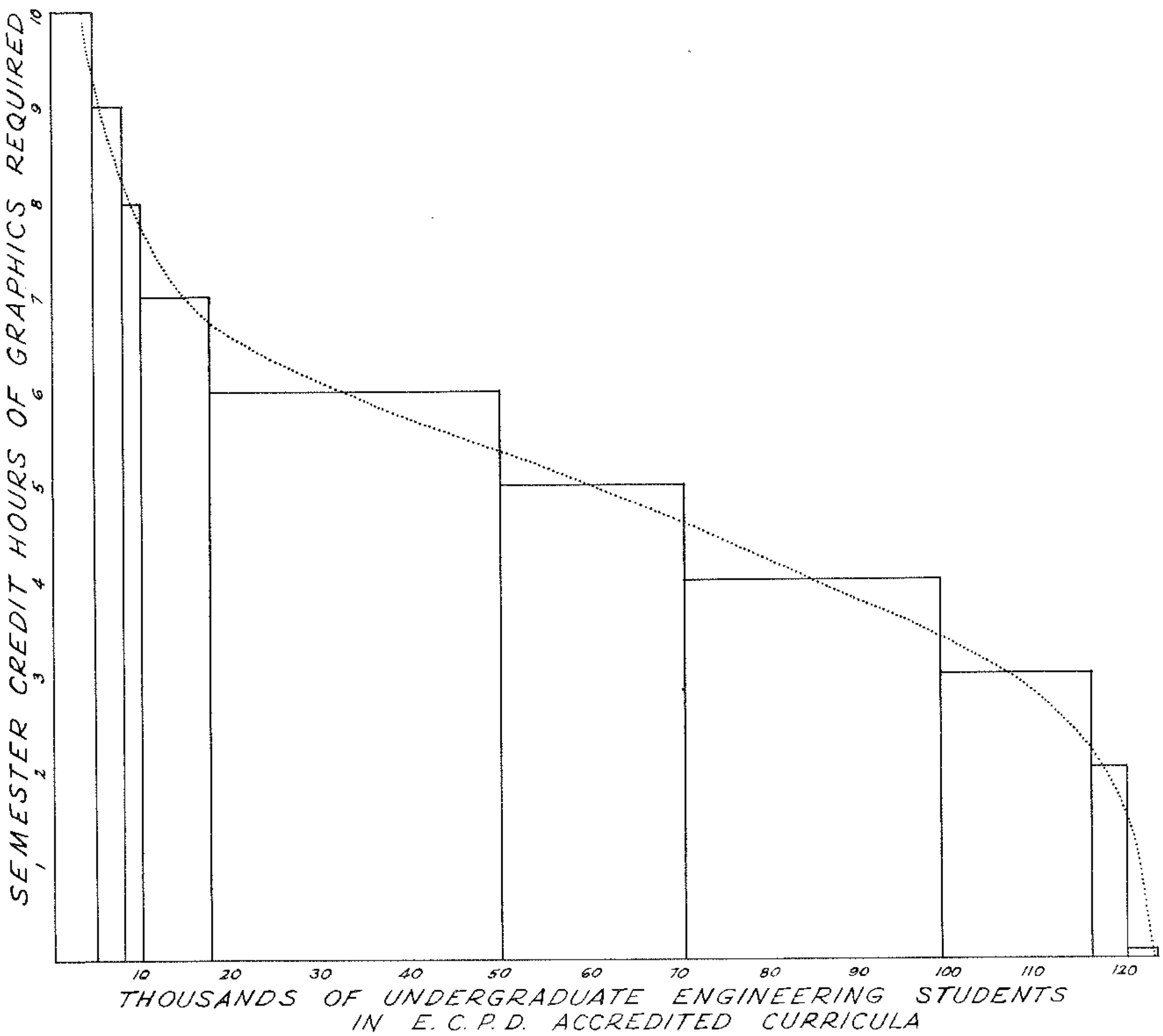
THE JOURNAL OF

ENGINEERING GRAPHICS



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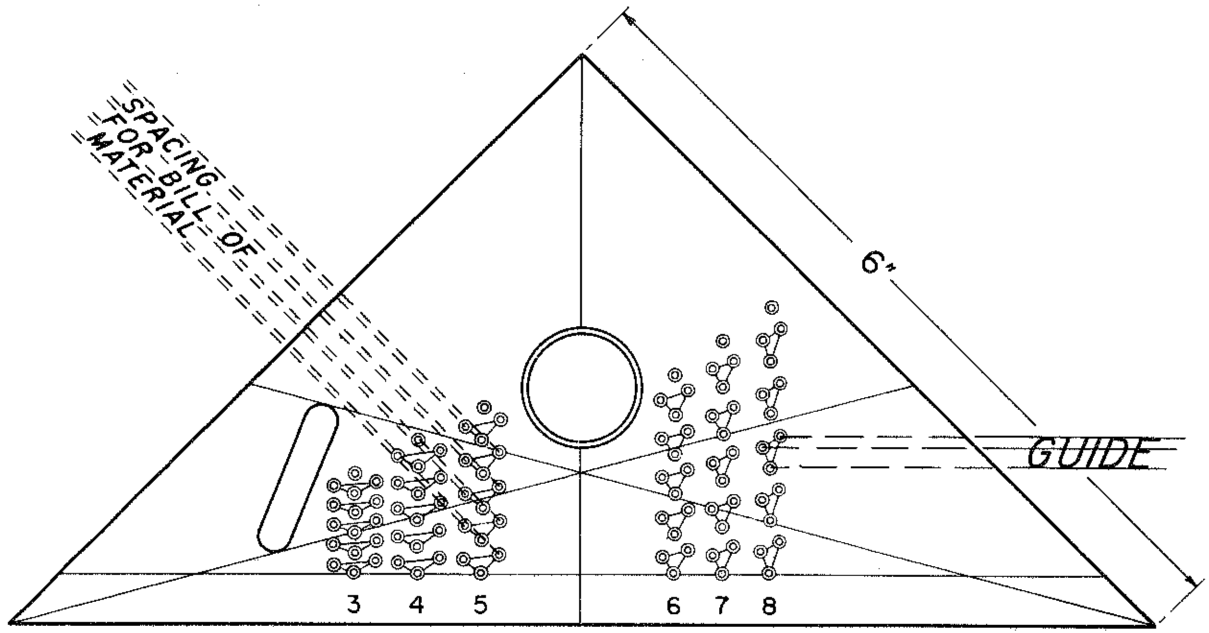

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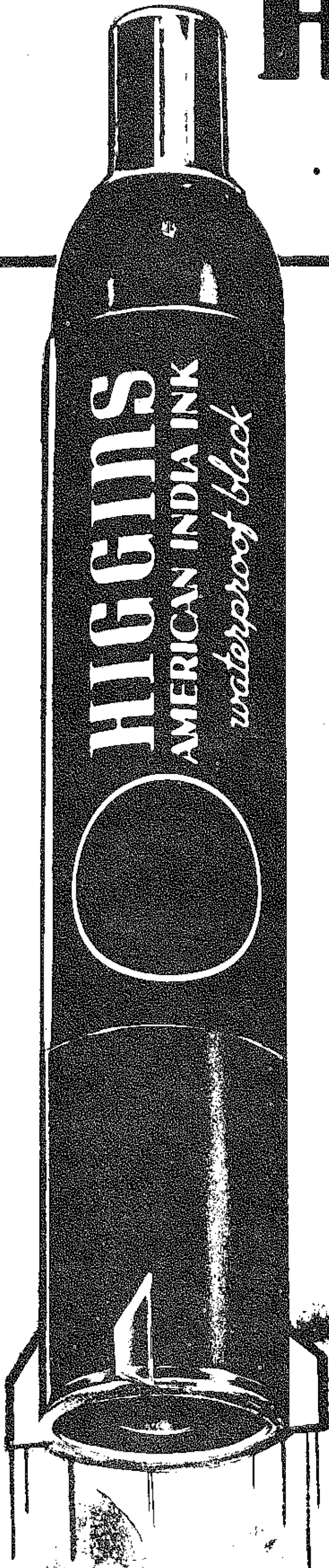

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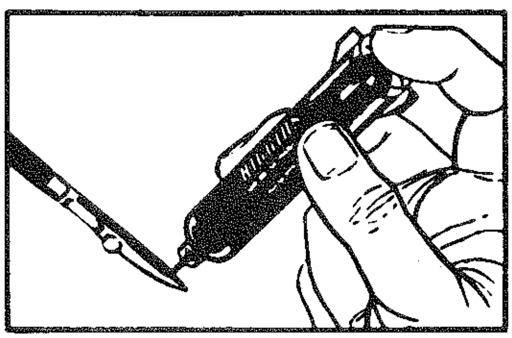

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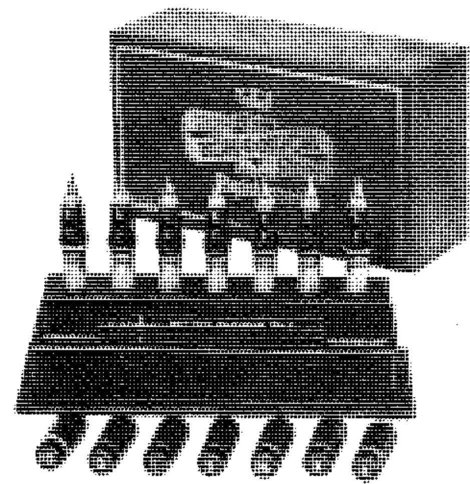

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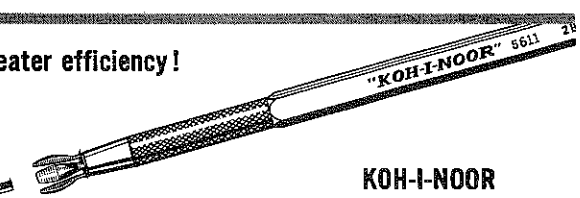

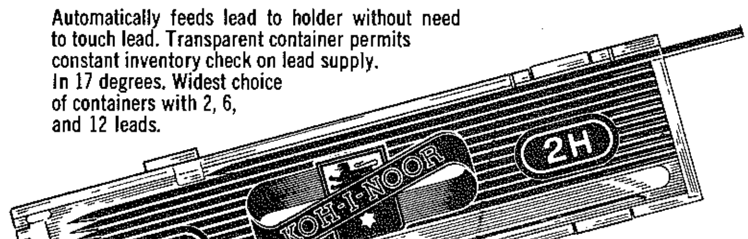

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by Myron G. Mochel, Clarkson College of Technology

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FUNDAMENTALS OF ENGINEERING GRAPHICS

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AT **M.I.T.**

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EDITORIAL PAGE

The COVER shows the present state of engineering graphics education in the United States. The average engineering undergraduate student is now required to receive five semester credit hours of engineering graphics instruction. Data were assembled from the University of Wisconsin "Survey of Thoughts and Trends in Current Engineering Graphics",(1) from college catalogs, 1959-1960, and from the A.S.E.E. annual, showing E.C.P.D. accredited schools and enrollments, 1959.

The Wisconsin study is too voluminous to be presented here. You may write to Professor Frederick O. Leidel, Department of Drawing and Descriptive Geometry, University of Wisconsin, Madison, Wisconsin. The survey is worth far more than its cost.

The Wisconsin Survey and the Purdue study(2) are agreed: Practicing engineers desire that engineering undergraduates receive more drawing and descriptive geometry than five semester credit hours.

In regard to reductions in time for graphics at several schools during the past decade (dates, schools, hours, etc., furnished on request) faculties of certain degree-granting departments have apparently acted contrary to the opinions of practicing engineers.

We have faith in the judgment and action of professional engineers. We believe that engineers, in person, in resolutions of their society chapters, in state and national meetings, in expressions to E.C.P.D., in alumni groups, and in contacts with engineering college offices, will provide engineering education with the benefit of their thinking on the subject of drawing and other professional needs.

We hope that adequate instruction in graphics will be restored in those colleges where it has been curtailed.

We must believe that all engineers, in academic roles and in professional practice, will act in the best interests of our future engineers and of the work to be done.

(1) Presented at the Mid-Winter Meeting of the Engineering Graphics Division of A.S.E.E., Missouri School of Mines, Rolla, Missouri, January 21, 1960.

(2) "A Study of the Purdue University Engineering Graduate", Journal of Engineering Education, pp. 930-947, Vol. 49, June, 1959. (Opinions of undergraduate freshmen, seniors and of faculty are added.)

APPRECIATION

We wish to express our appreciation to members of the division and especially to the engineers from industry who presented such useful information and challenging ideas at the Mid-Winter Meeting. To the hosts at Rolla, we are most grateful for the fine arrangements. This was a most inspiring event.

SUMMER SCHOOL

A summer school is contemplated for the annual meeting at Kentucky in 1961. The chairman for this occasion, Irwin Wladaver, is eager to receive your suggestions and help.

INFLATION

Although we have the strongest support of our advertisers and subscribers, the Journal has seen its small reserve decline due to increased costs. Therefore, the subscription rate will be increased to $1.50 per year after July 1, 1960. The subscription rate was increased from $1.00 to $1.25 per year in 1949. Before July, 1960, you may subscribe for as many years as you wish at the present rate of $1.25 per annum.

Advertising rates will also be increased to $30.00 per page, $55.00 for two pages and remain $100.00 for four pages. Such advertising rates will be effective for the November, 1960 issue.

GRAPHICS RESEARCH - PAST

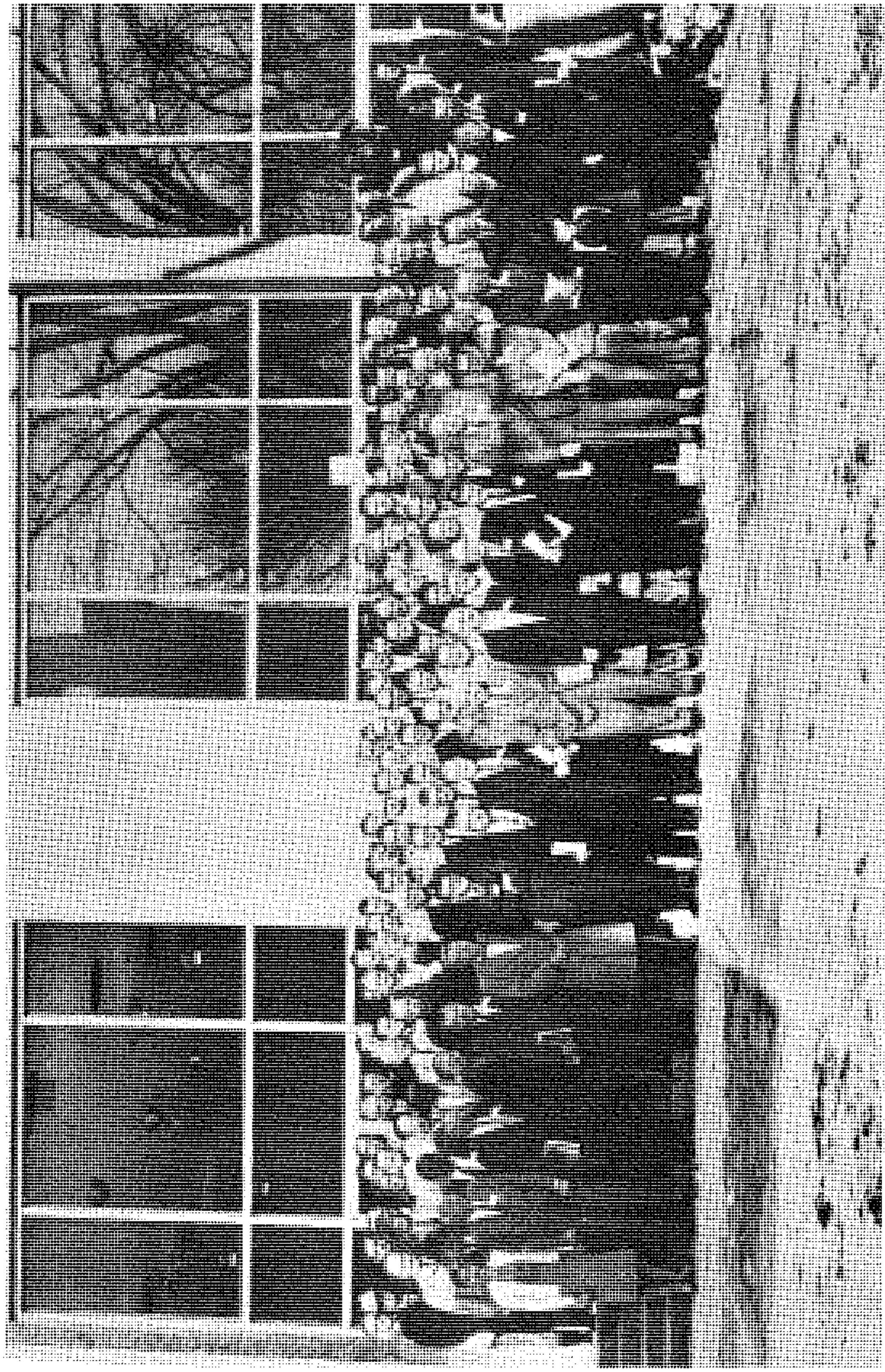
The value of history has been the subject of many essays. If you have any doubts as to the vitality of the men in the graphics profession, re-examine the record of the past. What an inspiration for the work we have before us is the record of past progress in graphics. It is unjust that the reward for such progress has been deemphasis of graphics by some engineering colleges.

The Journal of Engineering Drawing is a record of what has been done. To young and old members of the division, may we recommend a study of the seventy issues of this journal. The professional devotion of past leaders in engineering graphics deserves respect. May we try to do as well.

GRAPHICS RESEARCH - FUTURE

Congratulations to S. M. Slaby who has received an NSF fellowship for graphics research in Norway.

Please give us written notice of NSF and other grants for institutes and research in graphics, so that they may be listed in the May issue.



Mid-Winter Meeting of Engineering Graphics Division, A.S.E.E., Rolla, Missouri, January 21, 1960

EXCERPTS FROM THE ADDRESS OF C. V. MANN

To the Mid-Winter Meeting of the Division

January 21, 1960

In June, 1925 at the annual meeting of the Society for Promotion of Engineering Education--now the A.S.E.E.--I presented a report on the degrees held by members of engineering faculties. Following this report I was appointed to the Council of the Society.

During the years 1926 to 1929, our Rolla Drawing Department offered meaty courses in drawing and descriptive geometry. Along with these freshman subjects we included a group of courses of interest to senior students in our several engineering specialties--mining, mechanical, civil, metallurgical, and electrical. We had a course in City Planning. We had second, third, and senior year courses in Bridge Drawing. The Head of the Civil Engineering Department told us that the DRAWING of bridge plans BELONGED in OUR department--NOT in HIS. His work or function was to do the mothemotical calculation of the bridge stresses --our part wos to delineate the bridge so designed. We therefore ACTUALLY HAD senior civils taking our Bridge Drawing course. One of them, I am proud to say, is today in charge of our Missouri Highway Bridge Design work, in the State Highway Department. He says the drawing he did in our classes led him into that job.

The Foundation of the Engineering Drawing Division

On the train going to Chapel Hill (N.C.), several of us, including Higbee, Jordan, French and myself, discussed the idea of a Drawing Division. At that time there were no divisions of SPEE, yet its constitution outhorized divisions. Our troin discussion motured into a petition to the SPEE Council which was conveyed by French and myself as council members. Who had ever heord of a division?! Happily, Dr. W. E. Wickenden, director of the great study of engineering education and H. P. Hammond, his ossistant, supported our motion. The Division was approved. Back in our meeting, French wos elected chairman, our only officer. Our Division is now in the middle of its 31st year--and we can say that the 1928 Chapel Hill meeting was a leap from milepost zero to the hundredth.

(At this time, Dr. Mann osked those who attended the Chapel Hill meeting to stand. Professor R. P. Hoelscher was applauded.)

The 1930 Summer School was onother mile post. It was given over to a most thorough review of the needs of drawing work in the engineering curriculum, the manner in which drawing and description were being taught--should be taught, quolificotions of teachers, and tests.

The entire group, in a large classroom, sat down to take the Mann Drawing Test. It contained 100 score points, and had to be finished in 50 minutes. One presumably COULD flunk the test--and be forever disgraced. Justus Rising served as test administrator. He announced that the test would be scored right there in the room when time was up. He wos stern and strict. Even the mighty Dr. Wickenden was reprimanded when he stepped into the back of the room, creoting a slight disturbonce. The tested ended. Professor Rising picked a teacher at random and had him come forward to score a somple paper. Stencils and instructions for scoring were given the teacher--and in 3 1/2 minutes the paper was scored. What a sigh of relief went up when all were told that they might keep their own paper!

Our 1936 meeting, with the main Society at Madison, Wisconsin, was a mountain-top session. For the main Society, the meetings were burdened with the theme thot Science and Engineering have outstripped progress in the humanities. The Engineers begged the humanists to wise up, and be prepared to handle the humanistic problems thirty years hence that might result from scientific odvonce. Half a dozen great humonists were brought in to tell the Engineers that engineers ore the world's greatest sinners. They barge ahead with experiment, new godgets, without giving a care for what will result. "Let the humanists toke care of the social problems that result" is what engineers were accused of.

With that kind of spirit flooding the Wisconsin University campus, we Drawing teachers felt somewhot subdued. However, one crowning event happened when our Journal of Engineering Drawing (you now call it Engineering Graphics) was born. At this Modison meeting, Higbee took the floor with a motion to establish the Journal. It passed, and Higbee, with Russ and Monn, were made the first editorial staff. Higbee led off, then passed to Russ, who in turn passed to Monn--and he to all you others who hove since been editors.

Establishment of the Journal of Engineering Drawing was another milepost for the Division. It occomplished its purpose of providing a medium for exchonge of ideos. It stimulated writing, research, as one can learn if he scans the volumes from 1936 to 1960. But more, this Journal wos the very first of any written by a professional division of the Engineering Educotion Society. Others, like the Civil Engineering magazine, followed. We were first both as o division, and as a publisher of a divisional journal in the A.S.E.E. (S.P.E.E.).

The 1939 session was at Penn State College. Carl Svensen was the retiring Chairman. I was deeply involved with drawing tests and with general college comprehensive examinations. We seemed to be getting places in both fields. We had one of our best divisional photographs taken--perhaps 200 men in it. I was elected Division Chairman at this meeting.

When time came for the usual mid-year meeting of the Executive Committee, we found that its members were scattered clear across the United States, making it next to impossible to assemble a quorum. After deliberation, it was decided to arrange our first Divisional Mid-Year meeting, and along with it call in enough of the past members of the Executive Committee to conduct necessary business. After some letter writing, Armour Tech. in Chicago invited us to its campus, and we went. The date was in February of 1940. Professor Seegrist of Tech did a magnificent job of local planning. Lewis Institute and other schools were invited to send their drawing teachers. Even some of the prominent high school teachers attended. We held our annual mid-year banquet in the down-town loop dining hall of the Chicago Engineers Club. Doctor Henry Heald, president of Armour--and now Director of the great Ford Foundation in New York--gave the address of welcome. French was there as toastmaster, and Higbee made the formal address. One hundred and fifteen persons were in attendance. It was a great and inspirational meeting. I suspect that our good friend, H. C. Spencer, who was there to plan the ensuing San Francisco meeting, somehow got caught in the Armour snare--for he is now there on the faculty, instead as then at Texas A and M. Armour is now Illinois Tech.

We first had a "Dean" in the person of R. P. Hoelscher at our 1946 Summer School, held at Washington University, St. Louis, in June of 1946. That was a GREAT meeting--replete with technical papers and addresses, exhibits of all kinds of drawings and instruments, and attended by a great number of our best drawing teachers. Dean Haelscher certainly gave us a Good Lead! In the photograph then taken, I see many of the younger men who, since those earliest days, have taken over the lead the veterans once had. Street, Hill, Thomas, Aackus, Church, and so many more of you.

I should like to wind up this talk with a prediction. Through all the years the Division has existed, the drawing teachers have felt forced to protest at the pinching out of the time given to their courses in the engineering curriculum. Drawing feels that it has, somehow, to "save face" and win the approbation of the technical departments.

Let my prediction be in this wise. Until some towsel-headed scientist or engineer invents a magic type of camera that will, with perfection and in totality, take a photograph of the innermost thoughts and designs that perambulate through the heads of scientists, engineers, inventors, and drawing teachers--until that day there will be a continued use for ENGINEERING DRAWINGS. New buildings won't rise--neither will space satellites--without complicated, detailed drawings for the guidance of the technicians and machinists who fashion the multitude of parts. And until that woozly-headed chap invents that brain camera, you drawing teachers are going to have jobs that are not too much different from what you now have.

And now, from the bottom of my heart, let me thank you for inviting me to this meeting. Let me, through you, thank the Division for all the inspiration it has been to me these thirty years. Let me thank you for allowing me to mingle once again with a group that represents what is finest among the Men and Women of this world. My deepest wish is that this Division shall always be known as a group of true gentlemen.

METHODS OF TEACHING ENGINEERING DRAWING

By Earl D. Black

General Motors Institute

ABSTRACT. Methods of teaching are oriented to engineering drawing and set the stage for combining these methods in one class operation. Effective student learning is increased by the combination of classroom, laboratory-project assignments, and by working in team groups. The teamwork assignment impels each student into a sincere effort and pride in his own work. He learns to respect the suggestions of others in the exchange of ideas. He learns to use graphical solutions in developing accurate layouts and solving or analyzing engineering problems. Items of learning cease to be single and isolated ideas but become associated in a working knowledge by the student. Learning is given special emphasis, purpose, and direction through cooperative plant and school experience. Individual student attainment is higher, and the student develops an eager interest in learning.

The word "some" should be inserted at the beginning of the title, because all of us are continuously looking for more effective methods of teaching. At General Motors Institute, much consideration is given to the student's outlook on being exposed to an unfamiliar experience. The teacher displays a definite interest in each student, and consideration is given to making the student feel at ease in the learning situation. Commercial prints and current production parts are selected and used to provide an atmosphere of reality. All activity on the part of the teacher is directed toward making it easy for the student to learn. Student-time limitation and effective use of this time is of primary importance. Student participation and interest is encouraged at all times.

Let us examine the meaning of methods and their use in teaching engineering drawing.

LECTURE-DEMONSTRATION CLASSROOM PROCEDURE

During two hours of class time per week, at the opening session of six hours scheduled, the objective for the semester or month is thoroughly explained by the teacher. He presents the problem assignment by sketches, demonstration, prepared prints, charts or written instruction. Visualization and understanding is assisted by the use of slides, filmstrips, movies, Vu-Graphs, opaque projectors, models, mockups and other devices which create student interest. Special blackboard demonstrations assist in explaining particular phases of the assignment that might otherwise be complicated and difficult for student comprehension. Models for demonstrating design and perception may be constructed from heavy paper, plywood, pressed wood, plastics or other inexpensive and suitable materials. These are often assigned to students for construction.

Remedial instruction receives a major emphasis in the classroom. Students are assigned selected topics and technical questions for research during both school and cooperative work sessions. Oral and written reports resulting from this investigation are given by the students. The oral report is given in the drawing classroom; the written report is often used as an assignment in English composition classes.

Scheduled, written or oral tests are given to measure class progress. However, these tests are used in the dual capacity of an evaluating and teaching device. Individual or class reviews are conducted over each test given.

PROJECT-LABORATORY METHOD

Project-laboratory assignments are designed or selected from problems, where parts are closely related in function. These are problems which require continuous study of engineering drawing and manufacturing processes. The student's interest is captured and he is stimulated to constructive thinking. Project problems are designed to give an opportunity for making decisions in obtaining reasonable economy of production. Studies are made of the proposed product with a view to production processes and production schedules as they affect manufacturing considerations. Student interest, sketching, research for standard parts, and a variety of problem solutions is the order of the day, especially during the early stages in each problem development.

The laboratory experience provides sufficient practice for learning fundamental drafting techniques to the degree specified by course objectives. Emphasis is placed on such fundamental points set aside for mastery by the student. The project problems are chosen to provide for a degree of selectivity that meets the needs of the most capable as well as the needs of the less apt students.

Spectacular projects receive second choice to projects which provide valuable learning opportunities in fundamental engineering concepts. Assignments are chosen which are adequate for the lesson objective and represent a good instructional unit. Projects must be economical of the student's time. They must be easily performed with the equipment, supplies, and facilities available to the student.

The laboratory assignment and environment simulate actual working conditions to secure maximum transfer of learning to actual job situations. Discussion of individual problems with the student draw out the student's constructive thinking and development. Markings on checked and graded drawings of past sessions are interpreted to each student individually at the time his drawing is returned, if the drawing is not checked in the student's presence.

The student is permitted to exercise self-initiative in design and construction thinking (not a copy job) within the scope of his experience. He must justify his drawings by a display of knowledge of machine process limitations and mastery of related subject information involved in the project problem. He is expected to integrate all his knowledge in getting the job done. He is held responsible for mathematics, science, knowledge of machine shop processes, manufacturing methods, good speech practice, and technical terminology. He must provide freehand sketches and research data, and demonstrate his knowledge of any course informotion which he hos had at that concurrent time. The student is expected to use drafting instruments and equipment intelligently, and wherever practical, he is encouraged to use graphicol solutions and accurate layouts in solving or analyzing engineering problems.

The teacher acts as a consultant, activity director, and general advisor during laboratory sessions. He keeps himself available to his students throughout the laboratory session. He mokes numerous suggestions and aids the student to make a reasonable decision.

Each student is encouroged to select a practicol solution to the problem and be able to defend his answer by a display of technical knowledge pertinent to the problem. He is expected to use references, drafting standards, catalogs of standard parts, and combine his choices to secure practical interchangeability of parts in assembly.

The teacher confers with the student, either in working groups or individually. In fact, we have a special progrom of student-teacher conferences. This conference time is on the teaching schedule. During the conference the teacher gives remedial suggestions and special assignments when obvious laxity is encountered. Individual student progress is evaluated by one or more visits to the student's work place during each laboratory session. The teacher informs the student of this evaluation and records the score on the student's individual class record.

CONTRACT METHOD

The controct method involves the use of a series of related assignments designed for use in individual instruction and selectivity. Minimum essentials for student achievement and required assignments are clearly indicated. An optional assortment of related problems provides a challenge to all individual abilities. This method may increase student interest through providing opportunity for making decisions in self-direction. It is also usable for mixed classes being taught by one teacher during the same class time schedule.

The contract method relies basically upon written instructions posted on the bulletin board. Class instruction is given to a small group or by individual conferences with the students. Student drawings are checked carefully, usually in the student's presence. He is told of his shortcomings and given suggested remedial learning before the drawings are released. In fact, the teacher acts much like the checker in the plant drawing room.

The contract method is not recommended for large and crowded classes. It depends upon individual, student-teacher contact for effectiveness. It is quite effective with well-chosen students, but the average to lower-in-ability student will need more personal guidance. The student is left somewhat to himself, and without careful and frequent follow-up, may learn faulty techniques or acquire information that is only partially true or even completely false.

STUDENT TEAMWORK AS A METHOD OF TEACHING

Today's emphasis on the team approoch makes it very difficult for the lone wolf to succeed in his profession. The plan of students working together to accomplish a learning assignment is not new to teaching methods. The students are organized into working teams, eoch team being held responsible for a predetermined part of a total problem solution. One student of each team usually acts as a group leader for the project. He is selected either by appointment or by student group choice. His responsibility is coordinating his group effort with that of other groups in order to keep all completely informed and to secure practical workability of the final results. Each student is encouraged to propose suggested improvements in general design of the product or tools included in the problem assignment. He is expected to contribute especially to his own team group. He learns how to work with others, keeping them properly informed of his own activity as it affects the total job. He leorns the advontage of one pictorial method of representation over another by actual practice in "selling" his ideas to others. He quickly learns to make intelligent application of graphical communication through explaining and documenting the total team effect.

COOPERATIVE WORK EXPERIENCE[1]

The cooperative plan employs an alternating school and work-experience. These alternating periods

[1] Cooperative Engineering Program, General Motors Institute, Bulletin 1022, 25M-12-5911.

are usually of the same duration of time. As with the academic program, the work experience is progressively advanced, either in technical content or in level of responsibility. Student assignments in the plant are chosen and closely followed by the plant educational director who turns the student over to a work supervisor on the job. The student is required to write a series of industrial and technical reports, coordinating the instruction at the Institute with the practical experience at the plant. The experience of the work periods is arranged so as to supplement and complement school instruction.

The student acquires, what is to him, new information on products, processes, tools, and applications of engineering fundamentals. His written or oral reports in school also broaden the experience of his classmates and teacher. The student is provided a chance to make application of the fundamentals learned in school and tests himself on the accuracy and extent of learning needed. The result usually is a "buckling down" to serious work when he returns to school.

The cooperative plan provides the student with directed purposeful experience.

The plant supervisor and educational director follow the student's progress and give advice for his school program. They act as counseling agents to the student and often make direct contact with the teacher.

ENGINEERING DRAWING CONFERENCES

Further cooperation between plants and the school are practiced through engineering drawing and design conferences. Each conference consists of reports by students on various aspects of their training and experience. The climax of each conference is a major talk by a selected plant representative. For example, last September, Mr. Thomas E. Seavey, Master Mechanic of Pontiac Motor Division, discussed the topic "Manufacturing Trends and Their Effect Upon Engineering Drawing and Design." This conference gave the students practice in telling their story to top personnel. It also demonstrated the need for mastering engineering drawing as a scientific method of accurate communication. An exhibit of student drawings gave further impetus to quality and pride in work well done.

MAKING A CHOICE OF METHODS

The choice of method, or methods, to use in teaching engineering drawing is governed by the ultimate end results to be obtained. Is the objective to make engineers, draftsmen, craftsmen, mechanics, or tradesmen? We make a list of expected student-learning end results. Then we decide on the specific points for greater emphasis and choose assignments and methods for teaching which we consider most effective in securing the desired end results.

We consider the techniques which are to be used with the method of teaching chosen.

Enthusiasm, cheerfulness, friendliness, and willingness of the teacher all inspire the student to extend himself in learning. Visit any classroom and you may observe a general similarity in posture and attitude between the teacher and the students in a given room. It is only the unusual student who dares to be different.

Student and teacher time should be used most efficiently. This builds up confidence on the part of the student and gives him a sense of maximum progress and encouragement.

The drawing classroom and laboratory, its location and accessibility, lighting, heating and ventilation, drafting equipment, and drawing room and laboratory arrangement definitely influence the best choice of teaching method to use.

The teacher's personality, scholarship, attitude, initiative, enthusiasm, understanding, versatility, and ability to communicate (oral, written, and graphic) greatly influence the choice of methods for maximum effectiveness of instruction.

Many situations lend themselves to the use of teaching aids where none exist. These are designed for simplicity, convenience, and versatility.

USE OF A DESIGN LOG

It is the practice of industry to use a design log which contains a documented description of the job objectives, design proposals, production requirements, job progress, decisions, and authority.

Each drafting student is required to keep a design log which contains preliminary sketches, research information, routing sheets, worksheets, "void" sketches and other data pertinent to the problem. The design log documents his own activity and also shows the group progress into the development of the problem. Drawings, sketches, and design information are interpreted graphically and proposed solutions are explored. Each student is expected to develop sketches and collect design information necessary for the problem solution. He is expected to be prepared to explain his ideas and proposals. Drawings and sketches not used are marked "void." They are included in the design log as visible evidence and proof of the extent of workability or lack of practicality in the ideas included on such sheets. The student uses his sketches to "sell" his ideas to others, especially to his own team group. Thus, the requirements of communication combine the use of oral, written, and graphical languages with emphasis on the fundamentals of engineering drawing. As a result, students increase individual production and raise their own standards.

COMBINING METHODS

Combining the usual methods and techniques of teaching in one class operation is most effective. Variety of approach increases successful learning through developing interest to a point that the student has a desire to learn.

At General Motors Institute we successfully combine classroom, laboratory, project, team, cooperative training reports, and individual design logs into each week's teaching activity. New items and the project problem are explained and demonstrated in the classroom. Students are called upon to discuss and explore the items of learning by individual reports of their class experience. The design log documents their individual progress in planning and research which gets the student ready for full utilization of laboratory time. The students work in teams during laboratory sessions and further augment their experience by arguing their own proposals and by checking individual ideas against the team effort. The sluggard is "booted" into activity by his teammates who learn to be critical with intelligent diplomacy and decorum.

Especially good students become inconspicuous assistants to the teacher through the program of teamwork assignments and group leader supervision. In this day of specialization, the student can not expect to work alone. The teamwork experience tends to make each individual student stronger in his own right, in that it is difficult to bury even the weakest in a small group. Smaller teams make it more difficult for any student to depend exclusively upon his classmates, especially when a design log is used to document individual achievement. Each student is encouraged to stand on his own efforts.

Teacher Activity. Successful combining of teaching methods demands that problems and projects be designed or chosen with a general framework, having a variable texture in details and objective. Problems and projects should provide for adjustment to the needs of individual students. Problems are chosen to allow the student some latitude as well as opportunity for using creative and constructive thinking.

Successful classroom activity will be marked by a diversity in teacher activity. He will:

1. Present and explain the assignment in clear and concise language. This may be by a sketch, prepared prints, charts, oral dictation, written copy, or any other device that will save time, lead the student to understand the problem, and simulate working conditions which the student may expect to meet on the job.
2. Ever be willing to discuss or identify a source of research on any question arising from the assignment -- even help the student find the source of reference.
3. Feel obligated and show evidence of willingness to teach at any time a student shows a desire to learn. He will keep himself available to his students at least during regular hours.
4. Give blackboard demonstration of special phases of the assignment which might otherwise be overly difficult and complicated.
5. Conduct class reviews, give scheduled written or oral tests, perform remedial instruction, or other activities common to the classroom and laboratory.
6. Design and use teaching aids to augment instruction given by the lecture and demonstration.
7. Take students on prepared field trips.
8. Join and supervise student professional societies which support instruction and student well-being.

TEACHING RESULTS

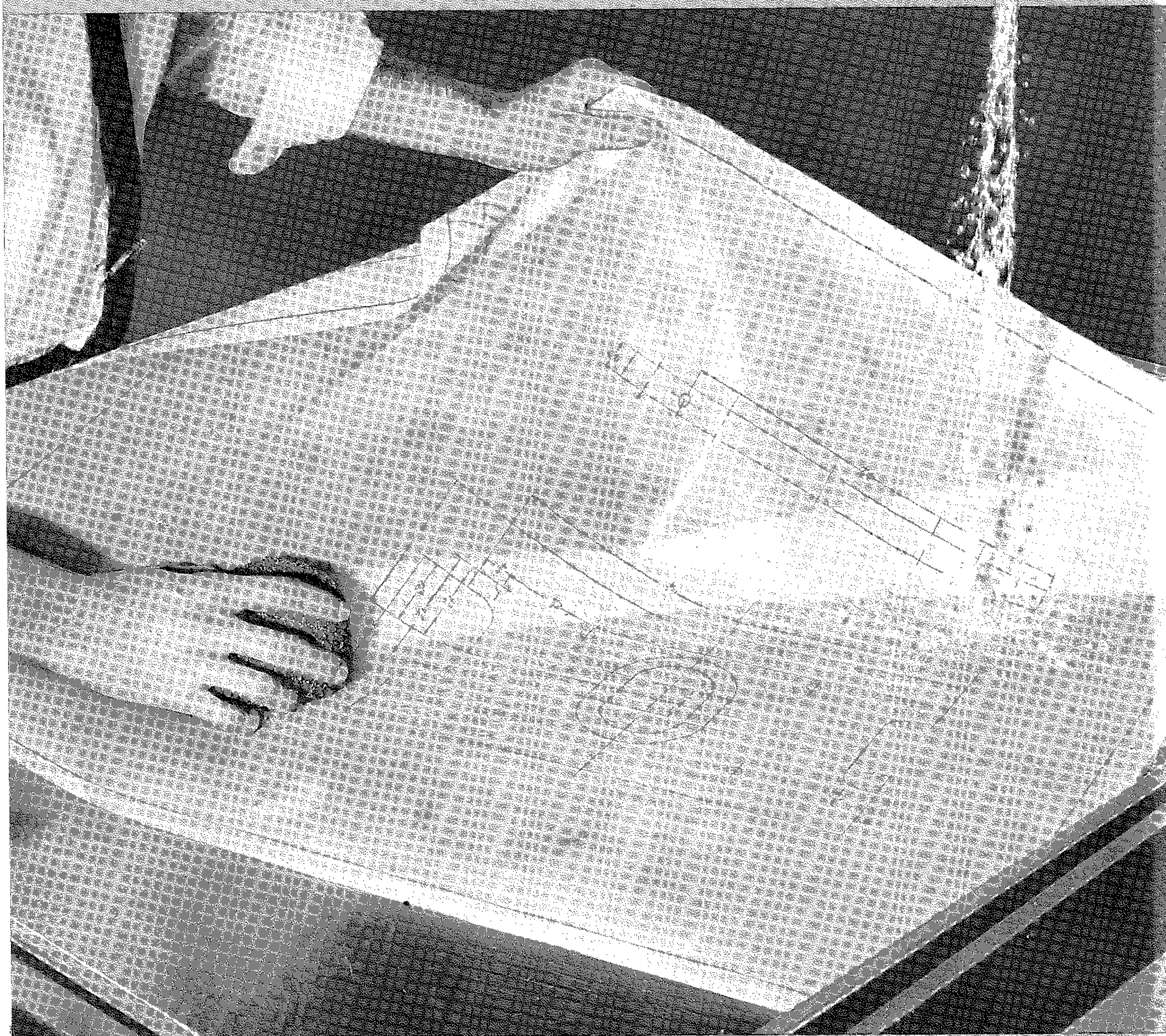
Teaching results show extra dividends derived from combining several methods of teaching in one class operation. The records show that the average student has an apparent higher individual attainment. Learning is given a purpose and retention is higher. Students develop an ability to do constructive thinking and analyze design problems with a logical approach.

Students learn to work together in getting the job done. They develop a sense of obligation to the team group, and pride in their learning attainment. They learn how to accept responsibility and make intelligent decisions. Course coverage is broadened and deeper penetration into the various aspects of a problem are explored. Students get practice in integrating all subjects into a working knowledge that helps them avoid frustration under unusual circumstances or debate. Each student is provided an opportunity for practice in "selling" his ideas to others.

Students get experience in the art of leadership. They also learn when to follow the leadership of others. They are provided an opportunity to collect facts and record required data through individual research. They report their findings to the group by combining methods of communication in order to make others understand their ideas. They are encouraged to exercise self-initiative and take criticism with outward calm and personal appreciation. Interest is developed to a high degree and students are propelled into the general class activity. Enthusiasm for the job to be done is high, and students discover that learning engineering drawing can be pleasant and rewarding.

Slash the high cost of "re-draws" with . . .

tracings you can wash!



on **HERCULENE**® *drafting film*

KEUFFEL & ESSER CO.

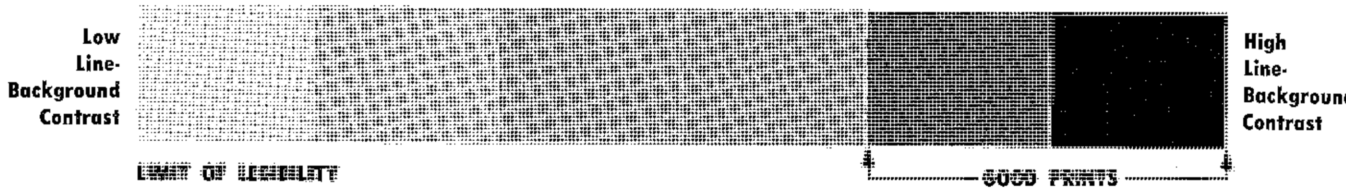
The case for WASHABLE TRACINGS

From a functional point of view, an engineering drawing is only as good as the prints it will produce.

This holds true whether your system of making distribution prints depends on conventional blueprints or white prints, reduced size prints, or on a full-fledged miniaturization program.

The life span of an original tracing can be defined as the length of time it will produce legible prints. A leading expert in drafting and reproduction methods has described the life of a drawing in terms of a "spectrum of printability." This concept is illustrated in the diagram below.

SPECTRUM OF PRINTABILITY (*Average Paper or Cloth Drawing*)



Top-notch copies are possible only when the original is in top-notch condition – roughly the right-hand 25% of the spectrum above. As line-background contrast diminishes (due to revisions, smudges, processing and filing) printability gradually drops off through the range of the spectrum. It finally reaches the point where legible prints can no longer be obtained. At this point, some form of rehabilitation is necessary.

Because of the high cost of "re-draws" – whether manual or photographic – leaders in the drafting and reproduction field have constantly been working for a better solution.

With the advent of a completely waterproof drafting base material – Dnpont "Mylar" polyester film – a new possibility came to light. Given the proper drafting surface, it appeared that tracings might be made *washable* with soap and water. The engineered drawing surface of HERCULENE® Drafting Film by K&E was designed with this long-range possibility in mind.

One further development was needed: a washable pencil line. Researchers from the Staedtler Pencil Company, working with K&E engineers, came up with the first answer. It was a unique new pencil, called Duralar, made of plastic rather than graphite, which bonded with the HERCULENE® surface, and gave a drawing of amazing permanence. Duralar lines were practically "smudge-proof." Soap and water could not wash the Duralar lines away.

The two developments brought about a completely new concept of tracing life. Now, for all practical purposes, drawings on HERCULENE® can be restored to maximum printability for an unlimited period, simply by washing them as you would a table top.

Drawings retain their crisp, sharp printing qualities. There is never a need for re-drawing. The table on the facing page shows the relative printing performance of standard graphite pencil drawings and Duralar drawings on HERCULENE® Film, which have been restored by the washing process.

A leading electronics concern has used this system of washing drawings with spectacular results. In the past twelve months, this firm spent approximately $50,000 on re-draws alone. This amount will be eliminated in the future by using the wash method. And, the savings in re-draws will pay the entire cost of the film, thus giving the concern a cost reduction of 20% over the price differential between film and tracing paper.

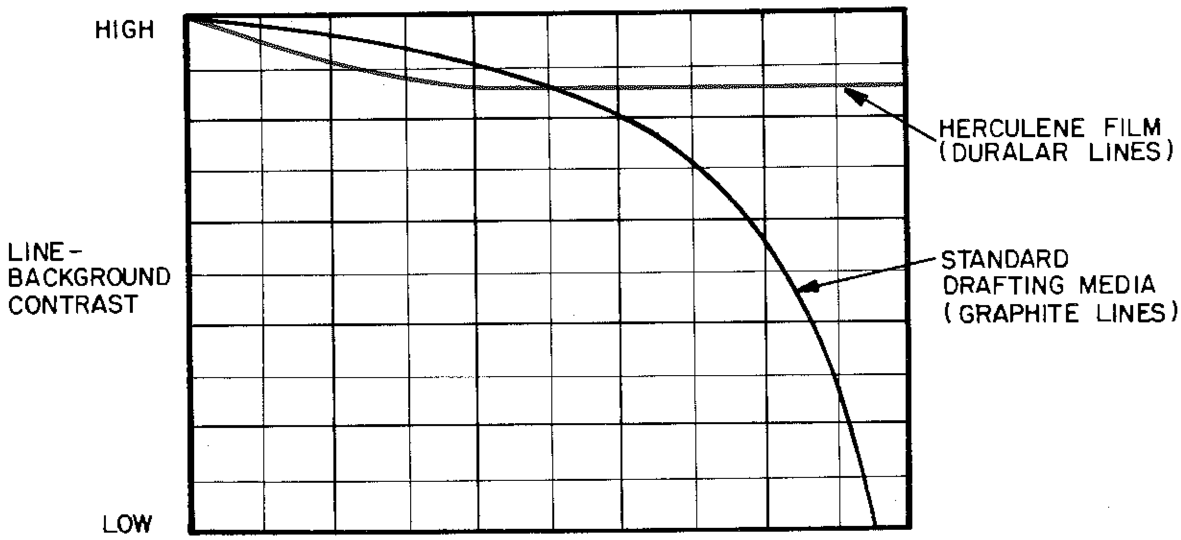
A large aircraft manufacturer has used the wash method even longer. While exact dollar savings are not available, they are reported to be impressive, and are complemented by greatly improved print quality.

A note of caution: Some of the more widely promoted drafting films have surface characteristics which were developed without consideration of this new technique. This means that plastic pencil lines are removed by washing.

Therefore, when comparing polyester films, check the washability of plastic pencil lines first, before making any other evaluation. Even if you do not want to adopt the washing technique immediately, it would be well to select your drafting film with this possibility in mind. If you should decide to change to this technique later, HERCULENE® Drafting Film will produce the results you want.

ɪn **HERCULENE®** *drafting film...*

PRINTABILITY COMPARISON



Make the Wash-test yourself

1. Use the enclosed Duralar pencil and sample of Herculene Drafting Film to make a test drawing.

2. Run off one or two prints of the tracing by your usual method.

3. Then soil the tracing. Spill graphite powder over it, smudge it with fingerprints, drop it on the floor and walk on it. Get it really dirty.

4. Wash the drawing clean with a sponge, using any mild soap and water. You'll see that background dirt washes away. The Duralar lines are unaffected. Wipe the drawing dry.

5. Make some additional test prints, and compare with the first ones made. You'll find they're identical — no loss of line-background contrast, no loss of detail. The tracing has been restored to its original condition.

Note: Ordinary graphite pencils or drawing inks will not pass the "wash-test." Only plastic pencils will produce washable tracings.

HERCULENE Drafting Film is available in the following varieties:

Cat. No.	Description			
163ET	base thickness	.002	in.	Matte one side.
PB163ET	" "	"	in.	Matte both sides.
163	" "	.003	in.	Matte one side.
PB163	" "	"	in.	Matte both sides.
163M*	" "	.005	in.	Matte one side.
163H*	" "	.0075	in.	Matte one side.

*Matte both sides — to order only.

K+E **KEUFFEL & ESSER CO.**

MEMO

TO: Head Engineers; Chief Draftsmen

FROM: K&E

SUBJECT: The use of plastic pencils and Herculene® Drafting Film

A completely new drafting technique, such as the use of plastic pencils on Herculene Film, requires a breaking-in period. Getting a washable tracing system into effect may well be stymied at the outset unless this fact is recognized, and steps taken to counteract it.

You will probably encounter some grumbling and complaints from your draftsmen about the plastic Duralar pencils. They may claim that the lines produced are not dense enough, that the points are more apt to break, that they are difficult to erase, and have a "crayony" feel.

Ask your draftsmen to keep such complaints to themselves for <u>one month</u>. We have a story from one chief draftsman with 100 men under him. He told us that at the beginning, not one of his men liked this new technique. But after riding out the rumbles for a month, they were almost all in favor of it. The entire drafting room of this concern now uses Herculene Film <u>exclusively!</u> It takes an average draftsman about three full drawings — from then on he's a convert to the new system.

To smooth the path to acceptance, here are a few additional suggestions:

1. Use only the K1 and K2 grades of Duralar pencils. The harder degrees do not give sufficient density.
2. Use a rounded point, rather than a chisel point, and turn the pencil while drawing a line. Use a sandpaper block for the final touches to the point. Avoid a needle-sharp point — rather, blunt the end slightly on the sandpaper after sharpening.
3. Dust off the drawing frequently with a brush to remove any small Duralar pencil particles which may accumulate. If not removed, these particles may cause surface marks which will not wash off.
4. Suggest that your draftsmen follow the prescribed erasing method: do not use electric erasing machines — best results are obtained with stick erasers which have a protective paper wrapping that can be peeled off as needed. After erasing, use pounce on the erased areas before re-drawing; this will increase the density of the re-drawn line.

Following these few suggestions, you should be able to get the washable tracing technique into operation in short order.

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EFFECTIVE PROGRAMS IN ENGINEERING GRAPHICS HOW SHALL THEY BE TAUGHT?

By R. P. Hoelscher

I. Objectives

The first consideration in setting up or in revising a program in Engineering Graphics is the objective to be attained. It should be noted that the title "effective programs" does not imply that there can be only one "effective program." Some may be more effective than others, but radically different situations may certainly require a variation in the program of studies recommended.

This discussion is limited to the training in graphics for the education of engineers where a reasonable time allotment is provided. The following objectives seem to be generally accepted. The over-all objective could be stated in one phrase, namely: To develop the ability to communicate to others accurately and precisely the engineers concept of any project for which he may be responsible. So far as the two basic courses in engineering drawing are concerned this will involve:

1. A thorough knowledge of orthographic projection, including first and second auxiliary projections, taught upon a sound and rigorous geometric basis for the purpose of describing accurately and precisely the shape of any part or project.

2. The ability to solve the more difficult relationships in problems involving points, lines, planes, curved and warped surfaces.

3. A knowledge of conventional signs, symbols and practices.

4. A rudimentary knowledge of shop operations and construction methods.

5. A knowledge of simple diagrams which the student will be called upon to make in his laboratory courses in physics, strength of materials and other courses.

6. Some knowledge of the elementary forms of pictorial drawing.

7. The ability to make a legible freehand sketch in either multi-view or pictorial form.

8. A working knowledge of standard dimensioning practice, including simple limit dimensioning.

The program presented will be regarded as conservative, but it is also progressive. It represents the program which has been developed at the University of Illinois by a staff of from 10 to 30 men over a period of more than 60 years of overlapping experiences. While our total program comprises many courses, we are most concerned with the two basic courses, engineering or technical drawing, and engineering geometry.

II. The Consecutive Program

The program presented may be called the consecutive approach to these two subjects and to the entire program as compared with the combined or integrated approach. One program is to be compared with another not <u>opposed</u> to another. Comments concerning the consecutive program should not be regarded as criticism of the combined approach. Each method has its merits and advantages.

The University of Illinois has adhered to the consecutive course program as many schools have done, for reasons which may be stated as follows:

1. With the exception of the pure projection theory which is the same in both courses, engineering drawing involves many conventional practices which have proved to be sound through long usage and are standard practice today. These are not at all involved in descriptive geometry. Conventional lines, sectional views, symbols of all kinds are just a few of these.

2. Handling one type of work in a course permits greater concentration by both students and staff. While the theoretical aspects of the two courses can readily be combined, the practical and conventional must be interjected rather frequently, somewhat disturbing continuity if both courses are combined.

3. Drawing is given first because students can understand plain solid objects, which they can see and handle, better than they can abstract points, lines and planes. The foundation for advanced work in orthographic projection can best be laid in this manner. Exact geometric theory of orthographic projection is emphasized in laying this ground work.

4. We believe the continuous uninterrupted study of the theory of descriptive geometry permits and promotes greater understanding and progress. In this way descriptive geometry is not restricted to theories which have a practical application any more than analytical geometry or other mathematics, a large part of which is relatively useless so far as engineering practice is concerned.

5. We believe the consecutive program is more simple to plan, teach, and administer.

III. Selection of Content and Teaching

A great deal more goes into the selection of a program than the foregoing five points. Through the years, we have considered many changes and proposals for alterations of our total program, both as to the individual course content, and our teaching methods and techniques. Such proposals have always been considered by the staff. They have never been imposed from the outside nor by one dominant individual. Sometimes these considerations have extended over a considerable period of time. Usually, if a project seemed promising, and it was of such a nature that experiment was feasible, a trial run would be made with from one to six sections. If the proposal proved effective it was usually adopted.

Just to indicate our procedure I would like to mention a few cases.

A. Segregation of Drawing classes on the basis of previous experience. About thirty years ago high schools offered as much as four years of mechanical drawing. We had many students coming to us from the larger schools with three and four years of high school drawing, but we had only one beginning course. These boys were a real problem in our classes.

We met this be setting up an advanced course for these students. Each boy at registration, if he had three or more years of high school or industrial drawing, was personally interviewed. If his experience was satisfactory he was given his choice of taking a proficiency examination or the advanced course.

We would get as high as 125 for proficiency exams and five or six sections of students in the advanced course. Of the proficiency exams about 10 percent would pass. Those who failed would be put in the advanced course or the beginning course depending upon the score they made.

A few years ago this program had to be dropped because of the lack of candidates. The number of students having even two years of drawing has dropped to about 5 percent.

B. Segregation of Descriptive Geometry Classes on a basis of ability. We have tried this twice. The first trial many years ago was considered by the staff to be a failure and was discontinued. The second attempt was more successful due to more careful planning and a better program of study. It was tried for two years with six sections each time.

Advanced classes were held to an enrollment of 15 students each while regular sections were about 25 each. Even so the instructors of the advanced classes got a real workout because the students had special and different problems. This experiment was carried on for the past two years and is being repeated again this year.

C. The "Lookie method". I think you recognize the method even though the misleading advertizing slogan used to promote it is not mentioned. You may remember that this method throws away the planes of projection entirely and is in no sense equivalent to the auxiliary method which many of you use. Without planes of projection there can be no quadrants and the relative position of views must be based on rule of thumb. This takes away whatever mathematical basis there may be for drawing. We felt that in our teaching we should adhere strictly to rigorous third quadrant projection with a sound mathematical basis for projection. This involves two fundamental principles in addition to right angle or orthogonal projection.

1. The plane of projection is always between the object and the observer.

2. The plane is always rotated away from the object. Both of these principles are specified in the American Standard Y 14.3-1957.

These principles are adhered to through the first and second auxiliary views in our teaching, and we believe them to be simple and effective.

True enough, after our students are thoroughly indoctrinated so that they know what they are doing, other reference planes such as a plane of symmetry parallel to one of the planes of projection may be used. We do use them, where it may definitely save time in moking drawings. We do not place them behind the object or below it just to be different and confusing.

We think that subsequent history has proved our decision to have been right. Third quadrant projection is now the basis for not only the American Standard but the Canadian and British Standards as well and was the basis for unification of these three Standards in the ABC Conference on Drawing Standards, October, 1957 at Toronto, Canada. Without planes of projection one cannot intelligently discuss first and third quadrant projection, conic, and axonometric projection.

D. Simplified Drafting. This scheme for cutting the costs of drafting was also considered carefully and the radical portions rejected. We have accepted only the portions of simplification authorized in the American Drafting Standards Manual. These are not insignificant. The most prominent proponents of Simplified Drafting, do not advocate the use of their practices in the classroom. They agree that an understonding of correct theory and standard conventions are essential before short cuts are begun. By analogy stenographers learn correct English before they learn shorthand. So it should be with the Graphic language.

E. Graphics. The content of this term, in the frame of reference which this Division uses could be outlined as follows:

1. Engineering Communication or Graphics
   a. Engineering Drawing -- or Technical Drawing

b. Engineering Geometry
   1. Descriptive geometry
   2. Vector geometry
   3. Graphic statics
c. Graphical Computation or Mathematics
   1. Nomography
   2. Curve rectification and empirical equations
   3. Graphical calculus

We have been thinking in terms of these subjects a long time. Our experience goes back to 1939 when Professor J. Norman Arnold was an exchange professor with us, and we gave a course involving the first two items--Nomography and Empirical Equations. It was and still is an elective course requiring analytical geometry as a prerequisite. It wos taken largely by juniors and seniors. You will note that we are still following the consecutive pattern. We have not attempted to merge or introduce any of this material in the beginning Drawing Course. We do not believe it belongs there for the following reason:

> If this material is put into a beginning Drawing Course we then have a survey course with not enough time to learn anything well. I need not remind you that survey courses are not popular in engineering circles, and a hodge-podge survey course seems to be a sure way for elimination of the work. Three semester credit hours is below the minimum required to teach Engineering Drawing effectively, and courses should not be diluted to such superficial content.

IV. The Total Program

With this background we can now present a program which has been carefully worked out and tested through the years, and which we think is good. This is not to imply that many other programs may not be equally good for the situations which others must meet.

1. Required Courses

A. G.E. 101 Engineering Communication. 3 credit hours. This course is basic drawing, 6 lab. hours, 3 hours home work. A twenty minute lecture is included in this time for each new topic.

B. G. E. 102 Engineering Geometry (Descriptive Geometry) 3 credit hours, 6 hours lab., 3 hours homework. This includes a twenty-minute lecture each period.

C. G.E. 111 Advanced Drafting for Civil Engineers. 2 hours credit. (Dropped this year to make room for more undergraduate research work and socio-humanistics)

D. G.E. 112 Engineering Technology for Mechanical Engineers (Dropped this year for reasons above in item C.)

E. G.E. 221 Introduction to Engineering Design. 3 hours. A combination of G.E. 111 and 112 for general engineers.

2. Elective Courses

A. G.E. 212 Graphical Computation. 1 credit hour. Nomography, Empirical Equations.

B. G.E. 210 Industrial Production Illustration. 3 credit hours. Theory of all types of pictorial drawing plus methods of rendering.

C. G.E. 313 Advanced Methods in Engineering Graphical Computation. 2 credit hours or 1/2 unit.

D. G.E. 393 Special Problems-Graduate level- 1/2 to 1 unit.

E. G.E. 330 Industrial Standardization - not drawing only.

3. Other Courses

A. G.E. 106 Elements of Drawing for students in chemical engineering. 3 credit hours.

B. G.E. 107 Architectural Projection. Orthographic projection, intersections, shades and shadows-perspective. 2 credit hours.

C. G.E. 108 Shades and Shadows, Isometric, oblique, and perspective drawing. A continuation of G.E. 107. 2 credit hours. (Over seventy semester credit hours of drawing are required of all architects.)

D. G.E. 205 Applied Descriptive Geometry in Geological Problems. A required course for students majoring in geology. 3 credit hours.

V. Drawing Course Content

Of this program, I believe we are primarily interested in the first two basic courses which almost everyone gives in some form or another.

Basic Drawing Course. Our G.E. 101 Engineering Communication is a basic drawing course. It encompasses the following topics, not necessarily in the order named or of equal importance:

- Lettering
- Freehand Sketching
- Geometrical Construction (limited amount)
- Use of Instruments (almost entirely pencil work)
- Orthographic Projection
- Sectional views
- Shop Processes and Terms
- Auxiliary views (first auxiliary only)
- Fasteners (a limited amount)
- Dimensioning (basic)
- Limit Dimensioning (basic hole method)
- Complete working drawings
- Charts and Diagrams (simple kinds a student would use in a physics or mechanics report)
- Isometric (theory emphasized)
- Oblique (theory emphasized)

It will be observed that this course covers the essential tools for engineering communication; namely, shape and size description plus the conventional practices and graphical idiomatic expressions necessary for describing and specifying an engineering project. Note again that while we were among the first to offer a graphical computation course in the Drawing Department we have not diluted our basic drawing course.

VI. Engineering Geometry (Descriptive Geometry).

Our Engineering Geometry is at present straightforward descriptive geometry, though the title provides room for other types of geometry. In this program we have tried for a well balanced theory course with as many practical applications as possible. The following major topics are covered:

- Lines; parallel; perpendicular; intersecting. Vector diagrams as an application of parallel lines.
- Lines; True length; point projection; Angle between lines.
- Planes; Position of; parallel; perpendicular; intersections of; angle between; edgeview; true shape.
- Lines and Planes; piercing points; angles between.
- Skew lines; shortest distance; shortest horizontal distance, etc.
- Construction cones.
- Intersections; cones, cylinders, spheres, prisms, pyramids, etc.
- Development, transition pieces.
- Warped surfaces.
- Shades and Shadows, orthographic.
- Oblique projection theory.
- Perspective; one point and two point
- Shadows and Reflections in Perspective

As I have indicated previously, we try to observe what is going on in industry and in engineering education. We try constantly to evaluate what we are doing, to eliminate the less useful and do a better job of teaching on what remains.

Thus in our drawing course lettering has been reduced almost to the vanishing point, ink work is almost nil, fasteners has been reduced mostly to the methods of specification on drawings.

We have placed increased emphasis on the theory of orthographic projection, dimensioning and most of all on freehand sketching.

Likewise, in our engineering geometry course, we have changed from the classical Mongean Geometry to a strictly third quadrant and auxiliary view system of solution. Rotation methods are used only where they provide more simple solutions.

Currently, we are seriously studying the content of the descriptive geometry course, and we are questioning seriously the value to the engineer of the time spent on intersections and developments, particularly the latter.

One year ago, we experimented with six sections (out of about 36) by deleting most of the work in developments and a part of the work in intersections and substituting lectures and problems in nomography. Student reactions were favorable, and many have been asking to get into these sections. We are, therefore, for this year devoting the last six periods of the semester to nomography for all classes in engineering geometry. Intersections supply an excellent basis for thinking and reasoning in three dimensions, but the student should also be introduced to the functions of nomography. Time does not permit extensive coverage of all worthwhile topics.

If we are forced to make a change to hold our time allotment in the curriculum, we believe this is one area where the adjustment can be made with the least damage. It was with ideas of this kind in the background that we changed the name of our course from Descriptive Geometry to Engineering Geometry a few years ago, thus permitting greater flexibility.

VII. How shall they be taught?

The second phase of our topic is "How shall these programs be taught?". While planning the program, which we have just discussed, is an essential part of teaching, the following five topics bear more directly upon the subject.

1. Incentives for Study.
2. The Class Discussion.
3. Keeping the Class together.
4. Choice of Problem material.
5. The human element.

1. Incentives for Study. It can be safely assumed that students will not read their drawing text unless they have a compelling reason. This is particularly true of those who have had a little drawing in high school.

A. A well organized schedule. We should make it easy to study by providing each student with a well planned, well organized assignment schedule for the semester or quarter. From this schedule without reference to any other document he should be able to tell: 1. What text material he is to study, and, 2. What problems he is to solve and exactly when both are due. With such a schedule he can open his book and go to work. This simplifies work for the instructor too.

B. Home problems. Many of the topics which we all commonly assign may cover more than one day's work. A home plate is helpful with a problem covering the material to be studied and due at the beginning of the first class period for that subject. The student may need to refer to the text to solve the problem. It should be corrected and graded. Since the student may receive help at home the weight of this work in computing the final grade should be relatively small.

C. Short Quizzes. Short quizzes of approximately fifteen minutes in length may be given on the first class day when a new topic is assigned. A variety of questions may be used which may cause a reading of the text. The following types are currently used.

1. True-false
2. Multiple choice
3. Fill in blanks
4. Simple sketches
5. Identification of sketches
6. Meaning of terms.

These quizzes are easy to grade and if ten are given during the term the average is easily determined. This is work simplification for the staff.

D. Unit text assignment. The fourth is a unit text assignment found in one place in the text and covering one subject. This permits rapid concentration on the material to be studied. The course is then based upon a sound text program, and class problems should be chosen to illustrate the text and not the reverse.

2. The class discussion. When all of the foregoing things have been done there still remains a very real need for a brief, pointed discussion of the principles involved and emphasis upon the points which the instructor knows from classroom experience that students will not understand or perhaps may overlook. The discussion period permits student participation which is essential to hold interest.

A. Need for emphasis. For example, in sectional views many students will omit the visible lines behind the cutting plane or reverse the section lining on opposite sides of a full sectional view.

Students read but do not comprehend. They look at illustrations but do not see them. Repetition and emphasis by the instructor are necessary.

B. Use of slides to save time. The class discussion must be kept short. Time can sometimes be saved by the judicious use of slides. If the student is to make one or more drawings to obtain a third view from two given views, for example, he can be given a problem on a single sheet and the instructor can have a slide throwing this problem on the board so that he can at once begin the solution while the class follows him on their sheets.

In descriptive geometry when the more tedious and difficult portions are reached, a series of slides showing a step by step construction will be a great time saver and produce better and clearer results. As much time as necessary can be taken and the student can ask questions.

C. Movies. We have tried movies but found them time consuming. They are excellent, however, for shop processes. In other areas they usurp the functions and prerogatives of the instructor.

D. View-graph. This instrument can also be used to get work on the board quickly for class discussion.

3. Keeping the class together. This is almost axiomatic in descriptive geometry and in fact in all other subjects. In drawing, however, students are sometimes permitted to fall behind even though they are present everyday. Brilliant students are sometimes permitted to work ahead. Neither situation is conducive to the best teaching and learning process.

Keeping the class together simplifies instruction and makes it more effective. The problem is how to do it.

The first step is to assign problems of the proper length and difficulty. This can be done only by one's experience or by relying upon the experience of others in selecting problems of suitable length.

For the better students who get done early an incentive may be provided by excusing them when their work has been satisfactorily completed.

A second method may be found in the use of bonus problems which may be solved to insure a better grade. The one difficulty with both schemes is the tendency of brilliant students to hurry and thus turn in sloppy work. Only good class discipline can correct this.

For the slower than average student the method is simple. The problems are taken up finished or unfinished at the end of the period at which they are due. This system is very effective. It prevents dawdling and emphasizes the necessity for speed and a well organized approach to problems acquired by careful study of the text. With a reasonable exercise of good judgment, it does not unfairly penalize the student, once he knows that the instructor means what he says.

If one instructor is handling three sections with a total of from 60 to 75 men, this is the only way to keep his work load within reasonable limits.

4. Choice of problem material. With the plethora of workbooks on the market and the superabundance of problem material in many textbooks, it would scarcely seem necessary to say anything about this subject. There are, however, a few guiding principles which it would be well to note.

A. Problems should be an application or illustration of the text moterial assigned. They should not include extraneous material except that of a review character.

B. Problems should be of reasonoble difficulty for a beginner permitting him to apply the principles he is studying. Problems which can be solved only by a half dozen intuitive guesses bring only frustration, not learning, to the student.

C. A machine part which actually exists in an industrial product while desirable for motivation is not necessarily o good teaching device. Such parts usually contain too many items which cannot be covered in a reasonable assignment or class discussion unless the part has been simplified to eliminate them.

Even when problems have been limited carefully to one area, say orthographic projection, the first ones should be simple with those following more difficult, but never the puzzle type either in drawing or descriptive geometry. We are employed to teach--not to show the student how smart we are.

D. Variety. The fourth principle which I would set up is that problems should provide variety and interest. If, in teaching orthographic projection ond ouxiliary views, we always find the third view from two given views this becomes mentally nauseating. There are other types of problems which ore equally good.

Some instructors seem to think that making two or three views from a pictorial is too easy. This is not true. The concepts of showing plane surfaces in true shape foreshortened or edgewise are new and difficult to the beginner even from a pictorial view.

Some of the problem types which can be used are:

1. Given two views, draw the third.
2. Given two or three views, draw missing lines.
3. Given a pictorial, draw the necessary one, two or three views. This requires an exercise of good judgment.
4. A combination of o drawing and verbal description.
5. Make freehand pictorial sketches from two or three view drawings.

VIII. The human element

Our students are human beings and like all of us they have emotions, ambitions and desires for achievement.

While engineering ond science have chonged very much, the human leorning process has not changed. Learning new concepts still requires time for assimilation, practice in its application and enough repetition to fix the idea.

If we con so design our courses that the student gets a sense of achievement, a feeling of hoving leorned something new, we can build in him a sense of confidence which makes him eager to try the more difficult.

If, along with the criticisms which must be made, we can give a word of praise for good work, this olso builds morale. The poor student needs this encourogement more than others.

The instructor is olso a humon being and his workload in groding should not be excessive. The student, at some point, should learn that instructors are people and that late work and requests for special consideration add to their workload.

Finally, if each instructor treots his students as he would like to hove his own son treated by some other teacher, this will go a long way toward better teaching.

Drawing is a profession in much the same sense as surgery or dentistry. In each of these the major content is factual or scientific material which the individual must know. In each case also, a certain amount of high calibre manual skill is required to give expression to the knowledge. The surgeon or dentist must have a skilled hand, but manual skill would scarcely be recognized as the major portion of his training.

Drawing is also more analogous to mathematics than it is to the trades. Its content is almost entirely geometrical. In addition it contains many conventions which have become standard practice. It is these things which must be emphasized rather than manual skills.

R. P. Hoelscher
Journal of Engineering Drawing, May, 1943

GRAPHICS PROGRAM AT KANSAS STATE UNIVERSITY

By A. E. Messenheimer

In 1956, our Machine Design Department was made a part of Mechanical Engineering and was immediately informed that the Department was not in agreement with the way in which Drawing was being presented. Almost the first directive that we received was to delete Descriptive Geometry as a course from our curriculum and to embody its principles in their properly related places when teaching orthographic projections. It was agreed that we should aim to design a sequence of courses that would prepare a student to be capable of making and reading complete working drawings with a definite knowledge of the functional relationships of mating parts; to be able to do a respectable job in pictoral sketching; to be able to prepare data and show proper relationships on graphs and to have some training in the use of vectors. This above undertaking would require six semester credit hours, being taught three terms of two credit hours each. The courses are Graphics 1, Graphics 2 and Graphics 3. Our present program was started in the Fall Term of 1957 with Agricultural, Chemical, Industrial and Mechanical Engineering taking the entire package; however, the other departments did not apparently see fit to use that much of their one hundred forty-two hours, thus taking a lesser amount.

In our era of Science Education and Scientific Engineering, the courses are requiring more and more of the student. Beginning this fall, September 1960, our universities in Kansas that are teaching engineering are not allowing credit toward graduation in engineering for the courses of College Algebra and Trigonometry; the student starts his college mathematics with Analytics and Calculus. Engineering Graphics is a science, and when taught by first presenting the theory in advance of the application problems does not use the process of memorizing how to do a thing.

At Kansas Sate, all students that take Engineering Graphics are engineers except those students in Milling Technology who do take the full six hours. Since development of ability to visualize in three dimensions is paramount to the one who may succeed in the Engineering School, many students learn during the first semester that they may have chosen the wrong profession.

Since initiating our program in Graphics, Fall of 1957, about 70 percent of the beginning students successfully complete Graphics 1. With relatively few exceptions, where a grade is literally given to a weak student, they complete the remainder of our sequence and progress with enthusiasm. I do not infer that the 30 percent of fall outs were failures in graphics alone. Students have other difficulties, such as mathematics and chemistry, or they may have found out early that they did not have the ability, the aptitude and the interest to further pursue engineering education.

Each instructor is supplied with a syllabus of the course, as is attached in this report, and he is expected to follow it closely as to subject content. The problems which are suggested are only helpful to the new instructor and allow him academic freedom. But the student is protected in having all materials covered, and he will be prepared for the final examination which is given to all students at one time. We have not been concerned about changing workbooks nor student copying because of the small amount of grade allotted to daily plate work.

Since each Engineering Graphics student has been informed during registration to have his equipment at the first class meeting we start immediately with a lettering exercise. The attached sheet of instructions tells the students exactly how the class operates.

Who can say what an effective program in anything might be? In our opinion, we believe that we have developed a rather sound sequences of material and course outline, but after our examination in the Engineering School by the ECPD group, we find that, according to the examining professor, the Departments of Chemical Engineering and Industrial Engineering are spending too much time in the laboratories. Thus, they will reduce graphics to four credit hours, beginning September, 1960. Our Graphics Committee is in the process of rewriting the syllabus for each course, Graphics 2 and Graphics 3.

ENGINEERING GRAPHICS
Faculty Instructions

Do not over-extend the use of sheets from the workbooks so that important problems suitable for Graphics II and III are used. Do not forget the possibility of the use of sketching for daily work. It is the responsibility of the instructor to plan definite test, classroom and homework assignments.

SC refers to the Engineering Drawing workbook, Series C
S2 refers to the Geometry Workbook, Series 2
Y refers to the yellow sheets of Series 2
W refers to the white sheets of Series 2

This worksheet represents a weekly guide and it is expected that each instructor will make the necessary adjustments to keep on the weekly schedule. At least five short quizzes, at random times, of 10-20 minute length, covering reading assignments should be given to each class to encourage the text study. Final grades should be determined by rating the daily work 20%, quizzes 20%, exams 30%, and final exam 30%. A uniform final exam will be given to all sections at a scheduled period during final exam week. Course assignments and presentations are left up to the discretion of the instructor, but it is expected in all classes that the prescribed text and course content area be covered during the prescribed time. Homework assignments should consist of both reading and graphical exercises, with careful consideration as to appropriateness.

ENGINEERING GRAPHICS
Student Instructions

Prerequisite to Engineering Graphics I is Plane Geometry.

The course consists of two, one-hour and fifty minute periods of class work, and two hours of reading or homework per week. A ten to twenty minute lecture or shotgun quiz, covering the assigned reading material, may precede laboratory work except when the period is used for a scheduled examination. Problem sheets will be assigned during the period and will be collected at the end of each period, and all homework sheets will be due at the beginning of the next class meeting unless otherwise instructed. Each student will be assigned a desk for his use and will be expected to do individual work without the assistance of other students. The student shall not leave his desk without instructor's permission. The final grade will be determined as follows:

20% - daily class and homework
20% - shotgun quizzes (5 minimum)
30% - one and two hour examinations (5 minimum)
30% - final examination
100%

Smoking is not permitted on the third floor of this wing in the class room, hall or rest room.

(Editor's Note: On the following worksheets specific text and workbook assignments have been deleted.)

Instructor's Worksheet for M.E. 211,
Engineering Graphics I, Fall 1959-60

Week	Course Content Area
1	Organization; lettering, sketching
2	Lettering; technique; tangencies; use of instruments
3	Geometric constructions; one-hour exam
4	Theory of projection; notations, locating points and lines; true length of lines
5	Bearings; slope; cone methods; relationship of lines, parallel and intersecting
6	Perpendicular Lines; one-haur exam
7	Properties of planes; points and lines in plane; strike
8	Point of projection of line; line projection of a plane; dip; true size af plane
9	Orthographic views; two-hour exam (9 wks)
10 and 11	Isometrics and orthographics
12	Review; oblique projection
13	Auxiliaries
14	Auxiliaries; two-hour exam
15	Sectional views
16	Sectional views
17	Review; one-hour exam (sections)
18	Final exam week

Instructor's Worksheet for M.E. 216,
Engineering Graphics II, Fall 1959-60

Week	Course Content Area
1	Plane in true size
2	Plane figure on plane; test
3	Point where line pierces a plane
4	Test
5	Intersection of planes and locus
6	Test
7 and 8	Intersection of solids
9	Test
10 and 11	Perspective
12	Test
13	Angle line makes with plane; skew lines
14	Cone constructions
15	Test
16 and 17	Analysis ond application problems furnished by the department
18	Final exam week

Instructor's Worksheet for M. E. 310,
Engineering Graphics III, Fall 1959-60

All work in this course will be done by freehand sketching except for center-line as assigned by instructor.

Week	Course Content Area
1 and 2	Pipe drawings
3	Shop terms and processes
4	Theory of dimensioning; tolerances and allowance
5	Dimensioning and fasteners
6	Test
7 and 8	Detailed working drawing
9 and 10	Pictorial sketching and dimensioning of parts from assembly; drawings furnished
11 and 12	Orthographic detail
13 and 14	Charts-diagrams
15 and 16	Vectors
17	Review application problems
18	Final exam week

STUDENT WORK AND QUIZZES DISPLAY

Engineering Graphics Division - ASEE

Purdue University

June 20-24, 1960

The committee is eager to have on hand, at Purdue, a good display of student work and quizzes for examinotion by Graphics Division members. This year we would particularly like to have on display:

1. Student work and quizzes from Engineering Graphics courses of all types.
2. Examples of courses taught for non-engineering curricula such as light building, forestry, etc.
3. Material used in Junior-Senior courses in advanced graphics and graphical analysis.
4. Several graphics departments teach graduate level courses for industrial education departments. Also, we know there are graduate courses which provide teacher training for college level instructors. We want exhibits of this kind too.

To facilitate handling and prevent possible loss, display material should be in bound or assembled form. The exhibitor should transport it to Purdue. However, packages may be sent prepaid to Professor Satterley, Graphics Department, Purdue University, Lafayette, Indiana.

Please include a statement on or inside the cover indicating the number of hours per week, credits, and other pertinent data.

Co-chairmen: E. T. Ratledge - University of Wisconsin-Milwaukee
W. O. Satterley - Purdue University

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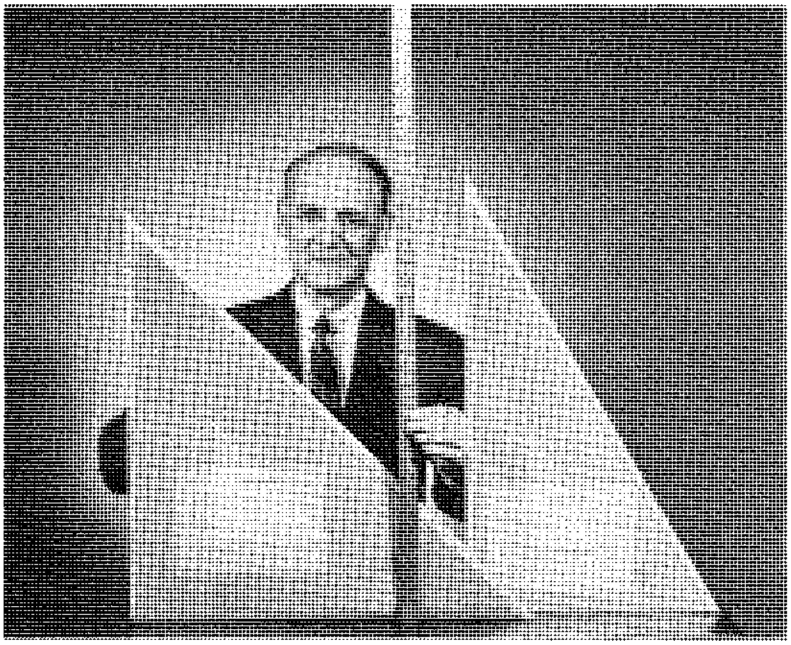

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Limits of graphical errors have become much narrower in many fields of industrial drafting and designing, and drawings and diagrams have increased in size. Dimensionally stable drawing surfaces of plastic and metal and improved reproduction processes have virtually eliminated distortion in reproductions. Accordingly, the requirements presented to a drafting triangle have often been beyond those satisfied by commercially available triangles or even obtainable in plastic drafting triangles made by conventional methods and equipment, in many instances common woodworking machines. Substantial changes in drafting triangles have been in the offing for a number of years.

Extensive tests of the properties of new materials became the first task for our engineers. Next, redesigning each specific size triangle was done on the basis of the properties of the new materials to avoid the pitfalls involved in merely reproducing in new materials the old designs developed over many years for the use of cellulose nitrate, a material of different properties. Thicknesses, construction and finish of guiding edges, corners, sizes and outlines of recesses, and other features of design had to be changed in order, first, to realize fully the advantages of the new materials and, second, to avoid problems resulting from different properties of the new materials. The increased degree of accuracy desired in the triangles could be ensured, only by designing and building special machines, a sizable project by itself.

As a result of such work of nearly seven years, we have made available for the profession its basic tool, the drafting triangle, that is better engineered and better made and at prices that are reasonable and fair and that even a student can afford.

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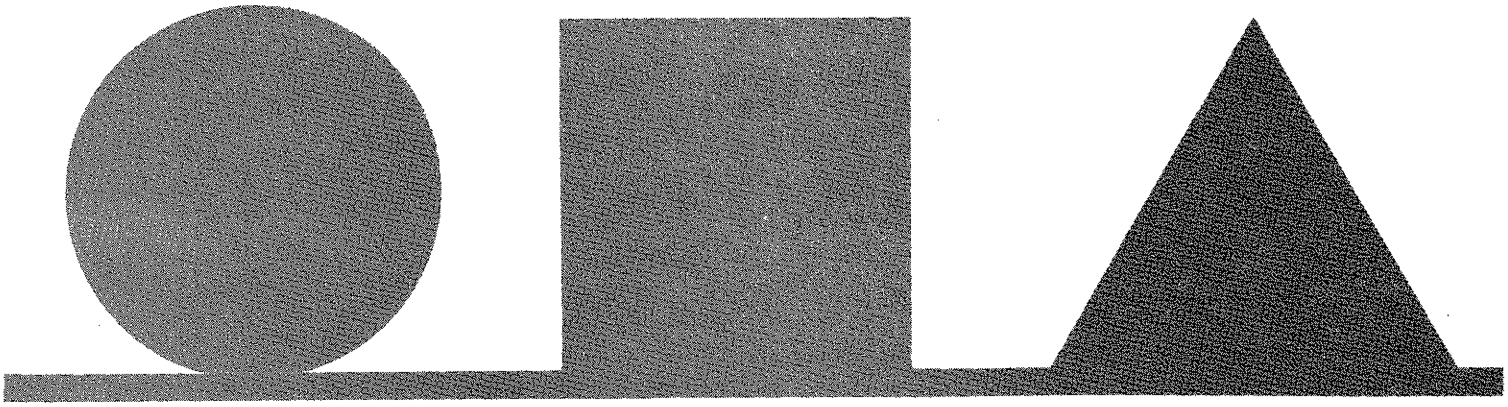

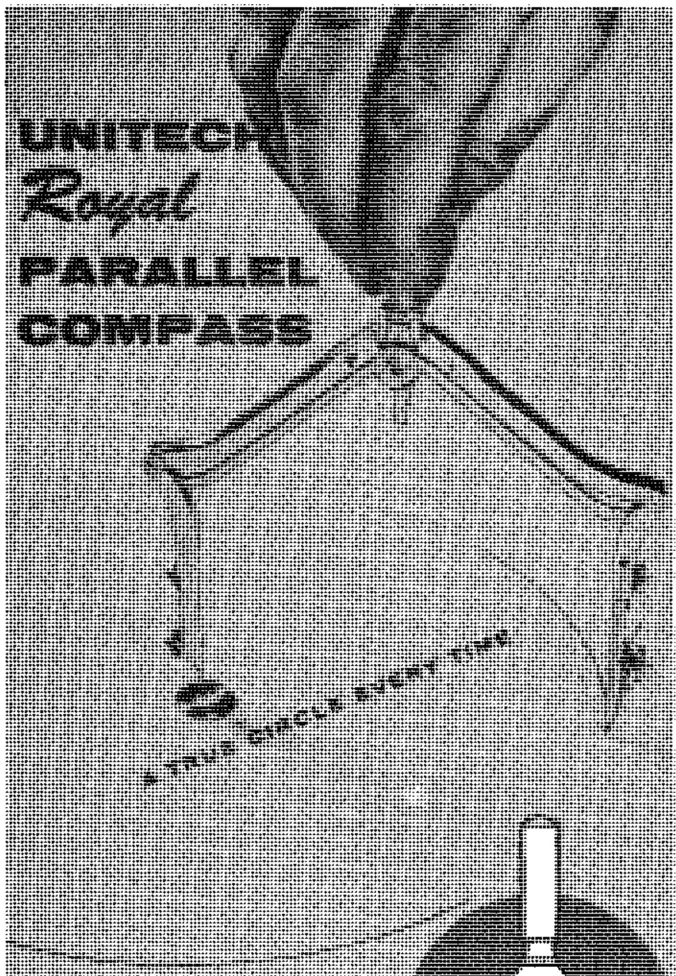

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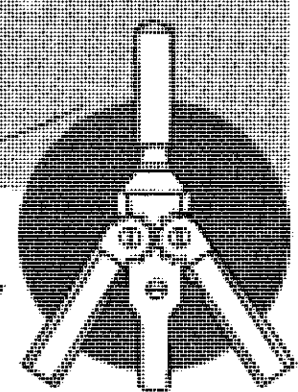

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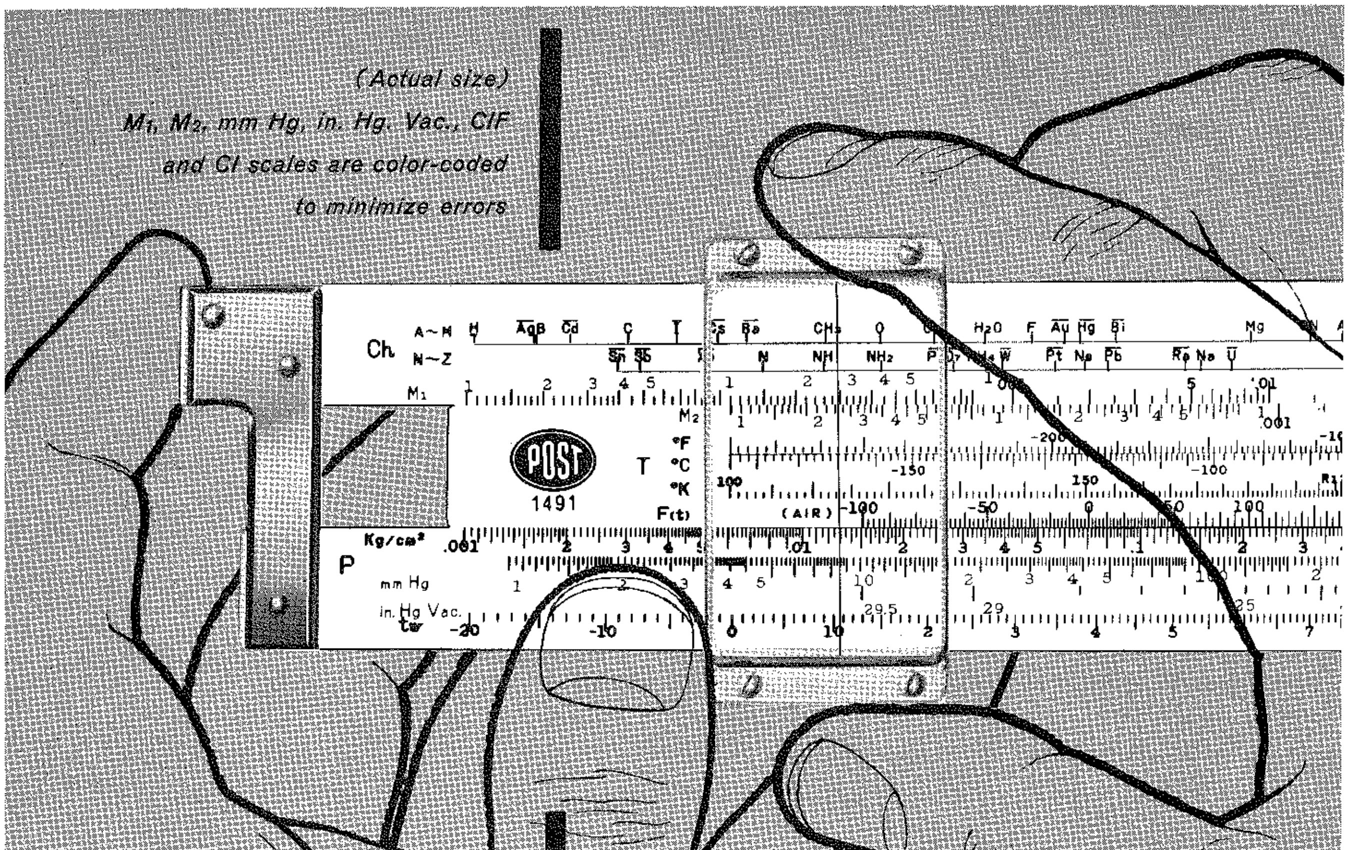

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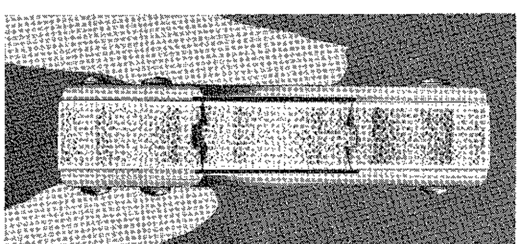

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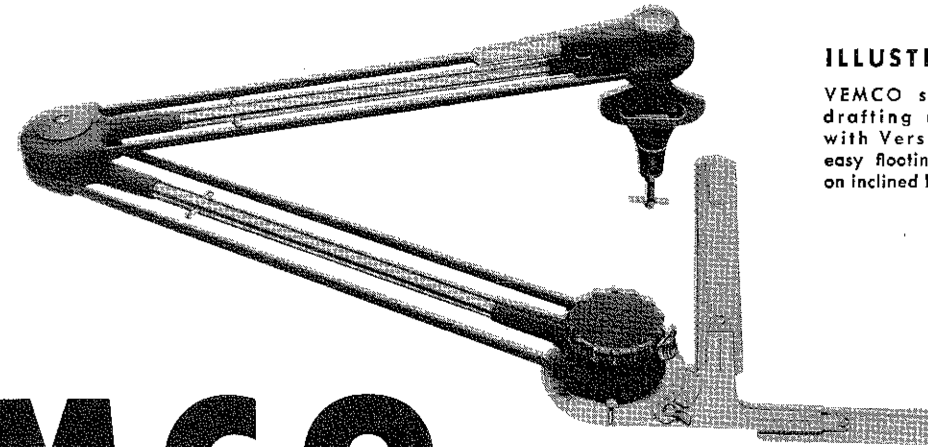

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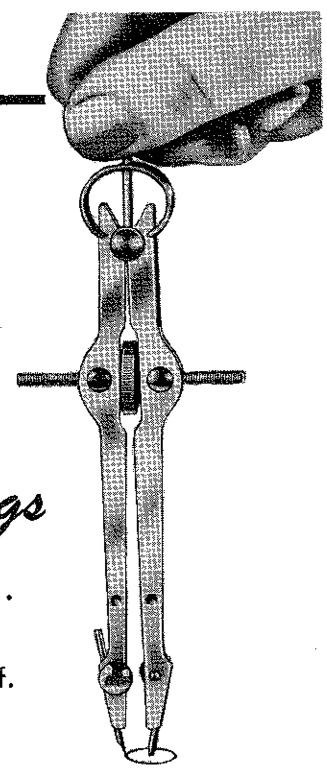

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