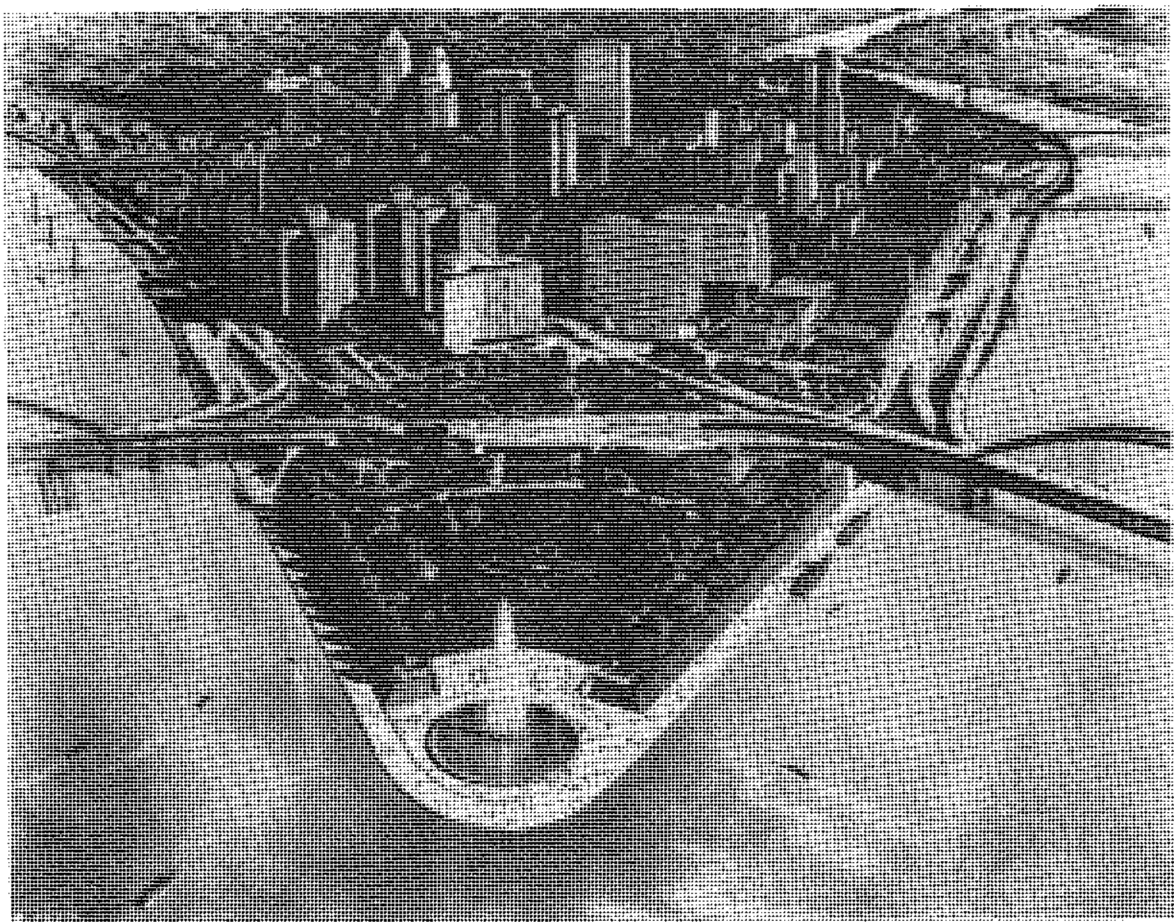
THE JOURNAL OF

ENGINEERING GRAPHICS



PITTSBURGH, PENNSYLVANIA

ASEE ANNUAL MEETING

JUNE 15-19, 1959

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PUBLISHED BY THE DIVISION OF ENGINEERING GRAPHICS
OF THE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

Some Ideas for your file of practical information on drafting and reproduction from KEUFFEL & ESSER CO.

One of the ways to judge a skilled craftsman is by the tools he uses. They're invariably the best he can find — chosen to lighten his work, sharpen his skills. And, if the craftsman is a draftsman, they are, more often than not, products of K&E.

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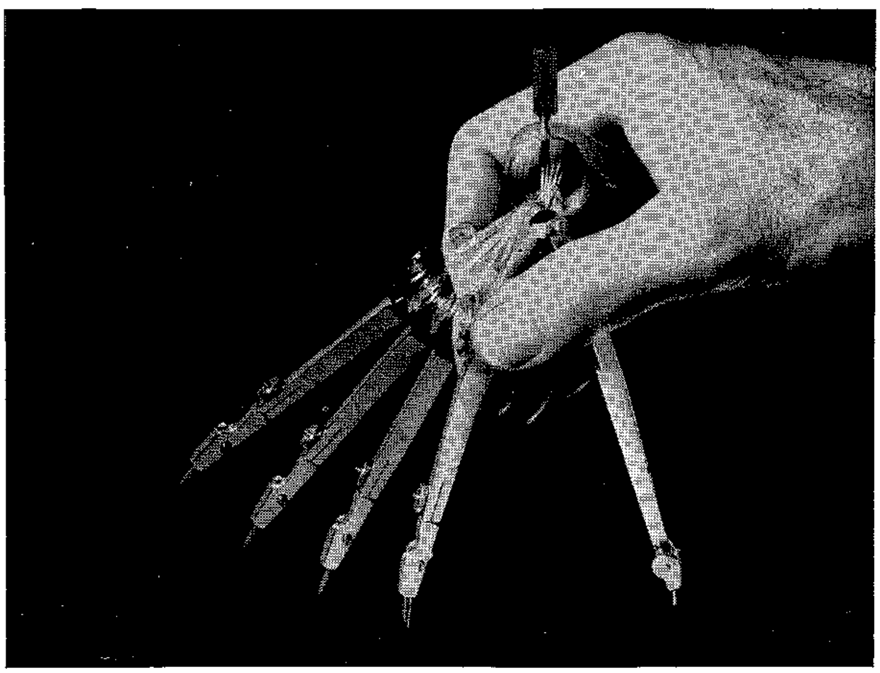
You'll find many products like these which can be highly useful in your work . . .



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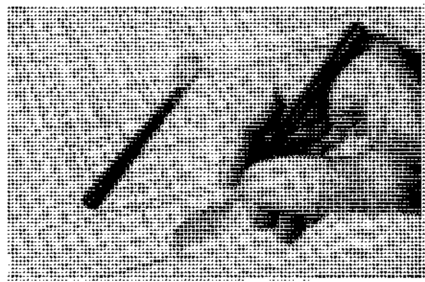

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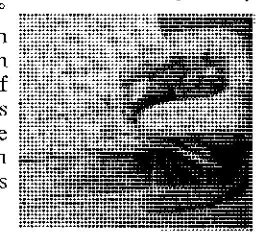

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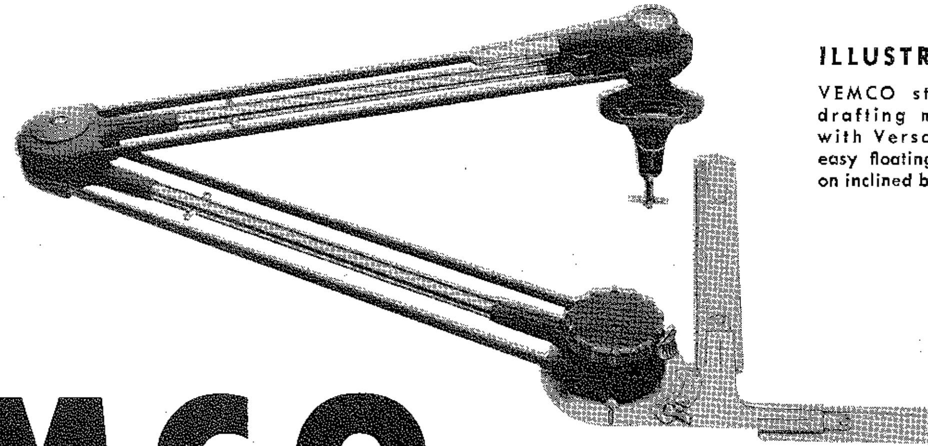

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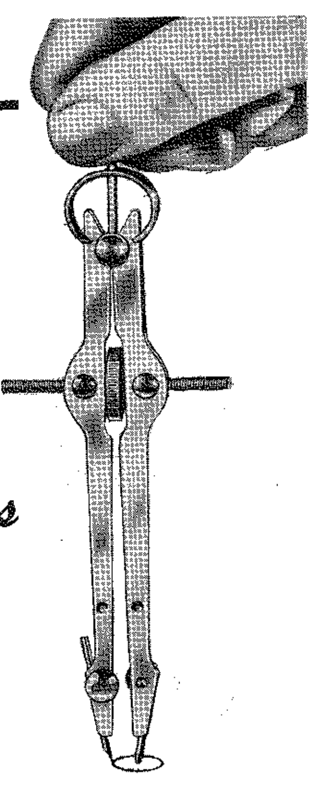

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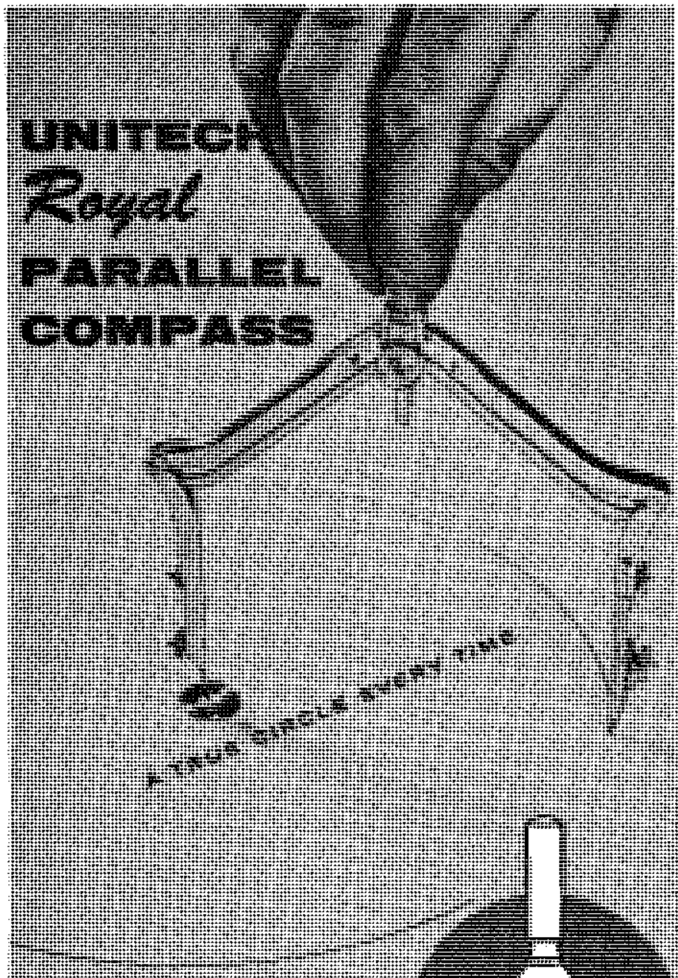
UNITECH
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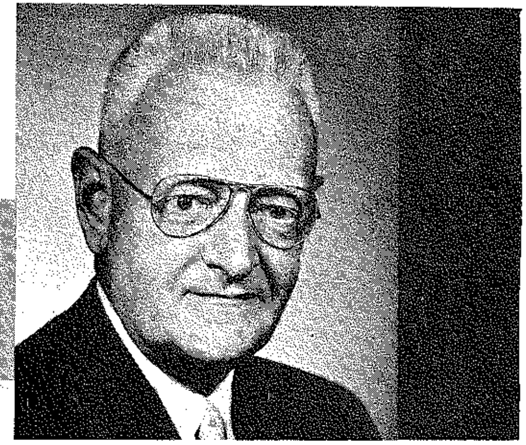
PARALLEL
COMPASS
A TRUE CIRCLE EVERY TIME

On the Importance of Drafting in Engineering Development



Drafting is probably the engineer's most important form of communication. Just as picture writing, the first form of written communication, was used to express thoughts and records, so do engineers working with graphics mold intangible ideas and theories into tangible goods and products. Yet, there is a tendency in present engineering education to minimize the importance of drafting.

In applying for their first job after graduation, the majority of young engineers express a definite preference for experimental and testing work rather than for design. To them, design is associated with the drawing board, and they have been led to believe that work on a drawing board is of a menial nature, perhaps all right for a tradesman, but certainly beneath the dignity of a graduate engineer.

We have found, however, that these same young engineers, after two or three years in experimental or test activities, usually request a transfer to design work. They have learned by actual experience that the real creative engineering is done in the drafting room and that there must be a design before there can be a test or experimental program. They have discovered that drafting has a vital, dual function in the engineering organization:

(a) As a means of communication whereby ideas can be presented to others quickly and vividly

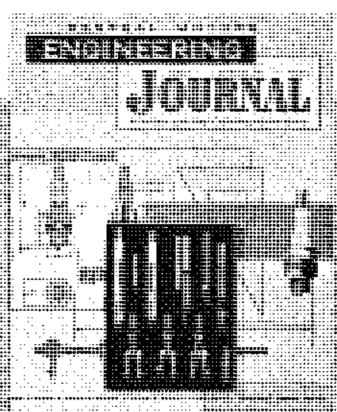
(b) As a tool whereby these ideas may be developed and expanded by graphical methods.

As with any language, skill can be obtained only by practice and certainly a few months of minimum drafting training received in college cannot be considered adequate practice for mastering such a vital skill. Consequently, young engineers should not only expect, but should seek several years of full-time design work.

It has been our experience that the most valuable men in an engineering development group are those whose broad background in designing permits them to follow a project from the initial freehand sketch to the finished prototype. Men of initiative and vision who have the ability to draw a good working layout, draw or supervise the drawing of the details, check the finished drawings, and then follow the parts in the shop through the assembly and testing phases are the type of "all-around" engineers constantly being sought to fill positions of higher responsibility.

As demonstrated by engineers of this type, drafting is by no means losing its place as an engineering tool.

Charles A. Chayne,
Vice President in Charge
of Engineering Staff



THE COVER

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Editor: Wayne L. Shick, 210 Transportation Building, University of Illinois, Urbana, Illinois

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FOR ENGINEERING GRAPHICS

With permission of General Motors Engineering Journal of General Motors Corporation we have reproduced the inside front cover of Volume 6, April, May, June, 1959, No. 2. We express our gratitude to Mr. Charles A. Chayne, Vice President in Charge of Engineering Staff, General Motors Corporation, for his forthright statement in behalf of engineering graphics.

NATIONAL SCIENCE FOUNDATION PROGRAMS

The National Science Foundation is sponsoring several institutes for high school and college teachers this summer. The University of Detroit has a two-week conference in July on force systems, nomography and graphical calculus. Iowa State College has a ten-day program in June for improvement of teaching in engineering drawing. We understand that enrollment in these institutes are filled, but inquiry may be directed to P. M. Reinhard, University of Detroit, Detroit 21, or to J. A. Greenlee, 12 Beardshear Hall, Iowa State College, Ames.

ABOUT OUR COVER

If you have not been to Pittsburgh in recent years, you will be pleasantly startled when you go to the ASEE annual meeting June 15-19. Our cover shows downtown Pittsburgh with its new look. See the center of the Journal for our program of the annual meeting.

SHOULD ENGINEERS BE MORE PROFICIENT IN INSTRUMENTAL DRAWING OR FREEHAND SKETCHING

By J. R. Simonin

The Detroit Edison Company*

This seems to be a direct clear-cut statement. But the more you pursue the question, the more convinced you become that it is at least a many-sided query, even to the point of being a leading question.

I firmly believe that both instrumental drawing and freehand sketching are useful and most necessary tools for all engineers. However, each type of drawing has its own definite application and neither one, in my opinion, completely supplants the other.

Within the last few years, instrumental drawing and its advocates seemingly have fallen on evil days. A great hue and cry has gone up on all sides. The watch-word is simplification. Maintain instrumental drawing, but use only the minimum of effort to produce the maximum of production.

Though not an expert in the field of drawing, whether it be instrumental or freehand, I have had many years of experience in the field of design engineering, particularly as it applies to the building of power plants. During these years I have been closely associated with engineering draftsmen who range from Junior Engineers to Design Supervisors. All these men are either graduate engineers or will be graduates when their night courses are completed. The point I want to make is that all these men use instrumental drawing and a modicum of freehand sketching in their daily work.

The product of our office is, by and large, information supplied in the form of finished drawings, bills of material, specifications, operating diagrams and instructions, etc. An engineer allergic to T square, triangles and lead pencils has no place in an organization such as this.

It is evident that in all industry, now as never before, we are confronted with a need to increase the effectiveness of engineering organization. This need is brought about not only due to a shortage of adequately trained personnel, but also by economic necessity. It is necessary that we obtain better over-all efficiency and increase individual output.

The engineer must design products and see that they are manufactured properly and economically. To do this he must have at his disposal some qualified means of conveying his ideas to the workmen and to other engineers.

The best method known, at the present time, is by engineering drawing.

To me this includes all engineers. Even the long-haired, scientific engineer must somehow get down to earth and converse with other mortals or he will lose out in the race with those ordinary individuals who create things for the benefit of mankind.

It is not necessary or desirable that topflight engineers spend long hours on the drafting board actually making the drawings. However, they must still know as much or more about the theory of drawing. And when the occasion arises, I feel that there is nothing degrading about handling the tools of the trade, namely, the T square and triangles.

Even though the design supervisor does not actually make the drawing, he should be able to read it. This attribute is at least a great morale builder.

In problems dealing with equipment location and arrangement, where close clearances are necessary and interference is expected, a concise drawing, to accurate scale, with many views, is a real necessity.

The technique or art of instrumental drawing may not be necessary for all engineers, but to those whose work entails design - no matter what sort - whether it be machinery, mechanisms, plant layout and detail, etc., it is certain that somewhere up the ladder of success, engineering drawing will be one of the rungs. And I think it is logical to say that as an engineer progresses up the ladder he may find that the art of making freehand sketches must be developed. This art is no more difficult to learn than the art of instrumental drawing, so it would seem that there is no basis for saying that engineers, now or ever, will have no connection with drawing.

And this is as it should be - engineering drawing is the language of the engineer. This is the manner in which he transmits his thoughts and desires to others. The engineer who must supervise designers, or make sketches and convey his ideas to workmen or to other engineers, must have a language or some medium of communication.

The making of drawings for the design and manufacture of industrial products is generally referred to as "industrial drafting". Progress in the development and production of modern machines and conveniences would have been greatly retarded without it. With it, the complex concepts of inventive genius have been successfully described in terms understandable to engineers and workmen alike, in turn making possible the step by step development of complicated machines and equipment of all description.

However, drafting, the industrial tool that has been largely responsible for making this increased production possible, has itself remained almost unchanged. It

*Presented at Mid-Winter Meeting of Engineering Graphics Division of ASEE, January 22, 1959.

functions today with nearly the same amount of time consuming elaboration of detail as was employed at the time of its inception. The old concept of drawing, which permitted, even demanded, that professional pride find expression in the beautiful and artistically executed mechanical drawing with its many projected views and sections, is slowly and surely becoming outmoded.

Many engineering departments have abandoned the time-honored precepts of conventional drafting and have adopted systems they consider faster, better and more economical. This evolution has produced two divergent forms or systems: simplification of graphical conventions and elaboration of informational content, especially in regard to dimensional information.

There is also a marked difference between the academic treatment of the subject, and the type of drawing practice which best serves the need of industry.

The reasons for this separation of theory and practice are not hard to find. Drafting materials, instruments, and reproducing techniques have changed; facilities and working conditions for the draftsmen have changed; so has the organization of many drafting operations. But the most important reason is what industry now expects of drawings. More and more drawings are expected to state exactly what is wanted, leaving little to the discretion of the shop. Moreover, when work is subcontracted, drawings must be regarded as legal documents, complete and unambiguous.

It seems unreasonable to believe that industry could function effectively without drawings, yet there seems to be a growing number of individuals who would have us believe this to be true.

Drawings perform many vital functions. A design as such takes form as thoughts in the designer's mind, but these thoughts are crystallized only when they have taken form, first in sketches and then in accurately scaled layouts.

Every drawing should justify the cost of its preparation and use - and the cost of its preparation and use should be maintained at a minimum. Assembly and detail drawings are especially important in this respect, and most drafting operations are concerned with making details and assemblies. There are not simple rules that show how drawings may be made that are just-good-enough. What is just-good-enough in one case may not be in another. These last two statements sum up the difficulties experienced in the administration of efficient and practical drafting practice.

It is well known that if two draftsmen, each independent of the other, develop a drawing of the same engineering product, the drawing will be different in each case, and one drawing will take less time to make than the other. One of the draftsmen will be more efficient than the other.

There are numerous equivalent conventions, techniques of graphical representation, methods of dimensioning, handling of explanatory notes and arrangements for formats, and the draftsman should be induced to use the more economical and standardized practice.

In many ways, drafting practice cannot be divorced from the background and personal traits of the individual draftsman or engineer. However, practices can be developed which satisfy established requirements and are acceptable compromises between individualistic preferences and work habits.

Merely observing the forms of efficient practice does not insure that a significant saving in cost of making drawings will be realized. Techniques of efficient practice only provide the possibility of savings - not the realization. Sensible drawing requires from an individual, both the desire to do a good job and also the ability to work well. Ability is closely related to attitude, and attitude to productivity. The engineering draftsman must have the proper attitude toward what he does; he must not feel that his job is merely to produce drawings. Drawings, however necessary, are not end products, but merely instruments used in building the final product. A better drawing should mean a drawing that is more readable, complete, unambiguous and representative of good design.

It is possible to draw attention to many personal, technical and organizational factors that may have an effect on the productivity of a drawing operation. Those in charge of such operations should take a good look at what is being done in their departments and determine what improvements should be made. This process of self-criticism should not be limited to evaluating. Educators should be among the first to evaluate any new or different practices and to discard methods that have become obsolete. It is also very important that the people who use the language of drawings in their daily work should understand the significance of the changes of this language and be ready to appraise and judge the merit or inadequacy of both the established and the newly proposed practice.

Modern industrial drafting practice can be simplified by the judicial use of freehand drawing. The challenge to modern drafting is to utilize to the fullest extent the ability of the engineer to contribute ideas for new products, and to improve existing products. One of the ways to accomplish this objective is through the widest possible use of freehand delineation. Freehand sketching has long been used when an emergency calls for rush instructions to the factory or field force.

An architect friend of mine once told me, "I have built many more houses and worked out far more details on the backs of envelopes and scrap pieces of lumber than I ever put on formal drawing."

Progressive supervisors and alert draftsmen are coming to realize that a method which has proven adequate for emergencies can be adopted for normal operation. There is a real distinction between accuracy and precision, at least from a drafting point of view. Accuracy in drawing means freedom from mistakes. Precision relates to appearance. We must appreciate this distinction in order to realize the value of freehand drawing.

The need for accuracy in drawing is, and must be, continually emphasized. Because of this emphasis, attitudes and habits which actually relate to precision develop under the notion that they improve accuracy. As a result, precision is often misconstrued as an aid to accuracy.

The preparation of freehand drawings differs from that of instrument drawing in only one respect. When using freehand method, the draftsman substitutes manual dexterity for instruments. He need not be an artist, or even have natural artistic talent to produce good freehand drawings. The major requirement is ability to draw a reasonably straight line between any two points. Some training and practice in methods are called for in this area, as in any skill requiring manual dexterity.

Sometimes a draftsman's hesitancy to utilize freehand drawing is traceable to professional pride. He feels that his lack of practice in freehand drawing will cause his drawings to suffer in appearance. However, he probably overlooks the fact that this type of drawing permits and encourages a freedom of thought and action that is of great value to him. It allows him to concentrate on the job at hand.

Freehand drawing is not an automatic license for careless, sloppy or indifferent work. The same habits of accuracy, neatness and care which apply to almost any drawing operation, apply also to freehand practice.

All along the line we have found that the greatest potential for economy in engineering operations is obtained by simplifying the delineations and eliminating the nonessentials from drawings and layouts. A mechanical drawing is an instruction, and must be simple, concise, accurate and understandable to the user.

Since drafting is of great importance in the engineering operation and is the method by which most drawings are produced, we should concern ourselves with the process by which the individual acquires the knowledge and skill necessary to produce drawings, namely the study of engineering drawing.

Drafting education has always been primarily concerned with the theory of drawing. The student is impressed with the importance of painstaking exactness in measurement and delineation, and with the necessity for time consuming overemphasis of details. As a result he emerges an artist, skilled in the theoretical niceties of drafting as an art, but with little knowledge of the practical requirements of industrial drafting. This concept is further developed when the novice sees many experienced draftsmen and engineers in industry using the same techniques. As a result, his drawings are letter-perfect according to the book, but expensive to prepare and keep up-to-date.

One criticism of mechanical drawing as it was taught in our schools, was that the old textbooks appeared to consider the drawings as ends in themselves. In reality, they are simply media by which information is conveyed from one location to another. In bygone days, textbooks of engineering drawing treated the mechanical drawing as a work of art, where it would be a sacrilege not to project every hidden surface whether the views were needed or not. Many teachers put forth a great deal of time and effort to obtain an artistic production from their pupils, rather than devote the time to the accuracy of the information provided, and the need for economy of time in the production of drawings.

We all feel and know that the basic theory - that is the theory of orthographic projection - the foundation on which engineering drawing stands, must still be taught. The draftsman must know how to project. When to project is of basic importance, and demands good judgment. A drawing must have enough lines on it to convey what is in the mind of its creator - no more and no less.

It does seem then that the teacher of engineering drawing should be vitally concerned with the trend indicated in industry today and should impress on his students the need for conservation of time and effort in the making of drawings.

New concepts are rarely received with complete understanding. Long established patterns of procedure may appear to be an unsurmountable obstacle, and the introduction of new practices presents a real problem. However, if the best results are to be obtained, the beginner must be properly trained. This is a real challenge to those whose job it is to teach students in engineering drawing.

The prime purpose of this discussion is to try, in some way, to discover if possible: Should engineers be more proficient in instrumental drawing or freehand sketching? The general plan of attack has been to state, what results should be expected from the use of each of the methods involved in the question. To give a basis for a conclusion as to what the answer should be, I shall review very briefly the main statements given concerning both sides of the question.

1. In industry the engineer must design products and see to it that they are constructed or manufactured properly. To do this properly and efficiently, he must have at his disposal a means to convey his ideas to other individuals. The best method known at the present time is by engineering drawing, which can well be said to be the language of the engineer.
2. All engineers should know the fundamentals, and have a sound working knowledge of this method of communication.

   The amount of time actually spent making drawings will depend almost entirely on the engineer's place in his organization, but there is no basis for saying that engineers, now or ever, will have no connection with drawing.

3. The concept of how drawings should be made is changing. Delineation and detail are being simplified, and the artistically executed drawing with its many projected views and sections, is definitely outmoded.
4. The judicial use of freehand sketching is a means of drawing simplification and economy. It also tends to utilize to the fullest extent the time and productive power of the engineer.

   Freehand drawing differs from instrumental drawing in only one respect, it substitutes manual dexterity for instruments. It is not a license for careless, sloppy or indifferent work.
5. Since drafting is a vital function in the engineering operation, great concern should be given to the study of engineering drawing. If the best results are to be obtained, those who teach drawing must accept the new concepts and trends as indicated by industry, and impress on the student the need for conservation of time and effort in making drawings.

With the foregoing statements in mind, I believe it is evident that all engineers should have a good basic working knowledge of engineering drawing.

They should be proficient in both instrumental drawing and freehand sketching because these are two closely related methods of obtaining the same end result, i.e., the accurate and efficient transfer of engineering information from one individual to another. The choice of methods used will depend almost entirely upon the education and experience of the engineer and the circumstances involved in the problem at hand.

NEW MEMBERS OF THE DIVISION OF ENGINEERING GRAPHICS

In the February Journal, we welcomed thirty-seven new members into the Engineering Graphics Division of A.S.E.E. By coincidence, thirty-seven more new members have expressed their interest in the Division. We are honored to have each one of them join us in furthering engineering education by graphics.

Many new members have subscribed to the Journal, and their contributions to the society's publication and to other engineering journals is encouraged.

Michael N. Besel, University of Wisconsin
Frank E. Bohata, Polytechnic Institute of Brooklyn
H. L. Bowman, University of North Dakota
Leroy Burris, South Dakota State College
Kenneth Carruth, Louisiana Polytechnic Institute
Shirley L. Cates, Amarillo College
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Milton J. Keiles, The City College of New York
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Elmer A. Lemke, Marquette University
Billy B. Letson, University of Alabama
Joseph C. Lindem, University of Wisconsin
W. A. Lyday, University of Tennessee
Clarke C. Marsh, General Motors Institute
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Walter A. Spurgeon, University of Dayton
Raymond Visser, University of Tennessee
William M. Whitley, Amarillo College
William R. Yencso, General Motors Institute

Members of the Engineering Graphics Division are members of the American Society for Engineering Education who have named engineering drawing, graphics or descriptive geometry as one of their two fields of academic or professional activity. New members of A.S.E.E. should notify our secretary, Professor Wladaver, New York University, of their interest in this division. All members of the division: Please advise the secretary of change of address.

WHO SHOULD TEACH NOMOGRAPHY - A MATHEMATICIAN OR A GRAPHICIAN?

By Robert H. Hammond

United States Military Academy

Who should teach nomography - a mathematician or a graphician? The answer is obvious. The one who should teach nomography is either or neither, dependent upon whether or not the individual is a good teacher who understands nomography.

Everybody agrees that the basis for a nomograph lies in plane geometry. The texts explain this and then develop lovely equations to use in solving the construction of a nomograph. Only a few texts show any application of the graphical principals that we purport to teach, and most of these texts do not apply completely these principals.

I would like to attempt to construct a double nomograph using mathematical formulae only, and then construct the same nomograph using graphical methods only. The nomograph I have in mind is one which was developed for use in my Department at the Military Academy.

The problem is this: Given a vertical aerial photograph of unknown scale; a map of known scale; and two points which can be identified on both the map and the photograph; the requirement is to determine the scale of the photograph. The expression of scale most widely used in the Armed Forces is known as RF or Representative Fraction. It is the ratio of map distance to ground distance written with the numerator as unity, i.e., a map having an RF of 1/25000 means that 1" of the map equals 25000" on the ground, or:

$$RF_M = \frac{D_M}{D_G} \qquad (1)$$

Equation (1) can be rewritten as:

$$D_G = \frac{1}{RF_M} D_M \quad . \qquad (2)$$

With two points identified on a map of known scale, the distance between them is measureable. Using Equation (2) the ground distance between the points can be calculated.

Applying the basic equation to the photograph:

$$RF_P = \frac{D_P}{D_G} \quad . \qquad (3)$$

We know the ground distance, and the distance between the points on the photograph can be measured. The RF of the photograph thus is determined. Since I am thinking along mathematical lines, perhaps I should express the combined equation:

$$RF_P = \frac{D_P}{\frac{1}{RF_M} D_M} \quad , \qquad (4)$$

which in reality adds little to our sum of knowledge.

Let's go back to Equation (2). This can be rewritten as:

$$\log D_G = \log \frac{1}{RF_M} + \log D_M \; ,$$

which can be set up as a nomograph with logarithmic scales.

To calculate the nomograph the scale modulii for the three scales must be determined. To do this, limits must be decided upon. The length of each scale shall be 6.6". The range of map RF's shall be from 1:10,000 to 1:500,000. The map distance shall range from 1" to 10". The distance between the outside scales shall be 4.30". Then by formula:

$$m_s = \frac{L}{S_N - S_1}$$

where m_s = a scale modulus; L = length of scale; S_N = final scale value; and S_1 = initial scale value. For the multiplicant (left) scale, this equation becomes:

$$m_{\frac{1}{RF_M}} = \frac{1}{\log \frac{1}{RF_N} - \log \frac{1}{RF_1}}$$

and since RF is a ratio:

$$m_{\frac{1}{RF_M}} = \frac{6.60}{\log 500{,}000 - \log 10{,}000} = 3.885 \quad .$$

Using the equation to determine the multiplier (right) scale:

$$m_{D_M} = \frac{6.60}{\log 10 - \log 1} = 6.60$$

The formula used in determining the modulus of the product (middle) scale is:

$$m_P = \frac{m_1 \cdot m_2}{m_1 + m_2}$$

where m_P = scale modulus of product scale

m_1 and m_2 = scale modulii of the outside scales.

This equation becomes:

$$m_{D_G} = \frac{3.885 \cdot 6.60}{3.885 + 6.60} = 2.445 \ .$$

Knowing all the scale modulii we can determine the spacing of the scales since:

$$\frac{m_1}{m_2} = \frac{x}{y} \ ,$$

and: $x + y$ = Distance between outside scales.
Using the values previously calculated:

$$\frac{3.885}{6.60} = \frac{x}{y} \quad \text{and} \quad x + y = 4.30$$

$$x = 1.593$$

Therefore the scale D_G should be 1.59" to the right of the $\frac{1}{RF_M}$ scale.

All that remains for the first part of the nomograph is to determine the scale markings for each scale. This is best done in tabular form and is shown in Tables I and II. A similar table would be set up for the D_G scale.

The second part of the nomograph can now be solved. Use Equation (3):

$$RF_P = \frac{D_P}{D_G} \ ,$$

and rewrite as:

$$\frac{1}{RF_P} = \frac{D_G}{D_P}$$

in order that the left hand member can be written as a whole number.

This can be expressed in log form as:

$$\log \frac{1}{RF_P} = \log D_G - \log D_P \ .$$

The negative sign can be changed by rewriting again as:

$$\log \frac{1}{RF_P} = \log D_G + (-\log D_P) \ ,$$

which means that the D_P scale must be inverted.

Two of the scale modulii of this part are the same as for the first part, namely m_{D_G} and m_{D_P} (which is numerically equal to m_{D_M}).

Thus, we can solve for the modulus of the product scale ($\frac{1}{RF_P}$):

$$m_{\frac{1}{RF_P}} = \frac{2.445 \cdot 6.60}{2.445 + 6.60} = 1.875$$

Determining the spacing of the scales:

$$\frac{2.445}{6.60} = \frac{x}{y} \quad \text{and} \quad x + y = 5.0$$

$$x = 1.352$$

Thus the $\frac{1}{RF_P}$ scale should be 1.35" to the right of the D_G scale.

The scale markings for D_G are already known, the scale markings for D_P are the same as for D_M (except that they are inverted), so that all that remains is to determine the scale markings for $\frac{1}{RF_P}$. This would be done in tabular form similar to Table II. It was felt that few photographs would have a RF greater than 1:100,000. Therefore the scale was not extended beyond that point.

Now all that is left, after all these calculations, is to actually construct the nomograph. Here the T-square and scales would be finally used.

Now let us assume that the nomograph is to be constructed by a graphician. He is lazy, or, to put it a little better, he is practical. Dean Potter, of Purdue, once defined an engineer as a lazy man, working very hard to find the easy way to do a job. So, our graphician is a lazy man. He believes in letting his drawing tools do his calculations and in using, when he can, what has already been done. I want to emphasize here that there is nothing new in the following discussion. It is merely application of graphic principles.

The lines representing the outside scales can be drawn the given distance (4.30") apart. Using commercially available logarithmic graph paper, the log values are projected onto the scale lines by the method long used to divide a line into proportional parts. (See Figure 1). The outside scales completed, there remains the problem of the product scale.

It is known that a logarithmic scale is cyclic and that the lengths of each cycle are equal. Therefore, if the location of one cycle can be determined, the cycle can be extended and marked as were the outside scales. In Figure 2, two lines which should pass through the product 100,000 have been drawn. The product scale must pass through the intersection of these lines. Since the product line is parallel to the outlide scales, drawing a vertical line through this point of intersection to a line which must pass through the product 10,000 establishes and locates one cycle of the product scale. A second point on the product scale should be located as an accuracy check. Preferably this second point should be another cycle so that the cycle length can be checked. The scale markings can be projected onto the product scale as was done on the outside scales. The first part of the nomograph is complete and all formulae and tedious calculations have been eliminated.

To complete the nomograph, a scale line for the photo distance scale would be drawn and marked, and the second product scale located as in Figure 3, using the same method as before. The completed nomograph is shown in Figure 4.

This form of construction eliminates the necessity of calculating the distances between scales and eliminates the rather boring and time-consuming job of calculating the scale divisions for each scale. Performed with attention to accuracy in construction, this method is more than sufficiently precise for the results desired here and in a great many other nomographs. It is easily done in one-tenth of the time required using purely a mathematical approach. There are nomographs of such size and desired precision that the mathematical methods are needed. However, I feel that the graphical construction is an indispensible tool of the nomographer.

In final answer to the original question; a teacher of nomography, in addition to being a good teacher, should know and understand both the mathematical and the graphical approach. He should be, to coin yet another new word, a graphmathtician.

TABLE I

$$L = 3.885 \log \frac{1}{RF_M}$$

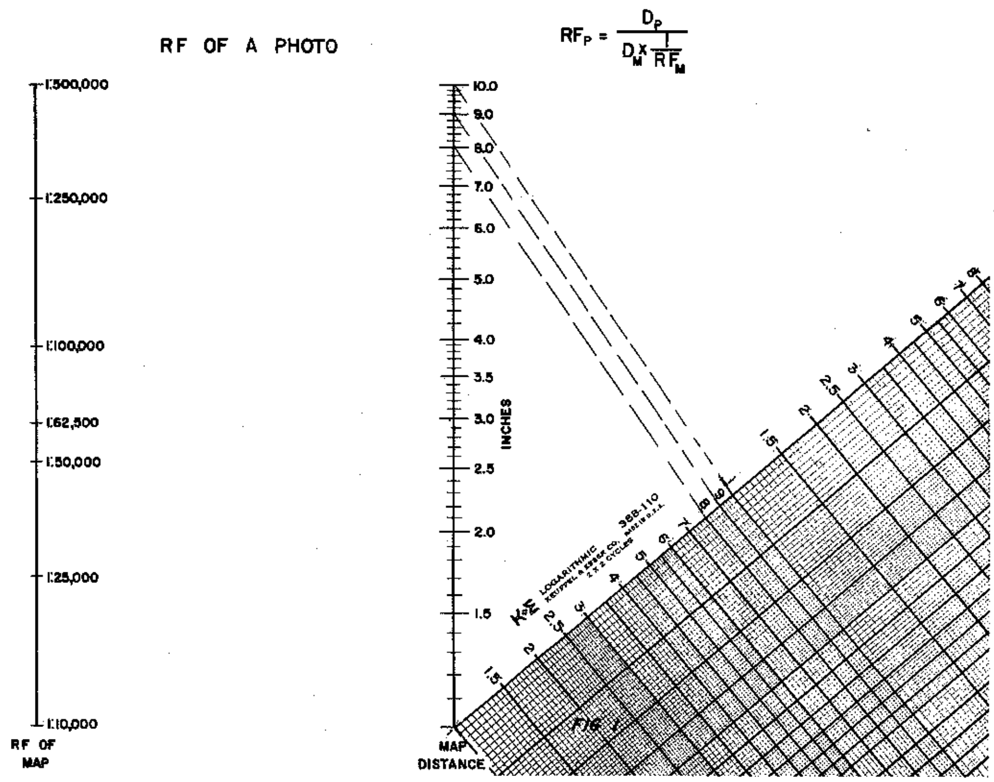
$\frac{1}{RF_m}$	$\log \frac{1}{RF_m}$	$L \frac{1}{RF_m}$
*10,000	0.00000	0.000
25,000	0.39794	1.546
50,000	0.69897	2.715
62,500	0.79588	3.092
100,000	1.00000	3.885
250,000	1.39794	5.431
500,000	1.69897	6.600

*Since in a log scale the distance from 1 to 10 is the same as from 100 to 1000, and since we want to start the scale at 10,000, it is proper to think of 10,000 as 1.

TABLE II

$$L_{D_m} = 6.6 \log D_m$$

D_m	$\log D_m$	L_{D_m}	D_m	$\log D_m$	L_{D_m}
1.1	.04139	.273	4.2	.62325	4.113
1.2	.07918	.523	4.4	.64345	4.247
1.3	.11394	.752	4.6	.66276	4.374
1.4	.14613	.964	4.8	.68124	4.496
1.5	.17609	1.162	5.0	.69897	4.613
1.6	.20412	1.347	5.2	.71600	4.726
1.7	.23045	1.521	5.4	.73239	4.834
1.8	.25527	1.685	5.6	.74819	4.938
1.9	.27875	1.840	5.8	.76343	5.039
2.0	.30103	1.987	6.0	.77815	5.136
2.1	.32222	2.127	6.2	.79239	5.230
2.2	.34242	2.260	6.4	.80618	5.321
2.3	.36173	2.387	6.6	.81954	5.409
2.4	.38021	2.509	6.8	.83251	5.495
2.5	.39794	2.626	7.0	.84510	5.578
2.6	.41497	2.739	7.2	.85733	5.658
2.7	.43136	2.847	7.4	.86923	5.737
2.8	.44716	2.951	7.6	.88081	5.813
2.9	.46240	3.052	7.8	.89209	5.888
3.0	.47712	3.149	8.0	.90309	5.960
3.1	.49136	3.243	8.2	.91381	6.031
3.2	.50515	3.334	8.4	.92428	6.100
3.3	.51851	3.422	8.6	.93450	6.168
3.4	.53148	3.508	8.8	.94448	6.234
3.5	.54407	3.591	9.0	.95424	6.298
3.6	.55630	3.672	9.2	.96379	6.361
3.7	.56820	3.750	9.4	.97313	6.423
3.8	.57978	3.827	9.6	.98227	6.483
3.9	.59106	3.901	9.8	.99123	6.542
4.0	.60206	3.974	10.0	1.00000	6.600


RF OF A PHOTO
$RF_P = \frac{D_P}{D_M \times \frac{1}{RF_M}}$
1:500,000
1:250,000
1:100,000
1:62,500
1:50,000
1:25,000
1:10,000
RF OF MAP
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.5
3.0
2.5
2.0
1.5
INCHES
MAP DISTANCE
LOGARITHMIC 358-110
FIG 1

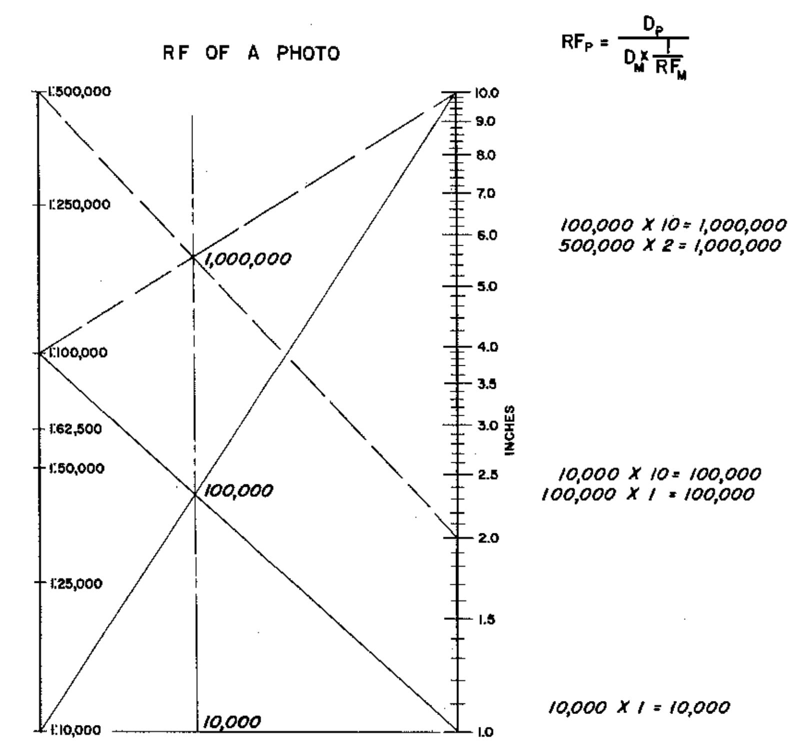

RF OF A PHOTO
$RF_P = \frac{D_P}{D_M \times \frac{1}{RF_M}}$
1:500,000
1:250,000
1:100,000
1:62,500
1:50,000
1:25,000
1:10,000
RF OF MAP
1,000,000
100,000
10,000
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.5
3.0
2.5
2.0
1.5
1.0
INCHES
MAP DISTANCE
100,000 X 10 = 1,000,000
500,000 X 2 = 1,000,000
10,000 X 10 = 100,000
100,000 X 1 = 100,000
10,000 X 1 = 10,000

FIG 2

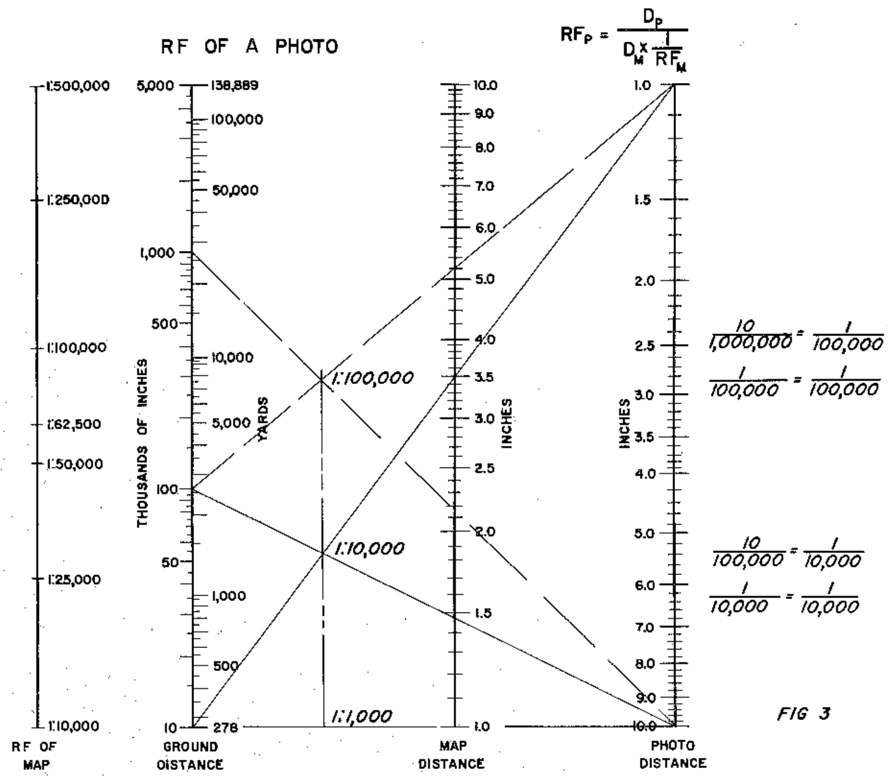
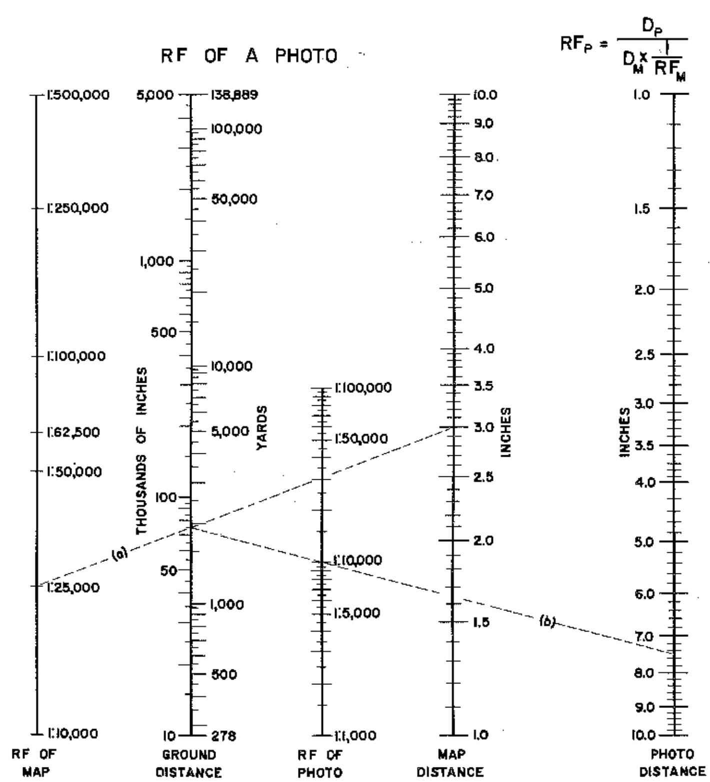


FIG 3



TO USE:

Given a photo of unknown RF and a 1:25,000 map. Two points are identified on both the map and photo. The distance between them is 3.0" on the map and 7.5" on the photo. To determine the RF of the photo:

(1) Draw a line from RF OF MAP to MAP DISTANCE (line a).

(2) From the point where this line intersects GROUND DISTANCE, draw a second line to PHOTO DISTANCE (line b).

(3) Read the RF of the photo at the point where the second line intersects RF OF PHOTO.

FIG 4

R.H.H. '56

REPORT OF THE BIBLIOGRAPHY COMMITTEE

S. E. Shapiro, Chairman

Books Published 1956 to 1959

Authors	Title	Publisher	Ed.	Year	Pages	Price
M. W. Almfeldt, D. D. Glower	Engineering Graphics Problem Book II	Wm. C. Brown	1	1957	88	3.00
J. N. Arnold	Introductory Graphics	McGraw-Hill	1	1958	548	7.75
J. N. Arnold, Bolds, S. B. Elrod J. H. Porsch, H. C. Thompson	Worksheets for Introductory Graphics - Form A	Balt Publishers	1	1958	100	4.00
E. J. Caldario, E. J. Mysiak H. A. Setton, H. D. Walraven	Problems in Engineering Drawing, Series D	Stipes	2	1958	70	3.00
T. E. French, C. J. Vierck	Graphic Science: Engineering Drawing, Descriptive Geometry, and Graphics	McGraw-Hill	1	1958	760	8.50
F. E. Giesecke, A. Mitchell H. C. Spencer	Technical Drawing	Macmillan	4	1958	844	7.50
H. R. Goppert, C. I. Carlson, G. E. Cramer, E. J. Caldario	Problems in Engineering Geometry, Series No. 3	Stipes	2	1956	88	2.75
H. E. Grant	Practical Descriptive Geometry (Alternate edition with Problems)	McGraw-Hill	1	1956	403	5.50
S. G. Hall, L. D. Walker E. D. Ebert, A. G. Frederich	Problems in Engineering Drawing, Series B	Stipes	2	1957	62	3.00
K. Hansson-Falk	Falk's Graphical Solutions	Columbia Graphs	4	1958	456	6.00
R. P. Hoelscher, C. H. Springer	Engineering Drawing and Geometry	Wiley	1	1956	520	8.00
R. P. Hoelscher, C. H. Springer B. O. Larson, J. E. Pearson	Problems in Engineering Drawing, Series A	Stipes	2	1956	58	3.00
R. P. Hoelscher, C. H. Springer B. O. Larson, J. E. Pearson	Problems in Engineering Geometry, Series No. 1	Stipes	2	1956	84	2.75
R. P. Hoelscher, C. H. Springer B. O. Larson, J. E. Pearson	Problems in Engineering Geometry, Series No. 2	Stipes	2	1957	84	2.75
R. P. Hoelscher, C. H. Springer B. O. Larson, J. E. Pearson	Problems in Engineering Geometry, Series No. 4	Stipes	1	1958	65	2.75
C. J. Hood	Geometry of Engineering Drawing	McGraw-Hill	4	1958	347	5.75
C. J. Hood, A. Parmerlee	Problem Sheets	McGraw-Hill	4	1958		3.75
L. O. Johnson, I. Wladaver	Engineering Drawing Problems	Prentice-Hall	1	1956	132	5.00
A. S. Levens, A. E. Edstrom	Problem Sheets to Accompany Graphics in Engineering and Science, Series A	Wiley		1956	102	6.50
A. S. Levens, A. E. Edstrom	Problem Sheets to Accompany Graphics in Engineering and Science, Book I: Descriptive Geometry	Fearon	1	1958	94	3.50

Authors	Titles	Publisher	Ed.	Year	Pages	Price
A. S. Levens, A. E. Edstrom	Problem Sheets to Accompany Graphics in Engineering and Science, Book II: Technical Drawing Practices and Graphical Computations	Fearon	1	1959	98	3.50
J. V. Lombardo, L. O. Johnson W. I. Short, A. J. Lombardo	Engineering Drawing	Barnes and Noble	2	1956	432	2.50
W. J. Luzadder	Graphics for Engineers	Prentice-Hall	1	1957	608	6.95
W. J. Luzadder, J. N. Arnold H. C. Thompson	Problems in Engineering Drawing - Abridges	Balt	4	1956	40	1.70
M. McNeary, E. R. Weidhaas E. A. Kelso	Creative Problems for Basic Engineering Drawing	McGraw-Hill	1	1957	48	3.75
H. C. Nelson	Handbook of Drafting Rules and Principles	Taplinger		1958	96	2.00
E. G. Pare	Engineering Drawing	Henry Holt	1	1958		
E. G. Pare, R. O. Loving, I. L. Hill	Descriptive Geometry	Macmillan	2	1959	349	5.00
E. G. Pare, R. O. Loving I. L. Hill	Descriptive Geometry Worksheets, Series C	Macmillan	1	1957	152	3.25
J. H. Porsch, S. B. Elrod Hammond	Descriptive Geometry Worksheets	Balt	3	1957	57	3.00
R. W. Reynolds	Problems for Modern Engineering Drawing, Series I	Fearon	1	1956	66	5.00
R. W. Reynolds	Problems for Modern Engineering Drawing, Series II	Fearon	1	1958	66	5.00
J. S. Rising, D. D. Glower	Engineering Graphics Problem Book I	Wm. C. Brown	1	1957	74	2.75
J. S. Rising, D. D. Glower	Engineering Graphics Problem Book III	Wm. C. Brown	1	1957	86	3.75
L. M. Sahag	Applied Graphic Statics	Edwards Bros.	2			
L. M. Sahag	Problems in Graphic Statics	Edwards Bros.				
L. M. Sahag	Problems in Kinematics of Machines	Edwards Bros.				
E. Scrogin	Applied Drawing and Design	Taplinger	2	1959	252	4.60
S. E. Shapiro, D. M. Holladay G. Wilson, W. L. Shick	Problems in Geometry for Architects, Series A, Part I	Stipes	1	1956	61	3.00
S. E. Shapiro, D. M. Holladay G. Wilson, W. L. Shick	Problems in Geometry for Architects, Series B, Part II	Stipes	1	1958		3.00
W. L. Shick, G. Wilson D. M. Holladay, S. E. Shapiro	Problems in Geometry for Architects, Series A, Part II	Stipes	1	1956	56	3.00
W. L. Shick, G. Wilson D. M. Holladay, S. E. Shapiro	Problems in Geometry for Architects, Series B, Part I	Stipes	1	1957		3.00
H. W. Shupe, P. E. Machovina	Engineering Geometry and Graphics	McGraw-Hill	1	1956	357	5.75
S. M. Slaby	Engineering Descriptive Geometry	Barnes and Noble	1	1956	353	2.50

Authors	Titles	Publisher	Ed.	Year	Pages	Price
H. C. Spencer	Basic Technical Drawing	Macmillan	1	1956	370	4.96
H. D. Walraven, C. I. Carlson E. J. Mysiak	Problems in Engineering Drawing, Series C	Stipes	2	1956	64	3.00
Warner, M. McNeary	Applied Descriptive Geometry	McGraw-Hill	1	1959		
B. L. Wellman	Technical Descriptive Geometry	McGraw-Hill	2	1957	640	5.75
F. Zorrora	Engineering Drawing	McGraw-Hill	2	1958	391	6.50

ENGINEERING GRAPHICS DIVISION OF ASEE - ANNUAL MEETING

Carnegie Institute of Technology, University of Pittsburgh, and Industry

Pittsburgh, Pennsylvania

June 15-19, 1959

- PROGRAM -

Monday--June 15

2:00 P.M.--Conference
Theme: Engineering Graphics Teaching Techniques
Presiding: Hugh Ackert, Notre Dame University

1. Teaching by Remote Control-- P. O. Potts, University of Michigan
2. Teaching Multiple Sections at the University of Minnesota--R. D. Springer, University of Minnesota
3. Creative Thinking and Engineering Methods Program for Electrical Engineering--Marquette University Panel, Marquette University

Discussers: Mary F. Blade, The Cooper Union
W. L. Shick, University of Illinois
R. D. LaRue, Colorado State University
Irwin Wladaver, New York University

6:30 P.M.--Meeting and Dinner of the Executive Committee, Engineering Graphics Division
Presiding: J. S. Rising, Iowa State College

Tuesday--June 16

12:00 Noon--Luncheon and Annual Business Meeting, Engineering Graphics Division
Presiding: J. S. Rising, Iowa State College

2:00 P.M.--Conference
Theme: Use of Graphics in Industrial Research and Development
Presiding: Albert Jorgensen, University of Pennsylvania

Tuesday--June 16 (Continued)

1. Graphics in a Process Industry--F. L. Dewey, Engineering Division, Proctor and Gamble Co., Ivorydale, Cincinnati, Ohio
2. Graphics in Research--S. A. Coons, Massachusetts Institute of Technology
3. Implementing Research--W. C. Morrison, Manager of Engineering Plans and Services, Radio Corporation of America

Discussers:
J. S. Blackman, University of Nebraska
J. S. Dobrovolny, University of Illinois
E. W. Jacunski, University of Florida
R. S. Paffenbarger, The Ohio State University

6:30 P.M.--Engineering Graphics Annual Dinner
Presiding: J. S. Rising, Iowa State College

1. Presentation of Descriptive Geometry Award by D. P. Adams, Massachusetts Institute of Technology
2. Presentation of Nomography Award by J. N. Arnold, Purdue University
3. Presentation of Distinguished Service Award by W. E. Street, Texas A and M College
4. Entertainment Feature
5. Address: The Art of Communication.
Dean H. C. Hesse, Valparaiso University

Wednesday--June 17--Guests of Industry Day

Host: Pittsburgh Plate Glass Company

Group I: 9:30 A.M.--Buses depart to visit the Glass Research Laboratories at Harmarville. Morning session includes orientation, films, and lectures on research and development pertaining to glass.

12:00-1:30 Lunch

Tour of facilities to inspect and discuss:
1. Measurement of Heat Transfer Coefficients
2. Applications of High Speed Photography
3. Spectrophotometry
4. Numerical Colorimetry (color specifications)
5. Special Purpose Computers
6. Miscellaneous Uses of "Graphics"

Return to campus by 4:30 P.M.

Group II: 9:30 A.M.--Group II of the Graphics Division will visit the Research and Development Center of the Pittsburgh Plate Glass Company at Springdale, Pennsylvania.

10:30-12:00 Welcome and tour of the Research and Development Center

12:00-1:30 Lunch

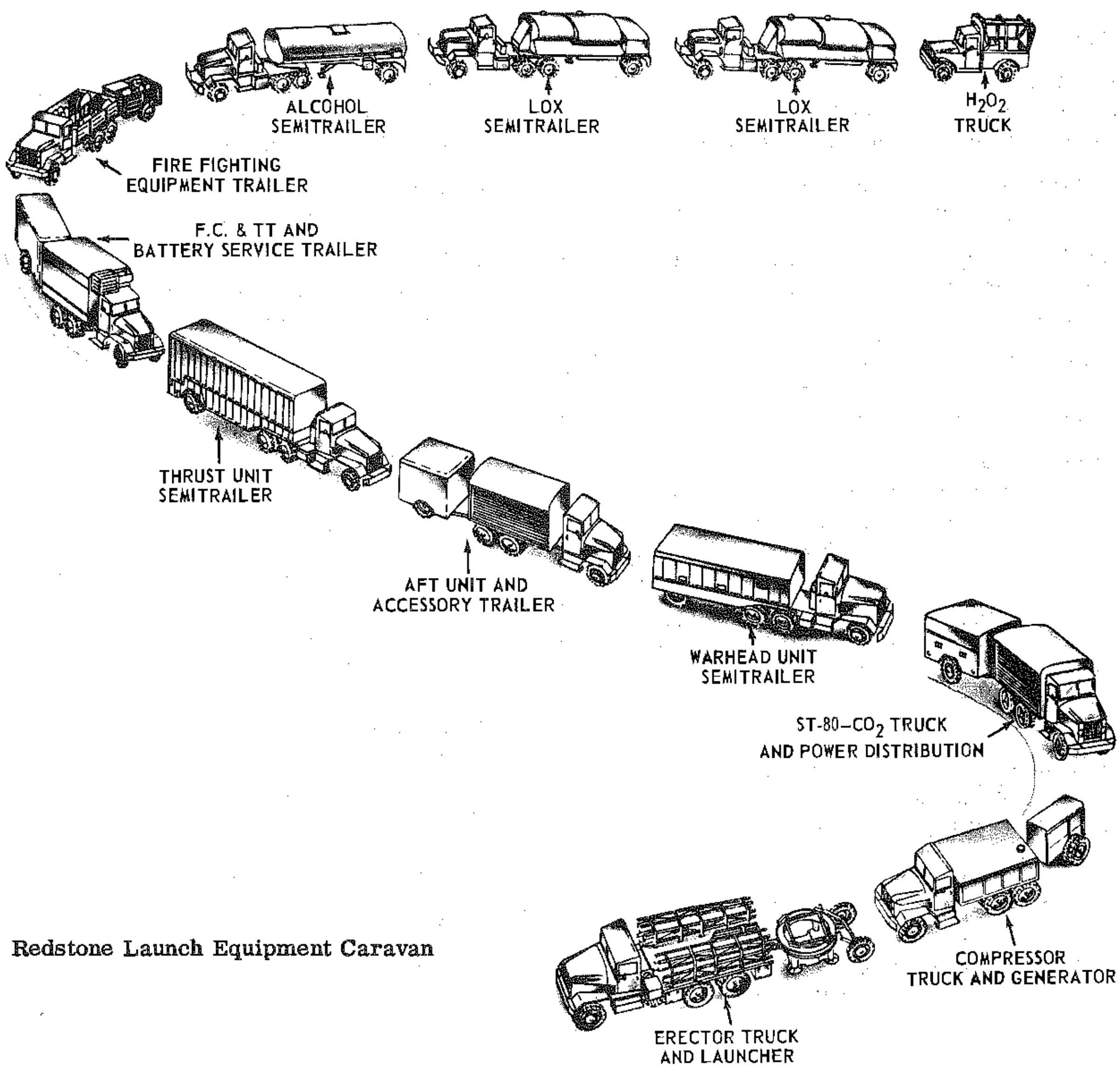
1:30-3:30 Symposium on Graphics in Engineering, Mr. Joseph J. Reis presiding

Speakers

1. Dr. Earl E. Parker--"Graphics in Basic Research of Polyesters"
2. Mr. Jerome A. Seiner--"Graphics in Process Equipment--Semiworks of Polyesters"
3. Mr. Thomas A. Risch--"Graphics in Process Development of Polyesters"
4. Dr. Thomas G. Tan--"Statistical Studies of Polyesters"

Return to campus by 4:30 P.M.

This tour is limited to 100 guests.



Redstone Launch Equipment Caravan

GRAPHICS AND ITS RELATION TO THE DEVELOPMENT OF GUIDED MISSILES

By Eugene V. Fesler

Missile Division, Chrysler Corporation*

Graphic Arts is somewhat difficult to define and to localize to any one particular activity in a Guided Missile Prime Contractor facility. Though not necessarily the most important, Drafting is certainly one of the Graphic Arts. Yet, the technique of conveying ideas in terms of drawing content and drawing concept is definitely different for Plant Engineering, Process Engineering, Tool and Die Design, Advance Preliminary Design, and Product Design. Besides the specialized Drafting art form, Chrysler Corporation Missile Division has a Graphic Arts Department whose primary mission is to illustrate technical manuals, Engineering Proposals, Training Aids, and Repair Parts breakdowns.

This discussion is confined to the drawings which are prepared for Advance Design and Product Design, some of the major problems encountered, and some of the trends that are apparent in the Drafting Field. (Mr. Fesler proceeded to show several slides of the major items of equipment used in the Redstone Weapons System.)

In practically all cases standard army vehicles are used. The prime system contractors principal concern is "stuffing" these vehicles with specialized equipment. By making use of available products for which drawing sets are on hand, valuable production lead-time is saved and a cost savings to the customer, the taxpayer, is realized. Yet the drawing problems are immense.

First and foremost, there is drawing quantity. There is too much. An example is the number of drawings created during a recent twelve-month period.

NEW PRODUCT DESIGN DRAWINGS

Size	Quantity
A	22,000
B	5,500
C	8,250
D	11,000
J	8,250
Layouts	1,350
Preliminary Drawings and Studies	10,250
Total	66,600

Even a casual appraisal of large ballistic missile systems at the present state of the art reveals a staggering complexity. Accordingly, there are enormous pressures at work to simplify the mechanisms and system.

Major technological break-throughs will be required to achieve this desired simplicity. Progress in the development of nuclear and thermonuclear devices is providing more compact and lighter warheads to accomplish a given job. This, in turn, has permitted the development of smaller and lighter missiles for transporting these warheads at a given range. Smaller and lighter missiles will permit lighter and more compact ground support equipment.

Genuine progress is being made in the fields of solid propellants and liquid propellants which will ultimately result in major simplifications of ground support equipment.

Progress is steady, also, in the fields of miniaturization and transistorization of missile electronic gear. This is leading to substantial reduction in the electrical demand in related ground support equipment.

One can visualize the ideal: A single wheeled package of ground support equipment, for one missile, with both operated by one man, and the entire complex capable of being helicoptered. We are a long way from this ideal right now, but substantial progress is being made.

Because of progress and the knowledge that missile weaponry are an infant art, the rate of change is staggering. There is always the urgent necessity of maintaining design compatibility between the missile and the related ground support equipment. It is well known that there is heavy pressure to reduce the "lead time" from the weapon-system-concept to field-deployment. In order to compete favorably with potential antagonists, we must reduce this "lead time" from a period of five or six years to a "lead time" of perhaps two years. Deployment arrangements must be made while the missile system is still in a violent state of flux as far as design is concerned.

For example, during a twelve-month period, Chrysler processed one design change for each 15 minutes and 22 seconds night and day, 365 days a year. At the end of that year, our Engineering Staff had published over 260,000 releases and change notices. Over 50,000 line items in the system were under documentary control. These figures give some idea of the staggering number of drawing revisions that are required and why the missile industry is ever seeking to improve its drafting techniques. Chrysler is experimenting with the use of finitely controlled microfilms for drawing sizes "A" through "D". The original design is made on a linen; the linen is

*Presented at Mid-Winter Meeting of Engineering Graphics Division of ASEE, January 22, 1959.

microfilmed at the time of initial engineering release. Thereafter, all revisions are made by reproducing the microfilm full size on a white paper print. The area of the drawing being changed is blocked out by a dimensioned overlay which is pasted on the white print; this is microfilmed as the revision, and the sequence is then repeated for each revision.

Once a system has been deployed, the amount of flexibility available for drawing-design-change shrinks rapidly. A drawing change which could be introduced rapidly and easily in the development phase becomes an almost impossible accomplishment in the deployment phase. Before the proposed drawing change can be evaluated, one must review the effect of the drawing change on delivery schedules of the parts, how the manufacturing inventory will be affected with various effectivity points, what obsolescence changes will be involved, how the repair parts inventory will be affected, how many of the training manuals will require revision and how long it will take to revise them, distribute them, instruct the instructors, and have the instructors instruct the personnel in the field. While all this investigation is going on, other proposed drawing changes are flowing through the mill, each one of which may have an impact on each of the others. If these changes could be processed one at a time, the job would be relatively easy. However, on the average, there are 1800 to 2000 drawing changes "in the float" at any one time; it requires a firm grasp of systems engineering, rigid management controls, and a large portion of intestinal fortitude to produce sound recommendations. Competence in systems engineering and drawing control, therefore, is a major problem in system development, manufacture and service.

Again, technological break-throughs advancing design simplification will provide the greatest progress. In the meantime, a drawing simplification program has been the order of the day. Drawing technique is another problem. Chrysler Corporation has found it expedient to displace the aircraft practice of using a loft as the major "Control" drawing due to the repeated design change during prototype and early development phases. No two prototypes are the same although the missile aerodynamic configuration may vary only slightly. The "stuffing" is always modified in pace with the latest missile mission. Each mission seeks new experimental or reliability data.

For ease of drawing change, a missile air frame is segmented into unit-assembly dimensioned layout type drawings. The "stuffing" is then laid out and where over-complexity of drawing detail occurs, sectional views are made.

During the early phases of Weapon System development, a limited amount of mono-detailing and intermediate subassembly drafting is performed. In the final stages of development, subassembly drawings are provided and, funds permitting, complete mono-detailing and proprietary envelope type drawings are prepared, with a priority being placed on items of supply which are designated as repair parts.

As a secondary practice, a missile loft is maintained of the air frame and its ring frame structure. This is a reference drawing used by Manufacturing in the preparation of tooling and fixtures.

The GSE drawing sets are based on what one might call the modification drawing set principle. The top assembly is a dummy drawing with two or more subassemblies, one consisting of the GFE item, the second consisting of the structural layout.

Because of the ponderous electrical networks involved in the ground support equipment and the missile, Chrysler has found it expedient to prepare only elementary pin-to-pin wiring diagrams, running lists, and interconnect wiring diagrams, during the prototype and early development phases. As the Weapon System progresses into final development and tactical phases of production, schematics, block diagrams, detail harness drawings, and routing drawings for piping and wiring are prepared.

Lastly, a major problem in the management of a Weapon System drawing set is uniformity. This is one area that needs the assistance of, and can be assisted by, the combined weight of the universities. The missile industry uses products from many sources which otherwise may be unrelated. Some examples are the chemical, electrical, pipe, trucking, fasteners, and plastic industries. Thus, a prime contractor delegates design responsibilities to suppliers, who have given distinguished service in the missile industry. These subcontractors are spread from border to border, and in accordance with their prime source of revenue, use a corresponding drafting standard. It is surprising the number of standards that are used for electrical symbols and for dimensioning. Obviously, if the subassembly supplier does not think in tune with the final assembly producer, chaos soon reins. As a result of these non-standard practices, our company now incorporates into its subcontracts a drafting practice code developed around the structure of the Ordnance Corp M4-4 Engineering and Drafting Manual.

GRAPHICS -- AN AID IN PLANNING, MANUFACTURING AND SALES

By J. L. Gilmour

Engineering Division, Chrysler Corporation*

The subject of GRAPHICS is a very broad one. It probably began back in pre-historic times when our caveman ancestor found that his words and gestures were not GETTING ACROSS to his listeners, so he started to illustrate his stories with drawings on the walls of his cave. The subject of GRAPHICS today, in the broad sense, covers all forms of pictures and charts used to supplement the spoken and written word.

The most widely used GRAPHIC form in industry today, of course, is the well-known mechanical or orthographic drawing without which our present industrial growth would have been impossible. My discussion, however, will not include this means of conveying the engineer's and designer's ideas to the men who creat the tools, make the pieces, inspect their accuracy, or put them together in complex assemblies. This phase of GRAPHICS is well-known. The subject this morning will be limited to certain special forms of GRAPHICS which have supplemented the traditional orthographic drawing as an aid in planning, manufacturing, and sales activities.

In our activities, PLANNING is the process of determining the WHAT, WHEN, and HOW of future products to be produced. The WHAT may consist of detail changes to existing components, in order to adapt them to a new vehicle package, or may be completely new components incorporating many design innovations. Our current pace of frequent and extensive changes in automobile design could never be realized without a sizable planning operation. The WHEN of planning is often referred to as PROGRAMMING and defines the timing or scheduling of a program. It is equally important because of the long lead time required by the complexity of present-day tooling. The HOW involves manpower, facilities, material, etc., required to implement a program.

How then, do GRAPHICS help in this WHAT, WHEN, and HOW process? One of the most important graphic aids in this work is the three dimension perspective drawing or sketch colloquially known as a GRAPHIC ILLUSTRATION. Figure 1 is an example of this type of GRAPHIC illustrating the torsion bar type of front suspension used on our products.

With the aid of a series of illustrations of this type plus a few words of explanation, you would have a good concept of the suspension in a few minutes. And what is often very important to us in planning, you would all have the same concept of it. On the other hand, suppose I had attempted the same explanation with only the orthographic layout of the suspension? All 18 feet of it. First of all, you could not even see it unless you came up one or two at a time to lean over the drawing, while even without the benefit of the projector, the original of this GRAPHIC could be readily and simultaneously seen by all those in a fair sized room. Second, even if you did come up for a close look, you could not get an over-all impression without studying the layout area by area and forming your own mental visualization. And with all regard to your specialized abilities in this field, I think you will agree that it would take you a great deal longer, at best, to obtain the same familiarity with the design.

Now then, let's say you are a Chief Engineer, a Vice President of Engineering or Manufacturing, or the General Manager of a Division -- you must make many important decisions regarding this suspension proposal-- your available time is short -- you may even be a little rusty on reading blueprints -- yet you must be thoroughly informed in order to make good decisions. I ask you, which form of GRAPHIC would you prefer? There really is no longer a question, these graphic illustrations, presentation renderings, or CARTOONS (as some of the old timers used to call them), are an indispensable aid in the fast, thorough and uniform dissemination of engineering information for planning purposes.

In addition to describing the physical construction of a new design, Engineering must SELL the benefits and advantages of the new proposal. Again, GRAPHIC aids are often worth the proverbial 10,000 WORDS in describing the features or operation of a new design. Figure 2, for example, was one of several used to describe the features of the new suspension previously shown. This particular feature of anti-brake dip was always a problem to describe and often would have been passed over for lack of comprehension if we did not have the aid of a GRAPHIC to explain it and leave a definite and correct impression in everyone's mind.

Figure 3, on the other hand, was one of several used to explain the operation of a new proposed hydraulic circuit. Without them, I am sure we would not even have been able to sell the idea of completing and testing the design. Explained in words, it just didn't sound practical, but the illustrations made the idea look much more feasible--and, fortunately for us, it did work.

These then are a few examples of how we use GRAPHICS to help establish the WHAT of future products. Of course, there are many more that are used as working tools to establish specifications, performance goals, package sizes, etc.

The WHEN, as previously indicated, concerns timing. Here the most important aid is a dressed up GRAPHIC version of the bar graph (Figure 4). This first example

*Presented at Mid-Winter Meeting of Engineering Graphics Division of ASEE, January 22, 1959.

is a simplified over-all programming chart. It serves to:

1. Impress all levels of management that the time to begin activity on a certain 195X program is now.
2. Remind all concerned that important decisions are required at key points and gives them the opportunity to be properly prepared. ("B", for example, indicates the beginning of body design activity which means basic styling must be finalized prior to this date.)
3. Emphasize that programs overlap so that one cannot be CLEANED UP before starting another. This complicates the managerial decisions and greatly increases work loads in operating sections.

Failure to realize and plan factors such as these can result in either a non-competitive product or, at best, excessive costs and trouble resulting from a last minute CRASH effort. These master programming aids are essential, if the most effective and efficient use of manpower and material resources is to be realized.

In addition to establishing a framework for an over-all program, the same graphic technique is also applied to individual elements of the program and to separate development projects. Figure 5 points out the significant timing events in a new engine program. The master timing chart previously shown is built up from the styling and body package requirements plus anticipated mechanical component programs such as this.

The same general technique is applied in more detail form to schedule the design and release activity for all significant parts in a new model program. It is also used to schedule the design, procurement, and build-up of experimental and engineering program cars.

We also find this type of GRAPHIC aid extremely helpful in following the progress of a program. It serves as a potent reminder that certain events must occur at specified times and provides a ready means of recording progress in relation to a plan. Used in this manner, GRAPHICS quickly emphasize a failure to conform to schedule and prompt suitable remedial steps to be taken before the entire program is jeopardized.

Similar aids are used to estimate and analyze manpower requirements, product cost trends, weight trends, and in many other areas where a graphic presentation is helpful in achieving a faster more thorough understanding of the program or problem. In this area, graphics are used to show and sell the HOW phase of planning--people, material, facilities, money, etc. These elements, of course, are necessary to the successful completion of any program.

These then are some of the many ways GRAPHICS are applied in the planning operation. They are helpful in showing product details, benefits, and timing considerations to managment as part of the background for good and timely product decisions. They are also essential to the effective initial planning of a program and serve as a valuable aid in insuring that the program is carried out according to plan.

In the manufacturing phase, most of the same techniques apply. We find graphic illustrations, often the same ones used in planning presentations, the best means of supplying advance information to those who are responsible for planning the manufacture of a new product. Again, a saving of time and a more thorough understanding resulting from the use of these GRAPHIC aids, makes them well worth the effort. Instead of countless calls from many different individuals in manufacturing to our engineering personnel, these GRAPHICS tell such an effective story that individual inquiries are kept to a minimum.

These same GRAPHICS are later expanded into more detailed illustrations including part numbers and assembly instructions. (Figure 6) These are reduced and distributed in 8 1/2 x 11 size in a production assembly manual. A complete book containing all the information on what goes into a car and how it should be assembled can be carried under your arm. Comparable information in the form of orthographic drawings would require a fair sized truck. The principal benefit, however, is the time saved as a result of the efficiency with which the information can be assimilated. Given time, top supervision and tooling personnel could presumably understand the subject from regular drawings, but the new graphic illustrations provide a means of instructing all personnell to a degree that could not be achieved with orthographic drawings. Often the related GRAPHIC is posted on a pillar immediately adjacent to the point where the operation is performed. This type of instruction cannot help but result in increased productivity and improved quality of product.

Other modern GRAPHIC aids similar to those discussed in connection with engineering also are used extensively in the manufacturing area. Graphs are utilized to plan and schedule tooling programs, to plan and sell manpower and facility requirements, record costs, quality, and production performance, and countless other uses where the high impact value of the modern graphic method provides a faster and more effective means of presenting information.

Lastly, in the sales field, it would be repetitious to detail the uses of GRAPHICS since they utilize the same tools to an even greater degree. After all, one of the major uses of GRAPHICS in engineering and manufacturing is to SELL. It may be an idea or a new piece of equipment rather than a finished automobile, but we found the HARD SELL necessary in these operations a long time ago. One of the most important uses of GRAPHICS in the sales area is in the compiling and presentation of marketing information. The effectiveness of GRAPHICS in presenting this type of information -- particularly statistical data -- has been outstanding.

To sum up then, the latest forms of GRAPHICS, particularly three-dimensional illustrations and special forms of bar graphs have proven their worth in:

1. Saving time
2. Promoting better understanding
3. Insuring more uniform understanding
4. "Selling" an idea
5. Improving efficiency and quality.

They have earned their place as a valuable tool in promoting better communications -- a very vital need today as always.

What does all this mean to engineering educators. We realize that you do not have the time to provide comprehensive instruction in the art of these graphic methods. But we place great importance on these new techniques; we really recognize the use of them. Impress upon your students that methods like these exist and are used effectively. Also, that the degree to which they recognize and use them may have a major effect on the success they gain in their profession. These methods, and other new techniques to come, will at least partially supplant our venerable mechanical drawings of today. For example, we are planning to use graphic illustrations to replace many of our current orthographic adaptation drawings.

Our rapidly expanding scientific knowledge and the developing shortage of technical personnel all portend an increasing need for faster and more effective means of communicating technical information. We, in industry, would like to work with you in developing the techniques and in creating an awareness and knowledge of their need and importance in the minds of our future engineers.

"K" SERIES FRONT SUSPENSION

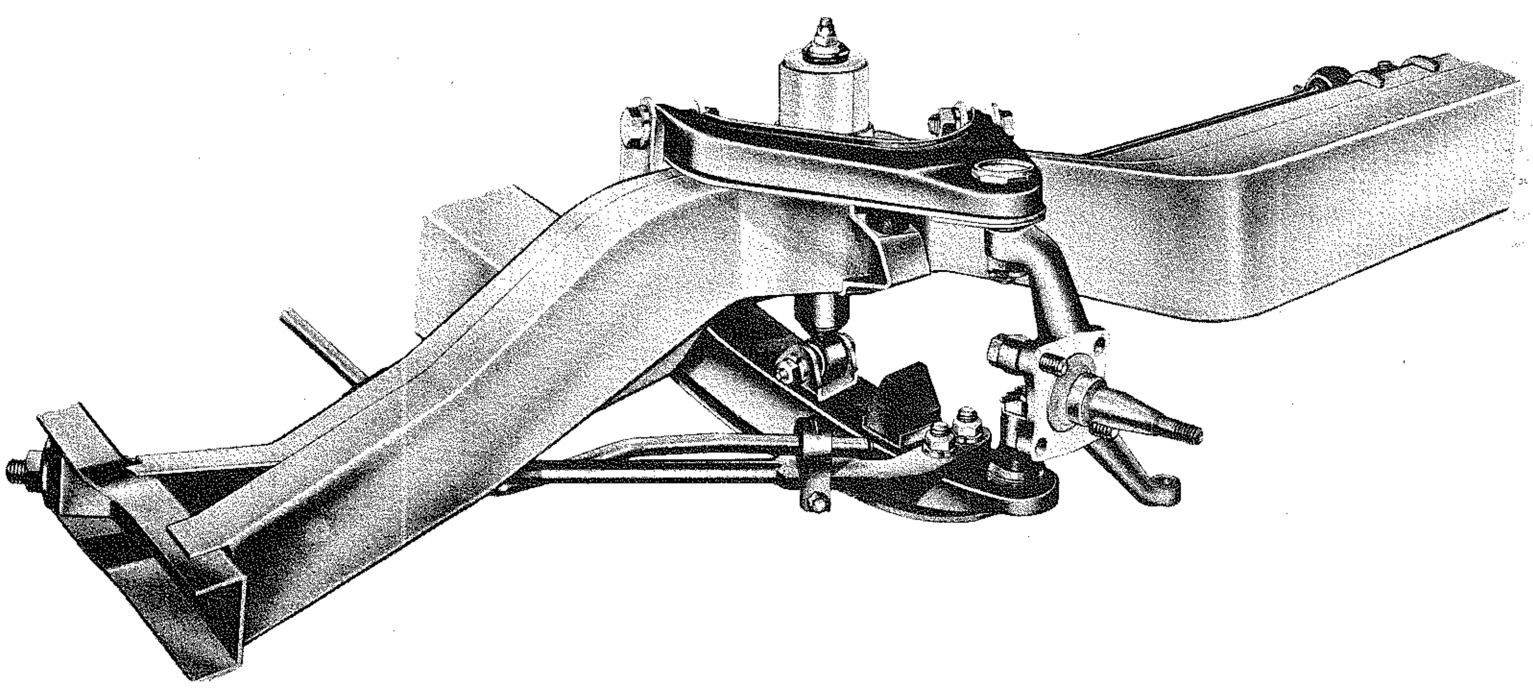


FIG 1

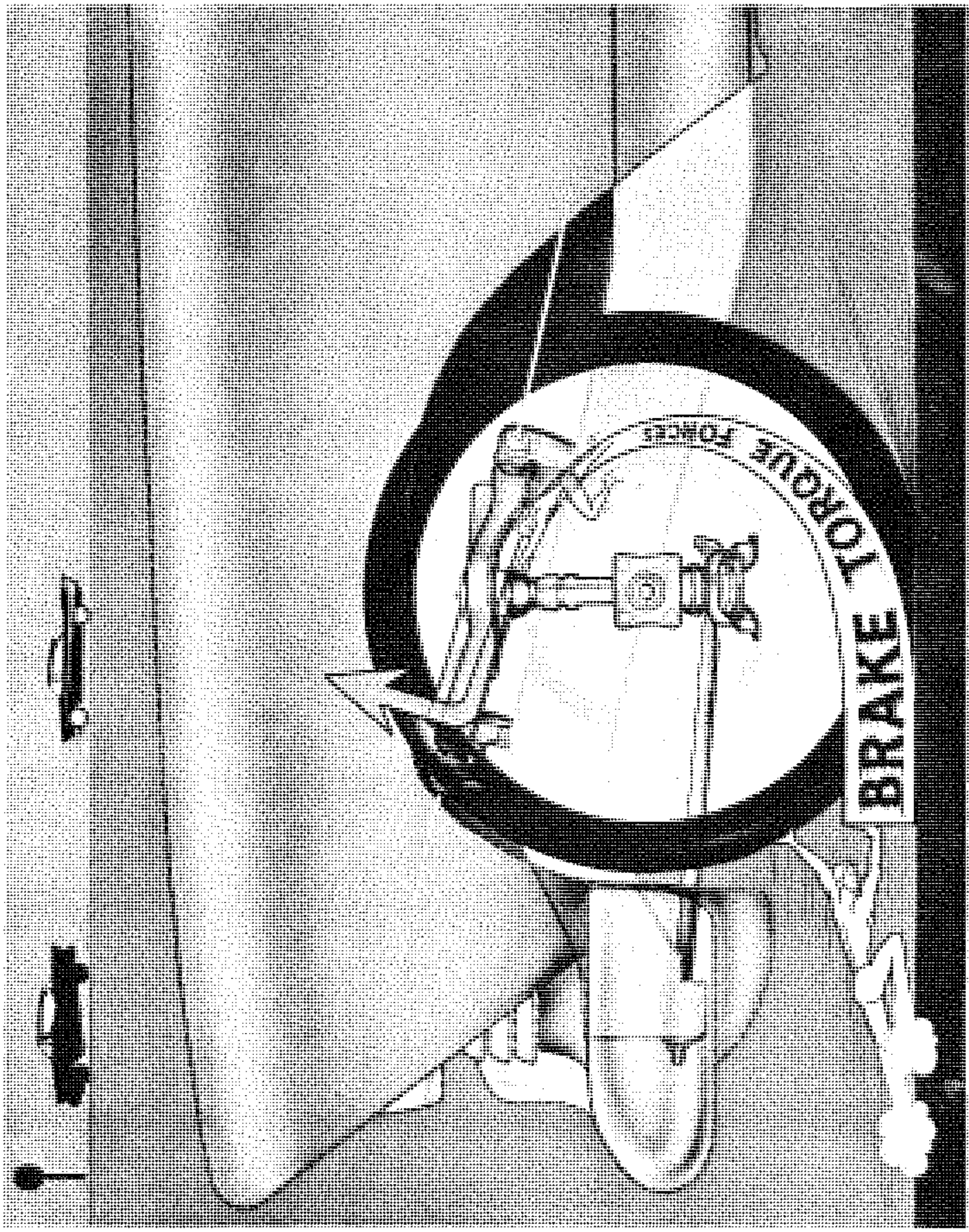


FIG 2

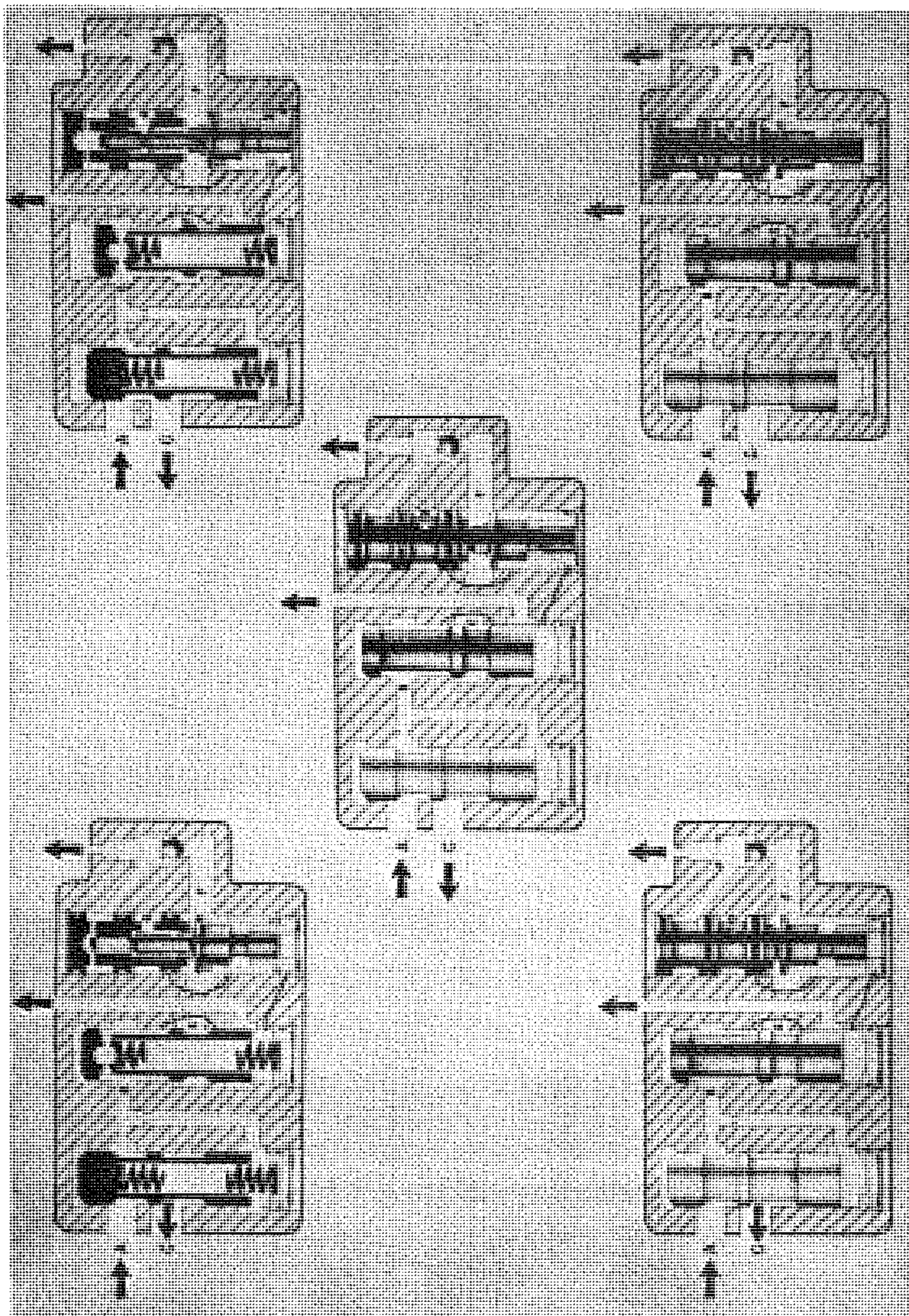


FIG 3

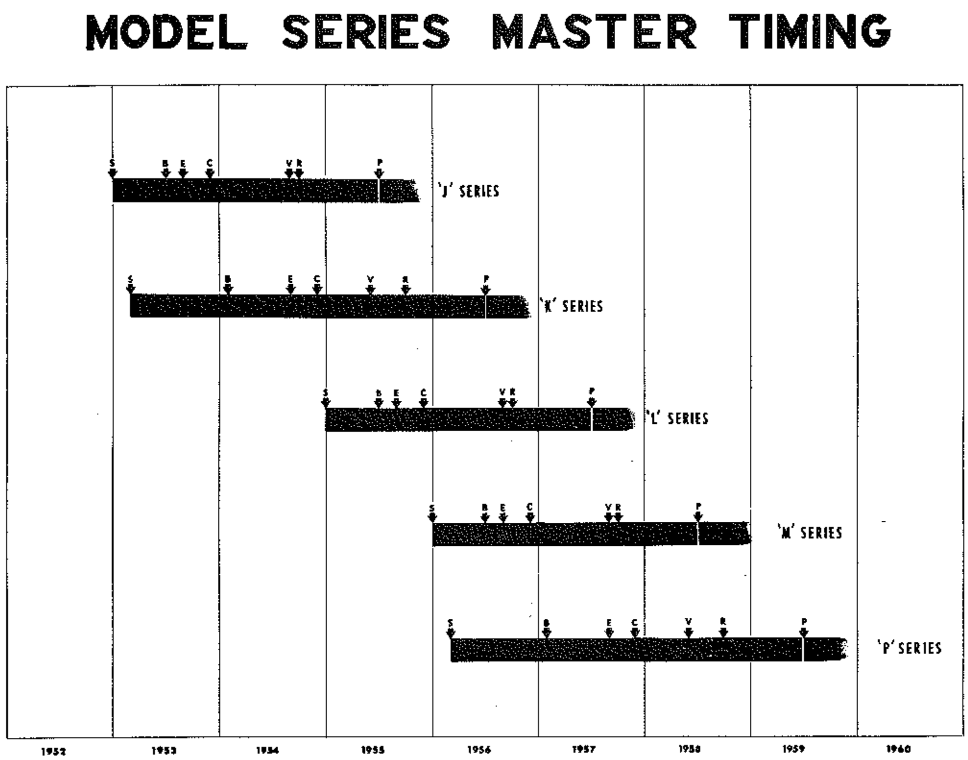

MODEL SERIES MASTER TIMING
'J' SERIES
'K' SERIES
'L' SERIES
'M' SERIES
'P' SERIES
1952
1953
1954
1955
1956
1957
1958
1959
1960

FIG 4

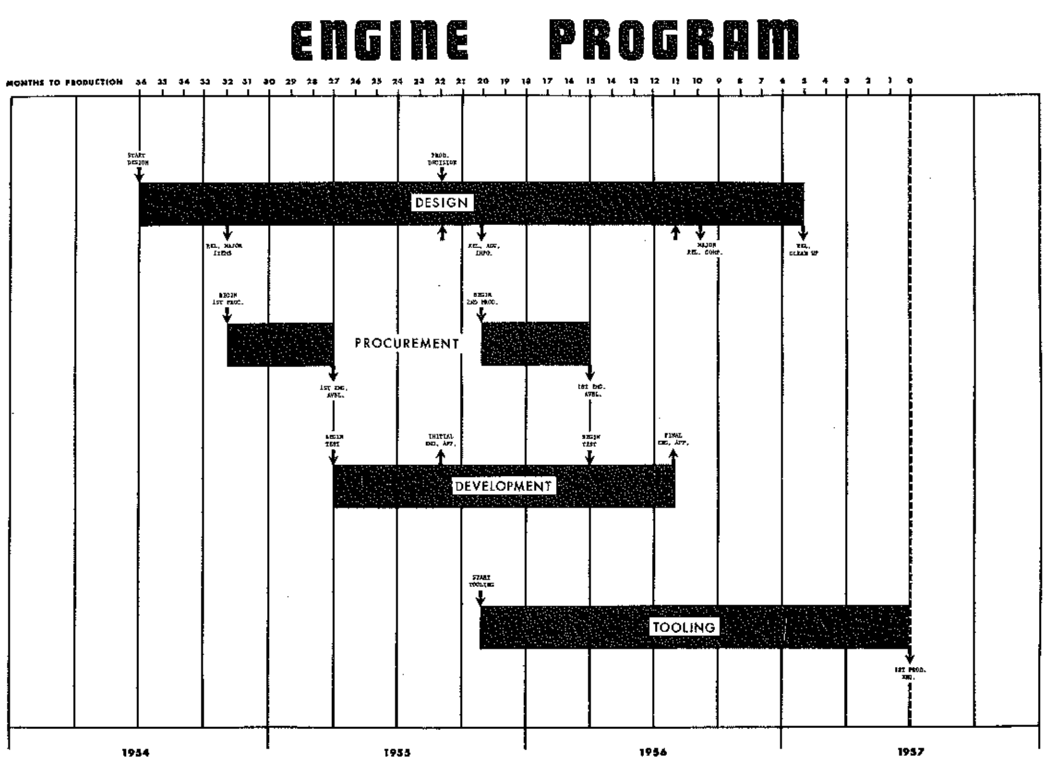
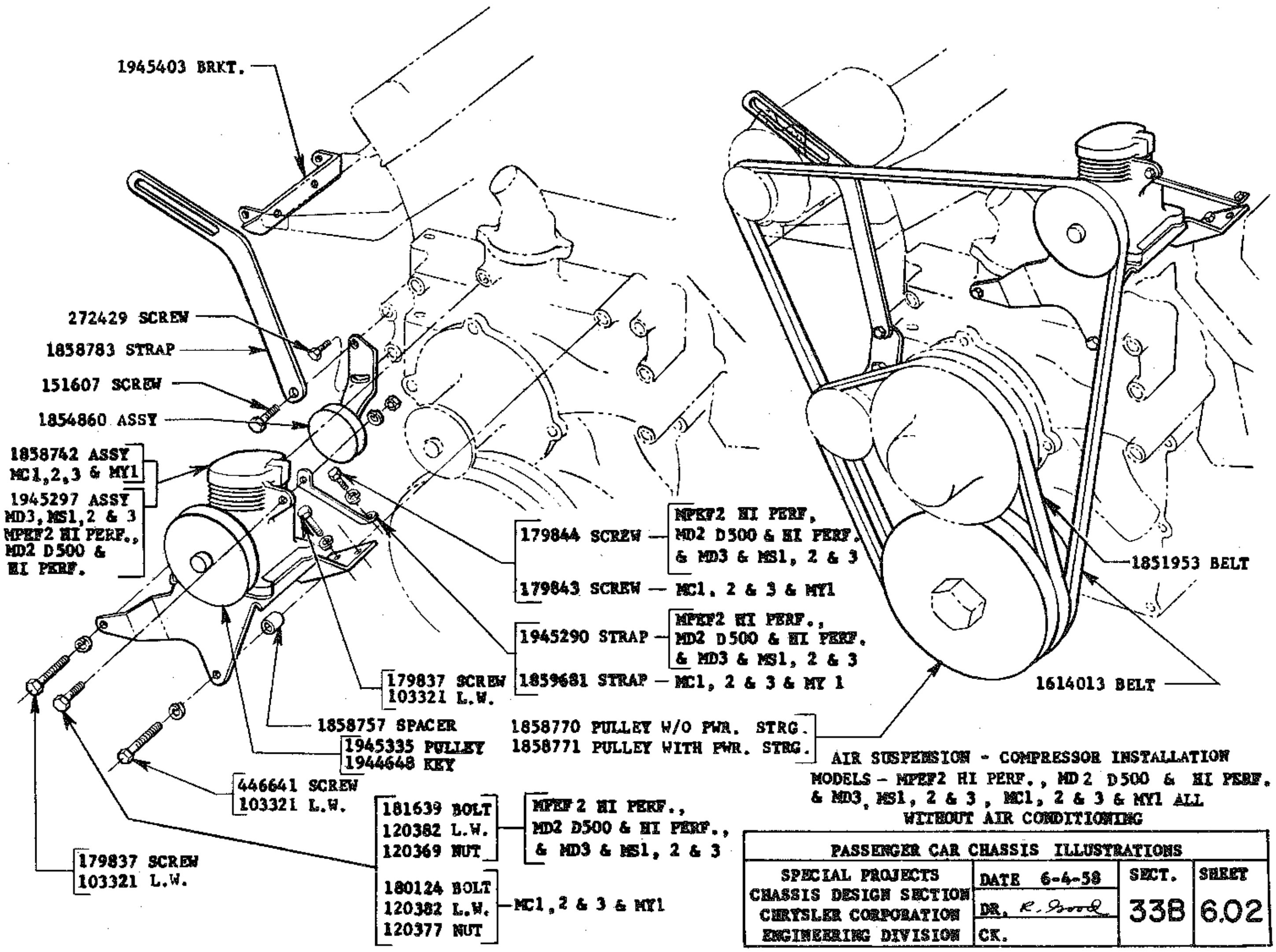

ENGINE PROGRAM
MONTHS TO PRODUCTION
START DESIGN
PROD. DECISION
DESIGN
REL. MAJOR ITEMS
REL. ADV. INFO.
MAJOR REL. COMP.
REL. CLEAN UP
BEGIN 1ST PROC.
BEGIN 2ND PROC.
PROCUREMENT
1ST ENG. AVBL.
BEGIN TEST
INITIAL ENG. APP.
FINAL ENG. APP.
DEVELOPMENT
START TOOLING
TOOLING
1ST PROD. ENG.
1954
1955
1956
1957

FIG 5



1945403 BRKT.
272429 SCREW
1858783 STRAP
151607 SCREW
1854860 ASSY
1858742 ASSY
MC1,2,3 & MY1
1945297 ASSY
MD3, MS1, 2 & 3
MPEF2 HI PERF.,
MD2 D500 &
HI PERF.
179844 SCREW
MPEF2 HI PERF.,
MD2 D500 & HI PERF.
& MD3 & MS1, 2 & 3
179843 SCREW — MC1, 2 & 3 & MY1
1945290 STRAP
MPEF2 HI PERF.,
MD2 D500 & HI PERF.
& MD3 & MS1, 2 & 3
1859681 STRAP — MC1, 2 & 3 & MY 1
1851953 BELT
1614013 BELT
179837 SCREW
103321 L.W.
1858757 SPACER
1945335 PULLEY
1944648 KEY
1858770 PULLEY W/O PWR. STRG.
1858771 PULLEY WITH PWR. STRG.
446641 SCREW
103321 L.W.
181639 BOLT
120382 L.W.
120369 NUT
MPEF 2 HI PERF.,
MD2 D500 & HI PERF.,
& MD3 & MS1, 2 & 3
179837 SCREW
103321 L.W.
180124 BOLT
120382 L.W.
120377 NUT
—MC1, 2 & 3 & MY1
AIR SUSPENSION - COMPRESSOR INSTALLATION
MODELS - MPEF2 HI PERF., MD 2 D500 & HI PERF.
& MD3, MS1, 2 & 3, MC1, 2 & 3 & MY1 ALL
WITHOUT AIR CONDITIONING
PASSENGER CAR CHASSIS ILLUSTRATIONS
SPECIAL PROJECTS
CHASSIS DESIGN SECTION
CHRYSLER CORPORATION
ENGINEERING DIVISION
DATE 6-4-58
DR.
CK.
SECT.
33B
SHEET
6.02

FIG 6

The Mark of Drawing Instruments
that are
BETTER ENGINEERED AND BETTER MADE
Much BETTER

T- SQUARES

You, like many other teachers, may have experienced within the last few years difficulties with T-squares. Of course, loosening of the joint between the wooden head and the arm has been a problem of such long standing as to have become almost "a necessary evil," and provision of various supplemental screw or bolt fastenings seeking to reinforce the joint has been going on for years.

However, excessive nicking of the guiding edges, breakage of the plastic corners at the end of the arm, usually followed by separation of the plastic edges from the wooden arm, thus making the T-square virtually unusable, have appeared to many as a very annoying but inexplicable failure of a proven construction.

There is a simple explanation for these difficulties. The familiar T-square construction including a wooden head and a wooden arm with transparent plastic lined edges was developed by trial and error over a period of many years with the use of "celluloid," i.e. cellulose nitrate, an exceedingly tough and virtually shatter-proof plastic material. With "celluloid," that construction served very well. However, the susceptibility of cellulose nitrate to attack by apparently contagious fungus disease which causes its unsightly discoloration and disintegration, reached alarming proportions in recent years. This and other important reasons accelerated acceptance of new plastic materials for drafting instrument applications.

Properly used, the new materials provide opportunities for important advances in this field. However, it should be fully appreciated that properties of the new materials are not the same as those of celluloid. Particularly, their increased hardness and brittleness has to be kept constantly in mind in designing. Unfortunately, in the case of T-squares the new materials were, in many instances, merely substituted for the old celluloid into virtually the same dimensional and constructional specifications not fully suited for the new materials. Similar "substitution of materials" has resulted in serious failures in many other fields of engineering design, and it proved to be very embarrassing in this instance as well, bringing about the difficulties which you have probably observed.

Working with the new materials, our engineers developed an improved T-square, basing its design on the purpose or function of the instrument and properties of the materials best suited for its construction. We avoided the temptation of following accustomed design by inertia. We also thought that an improved design need not necessarily look like the old wooden T-square.

Dolgorukov solid acrylic T-square is characterized by: elimination of wood as material of its construction; elimination of "extruded" or "molded" plastic parts which cause image distortion and resulting eye strain; one-piece fully transparent arm made of optically flat acrylic sheet material; non-loosening joint between the head and the arm; head size and arm width selected to make use of the T-square of that particular length most convenient, rather than to produce T-squares of different lengths using the same size head and merely changing the length of the arm; exclusive feature of chamfered working edges, rounded corners and beveled end edges virtually eliminate, in normal use and abuse, nicking of the guiding edges, breaking off of the corners of the arm and chipping of its end edges.

Other valuable improvements become apparent at the first trial.

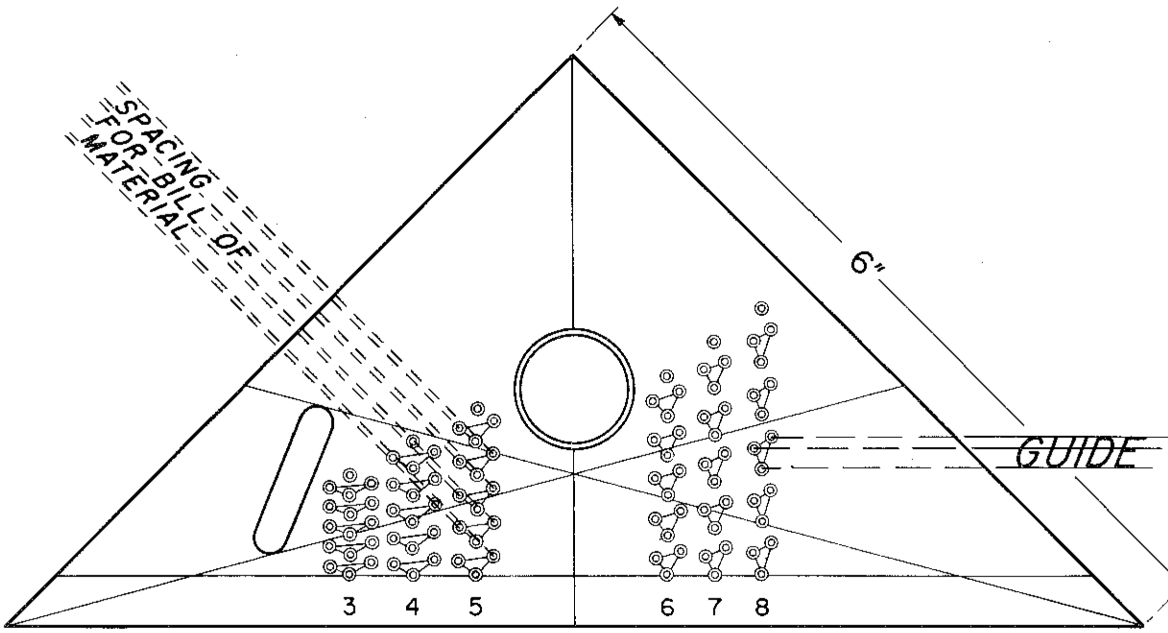
These T-squares are now ready for you and your students, and we shall appreciate your critical interest.

Write for further information

DOLGORUKOV MANUFACTURING CO. • 407 FISHER BLDG. • DETROIT 2, MICH.

Registered Professional Engineers. Designers and Manufacturers of Engineering and Drawing Instruments

BRADDOCK LETTERING ANGLES



6"-45° STYLE "A" LETTERING ANGLE

All Style "A" Lettering Angles have the black hairlines, as shown above, which enable one to obtain angles of 15°, 30°, 45°, 60°, 75°, and 90°, from either a 45°x45° or a 30°x60° Lettering Angle, by setting these hair lines on horizontal or perpendicular lines on the drawing board.

Style "A" Lettering Angles have the holes connected in groups of three by means of black lines, as shown above. This grouping makes it easy for the student and draftsman to understand the use of the holes.

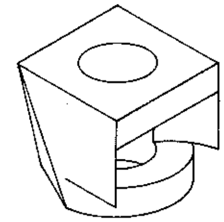
BRADDOCK INSTRUMENT COMPANY

PITTSBURGH 18, PA.

Problems In Engineering Drawing--Abridged

by W. J. LUZADDER and J. N. ARNOLD,
Purdue University

and F. H. THOMPSON, Senior Technical Artist,
Allison Division, General Motors Corporation



Forty problems sheets, some on tracing paper, some on bond paper.

The several editions of these problems have been used with marked success in engineering schools and technical institutes since 1943.

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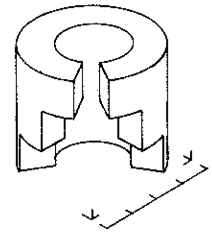
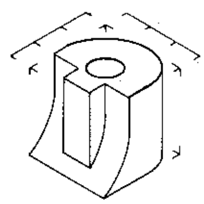
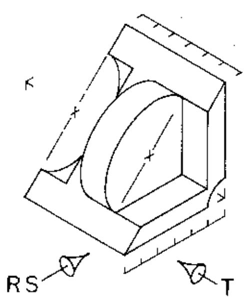
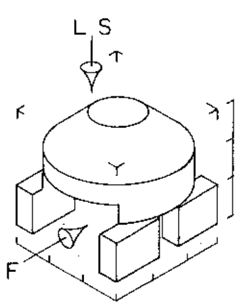
Use of Instruments and Geometrical Constructions
Detail Drawing ● Assembly Drawing
Auxiliary Views ● Sectional Views

Fourth edition 1956 **$1.70**









Worksheets For Introductory Graphics--Form A

by J. N. ARNOLD, M. H. BOLDS, S. B. ELROD,
J. H. PORSCH, RICHARD P. THOMPSON

members of Engineering Graphics staff
Purdue University

One hundred problem sheets, on a good quality of ledger paper. Introduces the student to a variety of graphic principles and learning experiences.

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Multiview Drawing ● Pictorial Drawing
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Drawings for Construction ● Representation of Data
Developments ● Space Problems of Angle and Distance
Representation of Equations ● Vectors ● Intersections
Graphical Calculus

1958 **$4.00**

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THINK

NEW . . . published in January

The fourth edition of Luzadder's

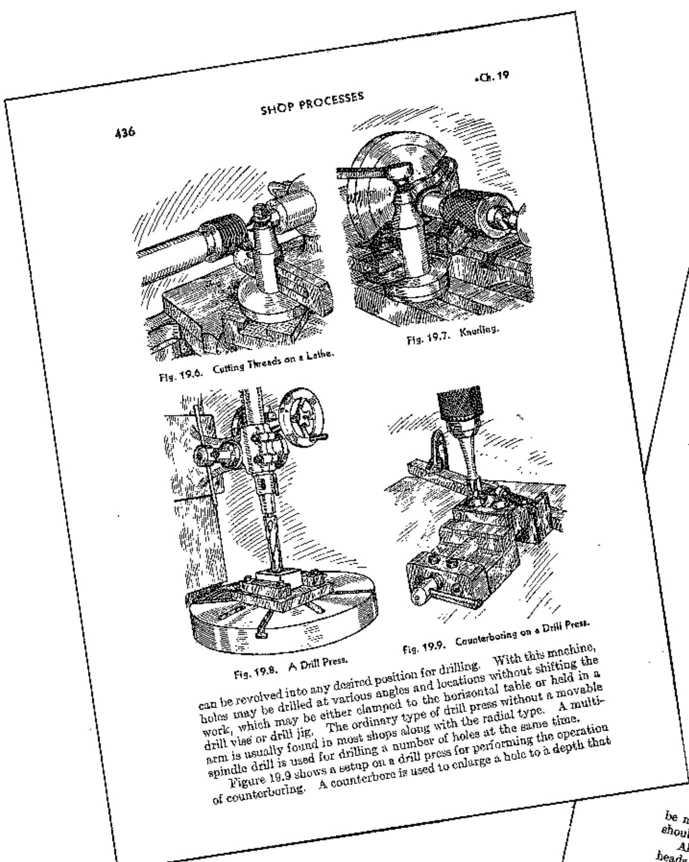
Fundamentals of Engineering Drawing

Considered by many a *standard* in the field, this engineering "best seller" — sales record: $1,000,000 — is now available in a new, improved, and completely revised fourth edition.

Through three successful editions "Luzadder" has helped to train many students in engineering drawing. In this new edition the author retains the tested and proved presentation that has won acclaim throughout the country. He also incorporates the latest drawing practices and standards approved by the ASA and SAE and accepted increasingly by modern industry.

Among the outstanding features of the 1959 fourth edition:

- Four hundred New illustrations to replace many of the old ones and to accompany new material
- A new chapter on pictorial sketching
- Chapter 15 covering dimensioning is expanded and now incorporates New practices—for example, the fits recommended for use between plain cylindrical parts as given in the recent ASA B4. 1-1955 standard.
- New problems are supplied for almost all chapters



436 SHOP PROCESSES Ch. 19

Fig. 19.6. Cutting Threads on a Lathe.

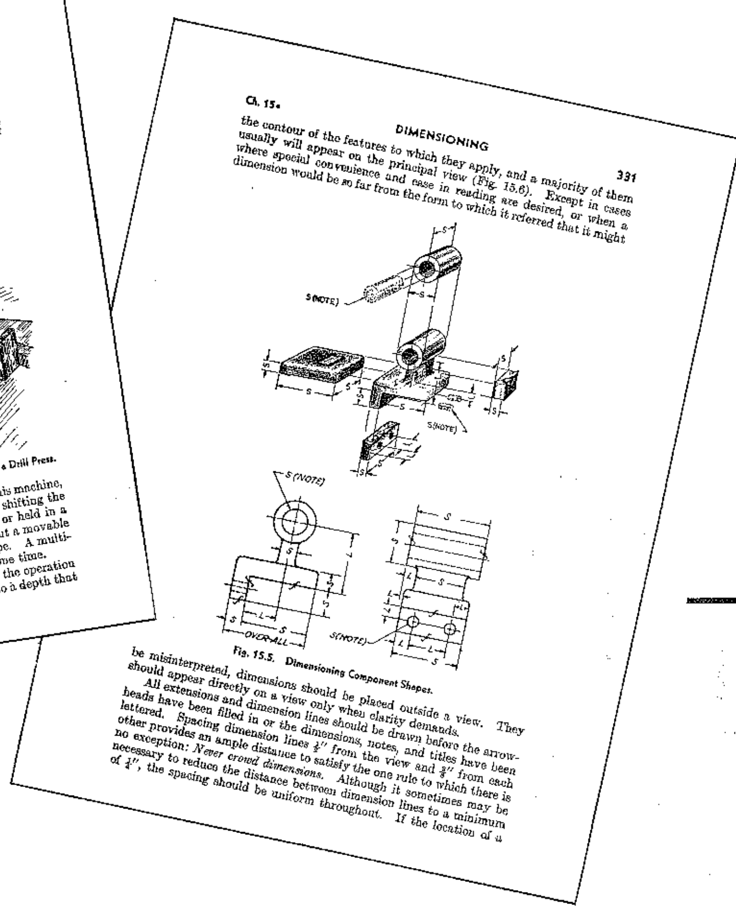
Fig. 19.7. Knurling.

Fig. 19.8. A Drill Press.

Fig. 19.9. Counterboring on a Drill Press.

can be revolved into any desired position for drilling. With this machine, holes may be drilled at various angles and locations without shifting the work, which may be either clamped to the horizontal table or held in a drill vise or drill jig. The ordinary type of drill press without a movable arm is usually found in most shops along with the radial type. A multi-spindle drill is used for drilling a number of holes at the same time.

Figure 19.9 shows a setup on a drill press for performing the operation of counterboring. A counterbore is used to enlarge a hole to a depth that



Ch. 15 DIMENSIONING 331

the contour of the features to which they apply, and a majority of them usually will appear on the principal view (Fig. 15.6). Except in cases where special convenience and ease in reading are desired, or when a dimension would be so far from the form to which it referred that it might

Fig. 15.5. Dimensioning Component Shapes.

be misinterpreted, dimensions should be placed outside a view. They should appear directly on a view only when clarity demands.

All extensions and dimension lines should be drawn before the arrowheads have been filled in or the dimensions, notes, and titles have been lettered. Spacing dimension lines ½" from the view and ⅜" from each other provides an ample distance to satisfy the one rule to which there is no exception: *Never crowd dimensions.* Although it sometimes may be necessary to reduce the distance between dimension lines to a minimum of ¼", the spacing should be uniform throughout. If the location of a

Designed for beginners, *Fundamentals of Engineering Drawing* is based upon a self-teaching approach that makes it uniquely easy to use as a guide through all phases of engineering drawing, regardless of background knowledge. The author has proved the value of this approach through years of successful usage with students at all levels.

Essential fundamentals . . . use of instruments, lettering, engineering geometry, multi-view drawing . . . are given at the outset of the book in a new and carefully revised presentation. Then the author turns to the all-important tool, language, for a dictionary-like coverage of the language of the draftsman and the engineer. Upon this bedrock foundation subsequent knowledge and understanding are built throughout the book.

The reader is given a crystal-clear analysis of Pictorial Sketching in an entirely new chapter. The chapter on Welding Drawing has been thoroughly revised in accordance with the ASA standard.

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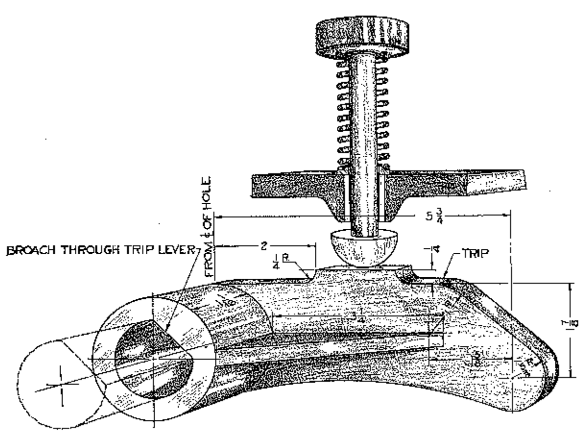

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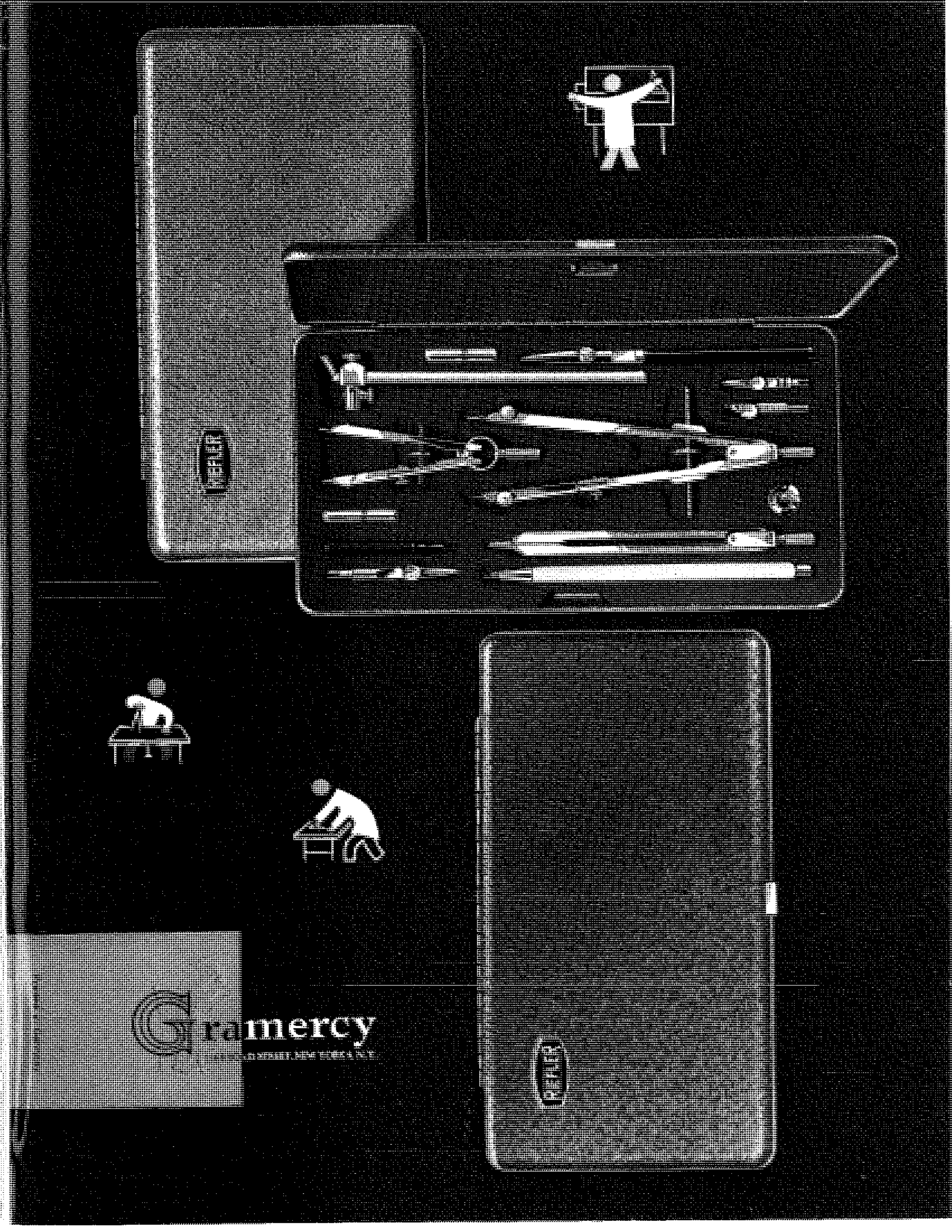
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