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JOURNAL OF ENGINEERING DRAWING

PUBLISHED BY
THE DIVISION OF ENGINEERING DRAWING AND
DESCRIPTIVE GEOMETRY
S P E E

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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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The Editor's Page

KEEP THE DIVISION ALIVE

To the readers of this Journal it is not necessary to stress the importance nor the intensity of the work being done by the Engineering Drawing Departments during this war period. But it is important that we keep our organization alive.

We all missed seeing a great many of our friends at the Annual Meeting at Columbia in June, and as long as this war lasts, we are likely to miss more meetings. Those that were there certainly made the most of the opportunity. There were some fine meetings, good discussions, and the program arrangement allowed the opportunity for the exchange of ideas and friendly arguments.

These small group get-togethers seem to form a real part of the meetings. Now, if we cannot get to as many meetings as usual, why not make use of the printed page?

Nearly everyone has something to say when he gets off in a corner with a few of his friends. Why not use the Journal for this interchange of ideas, and for maintaining our interest in the Division during these busy times?

Due to accelerated programs, shortened vacations, and the transportation situation, it seems doubtful if we can hold a mid-year drawing conference this year.

The various committees will be asked to continue their work, all of which means much in keeping up the interest in the Division and the Society as a whole.

It was voted at the Annual Meeting to discontinue the drawing competition for the present. This committee will become a Committee on Drawing Exhibits.

As a final word I want to express my appreciation for the amount of work that has been done in the past two years by the retiring chairman, Randolph P. Hoelscher and the Executive Committee. Their report on the National Survey of Engineering Drawing, which will soon be published in the Journal, is evidence of some of the things they have done. If the standard which they have set is to be maintained, our united interest and support will be necessary in the busy year ahead.

Walter E. Farnham

Walter E. Farnham, Chairman
Drawing Division, S.P.E.E.

In this issue, we publish the first three sections of the "Preliminary Report on the National Survey of Engineering Drawing". This is, as its title indicates, a preliminary report, and subject to revision. Our object in publishing it in this form is to obtain the suggestions, comments, and criticisms of those actively engaged in teaching in order to supply an authoritative background for revision where that is necessary. We hope the desire to amplify, to criticize, to comment, will be strong enough to bring you to the writing stage, for only by this means can the material so necessary to an intelligent revision be secured. Particularly do we invite high school teachers to comment on Section II, which appears in this issue. Sections IV and V will appear in the February issue.

Communications may be sent either to Prof. R. P. Hoelscher, or to the Editor of the Journal, who will forward them to him. We shall try to publish as much suitable and representative comment as possible in following issues of the Journal.

Again may we call your attention to the T-SQUARE PAGE, printed four times yearly in the parent journal, the Journal of Engineering Education. The Editor is again Prof. W. E. Street of Texas A. & M. College, College Station, Texas. He will greatly appreciate receiving contributions of suitable length for publication on this page. Since the page represents our Division in the parent Journal, we should endeavor to keep it well supplied.

A NATIONAL SURVEY OF ENGINEERING DRAWING*
PRELIMINARY REPORT

Conducted by

THE DIVISION OF DRAWING & DESCRIPTIVE GEOMETRY
SOCIETY FOR PROMOTION OF ENGINEERING EDUCATION

I ORIGIN AND PURPOSE OF THE SURVEY

For many years there has been developing a feeling of dissatisfaction among members of the Drawing Division concerning the difference in the practice of the various colleges and universities in the handling of high school credits in drawing. Among college teachers the opinion is general that too great liberality in recognizing secondary school work will result in lowering college drawing to the same level.

Among high school drawing teachers on the other hand there is a very definite conviction that not enough recognition is given to the work done in the high school. This has often been vigorously expressed in Drawing Division meetings at which high school teachers were invited to participate.

Again in our larger cities, Junior Colleges in particular have been subjected to considerable pressure to give definite recognition for high school drawing by excusing the student from college drawing.

A second problem which confronts the colleges is the transfer of credit among themselves. The difficulty arises largely because of the divergence in the amount of "credit hours" required in the engineering curricula in the various engineering colleges and the difference in the apparent rigor in teaching the course in schools having different purposes and objectives, as for example, liberal arts or teacher training institutions.

At the meeting of the Drawing Division at Berkeley in June 1940, Dr. C. V. Mann proposed that a national survey of engineering drawing be made to determine the facts (a) as to the practice of our engineering colleges in regard to the treatment of high school drawing credits

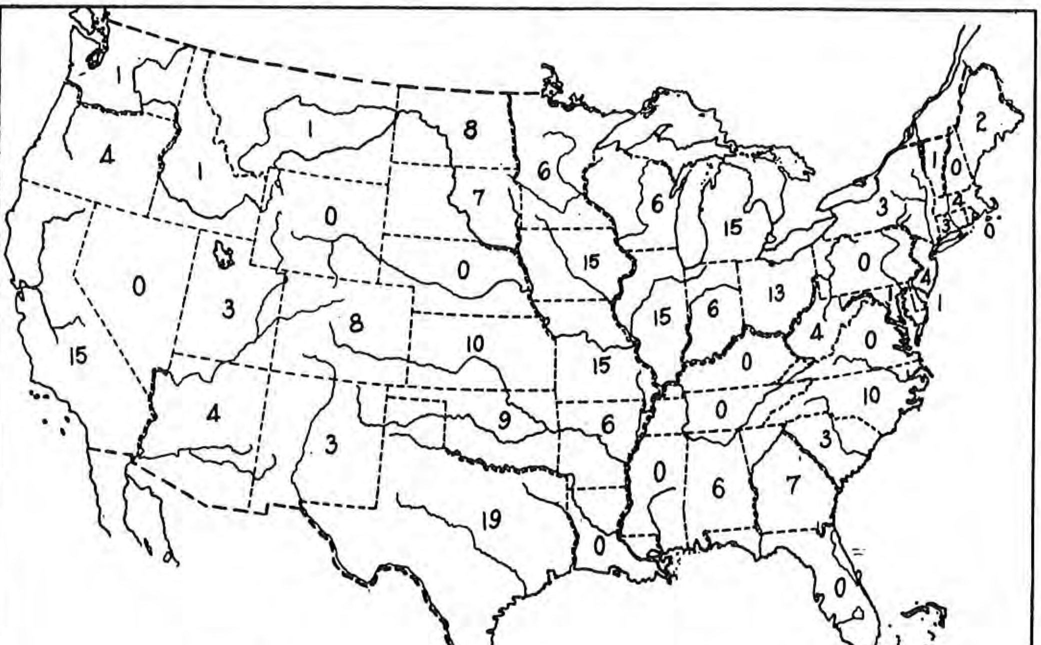


FIG. 1. GEOGRAPHIC DISTRIBUTION OF REPLIES

*Authorized and financed by the Council of the S.P.E.E.; supervised by the Executive Committee of the Division of Drawing & Descriptive Geometry, 1941-1942. Prof. R.P. Hoelscher, Chairman.

and (b) as to the general quality and method of conducting drawing courses in the colleges themselves. This proposal was approved by the Division.

In September, 1940, the executive committee of the Division met at the University of Illinois and after discussion of the various phases of the problem authorized the chairman to proceed with the preparation of a questionnaire, and a detailed statement of the purpose, estimated cost of making the survey, and the method of procedure to be followed. This was done and copies sent to the members of the executive committee prior to the mid-year meeting of the Division at Washington University in St. Louis on February 22, 1941. Suggestions and criticisms were received and the proposal redrafted for submission to the council of S.P.E.E. for the approval of the project with a request for an appropriation of $250 to finance it. Council approved the project and granted the funds at the annual meeting in Ann Arbor, June 1941.

After further study and debate, the questionnaire, a copy of which is appended to this report, was approved by the executive committee of the Drawing Division.

The cooperation of sixty-eight colleges in the forty-eight states in distributing and collecting the questionnaire was solicited. The colleges in each case were those whose curricula were approved by the Engineers Council for Professional Development (E.C.P.D.). Herein after these schools will be referred to simply as "E.C.P.D. Schools" for brevity, it being understood that this means schools which have had one or more of their curricula approved by E.C.P.D.

At least one college was selected in each state, with from two to four in the more populous states. Each one was asked to submit a list of not to exceed ten colleges or Junior Colleges (not on the E.C.P.D. list) from which they received transfer students with drawing credit. In states with two or more cooperating colleges these lists were checked to avoid duplication. Each college was required to stay within the territorial limits of its own state in making up its list.

Forty-eight colleges responded and did cooperate with a resulting accumulation of 239 usable questionnaires distributed geographically as shown on the map in Fig. 1.

Throughout the report the results have been studied and classified in various ways which seemed to promise significant results. A part of this study was to determine whether the group of 48 cooperating E.C.P.D. Schools was in any way superior to the general average and if so to use them as a basis of comparison with other groups and with individual schools. It was found that the distribution on the basis of financial support and control was as follows:

11 Private schools operated for profit.
31 Parochial Schools operated under church auspices.
53 Municipal Schools -- financed by cities or local districts.
43 Endowed Schools.
101 State supported institutions.

On the basis of major objective of the school they were divided into engineering, liberal arts, teacher training or vocational schools with the following distribution.

108 Engineering or pre-engineering curricula.
77 Liberal arts.
40 Teacher training.
14 Vocational.

Throughout the report it will be found that the geometric axiom, "the whole is equal to the sum of all its parts", does not hold. A total of 52 questions were asked. Some of these questions did not seem to apply to certain schools, for others data was not available and in some instances no doubt questions were overlooked. In general, whenever a question was answered it was tabulated and used unless a supporting question necessary to give meaning was overlooked. The conclusions drawn are not of such a character that the lack of a perfect mathematical check could invalidate them. The variation in general is slight.

The report has been made in the following five sections.

I. Origin and purpose (as above).

II. Treatment of high school drawing credit by the colleges.

III. Preparation and experience of drawing teachers.

IV. Course administration.

V. Course Content.

II TREATMENT OF HIGH SCHOOL DRAWING CREDIT BY THE COLLEGES

1. Entrance Credit. Not so many years ago manual arts subjects, as they were then called, were not accepted for admission to college. It was therefore decided to find out how far this practice had been modified with respect to high school drawing. The results are shown in Fig. 2 by groups and for the total.

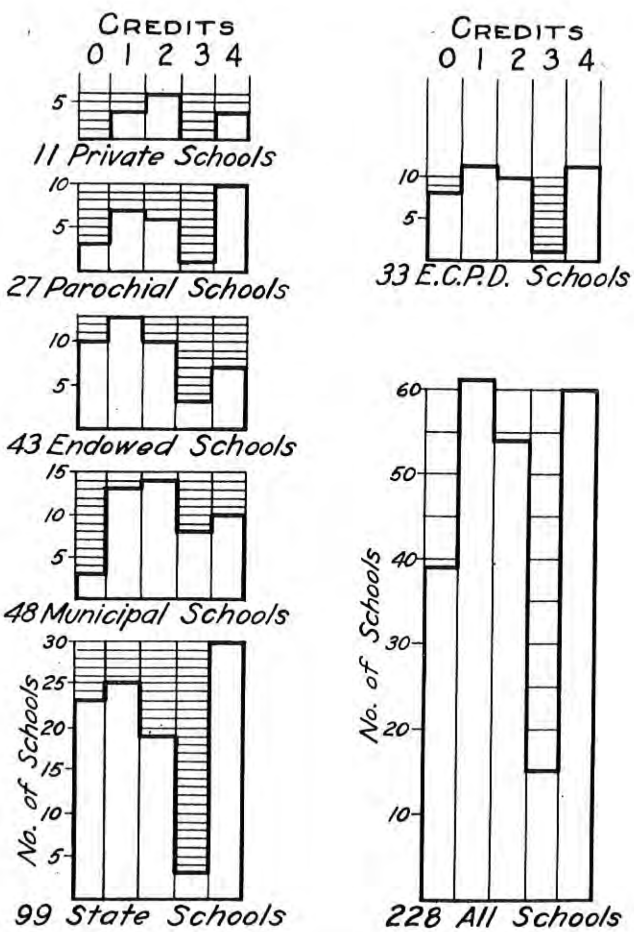


Fig. 2. High School Drawing Credits Accepted for College Entrance

It will be noted that all groups and the total follow essentially the same pattern. They indicate clearly the tendency to accept first one unit, then two. The low grouping at three units may indicate that at this point many schools have decided upon a complete revaluation of their entrance requirements and have either chosen to limit manual arts or vocational subjects or have decided to accept these subjects on the same general basis as academic subjects.

Another reason for the drop at two units is the fact that a large number of high schools offer only two units of drawing. Hence there is not the need or demand for further credit.

If we reassemble the data showing how many schools will accept one unit, how many two units and so on the distribution of Table I is found.

TABLE I. HIGH SCHOOL DRAWING CREDITS ACCEPTED FOR COLLEGE ENTRANCE

CREDITS	0	1	2	3	4	TOTAL SCHOOLS
NO. OF SCHOOLS	39	190	129	75	60	228

This indicates more clearly the fact that high school drawing still has a considerable distance to go to be accepted on a par with so-called academic subjects in meeting college entrance requirements. It is clear, however, that the colleges have liberalized their requirements a great deal and that in the great majority of schools at least one unit of drawing offers no handicap.

A further study of the thirty-nine schools which do not accept drawing as an entrance credit would be very interesting. Of this group, eleven were primarily liberal arts schools, eight teacher training colleges and twenty had engineering or pre-engineering curricula.

2. College credit for High School Drawing. This question endeavored to ascertain how many colleges, if any, gave credit toward college graduation requirements for high school drawing whether used for entrance or not used. Table II shows the results and distribution of the answers to this question. Such credit was granted on the students record, not by proficiency examination.

TABLE II. HIGH SCHOOL DRAWING CREDIT USED TOWARD COLLEGE GRADUATION REQUIREMENTS

TYPE OF SCHOOL	NO. OF SCHOOLS	
	YES	NO
Private	2	9
Parochial	1	25
Endowed	2	39
Municipal	6	45
State	3	104
E.C.P.D.	1	40
Total	14	224

A total of 77 persons received such credit in eight different schools, 60 of them in one school. While the results are not startling they do indicate a situation in a few schools which should be definitely discontinued. As one would expect the situation is most unfavorable among privately operated and municipally controlled schools, where pressure is probably greatest.

3. Students excused from college drawing on the basis of high school drawing. This question is one of the primary ones which prompted this survey. The problem arises because of the following situation.

(a) Ambitious and progressive high school teachers secure from various sources the problems which are used in college drawing classes and give these problems to their students. Subsequent comparison of one of the better high school sets of drawings with a college set reveals little difference except that the amount of work done in high school is larger.

(b) Some college texts are used widely in high schools. When the same text is used in both the high school and the college a still more difficult explanation is required of the school which refuses to recognize high school drawing.

(c) College methods of teaching, as revealed in not a few instances in this survey, differ little from those of the high school, especially when both are based on the false assumption that drawing is a subject peculiarly adapted to individual instruction without planned classwork. Little can be said for the college work in such cases.

On the other hand, the following conditions in the high school militate against the automatic acceptance of high school drawing as adequate preparation for an engineering career. These items stand out in many years of the combined experience of a large number of men:

(a) In large city schools where the preponderance of high school drawing is taught, sections or classes will be found to range from 32 to 45 or more. The instructor frequently will have from 5 to 6 such classes per day, each day of the week.

(b) Again because of the false assumption of individual instruction, class work is sometimes not planned and by the middle of the semester some students are working on the second problem, others will be on the ninth or tenth, and the class lacks coherence and homogeneity which makes group instruction possible. With the situation as in (a) above individual instruction is a pure delusion.

(c) High school administrators likewise often hold the erroneous notion of individual instruction and even in large schools where enrollments are ample to permit homogeneous registration as to grade, classes will be found in which first, second, and third year drawing students are indiscriminately mixed. Of course, if the high school practices this same theory with respect to Algebra, Latin, history and the languages, its position is at least consistent but it can scarcely be regarded as conducive to learning.

(d) The administrator occasionally makes the drawing course the dumping ground for the high school misfits. Here they can be kept occupied and out of trouble, learning is not expected.

(e) In addition to the foregoing, which are largely mechanical details which very seriously interfere with instruction, it must be clearly recognized that the objectives of the high school are no longer college preparatory but designed rather to meet the needs of the community in which it exists. This being the case instructors on both sides of the line must recognize that they have a particular job and that neither will necessarily fit perfectly into the work of the other.

The summary of the answers to this question is shown in Table III:

TABLE III. STUDENTS EXCUSED FROM COLLEGE DRAWING ON BASIS OF HIGH SCHOOL DRAWING WITHOUT EXAMINATION

TYPE OF SCHOOLS	NO. OF SCHOOLS	
	YES	NO
Private	1	9
Parochial	4	22
Endowed	7	29
Municipal	6	44
State	12	95
E.C.P.D.	6	35
Total	30	199

Here the private schools show the best record with the parochial and endowed schools above the average in liberality. This can be accounted for, though not approved, by the fact that these schools being more than half liberal arts institutions are likely to view drawing from the cultural rather than the engineering aspect. Comments on this question returned with the questionnaire indicate that many schools are rather careful in excusing students from college drawing.

Although the survey has given us a picture of the situation throughout the country and has given an answer as to the best practice by a ratio of better than 6 to 1 the problem needs further study since pressure upon this point is likely to continue particularly where local influences are effective.

4. Students excused from college drawing on the basis of commercial work. The data upon this question is summarized in Table IV.

TABLE IV. STUDENTS EXCUSED FROM COLLEGE DRAWING ON THE BASIS OF COMMERCIAL WORK, WITHOUT EXAMINATION

TYPE OF SCHOOL	NO. OF SCHOOLS	
	YES	NO
Private	1	8
Parochial	1	25
Endowed	13	22
Municipal	3	46
State	18	86
E.C.P.D.	15	26
Total	35	189

Here the E.C.P.D. and endowed groups are the worst offenders and the total record presents much the same picture as the high school drawing situation.

In both cases the total number of students excused from college drawing on the basis of either their high school record or commercial experience was 145. This is insignificant when compared to the total enrollment in college drawing which was 33,880 in the schools involved in this survey.

In this instance again we could dismiss the matter as satisfactory and point to majority procedure as the best practice. There is, however, a definite principle involved which the Drawing Division of S.P.E.E. considers it should call to the attention of the schools.

The excusing of students in the two foregoing groups, was presumably based upon the records of the students. Quite a number of schools indicated that they required the presentation of drawings but did not give proficiency examinations. This committee is definitely of the opinion that the examination of drawings, while more reliable than the outright acceptance of the students record, nevertheless gives no accurate measure of the students ability to accomplish more than the mere copying of drawings with acceptable technique. On the college level, drawing should do much more than develop technique or make draftsmen.

5. Proficiency examinations. Quite a number of schools are now giving proficiency examinations in drawing as indicated in Table V. This practice is recommended for it is manifestly unfair to require an individual to repeat work in any subject in which he can demonstrate acceptable proficiency and intelligent understanding. For college credit it must be above the vocational level.

TABLE V. PROFICIENCY EXAMINATIONS

TYPE OF SCHOOL	NO. OF SCHOOLS	
	YES	NO
Private	2	6
Parochial	6	18
Endowed	14	22
Municipal	10	35
State	31	65
E.C.P.D.	21	19
Total	62	109

6. Results of Proficiency examinations. The results obtained from proficiency examinations shown in Table VI and the comments added to the questionnaire indicate that in general such examinations are given with careful investigation into the students prior experience. In a few instances, however, exceptionally high passing rates involving large numbers would seem to indicate an examination that was unsatisfactory. The total result in this case was seriously affected by one school which gave 75 examinations and passed 75.

TABLE VI. RESULTS OF PROFICIENCY EXAMINATIONS (1940-41)

TYPE OF SCHOOL	NO. OF STUDENTS	
	TAKE	PASS
Private	18	16
Parochial	0	0
Endowed	16	13
Municipal	76	75
State	322	91
E.C.P.D.	303	81
Total	432	195

7. Segregation of Students based upon previous drawing record. The current practice is indicated in Table VII. The answers to this question are modified largely by the enrollment of the institution and its location. Quite obviously, schools with enrollments too small to provide an adequate section of advanced students cannot afford to provide this training. It should be said, however, that many of the smaller schools are attempting to meet this situation by special attention to the individuals who have had previous experience. While this does not permit of the same thoroughness as a segregated section it is nevertheless the best answer that can be provided in the particular case.

TABLE VII. SEGREGATION OF STUDENTS BASED ON PREVIOUS RECORD

TYPE OF SCHOOL	NO. OF SCHOOLS	
	YES	NO
Private	2	8
Parochial	1	23
Endowed	5	33
Municipal	11	38
State	15	92
E.C.P.D.	6	35
Total	38	192

It may be noted that although the E.C.P.D.

schools have the largest enrollments (41 schools enrolling over 19,000) yet these schools have almost the lowest record in the practice of segregation. It may be noted that 28 of our 48 states are still preponderantly rural with consequent small towns and small high schools where not a great deal of drawing is taught. Schools in these states may have little call for segregation.

8. Conclusions. The general picture as to the topics covered in this section is satisfactory. Individual colleges are here and there badly out of line. Conclusions on the various points covered in this section have been indicated in the discussion of each point. They are summarized here for convenience with a few additional recommendations.

a. Entrance credit being based largely on the function of the school was beyond the scope of this report and was presented as a matter of interest only.

b. College credit for work done at the secondary level should be definitely discontinued.

c. The excusing of students from college drawing should be based on adequate proficiency examinations at the college and not the vocational level. Drawings previously made by the student should be accepted as a part of this examination only as evidence of skill in technique.

d. It is recommended that the Drawing Division through one of its committees prepare a typical proficiency examination which may be used as a guide by those who may wish to use it.

e. Where conditions warrant, the practice of segregating students who have had two or more years of high school drawing into special sections is recommended. Short trial periods or brief screening tests may be used to weed out those unfit for more rapid or advanced work.

We believe that the offering of an adequate proficiency examination for those who appear upon interview to be able to pass it and the offering of advanced work in special segregated sections meets all the demands which any reasonable high school teacher may make. It also meets the need and recognizes the merit of the individual student who has applied himself and finally it protects and preserves college work at its proper level.

III PREPARATION OF TEACHERS

1. The purpose of the questionnaire relating to the preparation of teachers was to obtain some measure of the quality of teaching in engineering drawing. It is a well known fact, which is here clearly recognized that a mere statement of degrees earned, plus years of teaching experience plus years of experience in engineering or practical drafting work is not an accurate or infallible measure of the quality of teaching. There are individual exceptions to these measures of teaching ability just as there are individual exceptions to the validity of intelligence tests. There are no doubt some good teachers who do not hold degrees from any institution and likewise some Ph.D's whose teaching practices are totally inadequate, yet by and large it must be recognized that certain types of training as evidenced by degrees held from reputable schools are an essential foundation for successful teaching. Likewise it must be agreed that most normal individuals gain in skill from actual teaching experience.

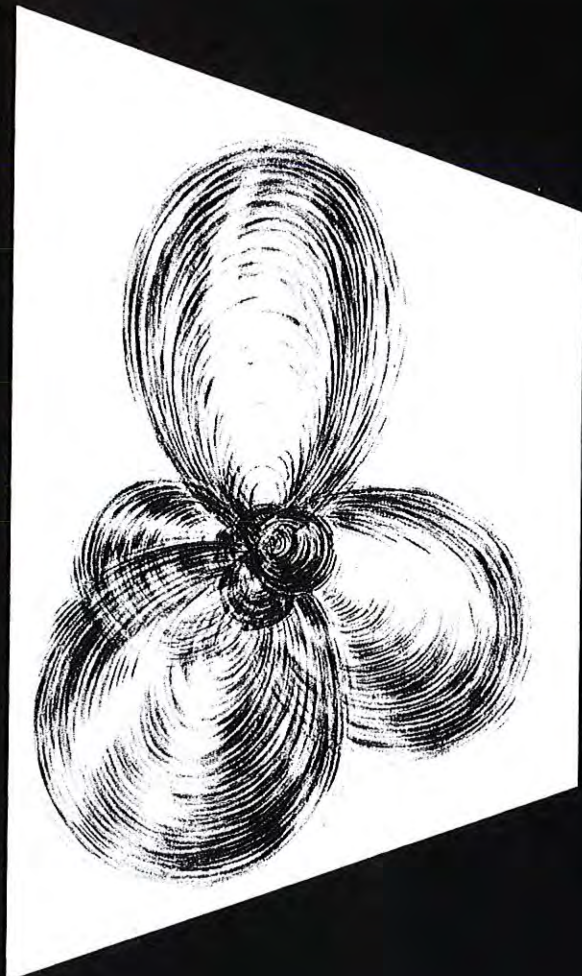
For the teaching of drawing, as for any other engineering subject, actual experience either in the preparation or in the use of engineering drawings is of marked value in lifting the teaching above a didactic academic level to the inspirational level which makes for real achievement.

In accrediting schools at the secondary level a definite amount of training in the field of specialization is a definite prerequisite for approval. This is no doubt assumed to be the case for teaching at the college level. In engineering drawing this is particularly necessary and requires considerable attention on the part of administrators and those responsible for accrediting.

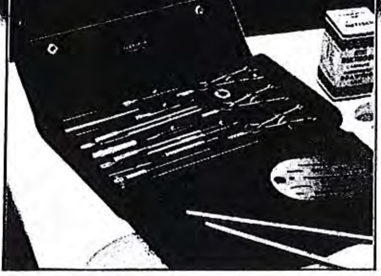
This is due to the fact that engineering drawing today is an art as well as a science. The course of instruction today is vastly different from that of twenty years ago. While the underlying principles of projection have remained unchanged a wider field of usefulness and application has come into existence.

For example, the subject of pictorial representation, in either isometric, oblique or perspective form, has changed from a matter of academic interest to one of practical utility not to say necessity.

Again the subject of dimensioning and of notation of shop operations scarcely to be found in the texts of 20 or 30 years ago now requires page after page of exposition and illustration. Production methods, precision measurements or gaging can not be ignored in the drafting room. With these rapidly



IN THE CELLAR, IT'S WORTH 12 DOLLARS A TON IN THE SHOWCASE, IT'S WORTH 2 BILLION



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Why this tremendous difference in values?—Simply the influences brought to bear on the original carbon deposits during what may be called their "formative years." The story of the Diamond and the Lump of Coal is another of the endless list of examples demonstrating what every intelligent educator knows . . . how early influences play a dominating role in shaping the careers of men-to-be. Wise educators know how plastic the young mind and spirit are. They know there's not a great deal of difference between the talent possessed by one boy and the ability possessed by another. They know that the will to win resides in the heart of every mother's son. They know that the influences brought to bear on a youngster will make the *great* difference between failure and achievement.

That is why educators who are truly worthy of the name go beyond the routine of "instruction" and seek to surround their students with the influences that fan into flame the spark of achievement. That is why exceptional instructors in mechanical drawing urge the use of fine quality drawing instruments. For, *chosen with care,* these instruments in the act of truly creative work can open up a new realm in the imagination of a youngster. They set a goal, and they show the way in which it is achieved. They initiate a boy into the discipline which is so essential a part of achievement. They train him in sensitive craftsmanship, in higher ideals and aims. They can even stimulate his ambition and lift his ability. Their slightly higher cost, when compared with their value and their use, is as nothing in this important work, the making of a man.

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advancing and changing techniques, the teacher of engineering drawing must be familiar.

Hence the recognized requirement of training in the field of specialization is particularly important for the teacher of engineering drawing. It is imperative that his training in drawing have the engineering background and outlook. It is also essential that he have some practical experience in the engineering drafting room and that in some way he maintain such contacts.

It must now be pointed out that courses in drawing as presented in Liberal Arts Colleges and Teacher Training Schools are not adequate as training for the engineer or the prospective teacher of engineering drawing. Objectives are different and purposes more diffused. For this reason a segregation has been made in the classification of the degrees of teachers.

In thus emphasizing the practical aspects of engineering drawing the cultural objectives of the college and university must not be overlooked. Likewise the professional ideals of engineering require that drawing be taught with more than the vocational or trade view point. This requires a depth and rigor in training in the principles of projection which will make of the student a master of the art rather than merely a skillful pusher of the ruling pen.

In the teaching profession, personality is as important as adequacy of training. Into these qualities this survey did not inquire. It should be pointed out, however, that many personal characteristics, such as judgment, patience, breadth of view, sympathetic understanding are the result in large measure of years of experience. Hence experience in the teaching field is important from this point of view as well as significant as a measure of the acquirement of skill in teaching techniques.

It is with this view point that the following data are presented. They are summarized first to present the total picture and then analyzed by groups as in the first sections of this report.

2. Education of Teachers. The degrees were tabulated according to the highest held by each individual. The B.S. and M.S. degrees were in most cases in engineering or the physical sciences. When indicated as in Education or other field they were separately tabulated and summarized with the B.A. and M.A. degrees. The Professional engineering degree was assumed to be for our purpose as of higher rank than the M.S. degree. The Ph.D. Degrees noted were in academic subjects with the exception of one or two honorary D.Sc. degrees.

In 239 schools reporting, drawing was taught by 283 full time teachers, 300 who devoted only part time to drawing and by 83 undergraduate student assistants. In 57 cases the experience record was omitted. The various parts of the analysis therefore do not total 583 teachers as we wish they might. The tabulated results are shown in Table VIII.

Relatively few persons (3%) held no college degrees but in most cases these persons had a record of long teaching experience. This situation needs little comment since it should correct itself as these persons retire with the passing years.

The total B.S., M.S., and professional degrees is 381 indicating that 72% of our drawing teachers have an engineering or scientific background in their training.

The total of B.S. in Ed., B.A., M.A., and Ph.D. is 128. Hence approximately 24% of the teachers have degrees which indicate training in Education or other liberal arts subjects. The training of this group must in general be regarded as inadequate for the successful teaching of modern engineering drawing. As will be noted later there seems to be little possibility of changing this situation.

Thirty-four per cent of the group hold M.S. or professional engineering degrees.

TABLE VIII. DEGREES HELD BY DRAWING TEACHERS

TYPE OF SCHOOL	NO DEGREE	B.S.	B.A.	B.S. ED.	M.S.	M.S. ED.	PROF.	PH.D.	TOTAL	DEGREE NOT LISTED
Private	1	4	0	0	1	4	0	1	11	0
Parochial	1	11	5	1	10	6	0	3	37	0
Endowed	2	46	4	2	21	10	17	7	109	10
Municipal	5	31	4	3	24	23	8	1	99	3
State	8	109	3	8	72	31	27	12	270	44
Teachers Training	0	4	1	2	10	20	1	3	41	3
E.C.P.D.	8	115	2	9	59	6	38	7	244	36
Total*	17	210	16	14	128	74	52	24	526	57

*Note - Totals represent the sum of the first five groups.

This group should become relatively much higher. With proper administrative encouragement this can be achieved.

3. Teaching experience. The record of teaching experience is shown in Table IX. The impression was formerly held that drawing teachers were a young and inexperienced lot. The chart clearly indicates the incorrectness of this impression. Of the 530 teachers for whom records were given 70% have had five years or more of teaching experience while 54% have had ten years or more.

TABLE IX. YEARS OF TEACHING EXPERIENCE

TYPE OF SCHOOL	Years of Experience 1	2	3	4	5	6	7	8	9	10	15	20	25	25+	TOTALS	NOT LISTED
Private	3	1	1	0	0	0	1	0	0	0	2	0	0	3	11	0
Parochial	5	2	3	3	1	2	2	1	2	1	9	3	2	1	37	0
Endowed	24	6	10	4	5	9	1	4	1	6	9	12	4	12	107	12
Municipal	4	0	3	7	3	6	3	2	0	17	13	23	9	8	98	4
State	44	10	15	9	16	11	6	5	6-	20	38	45	21	31	277	37
Teacher Training	3	0	0	0	2	3	0	0	2	2	4	12	4	9	41	3
E.C.P.D.	40	8	14	10	12	9	6	5	4	23	27	42	25	29	244	36
Totals	80	19	32	23	25	28	13	12	9	44	71	83	36	55	530	53

The first year of experience was difficult to break down since the reports came in almost throughout the entire 1941-42 school year. Many indicated a fraction of a year's experience which was interpreted to mean a beginning teacher. The record indicates that a considerable number drop out of teaching drawing after the first year but the continuity of the chart shows that the intake of new and inexperienced young men is normal for the maintenance of the group.

In counting teaching experience it will be noted that no class with zero experience is listed. This was due to the difficulty of segregating this group in the data secured. This may in part explain the great discrepancy between the one and two year experience records which as the total would indicate shows about a seventy-five percent loss between the first and second years which seems unduly large. We are therefore not in a position to make any comment on this turnover. The drop in employment nine years ago is clearly shown in the totals of Table IX.

4. Engineering Experience. The data concerning practical engineering experience is shown in Table X. Here again the record shows not only a very satisfactory amount of experience by the group as a whole but offers further conclusive proof that the assumption of inexperience concerning drawing teachers is totally unwarranted. From the replies received it appears that many men are able to carry on engineering work in conjunction with their teaching while others have acquired their experience largely by summer employment and some by years of experience prior to entering the teaching profession.

It must be said, however, that the number of men without engineering experience is much larger than the number who are first beginning their teaching careers indicating that a large number continue in teaching without an attempt to acquire practical experience by summer work or in any other way. In mitigation it may be said that during the past ten years of restricted business operations such work was difficult to get.

This situation can be and should be remedied by administrative effort in giving encouragement and, if need be, assistance to the younger men in securing summer employment.

While the total picture as to training and experience thus presented is quite satisfactory as a whole, a detailed analysis indicates some weak spots in certain groups, and in particular schools, which could well be remedied, with a distinct advantage to the schools and a corresponding benefit to the students whom they prepare.

The breakdown of the data according to groups is shown in the first three Tables where comparisons between groups can readily be made.

5. Study of Groups of Schools.

(a) Private Schools. In this group of eleven schools are represented 6 full time men, 5 part time instructors and 7 student assistants. Of the 11 teachers, 1 held no degree and 5 were Arts or Education degrees indicating little or no engineering background. The 7 student assistants were all in one school under the direction of a full time instructor.

Four of the 11 have had no practical experience and another 4 had only one year. Five had three years or less of teaching experience and 6 had seven years or more.

Student Assistants. Not only in the

TABLE X. YEARS OF ENGINEERING EXPERIENCE

TYPE OF SCHOOL	0	1	2	3	4	5	10	15	15+	Total	NOT LISTED
Private	4	4	1	0	0	0	2	0	0	11	0
Parochial	18	6	0	2	2	3	3	1	2	37	0
Endowed	17	11	12	8	6	28	14	9	4	109	10
Municipal	26	9	14	5	6	14	13	7	4	98	4
State	56	37	31	26	28	44	31	13	13	279	35
Teacher Training	21	6	1	5	1	4	2	0	1	41	3
E.C.P.D.	27	30	36	20	29	48	38	16	10	254	26
Total	121	67	58	41	42	89	63	30	23	534	49

group above but in all groups the use of student assistants, unless confined entirely to mechanical work such as recording grades, making blueprints, typing or the like must be regarded as unsatisfactory.

Granted that there is little difference between a senior and the man just graduated as far as ability is concerned nevertheless there is a marked difference in the student attitude. The student does not respect a fellow student nor his opinions and advice. The graduate who holds a degree and who is a regularly appointed member of the staff gains thereby respect and prestige that cannot be conferred upon a student assistant. Obviously the student assistant's major interest must be in getting his degree.

It should also be noted that the employment of young graduates without a few years of experience is not approved by the foregoing statement. A department having a ratio of one experienced teacher to 7 new and inexperienced men even with degrees could not be condoned except as a rather rare emergency situation. During the present war, obviously little can be done and the situation may become worse.

(b) Schools under church control. These schools listed 7 full time and 30 part time teachers with 4 student assistants. Only one held no degree while 21 indicated degrees of an engineering character. Fifteen had Arts or Education degrees.

From the view point of teaching experience the record of this group compares favorably with the total. The number of beginners is normal. The ratio of men without practical experience is high. In 14 of the 30 schools, no one teaching drawing has had practical experience.

In many instances the record of no experience corresponds with an arts degree and in quite a few instances with a long teaching career. Quite obviously these men are not in a position to secure engineering employment and their teaching must have a strong academic flavor. Furthermore because of small enrollments in drawing in many of these schools and the consequent large ratio of part time teachers devoting their major interest to other subjects there seems to be no reasonable solution for this situation.

(c) Endowed Schools. The forty-three schools in this group indicated 61 full time and 58 part time teachers with only 5 student assistants.

Eighty-four had engineering degrees while only 21 had Arts or Education degrees and two held no degree. The teaching experience record is about normal and the practical experience record is quite favorable to this group. In only eight of the schools was drawing handled entirely by men without practical experience.

(d) Municipal Schools. Fifty-three schools reported 35 full time and 67 part time teachers with 4 student assistants. Of these 63 held engineering degrees while 31 held Arts or Education degrees and 5 held no degrees. In this group the teaching experience record is quite favorable but the engineering experience record is not quite so good. In 17 of the schools drawing was taught by men entirely without practical experience. This group is again handicapped by small enrollments in drawing as evidenced by the record and the large proportion of part time teachers.

(e) State Schools. One hundred and one state supported schools reported 175 full time and 139 part time teachers with 68 student assistants. The student assist ratio is unduly large in this group in fact the worst of the lot except for private schools.

Of the total 208 had degrees representative of an engineering background, while 54 had degrees in Arts or Education and 8 held no degree. Only 14 of these Arts degrees were in Engineering Schools - the remainder being in Liberal Arts Colleges or Teacher Training Schools.

In teaching experience the group shows a normal distribution. In practical experience 56 men, approximately one-sixth of the total,

had none. This corresponds to the Arts degree ratio in training and while there is not an exact correspondence between the two groups of individuals the Arts degree may be said in general to correspond with very small or complete lack of practical experience.

(f) Teacher Training Schools. Among the State supported institutions a large number gave teacher training as their major objective. A total of 36 such schools have 13 full time and 31 part time teachers with 2 student assistants.

In this group 15 indicated degrees with an engineering background, and 26 with an Arts or Education outlook while 3 were not given.

In teaching experience the group is comprised of relatively old men, 25 of them having 20 years or more of experience. Twenty-one had no practical experience and six only one year. These schools trained 1400 students in drawing.

Since a very large number of high school drawing teachers are trained in these schools it is to be regretted that the proportion of teachers with engineering degrees and engineering experience is not higher. Granted that the high schools are not training engineers and that their outlook is vocational and cultural rather than technical, nevertheless vocational drafting is done primarily in engineering and architectural establishments of one kind or another.

From the cultural or general informational value thoroughness is of more real value than shallow acquaintance with a wide field. Because of mistaken laws, requiring too much emphasis on method and not enough on subject matter, engineering graduates, the best qualified in the field for teaching drawing and some shop subjects, are barred from the field of high school teaching. In general they are not barred from the college field and could render real service in the Teacher Training institutions.

(g) E.C.P.D. Schools. Forty-four schools whose curricula are accredited by E.C.P.D. show 188 full time and 92 part time drawing teachers with 48 student assistants. The ratio of full time to part time teachers is the best of any group and should tend toward excellence in the teaching of drawing since the full time men can devote their energies to the matter. The ratio of student assistants, however, is regrettably large, being exceeded only by the state group, of which they are a part, and by private schools. The difficulty is concentrated in about 8 schools and these institutions should be encouraged to remedy this situation.

The degrees of 36 teachers were not given, 8 held no degree, 212 held degrees indicating engineering background while only 24 held Arts or Education degrees. One hundred and ten were holding advanced degrees. As is to be expected this is by far the best record of any group.

In teaching experience the record is good and indicates only a normal intake of new men. The engineering experience record likewise is quite high with only 27 men indicating no experience. This number is in close relation to the number teaching for the first time and represent new men entering the profession in a normal flow.

In only six schools is drawing taught entirely by part time men whereas in 13 schools drawing is taught entirely by full time drawing teachers. In the remainder there are combinations. In only one school was drawing taught entirely by a man without practical experience.

6. Conclusions. As a result of this study it would seem highly desirable for the schools involved to study the student assistant problem for this seems to be one that can be remedied. In few cases was there any indication that the student assistant question was a war time problem. The situation is rarely complicated by small enrollments in the E.C.P.D. Schools which should give this matter careful attention.

A second recommendation is that all engineering schools scrutinize more carefully the work accepted for full credit from institutions in the other groups where the amount of time devoted to drawing may be short and teaching is likely to be academic in tone, cultural in purpose and lacking in rigor.

KEEPING PERSONNEL RECORDS OF DRAWING STUDENTS

by
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Since Departments of Engineering Drawing usually deal with students in their freshman or sophomore years, personnel records of such departments need not be so elaborate as would be needed perhaps in the departments representing major fields of engineering. Yet in order to anwser inquiries concerning a student's drafting record from prospective employers or from other departments of the college, and also to facilitate the handling of current enrollment matters,

(Continued on Page 23)

LIGHTING AND SEEING IN THE DRAWING ROOM

By
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General Electric Company

There are few vocations which the student can choose which make greater demands upon his eyes than that of drafting, both during the period of preparation and of practice. Consideration should be given, therefore, to every means which will make the seeing task easier. Lighting is one of these aids. Naturally when seeing is made easier, speed and accuracy are improved. The growing recognition of the severity of the draftsman's seeing problem has resulted in increased emphasis being placed upon the lighting requirements for drafting rooms and upon the choice of the drawing materials which are used therein. This is even more important where the work being done is connected with the war effort.

Recently, a comprehensive study of this problem was made, a full report of which will be found in the Transactions of the Illuminating Engineering Society.[1] Since much of the report deals with the experimental techniques developed, which are of general interest only to the illuminating engineer and the seeing specialist, only the more important findings of the study will be covered by the present discussion. This paper, however, does deal with lighting methods at some length.

Table I. Characteristics and Visibilities for Drawing Surfaces
(Average of 12 Lighting Conditions)

Drawing Surface	Character of Surface	Reflection Factor .77 Back grnd.	Reflection Factor 0.25 Back grnd.	Transmission Factor	Visibilities Drawing Medium	Visibilities Ave. PVM
Pencil Cloth	Matte	0.77	0.53	0.44	Ink*	66%
					Pencil**	23
Tracing Paper	Semi-matte	0.80	0.57	0.42	Ink	66
					Pencil	6
Card-board	Smooth	0.78	0.78	0.00	Ink	66
					Pencil	4
Ink Tr. Cloth-Glossy	Glossy	0.58	0.26	0.54	Ink	59
					Pencil	2
Ink Tr. Cloth-Dull	Smooth	0.58	0.26	0.56	Ink	59
					Pencil	0

*Average of three widths.
**Average of three pencils.

SEEING IN THE DRAWING ROOM

The study afore-mentioned was made to determine the visibility of various combinations of drawing materials and lighting systems. Five different drawing surfaces were studied: (1) Standard white tracing paper; (2) White pencil cloth; (3) Ink tracing cloth - glossy side; (4) Ink tracing cloth - dull side; (5) White glazed cardboard. (See Table I). Three different backgrounds for the drawing surfaces were studied: (1) 77% reflection-factor white cardboard (used for tests generally); (2) 24% reflection-factor gray cardboard; (3) 4% reflection-factor black cardboard.

The drawing media consisted of black India ink and H, 3-H and 6-H pencils.

Two positions of the drawing board were considered: (1) "Horizontal" - board inclined at an angle of 10° with the horizontal (80° with the nadir); (2) "Vertical" - board inclined at an angle of 10° with the vertical (or nadir).

Figure 1

The large-area (24" diameter) Directional Unit equipped with a 200-watt Silvered Bowl MAZDA lamp. Brightness measurements are being made.

1 - The data in this paper are taken from "Lighting and Seeing in the Drafting Room" - W. G. Darley & L. S. Ickis, ILLUMINATING ENGINEERING, December 1941 (Vol. XXXVI, No. 10) Page 1462.

Seven lighting arrangements were studied: Indirect lighting (Fig. 7) at two levels of illumination, 30 and 75 footcandles; Troffer* lighting (Fig. 10) at two levels, 40 and 80 footcandles; a Large-Area Directional Lighting Unit (Fig. 1) delivering 45 to 55 footcandles; an Industrial Diffusing Unit (Fig. 2) providing 40 footcandles; a Trans-illuminated Tracing Table.

On each of the drawing surfaces, six "broken-line" test objects were made with the various drawing media, the lines being 4 or 5 inches long with a 1/4-inch break at the center. One line each was made with an H, 3-H and 6-H pencil. The other three broken-line test objects were drawn with the India ink and were, respectively, 1/32nd, 1/64th, and 1/100th inch in width. The relative visibilities of the test objects were determined with the Luckiesh-Moss Visibility Meter.[2] The results obtained with the Visibility Meter are expressed in terms of Percent Maximum Visibility (PMV).[3]

The two cardinal points on the PMV scale (100 and 0%) are describable in terms of the physical characteristics of two simple test objects which are assumed as practical and useful standards of maximum and minimum visibility, respectively. The specifications of these arbitrary end points follow:

100 PMV - This standard of maximum visibility is obtained with an indefinitely large black object upon a white background illuminated to 10 footcandles, when viewed by a person possessing normal vision.

0 PMV - This standard of minimum visibility is obtained with a black object, whose critical details subtend a visual angle of about 2 minutes, upon a white background illuminated to 10 footcandles.

Between these arbitrary limits, the PMV scale is divided into 100 equal steps in visibility. The practical advantages of the

TABLE II.
VISIBILITIES WITH DIFFERENT SYSTEMS
(Average for Five Surfaces)

System	Footcandles on Horizontal Plane	Average PMV Determined from Visibility Meter Reading.
INK LINES		
Troffer	82	84-85
Indirect	77	84
Large Area Directional Unit	43	80
Troffer	40	75
Indirect	29	69
Industrial Diffusing unit	43	60
PENCIL LINES		
Large Area Directional Unit	56	31
Indirect	77	26
Troffer	82	23-27
Troffer	40	9-11
Indirect	29	6
Industrial Diffusing Unit	43	6

Figure 2

These lighting units accommodate two 200-watt MAZDA C lamps and are so designed that the large area of white opal glass is uniformly illuminated. Note indirect luminaires (one in background, others reflected in windows) which help to relieve brightness contrast between direct unit and ceiling.

* Trough reflectors recessed in the ceiling and accommodating white MAZDA F (fluorescent) lamps.

2 - "Visibility - Its Measurement and Significance in Seeing" - JOURNAL of the Franklin Institute, 1935 (Vol. 220) Page 431.

3 - "Thresholds and Supra-Thresholds of Seeing" - TRANSACTIONS, I.E.S., November 1938 (Vol. XXXIII, No. 9) Page 786.

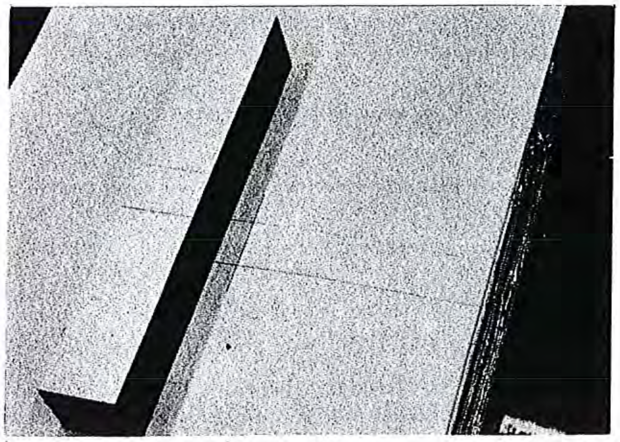

Figure 3

Shadow under troffer system with straight edge parallel to axis of troffers

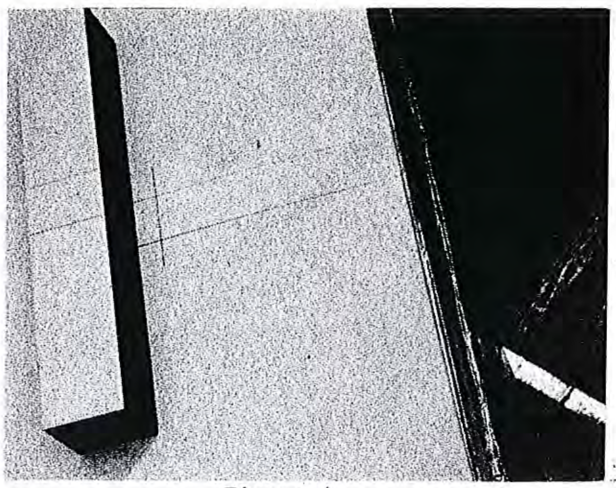

Figure 4

Shadow under troffer system with straight edge at an angle of 45° with the axis of the troffers.

PMV scale, as compared with a scale extending between absolute limits, are somewhat analogous to those of the Centigrade scale as compared with an absolute scale of temperature. Thus "zero visibility" on this scale is analogous to 0° of temperature on the Centigrade scale.

The PMV's of different systems for the "horizontal" board position are given in Table II. Visibility as influenced by various factors is discussed below.

Footcandles. From Table II it is evident that increases in a given type of illumination result in increased visibilities. This would be expected from the great amount of data which show that visual acuity (or the ability to see small detail) increases with increases in illumination to above 1,000 footcandles.[4,5]

Type of Lighting. It is evident that the visibilities provided by the indirect and troffer lighting systems are about equal for approximately equal footcandles. This is shown particularly by the data taken at the higher illuminations, at which levels the footcandles on the horizontal plane were more nearly equal.

From the pertinent data in Table II it appears that the Large-Area Directional Unit has quite an advantage. While for the ink lines most of the advantage came from the fact that the illumination was not diminished by shadows when the draftsmen worked at the board, for the pencil lines the directional form of illumination was decidedly more effective. It should be noted, of course,

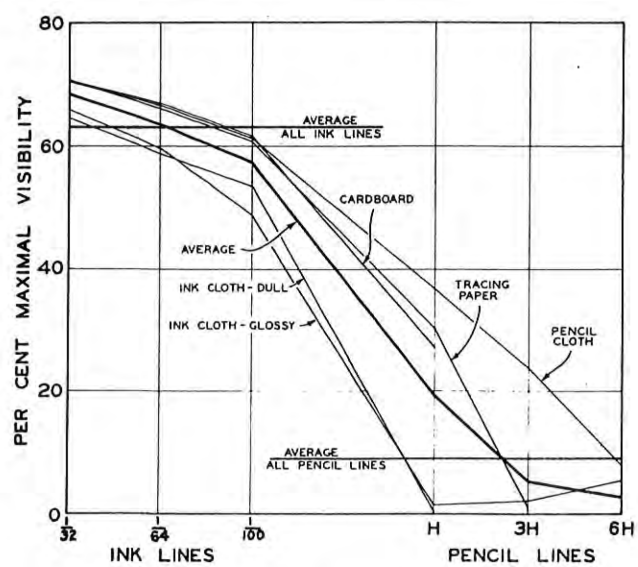

Figure 5

Percent Maximum Visibilities (PMV's) for all drawing material combinations - Data for all systems averaged.

4 - "Visual Perceptions Under Modern Conditions" - TRANSACTIONS of the Illuminating Engineering Society (London) January 1936 (Vol. I, No. 1) Page 3.

5 - "'C'-ing to See" - THE TECHNOLOGY REVIEW, February 1942 (Vol. 44, No. 4) Page 167.

that this exact kind of lighting would not be very practicable for a large drafting room, though it would be possible to incorporate the desirable directive feature in a general overhead system.

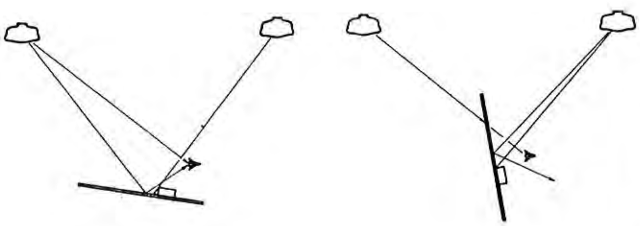

Figure 6A Figure 6B

Direct and reflected glare and shadows with board A-"horizontal"; B-"vertical".

The Industrial Diffusing Unit mounted over the board results in a considerable loss in visibility of the work, particularly for the pencil lines. It should be noted that it was observed that when the unit was located so that it was over the back, or lower edge, of the board, visibility of the work was improved but a very bad shadow condition resulted.

From the data on the two local lighting systems above discussed, it is evident that it is best to locate supplementary lighting units of the type studied to one side of the board in order to avoid reflected glare. In most cases this will result in reduced illumination on the board, a non-uniform distribution across the board, shadows, and a greater degree of direct glare. On the other hand, large-area diffusing units of really low brightness, such as shown in Fig. 2, have been found to work out in practice fairly well when mounted over the board.

Shadows. For "horizontal" boards the shadows cast by T-squares, for instance, were found to be less dense with the troffer system than with indirect lighting, but the annoyance of the shadows of "straight edges" under troffer lighting when the straight edges are parallel to the troffers (Fig. 3) is much greater. This annoying sharpness of shadow can be minimized by locating the lamp at an angle with the straight edge casting the shadow (or vice versa). Fig. 4. In this way it is possible to obtain a diffusion of the shadow comparable to the degree of diffusion obtained with indirect lighting.

In general, the desirable "feathering out" of the shadow edge begins to be noticeable when the axes of the straight edge and troffers reach of the order of a 15-degree divergence. Observation indicates that best overall results are obtained when the boards are rotated counter-clockwise with respect to the troffers, or the troffers clockwise with respect to the boards. The exact angle of rotation is not established; however, 45 degrees is often suggested for structural and aesthetic reasons. While this angle will result in shadows on the board from triangles, etc., at the 45-degree angle, this ordinarily represents but a small fraction of the draftsman's work.

Reflected Glare. Other data taken in this study illustrate the point that with fluorescent lighting systems which expose the work to the lamps, the higher the level of illumination the less troublesome are the specular reflections of the lamps. This is because the illumination is increased by adding more lamps, which does not increase the reflected brightness. This finding coincides with that made by other investigators.[6] Thus at 80 footcandles the reflected glare effect with the troffer system was much less than it was at 40 footcandles. There is reason to believe that below 30 footcandles this effect is definitely detrimental.

Drawing Media. As would be expected, the ink lines have considerably higher visibilities than the pencil lines (Fig. 5). Considering the ink line of approximately the same width as the pencil lines (the 1/100 inch width ink line), the PMV for the ink lines is some six times that for the pencil lines.

For pencil lines, the data show a considerable advantage of using the "H" pencil - except possibly where gray and/or glossy surfaces are employed.

Drawing Surfaces. The data in Table I show clearly that for ink lines visibility depends primarily upon the reflection factor of the drawing surface. However, for pencil lines visibility depends not only on the reflection factor of the drawing surface but upon its finish as well.

While it is apparent that care should be exercised in the selection of papers or cloths for use with ink, it is even more important that care be given to the choice of materials when pencil is to be used.

Horizontal vs. Vertical Position. Calculations based upon other data taken indicate

6 - "Comfortable Lighting" - ILLUMINATING ENGINEERING, December 1941 (Vol. XXXVI, No. 10) Page 1109.

that for the ink lines a footcandle on the "vertical" board was 10 to 20% more effective than a footcandle on the "horizontal" board. For the pencil lines the relative effectiveness of a footcandle on the "vertical" board was even greater, in this case of the order of 60% more effective for the troffer system and 25% more effective for the indirect system. As a matter of fact, in several instances individual pencil line visibilities were higher under a given system with the board "vertical" in spite of the much lower illumination on the board when it was in this position compared to that on it when it was in the "horizontal" position.

When consideration is given to other factors which influence seeing ease besides visibility, i.e., reflected glare and shadows (Figs. 6A and B), the superiority of the vertical position becomes quite evident. Furthermore, the vertical position has other advantages, such as greater visual comfort, by a more uniform surrounding brightness (board occupies most of visual field);[7] greater utilization of floor space (30 to 50% more boards in a given area);[8] and possible reduction in physical strain on draftsman through easier posture. Actually the first step toward the solution of the lighting and seeing problems in the drawing room is to adopt the vertical position.

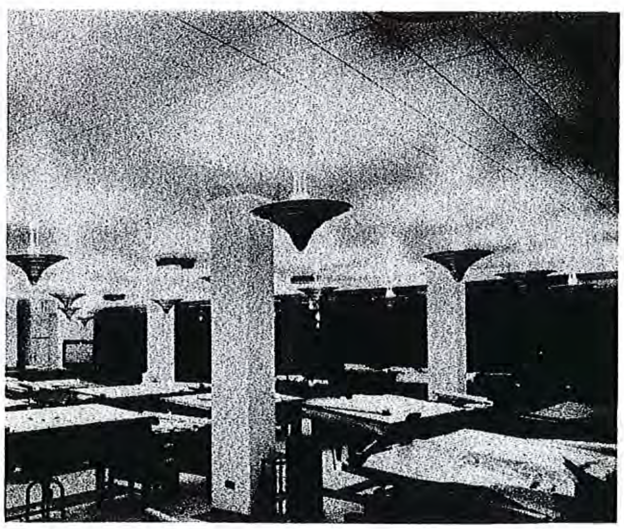

Figure 7

A conventional indirect system utilizing filament and mercury lamps in opaque-bowl indirect luminaires.

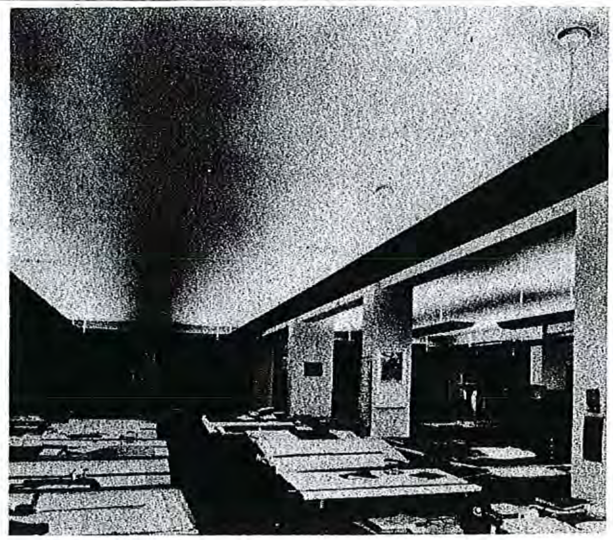

Figure 8

This drafting room is lighted with MAZDA F lamps in indirect equipment. Each trough accommodates two continuous rows of 100-watt white fluorescent lamps.

Tracing. One of the most difficult jobs which the draftsman is called upon to perform is that of tracing, particularly when the visibility of the original is low. The usual method of illuminating such work is by means of the regular overhead lighting, which might be referred to as surface illumination. The other method of lighting for tracing is to provide an illuminated surface which projects light through the original drawing. This method of lighting the work is known as trans-illumination.

The data in Table III indicate of the order of a 100% increase in PMV for the ink lines when "trans-illumination" is compared to

Table III. Trans-Illumination vs. Surface Illumination for Tracing.

System	Average PVM	Relative ft.-c required for Equal Visibility Factor*
Ink Lines - Average of 3 Widths.		
Transmitted Light	87%	100%
Incident Light	43	3000
Pencil Lines - Average of 3 Pencils.		
Transmitted Light	55%	100%
Incident Light	0	1500

*Based on Brightness Contrast Readings.

7 - "Brightness Contrasts in Seeing" - TRANSACTIONS of Illuminating Engineering Society, June 1939 (Vol. XXXIV, No. 6) Page 571.

8 - "Electrified Industry" May 1941.

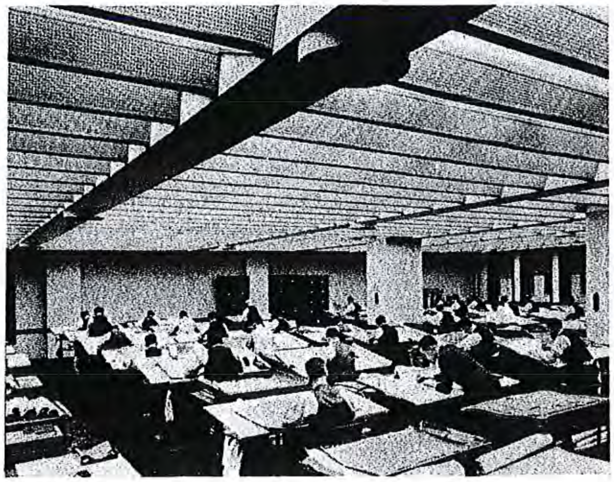

Figure 9

Continuous rows of fluorescent lamps on 2-foot centers in large-area semi-specular reflectors glazed with a lightly diffusing glass light this drafting room to better than 50 foot-candles.

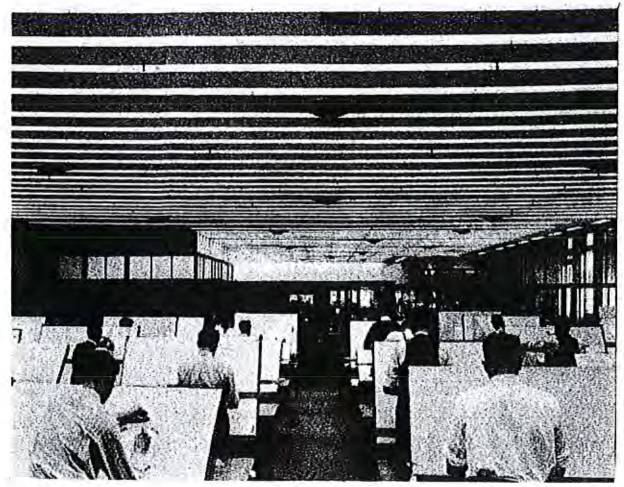

Figure 10

Continuous rows of open-bottom louvered white-finished troffers on 3-foot centers accommodating single rows of 40-watt MAZDA F lamps provide an illumination of about 65 foot-candles.

"surface illumination." For the pencil lines the improvement is even more note-worthy: from practically invisibility to over 50 PMV. An idea of the tremendous increase in foot-candles of surface illumination which would be required to obtain equal visibilities is also given in Table III. For the study, tracing paper was laid over pencil tracing cloth. Due to its somewhat higher transmission factor (Table I), if the ink tracing cloth had been used a higher order of visibilities would have been noted.

For many years the use of trans-illuminated tracing tables was made difficult by the necessity of using thumbtacks to hold the original and copying surfaces to the drawing table and by the problem of heat. The availability of easily removable adhesive tape now makes it possible to work on even the smallest drawing at any convenient location on the transmitting glass surface. The Mazda F lamp makes it possible to supply abundant light with relatively little heating.

It is quite feasible today to have large trans-illuminated tracing surfaces tilted to the vertical position, since use of the Mazda F lamp permits of more flexible construction. One drawback of the glazed trans-illuminated tracing table has been the fact that the weight of the draftsman leaning on the glass might break it. The vertical position would remove this hazard.

LIGHTING IN THE DRAWING ROOM

During the past few years there has been a considerable amount of field research on seeing as it is influenced by lighting.[9,10] In addition, to the technical reports of such data, the continuation of the "Better Light - Better Sight" movement and the activities on light-conditioning are bringing the researches to the attention of the public without undue delay. The cumulative effect of all of these factors has been to improve lighting practice both as regards quantity of light (footcandles) and quality of lighting (considering glare, distribution, diffusion, shadows, etc.). In 1936 the lighting recommendation for prolonged close work such as drafting was 30 to 50 footcandles. The recommendation today is for 50 footcandles or more. Researches previously mentioned indicate that for many common drafting room tasks 100 footcandles or more are really necessary for true seeing ease.[11]

Up until relatively recently the sources most commonly used for the lighting of drafting rooms, that is, the Mazda C (filament) lamps and the Mazda H (mercury) lamps, were concentrated light sources of high brightness. Since the most practical solution for the drafting room lighting problems has called for

9 - "A Summary of Researches Involving Blink Rate as a Criterion of Ease of Seeing" - ILLUMINATING ENGINEERING, 1940 (Vol. XXXV) Page 19.

10 - "Supra-Threshold Visibility" - JOURNAL of the Optical Society of America, 1940 (Vol. XXX) Page 62.

11 - "The Science of Seeing" - D. Van Nostrand Co., New York, N.Y., 1937.

large-area low-brightness general lighting systems, one of the most common methods used had been that employing conventional indirect luminaires in conjunction with a matte white ceiling, Fig. 7.

While as a rule the cost of the lighting is a relatively small sum when compared to the overall cost of operating the drafting room (considering labor and materials), objections have been raised to higher footcandles with conventional indirect lighting for other reasons. One of the reasons is the complex pscho-physiological reaction which causes us to brand an installation as <u>too hot</u>. While data[12,13] indicate that the actual heating effect of artificial lighting is not great, one can scarcely over-emphasize the importance of the psychological reaction. For instance, one has often experienced the sensation of heat in interiors lighted with artificial illuminants, (and may have burned fingers changing lamps), and therefore may expect artificial lighting to be warm. Heat is associated with the warm color of light from MAZDA C lamps, and naturally the more light and the larger the area of brightness, the hotter it seems.

Lighting practice has taken these factors into account in recent installations. For instance, beamed ceilings have been used to reduce the brightness of the ceiling in the normal field of view.

One of the advantages of the lighting provided by the Mazda H (mercury) lamps (Fig. 7) was that it was psychologically cooler.

One of the most interesting approaches toward overcoming the undesirable psychological sensation of heat from too high a brightness in the field of view has been the development of a metal ceiling with an aluminum-finished surface having ridges of a special contour which reflect the light rays in such a manner that a large percentage is directed downward, reflections near the horizontal being minimized.[14] As a result, the brightness of this ceiling, when viewed from a distance, appears much less than that of the usual matte white ceiling receiving the same light flux. Thus, for the same number of footcandles on the work plane the sensation of brightness is materially reduced; the color of the ceiling changes from the warm white obtained with a flat white ceiling to a neutral gray. The result is that the psychological reaction is decidedly on the cool side.

With the advent of the Mazda F (fluorescent) lamps, it was natural that they be applied in the drawing room in the same fashion which had proved so satisfactory with former sources, that is, in indirect luminaires. (Fig. 8) The fluorescent lamp, however, differs radically from the filament and mercury lamps in that instead of being concentrated and having a high brightness it is extended and has a relatively low brightness. For the majority of drawing room uses the brightness of the T-12* Mazda F lamps (such as the 40-watt size) is judged to be tolerable from the standpoint of reflected glare, particularly if footcandles are high enough (50 footcandles and up). At the same time, the brightness of the T-12 lamp is higher than one would care to tolerate in the normal line of vision in the drawing room. We find, therefore, that good lighting results can be obtained in the drawing room with the lamps employed in direct lighting equipment. These equipments permit the lamps to be "seen by the work," but protect the eye from the lamp brightness at normal viewing angles.

One such method of installing the lamps is to put them in continuous troughs with glass over the bottom (Fig. 9). Another way is to put them in open-bottom louvered contInous troughs, or troffers, as shown in Fig. 10.

One of the latest and most interesting developments in troffer lighting is the semi-parabolic troffer made of semi-diffuse aluminum or having an aluminum paint finish. So far the present emergency has limited the application of this form of troffer lighting, but it may be expected to enjoy considerable prominence when aluminum again becomes generally available for such purposes. The concentrating distribution of these parabolic aluminum-finished troffers offers possibilities for the illumination of "vertical" boards if the troffers are installed with their axes inclined toward the board.

In conclusion, it might be pointed out that there does not appear to be available today any type of lighting system which is not subject to some limitations. The following generalizations, however, may be made:

> For illuminations below 30 footcandles, indirect lighting is eminently satisfactory; between 30 and 50 footcandles with indirect lighting the brightnesses of large ceiling areas may become objectionable; in general, with large-area flat ceilings indirect lighting is uncomfortable above 50 footcandles. Of course, in small rooms indirect lighting of 50 footcandles or more may well be satisfactory from the brightness standpoint.
>
> On the other hand, direct lighting with fluorescent lamps is eminently satisfactory above 50 footcandles; between 30 and 50 footcandles it becomes less desirable; below 30 footcandles this type of lighting is definitely not recommended for the drawing room.

12 - "Effects of Artificial Lighting on Air-Conditioning" - American Society of Heating & Ventilating Engineers Transactions, 1938 (Vol. 44) Page 213.

13 - "Cooler Footcandles for Air-Conditioning" - HEATING, PIPING AND AIR-CONDITIONING, August 1940, Page 495.

14 - "Indirect Luminaires - Efficient and Inefficient" - TRANSACTIONS of Illuminating Engineering Society, March 1939 (Vol. XXXIV, No. 3) Page 261.

* - 1-1/2" diameter cross-section.

COMMENTS ON THE ACCELERATED SUMMER SESSIONS OF 1942

I. INTRODUCTION

by
The Editor

Due to the large and increasing demand for engineering and technical graduates to fill the needs of the war emergency, engineering schools and colleges were encouraged, last spring, to begin continuous, all year operation, thus enabling students to finish their normal four year course in about three years. Many schools started this continuous operation during the past summer. In securing the following group of short articles, it was your Editor's purpose to give some indication of the success of these summer sessions, particularly with respect to the entrance of new freshmen at this time.

It seemed that the stories of these summer sessions would make interesting and informative reading to many of our subscribers, both those who have already experienced an accelerated program, and those who are considering it for the coming summer. To those who have already had a summer of this work, these articles will probably be but a confirmation of their own experiences; to those who start their program with the coming summer, they" offer a preview of what may be expected.

Besides asking general information on this subject, three specific questions were asked pertaining particularly to the entering freshmen. First, how were these freshmen secured, and in what numbers, in view of the facts that (a) generally speaking, high school terms had not concluded when these sessions started, and (b) well paying jobs were largely available for many prospective freshman engineers who needed the summer's earnings to pay their way? Secondly, what quantity of work was done in freshman drawing courses, that is, were the regular drawing courses given, or were they abbreviated somewhat in time to suit the shortened session length? Third, what was the quality of work done, and how did it compare with the work of regular semester students?

A number of schools were contacted in various sections of the country, schools were the the Editor had knowledge of accelerated courses being given. The following replies were received.

II. UNIVERSITY OF MINNESOTA

by
C. A. HERRICK, CHMN.
Registration & Schedule Com.

Late in the spring in 1942 it was decided to introduce a program of accelerated courses in the College of Engineering and Architecture and the School of Chemistry in the Institute of Technology at the University of Minnesota.

These courses were in addition to the regular college three quarter system of courses which was at that time and at the present time given in the Institute of Technology.

The courses arranged permitted students who were in residence and registered in the aeronautical, civil, electrical, and mechanical engineering, chemistry, chemical engineering, and architecture to advance the time of graduation one to three quarters. The student in the last quarter of his junior year could finish his curriculum requirements at the end of the winter quarter 1943, one quarter earlier than usual; the sophomores at the end of the fall quarter 1943 and the freshmen at the end of the summer sessions, 1944 except the civil engineers who would not complete their work until the close of their camp in September.

No provision was made for a program of accelerated courses for entering freshmen in the College of Engineering. One was established in the school of Chemistry. Less than twenty-five freshmen applied for entrance.

It was felt that it was not advisable to introduce a freshman curriculum in the College of Engineering. There was a feeling that the Summer Sessions should be utilized as a period during which the entering freshman would make up any entrance deficiencies such as; high school higher algebra, solid geometry or Preparatory English. Unfortunately this information failed to reach, or impress upon the mind of the prospective student or his parents, the advantage of this arrangement.

We find we have 270 freshmen who are now enrolled in Solid Geometry, 150 in higher algebra and many in Preparatory English. All of these students will be unable to adjust their courses so that they could begin the accelerated program of courses at the beginning of their sophomore year.

The accelerated courses were conducted in

the Summer Session Division of the University. This division offers courses during two terms each summer of five and one-half weeks duration. The two terms corresponding in length to the usual quarter period of the college year.

Some courses in the accelerated program were programmed for one term and others were run thru the two terms. All courses, however, were given under similar conditions as to total hours and credits per college quarter for the same course. Therefore, no adjustment in course content or credits was found to be necessary.

In order to meet certain prerequisite requirements, to balance staff loads, and to avoid unnecessary repetition of certain courses some readjustment was made in the order in which courses appeared in the student's curriculum. This however, did not present any serious problems.

Total registration in the Institute of Technology approached 900.

A study of the students who registered in the aeronautical, civil, electrical, and mechanical engineering curriculum reveals that the largest numbers were seniors and juniors with the sophomores forming the smallest group.

Another fact observed was that about 40% of the students registered were not taking the complete accelerated course but were students who were making up courses which they had not completed at the time they were scheduled in their curriculum. Some of these will now be able to graduate at the end of the normal four year period.

The student magazine, The Minnesota Technolog, conducted a survey by questionnaire of the student opinion of the accelerated program.

Some of their findings may be of interest. They are as follows:

About 75% of those attending the summer session were in favor of the accelerated program.

30% of the sophomores, 35% of the juniors, and 45% of the seniors found it necessary to borrow money for the summer session. In this same group 47% of the juniors and over 60% of the seniors expect to find it necessary to borrow money this fall.

85% of the students who did not attend the summer session indicated lack of funds was the principle reason for not doing so. Only 25%, however, expressed regret for not attending.

As we pass thru the adjustment period we will no doubt find some rearrangements desirable. Starting out at three points to accelerate and at the same time running college courses "as usual" it will be several quarters before we will have this accelerated program running in the manner that would be desired.

III. A YEAR-ROUND ENGINEERING PROGRAM

Summer School Drawing at the University of Texas in 1942

by
C. E. ROWE
Professor of Drawing

The University of Texas has inaugurated an accelerated program in engineering in addition to the various war training courses offered. Acceleration is not quite on a compulsory basis, but Dean Woolrich of the College of Engineering made it clear to all students that he will not request deferment of any student who does not have junior standing and does not stay in school or do practical work during the summer. In other words, he has emphatically disapproved of summer vacations. A new order has been received from Washington stating that a student who has not attended Summer School shall not be granted a student federal loan.

In the past the University has been conducting two terms of Summer School of six weeks. Last summer there was also an Intersession of three weeks in which engineering and science courses were offered, thus inaugurating a year-round program. It will be possible for a student to complete the work for a four-year degree in about three years.

In former years freshman drawing and descriptive geometry were taught only in the first term of the Summer School. Each course is a three-semester-hour course and a student is required to work at least $4\frac{1}{2}$ hours a day five days a week. Last summer both these courses were given in both terms of Summer School and in the Intersession. Each course was given five times last year.

This was our first experience in giving three-semester-hours of work in three weeks. The students were scheduled eight hours a day, and there were two lectures a day. In one day a student did the equivalent of a week's work in the long session. Admittedly, the work was too much accelerated and a little short of that done in the long session. Very careful planning was necessary so as not to waste a single hour. The student who lost any time was "sunk". Although descriptive geometry is considered by all engineering students and engineers to be much more difficult than drawing, better results were achieved in the "descript" course. There were two reasons for this. First, the "direct method" was used, which enabled the class to get into the fundamentals much more rapidly than would have been possible by the Mongean method. Second, drawing being prerequisite, the students did not have to acquire manipulative skill. In the drawing course fairly satisfactory results were obtained with those students who entered with good high school drawing or previous training. There was not enough span of time to develop manual skill or a good understanding of the subject by those who started from "scratch."

Dean Woolrich made an effort to get the high school graduates to start work in June on their engineering degrees. This was only partially successful. There were 142 freshmen registered in June, and only 72 of these came directly from the high schools. This, however, was four times as many as in the previous year. For the entire summer the enrollment in drawing and descriptive geometry was three times as great as in previous years. It was expected that there would be a decrease in the number of students in the Department of Drawing this September, but 577 enrolled compared with 525 last September.

IV. IOWA STATE COLLEGE

by

O. A. OLSON

Professor of Engineering Drawing

For the past 28 years, Iowa State has offered freshman drawing courses in each of two six weeks terms that have been given during the summer. This summer (1942) in place of these six weeks courses, the regular quarter courses were offered. These regular term courses were made known to prospective students by means of letters to high school superintendents, student write-ups thruout the State, newspapers, letters to prospects, and radio announcements.

This resulted in a total of about 220 students taking freshman drawing courses. Of these, 160 new students, or seven sections, took first term engineering drawing; second and third term drawing were represented by one class each, with a few scattering students taking advanced drafting. As compared with a normal Fall quarter, this was about one fourth of the enrollment in the Fall quarter of 1941.

As regards quality of work, we found that the students we had during the summer were superior compared to the regular Fall quarter classes. They had come for a definite purpose, and did not do so much outside work. Nor did the weather affect the quality of work, since this last summer in Iowa happened to be fine for college work.

The regular instructional staff was employed for the summer quarter courses, and also were used for the E.S.M.D.T. courses which were conducted along with the regular courses. All courses ended about August 29th, giving the staff a brief vacation period up until Sept. 15th.

It is the present plan to continue this regular Summer Quarter term next year, and it may well become permanent. Do you not think that the twelve week quarter for summer courses will prove to be more popular than an eighteen week semester?

V. CASE SCHOOL OF APPLIED SCIENCE

by

C. W. COPPERSMITH

Professor of Engineering Drawing

So far, we have introduced an accelerated program only for the Senior class. The students, at the conclusion of their junior year, about June 1st, continued thru the summer, and will graduate at Christmas time. The summer term last year covered twelve weeks, divided into two six week periods. Half of the subjects were given during the first period, and the other half during the second. In this way, no instructor was required to teach more than six weeks during the summer.

For a good many years we have been admitting a small freshman class in January. The average size has been about 20 students. Last January, however, we admitted more than twice this number. These trailer students, as we call them, work straight thru the summer, and are ready to join the regular sophomore class in the Fall.

VI. CONCLUSION

by
The Editor

In summarizing the above data, three points stand out quite clearly. First, courses offered in the summer session, including engineering drawing courses, were practically identical with the corresponding courses of the regular sessions, so far as time allotment and course content were concerned.

Second, the length of session generally favored was twelve weeks. This was, perhaps, to be expected, since twelve weeks is about the maximum of the available time between Commencement and Fall opening. However, the point to be noted is that these sessions were not based upon the usual six or eight week summer school term, but planned to offer as nearly as it was possible to do so, a full term or semester of work. For those schools operating on the quarter system, a full quarter's work was possible; those on the semester system could offer only about 2/3 to 3/4 of a semester's work, the remainder to be completed otherwise.

Third, under conditions as they existed at the beginning of the summer, it was too much to expect that the enrollment would be the equivalent of a normal term or semester. As the data shows, this was particularly true of freshman enrollment, where time of termination of high school work, and availability of summer jobs precluded expectation of very great numbers. Moreover, there was at that time, small inducement for the freshman to plunge into his collegiate work at once, and much encouragement to take a last, and profitable, vacation from academic work. Many colleges recognized that fact, and did not attempt to provide special freshman work for the summer session.

However, under the presently proposed drafting of 18 and 19 year olds, conditions existing at the beginning of last summer may change radically. If draft deferrment, or enlistment in army or navy reserves with leave to finish their college work, is allowed this group, provided they show sufficient ability to succeed in engineering, a very considerable increase in freshman enrollment might be expected in the sessions of the coming summer, and should be provided for at that time. Furthermore, the next logical step to provide and maintain an adequate and continuing supply of technically trained men would seem to be for the government, thru the Army and Navy, to pay those men qualified for an engineering education during their attendance at college. This step would in itself demand, it would seem, the year round operation of our engineering schools, and the consequent enrollment of the great majority of our freshmen at the summer session rather than in the Fall.

(Continued from Page 12)

departments of drawing with any considerable number of students will need some form of student personnel record. Certainly our primary task is that of training in the understanding and use of the "language of the Engineer". But it is also vital that the department be able to refer to a detailed record of a student's accomplishment in drafting training. In colleges where enrollment in drawing courses is large and classes are sectionized, it is also essential to have a departmental record system to facilitate transfers, additions, withdrawals and other matters pertaining to enrollment. This might well be made the basis for the entire personnel record.

I cannot recall having read in this Journal nor in the Journal of Engineering Education, nor having heard in the S.P.E.E. meetings any discussions of this matter. It seems to me that an exchange of ideas concerning it would be profitable. At the A and M College of Texas a 3"x5" index card file is kept, with the data indicated as follows for every student enrolled in all courses taught by the department:

Name ________ Course ____ Section ____ Instructor ____

Years High School Drawing____ Teacher________

School____________ Location____________

Years Commercial Drafting____ Type____________

Firm____________ Location____________

These cards are usually filled out by the student at the first meeting of the class, then checked against the Registrar's class cards to insure correct course and section numbers. Then cards of all students from all courses are thrown together in alphabetical order. This is to provide a quick means of locating the section and instructor of any student currently enrolled in any course of drawing. It also gives each instructor some idea of the background in training or experience of the students in his classes. If a student is transferred to another section or withdrawn during the term, a notation to this effect is written on the card with the date and withdrawal grade if any, the card being retained in its alphabetical order in the file for quick future reference. One member of the department makes all changes of this nature in the department record and notifies the instructors of changes involving their respective students. A secretary might perform this task.

An adequate personnel record would necessitate adding to this card such information as grades upon completion of the course, and instructor's comments on quality of drafting work, personal characteristics, and similar items. If sufficient filing space were available, it would be enlightening to file a sample of the student's work, but with such large numbers as we have at our college, this would be impracticable. We file these cards away at the end of each semester, keeping an accumulative file by semesters. It would be desirable to merge all into one master file, adding the cards from each semester as it is concluded.

GUIDE LINES

Due to lack of space (and also a rather small amount of material suitable for it) we are, in this issue, combining the "Projections" column with this one. Next issue, we shall be back with it, full, we hope, of news and views of the 'profession'. We therefore particularly urge you, in returning your subscription renewals which will soon be due, to send back with them all the interesting and pertinent news which has accrued in your vicinity. These notes have furnished us with many interesting items in the past, and with attendance at various S.P.E.E. meetings considerably curtailed in the near future, this will be almost the only means of getting this information. We ask you to be liberal with your comments.

This seems to be a banner year for the engineering schools. Increases in freshman enrollment are general and heavy. To quote a few in different sections of the country, Tufts College in Massachusetts has an increase of 25%; the University of Texas about 10% in spite of a summer entering class of over 100; University of Wisconsin an increase of 32%; Iowa State at Ames, expecting 800, got 1140 new freshmen, and was forced to resort to night classes; and so it goes. Increases were to be expected, due to the leading part engineers are taking in the war effort, both civil and military. They are none the less gratifying, even tho at times inconvenient, for they indicate the public regard for the engineering profession in times of crisis. But the real test of this increase will come when the semester or term grades are in. Then we shall be able to separate the wheat from the chaff, and tell to what degree this large quantity also includes the quality of students necessary for engineering.

Some time ago, this column requested certain back numbers of the Journal to enable us to make up two complete volumes covering the entire life of the magazine. A number of the needed issues were forthcoming, but to complete the file we still need the following copies:

Two copies - Vol. 1 No. 1 December, 1936.
One copy - Vol. 1 No. 3 October, 1937.

We would appreciate it if some of our subscribers would offer some of their back copies for this purpose.

FLUORESCENT LIGHTING INSTALLATION IN A COLLEGE DRAFTING ROOM

Prof. Geo. J. Hood
University of Kansas

The photograph, Fig. 2., shows a few of the twenty-nine desks in the drafting room. The curtains have been drawn, and the light comes mainly from the fluorescent tubes, although some light comes from a small skylight. The absence of shadows, characteristic of fluorescent lighting, is noticeable.

The accompanying drawing Fig. 1 shows the arrangement of the desks and lights. In the drawing, three numbers are shown on each desk, for example: 12-18-70. These figures indicate the foot-candles at that desk. All were measured on cloudy days. The first figure gives the foot-candles with lights off. The second figure shows the light received from the former lighting system of nine 200 watt incandescent lamps. The third figure shows the footcandles provided by the nineteen fluorescent units. A skylight near one corner of the room, indicated by broken lines, increases the light on some of the desks.

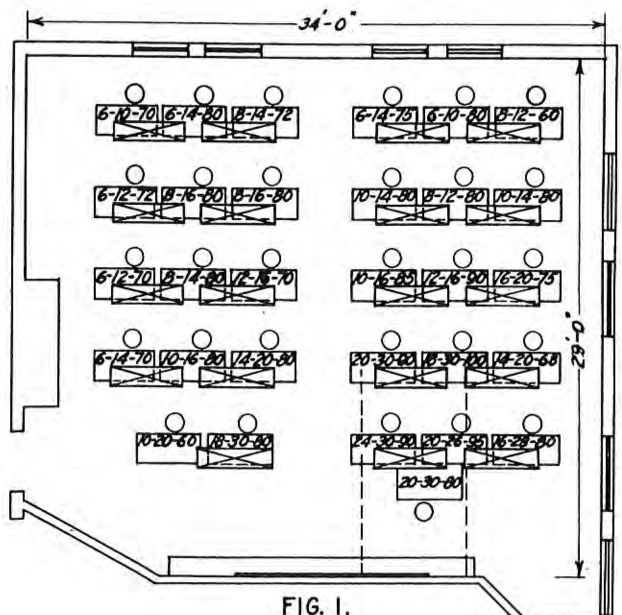

FIG. I.

Each fluorescent unit consists of two 48" daylight tubes under a porcelain-enameled reflector, 48" above the desk tops. The two tubes operate at approximately 90°, so that flicker caused by cyclic variations of the current is reduced to a minimum. Each tube is rated at 40 watts, and the two tubes and the necessary ballast apparatus use 100 watts. The efficiency is about 79%, and the overall power factor is rated as 95%.

This drafting room now uses approximately

1900 watts, as against 1800 watts used by the former installation. The gain is all in better working conditions. For drafting work, 35 to 50 footcandles is generally recommended. This new installation is brighter than it needs to be. Possibly it could to advantage be somewhat reduced. The total cost of the installation was nearly $500 for one room. Definite costs of maintenance are not available. The life of the tubes is shorter than we should expect. The servicing department of the university reports that the life of the fluorescent tubes is slightly shorter than the life of incandescent lamps.

Attention is called to the desks and stools shown in the photograph. Formerly the desk tops were 30" by 30". This was a most inconvenient size. When a drafting board was placed on the desk, the margin outside the board was too narrow for holding any book or equipment. Students constantly were pushing equipment on to the floor, and the instructor had to lean far over the desk to inspect the drawings.

Fig. 2

The new desk tops are 22" by 46", with an area fenced off at the right end for holding all equipment and books. The student sits to the left of the center of the desk top. The narrow top also is quite an advantage to the instructor, who, from his position behind the desk and facing the student, has a more comfortable and better view than he could have when the desk tops were wider. The students now sit farther apart, and are less crowded. The aisles are roomier, even though the new tops have a slightly larger area than did the old square tops.

The stools have been especially designed to fit the leg of the desk. The cast iron arm is hinged to the desk leg, and has leather-faced stops to limit the swing. The stools can be screwed up and down to suit the comfort of the individual. The floor is clear of stools. Formerly, the pipe foot rest was much smaller. The larger pipe is more comfortable to the feet, and with the change to a larger tie rod through the pipe the desk is much steadier.

REPORT OF THE BIBLIOGRAPHY COMMITTEE

Prof. H. H. Fenwick, Chairman
(For the period March 1 to October 1, 1942)

NEW AND REVISED BOOKS, ETC.

American Technical Society-Drafting for Machine trades-5 vol. $19.80 Chicago. '41.

Blackhurst J.H.- Thinking through geometry.- a guide to rigorous reasoning.2 books 250 p. Blackhurst Book Sales 1066 U.P. Station Des Moines .Ia. '42

Brodie H.J.- Engineering Drawing and Mechanism 241 p. Harper '42.

Bush, G. F. - Reading Engineering Drawings - 60 p. and supplement - John Wiley & Sons, '42

Dick A. A. - Blue print Reading; a visualized method of instruction. 157 p.-$2.40 Ronald Press '42.

Frylund V.C. & Kepler F.R. - General Drafting 160 p. bibliog. $150 Grossett & Dunlap. New York '42

Giachino J.W.- Aircraft sheet metal work Pt.II (Blueprint form work book) 59 p.-96¢ Manual Arts Press. '42.

Heine G.M. & Dunlop C.H. - How to read electrical blueprints. 318 p. $3. Am. Tech. Soc. Chicago '42.

Hesse, H. C. - A Manual in Engineering Drawing, Preliminary Edition. 118 p. with added problems - $1.50 - The Macmillan Co. '42.

Lincoln Elec. Co- Simple Blueprint reading with particular reference to welding and welding symbols. 2d. Ed. 146 p. Cleveland. '41

Owens A.A. & Slingluff B.F.- How to read blue prints; manual & key- 64 p. $1. John C. Winston Co. Philadelphia- '42.

MAGAZINE ARTICLES, ETC.

American Water works Assn- Graphical symbols for use on Drawings. J: 34; 313- 27 Feb. '42

Automotive & Aviation Ind. - Robot draftsman at work in the Martin bomber plants. Photographic reproduction of engineering drawings. il. Automotive & Aviation ind. 86;24-6 March '42.

Colby V.V.- Adding third dimensions to aerial photos. il. diags. Eng. N. -128;426-8 March 12, '42.

Compressed Air- Mass Production of Templates by photography. Comp. Air. M,47; 6820 Aug. '42.

Darley W.G. & Ickis L.S. - Lighting and seeing in the drafting room. bibliog. il. diags. Illumination Eng. 36; 1462-87 Dec. '41.

Due to lack of space, the remainder of this report will be completed in the February issue.