JOURNAL OF ENGINEERING DRAWING

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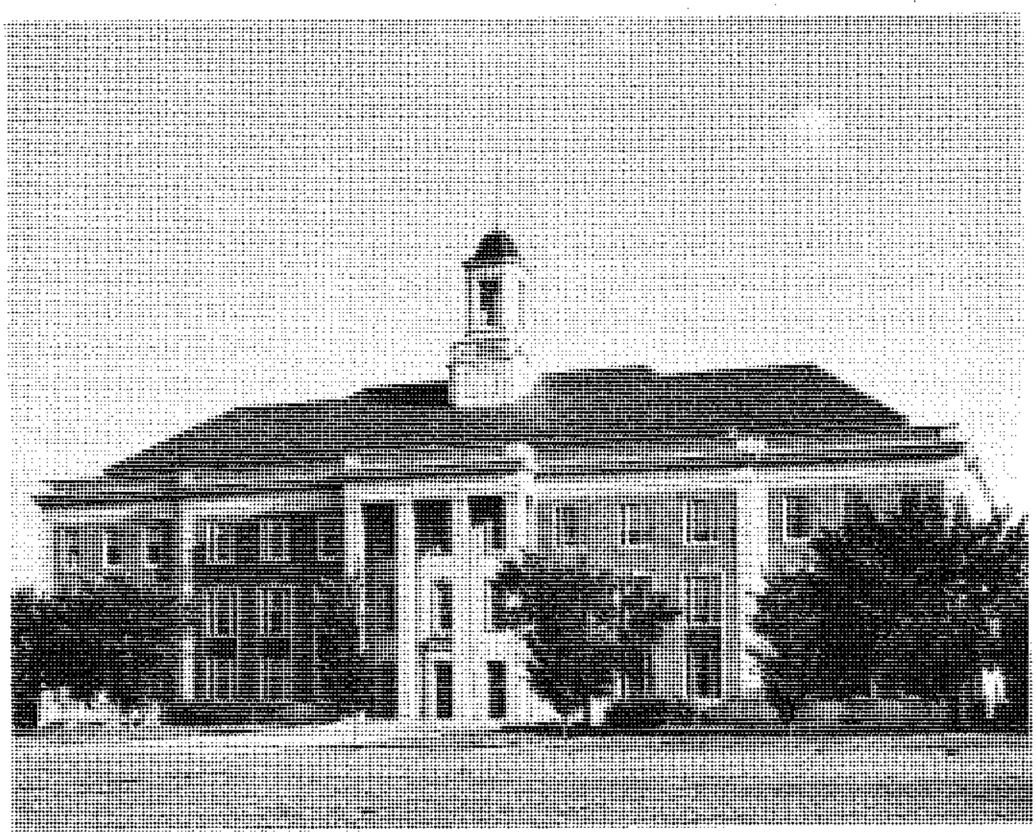

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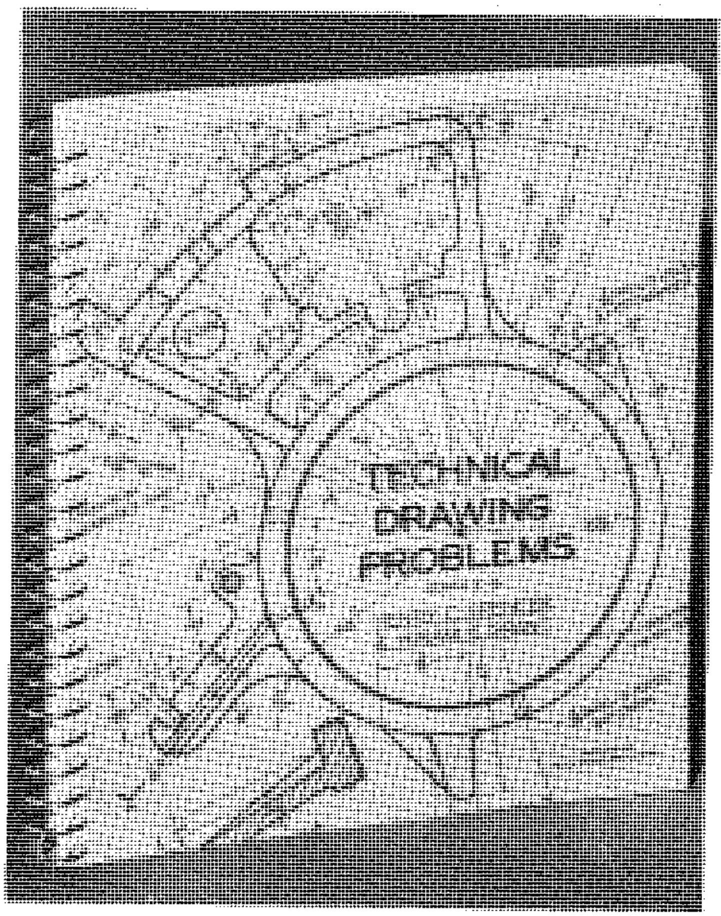

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PUBLISHED IN THE INTEREST OF TEACHERS OF ENGINEERING DRAWING AND RELATED SUBJECTS

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CONTENTS

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PUBLISHED IN FEBRUARY, MAY, AND NOVEMBER BY
THE DIVISION OF ENGINEERING DRAWING AND DESCRIPTIVE GEOMETRY OF THE
AMERICAN SOCIETY FOR ENGINEERING EDUCATION

Education by Example

Education does not mean teaching people what they do not know. It means teaching them to behave as they do not behave. It is not teaching the youth the shapes of the letters and the tricks of numbers, and then leaving them to turn their arithmetic to roguery, and their literature to lust. It means, on the contrary, training them into the perfect exercise and kingly continence of their bodies and souls. It is a painful continual and difficult work to be done by kindness, by watching, by warnings, by precept and by praise; but above all by example.

~ John Ruskin

REPORT OF THE MEETING OF ENGINEERING DRAWING DIVISION

by

Professor O. W. Potter, Secretary
University of Texas, Austin, Texas
June 14-18, 1948

The annual meeting of the American Society for Engineering Education was held this year at the University of Texas in Austin, Texas, June 14 to 18th. All the sessions were held on the campus of the University of Texas.

The Engineering Drawing Division had a most interesting program. The program was as follows:

Monday, June 14th 1:00 P.M. Luncheon Meeting
F. A. Heacock, Chairman, Presiding
Address:--Engineering Drawing an Experience in Engineering--E. M. Griswold, Cooper Union
Technical Session 2:00 P.M., F. A. Heacock, Chairman, Presiding.

This was a joint meeting with the machine design group of the Mechanical Engineering Division.

Papers presented:

1. Some Relations between Descriptive Geometry and Mechanics and Mathematics--W. H. Taylor, University of Alabama.
2. Preparing the Beginning Engineering Student in the Drawing Class for His Later Work in Machine Design--H. N. Tyson, California Inst. of Technology.
3. Standard Parts and Practices--A. W. Luce, Pratt Institute.
4. Modern Dimensioning Practices--S. B. Elrod, Purdue University

Tuesday 2:00 P.M.

Teaching Clinic on Engineering Drawing and Descriptive Geometry--W. H. McNeill, University of Texas presiding.

Panel and Program:

1. Blackboard demonstration of teaching engineering drawing--H. C. Spencer, Illinois Institute of Technology.
2. Objectives of an Engineering Drawing Course--R. P. Hoelscher, University of Illinois.
3. Methods for Stimulating Students' Interest in Engineering Drawing and Descriptive Geometry--F. G. Higbee, State University of Iowa.
4. Development of the Students' Ability to Think and Analyse in Space--F. M. Warner, University of Washington.
5. Importance and Place of Pictorial Methods in a Course in Engineering Drawing--J. T. Rule, Massachusetts Institute of Technology.
6. Grading Students Drawings--J. Gerardi, University of Detroit.
7. Preparation of Quizzes and Examinations--R. S. Paffenbarger, Ohio State University.

Wednesday 6:00 P.M. Dinner

W. H. McNeill, University of Texas, presiding.
Speaker: C. L. Svensen, Texas State Board of Registration for Professional Engineers.
8:00 P.M. Technical Session

Papers Presented:

1. Visual Aids and Models for Engineering Drawing and Descriptive Geometry--C. E. Rowe, University of Texas.
2. An Adaptable Teaching Model for Orthographic Views--P. M. Mason--A. & M. College of Texas.
3. A Rating Scale for Grading Engineering Drawings--E. G. Kirkpatrick--Purdue University.

The luncheon meeting was the first meeting for the group and was marked by greetings and handshaking as we met old friends and were introduced to newcomers.

Immediately after the luncheon Professor E. M. Griswold of Cooper Union gave an interesting talk on the subject "Engineering Drawing an Experience in Engineering."

The report of the nominating committee was called for. In accordance with the plans made at the previous annual meeting in Minneapolis the nominations and election were conducted by mail. The following officers were elected:

Chairman H. C. Spencer, Illinois Inst. of Technology

Secretary O. W. Potter, University of Minnesota

Member of Executive Committee for 5 Years W. E. Street, A. & M. College of Texas.

(Continued on page 34)

DRAWING IN ENGINEERING EDUCATION

by

Carl L. Svensen
American Society for Engineering Education
Drawing Division
June 15, 1948, Austin, Texas

Kipling might not have had engineering education in mind when he said:

"I keep six honest serving men (They taught me all I knew)
Their names are What and Why and When
And How and Where and Who"

But whether he did or not, his serving men are equally valuable to point to the elements of an engineering education and to serve as a guide toward the objectives for which this society of engineering educators exists.

Dr. Doherty, President of Carnegie Institute of Technology has been quoted as saying that great changes are now getting under way in all branches of formal engineering education and that these are aimed at placing greater emphasis upon fundamentals that lie at the center of scientific and engineering knowledge, and less upon the specialized information and "know how" that lie at the periphery. And in an SPEE report, we find "the attempt to make the undergraduate student proficient in specialized subdivisions of engineering practice must be abandoned in the interest of developing mastery of basic principles."

Mastery of basic principles will come with proper consideration of the "six (or more) honest serving men" of engineering education. These are the service courses such as mathematics, English, physics, chemistry, economics, and engineering drawing. Add to them if you wish but do not attempt to displace any of them. These are the subjects which provide the answers to "what and why and when and how and where and who" of an engineering education - education for a profession.

The place of engineering drawing in engineering education is that of a key subject. It provides the only means by which professional engineering can be understood. It is at once a service subject for study in acquiring an engineering education and for use in the practice of the profession of engineering after the education has been acquired.

These basic engineering serving men (the service courses) teach all the engineering there is - know them and you know all. It is then a matter of knowing where, what, when, why and how to use what you know and this is the objective of a professional engineering education. An education which requires a real knowledge and understanding of the engineering language - engineering drawing - and above all the ability to think in that language. This is the real meaning of drawing in engineering education. It is more than the ability to make a drawing, it is more than simply recognizing something which is already known or which has been seen, it is more than simply reading the size from the dimensions, it is more than simply a means of specifying or recording. The real meaning of drawing in engineering education is that of providing a means of understanding the components of professional engineering and a means of thought conception of all that enters into the practice of professional engineering.

It is true that drawing has a double value - value in itself as a great division of knowledge, and value as the basis for the study and understanding of all other divisions of engineering. Too often this second value is subordinated to the elements of the engineering language, or worse still training the hand and developing skill in execution alone. To many of our friends, drawing is still mechanical drawing with emphasis on the <u>mechanical</u>. As Dean Anthony once said: "The term Mechanical Drawing has been responsible for much that has limited the field of this language to geometry and penmanship, leaving its great function, the art of expression, almost untouched. Indeed the subject can be properly taught only from the standpoint of language." The geometry and penmanship are indeed necessary for the study of the graphic language as writing is for our written language but the time given to the graphic language ought not to be so short as to limit the course to the mere teaching of how to draw. Time is needed for the development of a very real facility in the use of the graphic language as a means of accurate thinking and accurate understanding.

There is as great a difference between learning to draw and "drawing" as there is between learning to write and "writing". Use, understanding, application, and practice are necessary to make any tool of value, and drawing is one of the most valuable of all tools in the study of engineering and in the practice of engineering. Without this tool one may be trained but there is a great gulf between being "trained" and being "educated for a profession." Without this basic tool - this engineering language - engineering education would be impossible. And, without the ability to think clearly and well in the engineering language of drawing, an engineering education is defective in the elements which are necessary to make it a truly professional education, with all that is implied in the word professional.

Engineering drawing in engineering education should be recognized in fact for what it is - the language of engineering and the means for thinking engineering. Yes, I know there is general lip service to the concept of drawing as the language of engineering, and there are some leaders in engineering education who are understanding and recognizing drawing as the actual language medium for a professional engineering education. But there must be recognition of the fact that drawing is not a subject <u>apart</u> from others but a subject which is a part of all others.

We have made the comparison of drawing and English as twin languages. But you do not find the subject of English separated from its use and development in literature, poetry, drama, etc. And so when a true recognition of drawing as a language is achieved, drawing will not be separated from its use and development in graphic statics, mechanism, machine design etc. These and other dependent subjects will be included in the department of drawing, or engineering graphics, where they belong so that drawing can take its proper place in engineering education.

Trying to teach the "practical" before the "understanding" is a mistake. "Basic understanding" is more important than practical application in an engineering education. Motivation! Yes! but it is necessary to remember the difference between "training" and "education" - the difference between knowing "how" and knowing "why" - the difference between a "trade" and a "profession".

Engineering has developed as a profession during the years since 1907 when the first law was passed in Wyoming to require the registration of professional engineers. Now all states have laws governing the practice of this profession. Engineering education has become "education for a profession" and must be considered as such. Every course must be considered for its value as a part of professional education. Engineering drawing must be so considered and we know how it forms a part of all engineering education. We know, but there are those who do not know. There is more to "drawing" than "learning to draw" and it takes more than a draftsman (using the term as it exists in the lay mind) to teach engineering drawing and to "represent" this important factor in engineering education. The engineering drawing teacher must be a professional engineer as must be the teachers of all engineering subjects. Who would want to study the practice of medicine except under licensed doctors of medicine or of law except under licensed attorneys? The importance - no - I mean the necessity for engineers engaged in engineering education to be registered professional engineers is being recognized.

In the Texas examination for candidates for registration, one part covers engineering fundamentals and is the same for all engineers. It is taken without the use of books. A second part covers each of the major branches of professional engineering and is taken with the use of books, reference material, etc.

The results of over twenty examinations have shown a very close correlation between the grades obtained on the two parts of the examination. The candidate who has a working knowledge of the fundamentals, such service subjects as mathematics, mechanics, engineering drawing, etc., will make a good grade. He will make very close to the same grade in the professional part. He indicates ability to apply engineering principles and to interpret engineering data. Where or how does engineering drawing come into the picture? It comes by way of a developed constructive imagination from the power of visualization, accuracy of thought, and ability to analyze, all of which are products of the study of engineering drawing and descriptive geometry. While drawing as such forms a small part of the fundamental examination, its effects are seen in answers to all other problems, in particular such problems as have to do with graphic solutions, shear and moment diagrams, mechanism, design, etc.

What I would like to bring out clearly and forcefully is that we have here an actual condition - a condition which exists in the practice of the profession of engineering. It is a condition which indicates that the engineers with eight or more years experience who know the meaning of the graphic language and who solve the drawing problems are the ones who can apply engineering principles and who make good grades on the professional part of the examination - they think, analyze and solve problems related to their branch of engineering. Truly there is more, much more to the graphic language, the engineer's language than simply making a drawing. Its greatest value is as "a language in which to think", a language in which to "think engineering thoughts", thoughts of space, size, motion, materials, and progress.

The May 1948 issue of "Mechanical Engineering" includes some informative articles associated with improving engineering education. Dean Arms of the College of Engineering, University of Delaware defines "the newly designated bachelor of mechanical engineering" as follows:

"He is a man who, we believe, has a rich background in the natural sciences, especially chemistry and physics. He should know how to use that important tool of all engineers - mathematics. He should be well grounded in his native language and should show competence in its use, both oral and written. He should know something of history and government of his native land, at least. He should have a thorough grounding in basic electrical engineering, including direct and alternating current circuits and machines, and some electronics. We believe that he should have been well trained in the three concurrent stems of mechanical engineering:
(a) Thermodynamics and heat power, including fluid flow and heat transfer,
(b) machine design, including engineering drawing, mechanics, and engineering materials, and
(c) industrial engineering, including economics, accounting, and a study of industrial organizations.
Through our training, we believe that we should have instilled in him habits of neat and orderly methods of assembling and presenting all kinds of data. He should have learned to adapt himself to new situations and to get along well with people. Finally, and most important, we humbly hope that we have taught him to think!"

If "to think" is important what is more effective than drawing and descriptive geometry as a means of developing the power to think, the power to think engineering thoughts, the power to think of shape and of size and of motion, and to think accurately and quickly.

You will note that Dean Arm recognizes engineering drawing as an important part of one of the three concurrent stems of mechanical engineering. As such it is equally important in every branch of engineering. When all deans and administrative officers realize this essential character of drawing as an element of an

(Continued on page 20)

GRAPHICS IN THE BELFRY

by

Professor Arthur Bigelow
Professor of Graphics, Princeton University

The subject of bells and carillons is fast becoming a familiar one on our college campuses today. Fortunate indeed is the institution which possesses a series of bells - chime or carillon - of pleasing tone, regularly played, adding to the atmosphere and tradition of student life. If the bells are in tune, they are mostly just accepted without further thought. If out of tune, their sour and harsh notes often cause unfavorable comment and even ridicule. Of all musical instruments, the least understood is the bell, and its interesting physical properties are never the subject of discussion even in the most advanced course in accoustics - simply because the bell is unknown. In the next few paragraphs I hope, with the aid of the graphs reproduced here, to present some of the hurdles which confront the bell-founder, and also to show why many series of bells sound out of tune and could never be put into tune.

Given a set of bells, it is not too difficult a task to design an adequate frame to house them. Though the general procedure of truss design in wood or steel - or both - involves nothing basically different from other structures, belfry design is always left to those responsible for the installation, much as the placing of a new pipe organ, for such an installation requires the experience of persons who understand its many problems before it may become the expressive musical instrument that it is.

It is, therefore, in the make-up of the bells themselves that knowledge is particularly lacking. The principles governing their proportions and tones are generally unknown. Indeed, it is correct to state that most founders today do not themselves know the correct procedure in designing a set of bells - be it just a chime of an octave or so, with 8 to 12 bells, or a complete carillon of three to four octaves, with 35 to 49 bells. Judging by the charts and graphs showing the curves and proportions of many series of bells, sizes and shapes have always been determined pretty much by rule of thumb. Their figures have never been subjected to analysis, and for this reason bell-founding and tuning has remained a craft and not become a science.

The design of a series of bells according to physical and accoustical laws constitutes the body of this article.

- - - - - - -

Any cup-like object of resonant material will ring. Its tone will be more or less pleasing according to its shape - the fundamental tone and partial tones which produce the timbre depending directly on the form. Physical law states that size is in inverse proportion to frequency, or pitch. A vibrating body having one-half the length of another will produce the octave of the other, having twice the frequency. In bells, size means the diameters, the height and the thickness.

It can readily be seen that the bell is a most complex form to work with. The pipe and string are comparatively simple, involving only length and diameter in the case of the pipe, and length and tension in the case of the string, with the thickness of the string also entering the picture. Consider the pipe: its length determines at once its pitch and its width its intensity. Compare this to the bell, whose diameter may vary indefinitely and still produce the same note. The thickness, the height, the complicated curves and proportions, exterior and interior, all combine to produce the tone of the bell, and may produce anything but a pleasing tone, if the bell is not properly designed. To this must also be added the fact that just metal of any quality will not produce a satisfactory tone.

A bell differs fundamentally, in other respects, from musical instruments in general. That a body pulsate, and a series of such bodies have their pulsations in logarithmical order - fixed pitch - is not enough to warrant the use of such bodies in an effective musical instrument. The pulsations must be amplified; otherwise they would be so weak as

(Continued on page 10)

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to have little musical value. Therefore, every musical instrument depends on two essential elements: the tremulous body, called a generator, and an amplifying device, called a resonator. Other forms of tone producers owe their quality and their intensity to both the generator and the resonator. The tone of the bell, to the contrary, owes its entire entire effect to the generator alone, and this must embody all the factors which make it a satisfactory element in those musical instruments called chimes and carillons. For where the violin string has its bridge and violin belly, the piano and harp their sound boards, the wind instruments their flaring mouths, and all have the added resonance created by the walls of the room in which they are played, the bell in its belfry has nothing whatsoever contributing to its resonance, and its tone is lost to the air the moment it is struck, free to spend itself in unlimited space.

But the greatest difficulty of the bell-founder is the realization of purity in his bells. This is dependent on a euphonious series of partials. Nature endowed the string and pipe with a consonant series of overtones; when the fundamental is tuned, the harmonics automatically arrange themselves in position relative to the fundamental. The overtones of a bell are not harmonics, but are a series of partials in very strange relationship indeed when compared to those of nature. Man himself had to discover which partials were the most pleasing, and then design a form of bell which would incorporate these partials - and finally learn how to tune them to agree with each other. The first five partials must be tuned, individually, before the bell may be pronounced pure. Add to this confusion of tones the fact that the principal tone of the bell is not its fundamental at all, but the first partial! (See Fig. 1)

Here, then, are some of the difficulties which confront the bell-founder when he undertakes to design a series of bells which are pure - and only pure bells are musical.

(Continued on page 12)

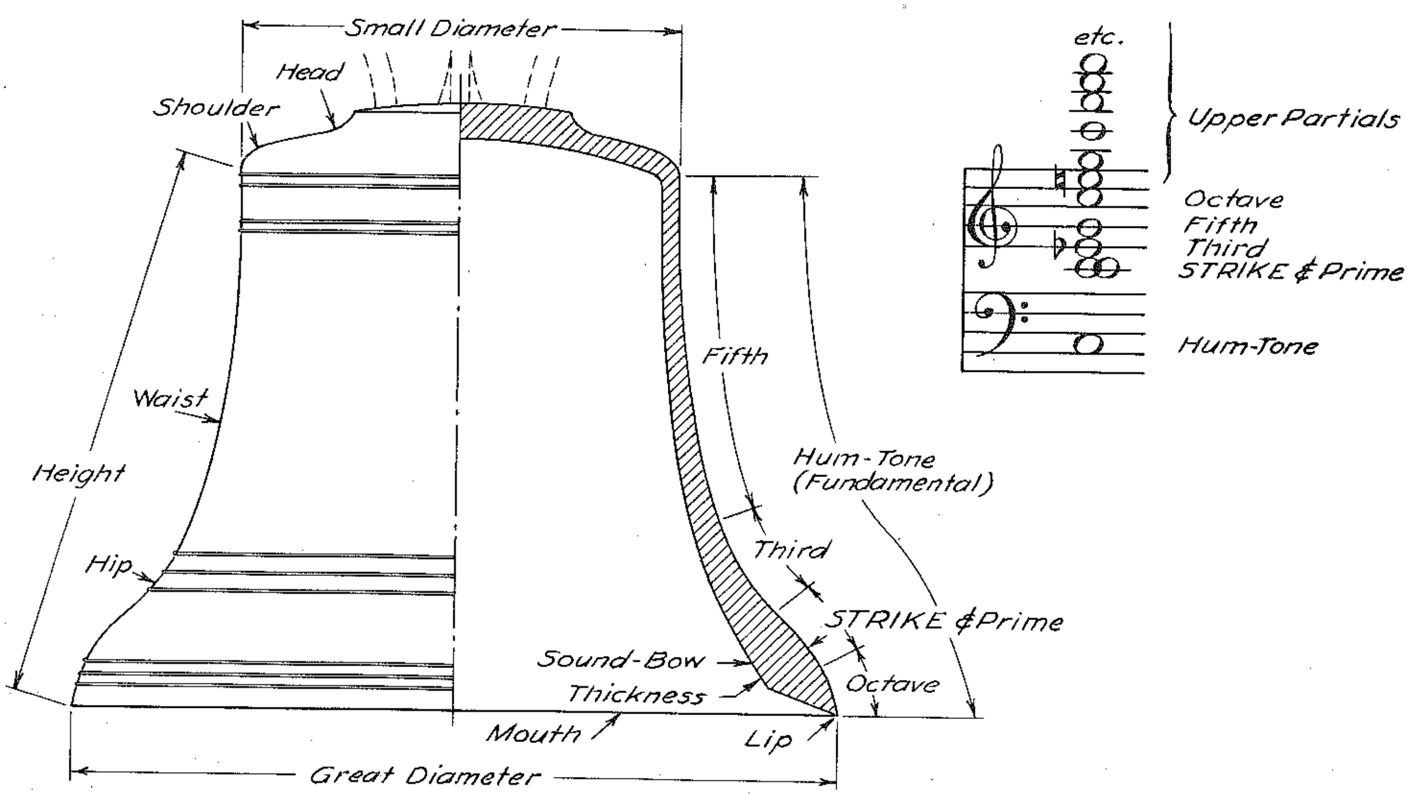

Fig. 1. The parts of a bell and its partials.

The overtones and their relative positions in the bell as here shown represent only a simplified version. The complete picture is much more complicated. The example reproduced here, typical of the bells of the Low Countries, is by Joris Dumery, 17 and hangs in the belfry of Bruges.

DRAWING DIVISION — A S E E
MID-WINTER MEETING
OHIO STATE UNIVERSITY
COLUMBUS, OHIO

JANUARY 29, 1949

The Ohio State University is celebrating this year its 75th Anniversary and has invited the Drawing Division to visit the school on the occasion of the College of Engineering Week in this celebration. The executive committee of the Division, at their meeting in Austin in June, 1948, accepted this offer and chose the above date for the mid-winter gathering. The drawing department at Ohio State is arranging an additional program in conjunction with the college program starting on January 27, 1949. They have extended a cordial invitation to the members of the Division to participate in this program. Tentative arrangements at this time have been made as follows:

THURSDAY, JANUARY 27, 1949

9:30-10:45 A.M. — Advanced Registration - 204 Brown Hall.

11:00-11:50 A.M. — Engineering Survey Lecture on "The History of Drawing" by Professor Frederick G. Higbee, The State University of Iowa - University Chapel.

12 Noon-1:00 P.M. — Drawing Division Luncheon - Guests of Department of Engineering Drawing at Staff Meeting - The Faculty Club.

ENGINEERING COLLEGE PROGRAM

GENERAL TOPIC: ENGINEERING RESEARCH

1:30-4:30 P.M. — Papers will include:
- A. College Research
- B. Research Institutes
- C. Industrial Research

7:30-9:00 P.M. — General Topic - "ENGINEERING-WHAT IS IT TODAY AND WHERE IS IT GOING"?

Paper and Discussion

FRIDAY, JANUARY 29, 1949

8:00-10:00 A.M. — Open House - Department of Engineering Drawing, Brown Hall.

10:00-12:00 A.M. — Plant Visitations: Ternstedt Division - General Motors, or Buckeye Steel Castings Company.

ENGINEERING COLLEGE PROGRAM

GENERAL TOPIC: ENGINEERING EDUCATION

1:30-4:30 P.M. — Papers will include:
- A. Undergraduate Study
- B. Graduate Study
  1. University
  2. Industrial

6:30 P.M. — COLLEGE BANQUET - Deshler-Wallick Hotel, Broad and High Street

INTERNATIONALLY KNOWN SPEAKER
SUBJECT - "THE PROFESSION OF ENGINEERING"

SATURDAY, JANUARY 29, 1949

MID-WINTER MEETING - ASEE DRAWING DIVISION

8:00-10:00 A.M. — Registration

8:30-10:00 A.M. — Executive Committee Meeting - Room 204 Brown Hall

10:00-11:30 A.M. — Inspection Trip - Jeffrey Manufacturing Company, Manufacturers of Conveying and Mining Equipment.

12:00 Noon — Division Luncheon - The Faculty Club, Ohio State University.

DIVISION PROGRAM

"Military Graphics" - Colonel L. E. Schick, Head Department of Military Topography and Graphics, United States Military Academy, West Point, New York.

"Development of Railroad Rolling Stock Specialties"-Harry W. Stertzbach, Engineering Consultant, The Buckeye Steel Castings Company, Columbus, Ohio.

"Development of Conveying and Mining Machinery"-James A. Flint, Assistant to the President-In charge of Research and Development, Jeffrey Manufacturing Company, Columbus, Ohio

"Trends in the Design of Highway Bridges"-Glenn R. Logue, Chief Engineer of Bridge and Railroad Crossings, Highway Department, State of Ohio

6:30 P.M. — DINNER MEETING - The Faculty Club

Speaker - Dr. Samuel Renshaw, Department of Psychology, The Ohio State University.
"THE VISUAL THIRD DIMENSION"

The above is the program as of October 1, 1948 when copy was submitted to the Journal of Engineering Drawing. The final program together with blanks for hotel accommodations and advanced registration will be mailed to members of the Division early in January. Reservations are to be returned to Professor Hollie W. Shupe, Department of Engineering Drawing, 218 Brown Hall, The Ohio State University, Columbus 10, Ohio.

PLASTICS FOR DRAWING INSTRUMENTS

by

A. F. Randolph
Technical Service
E. I. du Pont de Nemours & Company, Inc., Plastics Department
Arlington, New Jersey

Professor John M. Russ, whose note about drawing instruments appeared in the May issue on page 20, has kindly sent to us for examination some of the plastic which caused the reported deterioration of papers and corrosion of metal fittings. This we have found to be a transparent cellulose nitrate plastic in an unusually advanced state of decomposition, and showing evidence of having been exposed at some time to heat or light of severity or duration sufficient to initiate decomposition. We believe, then, that the experience reported by Professor Russ is somewhat out of the ordinary.

We can cite the fact that drawing instruments made from cellulose nitrate plastic have been found generally acceptable to several generations of draftsmen. The same plastics, pigmented to opaque white, have been widely and satisfactorily used in slide-rules and the like, to provide a washable white background which promotes the legibility of graduations. But it should be recognized by all users of drawing instruments that transparent cellulose nitrate plastics may be subject to some decomposition under very long exposure to conditions which may be not far out of the ordinary.

Cellulose nitrate itself, which makes up about 75 per cent of the weight of these plastics, is not a permanently stable material, and is subject to some decomposition, particularly under the influence of heat or of ultraviolet light. This slight decomposition releases traces of nitric oxide, and this in turn accelerates further decomposition. Because of this self-accelerating character of the reaction, it is obvious that decomposition once initiated is the more likely to proceed further if the material is kept in a confined place from which the acidic products of decomposition do not escape. And in a confined space over a long period of storage these may have opportunity to do damage to adjacent material.

As a means of preventing the decomposition of cellulose nitrate plastics, or at least of preventing its acceleration by the products of decomposition, it has always been customary to incorporate in these plastics a stabilizer, usually urea, which binds the nitric oxide as fast as it is formed and thus prevents its remaining to promote further decomposition. But despite the protection given by urea, the cellulose nitrate plastics must be recognized to be potentially a source of acidic products of decomposition.

While the cellulose nitrate plastics are still widely used for this purpose, and seldom do cause trouble, users of drawing instruments should recognize that triangles, curves and the like are now being made from other plastics, which offer no such risk. Such instruments are being made commercially from acrylic resins, which are superior in appearance as well as in stability to the cellulose nitrate plastics, and also practically free from any tendency to change in dimensions, or to warp, with change in atmospheric humidity. Also available are instruments made from polyvinyl chloride-acetate resins.

The purchaser of drawing instruments should have no difficulty in learning from the manufacturer of sales agent the identity of the plastic from which they are made.

(Continued from page 10)

The Method

It would be possible, theoretically, to make a bell of any desired size and give to it a designated pitch. A bell twice its size would normally sound its octave below, one-half the frequency, and a bell one-half its size would sound its octave, double its frequency. But the tone, the timbre, is dependent on other frequencies besides that of the Strike-Tone. Bells too heavy for their pitch - besides being too costly, if not disproportionately loud - would show deficiencies in the strength and balance of some of their necessary partials, and, what is more, their "ring" would tend to become stifled. On the other hand, bells too small for their notes would also lack the necessary quality, let alone carrying power.

It will then be imperative to select a definite bell for a note of a certain pitch, and use this as a basis for figuring the entire series. As the importance of a set of bells is reckoned by the size and weight of

(Continued on page 14)

EVEN THE CREATURE THAT CAN PEER BETWEEN FACTS NEEDS HELP . . .

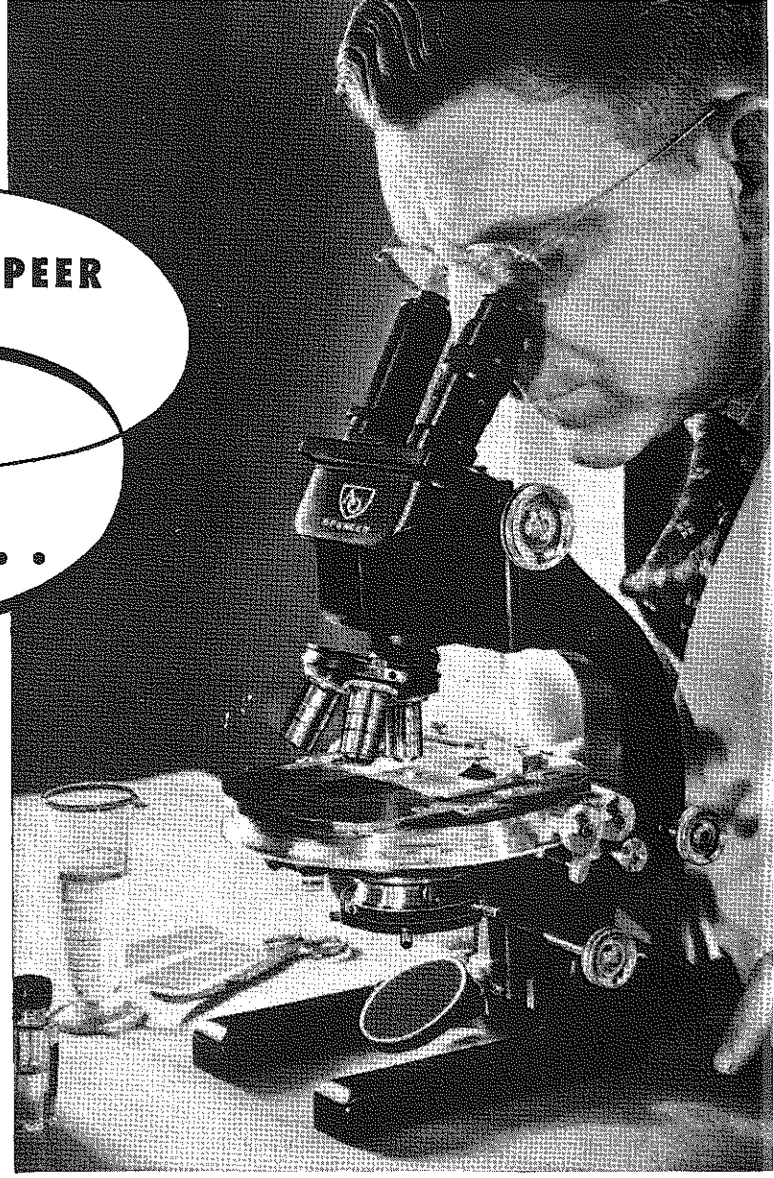

Photo courtesy American Optical Company

DID you ever try to study the "insides" of a piece of plate glass? That suggests the trouble biologists have in trying to see the "insides" of certain micro-organisms in a conventional light-microscope. These living cells are so transparent the light passes right through them and reveals nothing. However, scientists of the American Optical Company came up with help in the form of diffraction plates which capitalize on the fact that light rays passing through a cell change in phase. Using ordinary light sources, the diffraction plates make any phase changes in the light rays luminous or blacked-out at will, throwing the structural detail into vivid and clear relief.

The foregoing also suggests the trouble youngsters have in seeing the adult ideals and standards they must acquire for successful living. Man apparently is the only creature that can peer between facts and see the relationships called honor, integrity, ambition. But like the biologist, he needs help. It is often the responsibility solely of the educator to illumine these values and make them clear and compelling. What are the diffraction plates here? Nothing the educator can pass out among his students. They are within the educator's own being or they don't exist. A way he has of approaching his subject, a willingness to be sensitive to the overtones of a boy's need. A recognition that seemingly trifling things often take on tremendous significance in the boyish mind. What wise instructor in mechanical drafting for example, would overlook the significance of the selection of the drawing instruments his students will use? These should be of fine quality, something the boy can be proud of, leading to pride in work, pride of achievement, the value of achievement, the necessity of achievement. These can well be an object lesson on the difference between good and careless workmanship, projecting in recognizable form the idea of craftsmanship, which is honesty and integrity of effort. These can be the advance guard of the greatness of mind which alone results in greatness of contribution to the public welfare. There is, to the teacher with vision, so much at stake here that he laughs in the face of anyone who says it does not matter what kind of drawing instruments are used.

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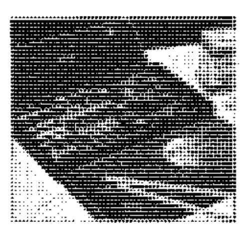


DIETZGEN

EVERYTHING FOR DRAFTING AND SURVEYING

(Printed in U.S.A.)

(Continued from page 12)

its bourdon, or bass bell, this lowest bell would be the logical one to begin with. Middle-C will be our starting point here. Experience through the centuries has taught bell-founders that a middle-C measuring around 62 inches in diameter and weighing around 5,200 pounds, incorporates the necessary qualities of timbre and possesses sufficient carrying power. This bell will serve as bourdon for a series of carillon bells four octaves in extent.

Applying the physical law which says that the size of a vibrating object is in inverse proportion to its frequency (pitch), we find:

$$\frac{\text{diameter bell 1} = \text{frequency bell 2}}{\text{diameter bell 2} = \text{frequency bell 1}}$$

The following equation may then be deduced:

$C = D_N F_N$, where C = a constant
D = diameter
F = frequency
N = a given bell.

The constant C in the series of bells with middle-C taken as norm, is computed by multiplying its diameter by its frequency: 62 X 256 = 15,872. Once this constant is known, the diameters of all the other bells in the series may be computed by substituting their frequencies in the formula.

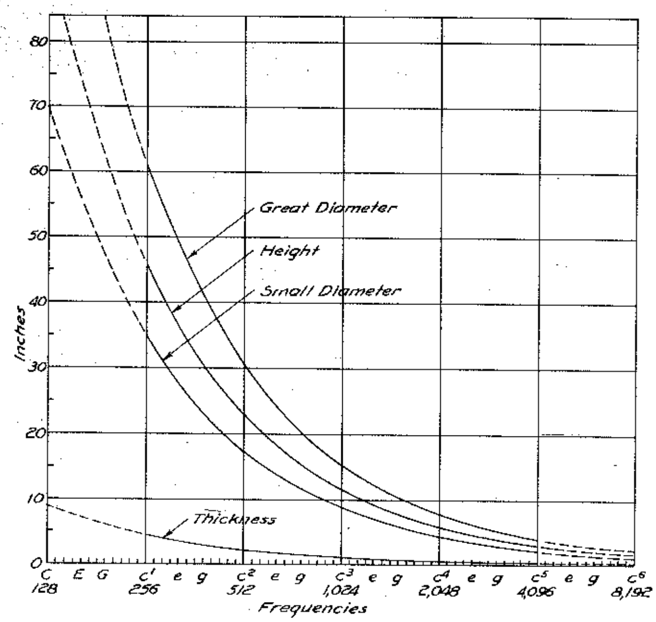


Fig. 2. The curves of proportion of a series of bells ranging from c^1 to c^5.

These hyperbolic curves follow the line of absolute musical proportion. The dotted lines show extension into the lower and higher registers.

The curve formed by their diameters is a hyperbola, reaching to infinity at both ends. There is, theoretically, no limit to the size of a bell, as one may always be made larger or smaller than the last. If a portion of this hyberbolic curve is plotted and drawn in, its ends could be extended to determine the diameters of bells not represented, since they must also lie on the curve. Without further figuring, it would be difficult to determine the curve beyond its known limits - assuming it to be correct in the first place. But if we reduce the curve to a "straight hyperbola" through the use of semi-log paper, the task becomes very simple, all values falling on a straight line. As before, the frequencies are taken on the abscissa and the diameters on the ordinate. The diameter of middle-C is plotted, and then the diameter of one other bell, preferably one at the other end of the series, the fourth octave of middle-C. The line which determines the diameters of all the bells in these four octaves may then be found merely by connecting the two points. Furthermore the diameters of bells larger than middle-C and smaller than the fourth octave may be found by extending the same straight line as far as desired.

In a similar manner the other basically important dimensions of the bell may also be determined. They are:

the small diameter;
the height;
the diameter;

for each of which a line is necessary.

The four lines resulting from this same procedure are termed the lines of absolute musical proportion, which means that the size of the vibrating bodies is in absolute proportion to the frequency of vibration of these bodies. Furthermore, the partials of the several bells are all in the same relationship to their fundamentals as the partials of the basic bell are to its fundamental, and also of the same relative intensity to their fundamentals.

If the establishment of these curves of proportion were all there is to the designing of a series of bells, the task would be a comparatively easy one indeed. The lines of absolute musical proportion, however, do not satisfy the requirements of the series and only a very small portion of (their lengths) may be used. For it is a fact that bells so formed, following the simply hyperbolic curve cut by a plane from a cone of revolution, which line is representative of absolute musical proportion, do not prove to be of an acceptable intensity, note for note, as the series continues into the higher registers. Such intensity, or "noise potential," is dependent principally on the force with which

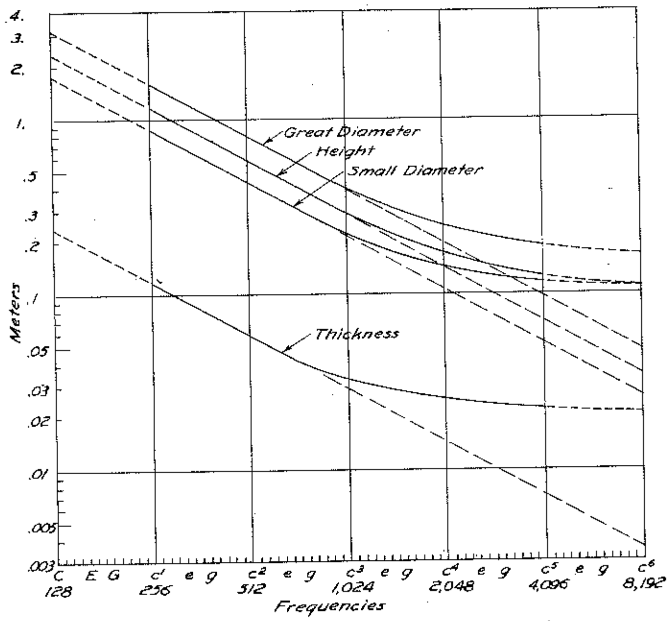


Fig. 3. The curves of proportion of the same series of bells, reduced to straight lines.

The dash lines are those of absolute musical proportion, while the full lines show the corrected proportions for increasing the intensity of the higher bells.

the bell sends out is pulsations - once the bell is pure to begin with.

In organ pipes, this factor of intensity is called "scale" (diameter : length). A pipe 4 feet long and 3 inches in diameter will have greater power than a pipe of the same length 2 inches in diameter. In bells, the "noise potential" is also called scale, but it best understood by the weight of the bell, rather than its diameter. Two bells of different size, therefore weight, both sounding the same "C", would represent bells of two different scales, a larger and a smaller.

It is only logical that larger bells require larger clappers - and a greater blow - to sound them properly. A clapper too small for its bell would cause the bell to vibrate in an unnatural manner, would awaken the partials in the wrong order and wrong intensities, and even cause undesirable partials to play an important part in the tonal picture. The result: The bell sounds shrill, tinny, and even out of tune. An extreme example example of this would be to tap a big bourdon with a jack-knife, a bolt 4 inches long or some other similar object, and notice the feeble, metalic response.

Smaller bells must have their clappers also in proportion. They require only a fraction of the blow needed to sound the larger ones. Bell, clapper, stroke, must all be in proportion if the entire series is to be of the same timbre.

As intensity is dependent upon weight, bourdons weighing ten times as much as smaller bells are heard, roughly ten times as far. Otherwise expressed, if we were to sound a bell weighing 10 lbs. at a distance of 10 feet from our ears, and a bell of 100 lbs. at 100 feet from our ears, they would both give us the same sensation of loudness. It is an impossibility to so design a belfry in such a manner that the smaller bells would be close to the listener and those weighing hundreds of times as much would be placed at greater distances in proportion to their greater weight. Although to a certain extent our ears tend to receive greater sensation from higher frequencies than lower, it is apparent that some adjustment must be made if we are to have an entire series of bells which will tend to exhibit some balance in their "noise potential," and be of equal - or practically equal - carrying power, from the deepest bourdons to the highest trebles. The intensities of a series of bells designed in absolute musical proportion could be balanced somewhat by striking the larger bells with strokes calculated to impart to the bell a blow proportionally many times lighter than that of the smallest trebles. But this would be defeating the purpose of the bell: to be heard for nominal distances. On the other hand, it would be impossible to sound the heaviest bourdons with a generous blow, causing them to sing out with their rightful intensities, and then expect to balance their noise potential in the higher bells by striking them with blows of increasing strength all the way to the highest treble. Even if proportionately heavier clappers are used in the highest bells, the desired effect would still be unachieved - indeed, the partials of the bells would be so disturbed that their timbre would be displeasing, if the bells themselves did not crack under the abnormally heavy blows.

The old bell-founders realized the situation: that it is impossible to have a carillon possessing any kind of tonal balance - equal intensity bell to bell - if the series is designed in absolute musical proportion. Their procedure was to augment the weak tone of the treble bells to match, more or less successfully, the tone of the bourdons, and not to reduce the tone of the latter to match that of the trebles. So they deliberately departed from the line of absolute musical proportion and gradually increased the scale of their bells as they went up into the higher registers. Heavier treble bells could withstand heavier clappers, and heavier clappers were capable of rendering heavier blows, with increased tonality the direct result. Later the stroke - not the weight - of the clappers of the largest bells was somewhat reduced, and the stroke of the clappers of the smallest

(Continued on page 21)

INTEGRATION OF ENGINEERING DRAWING AND DESCRIPTIVE GEOMETRY

by

Professor James S. Rising, Chairman
Department of Engineering Drawing
Syracuse University

The history of the Graphical Language is as old as civilization itself. The pyramids of Egypt, the Temples of biblical times, the remains of the Greek buildings, and the structural ruins left from the Roman Empire are mute evidences of the necessity for conveying plans and ideas from one person to another. Then, as now, the Graphical Language was used as an effective medium of expression.

It was only natural that pictorial representation was the first type of drawing to be developed. Early treatices on Linear Perspective pre-date flat or Multi-view projection. Although records of orthographic projection have been left from the first of the 18th century, it was not until the later 17 hundreds that Gaspard Monge, a French Mathematician, applied the name of Descriptive Geometry to the graphical solution of problems in Solid Geometry. His methods were capable of extensive practical application and were accepted into the educational plan of France, Germany, and England.

Claude Crozet is credited with the introduction of Descriptive Geometry into the United States in his classes at West Point in 1816, although Christian Zoeller had been made an instructor in Drawing there as early as 1807.

The beginning of the interchangeable system of manufacturing came with the establishment of technical education in this country. In 1849, the revised curriculum at Rensselaer Polytechnic Institute devoted four courses to Drawing spaced through the three year program. With the changing purposes for which the Graphical Language was used, the content of the courses and the method of teaching was changed.

It is interesting to note the evolution of Lettering from the decorative scrolls through the use of the Roman alphabet and within our memory to the almost exclusive use of single stroke letters on engineering drawings. The present trend seems to indicate the gradual replacement of freehand lettering on drawings by the wider use of the varityper and the several varieties of lettering devices. Drawing techniques have likewise changed as functional drawings have replaced decorative ones. The need for more copies as well as improved methods for reproducing drawings has had a definite influence upon their line quality. Little time is now used in the practice of fine line copy work in ink on white paper as was done in the past. The <u>Art</u> on draughting has developed into the <u>Science</u> of drafting.

Departments of Engineering Drawing have offered a great number of separate courses over the last 30 years. The following list, while probably incomplete, includes the names of some twenty courses which most of us have taught or at least have taken as undergraduates:

Lettering	Color Topography
Elementary Drawing	Descriptive Geometry
Freehand Sketching	Stereotomy
Projection Theory	Linear Perspective
Projection Practice	Projective Geometry
Mechanical Drawing	Shades and Shadows
Machine Drawing	Production Illustration
Engineering Drawing	Graphics
Industrial Drafting	Graphical Analysis
Architectural Technique	Nomography
Charts and Diagrams	Numerous courses in Design
Map Reading	
Pen Topography	

Some of the younger teachers may not recognize all of the names. I mention them only to show the trend over a period of 30 years in the offerings of a Department of Engineering Drawing.

The present engineering curricula usually include a course or courses in Engineering Drawing over one or two semesters. A recent survey of College Catalogs seems to indicate that a majority of schools have only one semester. An additional one semester course in Descriptive Geometry is usually given, often times with some groups of engineering students excepted. There seems to have been a definite trend in the last two decades to get away from the Mongean Method of Descriptive Geometry. In many schools a so-called practical or applied Descriptive Geometry has been adopted. Some of the larger schools offer a few specialized courses such as Production Illustration, Graphical Analysis and Nomography on an elective or graduate basis. It is also

Presented to the Drawing Division Group at the Northern New York Section Meeting of ASEE at Rensselaer Polytechnic Institute, Troy, New York, April 17, 1948.

noteworthy that the applied drawing done in many design courses in the past is gradually being omitted.

What is the reason for these changes and for the apparent decreasing emphasis on the Graphical Language? First, it might be noted that the continued curriculum crowding due to an ever increasing number of professional courses has caused some drawing courses to be omitted and the time allotment for others decreased. Perhaps it is more significant that the curriculum makers have felt that some of the former courses were not of college grade, but rather consisted of exercises that could be given better in the secondary schools. Also that the emphasis, for which some of us are guilty, was being placed too much upon specialty training and technique as compared to what would be of use to the average engineering graduate.

A parallel illustration could be drawn with a shop course. I believe the student would obtain a better background if he spent a certain limited time by learning from observation, demonstration and some participation concerning the range of work, its quality, the different kinds and amounts that could be produced on several types of engine lathes as opposed to spending the same time memorizing the parts of a lathe and having practice on turning one mandrel to a specified diameter within a tolerance of .001 inch. In other words, I believe that we should keep our emphasis on those objectives that encompass the whole picture of the Graphical Language and not lose ourselves in the details of the individual parts of that whole.

It is interesting to note a corresponding trend in the field of Engineering Mathematics. Most of us remember taking separate courses in College Algebra, Plane Trigonometry, Spherical Trigonometry, Plane Analytics, Solid Analytics, Differential Calculus, Integral Calculus, Differential Equations, and probably some others. It is my observation that many of our leading colleges now offer some 16 or 20 credit hours spread over four semesters, each course bearing the same name such as just "Mathematics" or in a number of schools, "Calculus", and each bearing a number to distinguish its position in the curriculum. Each course contains some analytics, as well as some trigonometry, and some calculus. The parts are integrated into a functional whole, designed to give the student a better over-all picture of his basic preparation in the field.

The idea of integrating the various phases or units of Engineering Graphics is not unique. Several members of the drawing division have talked about it but little has been done. One of our prominent schools, with which I am familiar, gives Descriptive Geometry to the entering freshman followed by courses in Engineering Drawing. Others introduce Engineering Drawing first, followed by Descriptive Geometry and conclude the sequence with a second course in Engineering Drawing. Others start with one or two semesters of Engineering Drawing and end the basic training in graphics with a course in Descriptive Geometry. Still others have been known to consider Descriptive Geometry as a part of the Mathematics sequence and have kept it divorced from the drawing department.

If one would concede that Descriptive Geometry is an essential part of the graphical courses for engineering students and that it has no sacred position in the sequence of those courses, it is not reasonable to believe that it would be as effective, if not more so, if it were integrated within the sequence? Not only do I believe that the conventional Engineering Drawing and Descriptive Geometry should be integrated into one sequence but also that there is a place in our graphical course for a greater emphasis on such topics as Graphical Mathematics to include as much as possible from curve plotting to graphical integration. An introduction to alignment charts and methods for graphical solution of engineering problems within the range of the students' academic experience may well be appended to the Engineering Graphics course. The utility and application of these several topics would be a supplementary aid in the development of visualization as well as an aid in knitting together the component parts of graphics into an integrated whole.

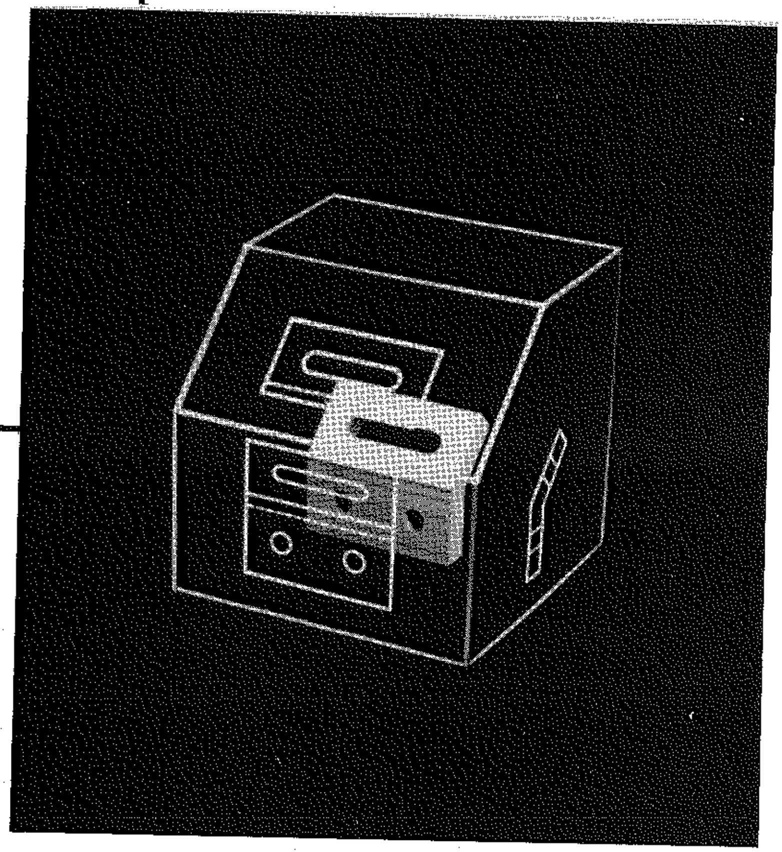
I feel that we should keep our course objectives constantly in mind. It is our job to present the graphical language in the most effective way to develop as far as possible the student's ability to read and write this language of the engineer. We must place a maximum emphasis on the qualities of space visualization in the solution of engineering problems. While technique in graphical expression should not be an end in itself, I feel that we should promote proficiency in execution with an accent upon Freehand Sketching as a skill essential to all branches of the engineering profession.

Standardization of drawing practices through the work of the American Standards Association has aided in the coordination of our work. The use of modern teaching methods along with the latest texts has increased our effectiveness. Time can be saved as well as an increase in the vividness of our story by the use of the many available Audio-Visual aids. While I make no claim that a certain amount of repetition is not desirable, I do believe that an integrated course in Engineering Graphics will help to eliminate some tedious and unnecessary repetition, thereby conserving time for a wider and more beneficial coverage.

Perhaps some illustrations would help to show what I mean by the relationship of certain topics in Engineering Drawing and Descriptive Geometry and how they fit together

(Continued on page 30)

Does your list of classroom aids include McGraw-Hill Text-Films on Engineering Drawing?



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(Continued from page 7)

engineering education there will be no shortening of the time allotted to drawing.

The mere making of a drawing is only an incident - there is much more to drawing than learning to draw.

Drawing is a language, the oldest language and the one universal language. It should be recognized as a language and should be taught as a language. Engineering education should include the development of ability to think in this language - in the engineering world the engineer must be able to think in the engineering language - must be able to visualize.

All things can be visualized both physical and non-physical and the accuracy of visualization is a measure of man's education (intellectual development, civilization, or whatever you may wish to call it). Our ancestors of the dim and distant past as well as the savage races of the present and near past give as one evidence of greatness and of the distinction and superiority of man over the brutes - the drawing of pictures and the invention of alphabets - things which no brute has ever been known to do. From the early pictures has come the possibility of visualization and the preservation of visualized things and thoughts, knowledge, and the growth in understanding of art, literature, religion, science and engineering. With the increase in accuracy of representation and visualization has come the life and growth of civilized man. Thus I repeat that accuracy of visualization is the yardstick of education. The power of visualization has been and must continue to be developed as an essential factor in education.

In the progress of mankind from early pictures and pictographs to a written language including the science of mathematics man has continued to use drawings and has found them necessary as the one definite and accurate means of shape and size description and as the most accurate means of visualization. The Egyptians preserved great events in picture language even though they had a practical every day writing.

Great deeds and great events have been stored in the minds of men but from the earliest times they have been visualized by monuments and pictures or drawings. When the Hebrews crossed the Jordan in safety, they placed twelve stones to commemorate and present visual evidence to future generations. The Egyptians built the pyramids as a means of visualizing the greatness of their kings. And so today we might say that Washington was a great man but we visualize his greatness in the awe inspiring Washington Monument. We visualize the greatness of our government by magnificent buildings. We visualize our religion by magnificent cathedrals, great churches and beautiful paintings.

Man must see to realize or visualize. The most important factor in our graphic language is then the factor of visualization and the factor of visualization is a problem of translation. In order to orient the graphic language, it may be considered as one division of thought development in which all thought is arranged in three divisions as:

Literary thought
Mathematical thought
Graphical thought

A truly educated man should be able to carry on his intellectual research in all of these divisions and to choose the one best suited to the character of his immediate needs. Without proper development of all, he is restricted in the extent to which he can pursue and understand a given subject.

To revert to the graphic language and its relation to other languages, we find the emphasis on the idea of translation:

- Translation from views to a Mind Picture of the Shape
- Translation from scale drawings to a Mind Picture of the Size
- Translation into a Mind Picture of Operation
- Translation into a Mind Picture of Capacity
- Translation into a Mind Picture of Weight
- Translation into a Mind Picture of Color
- Translation into a Mind Picture of Sound, Smell and any other characteristics.

All of these translation problems are a part of the teaching of engineering drawing - the graphic language.

Translation into a mind picture of shape and of position, either relative or in space, has made very wonderful progress especially since the publication of Monge's Descriptive Geometry. The graphic language - shape description and visualization has advanced to the extent that symbolism is finding a constantly increasing use. We have, of course, the old familiar line symbols, symbols for materials, symbols for "breaks" and the increasing number of substitutions for true projection, the idioms or conventional representations.

In the related fields of architectural and topographic drawing, the graphic language has long made a very large use of symbols. In electrical engineering graphic symbols are indispensible for study, understanding and design. The use of one or two-view drawings and of more or less conventional or type views for many parts of machines and for whole machines and apparatus, is a further growth of the symbolic representation of shapes. This is in accord with the growth of our written language. It comes, of course, with the growth of industrial and engineering intelligence or understanding. The first step was from models to drawings and now from complete views to conventionalization as the powers of visualization grow and require less aid from complete views.

Thus, it has been said that the experienced engineer or industrial worker seldom reads a drawing completely but that he recognizes the part, machine or construction with which his mind's eye is already familiar. The drawing then becomes the vehicle for specifications and dimensions. Dimensioning or size specification requires a complete visualization of shape and relative position for it is NOT the views which are dimensioned but the part or construction. Space conception is imperative as well as comparative size conception. Size specification and size visualization are inseparably related.

And so we might go on and on building up and classifying the many other features which form a part of the factor of visualization. Such branches of the graphic language as the literature of mapping, geology, graphic charts, and the many other graphic compositions should be analyzed, classified and then thoroughly visualized. Graphic charts offer a particularly effective survey of many kinds of visualization of quantities, sizes and comparisons and present examples of all kinds of visual knowledge.

However, we must return to our subject: "Drawing in Engineering Education" for here drawing is the indispensible factor, it is the factor of visualization. Without visualization there could be no engineering education - no truly professional engineering. The size and importance of this factor - engineering drawing - is too great to be comprehended at one time. Therefore, I would like to propose a breakdown of the subject of drawing in engineering education - that we may attempt a visualization of its size:

Size of the subject of engineering drawing.
Size of the job of teaching engineering drawing.
Size of the opportunity for instructors of engineering drawing.
Size of the work which can be done for other subjects, by engineering drawing.
Size and strength of the foundations of an engineering education which can be laid by engineering drawing and by the instructors of engineering drawing.
Size of the field of engineering which is covered by engineering drawing.
Size of the objectives of engineering drawing.

Then, I would propose the specification of:
Certain very real objectives.
Certain very real ideals.
Certain very real standards.

Following consideration of the size and specifications, I would propose the visualization of engineering drawing itself.

(Continued from page 15)

bells increased. With these changes, a surprisingly good approach to some semblance of balance was made.

It is this reduction in the stroke of the clappers of the larger bells which went far to equalize the dynamic tonality of the instrument throughout its entire compass, for it is very true that even with all the increase in scale that the upper bells could stand, they still could not completely equal the intensity of the basses. But with the added weight of the trebles and the surprising force and clarity they were then able to bring to the upper register of the carillon, together with the subdued power of the basses, there would have resulted, if the procedure had been carried out successfully, an equalization in carrying power of all bells to the extent that the entire instrument would have been perfectly balanced musically.

By far the more important of these changes was the increase in the scale of the smaller bells, and although early bell-founders accomplished it to a remarkable degree, they did not carry it out as far as was necessary. Founders of a later date have either ignored, to a great extent, the need for an increasing scale, or, as in the case of some founders, have increased their scales beyond the limiting factors, with the result that the tonal structure of their bells has been disturbed to the point where they lose their particular quality.

It is evident that there must be determined an ideal line for this increasing scale of proportions, one which will lie between the line of absolute musical proportion and that limit beyond which the bell would sound totally different.

Before we can determine where this new proportion line must lie, here again it is necessary to have conducted experiments in tone vs. size. Once one example has been made embodying the quality and intensity desired, this example can determine the position of the new line, and the measurements for all the other bells immediately become fixed. Refer again to Figure 3.

Bells whose dimensions do not conform fairly rigidly to these established lines will be false, for at the very outset their forms prohibit them from possessing a series of partials pleasing to the ear. It is for this reason that most of the bells made in this country today are false, for they are not of the correct proportion to begin with.

In plotting the final curves, we note that the Height line digresses from the absolute line in lesser degree than the Great Diameter, and that the Small Diameter and Thickness digress to a greater degree than the Great Diameter. This means that the smaller bells, in addition to their not being in absolute musical proportion, are also not in proportion to the bells of the rest of the series. The only bells whose measurements are in the same proportion are those in the curve between a and b!

If like timbre is dependent on adherence to the line of absolute musical proportion, then what of the timbre here? Is not our eagerness to increase the volume of sound going to be detrimental to the timbre?

As timbre is, among other things, largely dependent on the upper partials - those above the basic five or six - the higher we go in pitch, the higher these partials become and the less we hear them, due to nature's limitations on the frequencies that our ears are able to register. When notes become so high that their upper partials pass our audible sense, these partials play an increasingly less appreciable part in the actual tone that our ears pick up. Timbre becomes less and less a factor to the extent that in the highest notes we are quite at a loss to discern the difference between a bell of one particular quality from one of another (both bells being in perfect tune, of course). Yet our sense of pitch is always with us, as the tones determining the note of the bells are always of a frequency our ears can hear. Organ manufacturers very often complete a series of reed pipes with flue pipes of a reedy tone, so little can the ear tell the difference in the upper registers!

(Continued on page 24)

REPORT ON THE COMMITTEE OF ADVANCE CREDITS

DRAWING DIVISION, ASEE
Austin, Texas, June 16, 1948

Following the organization meeting of the Committee in Chicago, April 18 and 19, 1947, the Committee prepared fifteen unit experimental tests on the following subjects:

1. Use of Instruments
2. Orthographic Projection I
3. Orthographic Projection II
4. Sections and Conventions
5. Auxiliary Views
6. Elementary Dimensioning
7. Screw Threads and Threaded Fastenings
8. Advanced Dimensioning
9. Working Drawings
10. Isometric Drawing
11. Oblique Drawing
12. Perspective Drawing
13. Charts, Graphs and Diagrams
14. Intersections
15. Developments

After their preparation they were submitted to the Measurement and Guidance Project Office in Engineering Education, New York, New York, for editing and production in the experimental form. The tests were made available to colleges for trial samplings around February 12. The Project Office at this time was going through a reorganization and some delay was experienced by some schools in obtaining these tests. However, 600 to 1,000 samplings were obtained during the course of the past few months, and their results are now being studied for validation.

Under a new administrative setup in the Measurement and Guidance Project Office this material was turned over to the Educational Testing Service. The Educational Testing Service through one of its divisions will have complete control of the preparation and distribution of the tests in their final form.

The Committee met just one year from the date that it was organized in Chicago on April 17 and 18, 1948. The Committee had in attendance in addition to its membership, Mr. Charles Langmuir, Director of the New York office and Mr. Paul Burke, associate editor of the Educational Testing Service. During these two days the Committee met in consultation in four sessions. The whole of the first session was devoted to a consideration of the general problems of the Project. The other three sessions were devoted to an editorial review of the items in the fifteen tests which were available in experimental pre-test form. During the course of our deliberation the Committee discussed the possible ways of the handling the unit tests from here on out. Director Langmuir described the test program functions of the Educational Testing Service and explained various ways in which the unit test project might be handled. He also recommended the partial support of the Society backing the project.

Following this meeting, through the support of the chairman of the Drawing Division, the Committee had the approval of the Executive Board of the ASEE for request of an appropriation of $300 to the Engineering Drawing Division for the final draft of these tests. This will be paid directly to the Educational Testing Service for preparation of the final format on these tests.

The Educational Testing Service is making statistical analysis of the experimental test results and exploring a variety of possible ways of presenting the test material in final form. The final form which is adopted will be edited by our Committee and the distribution controlled by ETS. Prices are not immediately available for these tests, but they will be announced as soon as possible together with the time of distribution.

We would respectfully request the continuation of this Committee for further study of results in final form so that the project may be worked to completion.

Respectfully submitted,

Webster M. Christman, Jr.
Maurice Graney
Randolph P. Hoelscher
John M. Russ
Ralph S. Paffenbarger, Chm.

REPORT OF THE COMMITTEE ON MINIMUM STANDARDS

by

A. B. Wood
University of Tennessee

Early in 1947, a committee of the Drawing Division, composed of F. C. Bragg, H. L. Henry, Jr., Theodore Riebeth, and A. B. Wood, Chairman, was appointed "to study the matter of minimum standards for basic courses in Engineering Drawing, including course content and time allotment."

The committee sent out a questionnaire on the subject to 136 engineering schools and received 87 replies. On a basis of these replies a report was made by the committee at the annual meeting of the Drawing Division in June 1947. The report was discussed at the meeting but action was deferred because of objections to certain recommendations contained therein. The

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So it is that we may safely increase the size of the bells, within limits, beyond their line of absolute musical proportion, preferring in the higher register a constant intensity and carrying power to a more constant timbre.

Although it is only in the highest bells that timbre may be neglected, so to speak, it will be found that a certain lack of consideration for the timbre will of necessity enter into the proportion lines at an earlier moment, if there is to be no definite break between the lower and the upper bells, causing them to sound like two different families.

It will be seen in Fig. 3 that the adjusted line follows the line of absolute musical proportion from A to B. At B it leaves the line, deviating ever so slightly, while at C it has drawn away some distance from it. The upper partials of the bells at this point are approaching the limits of frequency audible to the average person, and timbre plays a lesser part in the tone of the bell. So here the series may be scaled ever higher than the previous bells, and timbre ignored in favor of carrying power.

The line above D is the normal continuation of the established curve. It could be extended further in the same direction until the series reached C^6 (with the Strike-Tone an octave above the highest C on the piano), a point beyond which bells become impractical. At the lower end - bells of low frequency - the curve would be extended along the line of absolute musical proportion.

Once curves of dimensions have been determined, it is certain that a series of bells cast to the measurements they represent would possess the sizes and proportions necessary to bells sounding their pitches and endowed with the correct partials to assure their being musically perfect - if they are properly tuned, of course.

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To determine the profile is the next step in the design. The laws governing the curve of a bell from shoulder to lip are closely allied to the partials and their intensities. Many different profiles may be drawn, all of which will incorporate the correct series of partials which, if tuned, assure the bell's purity. But the profile curves themselves - the degree of slant from the shoulder downward before the waist becomes fuller; the curvature of the waist from an almost pot-like straightness to a waist deeply concaved; a definite flare at the hips as the waist enters the lower part of the bell, or an almost imperceptible transition at this point; the bulge of the lip, whether radial in section or elliptical - all these are intimately related to the partials which find their notes of vibration at just those places.

The form of the lip, the most important part of the bell along with the sound-bow, may vary considerably, the partials and their strength at that place being dependent upon the particular shape of the part.

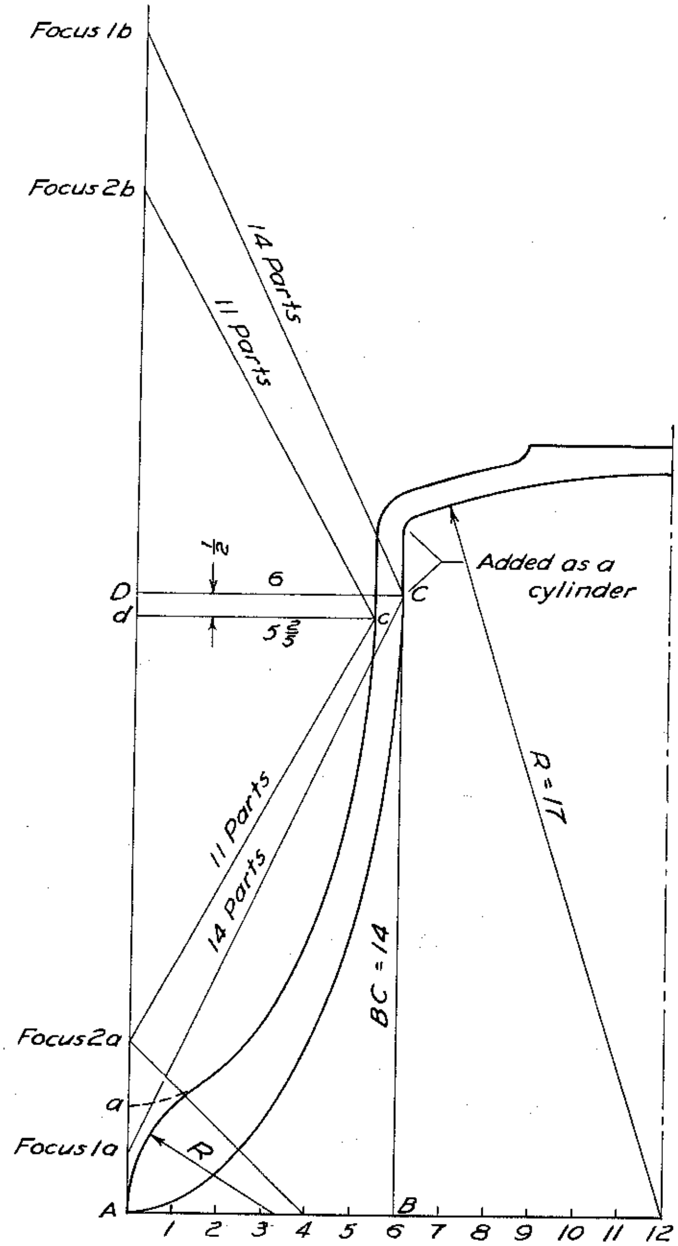

Fig. 4. The profile.

The method shown is for a bell typical of English founders. It is one method among many and if the over-all proportions fall within reasonable limits, the bell, when properly tuned, may be pure. It is a very different profile from that of the Flemish bell in Fig. 1.

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RECTIFICATION OF THE CIRCUMFERENCE OF A CIRCLE

by

Professor John S. Rackway
Lawrence Institute of Technology

The development of the surface of a circular cylinder, the drawing of the involute of a circle, and the construction of a cycloid involve the problem of the rectification (stretch-out) of the circumference of the circle.

The usual graphical approximation is to substitute the perimeter of an inscribed regular polygon for the required circumference. The resulting length will always be too short, and the theoretical error will decrease with an increasing number of sides of the polygon inscribed. It is obvious that, for practical reasons, this number cannot be taken too high. It is usual to lay out the perimeter of an inscribed twelve-sided polygon because this side can be readily constructed with the 30°-triangle, as shown in Fig. 1.

It can be seen from the polygon-table that the relative theoretical error is 1.138%. This error cannot be considered satisfactory. It may be possible to reduce the error theoretically by using the perimeter of an inscribed regular polygon of 24 sides, but this seems to constitute the practical limit and still involves a relative theoretical error of 0.285%.

A better method is to compute the product π d and to lay it out to scale.

In case a graphical method is required, the following construction is recommended (Fig. 2): *) Page 32.

Given: A circle of radius r.

Required: Draw the stretch-out of the circle.

Construction: Draw the diameter ACB and the tangent line through B. Make angle BCD = 30° and DE = 3r. The straight line AE has practically the length of half the circumference of the circle.

Proof: $a = r\tan 30^\circ$;

$b = 3r - a = 3r - r\tan 30^\circ = (3 - 0.57735027)r = 2.42264973\ r$

$\cot\theta = b/2r = 2.42264973\ r/2r = 1.21132487$;

$\theta = 39^\circ 32' 28''\ .025$;

$\sin\theta = 2r/c$; $c = 2r/\sin\theta = 2r/0.63663179$;

$\therefore c = 3.14153335\ r$.

The absolute theoretical error is $(2\pi r - 2c) = 0.00011860\ r$.

The relative theoretical error is $[(2\pi r - 2c)/2\pi r]\ (100) = 0.00194\%$.

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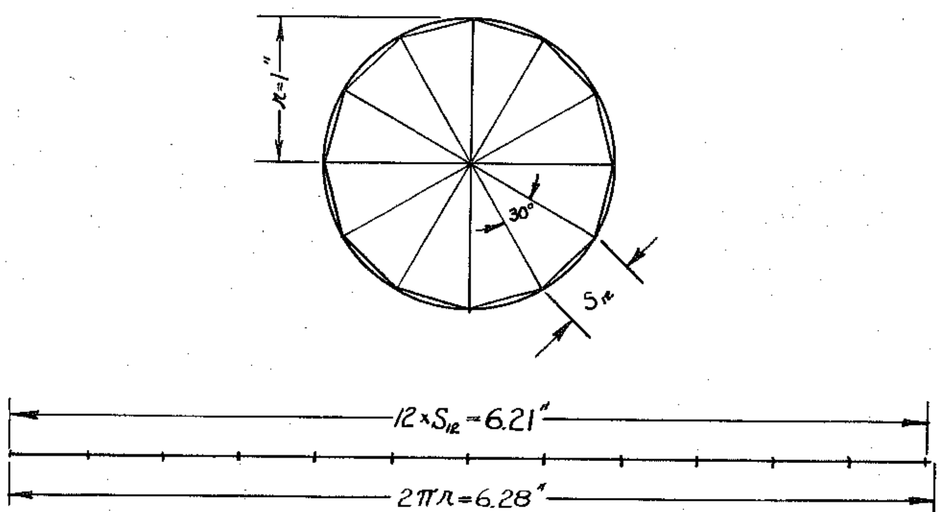

Fig. 1

*) This construction was shown, in 1910, by Prof. Dr. Georg Scheffers, Head of the Department of Mathematics at the Technical University of Berlin-Charlottenburg, Germany. Proof and error-percentage were not given.

(Continued from page 24)

Through the many years - and even centuries - of their practice, each bell-foundry has developed a profile which has become associated with that foundry alone. Let it be said that when founders today cast their bells to profiles handed down to them from their forefathers, as is generally the case, without any attempt to improve them through experiment and research to determine a form of lip and waist - let alone proportion - which would impart to the bell more beautiful and harmonious tone, then these founders are guilty of neglecting their craft. Not included here are those founders, by far the majority, who are not the least concerned with making musical bells. In fact, most of these are totally unaware that a bell can be used for anything but a signal, and the louder the better. Their innocence is their best excuse.

The inner profile is directly dependent on the outer. It can be determined through experience just how thick the bell should be at different parts. Bells are always cast purposely too thick for the tones they must give, so that they may be tuned down to tone. Only after the bell has been put into perfect tune will the final proportions be known for the entire bell. (If a bell be cast too thin for the note it will sound, or if in the process of tuning the note has been by-passed, there is no remedy but to recast the bell).

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When the series of carillon bells has been correctly designed, their proportions determined and profiles drawn, exterior and interior, when templates have been made and moulds shaped and dried, when the bells have finally been cast and the blackened clay cleaned away, they are still far from pure. The most important operation has yet to take place: the tuning. All the overtones, or partials, must be in harmonious relationship within themselves, and each bell must be in tune with all the other bells. This process cannot be determined through graphical analysis but is perfected only after long association with bells and their accoustics.

Over five centuries ago the Flemish knew the secret of a bell's partials and their efforts to control them resulted in a craft which has been jealously guarded for centuries in the Low Lands across the sea. Of late, founders in other countries, inspired by the increasing popularity of the carillon, have learned the art - but most of these owe their success directly to the old founders of Flanders and Holland, through the study of their bells. In spite of newer comers to the field, those who can tune an entire series of carillon bells can be counted on the fingers - with some to spare.

Admitting the difficulty of tuning, if the bells of a carillon are designed according to definite scientific procedure such as herein explained, the governing factors for a perfect series shall have been determined. For without correct proportions, both individually and throughout the whole series, no tuning is even possible.

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1	2*)	3*)	4	5
Number of Sides n	Length of Side $S_n = 2\sin(180^\circ/n)$	Length of Arc $arc_n = 2\pi/n$	Absol. Theor. Error $arc_n - S_n$	Relat. Theor. Error (%) $\frac{arc_n - S_n}{arc_n} \times 100$
6	1	1.0471976	0.0471976	4.543
12	0.5176380	0.5235988	0.0059608	1.138
24	0.2610524	0.2617994	0.0007470	0.285
48	0.1308062	0.1308996	0.0000934	0.071
96	0.0654382	0.0654498	0.0000116	0.018
192	0.0327234	0.0327249	0.0000015	0.005
384	0.0163622	0.0163625	0.0000003	0.002

Polygon-Table for $r = 1$

(Continued on page 32)

*) The figures in columns 1 and 2 are taken from a table-work by Dr. Werner F. Vogel, Professor of Engineering, Wayne University, Detroit, Michigan: "Polygon-Tables, Involutometry, and Trigonometry, Seven-Place Tables of Natural Functions", published by Michigan Tool Company, Detroit, Michigan, 1945.

(Continued from page 17)

into a natural sequence. Most Engineering Drawing texts introduce a certain amount of work on revolution problems although a great deal more is usually done with revolution in Descriptive Geometry. Cylindrical and conic sections have a place in Engineering Drawing but a continuation of the story takes place in Descript. along with a more complete treatment of the intersection and development of other ruled, doubly curved, and warped surfaces. I feel that we can develop the ability and visualization necessary for the solution of problems involving plane and dihedral angles and coordinate them with their application problems while teaching methods for size specifications. Good practice in pictorial drawing can be obtained as well as an "assist" in visualization by applying pictorial drawing to the space solution of Descriptive Geometry problems.

The length of this paper would not permit me to outline the topics of an integrated course in the order I think they should be covered. Suffice to say that all the salient features of what is commonly taught under the titles of Engineering Drawing, Descriptive Geometry and allied graphical courses can be grouped into a continuing sequence without slighting any of the topics.

A course of the nature which I have described will be inaugurated this fall at Syracuse University. Two semesters of Engineering Graphics will be offered for a total of 6 credit hours. While a longer course would obviously allow a more extensive coverage, I believe a total of 6 credit hours to be about the average allotment to the basic drawing courses although some schools have a greater and some a lesser amount. I expect that we will be able to accomplish a more comprehensive and thorough job for our students in this two semester 6 credit hour integrated course in Engineering Graphics than we are able to do in the present two 2 credit hour courses in Engineering Drawing and a 3 credit hour course in Descriptive Geometry.

Briefly, I would like to recapitulate some of the arguments which I have attempted to advance for using an integrated course in Engineering Graphics.

1. The integration of the subject matter of graphical courses follows a trend in education that has progressed over a period of years not only in graphics but in other subjects.
2. Related material should have a natural continuity of treatment.
3. The students will feel that they are getting a college level course.
4. It will eliminate excessive repetition, therefore making the most efficient use of the available time.
5. The integrated course will continually stress visualization.
6. It will break up the tediousness found in some conventional courses.
7. The confusion of several system applied to similar topics will be avoided.
8. The students and faculty will appreciate the value of the course and respect its place in the engineering curriculum.

In conclusion, I wish to repeat the statement I made toward the beginning, -- that we should keep our emphasis on those objectives that encompass the whole picture of the Graphical Language and not lose ourselves in the individual parts of that whole.

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was continued for a year and Dean R. P. Hoelscher was added to its membership.

Since that time the committee has corresponded with eighteen representative schools in the East, South, Midwest and Far West and as a result of suggestions and criticisms received now presents a revised report. The recommendations of the committee have been classified under the headings of Course Content, Time Allotment, and Applications.

COURSE CONTENT

The committee recommends that the following topics make up the minimum essential list for basic courses in Engineering Drawing:

A. Those items covered in ASA Standard Z14.1-1946 either specifically or by implication as follows:

1. Lettering
2. Use of instruments
3. Geometrical construction
4. Principles of orthographic projection
5. Two-view and three-view drawings
6. Auxiliary views
7. Sectional views
8. Conventional representation
9. Dimensioning
10. Working drawings
11. Screw thread representation
12. Inking and tracing

B. In addition to those listed above:

1. Technical sketching
2. Isometric drawing
3. Oblique drawing
4. Intersections
5. Developments
6. Fasteners
7. Reproduction of drawings

TIME ALLOTMENT

The time allotment for individual topics is subject to considerable variation because of different methods of presentation and is not included in the recommendations of the committee.

The committee recommends that the total time for basic courses in Engineering Drawing shall be equivalent to at least four semester credit-hours, each credit-hour to represent three clock hours of work divided between lecture, laboratory, and home work as the individual departments may see fit. This time is considered as a minimum for satisfactory presentation of the minimum list of essential topics and does not include other topics commonly covered in descriptive geometry.

APPLICATIONS OF MINIMUM STANDARDS

The committee recommends that this report be used for the following purposes:

1. As a reference in the consideration of college courses in Engineering Drawing.

2. As a basis for the evaluation of transfer credits in Engineering Drawing from one college to another.

3. As a means of increasing time allotments and of improving course content of drawing courses which are below the recommendations.

The committee recommends in conclusion that this report be brought to the attention of the A.S.E.E. and of the E.C.P.D.

A. B. Wood, Chairman

This report was approved by the Engineering Drawing Division of the A.S.E.E. on June 16, 1948.

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As can be seen from the polygon-table, this error is about the same as the one which would be involved in the lay-out of the perimeter of an inscribed regular polygon of 384 (!) sides.

In practical performance, the inaccuracy of the construction shown in Fig. 2 will certainly be greater than the theoretical error computed above.

The construction is readily done with T-square, triangle, and divider. It can easily be memorized. Its application to the development of a circular cylinder is shown in Fig. 3.

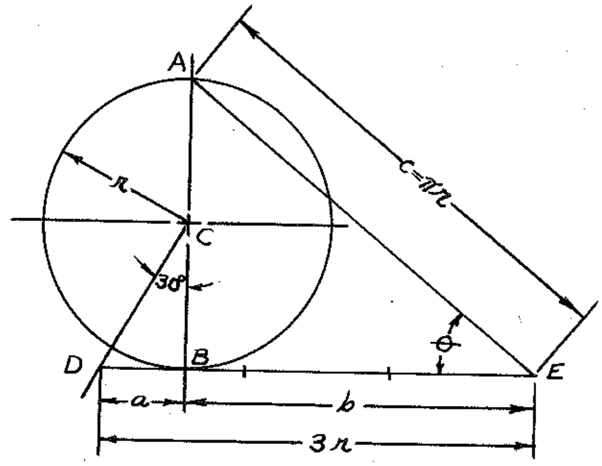

Fig. 2

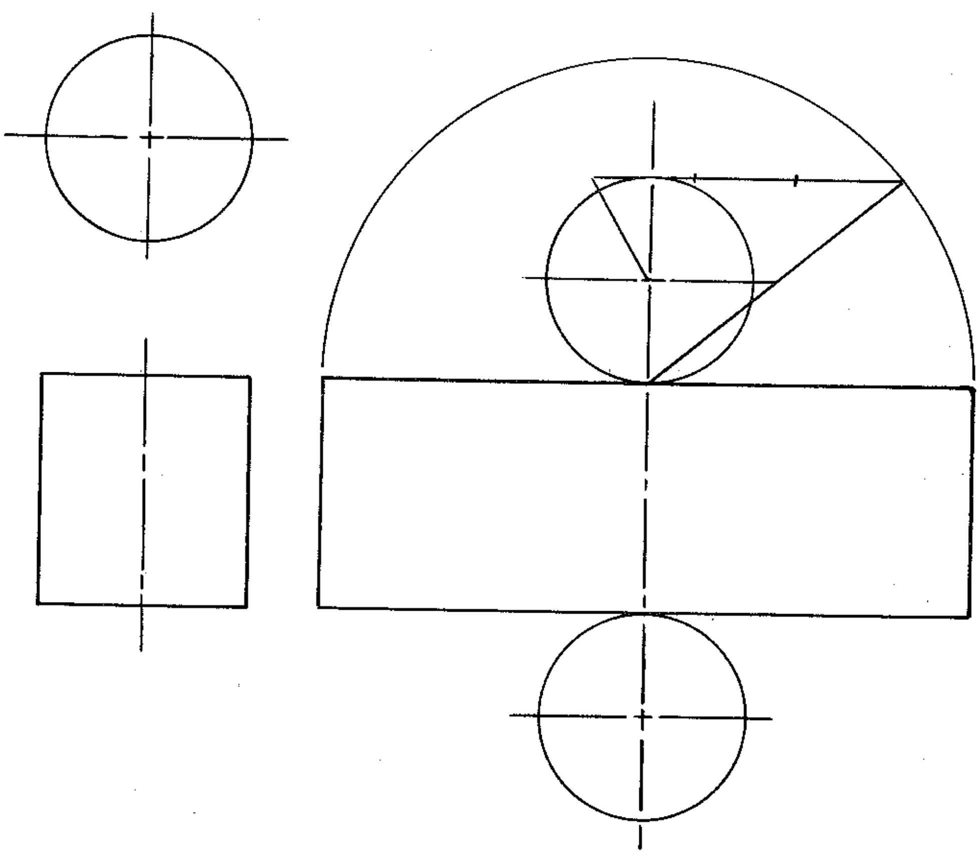

Fig. 3

(Continued from page 5)

Editor of T-Square Page W. J. Luzadder, Purdue University.

Member of Publishing Board of the Journal for 3 Years C. J. Vierck, Ohio State University.

Member of the Council of the A.S.E.E. R. P. Hoelscher, University of Illinois.

The first technical session was held Monday afternoon and was a joint meeting with the Machine Design group of the Mechanical Engineering division. Four papers were presented.

The Tuesday afternoon clinic for drawing teachers was something new. It was a most interesting session and many valuable hints on teaching were given.

The dinner meeting on Wednesday night was the highlight of the session. Mr. C. L. Svenson who formerly was a teacher of drawing and now with the Texas State Board of Registration for Professional Engineers, gave an inspiring address on the subject "Drawing in Engineering Education."

Mr. Svenson reemphasized again the importance of drawing in the Engineering training. Maybe we need this emphasis from time to time to bolster our faith in our own field of Engineering. However, one of our problems has always been how to get this message to the administrators and other departments of our Engineering Colleges.

After the dinner we adjourned to the Biological Laboratory for the final technical session. Here we had a most interesting talk on visual-aid models by Prof. C. E. Rowe of the University of Texas. This collection of models is no doubt the most complete and finest in the country. The only regret was that due to the full program there was not time to inspect this display, and find out more as to how they were made, the cost of making them, how they were used, and the benefit derived from their use.

Prof. P. M. Mason followed with a very interesting demonstration of the glass box model for the instruction of the student in our orthographic scheme of projection.

The final paper was given by E. G. Kirkpatrick of Purdue University on the subject "A Rating Scale for Grading Engineering Drawings." This paper produced some food for thought and no doubt may have been helpful in handling large numbers of students as was the case immediately following the close of the war in many schools.

Following the papers the committee reports were given:

Prof. A. B. Wood gave the report for the Committee on Minimum Standards and after certain recommended changes had been made it was unanimously adopted. This report is rather lengthy and so is not given here, but it no doubt will be published later in the Journal.

Prof. Paffenbarger gave a progress report for the Committee on Tests and as the work was not completed asked that the Committee be continued.

Prof. Northrup gave an abstract of the report for the Journal of Engineering Drawing. The Publishing Board is doing a fine job, the Journal is a publication of which we are very proud and it is increasing its circulation and operating at a profit. By a unanimous vote the Board was commended for its fine work.

Prof. Higbee reminded those present that this meeting marked the 20th anniversary for the Division and the 12th Anniversary for the Journal.

At each annual session the executive committee meets but this often does not appear on the program. It is here that all the problems are thrashed out, meetings planned, program devised, etc. The work of this committee does not get too much publicity but in fact this group is the "power behind the throne." The members of this committee are the ones who have developed the Division to its present important position, they have been responsible for the healthy growth of the Journal, and have laid the plans and programs for both the annual and mid-year meetings. This year the executive committee spent all of Monday evening discussing the problems of the Division and laying plans for future meetings. This committee deserves the wholehearted support of all the members of the division.

The 20th session of the Engineering Drawing Division ended with the Wednesday night technical session. The program was one of the best ever presented before the group, the meetings were well attended, and we all left with a feeling that it had been a privilege to have been present. The weather had been hot but the hospitality of the people of Texas made us forget the temperature. The entertainment provided for the members and their wives will long be remembered.

REPORT OF BIBLIOGRAPHY COMMITTEE

by

Prof. H. E. Grant, Co-Chairman, Washington University

FOREIGN PUBLICATIONS

Books Available from El Ateneo
340 Florir
Buenos Aire, Argentina

Author Title	Price in Argentine Money
Enrique - Lecciones de Geometria Descriptiva	$37.50
Aparici - Lecciones de Geometria Descriptiva	22.00
Ranelleti - Geometria Descriptiva	7.65
Haussnet - Geometria Descriptiva	9.50
Taibo - Tratado de Geometria Descriptiva	35.00
Taibo - Elementos de Geometria Descriptiva	22.00

(The Argentine "dollar" is worth approximately 25% of the U.S. dollar.)

Available from Libreria Ercilla
4a Ave Norte No. 3
San Salvador, El Salvador

Giombini - Geometria Descriptiva	$5.00 U.S. Currency

Available from Prof. E. J. Nystrom
Technical University
Helsinki, Finland

	Price in U.S. Currency
Graf & Nystrom - Deskriptiivinen Geometria	$1.60
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Nystrom - Perspektiivioppi	1.40
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(Prof. Nystrom would like to have the orders for the above books sent to H. E. Grant, Washington University, St. Louis 5, Mo.)

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(Divide the Spanish Currency by 10 for the approximate U.S. currency equivalent.)

Banks can supply the current rate of exchange. Payment may be made by international money order obtainable through the post offices. Personal checks are usually accepted.