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OF THE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

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>
> "Esthetic value is the final step only in developing the product. First of all comes useful service.
>
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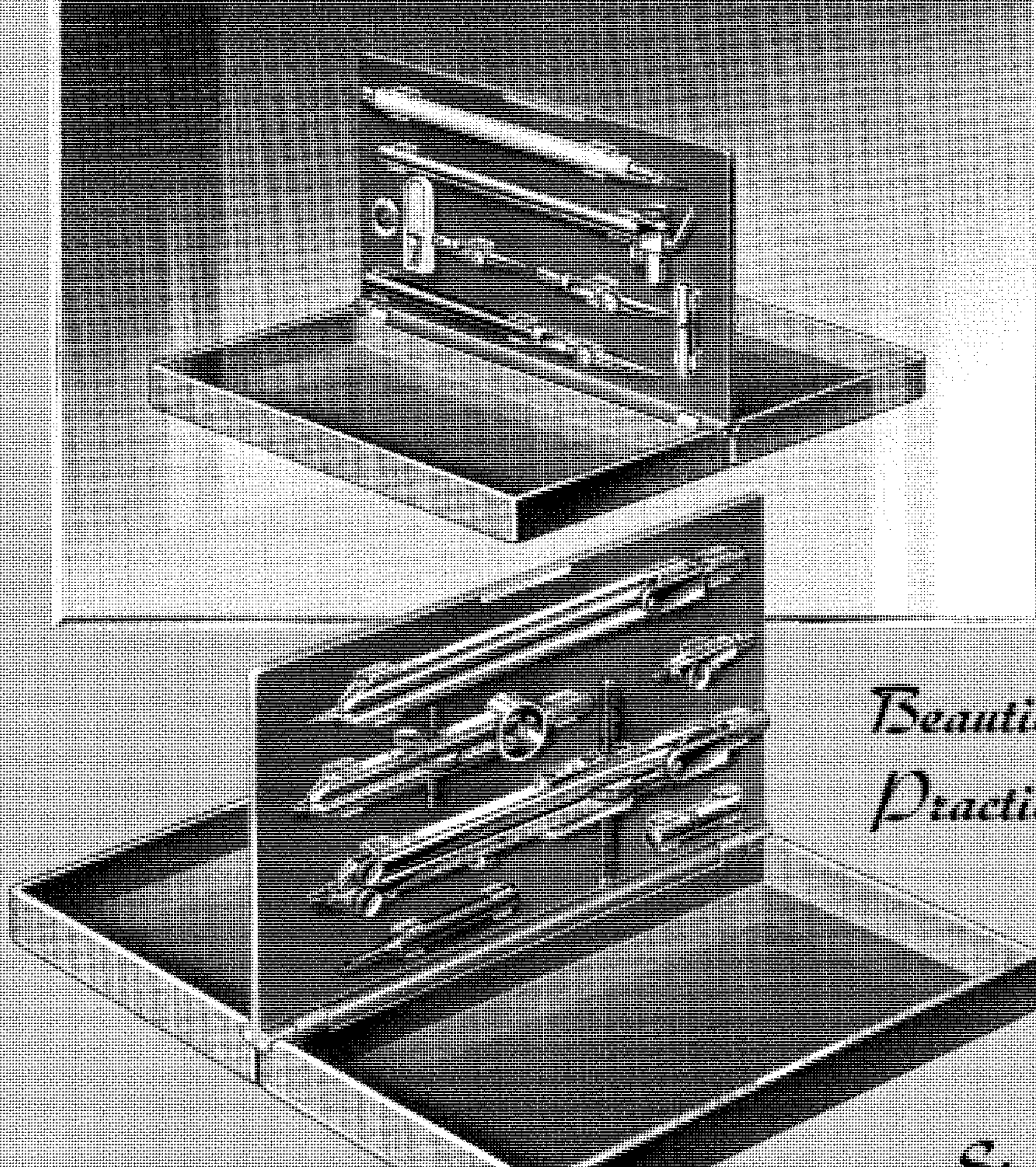

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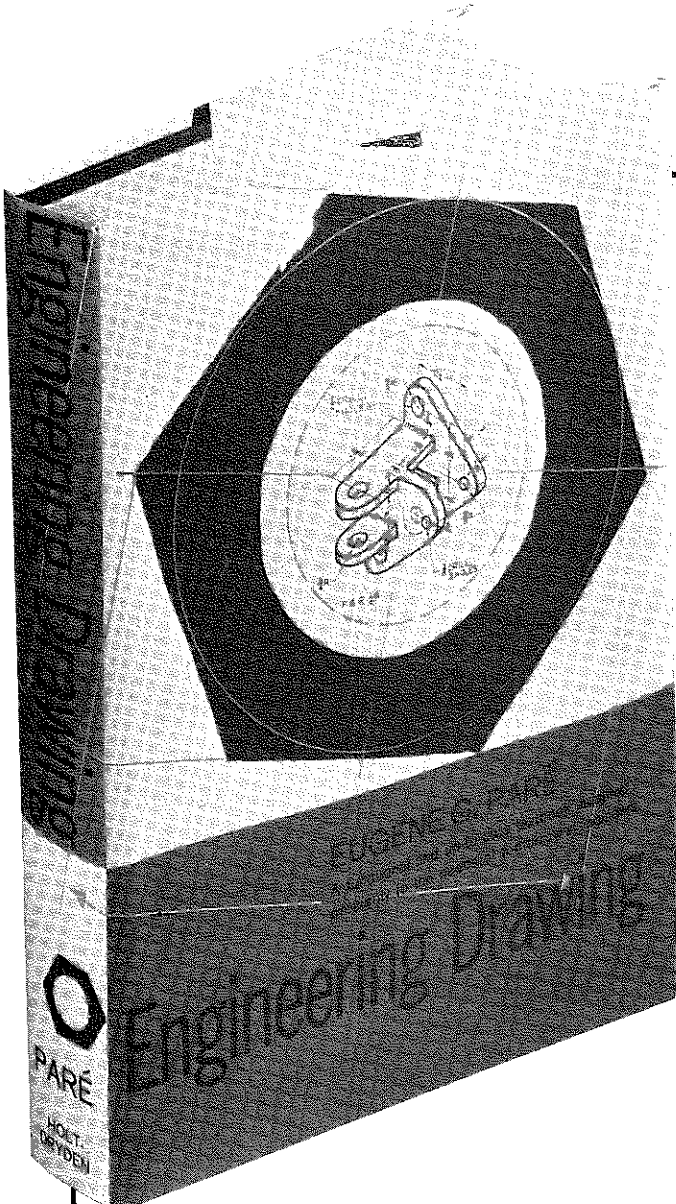

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CONTENTS

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GRAPHICS REQUIREMENT IN HIGH SCHOOL AND COLLEGE

The ideal arrangement for instruction in engineering graphics, whether in the USSR or the USA, would be an organized continuum of High School and College courses. The USSR is now perfecting such an arrangement (See the paper by S. M. Slaby in this issue of the journal).

In the United States, with few exceptions, about one-half of our entrants to colleges of engineering have not had a high school drawing course (See the paper by R. P. Borri, May, 1960 of this journal). Therefore, the traditional college graphics course has begun at ground zero, assuming that the student must begin at the most elementary level.

On the other hand, a mathematics department assumes that the student is proficient in arithmetic, basic algebra, and geometry, and the English department assumes that the student has a basic knowledge of English, grammar and spelling. In these departments of mathematics and English, placement tests are given to all college entrants to determine the status of each student. If the entrant does not meet a certain performance or knowledge standard, he must enroll in a remedial, non-credit course in mathematics or English, and succeed in this remedial work before he can proceed with his college work.

While mathematics and English have established more stringent requirements for college entrance, and therefore made their college courses begin at higher levels with more rigorous material, we in engineering graphics have weakened our course material by adapting to imposed reductions in time allotted for our courses. We have not set any standard of prerequisite performance in drawing for enrollment in the college course.

About one-half of our entrants in engineering colleges have had one, two, even four semesters of drawing in high school. Yet, the level of the complete first college course is often too difficult for such students to gain credit for the total course by means of proficiency examination. Therefore, the students with widely varying high school experience in drawing are placed in the same classroom with students who have had no drawing. Depending upon his high school experience, the student is subjected to a boring overlap of introductory material before his exposure to new materials begins in the college course.

One notable exception to this random state of affairs in pre-college drawing is the state of California (See the paper by A. S. Levens, Nov., 1960 of this journal). There may be other states or colleges with similar wisdom. In California, all college entrants are required to have had one year of drawing before college enrollment. If the entrant has not had such drawing courses before college entrance, he must pass a remedial course for which no college credit is given, before enrollment in the college graphics course. Most deficient students remedy the lack of prerequisite drawing by taking an intensive short-course in the weeks preceding the regular date of college registration. This policy is admirable.

A uniform policy in the U. S. of one year of drawing in High School for engineering college preparation would permit our college drawing courses to omit elementary training in the use of instruments, lettering, geometric constructions, graphs, principal views and other introductory material, and to begin the college course with a condensed review of projection fundamentals. With such a high school prerequisite, we could present college level material, beginning at a much higher point, and proceeding at an accelerated pace. Thus, there would be time to instruct in the important phases of graphics which merit college stature, including descriptive geometry with graphic-mathematical correlation, standards, tolerancing and dimensioning, multiple auxiliaries, intersections, developments, axonometry, perspective, programming for automated drafting, and nomography.

This is the kind of graphics program that has functioned so well in the state of California: One year in High School and one year in College of graphics for the engineering student. The standard of graphics instruction has not suffered; it begins at a higher level and maintains a rigor, and a challenge for all students.

We should consider starting our college courses in graphics at a much higher level, and providing an additional non-credit course for those students who enter college with no previous drawing experience. An alternate remedy would be to offer two first-semester courses in graphics. Both courses would receive the same credit. However, one course would have doubled instruction time; this would be the remedial course for those students without previous graphics instruction. The other first course would begin at a higher college level. Enrollment in one course or the other would be determined by a placement examination, similar to those now given in mathematics and English, to prove a certain level of proficiency in graphics. Deficient students would enroll in a remedial non-credit course, or an enlarged first course to correct such deficiency.

On this basis, we would hope that very few entering freshmen would find their first course in engineering graphics to be unchallenging or boring. The first course in college graphics could become quite intellectually stimulating, from the first lesson to the last, for <u>all</u> students.

And the second semester course could be even more enlightening.

IMPROVEMENT OF HIGH SCHOOL DRAWING COURSES

The paper by Robert S. Lang in this issue of the journal tells of the program recently initiated by one college to assist the high school teacher in improving his knowledge of graphics and his high school instruction. This is highly commendable.

In another university, the faculty has presented short course material, lectures and demonstrations in the larger technical high schools and at meetings of the state high school drawing teachers' association. A graduate course in drawing for high school teachers is now being taught, and a series of such graduate courses will be offered in cooperation with the college of education. Such courses will permit the high school teacher to gain a master's degree (and an increase in pay) based upon increased knowledge in his field--drawing--not just more philosophy and methodology of teaching.

We feel sure that many colleges of engineering in the United States are now initiating similar programs and courses in graphics to assist our colleagues in high school drawing instruction.

IGS

IGY meant International Geophysical year. IGS could stand for International Graphics Society. Other titles or groups of letters might be suggested. A society for graphics on the international level has probably been envisioned at various times in the past. Such a society was discussed by a few members of our division at that wintry meeting in Detroit not too long ago.

You could formulate your own statement of policy and objectives, regulations, and benefits relevant to such an organization. But one must ask himself, "Have I contributed enough to graphic science to merit membership or associate membership in such a society?" "Would I benefit from attending meetings of such a society and in what way?" "Have I accomplished anything new in graphic science that would interest such a group?" In the paper by S. M. Slaby (this issue) an international meeting of graphicists is proposed. Graphics workers of the world, unite!

POSITIVE VS. NEGATIVE

For years, we have heard the phrase "We must stop being negative, and be positive." The individual who would urge the positive approach and decry others as being negative has but one course to follow. Let him who would be positive, act. Positive action means innovation, invention, new geometry, new method. Words, whether the speaker fancies himself to be positive or negative, do not speak as loudly as action.

Each of us must ask himself "What have I done that is positive--new." "By their works, ye shall know them."

RESEARCH IN GRAPHICS

A paper was given at the mid-winter meeting which was so important that it will be shared with the entire society (A. S. E. E.) through the Journal of the Society. Watch for it soon. L. A. Nelson, Boeing Airplane Company, Wichita, is the author.

Automated drafting is not "just around the corner"; it's here. Are we prepared for it? Does automated drafting mean no more graphics instruction? Does it mean no more draftsmen, or engineers without knowledge of graphics? The answers are a repeated NO. Rather, the need for more and advanced graphics instruction is more acute.

How do you prepare for automated drafting? All of us must learn to provide mathematical-graphic information with which a computer-verifier-plotter can be programmed. Such programming is really a technician's job. Our task is to become knowledgeable in graphic-mathematic correlation. We must assume the formidable task of learning exact and complete mathematical equivalents for all aspects of descriptive geometry.

On page 13 of the November, 1959 issue of this journal is this startling statement: "In each of eight years, he (Professor Korst) studied mathematics...and descriptive geometry as major courses." This is not an unusual circumstance in European engineering education of yesterday or today. In European colleges, descriptive geometry is a graphic-mathematic correlation, often taught in a combined department of mathematics and descriptive geometry (see the paper by F. M. Hrachovsky in this issue of the journal). S. M. Slaby also emphasizes this graphic-mathematic correlation in his paper. This has been the rule, not the exception, in Germany, Austria, Hungary, and other European technical education.

The European professor in graphics and the European engineer would seem to be better prepared to proceed toward the higher level of programming shape description for automatic drafting. This is not a matter of learning only the technique of programming; rather, it is our concern to become mathematicians and graphicists embodied in one concept.

The computer with its vast memory wired to a verifier-plotter is not going to do all the drawing. It may not do half the drawing. But a significant portion of industrial shape description, especially in the missile, aircraft, and automative engineering, will be performed with the aid of the electronic brain and plotter.

We must fulfill our role to promote its best use. This is an opportunity, not a defeat.

GRAPHIC SCIENCE AND THE HIGH SCHOOL TEACHER

By Robert S. Lang

In the past few years, teachers of engineering graphics have been subjected to criticism from various evaluation and advisory committees. Some complaints are valid--some not. Not infrequent is the comment that too much time is spent on lettering or inking. This usually comes from an engineering educator who speaks from his own experience as a student some twenty or more years ago.

Other criticism is more valid. Drawing courses must be critically analyzed and revised to keep pace with the changing times in engineering education. As do other engineering areas, graphics must also improve. More and better graphics must be taught; the student must acquire the graphics which he will need in this era.

Lecture materials and texts must be revised, efficiency of teaching be increased, and more be demanded from the student in preparation and research. A good department of engineering graphics constantly revises its course content.

What can be done about better preparing the high school student for an engineering course of study? Interest has been aroused in the areas of science and mathematics, and public pressure is exerted on the high school to advance the teaching of these subjects. Through programs of the National Science Foundation and other agencies, mathematics and science teachers are acquainted with problems in their fields which are contemporary, not just traditional. Such modernization need not be restricted to the teachers of mathematics or science.

The competent drawing teacher can also make a worthy contribution to preparation for a career in engineering or science. Why is not this contribution more often attained?

One reason is that some high school teachers do not know the subject well. The high school drawing teacher may have a fine arts background (sometimes), an industrial arts education (usually), or an engineering major (rarely). He will often have much more college credit in education courses --how to teach--than credit in graphics--knowledge of his subject.

The high school drawing course may be offered for one term, one year, or up to four years. Classes may meet once a week or five days per week. The purpose of the course may be for college preparation or for a career as a draftsman.

It is no mystery that students come to engineering colleges with diverse and poor preparation in drawing. If the college is to teach more and better graphics, the high school drawing program must be improved. Random training in the high school impedes the advancement of college instruction.

The high school situation has been evident for some time, and little has been done about it. But now cooperative efforts are being made to help the high school teacher to fulfill his proper role in drawing instruction.

Typical of such efforts is the program of an eatern university. As a means of beginning a program of improvement, a conference of high school drawing teachers was called. This brought together teachers who were a loosely knit group with little contact between schools and no unified program. The conference provided the opportunity to exchange ideas between teachers, to meet leaders in the field, and to become aware of the college engineering graphics program. All drawing teachers within a thirty mile radius were invited to attend. Superintendents were asked to grant the teacher a day off from classroom duties.

The program began with talks to the entire group by three teachers in the field of drawing. A vocational education teacher spoke on "A Drawing Program for Vocational Schools." He had been president of the state Vocational Teachers Association and a teacher-trainer for the state Department of Vocational Education.

The topic of the second speaker was "A Drawing Program for High Schools." This was given by a young teacher with progressive ideas from a large technical high school. This school has a first class drawing program for both college preparatory students and for those entering industry or technical institutes.

Finally, a university professor of graphics spoke on "An Engineering Graphics Program at the College Level." A discussion period followed, and an hour for viewing displays. Drawing supplies, texts, and audio-visual equipment were exhibited, as well as student drawings from various high schools. Posted in the drawing rooms was typical work of college students, along with blackboard illustrations used in lectures.

At the luncheon, the Dean of Engineering spoke on "Education in Russia Today." The luncheon provided a social period before the afternoon session.

The afternoon program consisted of small discussion groups. Topics were "A Basic Drawing Program", "An Advanced Drawing Program", and "The Use of Audio-Visual Aids." A discussion leader summarized the conclusions of each group. The meeting closed with an assembly to hear and discuss reports of the group leaders.

The conference was a success, both for the host institution and for the teachers. It was the first such meeting in the area for many years, and was well attended by eighty teachers, representing some fifty high schools.

The teachers were enthusiastic about the ideas presented. All favored the formation of an active organization to continue the work which the day had begun. A committee was named to meet with two members of the university faculty, and to arrange for a meeting in the Fall.

No absolute conclusions were reached on the topics discussed, but a start was made toward thought and action on the problems of the high school drawing program. Issues will be resolved in subsequent meetings.

The visiting teachers appreciated the interest shown in them and efforts toward solution of their problems. They look to the college for leadership, especially in making clear what a pre-engineering drawing program should include.

The college must do more for the high school teacher of drawing. His vision must be widened, and his knowledge increased. He must become aware that drawing is more than making a front, top and side view. As minimum preparation for teaching, he should acquire a firm background in multi-view projection on a logical basis, and have some exposure to other fundamental topics.

Training programs in drawing must be initiated for high school teachers. Only through such programs can coordinated, sequential, and unified courses of study in the high school be achieved, worthy a place in the curriculum. Improved high school instruction will alter college courses in drawing. In some topics, the college course may begin where the topic now ends.

To help achieve these results, a graduate program of courses is offered through the College of Education. The first course is in "Technical Drawing and Descriptive Geometry". This gives the high school teacher a solid foundation for multi-view and pictorial work, as well as a reservoir of learning from which he can provide problems for his advanced and exceptional students. The course is not all new to him, since much of it deals with multi-view drawing with which he is familiar. The presentation of the subject matter is on a more scientific basis. Further, concepts of parallelism, perpendicularity, space angularity, intersections, etc. may be new to him.

A second course follows on "Advanced Graphics." Topic areas are graphical equivalents to mathematical operations in arithmetic, algebra, trigonometry, and calculus, analysis of space and plane curves having scientific application, presentation and analysis of empirical data and other topics.

With improved understanding from such courses, the drawing teacher can provide instruction to interest and challenge the high school student. His work could be integrated with that of the high school mathematics department, and he would gain prestige for himself and his department.

One high school teacher does have a drawing program which is accepted as a major subject for seniors. He has accomplished this by providing course content worthy of a major subject, content which competes with mathematics, physics, chemistry and other science subjects for the students' attention.

Few drawing teachers are permitted to offer such a course. All conscientious teachers would like to improve their courses, and to improve their own proficiency in subject matter--to gain in knowledge. The responsibility and the opportunity to help them lies with the college faculty in graphics.

In our efforts toward improving engineering education we must consider secondary, undergraduate and graduate programs as a unit. We must find out what the high schools are doing and help them in their engineering-preparatory courses.

The college in a large city may find ample demand from the high school drawing teachers within the city or suburban limits. Nearly all colleges can offer drawing courses for high school teachers. These can be on-campus courses, or off-campus. One university holds such courses within a radius of nearly two hundred miles. It is not unusual for the professor teaching such a course to fly to and from class in a university plane.

A well designed program of graphics instruction for high school teachers might be sponsored by the National Science Foundation as a summer institute. Units may be offered for graduate credit in cooperation with a college of education.

Improvement of high school drawing instruction is a major undertaking which requires the best efforts of all colleges to assist the high school teacher. It is a need, a challenge, an opportunity, and a responsibility.

Annual Meeting
of
Division of Engineering Graphics
American Society for Engineering Education

University of Kentucky
Louisville
June 26-30, 1961

REPORT ON COURSE CONTENT

Committee on Aims, Scope and Status of Engineering Graphics
Engineering Graphics Division, ASEE

This report is your committee's current thinking on topics of importance for basic engineering graphics courses. It is similar to the progress report distributed at the annual meeting in Pittsburgh, June, 1959, with an invitation to all Engineering Graphics Division members to offer suggestions or criticism.

Course Content for Engineering Graphics

I. Introductory Topics
   1. Freehand sketching techniques
   2. Instrumental techniques
   3. Lettering

II. Representation of Solids (Delineation and Symbolization)
   1. Pictorial drawing and sketching
   2. Multiview drawings
      (a) Principal views
      (b) Auxiliary views
   3. Conventional practices
   4. Graphic symbols and specifications
      (a) Screw threads
      (b) Fasteners and other standard parts
      (c) Piping
      (d) Welding
   5. Size Description
      (a) Dimensions
      (b) Limit dimensions and geometric tolerances
      (c) Economics of precision
   6. Working drawings

III. Descriptive Geometry (Spatial Analysis)
   1. Point, line, and plane relationships
   2. Method of revolution
   3. Curved surfaces
   4. Intersection of surfaces
   5. Development of surfaces
   6. Vector applications

IV. Graphical Analysis
   1. Basic geometric constructions
   2. Properties of the conics
   3. Graphical equivalents of arithmetic, algebra, and calculus.
   4. Harmonic analysis of periodic curves
   5. Graphic representation of data
   6. Empirical curves
   7. Functional scales
   8. Nomography

It would be futile to do justice to all of these topics in less than six credit hours, and even with six credit hours one would be hard-pressed to cover the listed material. If this list is used as a guide, institutions will have to be selective and pick those items that seem most important in designing a course to fit local conditions. Obviously the degree of emphasis on many of the items will depend on the time allotted in the curriculum for graphics and on the institutional objectives.

We have purposely omitted much detail that could have been added in the form of subheadings in an attempt to keep the outline as simple and flexible as possible. The topics are offered without suggestion as to order of importance, sequence of presentation, or organization of the material in either "separate", or "integrated" courses. It is also understood that none of this outline is to be considered mandatory.

Group IV, Graphical Analysis, contains many topics that are more recent and controversial. Some of these topics may be introduced in the drawing course, experimentally. Only in this way can they be evaluated fairly.

Committee on Aims, Scope, and Status of Engineering Graphics:

James S. Blackman
Carson P. Buck
Jerry S. Dobrovolny
Jasper Gerardi
Eugene G. Pare'
B. Leighton Wellman
M. McNeary, Chairman

June, 1960

TECHNOLOGICAL EDUCATION AND GRAPHICS IN CZECHOSLOVAKIA

By Frank M. Hrachovsky

Introduction

A brief report of this nature puts one to a disadvantage. It does not allow for completeness, and must include many assumptions. It has to start at the point of departure, which may not be altogether clear to the reader.

I will therefore proceed to examine technological education in Czechoslovakia from a historical perspective, describing its present status without editorial comment, because any comments or criticism would be lengthy and certainly very subjective. It appears that the primary significance of a report of this nature lies in its comparison value. In this respect it can be useful.

Some of the lesser known facts should be clarified at this point. All colleges and universities in Czechoslovakia are state controlled schools, and have always been so. The Prague Polytechnic Institute, which is the main topic of this report, has always been operated by either the provincial or state government.

Czechoslovakia itself may serve as a good example of what is occurring in engineering education in the Eastern World. First, it is the westernmost country of the Eastern block, and its educational system has been closely related to that of continental Europe. And secondly, it was the first highly developed and industrialized country with privately owned industry to change over to a socialistic economy.

It was my privilege to be able to talk to some of the more prominent men in the field of higher education in Czechoslovakia, for whose valuable assistance in gathering the data and other information I am very grateful. Among those deserving particular mention are Dr. F. Kysela, prorector of Prague Polytechnical Institute, Dr. F. Meduna, rector of Brno Polytechnical Institute and Dr. J. Kotalik, rector of the Academy of Fine Arts.

History

In 1957, the Prague Polytechnic Institute celebrated the 250th anniversary of the founding of an engineering school in Prague. When C. J. Willenberg began the first lectures in his own flat in the year 1707, the so-called Estate School of Engineering had nine students. The proportion of the Estates in the student body were set in this manner: 6 noblemen, 4 squires, 2 burgers. This ratio was not maintained because the interest in engineering studies was changing continuously. The school had a curriculum that included geometry, fortifications, water engineering and irrigation, and mechanics. The students also studied at the same time such subjects as mathematics, astronomy, mineralogy, chemistry, etc. at the Philosophical Faculty of the university.

For a time, at the end of the 18th century, the engineering school was actually absorbed by the Philosophical Faculty and remained under its jurisdiction until the year 1803, when upon the proposal of F. J. Gerstner the so-called Prague Polytechnic Institute was organized as a branch of the university.

Lectures in civil engineering were started in 1806, and this department for a time functioned as a section of the mathematics department. A three year curriculum contained mathematics and geometry in the first year, solid state mechanics and hydraulics in the second year, land and water structures, highway building and maintenance in the third year.

In 1815, the Prague Polytechnic Institute separated from the University and was established as an independent school. From this point on, the growth of the Institute was very rapid and some fifteen years later the curriculum was expanded to include railroad construction, steel and iron structures, bridges, and the theory of vaulting.

The chair of Descriptive Geometry was established in 1850, although the teaching of this subject is of a much earlier date. The importance of Descriptive Geometry in the engineering curriculum is best indicated perhaps by the fact that the chair of Mathematics was not founded until 1852. The year of 1863 is an important milestone in the development of Prague Polytechnic Institute. The school was organized into four major departments called "faculties." They were civil and highway engineering, architecture and land structures, mechanical engineering and chemical technology. Later, the curriculum was expanded, and in five years (or ten semesters) offered the following subjects: Mathematics, Descriptive Geometry, Topology and Graphic Statics, Surveying, Geology and Mineralogy, Survey of Chemistry, Statics, Dynamics, Hydraulics, Building Mechanics, and Stereotomy, plus subjects in the specialized disciplines of building, such as Highways, Bridges, Steel Structures, etc.

The number of students enrolled in the school constantly increased. From an original nine students, it increased to 106 students in 1806, and then to 381 in 1812. In 1869, 706 students attended the lectures, and this number grew to 4,190 in 1936, to 10,055 in 1956.

The teaching staff for more than a century was composed of no more than two men. In 1875, 13 professors, 2 docents and 10 graduate assistants were lecturing on 21 principal subjects. In 1936, there were 395 staff members; 91 were full professors, 6 associate professors, 106 assistant professors and 192 instructors and others. At the present time, the school is staffed by 173 professors, 726 assistants and lecturers and 38 instructors and technicians.

The growth of the student body, as well as the growth of the faculty and its stature, best reflects the rapid industrialization of the geographic region now called Czechoslovakia. This area was the most industrialized section of old Austria-Hungary, and even today represents the most technologically advanced section of the Eastern world.

This brief historical review has dealt exclusively with the development of the Prague Polytechnic Institute, because this was the first and only engineering school in the territory of Czechoslovakia until the last decade of the 19th century, when two polytechnical institutes at Brno were founded as separate schools. One used the German language for teaching and the other used the Czech language.

Thus the Republic of Czechoslovakia inherited from Austria-Hungary two Czech and two German Polytechnical Institutes plus one School of Mines. A new school of Agricultural and Forestry Engineering was founded in 1919, and the Polytechnical Institute of Bratislava opened in 1937. The German occupation soon dispensed with all institutions of higher learning, and they remained closed until the end of World War II in 1945. After this date, the growth of technological schools accelerated, and at present there are 15 independent schools of engineering.

Present Status

Socio-political changes that took place in Central Europe after the Second World War resulted in the integration of the Czechoslovak economy with the Russian system, and left a deep impression on the development of technological education in Czechoslovakia. These new and constantly changing concepts found an expression in two major reforms codified by the Public Law of 1950, and its revision of 1956.

The objectives of technological education are stated in the book "Technological Institutes in Czechoslovakia" (Vysoke Technicke Skoly v Ceskoslovenske Republice) by the following quotation:

"The principal objective of the institutes is to educate for the state highly trained and ideologically conscious technical specialists, who can actively and creatively participate in the building of the national industrial potential and economy and the building of the socialism in the country. To this should be added also the aid in the education of the technical personnel of less advanced peoples democracies, namely Albania, Bulgaria, China, Korea, Vietnam, etc."

The means by which this type of education can be obtained are by regular or full time day studies and external studies organized into the evening programs, correspondence studies, on-the-job courses, and specialized studies of individual disciplines.

All full time curricula are of 10 semesters in length, with two semesters comprising one 10 month school year from September 1 to June 30.

The full time studies are divided into a general program of approximately 6 semesters and specialized studies of approximately 4 semesters. The length of the specialized studies varies with the department and option. There are at present 60 faculties of 27 major divisions of engineering with additional options in each of those. This contrasts with 12 divisions before the reforms and reflects the high degree of specialization required by the present state controlled and operated economy.

Student selection is based wholly on the needs of current economic planning. The state planning board sets the quotas of engineers in each major division required five years later. On the basis of this quota and the rate of attrition, the number of entering freshmen is set for each individual school. Even with this planning, the quotas are not always reached because the potential student material is not of the desired quality.

The explanation of this phenomenon lies in student preparation at the secondary level. Here the original prewar 12 or 13 year schooling consisting of 5 primary and 7 or 8 secondary grades of Real High School (German Realschule) and Gymnasium, respectively were changed to 8 primary and 3 secondary grades of a so-called Eleven Year School. Reduction of time necessitated inclusion of teaching of Trigonometry and Analytic Geometry in the curriculum of the Polytechnic Institute. This arrangement fashioned after the Russian prototype, proved to be highly unsatisfactory from the standpoint of preparation for higher studies, and the first 12-grade schools opened their doors in 1959. This brought the length of preparation to the prewar level, but not necessarily to its educational level. Many of the fine features of the original semi-classical and liberal arts education were lost forever. The fast tempo of present day life, the stress on political education and practical training in industry (which parallels theoretical schooling) are factors which have reduced available classroom time considerably.

Based on this type and level of preparation, higher technological education took a realistic view of the situation, and extended the studies to 5 years, starting with the Freshman program. An outline of the program is shown in the chart below:

(Numerals are clock hours per week)	Semester I		Semester II	
	Lect.	Lab.	Lect.	Lab.
Mathematics*	4	5	4	4
ROTC	5	0	5	0
Descriptive Geometry	3	4	2	2
Marxism-Leninism	2	2	2	2
Physics	-	-	4	1
Engineering Drawing**	3	2	0	2
Chemistry	-	-	2	0
Russian	0	2	0	2
Machine Shop	0	2	0	2
Physical Education	0	2	0	2

*First semester - trigonometry; second semester - analytic geometry.

**Exactly translated "Elements of Machines".

Mechanical Engineering was selected as the most representative sample for comparison with our curricula. The subjects offered varied with each different type of engineering, and therefore the number of hours assigned to each will vary. The number of lecture hours in Mathematics, for example, increased to 5 plus 6 in the first semester and 6 plus 6 for Electrical Engineering decreased to 4-4 and 3-3 for Economic Engineering and so on.

Teaching of service subjects such as Mathematics, Descriptive Geometry, Languages, Economics, etc. is carried on by individual departments organized in each engineering division for this purpose. For example, Descriptive Geometry for Mechanical engineers will include the Kinematics of Plane and Space, while the same course for Civil Engineers will contain a section dealing with Topography. The same arrangement can be found in the Mathematics department and other service courses.

The requirements for graduation (diploma) are: successful completion of theoretical studies, concurrent industrial experience conducted under the supervision of the school, diploma project and the state board examination consisting of the defense of the diploma project before a commission of experts.

The diploma project consists of an actual technical project in the field of specialization. The problems are selected and assigned with the assistance of leading engineers in industry and are composed, in general, of the design which includes working drawings and a technical report dealing with processes and innovations.

Post-graduate studies are conducted on two levels. These are Candidate of Engineering Science, and Doctor of Engineering Science.

Graphics

The role of graphics and Descriptive Geometry in the engineering curricula of Czechoslovak technological schools was and still remains an important one. As stated above, the independent chair of Descriptive Geometry was established in 1850. The primary accent at the time was on graphic solutions as testified by the inclusion of Graphic Statics, Stereotomy and others. The number of lecture and laboratory hours of Descriptive Geometry included in the present day curriculum seems to be large, but the outline includes such topics as Projective Geometry, all types of Pictorial projections, Orthographic projection on one plane, Photogrammetry problems dealing with the surfaces of higher order, and Shades and Shadows. From this, it can be seen that coverage of the subject is not only more comprehensive in scope but also more intense in depth than in the U. S.

Perhaps the most interesting aspect of all of this is the fact that Descriptive Geometry remains as one of the keystones of general engineering education. The pressures to reduce the contact hours in drawing are evident, and machine parts drawing and other practical work of a specialized nature will be progressively reduced in the same manner as in this country. Why is it then that Descriptive Geometry remains? We have sought the answer from many sources, and the general consensus is that Descriptive Geometry is an indispensable tool for graphical solutions of engineering problems. Its value in training analytical thinking is generally recognized. Its important place in the engineering curriculum remains.

The relative weights of Engineering Drawing and Descriptive Geometry are best expressed by the number of contact hours in the Freshman year. Drawing - 3 lecture hours in the first semester, laboratory - 2 hours in the first and 2 hours in the second semester. Descriptive Geometry - 3 lecture hours in the first, 2 lecture hours in the second, 4 laboratory hours in the first and 2 laboratory hours in the second semester. While theoretical solutions form a basis for the Descriptive Geometry course, Engineering Drawing deals primarily with representation of solids, conventional practices and the use of symbols. Conventional practices cover topics we usually list as Sectioning, Screws and Fasteners, and Dimensioning.

The scope of Graphics in the engineering curriculum can best be illustrated by listing the subjects that have a drafting laboratory.

In Mechanical Engineering, consisting of 12 specialized options in the Fifth Year, the Machine Design option was selected as an example. The first four years, common to all options contain the following Graphics Laboratories:

		Semester Hours	
		Lect.	Lab.
Freshman Year	Engineering Drawing	0	4
Sophomore Year	Elements of Machines	0	4
Junior Year	Machine Design I	0	7
Senior Year	Machine Design II	0	11
	Total	0	26

The Fifth Year requirements vary from 0 to 14 semester hours in the Automobiles and Tractors option to 0 to 6 semester hours in the Fine Mechanics and Optics option. The Machine Design option selected in the above example lists 0 - 11 semester hours in the Fifth Year. This will total 32 to 40 semester hours of laboratory practice in Engineering Drawing and Machine Design.

The Descriptive Geometry laboratory, which deals with theoretical problems is not included in this tabulation. If this inclusion would be desired, the totals would read 38 to 46 hours respectively.

In addition to this, an extensive program of graphical applications is carried on in many other departments. Graphical solutions are used in the area of empirical equations, integration and differentiation. The curriculum of Industrial Engineering offers a separate course in Nomography and Graphical Solutions.

This report is intended to be a factual description of the status quo. For this reason I have omitted a discussion of the program of political and economic indoctrination carried on extensively in the first three years.

A total of 12 semester hours of lectures and

8 semester hours of discussion are offered in the first six semesters in the subjects of Marxism-Leninism and Political Economics.

It is hoped that even in this very brief form, this report may serve as a point of departure for the discussion of what is the meaning and intent of the immense changes occurring in the last decade in the engineering curricula in Czechoslovakia and the Eastern world, and what the impact of these changes may have on our engineering education, on our economy, and on our way of life.

May it also in the end serve as a basis for comparison in the work of our committees on curriculum development, and also be of some comfort and hope to our department heads.

* * *

Explanatory Notes:

1. The Faculty at a European University of a Polytechnical Institute could be equated with our school of specific engineering. Thus the Faculty of Mechanical Engineering refers to the College of Mechanical Engineering. Each Faculty consists of cathedras (chairs) or Departments teaching individual subjects.

2. Descriptive Geometry is always a part of the Department of Mathematics --whose official name is Department of Mathematics and Descriptive Geometry.

3. Engineering Drawing and successive courses in the Machine Design laboratory are taught by the Department of Machinery and Machine Parts.

Editorial

FOR THE AUTOMATED AGE

To adequately prepare the engineer of the near future to design and to program electronic-mechanical devices for automated graphics and automated production of engineering products, the following sequence of engineering graphics courses is proposed for the undergraduate engineering curriculum:

Course:	Semester Credit Hours
Mathematical-Descriptive Geometry I (Elementary)	3
Mathematical-Descriptive Geometry II (Advanced)	3
Mathematics and Graphics of Axonometry and Pictorials	2
Engineering Product Drawing, Standards, Tolerances	2
Freehand Drawing	2
Programming Shape Description for Drafting by the Verifier-Plotter of Orthographics and Pictorials	2
Programming Shape Description for Automated Production Machines and Testing Devices	2

The above program assumes one-year of secondary school graphics instruction in skills and fundamental considerations.

ENGINEERING GRAPHICS IN NORWAY AND THE USSR

By Steve M. Slaby

In the past few years the field of Engineering Graphics in the United States has been going through a process of evolution in its content and presentation, and we are well aware of what this has involved. The possibilities of expanding the concepts of graphics beyond that of communication and analysis have not been fully explored. Theoretical aspects of this area of knowledge have advanced slowly. In support of these opinions, I was granted a National Science Foundation Faculty Fellowship to do work in Engineering Graphics at the Norges Tekniske Høgskole (Norwegian Technical Institute) in Trondheim, Norway. In Europe and Scandinavia, a greater understanding of pure graphical thought processes exists. I worked with Professor Ole P. Arvesen at the Institute for a period of seven months, and also visited in the Soviet Union with persons in the field of Engineering Graphics. This paper relates experiences in Norway and the USSR, and attempts to correlate these experiences with our present situation in engineering education in the U. S.

The Norges Tekniske Høgskole was founded in 1900 by the Norwegian Parliament. It is a state governed and financed institution at the university level. Its administration is handled by a board consisting of a professor from each faculty and a council composed of all professors.

Requirement for admission consists of the matriculation examination (eksamen artium - similar to our Bachelor's Degree) with a mathematics major, or qualifying tests in mathematics and physics. In addition, twelve months on the job experience in industry or research is specified before admission to the Institute. Foreign students are admitted on equivalent credentials. Competition for admission is high, with only one-half of the qualified students able to matriculate because of lack of facilities to handle greater numbers. At the present time an ambitious plant expansion program is under way to partially alleviate this situation.

Tuition is free for all students. The total enrollment is approximately 1700 students. The time required to complete work for a degree in engineering is about $4\frac{1}{2}$ years.

Professor Arvesen has the degree of Doctor of Mathematics and is Head of the Descriptive Geometry Department. Approximately 280 students per year take the required engineering graphics courses at the Institute. All engineering students except those going into Chemical Engineering are required to take Descriptive Geometry. The various fields of engineering receive different concentration in engineering graphics instruction. For example, Mechanical Engineers spend a greater amount of time on machine drawing compared to Civil Engineers who spend proportionately more time on drawings related to their field.

Professor Arvesen felt that a study of Engineering graphics was essential to all engineers as a method of visualization and communication and as a background discipline.

In general, the required courses in graphics which involve Engineering Drawing and Descriptive Geometry are taken for two semesters (academic year) at 4 contact hours per week. The time spent by the students on outside work and preparation for these courses amounts to approximately 14 hours per week during the first semester and about 5 hours per week during the second semester. This is equivalent to about 9 semester credit hours by U. S. standards. The method of presenting the subject matter is similar to ours with the exception that the lectures are held separately from the actual laboratory session. The laboratory session is strictly a work session with assistants on duty to supervise and help the students.

All papers are not graded - and those that are are graded by assistants. Professor Arvesen only grades the final examinations which are then independently graded by an impartial and qualified "censor" from another institution to guarantee a fair evaluation of each student's work. The final grade in the course is based solely on the final examination.

The course in Descriptive Geometry is introduced by the concepts of central projection, parallel projection, including simple perspective and axonometry, normal projection, and some concepts of projective geometry. The formal descriptive geometry principles are presented in the first quadrant using for the most part the Mongean system of projection. The next area covered involves axonometry and is broken down into subdivisions of normal axonometry, various axonometric systems such as isometric, trimetric and axonometric projection.

A significant part of this course includes the concepts of geometric transformations through projective geometry and a section on spiral lines and warped surfaces. This leads to a consideration of geometric solids and their properties handled through normal projection techniques and includes surface development.

A major section of the descriptive geometry courseis devoted to the intersection of surfaces and geometric solids.

An introduction to shades and shadows as well as perspective projection is presented with a section of the final portion of the course devoted to conformal mapping and nomography.

The significant feature of the entire course in descriptive geometry is the fact that all through the course a graphical correlation is maintained and developed along with its mathematical counterpart. The students are expected to be well versed in this graphical-mathematical correlation. With graphical-mathematical correlation, the discipline attains a strength and stature which overshadows most of the undergraduate courses in the U. S.

Graphical-mathematical correlation increases the growth potential of the field we call Engineering Graphics. This is reflected in the research and writing of Professor Arvesen. One example of his work is a paper presented to the Royal Norwegian Scientific Society in which he developed a graphical presentation of an abstract mathematical concept involving the 4th dimension (published in November, 1960 issue of our Journal of Engineering Graphics). A whole new area of engineering graphics can be explored by such an approach. The descriptive geometry course presented by Professor Arvesen is basically abstract and theoretical; practical applications of descriptive geometry are not stressed.

The final examination in this course consisted of three problems: (1) Design of a nomograph with accompanying scale equations and determination of scale divisions; (2) Intersections of a cone and cylinder; (3) Consideration of the properties of an ellipse, points thereon, determination of slopes of tangents at given points. The final examination period lasted from 9:00 AM to 3:00 PM.

Contacts in the Soviet Union were with the Academy of Construction and Architecture of the USSR. The deputy director of the academy introduced me to Professor Zelinin of the Polytechnic Institute of Moscow, who is a Professor of Engineering Drawing and Descriptive Geometry. Our discussion dealt primarily with Descriptive Geometry, and it was learned that a number of programs were in operation in this field and in other aspects of Engineering Graphics. A brief summary of these programs follows:

One program dealing with the elements of Descriptive Geometry was being developed for presentation at a level equivalent to our high school. This program would involve one hour per week of instruction during the 7th and 8th years of school and 2 hours per week during the 9th year of school. Through experience, it has been evident that the students entering Russian engineering schools are not able to move fast enough in the area of spatial relationships and descriptive geometry at the college level; a similar difficulty is evident in the U. S. Professor Zelinin feels that an introduction to some concepts in this area of study before college will be helpful in improving the rate of learning and comprehension of the engineering students. This program begins with orthographic projection in the engineering drawing context, and also includes pictorial projection, sections, developments, revolution, elementary geometric solids, intersections, auxiliary views, conic sections, dimensioning, fasteners, shades and shadows, and a few projective geometry concepts correlated with mathematical expressions.

Another program which is in progress is one which is conducted on the university level for technical and engineering students. This is a general course in descriptive geometry which involves 2 hours of lecture and 2 hours of laboratory for a period of 18 weeks. The major topics covered are: (1) Concepts of perspective projection; (2) Elements of projective geometry; (3) Planes of projection and their relationship to coordinate axis systems; (4) Line-plane relationships handled graphically and mathematically; (5) Intersections; (6) Revolution; (7) Curves - solids - surfaces - and developments.

Another large area of activity in the field of Engineering Graphics in the Soviet Union is one involving extension and correspondence courses in technical university subjects. The program is general in character, and similar to our average Engineering Drawing and Descriptive Geometry courses.

On the theoretical level some interesting work has been done in what is entitled "homology" --a study of degrees of shades and shadows. In addition, work in graphical analysis and representation of n-dimensional concepts has taken place. Descriptive geometry principles have also been applied to the solution of chemical equations.

In general, Soviet Union work in Engineering Graphics is of a high caliber, with mathematical correlation included. The impressive aspect of this field of study was that the Descriptive Geometry educational and scientific groups in the USSR are quite active. For example, every 3 weeks a Descriptive Geometry Seminar is held in Moscow. To this seminar come engineering graphics people from all over the Soviet Union (flown by jet planes), and these seminars have resulted in many new and interesting developments in the field of Descriptive Geometry. It was suggested by the Deputy Director of the Academy of Construction and Architecture of the USSR that perhaps an international conference of Engineering Graphics people could be organized with the purpose of exchanging ideas in fields such as Descriptive Geometry.

The Division of Engineering Graphics has been one of the most active divisions in the American Society for Engineering Education. However, not many of us have attempted to originate and develop new concepts in graphics as has been done in Norway and the USSR. Few have made efforts toward the development of graphics as a science, too few for an outstanding group such as this.

For our profession of teaching in engineering graphics, working conditions have not been most conducive to scientific development. Reduction of instruction time in engineering graphics does not permit the inclusion of advanced concepts and graphical-mathematical correlations. Many engineering graphics teachers must maintain heavy teaching loads--up to 30 contact hours per week--exclusive of paper grading, record keeping, lecture preparation, and the generally expected committee and extra-curricular college activities.

Compared to teaching loads in engineering graphics, teaching loads of faculty members in other engineering departments, in liberal arts, and in Norway and the USSR, are markedly different. Such teaching loads vary between 6 to 15 contact hours per week, and certain projects are handled by paper graders and assistants, not by instructors.

Professors with reasonable teaching loads and nominal paper work have time to think.

To initiate and progress in research, the faculty member must have time to think and to meditate. Such time is amply given to the professor in Norway and Russia. The administration at each of our engineering colleges should adjust teaching loads and conditions for the faculty in engineering graphics to promote scientific development in graphics. Under such permissive conditions for thought and research, the teacher would be obliged to prove himself with accomplishment in his field. Whether such conditions exist or not, some very busy individuals have done creative work in various sciences.

We must raise the intellectual level of our publications if we are to sustain our field. Our publications must also find their way not only into journals devoted to engineering graphics but also into mathematics, physics, and the various engineering journals.

We should invite persons from other fields and countries to contribute to our engineering graphics journals. We should encourage and develop cross-fertilization of ideas by instituting exchange programs. Visiting foreign colleagues would teach engineering graphics in our colleges while we would have the opportunity to teach in their schools. We should consider organizing frequent national seminars in Engineering Graphics as is done in the USSR. We need originality in our ideas and concepts--and originality can come only from diversity of experiences and thought.

If you examine any textbook or journal in mathematics, physics or engineering you will usually find rather neat presentations of graphic solutions and analysis. While some of these solutions have been derived and presented in collaboration with men in our field of graphics, we have not been vigorous in initiating new methods of graphic analysis and presentation. We have been engrossed in the teaching of graphics, for as much as thirty contact hours per week, and we have developed the teaching of graphics into a precise science. But with concentration on teaching, new areas of growth in engineering graphics have been neglected.

Experiences here in the U. S., in Norway, and in the Soviet Union support the following conclusions. We must attempt to develop graphics as a total concept similar to that of mathematics. Engineering graphics is more than a means of communication of engineering and scientific ideas. Graphics is a thought process just as valid as the mathematical thinking process, and potentially just as powerful. The graphicist must think in terms of totality, integrating graphic science with all fields of engineering, science and mathematics.

No individual can become an authority on all aspects of graphics in all research, development and application. But each of us must contribute to the advancement of graphic science by work and research with other fields of engineering and science. By the combination of our individual endeavors, the science of graphics can be developed into a science of unlimited scope.

NOMOGRAPHY AWARD

The award of $100.00 for the best engineering nomograph published between January 1, 1960 and December 31, 1960 was generously donated by the International Harvester Company.

This award, together with an appropriate certificate, will be presented to the winner of the Fifth Nomography Competition at the ASEE Convention in June, 1961.

Richard G. Huzarski
Chairman
Nomography Committee

TRIMETRIC PROJECTION

ANOTHER REASON AND ANOTHER WAY

By J. R. Holmes

There is a continuing search for better ways of solving problems in science and engineering. At a recent program of our society, a new method for drawing orthographic and isometric views was given*.

With industry increasing its demand for pictorial drawing and more efficient methods, those who wish to acquire skill in this direction should have access to both old and new methods. Due to the present trend of limited supervised time in college drawing courses, students may have to increase their knowledge of drawing and pictorial presentation outside of class instruction.

Although perspective and axonometric drawings are widely used in drafting rooms of industry, they are usually omitted in the brief drawing courses so many colleges have been obliged to adopt. Theory and procedures for such drawings are introduced in most current texts, at least in elementary form.

In a recent study requiring the construction of many trimetric drawings of houses and school buildings, the author used a rearrangement of the old principles not only to eliminate effort, but to help overcome the problem of limited size in a small layout area.

Various trimetric views were used in determining the approximate direct solar heat load on the buildings at different times of the day and during different seasons of the year. The views provided the building's sun-exposed surfaces as areas projected to a plane perpendicular to the solar beam. The product of a building's projected area in square feet and the amount of sun heat being delivered at the moment in BTU/square feet was the approximate direct solar heat load.

An instrument called the Heliodon[2] can be used in making such studies. The building's projected area is determined by the shadow of a scale model of the object cast on a plane at right angles to the sun's rays. This area may be determined by calculation, by graph paper with square foot divisions at the same scale of the model, or by the use of a planimeter. The amount of solar heat delivered from different sun altitudes may be found in a table compiled by P. Moon which is usually printed in air conditioning textbooks and in the American Society of Heating and Air Conditioning Engineers' Guide.

The author's trimetric projections were made directly from quarter size drawings of the plans of the buildings, using the procedure described below for the simplified objects of Figures 1, 2 and 3.

* "A New Drawing System", Wayne L. Shick, presented at the annual meeting of A. S. E. E., Engineering Graphics Division, Purdue University, June 23, 1960.

2) Physiological Objectives in Hot Weather Housing. United States of American Housing and Home Finance Agency, Washington 25, D. C.

Assume that in all three figures, the arrow XY represents the solar beam properly related to the structure[3].

Figure 1 shows a conventional oblique view in the direction of arrow XY. It also contains a trimetric projection constructed by using offsets a, b (and others) from the line RP (Reference Plane). Figure 2 shows a prism where the pictorial projection is drawn under the top view. If this arrow represented the solar beam from a position where the solar heat delivered to each square foot on the projection plane is 200 BTU/H, the direct heat load on the building would be the product of 200 BTU/H and the number of square feet represented within the outline of the drawing. The total amount of heat impinging upon a small residence can be on the order of 250,000 to 300,000 BTU per hour. Figure 3 shows the procedure that provides the trimetric drawing. The plan is turned at an angle so that the arrow XY is vertical (ortho-T-square) on the sheet.

On tracing paper placed over the plan vertical lines are drawn through the corners. In the side view, ground line (HRP) and the roof level (H_1) only are needed. Arrow XY is located at the desired angle. Draw lines RP_1 and RP_2 in the two positions as shown. To determine position of Corner A above RP_1, first locate this corner in the side view by drawing sight line from A_H to A_R. Use offset "a" to locate corner A. The side view need not be completed because after a point is properly located in the side view only the offset-distance is needed to find the point in the axonometric view.

This procedure is not claimed as a discovery of new principles, because it is simply a convenient rearrangement of relations that probably many others have noted. However, it is hoped that this method may prove useful to someone and may be recognized as another effort in the search "to find a better way."

3) Solar Control and Shading Devices, Olgyay and Olgyay.

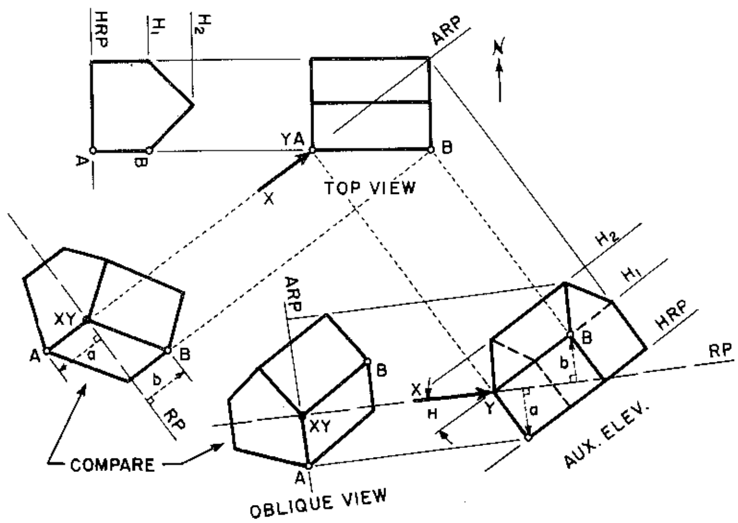

FIG. 1

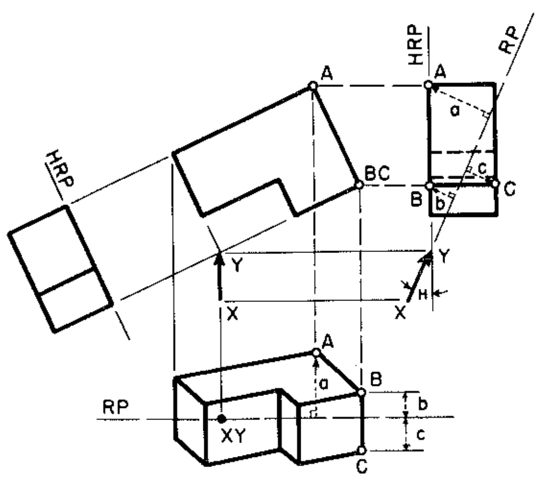

FIG. 2

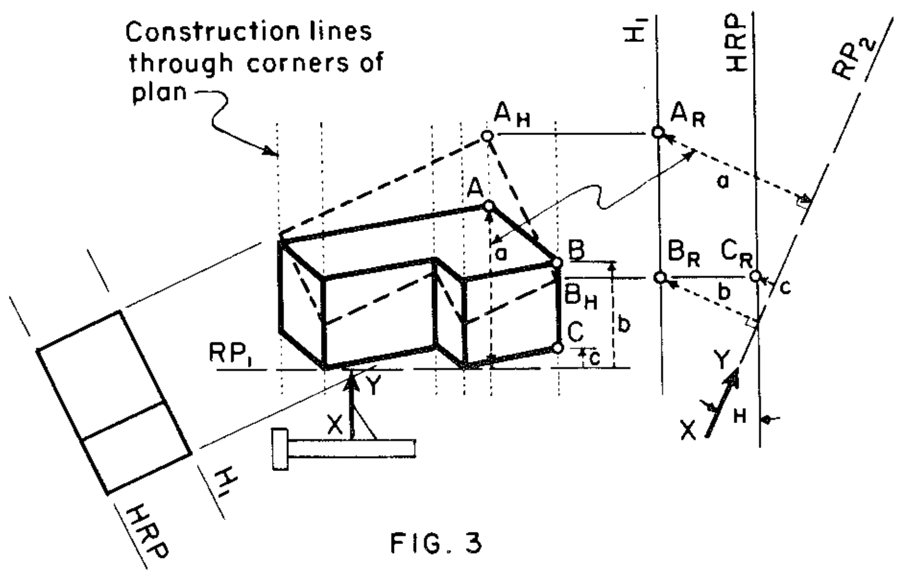

FIG. 3


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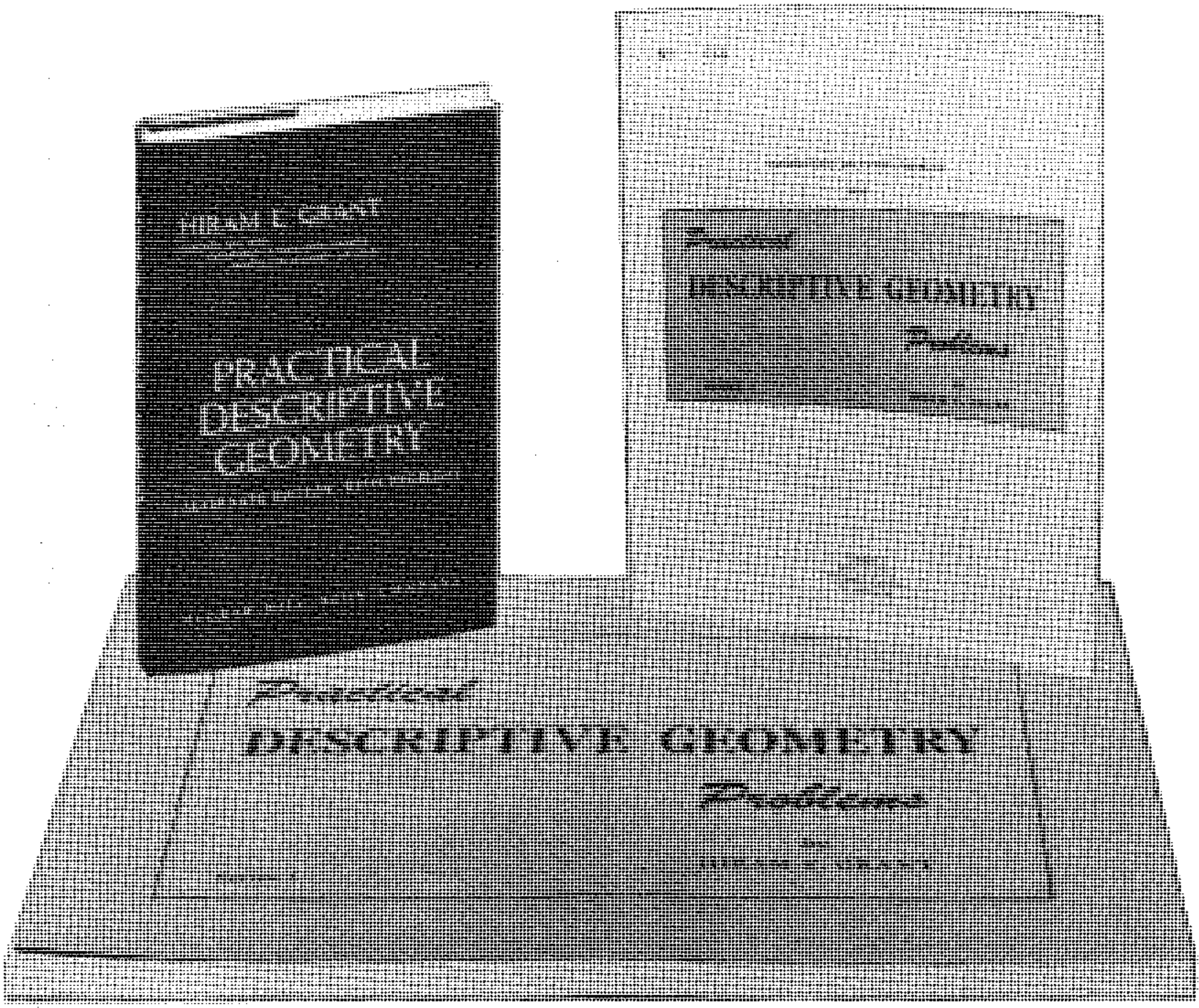

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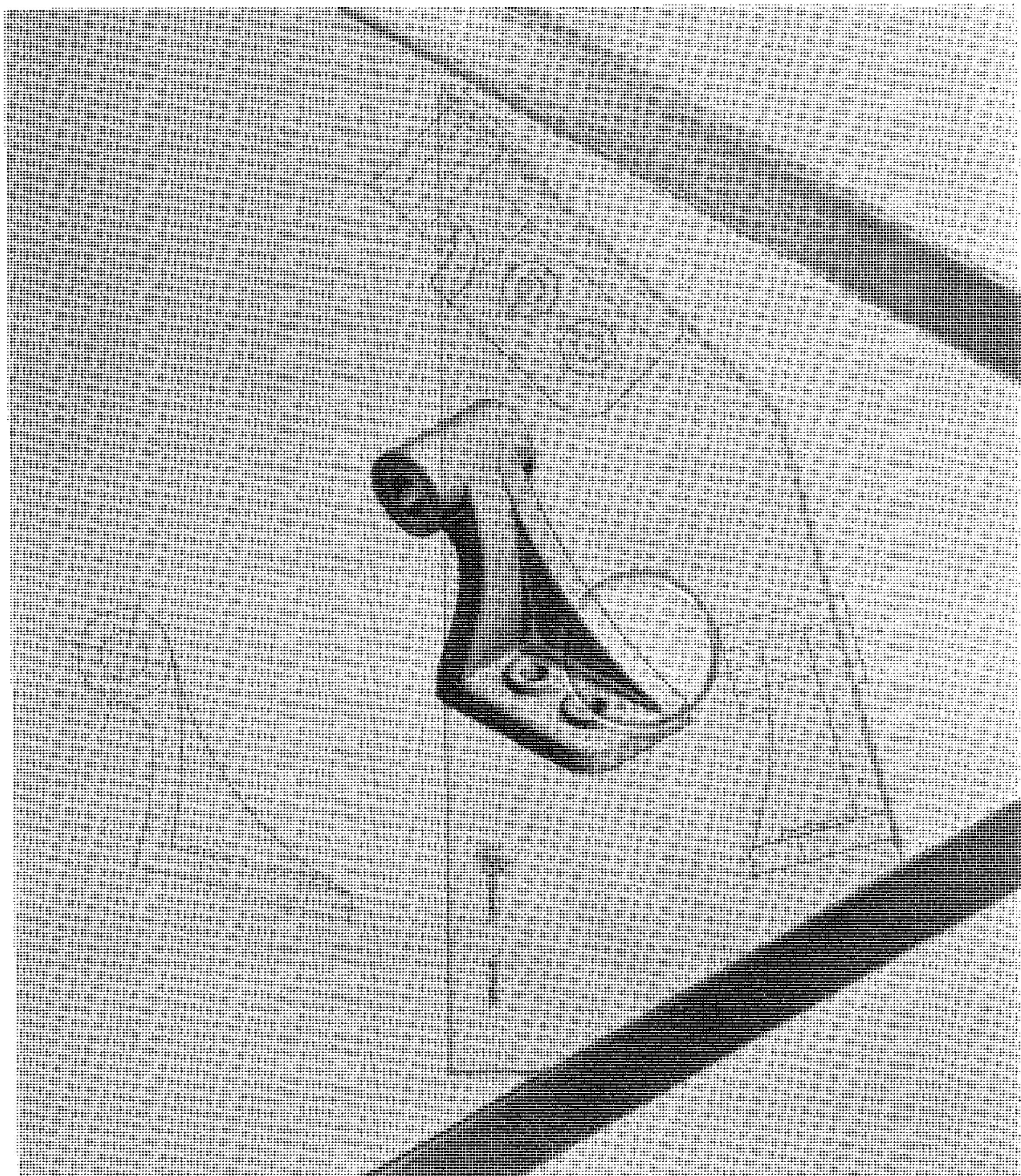

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