THE JOURNAL OF

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DIMENSIONING AND NOTES

THIS ON THE DRAWING — MEANS THIS IS ACCEPTABLE

SPECIFYING THAT A HOLE MUST BE LOCATED FROM, AND IS PARALLEL TO, ANOTHER HOLE

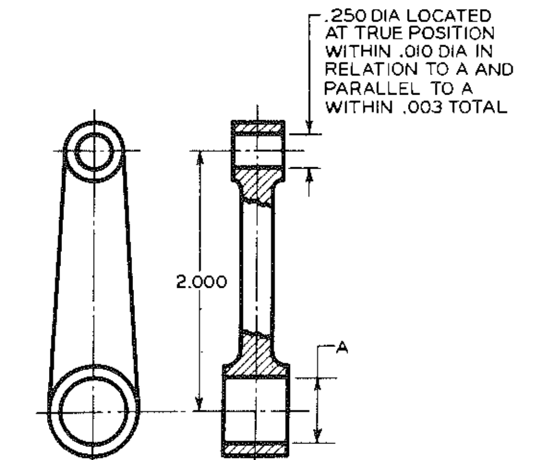

FIG. 57a

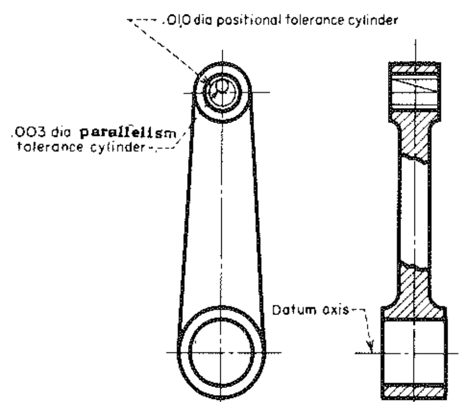

FIG. 57b

TOLERANCE ZONE OR BOUNDARY WITHIN WHICH FORM MAY VARY WHEN NO TOLERANCE OF FORM IS GIVEN

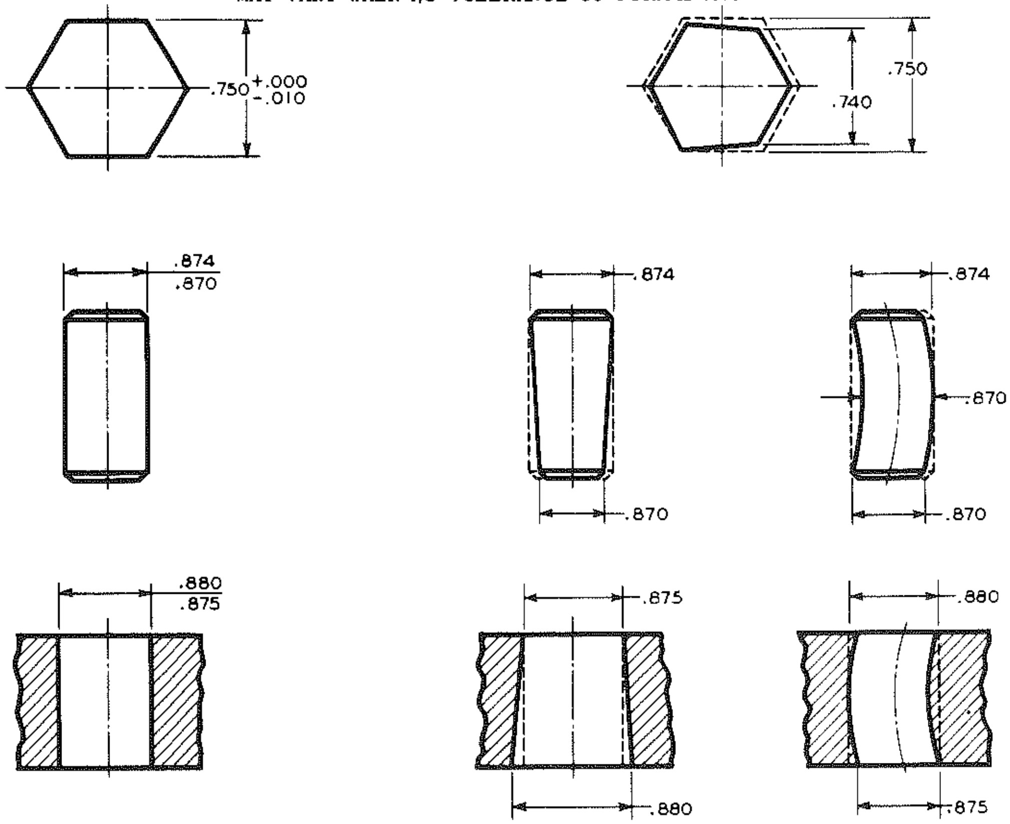

FIG. 58

VOL. 22, NO. 3 — NOVEMBER, 1958 — SERIES NO. 66

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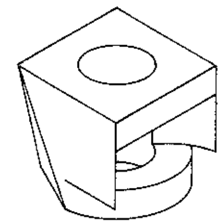

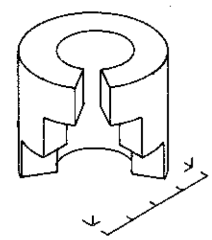

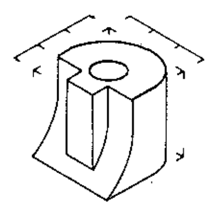

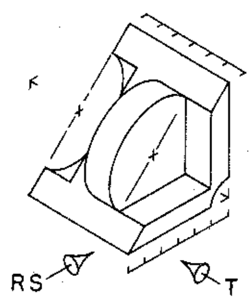

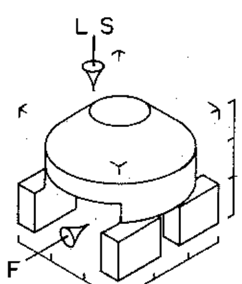

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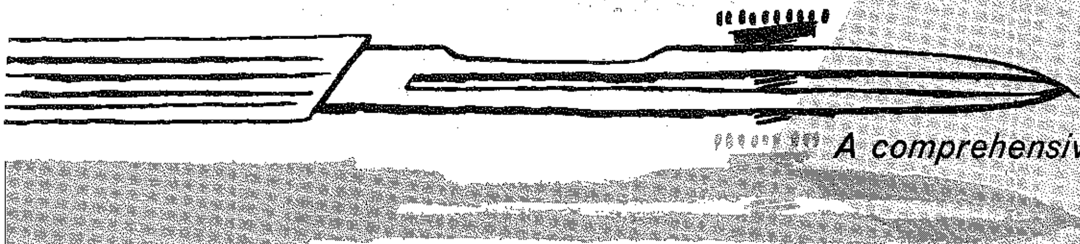

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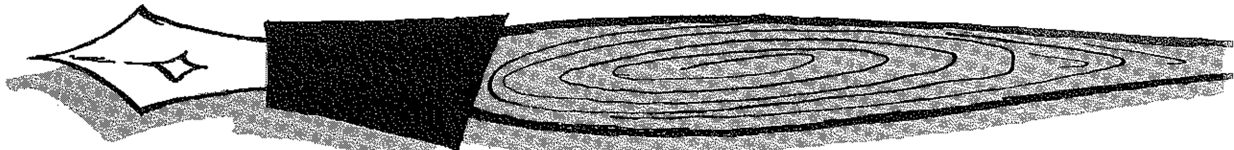

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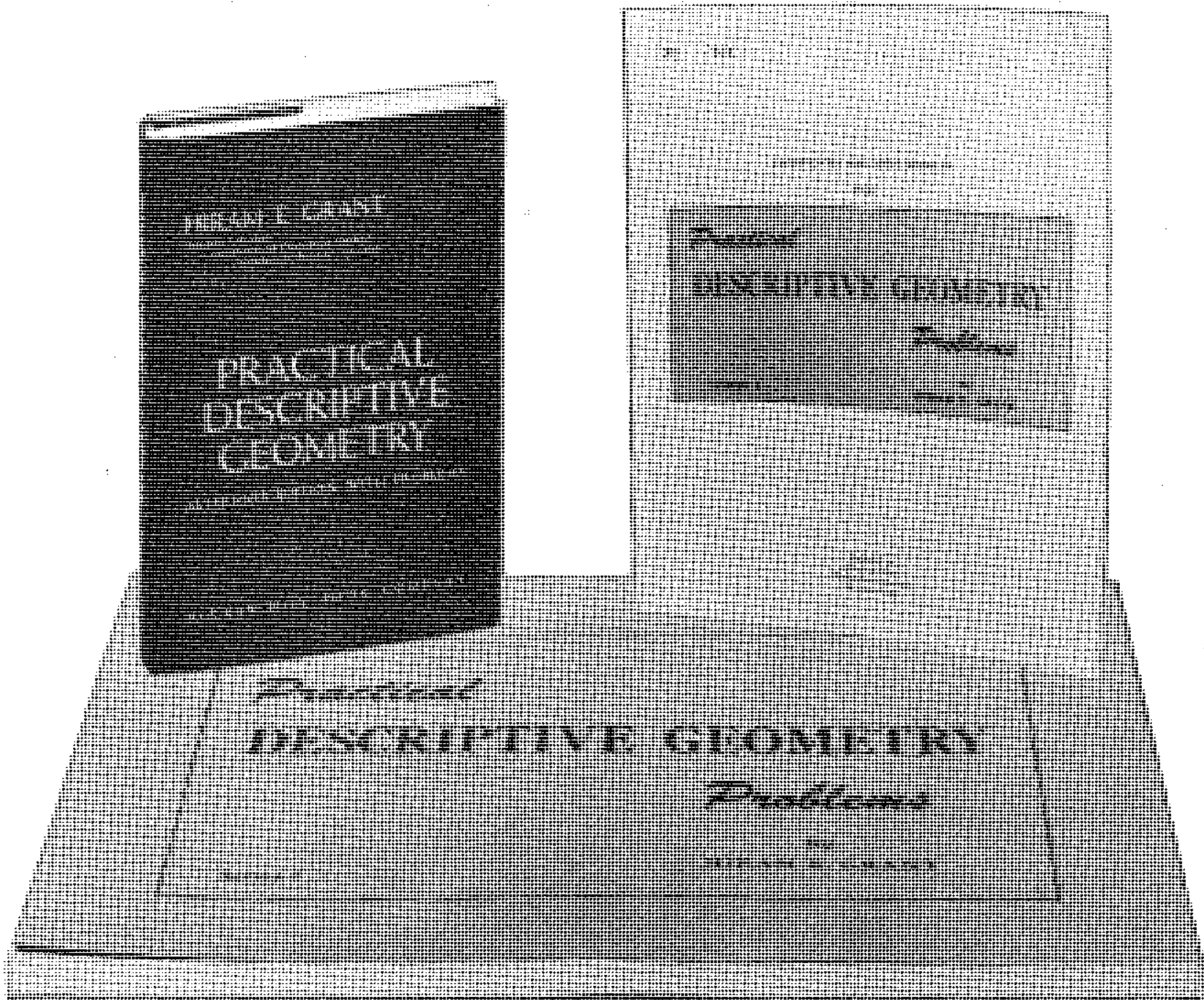

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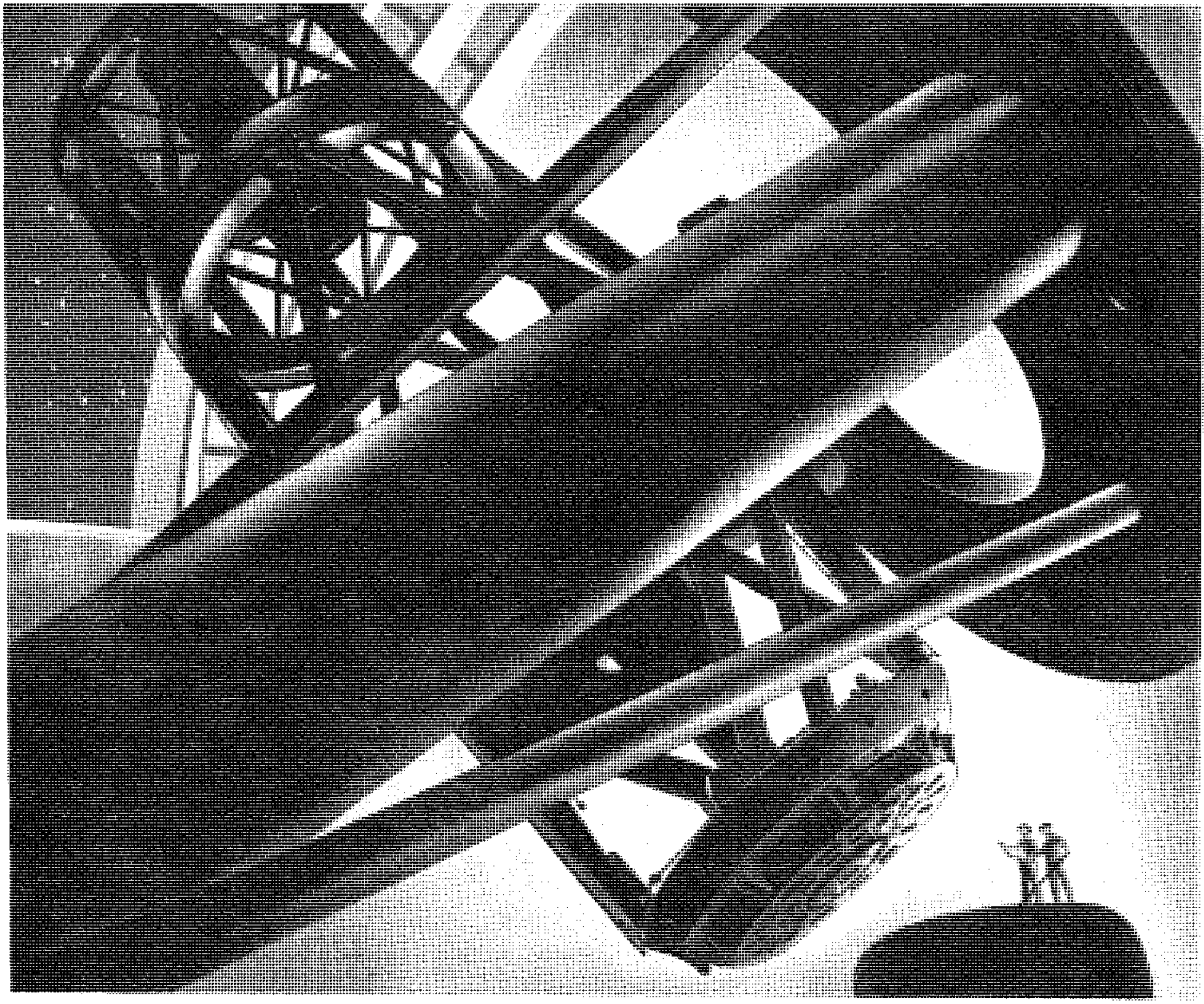

CONTENTS

About the Cover:

Understanding it, you are aware of one particle of drawing progress: Standardization. The cover of our next issue of the Journal will be more of a challenge. See ASA Y14.5-1957, Section 5, for further explanation of the cover.

EDITORIAL PAGE

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THE NEW NAME

The Division of Engineering Graphics of the American Society of Engineering Education is now the name for the organization formerly entitled the Division of Engineering Drawing of the American Society for Engineering Education.

In the May issue of this Journal, the announcement and argument for the change of name were presented. In June, at the annual meeting of the Division, 45 members voted for the change of name and 22 members voted against.

By our vote, "drawing" does not become an archaic or tarnished word. We will always use the word when appropriate. Many strong colleges and universities will maintain departments of engineering drawing without stigma or shame. A book may use the word "graphics" or "drawing" in its title, neither enhancing nor detracting from the merit of the content beneath its cover. We presume that engineering documents will be called "drawings and specifications" rather than "graphics and specifications" for many years. For some time, we must explain that the principal meaning of the word "graphics" is the more familiar word "drawing".

What connotation presently goes with "graphics" derives from the past. What the word will mean in the future is not a matter of semantics, but of what each of us does. Argument about a word is futile. What matters is that each of us do his best to increase the power of graphics (engineering drawing, descriptive geometry and nomography) in solving the engineering problems and creating the engineering works of the future.

OUR PAST EDITOR

We pay our respects to the former editor of the Journal, Irwin Wladaver. During his years of service he worked diligently and advanced the quality of this Journal and the cause of engineering drawing. He deserves the admiration and gratitude of the entire division of engineering graphics for a job well done.

COMMUNICATIONS AND WORK

Our communication between members of this division has been excellent. We have done a good job of talking to ourselves, but we must also concentrate on speaking to and working with other engineers. The Journal will continue to invite your contributions, both essays on drawing and new graphic procedures. But please submit for publication to other engineering journals, to public magazines, and to newspapers your ideas in graphics and your assessment of the state of engineering graphics in engineering education.

Some of us may even have the opportunity to present drawing instruction on television. You will not be asked to present a TV program; you must work for the time. Prepare and rehearse a worthwhile and imaginative show--then use ingenuity and initiative in gaining acceptance. Emphasize that the show is only an elementary fragment of the scope of engineering graphics.

A teacher of engineering graphics would do well to engage in research and consulting work on engineering projects during the school year, and during vacations to engage in engineering design, production or research. Thus, he will increase his proficiency as an engineer and teacher, and perform the best kind of missionary work for engineering graphics. We are surfeited with excellent books and workbooks in drawing and graphics; now, each of us must devote himself to an integrated role in engineering work.

THE IMPORTANCE OF ENGINEERING GRAPHICS TO THE PROFESSIONAL ENGINEER

By

Andrew MacLellan, Senior Dynamics Engineer

CONVAIR (San Diego)
A Division of General Dynamics Corporation

According to my dictionary, there are two definitions of the word graphics. One is concerned with the very broad definition of the art of drawing, and the other defines it as the science of calculating by diagrams. This article will concern itself with both of these definitions since both play an important part in the aircraft industry. I must, of necessity, confine my discussion to the aircraft industry since I am most familiar with it. Perhaps the most direct way of explaining the use of graphics in our industry is to follow the development of a new aircraft, either airplane or missile, through our establishment.

I shall define the primary steps in the development as:

1. Preliminary design
2. Engineering development
3. Detail design
4. Construction of prototypes
5. Flight test
6. Production

This article treats primarily the first two steps and touches very lightly on the others to indicate some other problems solved through the utilization of graphics.

The most important consideration in a new project is that it be salable. We are not concerned here with how the need is determined, but suffice it to say the need for a type of aircraft has been established. The first problem which we hope to solve with an assist from graphics is how to sell our product to satisfy the need. The preliminary design group prepares many sales brochures toward this end. As an example of sales brochures I shall use one for our jet transport, the "880". To give a good first impression one of the first pages of such a brochure will contain a three-view drawing of the proposed aircraft, as shown in Figure 1. This is an application of graphics in the broad sense, but it is nonetheless useful in the solution of the problem stated earlier. Also under the broad definition of graphics comes the important internal arrangements of the aircraft, as indicated in Figure 2. Following this introduction to the hardware is the consideration of costs, as illustrated in Figure 3. The two-axis plot with cartesian coordinates is the most common type of engineering graphics encountered in the aircraft industry and probably in most other engineering endeavors. Figure 3 shows two of a family of curves for determining cost per passenger mile over various route lengths for types of passenger arrangements. Although the solution of a problem to the engineer on such a plot is near trivial, the numbers on the axes make it extremely important to him since his job may be dependent on the accuracy of such figures.

Throughout the preliminary design stage, cost studies are made to assure presentation of the most salable item. In preparation of brochures for the customer, the preliminary design group is assisted by the technical groups, which include aerodynamics, thermodynamics, dynamics, and hydrodynamics. During the initial period of development, the studies of these groups most often culminate in the familiar cartesian coordinate plot showing trends in the aircraft's characteristics as certain parameters are varied.

Typical of such trend plots for a military project is the variation in the flutter speed at high Mach number of an all-movable control surface shown in Figure 4, which might be a missile or interceptor. From the plot shown in Figure 5, the design engineer can determine how the flutter speed will be affected by change in the hinge line location or mass balance of the surface about its hinge line. The solid lines show variations for constant hinge line location as the mass balance is varied. A vertical projection on the plot is a simultaneous change in hinge line location and mass balance.

Once the general configuration has been established and customers have been found, the next step -- engineering development--is undertaken. At this stage the definition of graphics as the science of calculating by diagrams becomes more prevalent. An example of this is the recent development of a nomograph to assist in the design of a nose cone for a re-entry vehicle (Reference 1). The equation for stagnation point heat transfer as developed in Reference 2 is:

$$q = \frac{17600}{\sqrt{D/2}} \; \rho/\rho_o{}^{2} \left[\frac{V}{26000}\right]^{3.15} H \left[\frac{\text{B.T.U.}}{\text{ft}^2\,\text{sec}}\right]$$

Where:

- q = Stagnation point heat transfer rate
- D = Nose cone diameter in feet
- ρ = Density
- ρ_o = Sea level density
- V = Re-entry velocity ft/sec
- H = Function depending on the enthalpy change through the boundary layer

This expression, as you may already have surmised, is a little clumsy for use by a designer, so a simplification was made be assuming H = 1, i.e., the missile surface is much cooler than the local stream and utilizing

Allen-Egger's (Reference 3) trajectory approximation:

$$V = V_E\, e^{\left[-3794 \frac{C_D A}{W} \frac{1}{\sin \theta_E} e^{-\beta Y}\right]}$$

Where:

$$\rho/\rho_o = e^{-\beta Y} \qquad \beta = \frac{1}{22000}$$

$\frac{C_D A}{W}$ = Drag to weight parameter for the body, ft^2/lb

Y = Altitude in feet

θ_E = Angle between horizontal and missile direction at re-entry

V_E = Re-entry velocity, ft/sec

the following expression is arrived at:

$$q\sqrt{D} = \left[\frac{V_E}{1045}\right]^{3.15} e^{-\frac{\beta Y}{2}} + \left[-3794 \frac{C_D A}{W} \frac{}{\sin \theta_E} e^{-\beta Y}\right]$$

Utilizing the logarithm of this expression yields the nomograph shown in Figure 6. Shown on this figure is a sample problem for the satellite put into orbit by the Vanguard project. If the velocity, re-entry angle, drag to weight characteristics, and altitude of interest are known, the heat transfer at the stagnation point may be arrived at by drawing four lines as indicated. The first two points located are the re-entry angle (θ_E) and the body drag to weight parameter C_DA/W. Connecting these points gives a point on the (G) auxiliary axis. Choosing an altitude for the computation on (Y) and drawing a line through the point on (G) yields a point on the auxiliary parameter line f(log). This point is then transferred to f(linear), where it is used with a point on the re-entry velocity (V_E) axis to obtain a point on the auxiliary axis (S). The point on (S) is used with the altitude point on the (Y) axis to obtain the desired heat transfer ($q\sqrt{D}$) value.

Although nomographs are important examples of graphics, the greatest use of graphics in the technical groups is for solution of nonlinear problems. For example, the determination of the combat radius of an interceptor is shown in Figure 7. It is a relatively simple graphical solution but is quite difficult of solution employing mathematics alone. Two initial points on the plot are known: the gross weight at engine start (Point S on Figure 7) and the minimum gross weight permitted by military specification for landing (Point L). The amount of fuel used in engine warm-up and taxi is a known quantity with no resultant distance covered. The fuel required to climb to cruise altitude is next subtracted, and the miles traveled permit plotting the third point on the upper line of Figure 7. The fuel used during cruise-out at a constant air speed is known, and this line may be plotted. Beginning now at Point L, a specified reserve fuel is added to obtain the next point, and the fuel consumption at cruise is plotted on the lower curve from this point at the negative of the slope for the cruise-out. The intersection of the two cruise lines yields the maximum airplane range with no combat. The combat altitude dictated by specification requires a certain fuel consumption to attain it. The combat time is also specified or may be a variable. Such combat is to be performed at a given speed, thereby requiring a certain fuel consumption. The line for fuel to climb to combat and the the line for combat fuel are plotted to obtain the combat radius.

A common problem found in the Thermodynamics group during studies for an interceptor or bomber project is the selection of an optimum supersonic inlet shape. Figure 8 shows a section through a typical inlet with five source points shown. Plotting Mach lines from the five points where the thermal characteristics of the incoming air are known, the distance to the intersect points is scaled from the drawing and entered in a calculation to determine the thermal properties of the air at the intersect point. This procedure is carried out along the length of the inlet. The method of computation utilized is referred to as the characteristics method (Reference 4) for irrotational flow. The intersection of a number of Mach lines at any point in the inlet indicates the formation of a strong shock wave which will disrupt the flow in the inlet. The graphical detection of the shock wave is cause for rejecting the inlet design.

The Dynamics group conducts studies of rigid body airplane stability, flexible airplane stability including wing divergence, control reversal and flutter, and the control system design including its stability and response characteristics.

A unique method sometimes employed in the Dynamics group for the determination of rigid body stability characteristics is a graphic solution utilizing vectors (Reference 5). Figure 9 shows a simple solution of the rolling moment vector polygon for Dutch Roll oscillation. The rolling moments due to: sideslip angle (β), roll velocity (L_p), rolling moment of inertia (I_x), product of roll and yaw inertia (I_{xz}) are known, are well as the phase angle ($\epsilon_{\psi\beta}$) between heading angle and sideslip angle. Closing the polygon yields the rolling moment due to roll damping and the phase angle ($\psi_{p\beta}$) between rolling velocity and sideslip. Similar plots are made for the other degrees of freedom. Certain initial assumptions of approximate values for the vectors are made for these plots; and, as the plots of cross wind force and yawing moment are completed, the approximations must be altered and are refined until the final iteration yields the answers (damping phase angle ϵ_D, phase angle of roll with respect to sideslip, roll-sideslip ratio, roll-yaw ratio, and frequency of the undamped Dutch Roll oscillation ω_o) with desired accuracy.

The flutter investigation conducted in the Dynamics group requires initially the establishment of the various resonant frequencies and corresponding deformation patterns (modes) of the aircraft. These modes are used in the flutter analysis. There are limits to the number of modes which may be utilized in such an analysis, even though the mode analysis may determine as many as seventy modes. In most present-day complex aircraft, there are often resonant frequencies which are quite high that have deformation patterns which should be considered in the analysis. It is important that these modes not be overlooked. Therefore, a graphic presentation of the modes, such as Figure 10, is extremely useful to determine the character of the deformation patterns which in turn decides which of the many, many modes of vibration are to be used in the analysis. Three three-dimensional type plots are also useful in establishing the parts of the airplane which will be most affected in a certain mode, an item of much import in the mounting of electronic gear and control system gyros.

One of the most useful tools during the engineering development is the wind tunnel. All technical groups make use of wind tunnels or water tunnels, and one of the indispensable items for such use is the operating charts for the wind tunnel. Figure 11 shows the operating chart for the transonic test section of the Southern California Cooperative Wind Tunnel. From this chart, it is possible to determine the dynamic pressure, Reynolds' number, and stagnation pressure for any given Mach number. It is also possible to determine the operating limits of the tunnel by the power curves shown. This is an excellent example of how a great deal of information may be presented with a minimum of text through the use of graphics.

For the detail design and in the construction of the airplane, the graphics used include: perspective drawings of control system layouts as shown in Figure 12, lofting as shown in the example of Figure 12, and many mechanism layouts for landing gear, ejection seat operation, armament bay doors, and one trademark type of mechanism for Convair (the integral stairway entrance as shown in Figure 14).

During the flight test of the airplane, the performance limits attained and the various aircraft limitations are charted on a plot of the type shown in Figure 15. This figure permits simultaneous determination of Mach number, true airspeed, indicated airspeed, and altitude for each point plotted thereon--another graphical presentation of much data with minimum effort.

The preceding discussion has indicated a few of the many uses of graphics in the aircraft industry. There is obviously a great importance placed upon graphics in our industry. However, perhaps the most important two items in the field of graphics for each aspiring engineer, regardless of his field, are the ability to print neatly and legibly and the ability to plot smoothly faired curves. Regardless of the latent abilities of the young engineer, his work can only be judged and his progress in the industry decided by the written or drawn presentation of his efforts. Typing has eliminated the need for stressing penmanship; but printing on drawings, plots and charts, as well as the completion of the actual drawings and executing smooth curves for data presentation still remains the task of the engineer. It is without question easier and more pleasant to use neat, well executed drawings or plots, and, all other things equal, the engineer who prepares such drawings or plots is the one who will be favored.

In conclusion, I can only repeat that the role of graphics in the aircraft industry is one of much import, but they must be done neatly, legibly, and accurately, or they may be rendered useless or neglected because of their poor appearance.

REFERENCES

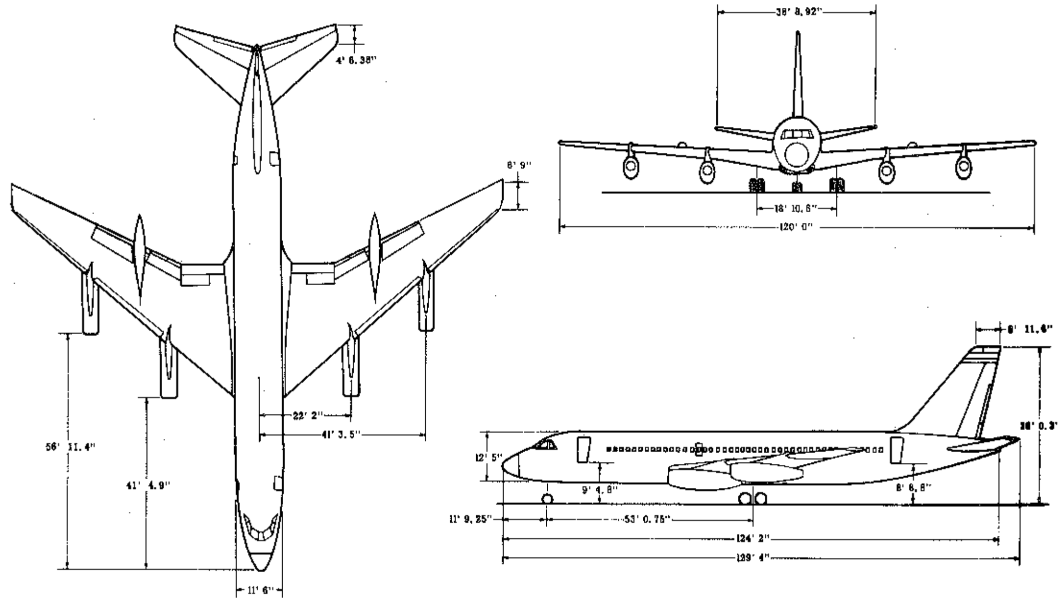
1. Convair Scientific Research Laboratory Research Note 15, "A Nomograph for Stagnation Point Heat Transfer Rate during Hypersonic Ballistic Re-Entry" by Mary F. Romig, March 1958.

2. Addendum to "Heat Transfer to Satellite Vehicles Re-entering the Atmosphere" by Detra, R. W., Kemp, N. H., Riddell, F. R., Jet Propulsion, December 1957.

3. "A Study of the Motion and Aerodynamic Heating of Missiles Entering the Earth's Atmosphere at High Supersonic Speeds" by Allen, H. J. and Eggers, A.J., NACA RM A53D28, 1953.

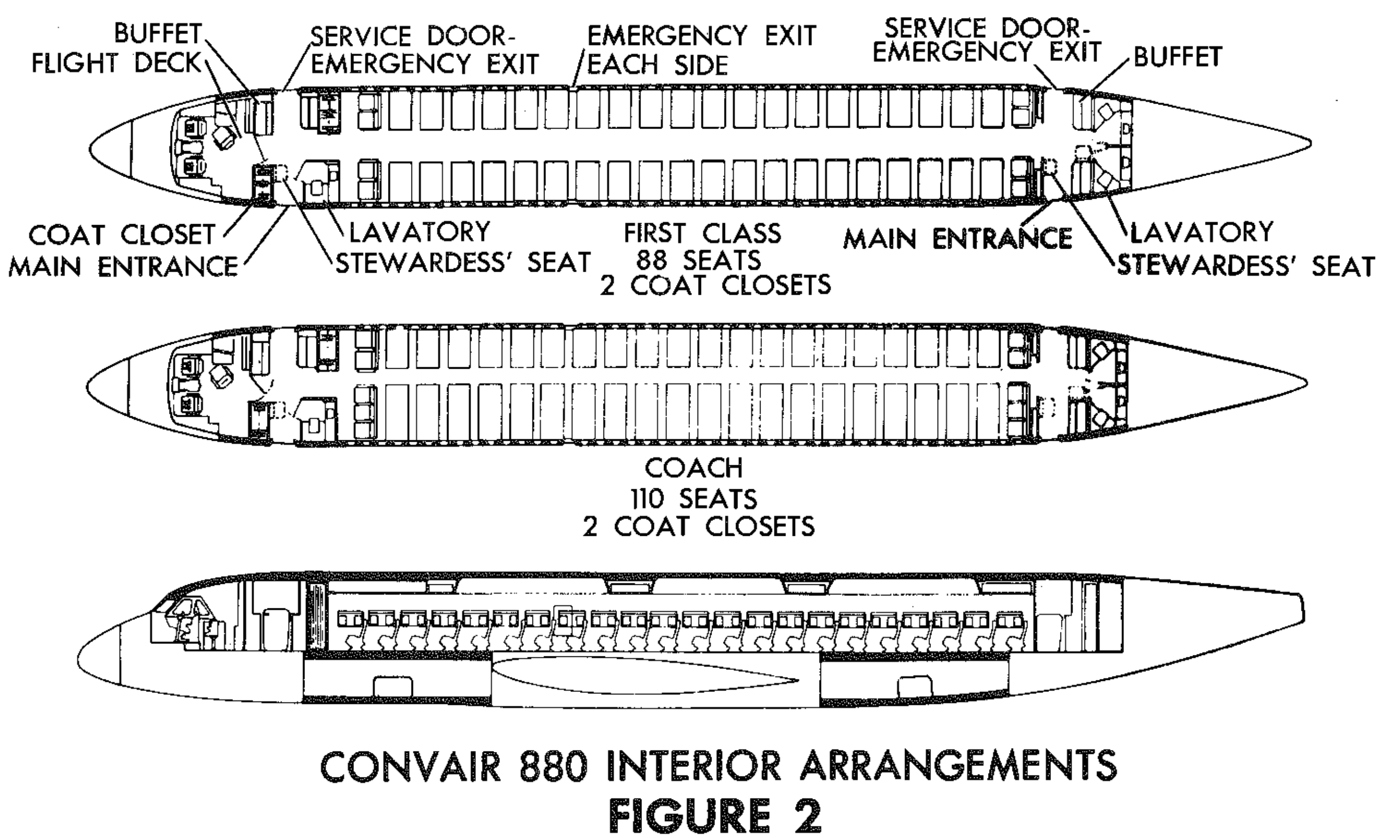
4. "Some Practical Aspects of Calculations Using the Characteristics Method" by Sanchia Foiles, unpublished.

5. "Resume of the Time Vector Method as a Means for Analyzing Aircraft Stability Problems" by W. O. Breuhaus, WADC Technical Report 52-299, November 1952.



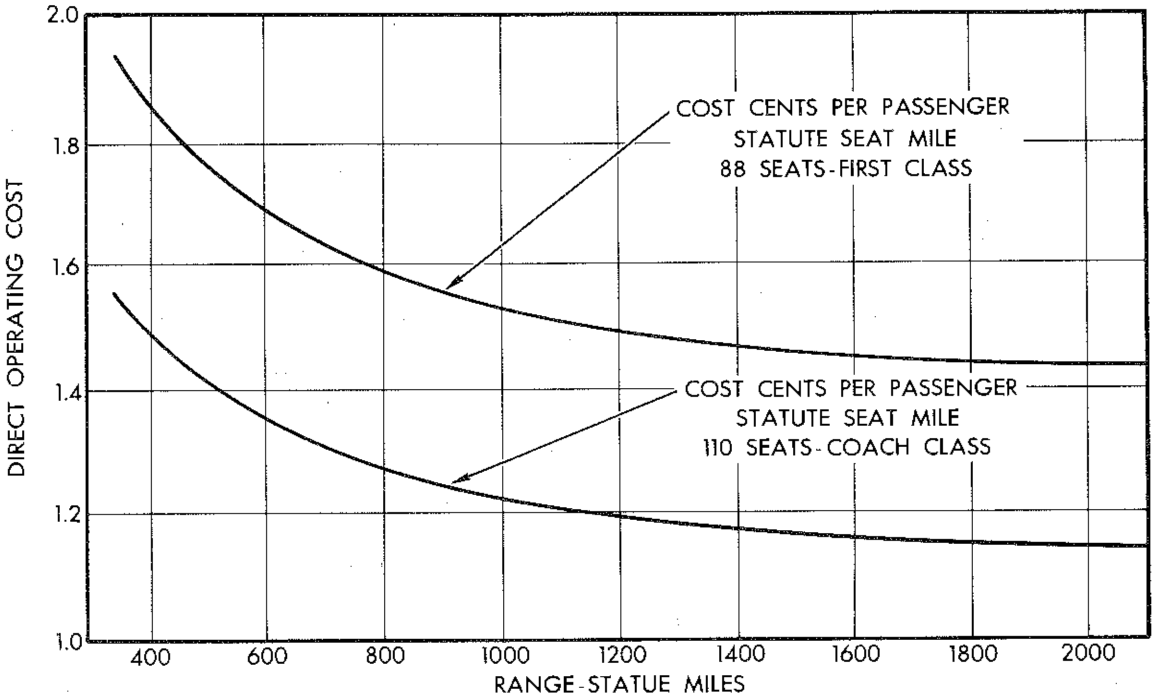
CONVAIR MODEL 880 GENERAL ARRANGEMENT

FIGURE 1



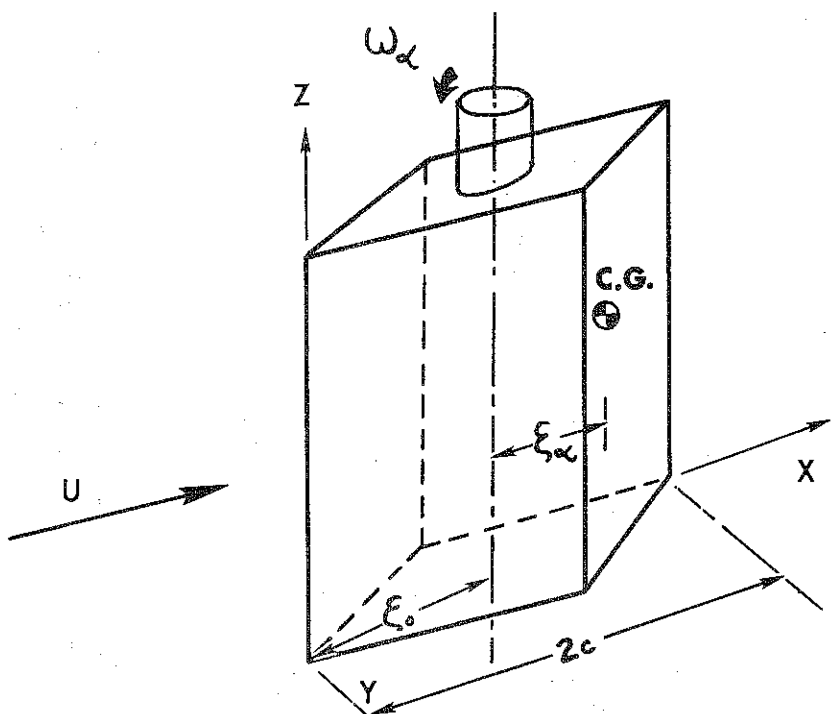
CONVAIR 880 INTERIOR ARRANGEMENTS

FIGURE 2



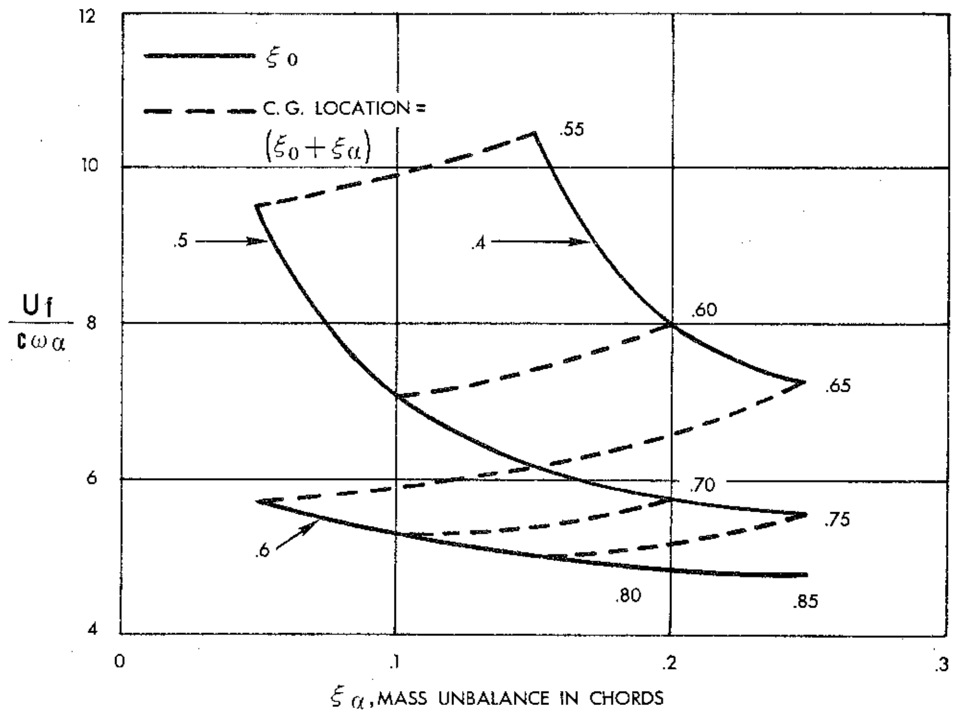
CONVAIR 880 OPERATING COSTS

FIGURE 3



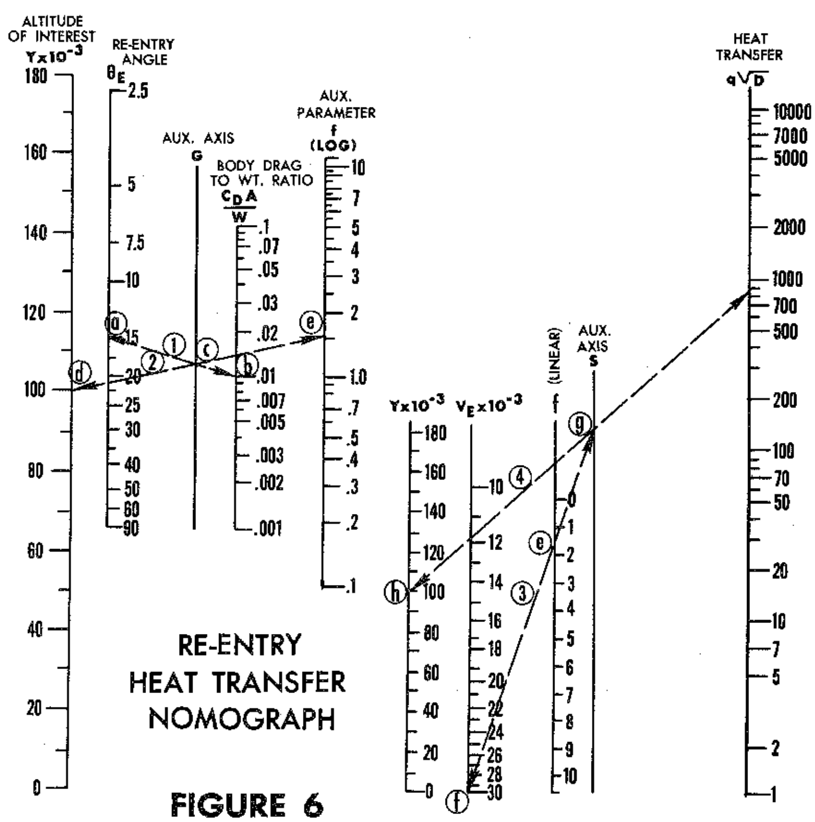
SUPERSONIC DOUBLE WEDGE CONTROL SURFACE

FIGURE 4



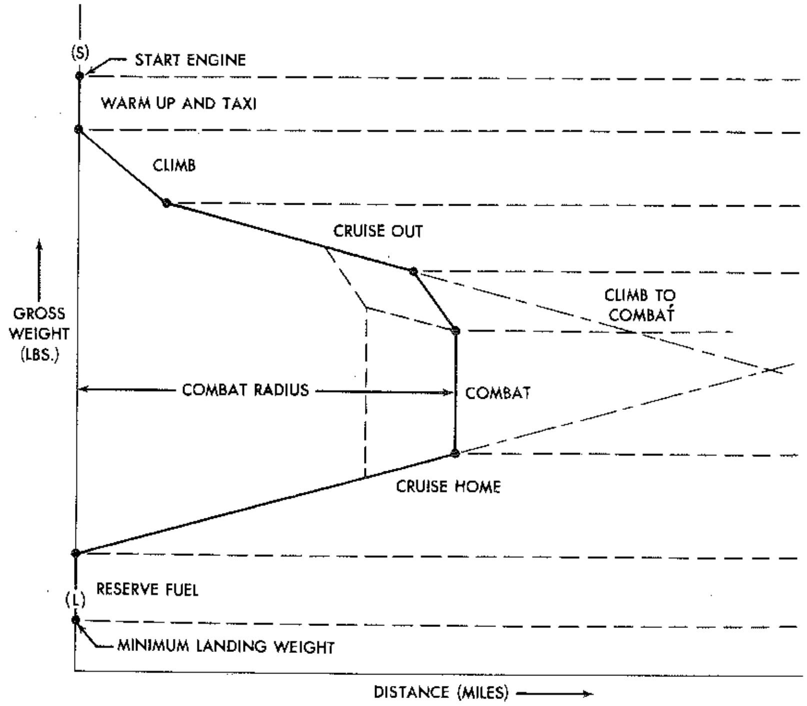
PARAMETER AS A FUNCTION OF SURFACE UNBALANCE
(FOR A GIVEN TOTAL WEIGHT)

FIGURE 5

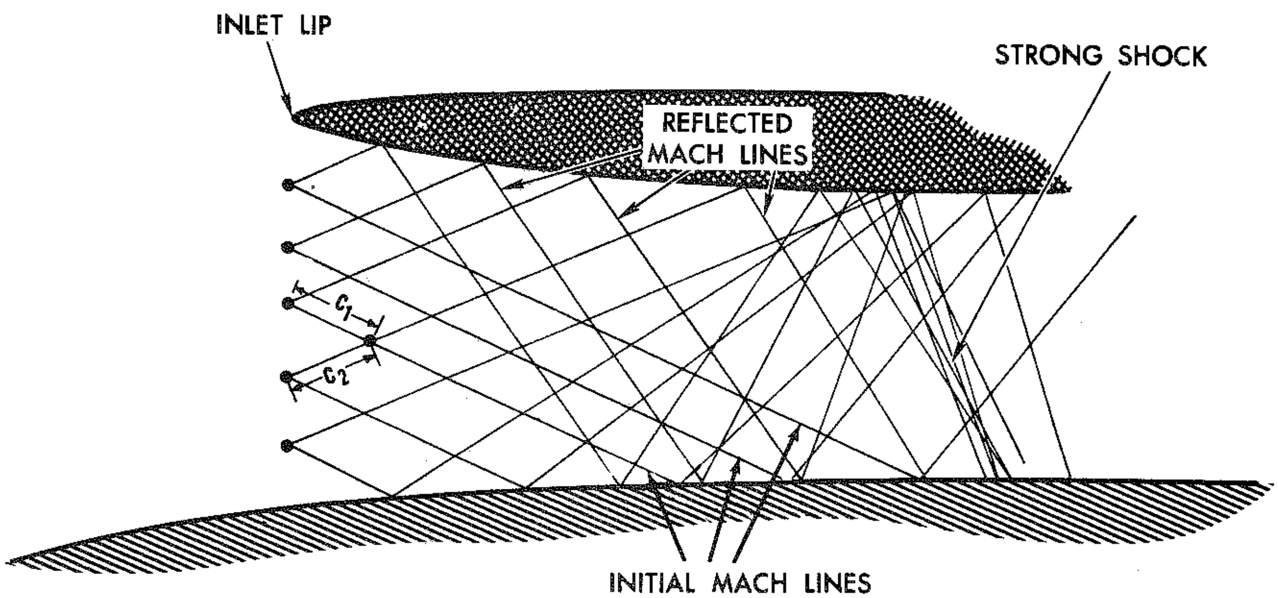


RE-ENTRY HEAT TRANSFER NOMOGRAPH

FIGURE 6

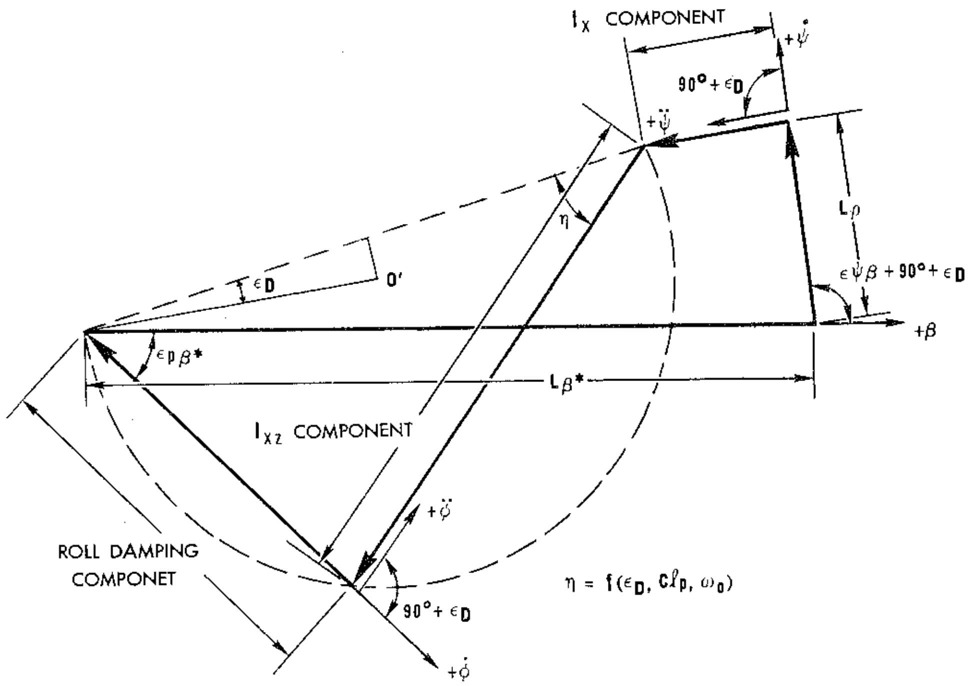


MILITARY AIRCRAFT
(FIGHTER-INTERCEPTOR MISSION)
FIGURE 7



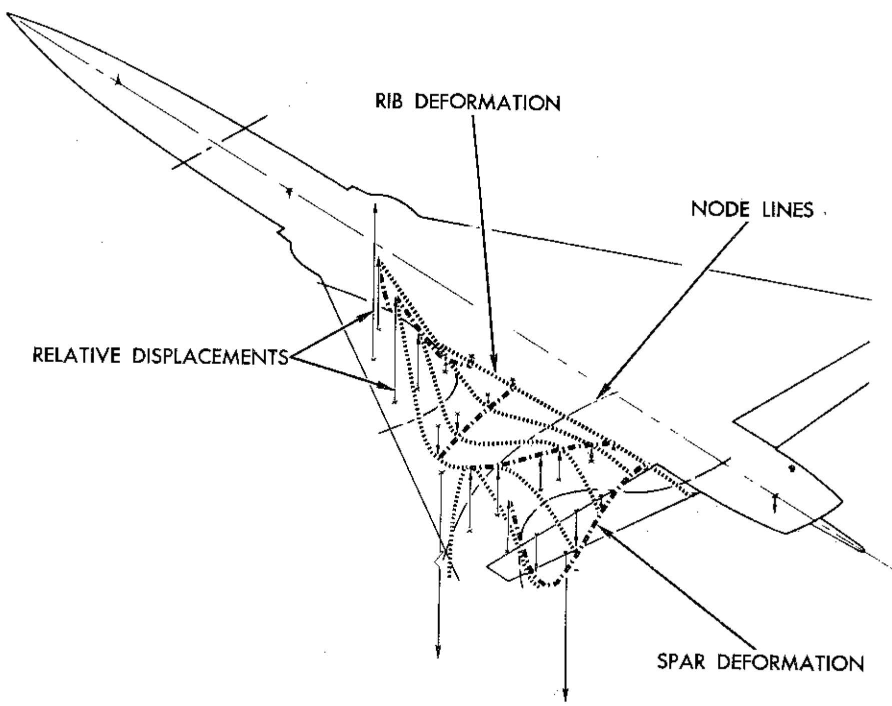
SUPERSONIC INLET DESIGN STUDY
UTILIZING CHARACTERISTICS METHOD

FIGURE 8



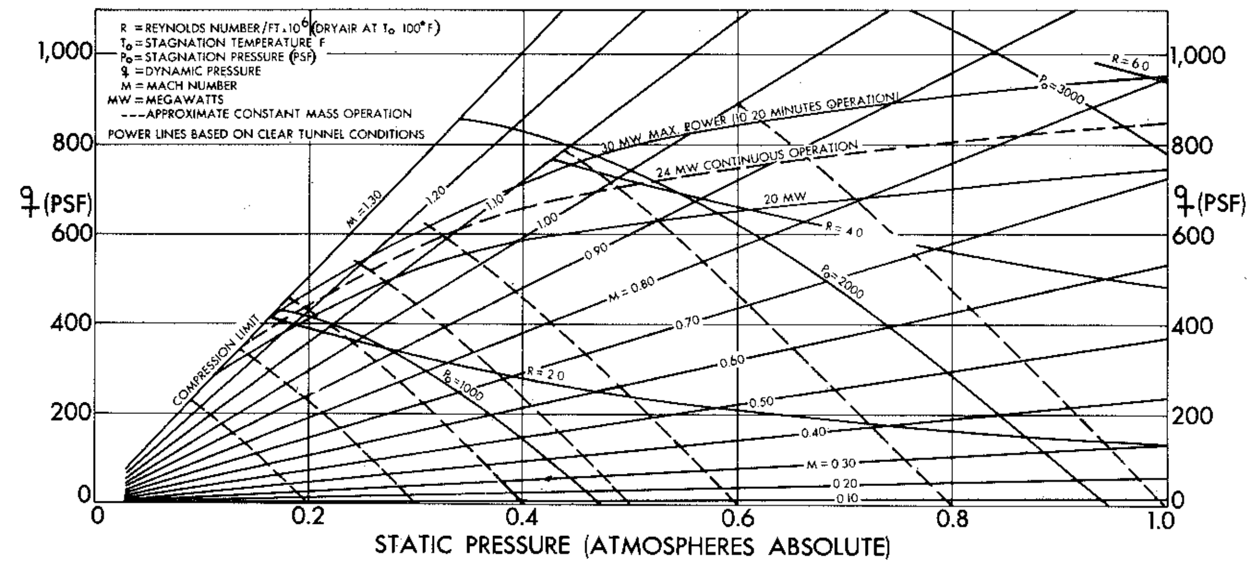
ROLLING MOMENT VECTOR POLYGON
FOR DUTCH ROLL OSCILLATION

FIGURE 9



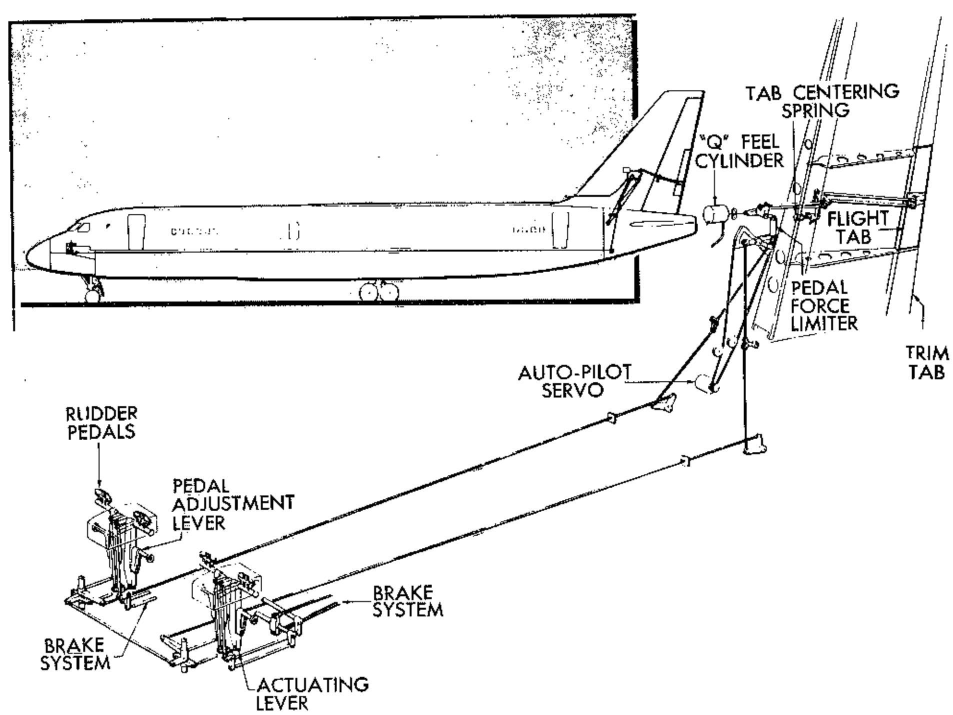
SYMMETRIC DEFORMATION PATTERN

FIGURE 10



TRANSONIC CART PERFORMANCE CHART
COOPERATIVE WIND TUNNEL

FIGURE 11



CONVAIR 880-RUDDER CONTROL SYSTEM

FIGURE 12

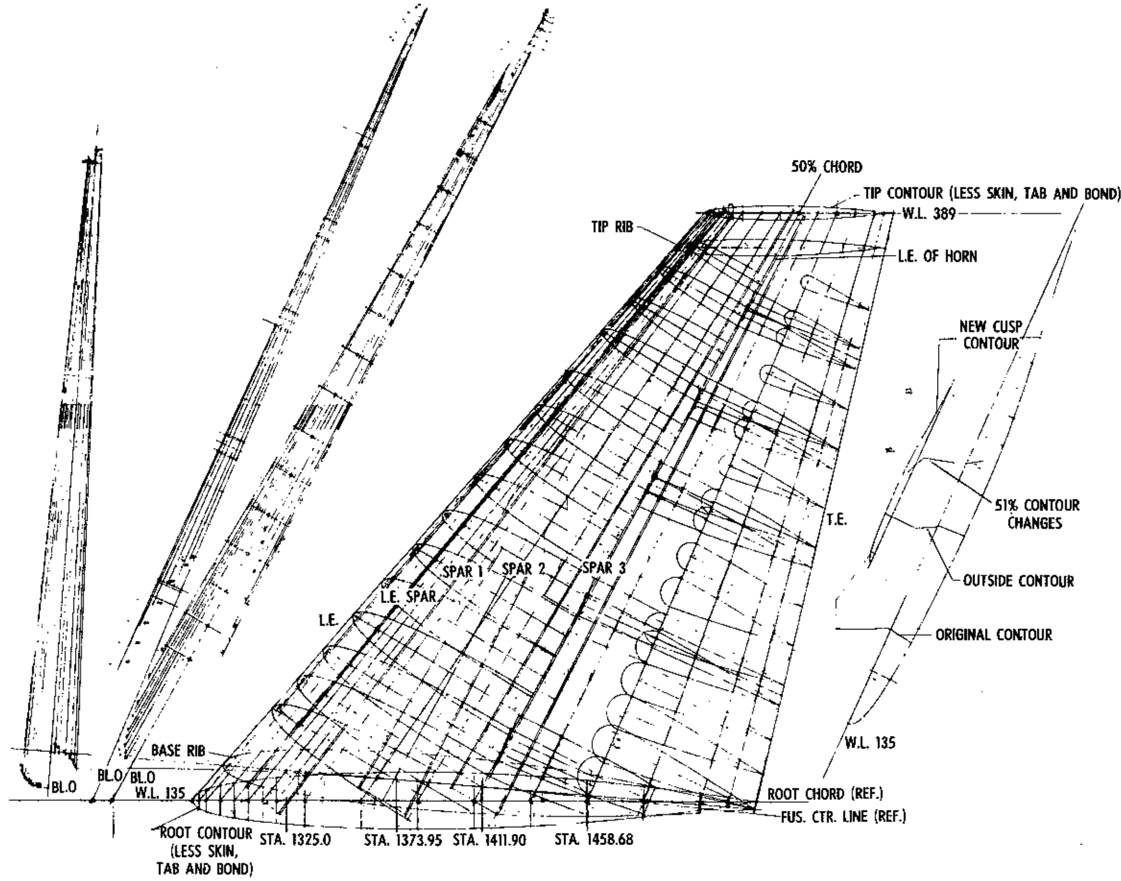
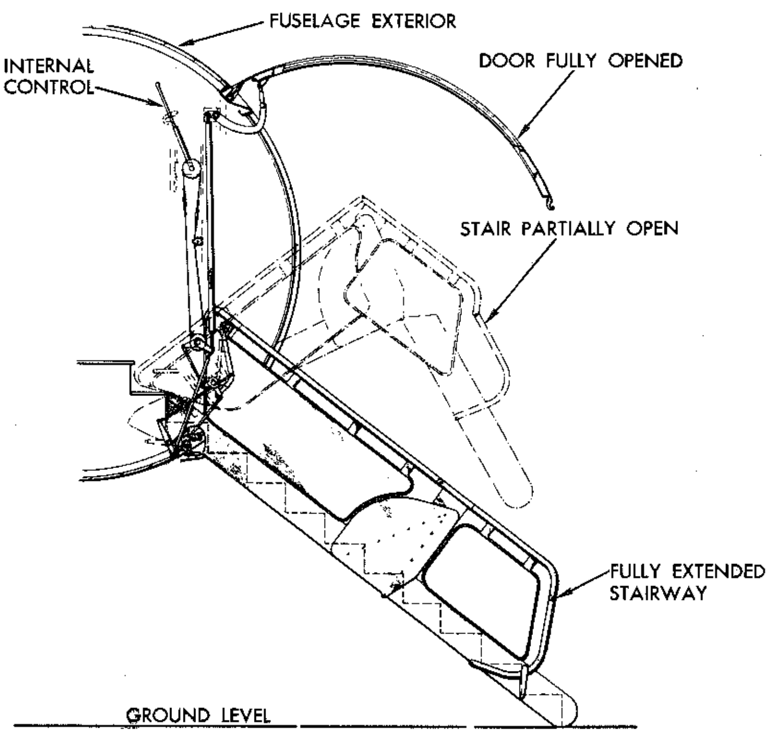


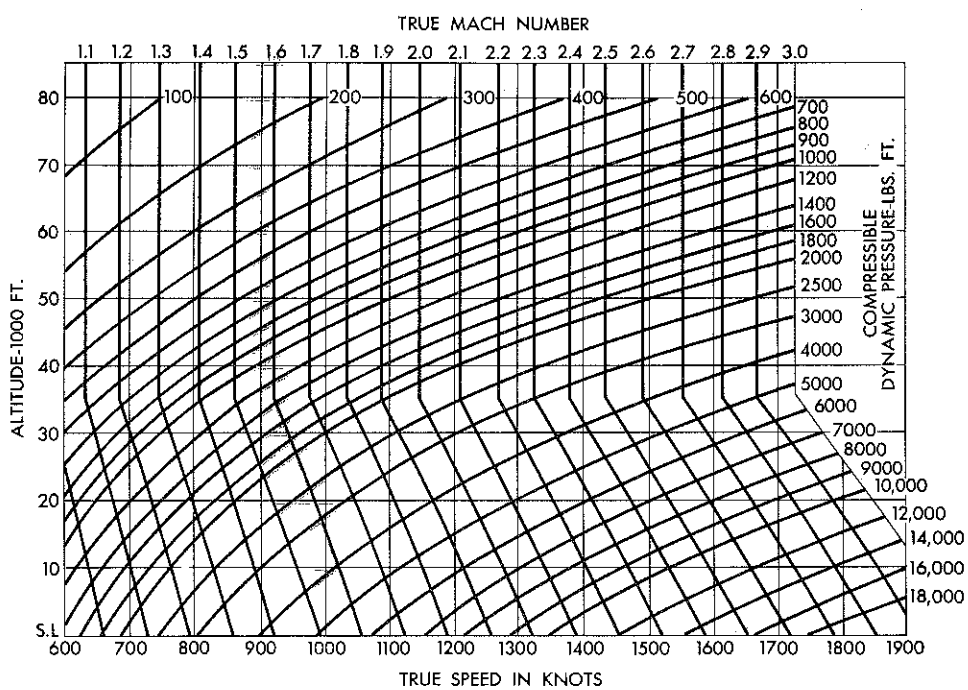
FIGURE 13.

LINES-VERTICAL TAIL FOR .050 SCALE FLUTTER MODEL



CONVAIR FOLDING ENTRANCE STAIRWAY

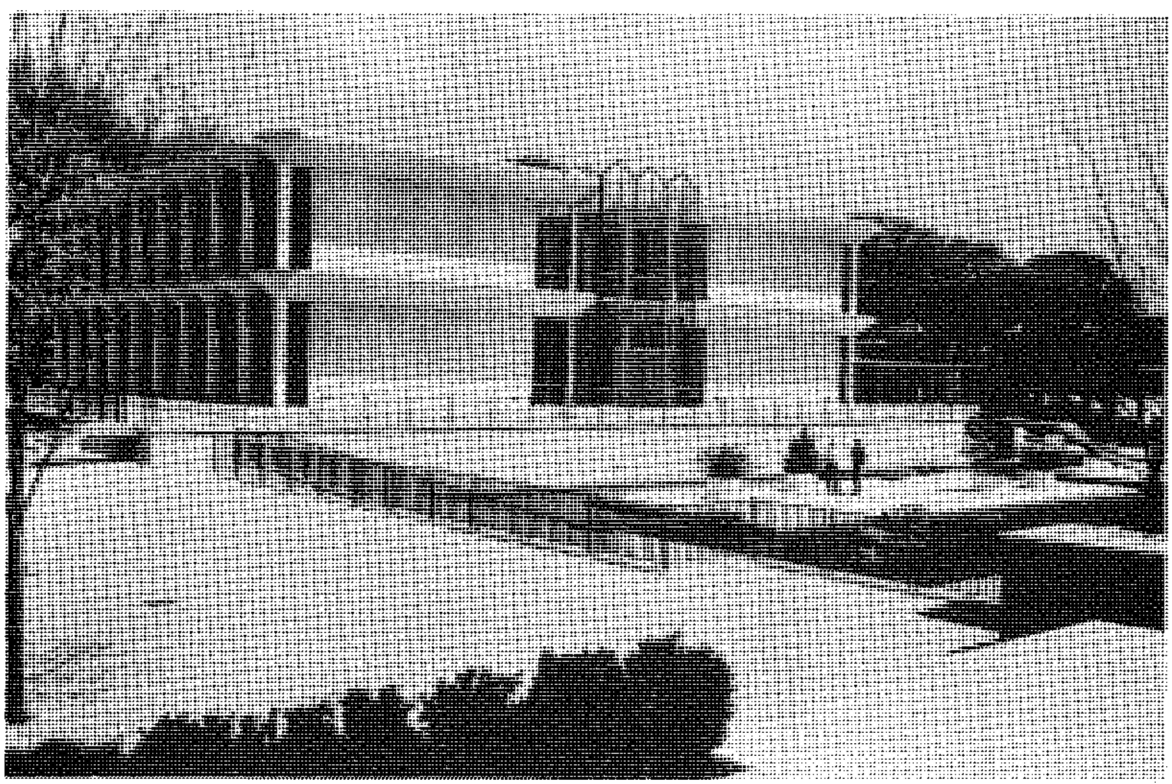
FIGURE 14



TRUE AIRSPEED-MACH NUMBER-
DYNAMIC PRESSURE-ALTITUDE RELATIONSHIPS

FIGURE 15

Engineering Graphics Division A. S. E. E. 1958 Meeting
Berkeley, California



McGregor Memorial Conference Center
Detroit, Michigan

WAYNE STATE UNIVERSITY

Detroit, Michigan

Host for the Mid-Winter Meeting of the
Graphics Division, ASEE, January 1959

Wayne State University has developed a very fine and profitable Mid-Winter Meeting for the Engineering Graphics Division of the American Society for Engineering Education. The executive dinner will take place at 6:30 p.m., Wednesday, January 21, 1959 at the Engineering Society of Detroit, which is adjacent to the Wayne State University Campus. On Thursday, January 22, registration, coffee hour and a general get-together will take place at the McGregor Memorial Conference Center, located at Second and Ferry Avenues. All of our regular meetings are planned to be held at the new center, which was developed by Mr. Minoru Yamasaki, an outstanding architect in the Detroit area. Headquarters for the meeting will be the Hotel Park Shelton located at 15 E. Kirby, Detroit 2, Michigan.

Transportation facilities to the Detroit area are excellent by air, by rail, and by private automobile. Wayne State University is located in the center of the city, approximately 1 1/2 miles from the downtown area. The University area can be reached by two of our fine recently completed expressways. The north-south John C. Lodge expressway passes just to the west of the University, and the east-west Edsel Ford Expressway passes just to the north. Each of these have easy access to the campus area.

The McGregor Memorial Conference Center, an integral part of the University has been in use since this past spring to provide much needed conference and meeting space. Many other fine new buildings have been completed in the University building expansion program. Some are now under construction and others are still in the design stage, illustrating new trends in school architecture.

In addition to our regularly scheduled meetings, a trip to the General Motors Technical Center has been arranged for Friday afternoon, January 23, 1959. Exploring this marvel of engineering and architecture in itself will well be worth the trip to the Mid-winter meeting. We will have an opportunity to closely examine the General Motors facilities at this center for research, experimentation, and design.

Entertainment in the Detroit area is plentiful: Broadway plays, current movies, professional basketball, hockey, etc. In addition, many of our members will be interested in exploring the new Detroit Civic Center and visiting such outstanding places as the Greenfield Village, Edison Institute, or one of the several automotive plants.

SEE PROGRAM ON NEXT PAGE.

MID-WINTER MEETING

Division of Engineering Graphics, A.S.E.E.
January 21-23, 1959
Wayne State University, Detroit, Michigan

Tentative Program

Theme: Graphics for Tomorrow

WEDNESDAY, JANUARY 21

6:30 p.m. Executive Committee Dinner - Engineering Society of Detroit

THURSDAY MORNING, JANUARY 22

8:00 - 10:00 Registration and Coffee Hour - McGregor Memorial Conference Center
10:00 - 12:00 General Session

Theme: Teaching Techniques in Graphics
Chairman: Ralph T. Northrup, Wayne State University
Greetings: President Clarence Hilberry, Wayne State University
Welcome: Dean J. Stuart Johnson, Wayne State University
Presiding: James Rising, Iowa State College Graphics Division Chairman

1. Instruction in Graphics by Remote Control
   O. M. Stone, Case Institute of Technology Cleveland, Ohio
2. Panel Discussion
   Jasper Gerardi, University of Detroit Detroit, Michigan
   Norman Arnold, Purdue University Lafayette, Indiana
   Bernard Wellman, Worcester Polytechnic, Worchester, Massachusetts
   William Street, Texas A and M College College Station, Texas

THURSDAY AFTERNOON, JANUARY 22

12:00 - 1:00 Informal Luncheon
1:00 - 1:45 Tour of Engineering Drawing Department and Campus
2:00 - 4:30 General Session

Theme: New Horizons in Graphics
Chairman: Vice Chairman Graphics Division

1. Challenging the Exceptional Student in Engineering Graphics Courses
2. The Role in Industry of the Engineer, Designer, and Draftsman
3. Graphics and Its Relation to the Development of Guided Missiles
4. Discussion

THURSDAY EVENING, JANUARY 22

6:30 Mid-Winter Banquet
Engineering Society of Detroit
Presiding: Ralph T. Northrup, Wayne State University
Invocation:
Remarks and Introductions: James Rising, Iowa State College
Entertainment: Music by Wayne State University Music Department
Special Speaker:

FRIDAY MORNING, JANUARY 23

8:00 - 10:00 Coffee Hour - Engineering Bldg. Dept. of Engineering Drawing
10:00 - 12:00 General Session

Theme: Graphics: An Engineering System or Science

1. Should Engineers Be More Versatile in Freehand Sketching Than in Instrumental Drawing
   Joseph Simonen, Detroit Edison Company
2. How Much Creative Thinking Can Be Introduced Into a Basic Drawing Course?
3. Graphics: An Aid in Planning, Manufacturing, and Sales
4. Discussion

FRIDAY AFTERNOON, JANUARY 23

12:00 - 1:45 Business Meeting and Luncheon - McGregor Memorial Conference Center
2:00 Board busses for General Motors Technical Center
2:45 - 5:00 Visitation and Inspection
General Motors Technical Center
5:00 - 5:30 Return trip to campus
6:00 Adjournment

DIVISION OF ENGINEERING DRAWING

OF THE

AMERICAN SOCIETY FOR ENGINEERING EDUCATION

RESOLVED:

THAT, WITH THE PRESENTATION OF THIS AWARD, THE ENGINEERING DRAWING DIVISION OF THE AMERICAN SOCIETY FOR ENGINEERING EDUCATION BY THIS TOKEN ACKNOWLEDGES THE MANY DISTINGUISHED SERVICES RENDERED BY

Henry Cecil Spencer

THE SOCIETY EXPRESSES ITS DEEP APPRECIATION FOR THOSE SERVICES, AND THE GREAT PERSONAL PLEASURE OF THE INDIVIDUAL MEMBERS IN HAVING HIS FRIENDSHIP.

June 17, 1958

Warren J. Luzadder
Chairman of the Division

James S. Blackman
Secretary of the Division

Recipients of the Award:

1950 - Frederic G. Higbee
1951 - Frederick E. Giesecke
1952 - George J. Hood
1953 - Carl L. Svensen
1954 - Randolph P. Hoelscher
1955 - Justus Rising
1956 - Ralph S. Paffenbarger
1957 - Frank A. Heacock
1958 - Henry Cecil Spencer

DISTINGUISHED SERVICE AWARD

FOR 1958

The members of the Distinguished Service Award Committee for this year were: William Street, Ivan Hill and T. T. Aakhus.

It is a pleasure for me to perform my assignment this evening, that of presenting the Distinguished Service Award of the Engineering Drawing Division. The pleasure of presenting this award is intermingled with regrets because the recipient of this award is not able to be here tonight.

Henry Cecil Spencer of the Illinois Institute of Technology has been chosen to receive the Distinguished Award for 1958.

It seems paradoxical that on a similar occasion at Dartsmouth in 1952 when Professor Spencer presented the Distinguished Service Award to Professor George Hood, Professor Hood was not present. Tonight when he is on the receiving end, Professor Spencer cannot be here. Nearly all that are here tonight know Cecil and his lovely and charming wife Juanita. These two people complement each other in a way that has been a pleasure to observe and a genuine treat to experience.

Professor Spencer is a graduate of Baylor University and Texas A and M College with degrees in Arts, Architecture and Industrial Education.

He has been a teacher and college administrator for 32 years. In 1930 he joined the faculty of Texas A and M College as an instructor in engineering drawing and by 1940 had advanced to full professor and chairman of his department. Since 1941 Professor Spencer has been the director of the Department of Technical Drawing at the Illinois Institute of Technology. He is a distinguished teacher, author and consultant in the field of engineering graphics. The generous acceptance of his many textbooks bespeak their quality. He has been a prolific writer of articles in the field of Engineering Drawing. He has served actively and effectively in the Engineering Drawing Division of the ASEE as a member of our Executive Committee, Secretary, Chairman, and member of the Council. He has pioneered in offering a Bachelor of Science degree in Technical Drawing and a Master of Science degree in Engineering Graphics at Illinois Institute of Technology.

As a teacher Professor Spencer is held in high esteem by former students, colleagues and his many coworkers from coast to coast. He is admired for his ability, for his understanding and kindliness, and for his loyalty.

I send this certificate duly signed by messenger in the person of Ivan Hill for delivery to Professor Spencer and wish him God-speed and a hasty recovery from his illness.

RESPONSE TO THE AWARD CITATION

By H. C. Spencer

Hello folks! Here I am, but not in the flesh, I am sorry to say. It is a great disappointment to Juanita and me not to be here - especially since I should like to tell you in person how grateful I am to receive this high honor. But my doctor says I should not think of traveling for a while.

I was just starting as a young instructor at Texas A and M in 1930 when the first Engineering Drawing Summer School was held at Carnegie Tech. I missed this meeting, and I have regretted it ever since. At the time I felt that I didn't have the money, but why didn't someone pound it into my head that I should go anyway? There was nothing wrong with my credit, for instance.

My first national meeting was at Georgia Tech, and I was thrilled to meet the actual authors of text books I had at home, and to get really the latest and most authoratative information from men like French, Svensen, Higbee, Hood, Hoelscher, Mann, Jordan, Jud Rising, and many others.

When I got back to Texas, I reported to the fellows in the department who had not gone to the meeting: "Well, I liked the talks, but the best part was just getting to know the men in our field." Since then, I have missed only a few meetings, and most of them just recently, but I haven't changed my mind. The programs are important, and the papers are important - at least many of them are - but the greatest value derives from private conversation with old friends and with new ones at the dinner tables, between conferences, and elsewhere.

To the young instructors, I have tried to emphasize the point that whereas the engineering teachers usually go to meetings of several professional societies in addition to the ASEE, the drawing teacher has only one society that he should be bound to, and that is the ASEE. He should belong to the ASEE whether he joins any other society or not.

The future belongs to the young instructors and graduate assistants who will be the professors of tomorrow. These young men should regularly attend meetings of our society, and should start participating at the earliest opportunity, if no more than joining in the discussions and making remarks from the floor. In a very short time these younger men will be given responsible tasks, in performing which their abilities will be recognized. Eventually one might even be elected as an officer of the Society at which time he will find out what work really is, but at the same time he will realize how rewarding active participation in the society can be.

The young instructor should take the new ideas home with him; those that seem useful should be given a trial. Each year he should try out new things - or at least things that are new to him. I should hope that he would not regard a new idea as good just because it is new. Chances are it is not new anyway; it is just new to him. He should be ready and willing to try out new methods or approaches if they seem to hold promise. But he should be very careful not to discard a method or practice that has been used for a long time just because it is not new. I believe it was Voltaire who once returned a manuscript to a young writer with the notation, "There are some things in here that are true, and some that are new, but the new things are not true, and the true things are not new." So when a new idea comes along, check carefully; it may be worth while and it may not.

Time is fleeting, 16 mm. film costs money, so I should like to express again in closing the deep appreciation Juanita and I both feel in my receiving this grand award. Greetings to all of you, and from the bottom of my heart a sincere "Thank you" for this expression of your confidence. Finally, I should like to thank Jud Rising who made this film.

WHAT ENGINEERING DEPARTMENTS EXPECT FROM THE DRAWING COURSES

By Herman C. Hesse
Valparaiso University

The early years of any engineering curriculum are devoted, for the most part, to a consideration of the basic sciences and languages that underly a study of the profession of engineering. The most important of the basic sciences are physics and chemistry; the former serves as the core of the engineering sciences, upon which all professional work is based; the latter gives a basic understanding and appreciation of the nature and properties of the materials with which an engineer must deal. Both these areas of study are sciences "within their own right" - with a logical pattern of development, experimentally verifiable within the limits of our present knowledge. English and modern foreign languages, on the other hand, fulfill the need for verbal communication, both within the profession and without. While they are absolutely essential as such a medium of communication, they do not in themselves contribute to the sum total of the knowledge in the field.

The science of mathematics occupies a rather unique position between these areas. Mathematics has permitted and promoted the extension of scientific thought, but it is still a language - the language of symbols as applied to engineering science. Its scope, however, is far more extensive than any verbal language, since it enables us to develop the theoretical concepts and abstractions that are frequently far in advance of the limitations of experimental science and practical or applied engineering.

What, then, of Graphics? It has often been defined as one of the languages of engineering and the physical sciences. This definition may be correct as far as it goes, but it is too limited in scope. True Graphics is the language of engineering - but it is also a science in the same sense as Mathematics - and in its turn affords the possibility of an extension of the horizons of scientific knowledge. Perhaps we could say that both Mathematics and Graphics are media for scientific communication and extension, in that they enable us not only to communicate intelligently and logically with our fellows, but also permit us to "extend" the frontiers of scientific knowledge past the experimentally - verifiable present.

Graphics is a universal language in that it can be understood by all nations and peoples; it is far more logical than any verbal language; and it is changing and developing, for the promotion of clarity and better understanding, far more effectively than any other spoken or written tongue. It teaches the comprehension of spatial concepts, will develop ability to think imaginatively, will encourage analysis and synthesis, and is of major importance in the development of sequential thinking and an orderly approach to science and professional engineering.

The teaching of Graphics may, for the purposes of this discussion, be divided into three major areas; the abstract science, the technical application, and the techniques or skills. Each of these areas bears within it some of the language elements. If Graphics be defined as the science of representing three-dimensional elements on two-dimensional surfaces, its study should begin in the primary and most vital area - orthagraphic projection. At the risk of a quarrel with the semanticists, I shall take this term to include not only the principal views, but also all types of auxiliary views, including primary and secondary (or oblique) representations. Training therein should be continued to the extent that the student develops a major facility in handling successive auxiliary views, and an ability to apply these methods when they become useful or necessary.

This training will afford an implicit and, therefore, very effective introduction to the major problem of visualization and spatial relationship and should thereby facilitate the abstract study of descriptive geometry. This area should be covered as extensively and as thoroughly as time will permit. Applications to practice may be necessary or at least useful in the pedagogy of descriptive geometry, but linear and angular relationships of lines and planes in an abstract sense should not be omitted, since theory that is based solely upon application or present utility may stultify the imagination and may limit the extension of the frontiers of the graphic science.

Curve construction and delineation should be spatial or three-dimensional rather than planar. The helix is, therefore, of major importance - also because it is rarely if ever discussed in the undergraduate courses in Mathematics. Conics such as the parabola and the hyperbola should be considered as graphic abstractions - intersections of a plane and a cone - in preference to treatment by graphical Mathematics. Developments in the field of aviation have emphasized the importance of warped and faired surfaces, but an equally essential although lesser known surface is the helicoid. As an oblique, a right, or an involute helicoid it is of great importance in the study of twisted-tooth gearing (worm, hypoid, helical, etc.), screw thread surfaces, and screw propellers.

Intersections of lines and surfaces are important in the geometrical rather than the applied sense. The intersection of two cylindrical surfaces of a casting is essentially a problem for the draftsman; the intersection, of the lines of contact, of a worm and a gear is the problem of the engineer. The treatment of the subject of intersections should, therefore, be carefully balanced between the abstract and the practical, with the emphasis, if any, on the former.

The topic of surface delineation and sheet metal development may be radically limited in scope. Its study should concern itself with the basic principles and a very limited number of representative applications, sufficient to qualify the practitioner to seek out and use further data on the subject. The engineering student should have an understanding of the principles of perspective representation, both from the projective and the so-called vanishing point approaches, since perspective is the basis for all other forms of pictorial representation. He should also be familiar with the pseudo-perspective forms such as isometric, oblique, cavalier, and the like.

The topic of sectional views and sectional representation may be considered the transition between the abstract science of graphics and its technical application. It is probably safe to say that sectional views are used as much as principal views - particularly in the field of mechanical engineering. Machine part detail draftsmen are encouraged to use sectional views in preference to the introduction of invisible lines. One industrial organization, in its engineering handbook, stated the following, "The use of the invisible line is prohibited. It may be used only if a single invisible line will serve to replace one or more sectional views."

It may not be necessary to devote much time to sectional views in the abstract; after the preliminary treatment, the topic can be expanded in the construction and use of assembly, detail, and shop drawings. It is in this area that sectional conventions and conventional intersections may be handled.

Every engineer must be thoroughly familiar with the symbolic representation of the graphic language, since conventional representations of screw threads, fasteners, pipe elements, and symbols for surface finish and welding constitute the "shorthand" of the profession. In re-reading one of the workshop reports of the mid-winter meeting, January 1958, at General Motors Institute, I noted with dismay that many of the group felt that the treatment of symbolic representation should be limited, and in some instances omitted entirely. I think this would be a serious mistake. It may not be necessary for the engineering student to be able to execute or delineate some of the symbols, but they should certainly be familiar and as recognizable as his ABC's. In the future, the extent and use of symbolic representation will increase, rather than diminish; particularly so in view of the extensive activities of the American Standards Association, and also because time and labor will be at a greater premium than ever before. In our efforts to increase the scientific competence of our students, we must avoid the pitfall of engineering illiteracy.

Dimensioning, size description, detail drawing, and a knowledge of shop processes are so intimately connected that it would be difficult or impossible to separate the constituent elements of each area. It is difficult to ascertain how any of these essential elements of basic engineering courses can be omitted, or where a substantial reduction in their content may be effected. Since much of this work will, in the future, continue to lie in the field of activity of the technician and draftsman, it is possible that college study may fall into the "reading" or interpretation area, rather than the actual delineation and execution of detail and shop drawings.

In the same sequence of thought it is probable that such adjuncts to engineering drawing as applied geometry, graphical mathematics, nomographs, charts and diagrams will be eliminated from the basic graphics courses. Since time is, and will be, of the essence, it is necessary that the profession will use it for instruction in those areas that are not handled by other disciplines. Applied geometry and graphical mathematics should be included in offerings in mathematics; construction of diagrams, plotted data, and charts must be initiated in the professional departments. In the latter instances, there is usually so great a variation in the requirements that the instruction originally presented in the division of Graphics must in any event be modified and reorganized to serve the professional needs.

All of you, I believe, are familiar with recent revisions of engineering curricula in the United States. The principal changes that are immediately apparent are the addition of more work in physics, in mathematics, and in the engineering sciences. Course offerings have become more theoretical and possibly less practical or applied than has been the practice heretofore. The most significant change in course presentation or pedagogy in the engineering curriculum is the elimination of work which is devoted wholly or partly to skills and techniques. This tendency began a number of years ago when courses in foundry practice and machine shop were eliminated, if not in all curricula, at least in those other than mechanical or industrial engineering. In other courses there has been a decided reduction in laboratory time. Some of the conventional laboratory work in the electrical field, in engineering materials, and in heat power has been at least curtailed if not entirely eliminated. In Graphics we should understand and appreciate the significance of this trend. Frankly, it may be necessary for us to modify, to reduce, and even to eliminate some of our most cherished topics.

Some of you are old enough to remember the time when neat, legible penmanship was an essential factor in elementary education. And all of us know that it is no longer considered important; Frankly, the advent of the typewriter gave the deathblow to penmanship. In a similar vein, should we not realize that much of the teaching of skills that has been so prevalent in our engineering drawing courses should be eliminated: I can, without too much danger, suggest that we abandon the practice of inking drawings, or tracing drawings in ink, but I offer, with a great deal of trepidation, the proposal that much of the time spent in lettering be eliminated. Mechanical lettering devices are coming into frequent use; special long-carriage typewriters have been developed for detail drawing and lettering for bills of materials; and some industrial organizations are permitting the use of script on drawings. There are three "skill" areas, however, that are of vital importance to the student and the engineer - legible figures, freehand sketches, and accurate linework.

Indifferent or poor lettering on the part of the engineer may be tolerated or excused in industry; drawings or sketches with written explanations are often used for experimental projects, and no one should expect an engineer to devote the same time to the preparation of a detail drawing that would be looked for from a draftsman. Poor figures, however, are an entirely different matter, since figures, as used for dimensions and specifications, convey so large an amount of information for so small a symbol. Clarity and accuracy of figures should have priority over all other skills and techniques.

Freehand drawing and freehand sketching are techniques that serve a steadily increasing segment of the area of graphic exposition. These arts are important not only because of their economy of time in execution, but also because freehand drawing is excellent practice for developing accurate observation. An engineer may still employ instrument-executed linework for design assembly drawings, and for graphical solutions of problems in force analysis and in deflections, but he will rarely, if ever, execute a detail or a shop drawing through any medium other than a sketch. One of the problems connected with the execution of freehand sketches is that of time - even if he has had extensive practice, it takes the average student too much time to make a neat, utilitarian freehand sketch on blank paper. We have little or no time for artistry, and should not expect a student to use instrumental techniques in the sketching of circles and similar figures. In order to facilitate the teaching and execution of freehand drawings, more extensive use should be made of coordinate paper. An engineer will do a great deal of freehand drawing in design conferences, and others in the group will rarely sit patiently by while the originator of a design detail goes through the laborious process of making a neat and well-executed sketch on blank paper. Coordinate paper will expedite the production of sketches and will further permit at least some phases of scalar proportion and interpretation.

Accurate linework is the very life-blood of the graphic sciences, particularly in those areas of application in which it serves as a substitute for mathematical computations. In a problem in force analysis, for example, the entire utility of the graphical method of solution is negated if the graphical vectors are not precisely drawn. The limits of error in solutions of this character should be at least within those obtainable on a ten-inch slide rule. In this connection, I may observe that many engineers, and many instructors in the professional divisions and departments, are not cognizant of the possibilities of graphical solutions to problems in structural and machine design. The resolution of the transmitted force on a spiral bevel gear into diametral, transverse, and axial components whose magnitudes depend upon combinations of the pitch cone angle, the spiral angle, and the pressure angle of the tooth, are far more easily and clearly determined by a graphical solution, using orthographic projection, than by computation. The determination of the deflection, and the location of the region of maximum deflection, of a shaft or beam of non-uniform section, can be effected graphically in about one-fifth the time that is required for an algebraic or a geometrical analysis. It will be said, of course, that the graphical solution is not as "precise" as the analytical, but if the work is carefully executed, the limits of error will be well within the probable errors in the original data.

I do not think it is feasible, or even possible, to teach details of such methods of solution in Graphics courses. It would be well, however, if the Division of Graphics of the American Society for Engineering Education were to carry on a program of continuous research to determine ways and means for the utilization of graphical solutions in the work of the professional divisions.

I have recently examined a number of books in statics, and find that while almost all of them devote some text space to graphic solutions, few or none make the fullest possible use of this method. In the solution of problems involving non-coplanar forces, for example, none make use of orthographic projection in the resolution of oblique forces. Little or no mention is made of graphical solutions for problems in beam deflections in books on Strength of Materials. In civil engineering, graphical solutions are usually treated in a subsequent and separate course of study; in mechanical engineering, the already over-loaded course in machine design must serve as the vehicle of education in graphic solutions. A program of education, at least, should be carried on by the members of this division for the engineering science areas as well as for the professional groups. The entire utility of the graphic method, however, is ignored or lost unless the student or engineer can execute accurate linework.

In conclusion, I should like to refer to the founder of the graphic science - Gaspard Monge. The story is told that, while working as a designer for the French government, he was given the job of making plans for a proposed fortress. This was a tedious process and involved long arithmetical calculations. Monge invented graphical solutions and completed the plans in such a short time that at first the commandant refused to accept them. We may consider this the basic reason for employing graphics in the universality of the language, the clarity and ease of expression and exposition, and the speed with which solutions to engineering problems may be obtained. Perhaps the most competent answer to the question "what engineering departments expect from the drawing course" may be summarized in the simple statement - a department of engineering requires an awareness of the utility of Graphics. If you can show that your science and your language are useful, if you have made an intelligent use of the time allocated to you, if you can show that you can make more effective use of certain additional hours than the department can, you will never have to concern yourself with further diminution of time and course content.

DISTINGUISHED SERVICE AWARD

To the members of the Graphics Division:

The committee on Distinguished Service Awards solicits your nominations for this Service Award. This committee consisting of the three immediate past chairmen of the Division gets together at the Mid-Winter Meeting of the Division to determine the recipient of the award, hence it will be necessary to have your nominations mailed to the undersigned not later than January 8, 1959.

To be eligible for the award a candidate must have made clearly discernible contributions to teaching the art and science of graphics; contributed to the literature in his field; and rendered a distinct service to the Division of Engineering Graphics. Refer to page 27 of the May 1952 issue of the Journal of Engineering Drawing for a full statement of the requirements for the Distinguished Service Award. Send your nominations to me singly or in groups. Your cooperation will be greatly appreciated.

For the Awards Committee

W. E. Street, Chairman
Engineering Drawing Department
The Agricultural and Mechanical
College of Texas
College Station, Texas

COURSE CONTENT IN BASIC ENGINEERING GRAPHICS

By James S. Rising

Iowa State College

Historical records indicate that the origin of graphical disciplines stemmed first from the pictorial, followed by the evolution of orthographic projection and the problems of descriptive geometry. In the early part of this century, our engineering schools had curricula containing a number of courses in the field of drawing. Over the last three decades these courses were gradually trimmed and consolidated into the classical two,--Engineering Drawing and Descriptive Geometry.

While the usefulness of drawings for the communication of ideas had been established for a long time, the realization of an increased importance and power of graphical solutions for engineering problems developed about the time of World War II. As a result, the course content and order of topics of the two basic drawing courses have fluctuated. During the past fifteen years some schools have added courses at the junior, senior, and graduate level; while others, having lost time in the curriculum devoted to drawing, have trimmed what they consider to be non-essential or less important topics and made way for new material. Some sifted the new material into Engineering Drawing, some into Descriptive Geometry, and some grouped all basic graphical material into a sequence called Engineering Graphics.

In this discussion I shall use this broad term, Engineering Graphics, rather than engineering drawing, descriptive geometry, or other branches which go to make up the graphical language. The graphical subject matter will be treated as a whole in order not to emphasize or detract from any particular part. The job at hand is to discuss what is essential to a basic sequence, not how or why it is divided, combined, or integrated.

The graphics division must recognize that curriculum committees are faced with a real problem of curriculum crowding. There has been a great increase in the amount of knowledge within our lifetime. Some people feel that a solution to the problem is to adopt a five year or longer program. A more prevalent opinion seems to favor a squeeze on the so-called lower level or basic courses. Only mathematics and physics seem to have survived the squeeze,--and blossomed. I would like to quote from a recent letter which I received from a member of the drawing division.

> "We have seen Engineering Drawing in the United States--not in Europe and Russia--degraded, even deleted from the engineering curricula in a certain supposed leading school in engineering education,--this with the beaming approval of E.C.P.D."

I also wish to quote from Professor B. Leighton Wellman's paper delivered at the Ames summer school in 1956.

> "Since time is so precious today, bold and realistic action is imperative. First, we must weed out of our drawing courses every topic--however traditional or interesting it may be--that is not a basic, vital, and important part of graphics instruction. Second, we must use every hour in the most effective way possible. The success of every class period must be judged by the number of ideas inculcated, and not by the number of precisely executed sheets that have been drawn."

On the other hand, the course content must not overlook the obligations to industry. Mr. John W. Titus, structural engineer of one of the nation's largest consulting firms, Howard, Needles, Tammen, Bergendoff of Kansas City, says in an article in the May 15, 1958 issue of Engineering News Record, that drafting is virtually the only way that an engineer can convey his conception of a project. He says that drafting is to the engineer what a lecture is to the professor, or a sermon is to the minister. It is an integral, inseparable, and necessary part of engineering.

Most of us are familiar with the statement concerning drawing in the Evaluation of Engineering Education report, commonly known as the Grinter Report. It is brief, to the point, and essential as a guide for the emphasis on the topic content of our courses.

> "Graphical expression is both a form of communication and a means for analysis and synthesis. The extent to which it is successful for these purposes is a measure of its professional usefulness. Its value as a skill alone does not justify its inclusion in a curriculum. The emphasis should be on spatial visualization, experience in creative thinking, and the ability to convey ideas, especially by free-hand sketching, which is the normal mode of expression in the initial stages of creative work. Though the engineer may only supervise the preparation of the drawings required to execute his designs, he can hardly be expected to do this effectively unless he himself is thoroughly familiar with graphical communication."

My first inclination in preparing this paper was to seek opinions on course content from members of of the Drawing Division through a survey. I thought it was important to determine which topics should receive maximum emphasis, which should receive limited treatment, and what ones should be omitted. If there was one answer to this, the problem would be simple. A trial questionnaire answered by several widely separated people showed great divergence of opinion on the subject.

A similar survey was conducted with about 35 people in one of the workshops at the 1958 mid-winter meeting of the Division at Flint, Michigan. Not only was there variation of opinion but also evidence of inconsistency. A letter from one division member, while praising the work of the workshop, said, "The strange and sometimes illogical voting (including my own) was rather revealing."

Further thought and counsel on the matter convinced me that the best approach was to isolate the general areas in which there might be some common agreement among the graphics division members, graduate engineers, and degree department administrators.

Because the aims in teaching have a definite bearing on the course content, I would like to review some of the principal objectives of Engineering Graphics abridged from those proposed by our Aims and Scope Committee.

Our aims are to develop and teach:

1. Principles of communicating ideas graphically.
2. Comprehension of physical and spatial concepts.
3. Graphical methods of approach and procedure in solving engineering problems.
4. Sequential thinking.
5. Analysis and synthesis.
6. Creativity.
7. Resourcefulness, initiative, orderliness, neatness.

Keeping in mind the controlling influences which have been considered, I shall attempt to divide the course content for a sequence in basic engineering graphics into two general categories with more specific, although still general, areas under each category. There is no relation to the name or number of courses included. In fact, for a comprehensive coverage, four or even more courses of three semester credit hours could evolve without exhausting important and applicable material and educational values.

The first category, called Delineation, refers in particular to the mechanics and methods of graphical representation. The word delineation, according to Webster's Collegiate Dictionary, means,-- "A representing, portraying, or describing, as by lines, sketches, etc."

The second category is Analysis and Synthesis. This includes those areas of graphics which feature three dimensional thought and space relationship. Much analysis and synthesis should be taught in that part of our subject matter that may call descriptive geometry. However, the development of engineering thinking and creative desire is of great importance throughout the graphics sequence.

The following outline shows briefly the general areas that are included in the basic graphics courses for engineering students.

ENGINEERING GRAPHICS COURSE CONTENT

I. Delineation - freehand sketching and instrument drawing
  A. Orthographic Projection
    1. Representation of points, lines, planes, and solids in space.
    2. Shape and size description
    3. Production standards, symbols and specifications
  B. Pictorial Representation
  C. Engineering Data Depiction
    1. Charts and graphs
    2. Scales and vector quantities
    3. Graphical mathematics
II. Analysis and Synthesis--The scientific approach
  A. Spatial Concepts
    1. Graphical solution of fundamental space problems
    2. Visualization--thought problems in space
  B. Sequential Thinking
    1. Creative problems
    2. Layout and design

I again note that these are very general headings as opposed to particular topics. For example, no mention has been made of such topics of study as lettering, sections, rotation, development, surface intersection, screw threads, welding, or the many other traditional topics.

It is recognized that freehand work should be emphasized continuously to prepare the engineer to think and create by sketching.

Only the scientific approach to teaching drawing as opposed to teaching draftsmanship as a skill, will merit the consideration of engineering graphics as a basic science in our curriculum.

The inclusion, emphasis, or deletion of specific topics in a course has several controlling factors:

1. Time or credit allowed for the courses
2. Type of curriculum
3. Type of school
4. Geographical location of the school

The first item is self-explanatory. With very limited time at our disposal few of us find it possible, at best, to make what we would consider a complete coverage. We, therefore, have to exercise our best discrimination as to what to delete.

Most will agree that somewhat different coverage is possible for the highly scientific compared to the more professional type of program. The present concern and glory among engineering educators appears to point to the education of only research scientists. Recently, a well known dean of engineering stated that this problem should be faced more realistically with about 25 schools approaching engineering education from the scientific direction and that the remaining schools should offer a general engineering education suitable for persons who are to serve as project engineers, production engineers, design engineers, etc.

The emphasis on graphics is different in the technical institute and the industry supported professional schools from that in the large engineering college or university. The geographical influence of varying types of industry has its effect on emphasis. For example, the automotive industry, the aircraft industry, the electronics industry, the oil industry and others, exert influence in particular geographical areas. There is also a problem of graphics given in pre-engineering courses at liberal arts and junior colleges, sometimes by ill-prepared and often disinterested teachers.

My thesis is that the persons in charge of engineering graphics course content should review with care those things which we have discussed so as to arrive at a program that has balance, continuity, and best meets the need of their particular situation.

Conclusions

It seems reasonable that we should recognize the following criteria as having a definite influence on the course content of a sequence of basic courses in Engineering Graphics.

1. Graphics is an important part of an engineering education.
2. The philosophy of engineering education in our nation, in our separate schools, and in our individual departments needs to be better crystalized.
3. Our courses need continued and careful inspection for content and emphasis in the light of our objectives and the available time for their accomplishment.
4. The content and teaching should be maintained at a college level.
5. There will be justified variations in quantity and quality of course content depending on its position in the curriculum, the type of curriculum, the type of school and the geographical location.
6. Advanced graphics courses are desirable and should be available in an engineering curriculum.
7. There is a minimum of time required to accomplish a worthwhile job of teaching the graphics language, below which the value of the course becomes negligible.

An attempt has been made to be honest and objective in the overall consideration of course content in Engineering Graphics. One fact is clear, --that further study should be made by the most capable and forward looking people in the graphics field. It is for this reason that the Committee on Aims, Scope, and Status of Engineering Graphics is being continued under the leadership of Professor McNeary of the University of Maine. Also, a new committee on Future Development--Engineering Graphics in 1965-70 has been established with Professor Buck of Syracuse University as chairman. I look forward to some very constructive work in these interests of the division from these two committees during 1958-59.

NOMOGRAPHY AWARD

The second annual nomography award was presented at the Annual Meeting of the Division of Engineering Drawing to Donald F. Othmer, Paul W. Maurer, Charles J. Molinary, and Ronald C. Kowalski, all of the Polytechnic Institute of Brooklyn. Their winning nomograph appeared in an article "Correllating Vapor Pressures and Other Physical Properties", Industrial and Engineering Chemistry, January, 1957. The prize of $100 was given by the Barber-Colman Company, Rockford, Illinois. Edward C. Varnum of Barber-Colman, Head of Operations Research, is well known for applications of nomography.

This year's winning nomograph was particularly effective in presenting complicated relationships between many variables for nomographic solution. The derivation of the nomograph, drawing and manner of use were concise and effective.

The third annual nomography competion sponsored by the Graphics Division of A.S.E.E. is hereby announced. The prize of $100 is sponsored by Convair of California. Nomographs should be addressed to Professor Norman Arnold, Purdue University, Lafayette, Indiana.

THE ENGINEERING DRAWING COURSE at THE UNITED STATES AIR FORCE ACADEMY

By John W. Coffey, Jr.

The United States Air Force Academy

The Air Force officer uses drawings to varying degrees in many ways. Of course, those officers involved in technical fields such as installations, armament, maintenance, and research and development work with drawings every day. The pilot learns his aircraft and its systems by studying graphic presentations. He brings his aircraft down safely under instrument conditions after consulting graphic instrument approach diagrams. The staff operations officer, using plan and profile diagrams of his strike forces, plans a complicated air mission. Using graphic displays, he explains to the combat crews their mission and procedures. There are other ways that the Air Force officer uses graphics, but in all cases the use of this communicative tool enhances his effectiveness. The professional air officer who lacks ability and skill in the various forms of graphical expression is handicapped in the efficient performance of his duties.

Prior to a discussion of the Engineering Drawing Course at the Air Force Academy, it is appropriate to point out to the reader the overall mission of the Air Force Academy so that he may have a better understanding of the objectives of the Engineering Drawing course within that mission.

The mission of the Air Force Academy is to provide instruction, experience, and motivation to each cadet so that he will graduate with the knowledge and the qualities of leadership required of a junior officer in the United States Air Force, and with a basis for continued development throughout a lifetime of service to his country, leading to readiness for responsibilities as a future air commander.

To support this mission, the objectives of the Engineering Drawing Course are:

a. To enable the Cadet to read and understand engineering drawings with facility.

b. To instruct the Cadet in methods of graphical expression, both freehand and with standard drawing instruments.

c. To develop the ability of the Cadet to visualize objects in space.

d. To familiarize the Cadet with working drawings and their use in the aircraft industry.

In order to accomplish the above objectives, Engineering Drawing is taught during the first semester of the Freshman year. Each cadet attends 43 periods of 2 hours duration and the general pattern of each period is as follows:

a. A 20 minute reading assignment.

b. A 15 minute instructor talk and demonstration.

c. Problems (about 90% of the Cadet's work is graded).

II

Broadly speaking, the contents of the course can be broken down into 6 areas.

I	Methods of Portrayal	14 periods
II	Descriptive Geometry	10 periods
III	Technical Practices	6 periods
IV	Aircraft Working Drawings	8 periods
V	Charts and Graphs	2 periods
VI	Examinations	3 periods

In detail, the 43 periods in the Engineering Drawing Course are divided as follows:

1. Introduction, Sketching and Lettering: Discussion of course objectives and procedures; Technique of lettering; Freehand drawing tools; Sketching straight lines, circles, ellipses and curves; Practical exercises in sketching.

2. Pictorial Sketching (isometric): Theory of isometric projection; Principles of isometric drawing; Box-in construction; Offset construction; Angles, circles and curves; Exercises.

3. Pictorial Sketching (oblique): Principles of oblique, cavalier and cabinet projection; Box-in construction; Circles, arcs, curves; Exercises.

4. Pictorial Sketching (isometric and oblique): Written quiz on theory and principles of isometric and oblique drawing; Practical exercises in isometric and oblique sketching.

5. Use of Drawing Instruments: Use and care of drawing equipment; Alphabet of lines; Practical exercises in drawing straight-line geometric figures using drawing instruments.

6. Use of Instruments and Geometric Construction: Use and care of drawing instruments; Methods of dividing a line; Drawing parallel and perpendicular lines; Tangents and tangent arcs; Irregular curves; Construction of ellipses and parabolas; Practical exercises in drawing curved line figures using drawing instruments.

7. Orthographic Projection: Theory of orthographic projection; Principles of multiview drawings; Layout and relationship of views; Practical exercises.

8. Orthographic Projection: Film on theory and principles of orthographic projection; Visualization

of nonsymmetrical objects in or thographic projection, use of reference plane; Practical exercises in drawing nonsymmetrical objects.

9. Orthographic Projection: Reading orthographic drawings; Visualizing planes projected on principle planes; Practical exercises in orthographic reading.

10. Orthographic Projection: Written quiz on theory and principles; Practical exercises in drawing and reading.

11. Auxiliary Views: Theory of Auxiliary Views and reference planes; Practical exercises.

12. Auxiliary Views: Principles in drawing first auxiliaries; Practical exercises.

13. Auxiliary Views: Theory and principles of 2nd auxiliary views; True shape of an oblique plane; Practical exercises.

14. Auxiliary Views: Practical exercises in 1st auxiliary and 2nd auxiliary views.

15. Mid-term Exam: Drawing techniques, Methods of portrayal, Pictorial drawings, Orthographic projection, Auxiliary Views.

16. Descriptive Geometry: Classification of lines (normal, oblique, inclined); Discussion of point on a line, parallel and intersecting lines, true length of a line by rotation and auxiliary view; Application of principles.

17. Descriptive Geometry: End view of a line; Perpendicular lines; Angles with principle planes; Distance between skew lines; Application of principles.

18. Descriptive Geometry: Classification of planes (normal, inclined, oblique); Edge view of a plane; Line piercing a plane (edge view method, cutting plane method); Normal view plane; Application of principles.

19. Descriptive Geometry: Practical problems using principles of previous three lessons; Angles between planes; Angles between line and plane; Constructing parallel planes.

20. Descriptive Geometry: Problems combining principles in Descriptive Geometry.

21. Intersections: Intersections of planes; Intersections of prisms and pyramids; Problems.

22. Intersections: Intersections of plane surface and curved surfaces; Intersection of two curved surfaces; Cutting plane method; Problems.

23. Intersections: Practical exercises in determining intersection of two curved surfaces.

24. Developments: Development of prisms, pyramids, cones, and cylinders; Problems.

25. Developments: Development of truncated cones, pyramids and cylinders.

26. Sections: Theory and principles of sectioning; Full section, half section, broken out section; Revolved and removed sections; Application of principles.

27. Conventional Practices: Conventions in portraying drilled flanges, spokes and webs, fillets and rounds; Conventional symbols; Application of principles.

28. Dimensioning: Film on machine shop practices; Theory of dimensioning; Size and location; Callouts (specifications and notes); Problems to dimension.

29. Dimensioning: Aircraft practices and Problems in dimensioning.

30. Fasteners: Screw threads -- definition and types; Thread representation and symbols; Classes of threads and specifications; Thread notes; Application of principles.

31. Fasteners: Threaded fasteners -- bolts, studs, cap screws, locking devices; Keys, Pins, Rivets, Springs; Problems.

32. Aircraft Working Drawings: Lecture on procedure in developing a weapons system, organization of aircraft plant, and uses of aircraft working drawings.

33, 34, 35. Aircraft Working Drawings: Design Problem - designing and drawing a hydraulic check valve.

36, 37, 38, 39. Aircraft Working Drawings: Aircraft master layout - layout inboard, plan and aft view of wing section; layout plan and aft view of fuselage, determine intersection; develop wing tip section.

40. Charts and Graphs: Theory and Principles of technical charts: rectilinear, Log, Semi-log, polar, and trilinear charts.

41. Charts and Graphs: Theory and Principles of Presentation charts: organizational, route, bar, pie, pictorial charts.

42, 43. Final Examination: Drawing techniques, Methods of portrayal, Descriptive geometry, Technical practices, Aircraft working drawings, Charts and Graphs.

III

Each period in the course is conducted under a rigid time table, and instructor conferences are held prior to each meeting with the cadets. Frequent use use is made of selected audio-visual materials such as

Vu-graph transparencies, films, charts, and in addition to the use of a well-known drawing text, two supporting pamphlets have been prepared by the Department. One pertains to descriptive geometry, and the other is concerned with aircraft working drawings.

A validation program was introduced during the summer of 1957 in which entering cadets with prior college Engineering Drawing and Descriptive Geometry were given a modified final-type examination soon after their arrival at the Academy. The twenty-one cadets who demonstrated proficiency were given credit for the Engineering Drawing course and permitted to participate in the curriculum enrichment program. The objective of this program is to offer the cadets learning-experiences beyond those of the prescribed curriculum. After the first 14 periods of the regular course, those cadets with the highest grades were put into an advanced Engineering Drawing class. The advanced work while completing the phases of the regular course at an accelerated rate, contains in addition two periods of perspective drawing and more "design" type work in the Aircraft Drawings phase.

Every effort is made to integrate the Engineering Drawing problems with the subject matter of other Departments at the Academy. Particular success has been achieved in the Charts and Graphs portion of the course. Actual experimental data acquired from the Physics and Chemistry Departments have been utilized in the preparation of the problems in this area.

In review of our objectives, it is clear that we are not attempting to produce draftsmen. In the course presented, we can only expect to reach a reasonable level of skill among the cadets. We are attempting to give the cadet a practical and useful means of communication It is anticipated that Senior year courses will channel his communicative skills and abilities into creative design work. Comments and criticisms by readers of the Journal of Engineering Graphics are sincerely solicited and encouraged. Samples of our course materials and pamphlets may be obtained upon request.

The ability to express himself effectively and to communicate with others is an essential element in a military leader. It is in these areas that the Engineer-Drawing course directly supports the Academy mission.

TENTATIVE SLATE OF CANDIDATES FOR OFFICES OF THE DIVISION, 1959-60

The Nominating Committee of the Engineering Graphics Division met at Berkeley, California and selected the following candidates for the offices indicated.

VICE-CHAIRMAN:
Irwin Wladaver, New York University
James Blackman, University of Nebraska

SECRETARY TREASURER:
Edward M. Griswold, The Cooper Union
Hugh P. Ackert, University of Notre Dame

EDITOR OF GRAPHIC SCIENCE PAGE:
Edwin W. Jacunski, University of Florida
B. F. K. Mullins, A and M College of Texas

CIRCULATING MANAGER OF JOURNAL OF ENGINEERING GRAPHICS:
Albert S. Palmerlee, University of Kansas
Robert D. LaRue, Colorado State University

MEMBER OF THE EXECUTIVE COMMITTEE:
Lloyd B. Christenson, Missouri School of Mines
Ralph M. Coleman, Texas Western

Additional candidates may be nominated by petition. A petition should be signed by ten members of the Engineering Graphics Division. The candidate must have expressed his willingness to accept office if elected. Such petitions for nominations should reach T. T. Aakhus, University of Nebraska, Lincoln, by the opening of the Mid-Winter Meeting in January 1959.

Nominating Committee
Marilyn J. Wolff
Kerby Backus
Ivan Hill
William Street
T. T. Aakhus, Chairman

OFFICERS AND COMMITTEES - 1958-59
DIVISION OF ENGINEERING GRAPHICS, ASEE

OFFICERS:

Chairman: J. S. Rising, Iowa State College.
Vice-Chairman: Al Jorgensen, University of Pennsylvania
Secretary-Treasurer: Irwin Wladaver, New York University

COMMITTEES:

Executive Committee:

J. S. Rising, Iowa State College
Al Jorgensen, University of Pennsylvania
Irwin Wladaver, New York University
W. J. Luzadder, Purdue University, Past Chairman
Jasper Gerardi, University Detroit, Member Council (2 years)
C. J. Vierck, The Ohio State University (1 year)
J. H. Porsch, Purdue University (2 years)
M. McNeary, University of Maine (3 years)
B. L. Wellman, Worcester Polytechnic (4 years)
Earl D. Black, General Motors Institute (5 years)
B. H. Hammond, U. S. Military Academy (1 year)
W. L. Shick, University of Illinois (3 years)
A. P. McDonald, Rice Institute (2 years)
E. M. Griswold, The Cooper Union (1 year)

Representative to General Council, ASEE

Jasper Gerardi, University of Detroit

Committee on Publications

Journal of Engineering Graphics:
Editor: W. L. Shick, University of Illinois
Advertising Manager: A. P. McDonald, Rice Institute
Circulation Manager and Treasurer:
E. M. Griswold, The Cooper Union

Graphic Science Section, Journal of Engineering Education:
Editor: R. H. Hammond, United States Military Academy

Committee on Policy

Warren J. Luzadder, Purdue University, Chairman
Jasper Gerardi, University of Detroit
Frank A. Heacock, Princeton University
Randolph P. Hoelscher, University of Illinois
William E. Street, A and M College of Texas

Committee on Nominations

Theodore T. Aakhus, University of Nebraska, Chairman
William E. Street, A and M College of Texas
Ivan L. Hill, Illinois Institute of Technology
Kerby D. Backus, The Rice Institute
Marily J. Wolff, University of Wisconsin, Milwaukee

Committee on Special Awards

William E. Street, A and M College of Texas Chairman
Ivan L. Hill, Illinois Institute of Technology
Warren J. Luzadder, Purdue University

Committee on Aims, Scope, and Status of Engineering Graphics

Matthew McNeary, University of Maine, Chairman
James S. Blackman, University of Nebraska
Carson P. Buck, Syracuse University
Jerry S. Dobrovolny, University of Illinois
Jasper Gerardi, University of Detroit
Albert Jorgensen, University of Pennsylvania
Eugene G. Pare', Washington State University
B. Leighton Wellman, Worcester Polytechnic Institute

Committee on Future Development (Engineering Graphics in 1965-70)

Carson P. Buck, Syracuse University, Chairman
Frank J. Burns, Newark College of Engineering
Ralph E. Lewis, Duke University
Austin G. Loveless, Utah State University
Joseph W. McCutchan, University of California, Los Angeles
Elman A. Morrow, William Jewell College
Kevin B. O'Callahan, University of Buffalo
Marilyn J. Wolff, University of Wisconsin, Milwaukee

Committee on Industrial Relations

Ralph S. Paffenbarger, Ohio State University, Chairman
Melvin L. Betterley, State University of Iowa
Earl D. Black, General Motors Institute
C. Albro Newton, University of Tennessee
John E. Pearson, University of Illinois
L. R. Schruben, University of Southern Califomia
William E. Street, A and M College of Texas
B. Leighton Wellman, Worcester Polytechnic Institute

Committee on Research and Publications

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Steven A. Coons, Massachusetts Institute of Technology
Frank A. Heacock, Princeton University
Herman C. Hesse, Valparaiso University
Wayne L. Shick, University of Illinois

Committee on Nomography
J. Norman Arnold, Purdue University, Chairman
M. W. Almfeldt, Iowa State College
Douglas P. Adams, Massachusetts Institute of Technology
Richard A. Huzarski, University of New Mexico
Alexander S. Levens, University of California
Jacob H. Sarver, University of Cincinnati

Committee for Descriptive Geometry Award
Douglas P. Adams, Massachusetts Institute of Technology, Chairman
Jerry S. Dobrovolny, University of Illinois
Ivan L. Hill, Illinois Institute of Technology

Committee on Teaching Techniques
Hugh P. Ackert, Notre Dame University, Chairman
Carl A. Arnbal, Iowa State College
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Clarence E. Douglass, University of Washington
Kermit R. Gulden, Rensselaer Polytechnic Institute
Elizabeth A. Kelso, University of Maine
Robert D. LaRue, Colorado State University
Elmer E. Petty, Milwaukee School of Engineering
Oliver M. Stone, Case Institute of Technology

Committee on Bibliography
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Theodore Dolan, Illinois Institute of Technology
Robert L. Hang, Ohio State University
Gerald W. Walsh, Syracuse University

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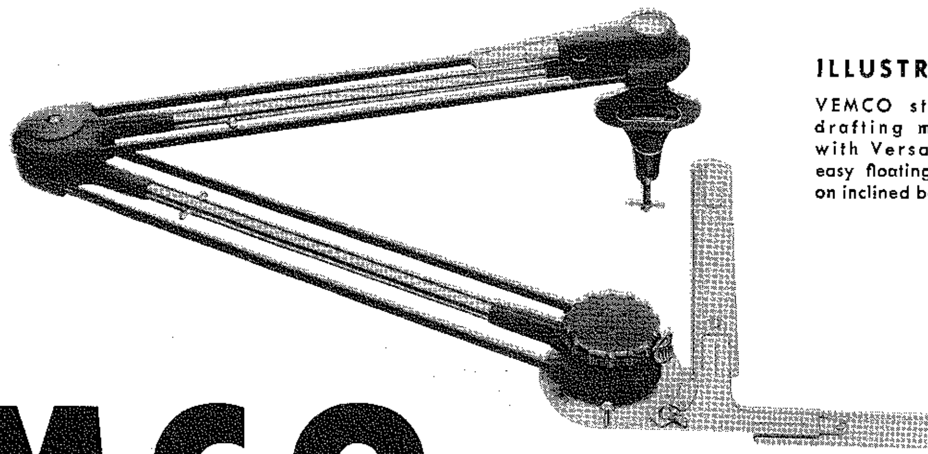

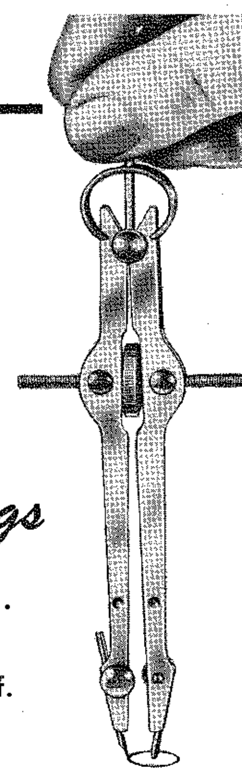

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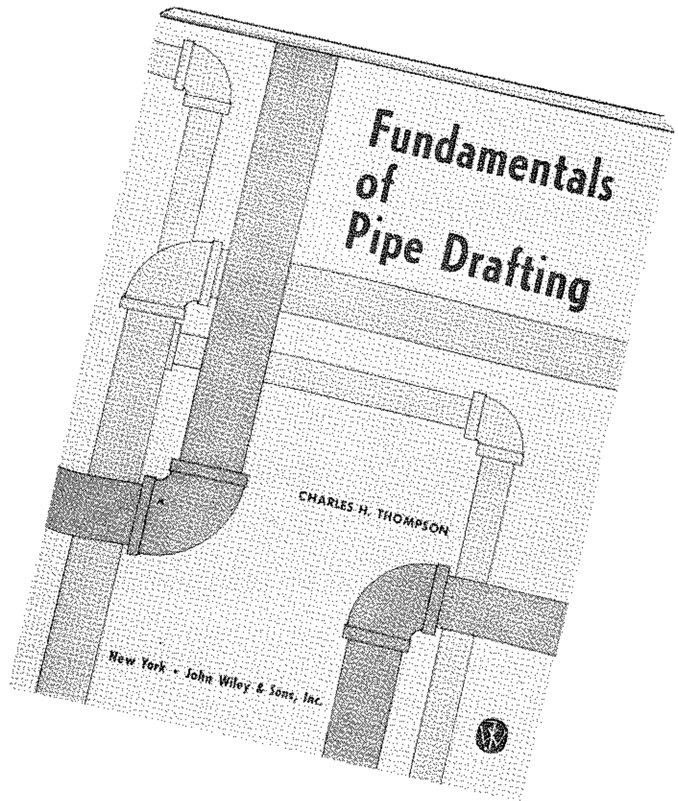

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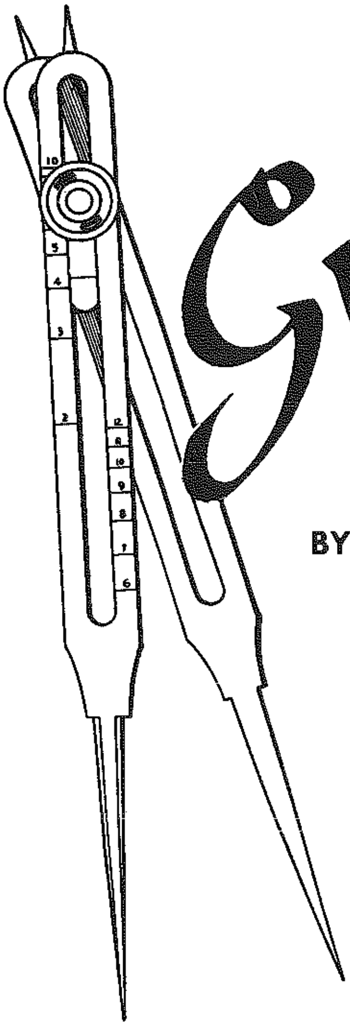

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