the subject of thermodynamics. We cannot and must not, however, escape our responsibility by acceding to the student's failure to appreciate the true purpose of education.

Insofar as the communications specialist is concerned, those persons responsible for the formal training in the art of communications, through courses established for this purpose, must not become so enamored of their own specialization that the course itself becomes a subject matter course. Teachers must continually strive to relate communications techniques in graphics, mathematics, and English to professional competence and effectiveness. Just as the technologist frequently retreats into his own subject matter area and builds for himself an isolation shell, so the communications specialist can well allow the student to lose sight of the broad long-range objectives of the course he is taking in the area of communication skills.

Thus far, the comments have all been directed toward student acquisition of skill in the art of projecting and understanding ideas relating to his technological specialty through the medium of the communication arts. The common concept, for example, relates multiple technological disciplines. It is necessary that the student, in threading his way through one area of technology, recognize its analogous relationship to one or more other technological areas. The instructor in the single area must make the student aware of, even though not thoroughly conversent with, these parallels so that the student can work back and forth between or communicate across, if you like, the traditional and often zealously guarded and not infrequently artificial lines of demarkation.

With the increasing emphasis on the scientific fundamentals underlying engineering applications, an awareness of the existence of common concepts on the part of the student, as well as the instructor, is increasing. I think the pattern of such interrelationships is evolving and spreading and I feel no serious concern over the future of this significant, I might say, philosophy. It will not come as rapidly in all areas or institutions as could be desired but it is definitely coming.

With reference to the language of computers, here again we have a new language and a complex device deposited in our kit of operating tools with which the student must become familiar if he is to use his technological talents to their fullest. To the average, and even to the above average undergraduate the computer is an awesome device. This statement can even be extended to a great number of engineering faculty members. Efforts are being made, and being made effectively, to reduce this fear through injection of computer activities into undergraduate courses and by the exposure, through seminars, of faculty members themselves to the use of computers both to extend their individual abilities as well as to assist them in the training of the students under their direction. Here again is an area to which much attention is currently being given and in which progress is being made at an ever increasing rate.

In summary I think it can fairly be said that the schools are doing a better job today than in the past. Their products come out better equipped in every sense. However, individual instructors in every area must necessarily assume a greater and, in fact, the major responsibility for the development of communication skills in their students. In addition, in some manner and probably not identical for each instructor and perhaps even for each student, motivation through understanding must be established. Awareness of the situation, acceptance of the need on the part of all concerned, industrialist, educator and student, must be sincerely acknowledged before positive results can be expected and any measurable improvement in the situation observed.

Too often drawings are expressions only, rather than the definitive technical communications which they should be.

MID-YEAR PROGRAM continued from page 27

Numerical Control
Room 105A

Presiding: Prof. Robert B. Thornhill
Wayne State University

Presentations: Basic Principles of Numerical Control
Norman Prochaska
Bendix Corporation

Numerical Control in Manufacturing
Donald Beran
General Motors Institute

Graphical Solutions
Room 110

Presiding: Prof. Jacob H. Sarver, Head
Engineering Graphics
University of Cincinnati

Presentations: New Concepts in Teaching of Descriptive Geometry
Profs. Klause E. Kroner and Frank Umholtz, University of Massachusetts

New Ideas on Nomography
Hugh F. Rogers
Pennsylvania State University

4:00 p.m. Coffee Break
Big Ten Room

4:30 p.m. Committee Meetings

Awards Committee
Room 110

Membership Committee
Room 107

Teaching Techniques Committee
Room 105A

6:30 p.m. Banquet
Centennial Room

Presiding: Prof. Earl C. Zulauf
University of Detroit

Speaker: Mr. Frank A. Bianchi
Ford Motor Company

Subject: "Styling: The Mustang Story"

Saturday, October 23

8:30 a.m. Coffee
.Big Ten Room

9:00-11:30 a.m. General Session
Kellogg Center Auditorium

Presiding: Prof. Ernest R. Weidhaas, Head
Dept. of General Engineering
Pennsylvania State University

Report on Study of the Goals of Undergraduate Engineering Education

Presentations: Dr. William K. LeBold
Assistant to the Dean of Engineering
Purdue University

Col. Archie Higdon
United States Air Force Academy

Discussion

11:30 a.m. Announcements and Adjournment

Local Arrangements

Display - Prof. C. C. Cooley
University of Detroit

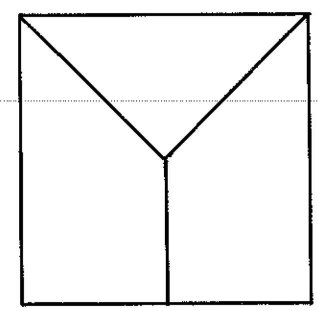
Audio Visual - Prof. Wayne Felbarth
University of Detroit

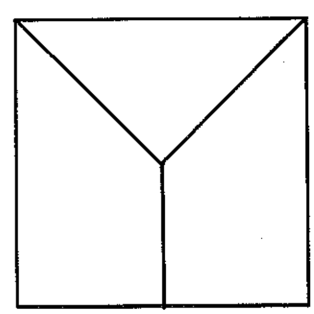
Banquet - Prof. E. C. Zulauf
University of Detroit

CAN YOU DRAW THE CORRECT RIGHT-END VIEW? PUZZLER

Submitted by:

E. W. Knoblock
Engineering Graphics
The University of Wisconsin-Milwaukee
Milwaukee, Wisconsin 53211





Continued From Page 14
which the product is to be built. Reliability uses these drawings to the end that they keep production in line, so to speak. They indicate whether or not the product is going beyond the specifications set up by the Engineering Department for proper reliability and proper durability.

In some plants, the Plant Engineering group is organized somewhat differently from what it is at the Pontiac Division. At Pontiac the Plant Engineering group, aside from being a maintenance group, has the responsibility of implementing designs following procedures that are set up by the Standards Department on equipment and materials handling used to move the production parts between departments and between operations. They necessarily must use these drawings in much the same manner as the Standards Department.

The Master Mechanics Section probably has as many diversified uses of the drawings as any one group. At the Pontiac Division the Master Mechanics Department has the responsibility to receive product design drawings and to process the parts - that is evolve a sequence of operations by which each part is to be manufactured.

Now on this cylinder block there are many operations that must be performed. They start with the making of a casting in the foundry, and extend to the final honing of the cylinder bores and inspection. The processing group will set up the sequence of operations by which this part is to be manufactured as specified on the drawing, and which is conveyed to the process man from the engineering group, by use of the graphical language.

Theoretically, if a part is properly drawn, there should be no communication verbally between the process department and the design engineer. Of course we know that this condition is theoretical and ideal and doesn't quite operate in this manner But properly drawn, the print should convey to the process men every idea that the design engineer has and every specification that must be adhered to in the manufacture of each part.

After the processes evolve, the orders are written and they are given to the Tool Design group to design the various gauges and fixtures to hold the part properly and to manufacture it through the sequence of operations. There may be outside vendors involved, machine tool vendors that will manufacture the various transfer equipment that will make each part. These people are given prints of these same drawings to work from.

It is extremely important that these prints tell all, because everyone works to the same drawing. It must mean the same to all people. The engineer must realize that everyone using the drawing looks upon the print a little differently. The Standards Department is interested in the paint specifications. The Process Department is interested in how the part is to be made, another plant may be interested in plating, while another plant may be interested in assembly. The originator of the drawing must remember that people look upon his product and detail drawings from many different viewpoints.

Once the process is evolved and the tools are designed, of course, these various designs go to the shop to be built, whether it be their own shop or to an outside tool design shop, or to an outside tool building shop. Many times these Part Prints, as they are called, from the Product Engineering Department, go along with the job to be built so that if there is any question about the design of the tools, it can be checked against the Part Print. The shop services, out in a plant such as Pontiac, would be the Toolroom, the Machine Repair group, and the Tool Stores. They will all use these prints, so you could see that the use of a drawing is not necessarily stopped at the first level. Everybody has his finger in the pie. Hundreds of these prints are run off the same tracings. They convey definite information to each reader. To the Toolroom, for example, the drawing might mean how the operation is to be performed, or it might be boring of the cylinder bores; to the Machine Repair group it might mean this cylinder bore machine must cycle or sequence in a particular manner; to the Tool Stores Department, which must procure the proper tools, it might mean the definite size, type of material and other specifications that they must work with. So, it boils down to one thing: the drawing is a set of complete specifications for a part that must be built. It is important that you remember this, because there is no other use of the drawing except to make sure that everyone has the selfsame set of specifications for each part.

We get into one other area here: that is, sketching. Probably some of you gentlemen feel that if you know how to sketch, you've got it made. This isn't quite true because to be able to read a formal blueprint, such as we have behind us here, you must necessarily be able to make a drawing. I know many of you probably haven't had much drawing in high school, some of you probably had none at all. I know that in one high school I attended, the faculty wanted to teach me how to plant corn, but I certainly wasn't interested in that. So I imagine that some of you men came from the same sort of school. You will have a lot of sketching to do, but sketching is not in itself a means to an end.

Sketching is very important. I don't want to deprecate its importance in the shop, because it is very important; but I might describe sketching to you as being the lowest form of graphical communication, so to speak. Sketching is somewhat an off-handed thing that people do between themselves. If it happens once a day, it probably happens a dozen times. The young man will run into the office and he will try to describe what has happened out in the shop. As he starts to try to describe it, he immediately finds out that he is at a loss for words, because he can't completely describe it verbally to me or to anybody else. By use of the "talking" paper (a term used in the shop) and by sketches, he conveys to me and to others his ideas - that which he has seen in the shop, things that he would like to change, and so forth. Sketching is very important; it is important that

you be able to do it and do it well. But I would like to try to impress upon you that sketching does not supplant the making of a formal drawing. I am sure that we would all take an extremely dim view of having the Product Engineering Department send over a couple of sketches to make an automobile and say go on from there. These sketches would lack a little of the formality we would like to see in a drawing.

You would be surprised how many fellows you see in the shop that can't sketch and can't even put their ideas on paper. It's important that you as engineers are able to understand a sketch in which somebody is trying to convey to you his ideas.

You would be surprised at how many times you are given the opportunity, or forced into the position of talking to the people upstairs in the upper echelon where you can make an impression. You are called upon to make a quick sketch to supplement your conversation with your boss or his superior. If you are unable to perform, it casts a very sad reflection upon your ability as an engineer, because even the poorest of the engineers in the shop are able to sketch.

But I want to make sure that you don't believe that sketching is something that can be done without the necessity of learning to make a formal drawing. You will be very embarrassed as an engineer or as a student, when you are working in the shop, if you do not find yourself as well equipped to read and understand drawings as others do. You may be working with your supervisor, and he will say to you, "See this capital such and so?" If you can't see it immediately, you are going to be "like long gone," because it is just accepted that fellows that come from an engineering school, whether it be your school, or any other, know how to read a drawing and can do it immediately.

Now if I said to you, and you had a book open here, to look in the second sentence in the second paragraph on a particular page, I am sure you could all do it and very rapidly and rightly so; you have spent something like twelve years in the lower grades in school. At last you learned to read there, and now you are going to spend some of your next four years learning to read and write the graphical language, and half of this time will be at the plant and half of the time will be in school. It is important that you don't goof-off your time in the drafting class (which some fellows are prone to do), but take this opportunity to get next to these drawings and read them. Even if you are working out in the shop and they give you a job on the lathe, (which you feel is the lowest form of activity that you're called upon to do, since you are a higher grade fellow who is going to engineering school) and you are given a print to work to, (it might be a sketch) you are going to look very sad indeed if you are unable to read the drawing to do even a simple maching job on it. The first time you scrap a part and take it to your supervisor and he asks what happened, and you can't tell him you understand it, you will really be embarrassed. It would be wise if you gentlemen would take every opportunity to master this graphical language.

I know you feel that this is needless repetition, but I can't hammer at you too much that this is the crux of engineering; and if you don't understand the language, you just don't understand the work. As I said when we started, you have been transplanted to a so-called foreign country. To get along in this foreign country, you must get with the "natives," so to speak, and understand the language. If you don't understand the language, everything the "natives" here say to you when they are standing up in front of you in class will be completely over your head whether you're asleep or not. So you had better learn the language. The language is graphical in nature. Whether you are in physics, in geometry, in mechanical drawing, or whatever, it all boils down to the same thing.

You might be interested in some common terms that are used for prints such as the one I have here. They're referred to in the shop as the "bible," and many times the place from whence this drawing emanates, is called the "monastery." We always refer to the boys over in Product Engineering as the "monks" in the "monastery." The boys in the lab over there come up with material specifications as the "witch doctors," because some of their stuff seems far out. These things are said many times in jest, and a lot of times we say it and we think we mean it, but we don't really mean it. Those are the things that you become accustomed to, I am sure, with your experience on the job.

Another type of drawing that is used, which you may or may not be exposed to, are pictorial types of drawings. I am sure that many of you fellows have purchased from downtown one of these do-it-yourself kits which has a piece of paper inside and shows all the parts scattered out and how to put them together. This type of drawing is used throughout industry and with good results. This pictorial type of drawing and the exploded view type of drawing was used many times to replace layouts. Today they don't supplement, but they augment layouts that are made in assembly work.

Pictorial drawings are used with production people who would find it very difficult to read a conventional layout drawing that would show, for example, how to put an exhaust system in an automobile. I don't know whether any of you have ever seen a layout drawing showing the exhaust system and how it's routed to the frame and the various brackets, but it becomes quite a maze. They have evolved this exploded view type of drawing; it works very well, and even the fellows out in the shop, as I said, who cannot figure out the various details on a conventional layout, can see very well how to put parts together, making sure that they get the proper lock washer, and nut and bolt in correct assembly position.

My first experience with exploded assembly drawings was in about 1950 when Pontiac was involved in building the amphibious cargo carrier that they called the Otter. The exploded assembly drawing was reduced in size from its regular size

to an 8-1/2 by 11 sheet, which is put in a booklet, a large loose leaf book, and sent to the various BOP assembly plants to make sure they put four tires on every Pontiac, much the same as we do. But I want to impress upon you again that it does not take the place of a conventional layout.

In summary, you should extend every effort in your engineering classes to learn how to make an acceptable mechanical drawing. You should be able to do it swiftly and well, and be able to read drawings and understand them.

You should take your drawing courses as a very important part of your curriculum here, do the jobs as they come up, and do them well. It's important that you understand what you are doing, not just make it a copy course out of the book. Believe me, you may "cheat" a little now, but there will be a day of reckoning when you get out on the job. You won't be able to copy out of the book when faced with the dilemma of taking a part as per print or reading a drawing and explaining to someone else the details of a complicated part and how to make it.

INCIDENTALLY Continued from Page 9

The primary interest of the Divisional Membership Committee is to enroll members for ASEE who will be active in the Division of Engineering Graphics as well as other divisions but who share our belief that a knowledge in engineering graphics is necessary for engineers.

Mr. M. G. Thomas, K & E Company, expressed a philosophy concerning the value of Divisional membership. His ideas are related in brief form in More than Membership for your consideration.

MORE THAN MEMBERSHIP

The Division of Engineering Graphics is in need of a program that offers more than mere membership. The Division would do well to select needs which in themselves have validity and which the Division has the ability to meet. The Division should recognize a changing requirement in technical areas for the future and institute a program based on the following concepts:

1. The role of Engineering Graphics as the basis of communication in, and thereby orientation to, the Technical Arts.
2. The role of the Technical Arts as an enrichment element for the Liberal Arts.
3. The role of the Division of Engineering Graphics as the advocate of engineering graphics through the distribution of enrichment in engineering education.
4. The role of the Professor of Engineering Graphics as writer and speaker for the implementation of the Division's enrichment program.
5. The role of the Journal of Engineering Graphics as the medium - in itself and by reprints of articles - for publication of the Division's enrichment material.
6. The role of the teacher of Liberal Arts subjects as the recipient of the Division's enrichment material as the benefit of membership.

PECULIAR LINES AND PLANES - Continued From Page 22

is illustrated (i.e., in oblique axonometry) in Figure 1, where also the derivation of affinity from collineation (or vice versa) is demonstrated.

There are three centers of projection:

(a) Affinity . . . . S_∞ , ${}^1S_\infty$, ${}^2S_\infty$

(b) Collineation . . . . S , ${}^1S$, ${}^2S$

The principal projection planes, π and ν, are mutually orthogonal. The indices 1 and 2 (used as superscripts and subscripts) designate the projections of ΔABC (in space) into the H-plane and V-plane respectively. In (b) the centers of projection have been shifted from infinity in order to become finite.

For the sake of simplifying the relative constructions, ΔABC has been selected to lie in a plane passing through the intersection of the principal projection planes, π and ν. This selection does not imply any ambiguity between this semi-special and a more general case.

Thus the intersection of the plane of identity and the plane of ΔABC is identified as the intersection between π and ν, which is the axis of homology at the same time.

Shifting the centers S_∞ , ${}^1S_\infty$ and ${}^2S_\infty$ in order to locate them within a finite distance from π and ν, we again obtain a straight line, $S{}^1S{}^2S$, the peculiar Line III which is the axis of homology for the vertices of three triangular pyramids: S, ${}^1S$, ${}^2S$, mutually related by the concept of perspective collineation in space. (Note: the word "perspective" may be omitted). In other words, we are collinearly transforming triangular prisms into triangular pyramids, the lateral edges of those being formed by the respective ray pencils issuing from S_∞ , ${}^1S_\infty$, ${}^2S_\infty$, or S, ${}^1S$, ${}^2S$.

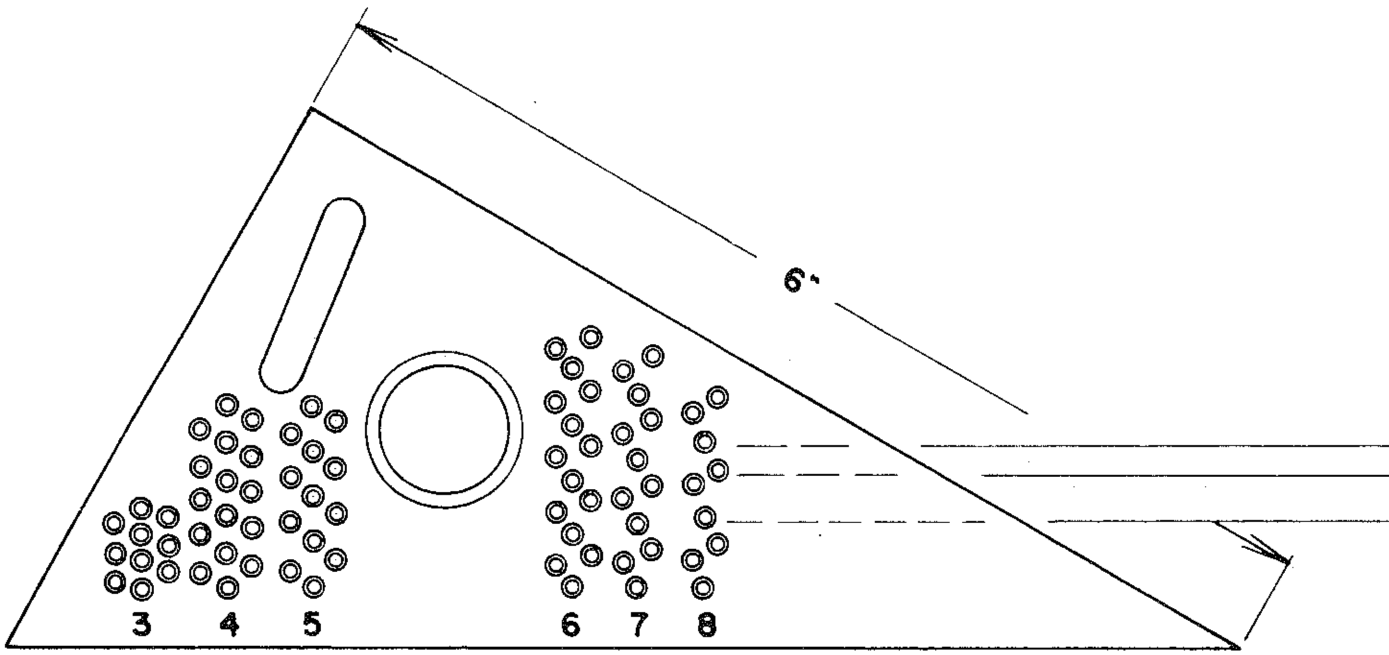
In this manner several important concepts of projective geometry in relation with descriptive geometry have been demonstrated in one picture.

Since the pictorially shown graphical proof is based on an exact construction, it is perfectly adequate, and no analytical proof need be furnished.

The latter concept of collinear transformation of pyramids into prisms (or vice versa) indicates

continued on page 50

BRADDOCK LETTERING ANGLES



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6"-60		6"-60
7"-60		7"-60
8"-60		8"-60
9"-60		9"-60
4"-45		4"-45
5"-45		5"-45
6"-45		6"-45
7"-45		7"-45
8"-45		8"-45
6"-45 Brd.-Rowe		6"-45 Brd.-Rowe
8"-45 Style "C"	8"-45 Style "B" Brd.-Rowe	Lettering Device

These combination lettering guides and triangles make it easy and simple to draw accurately spaced guide lines for lettering uniformly spaced parallel lines and systematic dimensioning.

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Continued From Page 16

Step	Procedure
9	Draw a line parallel to the vector whose value is represented by $\frac{F_o}{A_1}$ through 0_1. The angle between the vector represented by the value $m_1 w^2$ and this line is ϕ_1.
10	Extend the vector represented by the value $\frac{F_o}{A_1}$ and the vector represented by the value $m_2 \frac{A_2}{A_1} w^2$, the angle between these two lines is ϕ_2.

With A_1, A_2, ϕ_1 and ϕ_2 determined, the steady state response is fully determined.

It is of interest to note that the vectors in Figure 2 or the vector polygons in Figure 3 retain for all time the geometric relations as indicated; and, in fact, the vectors in Figure 2 and the vector polygons in Figure 3 rotate with the angular velocity w while retaining the geometric relations as indicated.

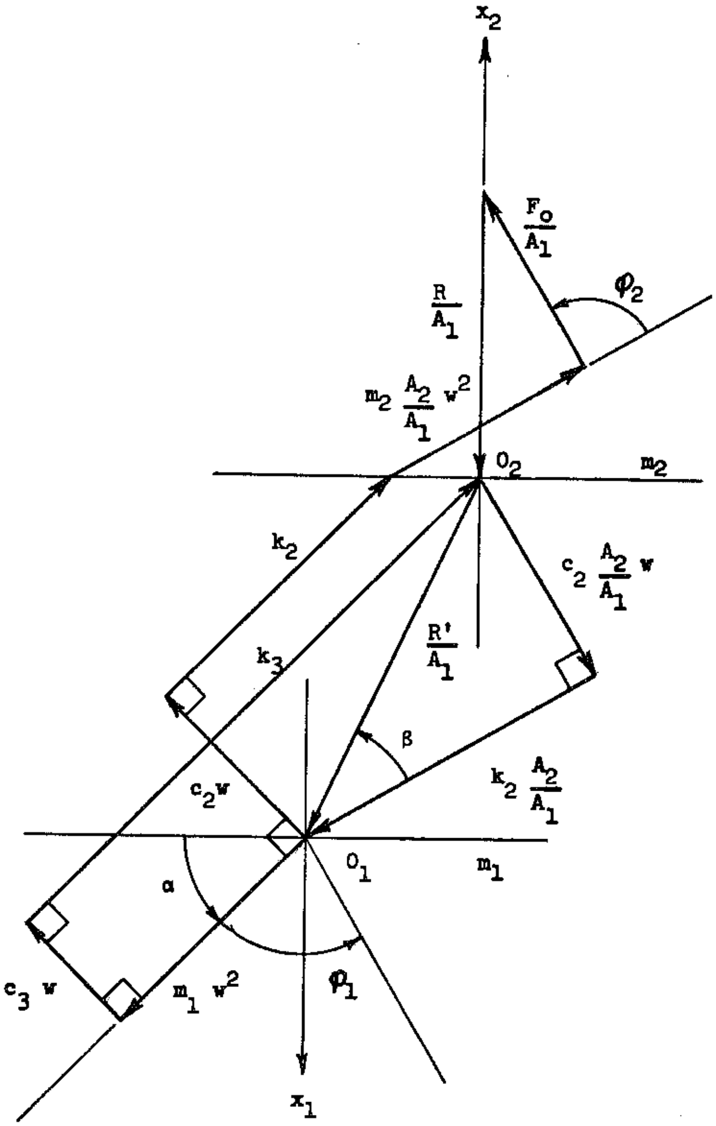

Figure 3. Graphic Solution of Equations 5 and 6 for A_1, A_2, ϕ_1, ϕ_2

PECULIAR LINES AND PLANES
Continued

that we also may operate with spatial objects in the same manner as with planar configurations. The contemplation of such or similar transformations is left to the reader[4].

PLANE OF SYMMETRY AND PECULIAR LINE II. Figure 2.

The principal projection planes of orthographic projection, π and ν are again represented pictorially in oblique axonometry. τ is the plane of identity. Line a, located within the first quadrant, defined by points A and B, is projected first orthogonally from ${}^1S_\infty$ and ${}^2S_\infty$ into π and ν; then π is revolved about the x-axis into ν. The projections of the Line a, i.e., a_2 and ${}^s a_1$ are extended and projection planes π and ν), N and P, are found.

Next, the line a is projected into a' by oblique parallel rays, e.g.: $S_\infty A_1 {}^s A_1$, perpendicular to the plane of identity τ, into ν. Line $a' \equiv P_1 N_2$ is the peculiar Line II.

The following relationship exists:

The point of intersection of a with the plane of symmetry, σ, R, projects obliquely into point R' which is incident with the x-axis. Construct the ordinate y_R (i.e., a projector for the adjacent principal views) through R'. This projector intersects the respective projections a_1 and a_2 in R_1 and R_2 which are equidistant from the x-axis.

In fact, the cross-ratios between the respective points of the point tetrads P, N, R, Q, on the line a as well as on its projections, are harmonic. We abbreviate, by simply writing:

$$(PNRQ) = (P_2N_2R_2Q_2) = P_1(P_2N_2R_2Q_2) = -1$$

Therefore, in accordance with the construction in Figure 2,

$$R'R_1 = R\,R'_2$$

Also, the length $B_2B' = y_B$.

continued on page 54

Continued From Page 18

11. Sections
12. Screw Threads and Fasteners
13. Basic Dimensions and Notes
14. Limits and Tolerances
15. Geometrical and Positional Tolerancing
16. Drafting Standards and Handbooks
17. Conventional Practice
18. Use and Purpose of Drawings
19. Layout Drawings and Design Sketches
20. Working Drawings
21. Reading a Drawing
22. Checking a Drawing
23. Reproduction of Drawings

B. Descriptive Geometry Area.

1. Point, Line, and Plane Relationships
2. Successive Auxiliary Views
3. Revolution
4. Curved Lines and Surfaces
5. Intersections and Developments

C. Graphical Representation.

1. Charts and Graphs
2. Empirical Curves and Equations

D. Problem-Solving Area.

1. Comprehensive Problems
2. Creative Engineering Drawing and Design
3. Projective Geometry in the Solution of Graphic Problems
4. Applications of Descriptive Geometry to Various Engineering Problem Areas

E. Modern Graphical Approaches.

1. Use of Special Equipment

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continued on page 54

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PECULIAR LINES AND PLANES

Cont.

Remark:

The principal projections of points on a line form two similar point ranges which are also similar with the point ranges on the line, e.g.:

$$\frac{AR}{BR} = \frac{A_1R_1}{B_1R_1} = \frac{A_2R_2}{B_2R_2}.$$

Since the angles between the principal projection planes are bisected by the planes of identity and symmetry, we obtain a system of projective planes, the planes τ and σ separating harmonically planes π and ν. If this bundle of planes is intersected by any line, then in accordance with one of the fundamental but a very important concept of projective geometry, the points of intersection of the line with the bundle form a harmonic tetrad of points.

Comment on the "direct method."

The direct method is inadequate.

The original Mongean concepts are distorted, and the orthographic projection is truncated, i.e., deprived of its artificial but most important device of traces, indispensable in other methods of projection and in constructions of higher descriptive geometry. For example, in perspective projection, in illumination objects (establishment of shades and shadows), in axonometry, in stereoscopic projection, and other methods of projection, the direct method cannot be used, or is difficult to apply.

The third quadrant projection closely related to the direct method, is confusing; not only from the standpoint of construction, but mainly for reasons of an improper demonstration. It is not easy to illustrate the princples of projection to students when the object is hidden behind two opaque (or quasi-transparent) planes of projection. The best visualization of spatial objects and an elucidative construction is obtained when the object is located in the first quadrant.

Many authors operating with the "direct method" in their texts are often at a loss when trying to circumvent traces and first quadrant projection. In most cases they switch over to the first quadrant anyhow, when they desire to show objects and the related constructions to engineering problems pictorially.

---

[1] The content of this article explained in greater detail will appear in the monograph on "Technical Projective Geometry" by V. P. Borecky.

[2] e.g., C. Ernesto S. Lindgren, Research worker and visiting engineer, Princeton University, New Jersey.

[3] See article: "Relationship between Projective and Descriptive Geometry" by V. P. Borecky, Journal of Engineering Graphics, Volume 26, No. 1; February, 1962.

[4] Several cases and examples on collinear and affine transformations are treated in detail in the aforementioned monograph by the author.

AXONOMETRIC PICTURE

Cont.

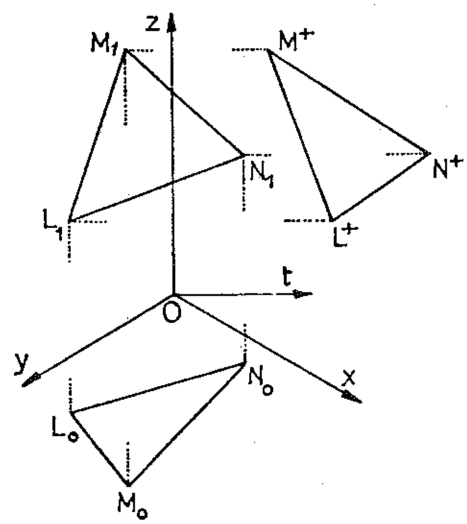

Figure 3

4. Stereoscopic Model of a Point

Draw the (0-P) A_o and the (I-P) A_1 of the given point A(a, b, c, d). After that translate the axes x, y, z, t to the new location x , y , z , t so that the two axes t and t lie on the same horizontal line; thus z and z are parallel. See Figure 4.

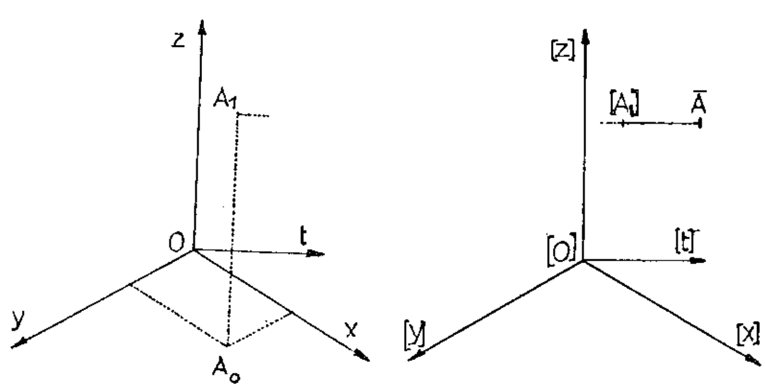

Figure 4

The length of the segment 0 0 i.e., the value of the translation is about 25 cm. if we merge the two sets of coordinates by means of a normal stereoscope and about 63 mm. (average interpupillar distance) if we merge them by means of the naked eye.

According to this translation the point A_1 should be transposed to the new location A_1 , but instead we locate a point $\bar{A}$ lying on a parallel to t through A_1. The length of the segment A_1 $\bar{A}$. (The distance from the hypothetic point A_1 to the actual point $\bar{A}$) is called horizontal parallax.

If we look at the (R) part of the Figure 4 with our right eye and at the (L) part of it with our left eye the two parts will merge into a single view. The merged set of coordinates appears to be lying on the sheet of the drawing because the two sets 0; x, y, z, t and 0 ; x , y , z , t are identical but the two points A_1 and $\bar{A}$ are seen as a single point floating below (if $\bar{A}$ is to the right side of A_1) the sheet of the drawing at a distance from it depending on the value of the horizontal parallax.

We must perform the same construction for each other point B, C . . . etc., of the body that we want to represent.

The length of the segments A_1 $\bar{A}$; B_1 $\bar{B}$; C_1 $\bar{C}$ . . . must be proportional to the correspondent fourth coordinate of the points A, B, C . . . and in addition, in order to allow an easy merging of the points A_1, $\bar{A}$; B_1, $\bar{B}$; C_1 $\bar{C}$ . . . , each horizontal parallax must not exceed more than a few millimeters.

The practical way for obtaining this is to enlist the fourth coordinate d, h, l . . . of the points A, B, C . . . and to multiply them by an arbitrary ratio of proportionality so that the product of the biggest among them will not exceed three or four millimeters. In order to be sure that the model is perfect it is advisable to visually melt the two pairs of axes first, and after that to look at the model of the body.

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A TECHNICAL ONE-YEAR DRAWING COURSE continued from page 24

Some explanation and interpretation of the proposed course is in order. The time specified for 1, Use and Care of Instruments and 2, Lettering, does not necessarily imply ten consecutive lessons on these two items but rather some formal instruction on each followed by some application. Lettering skills especially are best developed by extending the instruction over perhaps a term's work or longer and reiterations after the initial lecture-demonstration.

A similar procedure would be advisable for 5, Freehand sketching. Sketching is a skill which is best developed by applying oneself not during an isolated burst of application but by introduction followed by extension over the remaining year coupled with work in other topical areas such as orthographic studies and pictorial drawing. Dimensioning practice should be limited to dimensioning techniques but not including limit dimensions, tolerances and classification of fit.

The order of topics as listed indicates a possible logical sequence but not the only one of course. Variations might be desirable and preferred by the experienced teacher under the constraints imposed on him by his own environment. Any experienced and competent teacher of the subject immediately realizes upon inspection of the proposed course content that it contains material which is neither new nor advanced. Let us point out here that what we propose is a Basic Course in Technical Drawing. Naturally there is much more that could be presented. In schools offering two or more years of drawing, the teachers enjoy a greatly extended scope of activity and perhaps teach more effectively than those operating on a restricted schedule. There is no attempt to limit these superior schools here, but rather to offer a substantial core course in technical drawing for those schools having limited time allotted to them.

We realize that many, if not a majority of schools, especially those excelling in the classical studies do not at present enjoy the proposed 180 periods of class time allotted to them. In these schools, the instructor must chose from his own experience the subject matter and time to be allotted for adequate coverage of his field. A less ambitious program including fewer topics but with adequate comprehension of the areas covered would certainly be preferred to an overambitious and hasty exposure of all topics with little understanding of concepts and no mastery of skills.

Let us reemphasize the understanding of concepts. A high degree of technique in lettering and linework must be developed by the student and these standards must be maintained by the teacher. There is, however, no place in the program for copy work or solutions whose primary worth is determined by the artistry of the draftsman. Technical drawing is not a fine art and should not be judged as such. A thought process not unlike that required in mathematics and science should be evidenced and evaluation should be dependent on solution of the problem, not on draftsmanship.

TEACHING MATERIALS

Every one of the topics proposed in our course content are adequately covered in any good high school text. The committee has made an extensive study of the textbooks available for high school use and found many to be of first quality. Among these are Basic Technical Drawing by Spencer, Essentials of Drafting by Svenson, Engineering Drawing, 2nd Edition by Zozzora, Mechanical Drawing by French and Svenson as well as others.

In most cases a textbook written for the high

continued on page 58

5. Examples

A few illustrative examples are shown.

Note. All the stereoscopic models have been prepared for looking at them with the naked eye. If someone wants to look at them by means of a stereoscope he has to cut the two parts of the drawing and translate them until the model becomes clear.

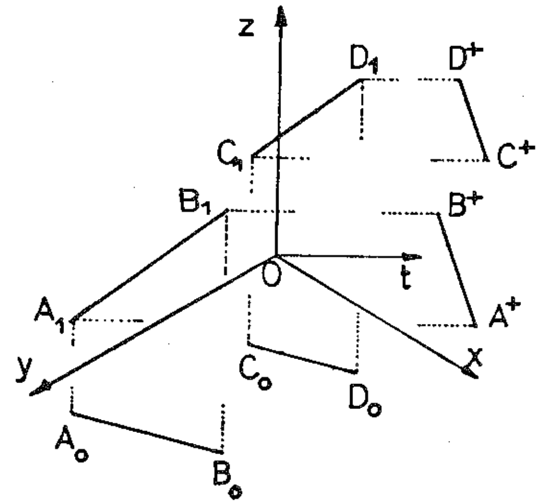

Figure 5.

Axonometric picture of two parallel segments.

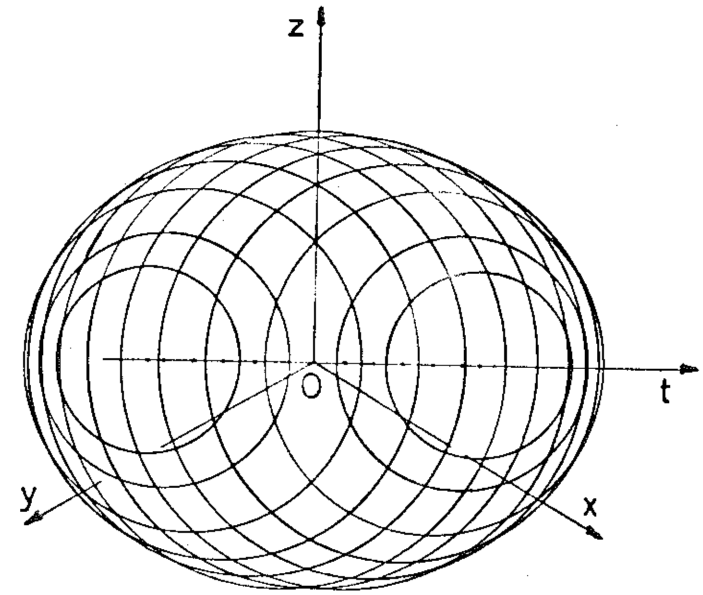

Figure 7.

Axonometric picture of the hypersphere..

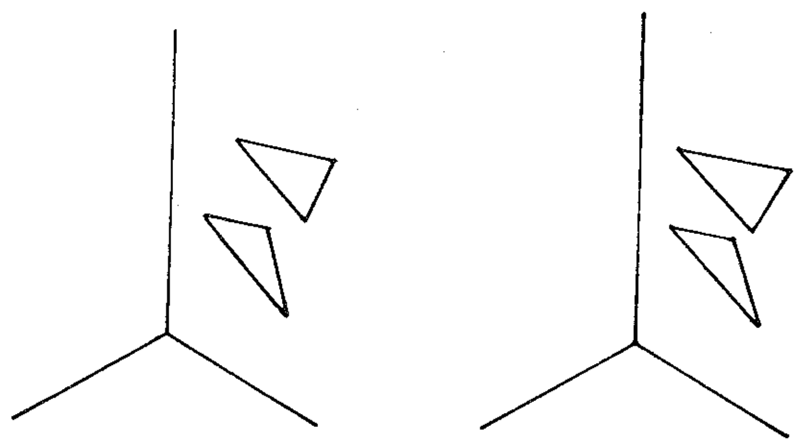

Figure 8.

Stereoscopic model of two parallel planes.

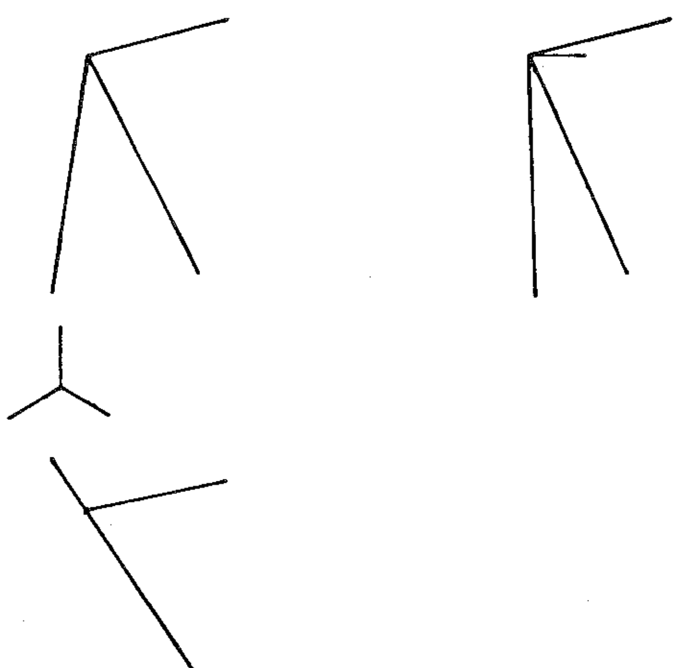

Figure 6.

Axonometric picture of four concurrent lines perpendicular two by two. (The same figure can be used as stereoscopic model.)

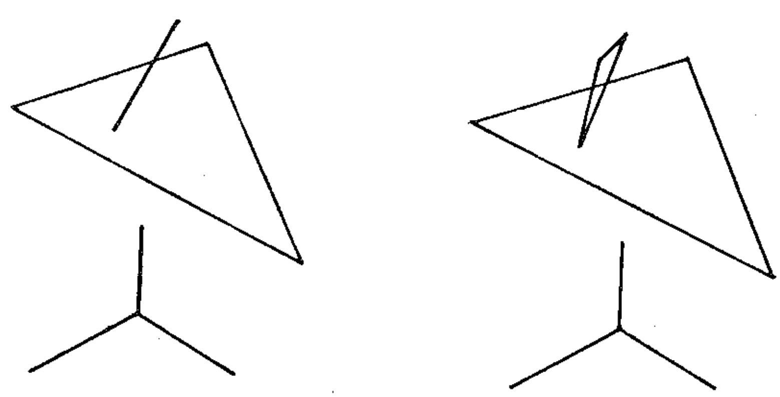

Figure 9.

Stereoscopic model of two absolutely perpendicular planes.

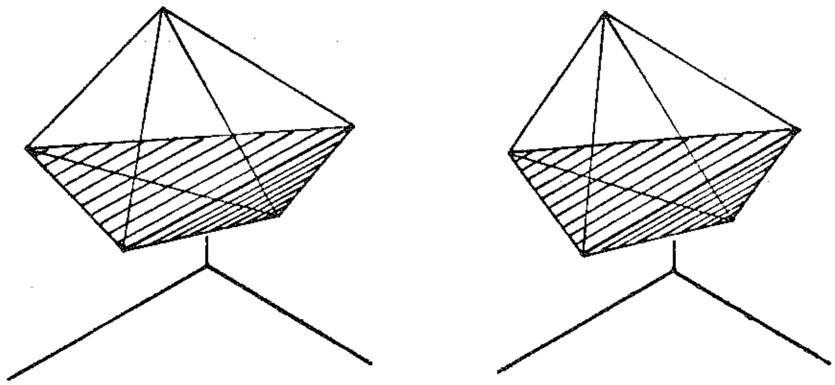

Figure 10.

Stereoscopic model of a hyperpyramid.

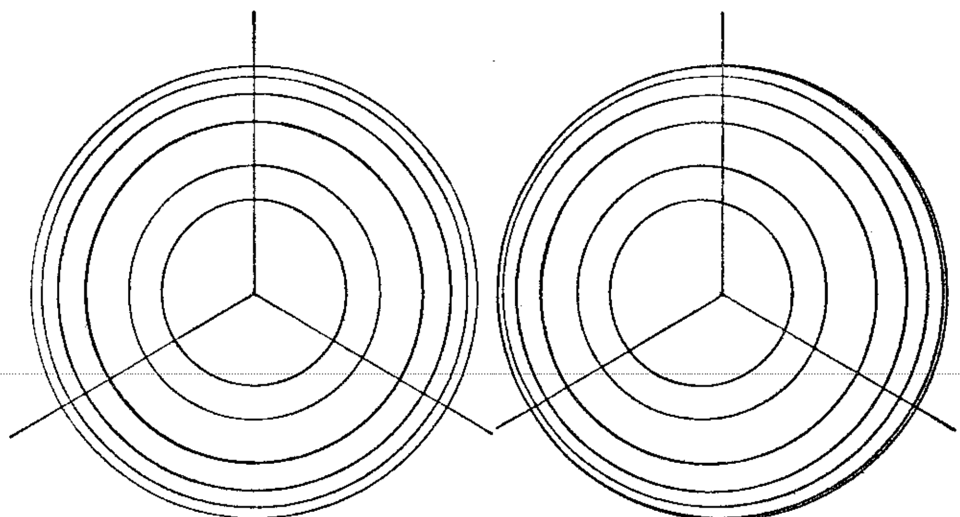

Figure 11.

Stereoscopic model of the hypersphere. (For the sake of clearness half a hyper-sphere has been drawn.)

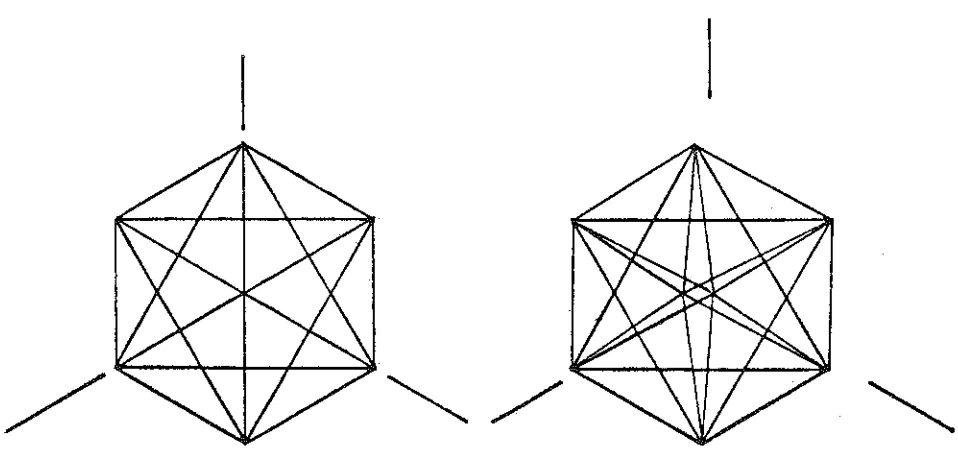

Figure 12.

Stereoscopic model of the hexadekahedroid.

Continued From Page 55

school level should be chosen. Many schools, however, do use college level texts with effective results. For those schools able to obtain funds, purchasing of a good high school workbook most efficiently minimizes layout time by the student and eliminates unproductive repetitive drawing by him. Workbooks optimize the student's learning and drawing process by focusing his efforts only on the new and germane material under study. In the better high schools some teachers have made up their own worksheets thereby achieving much of the benefit of a workbook.

SUMMARY AND CONCLUSION

As we noted before, the content of the proposed course presents no new or unusual ideas in selection, sequencing or presentation of material which constitute the course in "Pre-engineering drawing" if that may be considered its title. Our aim is solely to construct a basic course in drawing approved by a committee of responsible college faculty who are actively engaged in teaching engineering graphics at the college level for those high school faculties who are desirous of formulating an effective technical drawing course for their college preparatory students.

We seek to overcome the discrepancies and inadequacies that exist in the high school program by elimination of redundant exercises emphasizing skills rather than reasoning. We have attempted to suggest a core course which can be attained by the realigning and restructuring of courses now in existence.

The course content is for a Basic Course in Technical Drawing. It might be noted parenthetically that all members of the Educational Relations Committee of the Division of Graphics would encourage the high schools' drawing teacher to do more and thus exceed the limitations of the Basic Course if time allowed. Many fascinating aspects of graphics exist that relate to the high school educational process especially in the area of graphical computation. However, that would be the subject for a further report and for an advanced course in drawing.

The means by which man communicates are three-fold: the verbal and written form employing speech and writing; the symbolic form which makes use of mathematical and scientific notation; and the graphical form which utilizes lines and points.

Modern man needs facility in all three media as he never has needed it before. Today's students devote countless years of study to master the first two with the third generally expected to be acquired in an incidental manner without formal instruction. The potential of graphical methods of thought and expression is seldom brought fully to development. Here, the teacher of technical drawing and later the professor of engineering graphics should play his role bringing out the essential worth and value of the graphical mode of thought and expression. With the multi-faceted demands of industry on our graduates, we can afford to leave no part of their growth and educational experience undeveloped.

Both the high school and the college teacher play a unique role in this educative process. Let us make full use of the opportunity that is ours.

THE COMMITTEE MEMBERSHIP

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Stuart Allen - Michigan Technological University

Cecil Marion - University of Miami

Lloyd Christianson - University of Missouri

John Barylski - New Bedford Institute of Technology

Samuel Owen - Rutgers State University

H. Dale Walrayen - University of Illinois

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Klaus Kroner - University of Massachusetts

Robert Lang, Chairman - Northeastern University

FILE TO FILE continued from page 37

Project to front view of stress diagram. The horizontal spaces between which the front views of the forces must be drawn are determined in the top view. Construct front view by paralleling members in the front view of the space diagram. The vertical force closing the stress diagram is the load which will create the stresses shown in the three members. By a simple true length diagram, these magnitudes may be determined, Fig. 3(c).

The ratio diagram in which the three stresses are proportioned to the 800 lb. load is shown in Fig. 3(d). It will be noted that the stresses obtained graphically do not agree exactly with those of the mathematical solution. However, these variations are less than two per cent of the load and are permissible in engineering practice.

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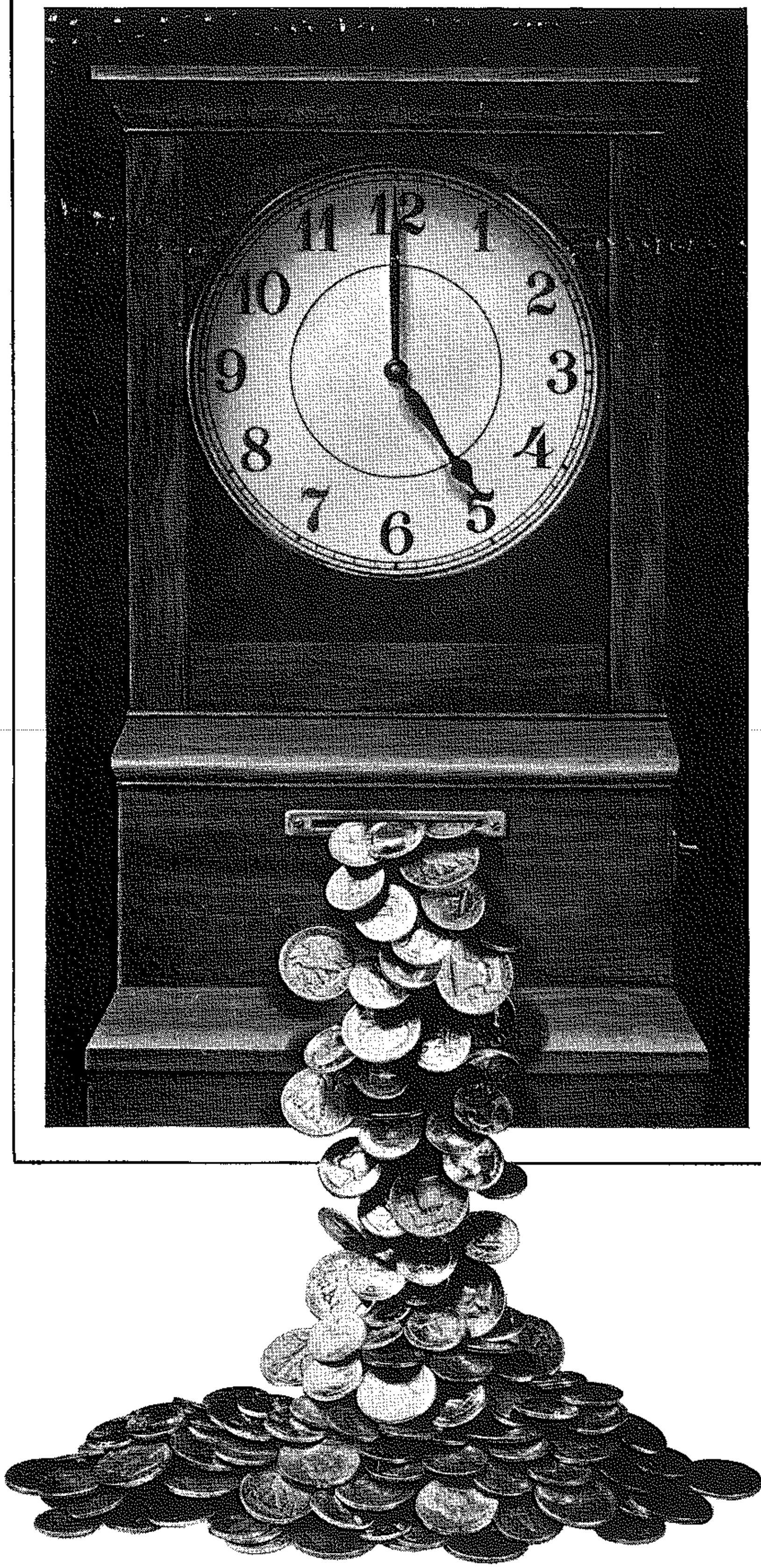

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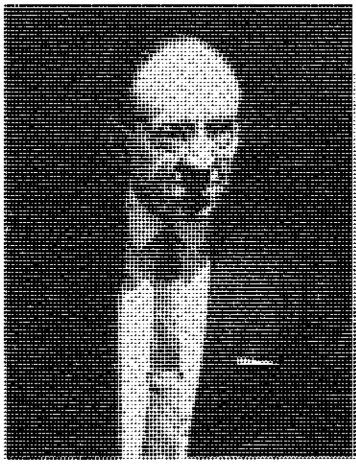

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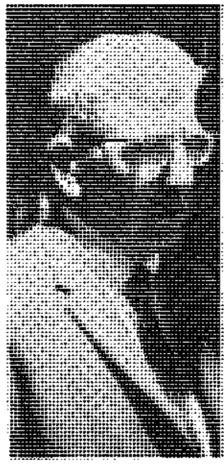

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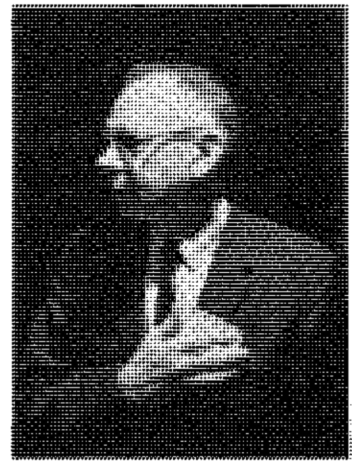

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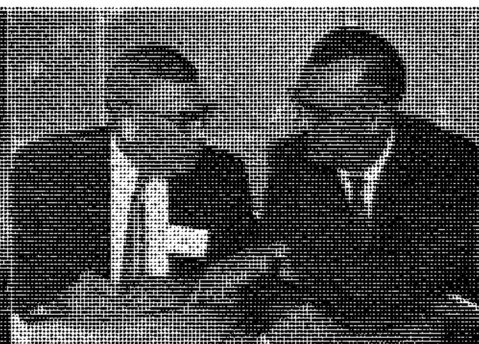

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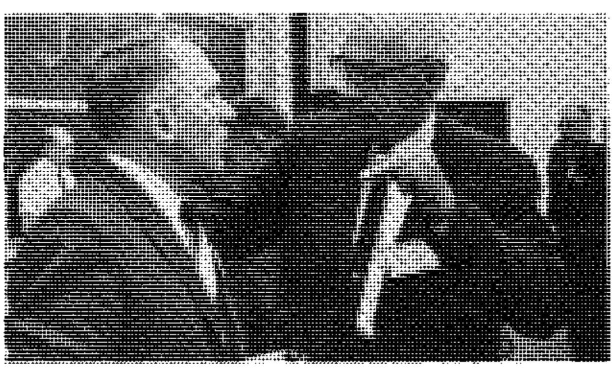

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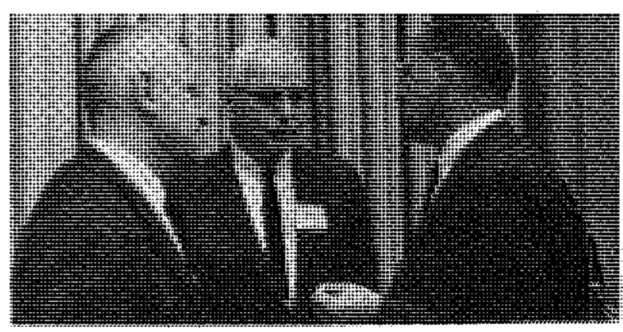

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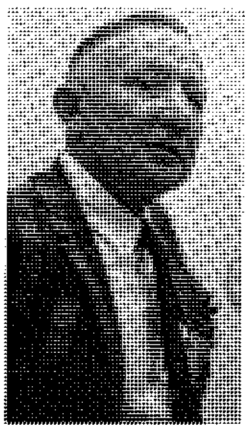

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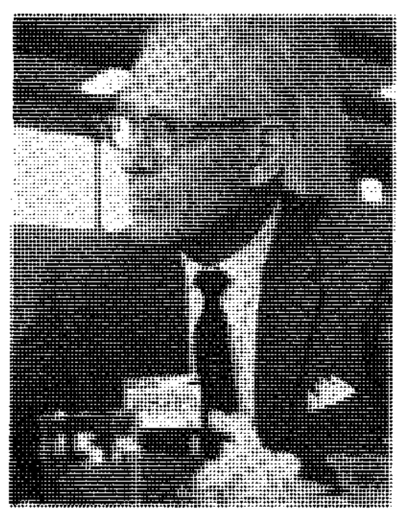

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- * Instructor's Manual with solutions to the problems in the workbook

Fundamentals of Three-Dimensional Descriptive Geometry is the first publication in the new Projective Graphics—Technical Design and Analysis Series under the editorship of Professor Slaby. Designed to meet the growing need for educational materials that will keep abreast of rapidly developing technologies, the Series will offer textbooks for undergraduate courses in mechanical, civil, aeromechanic, chemical, electrical, and architectural engineering.

Fundamentals of Three-Dimensional Descriptive Geometry is intended for use in a one-semester or two-quarter course for first-year engineering students in technical institutes, colleges, and universities. Its main objective is to develop the student's ability to think graphically through a carefully organized presentation of the basic concepts of three-dimensional descriptive geometry. In a logical and sequential manner, Professor Slaby discusses theoretical principles based on classical geometric reasoning and relations and shows their practical applications through orthographic examples and construction programs. At the end of nine chapters there are sample quizzes and practice problems accompanied by illustrations showing the given lines and points on grid paper. Two sample tests and one sample final examination with solutions are suplied in the appendix.

The clear, logical organization is reinforced by the use of a second color iu almost all the figures. For the first time in a descriptive geometry textbook, color is used in drawings to clarify relationships among lines and to identify planes in constructions. Specifically, the two most important functions of the second color are: In the construction programs that require an object—a point, line, plane, or geometric figure—to be translated from one view to another, color is used to distinguish the object lines from the construction lines. Here the second color helps the student understand graphical relations. In the pictorial representations of solids, which often show the iutersection of one solid with another, the second color clearly distinguishes the elements of one solid from those of another. For the student who will eventually construct these lines himself, color is important in showing him how they are evolved and how they are related to the solids.

In order to maintain a consistent three-dimensionality throughout the illustration program, labels appearing in figures on planes not in the same plane as the page are distorted so that they appear in the proper perspective. This technique, combined with the use of a second color, readily clarifies geometric drawings.

A Student Workbook prepared by Professor Slaby and Sanford Gum of the College of San Mateo accompanies *Fundamentals of Three-Dimensional Descriptive Geometry*. Each page in the workbook contains one or two problems derived from the textbook. Bound between the pages is a detachable transparent sheet of grid-lined paper, on which the student can sketch his preliminary solution to the problems beneath the overlay. The grid-lines are printed in the same color as that used in the textbook. An Instructor's Manual containing answers and solutions to the problems in the workbook is also in preparation.

Text: 480 pages, with 280 drawings and 120 problems, $7.50 (probable). Workbook: Spiralbound. 160 pages, $5.25 (probable). **Publication: March**

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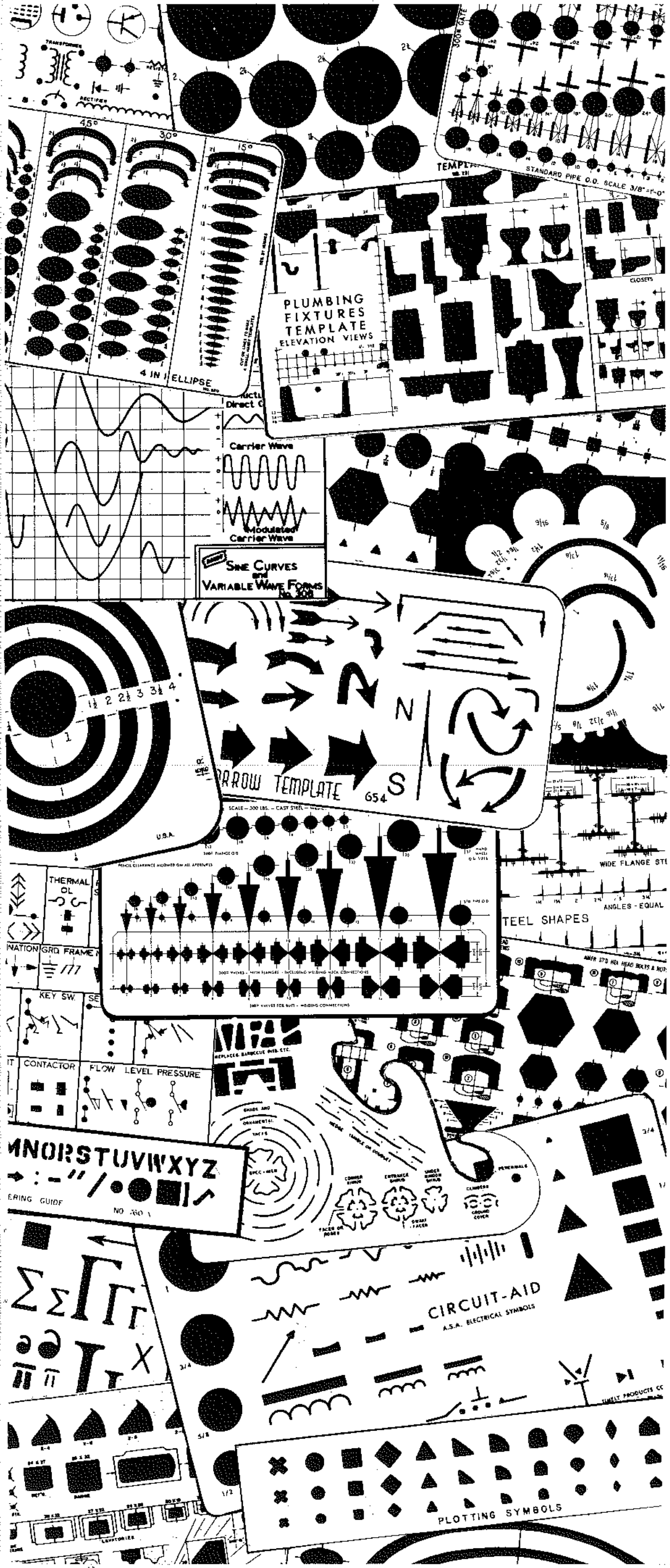

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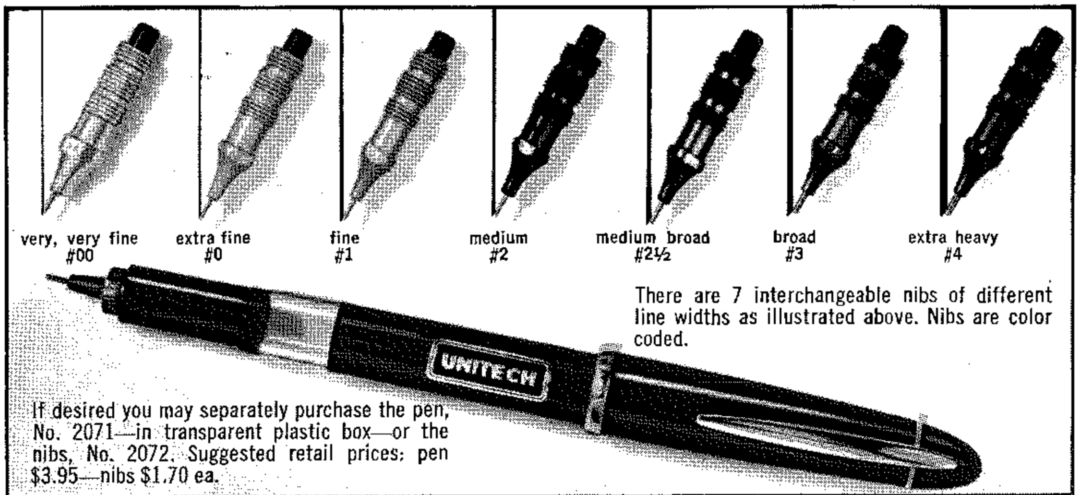

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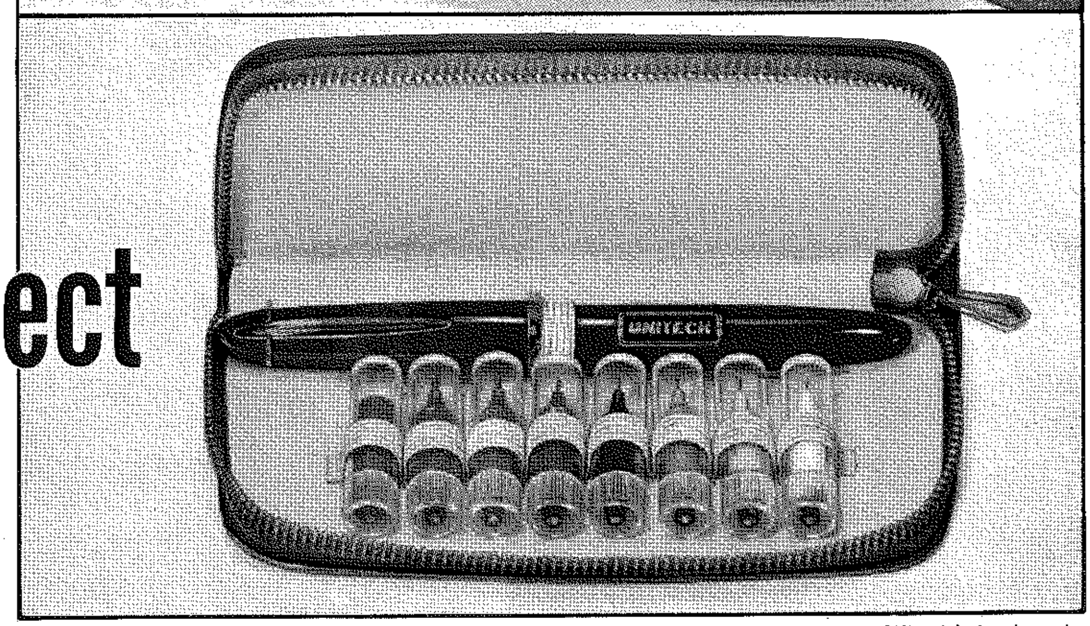

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