1972

# A Comparative Analysis of the Mechanical Engineering Technology Curriculum as Offered in the Community Colleges of Illinois

Richard William Koppitz
*Eastern Illinois University*

PAPER CERTIFICATE #2

TO: Graduate Degree Candidates who have written formal theses.

SUBJECT: Permission to reproduce theses.

The University Library is receiving a number of requests from other institutions asking permission to reproduce dissertations for inclusion in their library holdings. Although no copyright laws are involved, we feel that professional courtesy demands that permission be obtained from the author before we allow theses to be copied.

Please sign one of the following statements.

Booth Library of Eastern Illinois University has my permission to lend my thesis to a reputable college or university for the purpose of copying it for inclusion in that institution's library or research holdings.

______________________ ______________________

Date Author

I respectfully request Booth Library of Eastern Illinois University not allow my thesis be reproduced because OF POSSIBLE PLAGIARISM.

______________________

5-19-72

Date

A COMPARATIVE ANALYSIS OF THE MECHANICAL ENGINEERING TECHNOLOGY CURRICULUM

AS OFFERED IN THE COMMUNITY COLLEGES OF ILLINOIS

(TITLE)

BY

Richard William Koppitz

# THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF

Master of Science in Education

IN THE GRADUATE SCHOOL, EASTERN ILLINOIS UNIVERSITY
CHARLESTON, ILLINOIS

1972
YEAR

I HEREBY RECOMMEND THIS THESIS BE ACCEPTED AS FULFILLING
THIS PART OF THE GRADUATE DEGREE CITED ABOVE

5,19,72
DATE

5-17.72
DATE

ACKNOWLEDGEMENTS

Appreciation is due to the many people whose assistance and cooperation made this study possible.

Special appreciation goes to Dr. C. E. Strandberg, thesis advisor; and Dr. R. B. Sonderman, department head; for their advice and guidance during the progress of this study.

Further acknowledgement is due Dr. C. A. Elliott, Dr. C. H. Erwin and Dr. P. L. Ward for their assistance in the preparation of this manuscript.

Recognition is given to the numerous educational respondents for assisting with this study.

Very special gratitude is expressed to my wife, Christine, for her encouragement and assistance.

TABLE OF CONTENTS

LIST OF TABLES

# CHAPTER I

## INTRODUCTION TO THE STUDY

### Statement of the Problem

The engineering technician is assuming an ever increasing role in todays' technologically oriented society. This scientific and technological emphasis is creating countless career opportunities for the properly trained technician. The annual average of technician requirements for the period 1963-1975 is put at 86,000, of whom 54,000 are needed to fill new positions, 10,000 to replace deaths and retirements and 22,000 to make up for transfer losses.[1] The United States Office of Education also expresses this point of view:

> The demand for people with technical skills is growing twice as fast as for any other group... There aren't enough applicants to fill technical jobs now. Yet, the United States government estimates well over 1,000,000 more will open by 1975.[2]

As with most states, the state of Illinois contains a large number of diversified industries. These industries require large numbers of trained technicians. In 1967, only two engineering technicians were graduated for every five engineers, while the United States needs two or three engineering technicians for each design

---

[1]Clifford H. Doolittle, Trends in Engineering Technician Enrollments and Graduates (New York, New York: Engineering Manpower Commission of Engineers' Joint Council, 1967), p. 27.

[2]United States Office of Education, 25 Technical Careers You Can Learn in 2 Years or Less (Washington: United States Government Printing Office, n.d.).

engineer.[1] These technicians can receive their academic education by attending a public technical institute, a private technical institute, or a community college. The community college today plays an important role in technician education, and its importance in this field is increasing.[2] How the community colleges of Illinois educate engineering technicians, in the field of mechanical engineering technology, is the focus of this study.

## Purpose of the Study

The purpose of the study will be to ascertain:

1. What similarities and differences exist among schools regarding required drafting courses (i. e., technical illustration, tool and die drafting, etc.) and required technically related courses (i. e., manufacturing processes, pneumatics and hydraulics, etc.).

2. What duties the mechanical engineering technician is expected to perform, as illustrated by the schools' emphasis of particular technical areas.

## Significance of the Study

Results of this study may prove significant to:

1. Community colleges engaged in upgrading their program.

---

[1]American Society for Engineering Education, The Engineering Technician (Washington: American Society for Engineering Education, 1970).

[2]Walter J. Brooking, ed., Career Opportunities - Engineering Technicians (Chicago, Illinois: J. G. Ferguson Publishing Company, n.d.).

2. Members of state and local organizations who are concerned with the organization and administration of engineering technology programs.

3. Prospective engineering technology teachers now receiving their education.

4. Instructors and counselors in secondary schools offering vocational mechanical drafting.

5. Private commercial companies engaged in upgrading or instituting educational programs.

6. Parents and students interested in receiving information concerning engineering technology programs.

## Hypotheses

1. Required drafting courses will not differ significantly, from school to school, regarding basic cognitive and manipulative areas (i. e., geometric construction, production dimensioning, etc.).

2. Required drafting courses will differ significantly, from school to school, regarding the degree of emphasis placed upon each specialized area of drafting (i. e., technical illustration, descriptive geometry, etc.).

3. Required technically related courses will differ significantly, from school to school (i. e., manufacturing processes, strength of materials, etc.).

## Limitations

The study was controlled by the extent to which the actual responses of the educational institutions could be successfully measured through the use of the information form.

The study was limited to:

1. Public-supported community colleges, in the state of Illinois, offering an associate degree program in mechanical engineering technology.

2. The two year terminal program and not the pre-engineering program. The role of the technician, and not the engineer, is the focus of this study.

3. The areas of mechanical drafting and technically related courses. Not included are the architectural, chemical, civil, electrical and structural areas of engineering technology.

## Definitions of Terms

The following definitions refer to this study only:

Engineering Technology: That part of the technological field which requires the application of scientific and engineering knowledge and methods combined with technical skills in support of engineering activities; it lies in the area between the craftsman and the engineer in the part closest to the engineer.[1]

---

[1]American Society for Engineering Education, The Engineering Technician (Washington: American Society for Engineering Education, 1970), p. 1.

Mechanical Engineering Technology: Concerns the generation, transmission and utilization of mechanical energy and the design, manufacture, testing, operation and maintenance of all kinds of mechanical equipment, devices and tools.[1]

Engineering Technician: One whose education and experience qualify him to work in the field of engineering technology.[2]

Mechanical Drafting: A systematical, graphical representation and dimensional specification of the design, production and use of products or systems produced by machines and tools.

Community College: A fully accredited two year state education institution, offering both college preparatory and vocational-technical programs.

Terminal Program: A program in which the student is to have concluded his academic education upon graduation, with the possible exception of refresher type courses.

---

[1]Walter J. Brooking, ed., Career Opportunities - Engineering Technicians (Chicago, Illinois: J. G. Ferguson Publishing Company, n.d.), p. 209.

[2]American Society for Engineering Education, The Engineering Technician (Washington: American Society for Engineering Education, 1970), p.1.

# CHAPTER II

## REVIEW OF LITERATURE

There have been a number studies conducted in the field of graphics, but only a few have dealt with the mechanical technology program. In reviewing the literature, certain segments relating to this problem were noted.

The Curriculum Materials Laboratory at Mississippi State University published a guide in developing a mechanical technology program. Their curricular analysis concluded, relative to this study:

1. The training of the technician is not of a limited or single skill type. Rather, his training should equip him with basic qualifications and the ability to accept broad responsibilities that will prepare him for entry into multiple employment areas within a field.[1]

2. For the graduate technician, therefore, specialization and specific job information come through experience, a company training program, or the pursuit of higher education.[2]

3. Experience has shown that technical and supporting courses must be initiated immediately to successfully complete training in the allotted time. Inasmuch as technical and supporting courses comprise approximately two thirds of the total semester hours, they cannot be postponed until the second year or even the second semester.[3]

---

[1] A Guide For Use in Developing Training Programs in Mechanical Technology (State College, Mississippi: State Department of Vocational Education, 1966), p.2.

[2] Ibid., p. 4.

[3] Ibid.

Table I indicates a proposed curriculum suggested by the Curriculum Materials Laboratory at Mississippi State University.[1]

TABLE I

PROPOSED MECHANICAL TECHNOLOGY CURRICULUM

| First Semester | Semester Hours | Third Semester | Semester Hours |
|---|---|---|---|
| Manufacturing Processes I | 4 | Hydraulics & Pneumatics | 3 |
| Materials of Industry | 3 | Metallurgy | 3 |
| Mechanical Drafting I | 3 | Inspection Techniques | 2 |
| Social Science (Economics) | 3 | Physics II (Heat, Light & Sound) | 3 |
| Technical Math I (Algebra) | 3 | Technical Math III (An. Geometry & Calculus) | 3 |
| English (Composition) | 3 | Industrial Organizations & Institutions | 3 |
| | 19 | | 17 |
| **Second Semester** | | **Fourth Semester** | |
| Manufacturing Processes II | 4 | Strength of Materials | 3 |
| Mechanical Drafting II and Tool Design | 3 | Motion & Time Study | 3 |
| Physics I (Properties of Matter & Mechanics) | 3 | Production Planning and Problems | 4 |
| Technical Math II (Trigonometry) | 3 | Physics III (Electricity & Magnetism) | 3 |
| English (Technical Writing) | 2 | English (Speech) | 2 |
| Social Science (History) | 3 | Industrial Psychology | 3 |
| | 18 | | 18 |

Another proposed curricular outline was put forth by the Engineering and Technology Advisory Committee of the College of Engineering, at the University of Illinois. Table II illustrates the suggested curriculum.[2]

---

[1] Developing Training Programs, p. 15.

[2] Engineering and Technology Advisory Committee of the College of Engineering, at the University of Illinois, Machine Design Technology - A Suggested Two-Year Post-High School Program, Engineering Technology Series, No. 4 (Urbana, Illinois, 1968).

TABLE II

SUGGESTED TWO-YEAR MACHINE DESIGN TECHNOLOGY CURRICULUM

| First Quarter | Quarter Hours | Fourth Quarter | Quarter Hours |
|---|---|---|---|
| Mathematics I | 5 | Technical Physics III | 4 |
| Manufacturing Processes I | 3 | Strength of Materials | 4 |
| Materials of Industry | 4 | Metallurgy and Heat Treatment | 4 |
| Technical Graphics I | 3 | Technical Report Writing | 3 |
| Communications I | 3 | Economics of Industry | 3 |
| Orientation | 0 | Seminar | 0 |
| | 18 | | 18 |
| **Second Quarter** | | **Fifth Quarter** | |
| Mathematics II | 5 | Machine Design I | 5 |
| Technical Physics I | 4 | Control systems | 4 |
| Manufacturing Processes II | 3 | Industrial Organization and Operation | 3 |
| Technical Graphics II | 3 | American Government | 3 |
| Communications II | 3 | Technical Elective* | 3 |
| | 18 | Seminar | 0 |
| | | | 18 |
| **Third Quarter** | | **Sixth Quarter** | |
| Mathematics III | 5 | Machine Design II | 4 |
| Technical Physics II | 4 | Design Projects | 5 |
| Applied Mechanics | 3 | Psychology and Human Relations | 3 |
| Mechanisims | 4 | Technical Electives* | 3 |
| Computer Programing | 2 | Seminar | 0 |
| | 18 | Non-Technical Elective | 3 |
| | | | 18 |

*The technical electives should be courses in some area of specialization related to this program and relevant to the local needs.

Typical Technical Electives

| | |
|---|---|
| Tool Design | Technical Graphics III |
| Digital Computer Principles | Statistics |
| Electrical Machines | Experimental Methods for Determining Stress |
| Instrumentation | |

Note: Suggested classroom and laboratory contact hours were omitted from the table.

Dobrovolny cites the transformation from the earlier drafting programs to the present machine design program:

> In too many cases, the drafting program of 20 years ago has had the name changed to drafting technology or drafting-design technology without changing the program at all.
>
> Today the need hardly exists for a person trained as a draftsman was trained 20 years ago. There are many reasons for this, one being the tremendous advances in our technology that now require every member of the engineering manpower team to have greater cognitive skills in order to do his job.
>
> The pure drafting job, where an individual either traces drawings or copies drawings of others, does not exist due to the sheer economics of the industrial cost structure.[1]

Dobrovolny then advocates what the program of today must include:

> For the engineering technician to function properly . . . he must have the necessary cognitive skills to be able to be a designer. To be a designer he must be familiar with the materials of industry, manufacturing processes, communication skills, technical graphics, applied mechanics (statics, dynamics and strength of materials), mechanisms, metallurgy and heat treatment, economics of industry, computer programing, machine design and the design process.[2]

Physical structuring of the program, Dobrovolny believes, is also a significant consideration:

> In structuring a machine design technology curriculum, it becomes more and more apparent that a six-quarter curriculum is much more effective in producing the engineering technician than a four-semester program. It is much easier to break up the topics into meaningful pieces so as to provide the necessary sequencing for prerequisites as well as for horizontal and vertical articulation.[3]

---

[1]Jerry S. Dobrovolny, Drafting Technology Versus Machine Design Technology, Technical Education, November, 1969, p. 11.

[2]*Ibid.*, p. 23.

[3]*Ibid.*

An analysis of various technical programs concluded the following common characteristics:

1. The program is directed toward the development of technical skills in specific fields of technology.
2. The program is aimed at preparing the student for employment immediately upon completing the training.
3. The curriculums are based on accurate and up-to-date analyses of the needs of the occupations in which graduates may expect to find jobs. They attempt to prepare the student for entry into any one of a group or cluster of closely related technician occupations. This gives the graduate some leeway in finding the job that suits him best.
4. The curriculums include both basic and applied mathematics and science, and basic and applied technology. Some of the applied technology is placed in the early part of the curriculum to provide greater interest for the student.
5. The curriculums provide for developing the manipulative skills a technician needs in handling tools and machines.
6. The instruction emphasizes laboratory experience to teach scientific and technological principles by applying them to typical technical tasks.
7. The mathematics and science in the program are tied in with the technical instruction.
8. Curriculums generally include instruction in oral and written communication pertinent to the field, and frequently provide courses in basic economics, industrial relations and other general education subjects.
9. The programs are rigorous and require students with a high enough level of ability to handle mathematics, science and technology on a college level perhaps slightly below that of engineering curriculums.[1]

An evaluation of how technician and engineering curriculums differ is reviewed:

> The first two years of the engineering curriculum are made up largely of mathematics and science courses, with relatively little application of technology to the special field.

---

[1]Brooking, Career Opportunities - Engineering Technicians, p. 46.

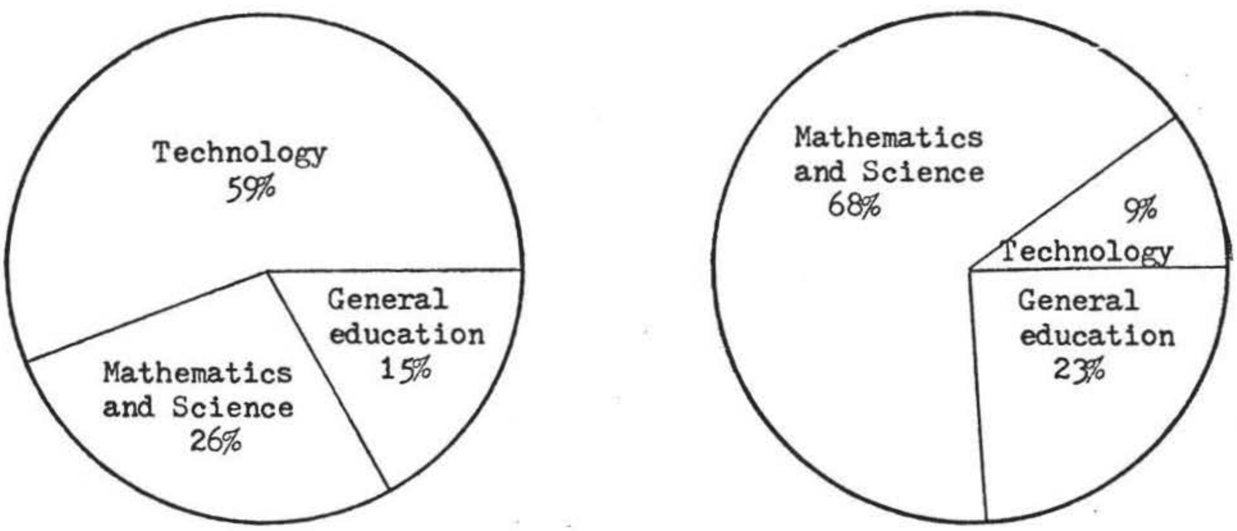
In contrast the technical institute type curriculum provides less science and mathematics, and applies these subjects to the technology. It also includes some applied technology in the first term, with increasing amounts in the later terms.

. . . Although most technical institute type curriculums in a given field, mechanical technology for example, include much the same course content, they differ from one institution to another. The titles of courses vary greatly, the amount of basic mathematics and science may be different, and there is considerable variation in the course offerings in general education.[1]

Table III graphically differentiates curriculums.

TABLE III

HOW TECHNICIAN AND ENGINEERING CURRICULUMS DIFFER




Mechanical technology

Transfer curriculum in Mechanical Engineering (First two years)

Source: Brooking, Career Opportunities - Engineering Technicians, p. 46.

[1]Ibid.

Dreyer made several conclusions based on the findings of his research, several of which relate to this study. Relative to an engineering curriculum:

1. Objectives of spatial visualization, conventional practices, and orthographic projection ranked higher than the objectives of graphical solutions and computations, drawing techniques, and creativity.

2. Development of drafting skills was not rated as being of primary importance, but was indicated as being worthy of limited to moderate emphasis. The only skill that received a high ranking was freehand sketching.

3. A balanced program of engineering graphics for mechanical engineers should provide experiences in the areas of descriptive geometry, technical drawing, and graphical mathematics.

4. A minimum acceptable program should include the following items of content: Orthographic projection; auxiliary views; point, line and plane relationships; intersections of surfaces; revolution; freehand sketching; sectional views; working drawings; applied geometry; lettering isometric drawing; charts and graphs; graphical calculus; and vectors.[1]

The study was conducted in 1959. Areas covered in the study are now included in the mechanical engineering technology programs offered at most community colleges. An illustration of the technicians' changing duties, continuously encompassing additional activities originally assigned only to the graduate engineer.

---

[1]S. F. Dreyer, "Engineering Graphics Courses From the Viewpoint of Mechanical Engineering Educators" (unpublished Doctor's dissertation, University of Oklahoma, Norman, 1959).

# C H A P T E R  I I I

## PROCEDURE OF THE STUDY

The physical scope of this investigation prohibited personal contact with each respondent. Information forms were devised to secure data for this study. Data received from the respondents served as the basis for this research. The accuracy of this study was directly ascertained from the information form responses.

### Preparation and Validation of the Instrument

An analysis of the areas of mechanical drafting and technically related courses was made. Current school catalogs of those participating community colleges were reviewed to provide a preliminary concept of the topics emphasized in the technical program. Current school textbooks, both of a general and highly technical nature, were also used in the preparation of the instrument. The instrument was arranged into two major sections: 1) drafting areas; 2) technically related areas. Validation of the information form was performed by graphics professors Dr. C. Elliott and Dr. C. Erwin of Eastern Illinois University. Their comments guided final completion of the information form.

## Selection of Respondents

The Illinois Department of Vocational Education supplied the name and addresses of community colleges in Illinois, which complied with the studys' limitations. Because of the limited number of possible participating respondents (resulting in decreased credibility of the potetial conclusions drawn) no additional limitations were applied. Factors such as school enrollment and the number of years the program had been in existance were not taken into account. A total number of forty schools were eligible. All were contacted for possible inclusion in the study.

Each school was contacted by letter explaining the purpose of the study. The schools were requested to complete the enclosed information form indicating what emphasis specific areas received at their sch ool. As an added incentive toward participation, it was noted that only participati ng institutions would receive the results of the study.

## Collection of Data from Community Colleges

An information form was sent to each of the forty schools resulting in a return of twenty-one, or fifty-two per cent, of the information forms. Fourteen days after sending the initial letter and information form, a second information form was sent to each of the nineteen schools not responding. Four of the nineteen, or twenty-one per cent, returned forms. Fifteen of the nineteen, or seventy-nine per cent, did not respond.

Twenty-five of forty schools, sixty-two per cent, responded to both letters explaining the problem and requesting their assistance. Fifteen of the forty schools, thirty-eight per cent, did not respond to the letters. All schools responding complied with the limitations of the study.

## Treatment of Data Received

The data used in this study were obtained from twenty-five community colleges in Illinois offering a two-year degree program in mechanical engineering technology. Those responses indicated on the information form which were unusable were recorded as "no answer" during the collection of the data. The remaining usuable portions of the form were recorded. Responses were collected, tabulated and converted into percentages. Since a total of twenty-five schools responded, each school converted to a four per cent rating.

# CHAPTER IV

## DATA RECEIVED FROM INFORMATION FORMS

### Curriculum Title

Terms listed in the respondents' curriculum titles are listed below in Table IV, with the respective percentages of use.

TABLE IV

| TERMS | PER CENT |
|---|---|
| Technology | 60 |
| Design | 44 |
| Mechanical | 40 |
| Drafting | 24 |
| Machine | 16 |
| Engineering | 8 |
| Technician | 4 |
| Occupations | 4 |

### Curricular Participation by Industry

Curricular participation by industry was indicated by eighty-four per cent of the respondents. Table V indicates the frequency of these consultations.

TABLE V

| FREQUENCY | PER CENT |
|---|---|
| Two months | 4 |
| Three months | 12 |
| Four months | 4 |
| Six months | 32 |
| Twelve months | 24 |
| Never | 16 |
| Did not answer | 8 |

## Industrial Internship

Thirty-six per cent of the respondents maintained an industrial internship program. Table VI lists the range of semester hours credit awarded for such internship.

TABLE VI

| SEMESTER HOURS | PER CENT |
|---|---|
| 3 | 8 |
| 4 | 4 |
| 6 | 8 |
| 8 | 12 |
| 9 | 4 |

## Drafting Credit

Listed below in Table VII are the number of drafting courses required and the percentage of respondents requiring these courses..

TABLE VII

| COURSES | PER CENT |
|---|---|
| 0 | 8 |
| 2 | 24 |
| 3 | 16 |
| 4 | 24 |
| 5 | 4 |
| 6 | 8 |
| 7 | 12 |
| 8 | 8 |

Credit awarded for these drafting courses are listed in Table VIII.

TABLE VII

| SEMESTER HOURS | PER CENT |
|---|---|
| 0 | 8 |
| 6 | 16 |
| 8 | 8 |
| 9 | 8 |

| SEMESTER HOURS | PER CENT |
|---|---|
| 10 | 4 |
| 11 | 4 |
| 12 | 24 |
| 16 | 4 |
| 18 | 4 |
| 20 | 12 |
| 22 | 4 |
| 24 | 4 |
| 32 | 4 |

## Mathematics

Ninety-six per cent of the respondents included mathematics in their program. Sixty-eight per cent required technical mathematics, twelve per cent required "general" mathematics and sixteen per cent required both technical and "general" mathematics. Table IX lists mathematical areas and the percentage of respondents which required that area.

TABLE IX

| AREA | PER CENT |
|---|---|
| Basic math | 36 |
| Algebra | 92 |
| Trigonometry | 92 |
| Analytic geometry | 76 |
| Calculus | 36 |
| Slide rule | 52 |
| All six | 8 |

Credit awarded for required mathematics courses are listed in Table X.

TABLE X

| SEMESTER HOURS | PER CENT |
|---|---|
| 0 | 4 |
| 6 | 12 |
| 8 | 28 |
| 9 | 4 |
| 10 | 32 |
| 11 | 8 |
| 13 | 8 |
| 16 | 4 |

## Physics

Ninety-two per cent of the respondents included physics in their program. Seventy-two per cent required technical physics, sixteen per cent required "general" physics and four per cent required both technical and "general" physics. Table XI lists areas in physics and the percentage of respondents which required that area.

TABLE XI

| AREA | PER CENT |
|---|---|
| Mechanics | 88 |
| Heat | 88 |
| Sound | 52 |
| Electricity | 80 |
| Magnetism | 80 |
| Light | 52 |
| All six | 44 |

Credit awarded for required physics courses is listed in Table XII.

TABLE XII

| SEMESTER HOURS | PER CENT |
|---|---|
| 0 | 8 |
| 3 | 16 |
| 4 | 4 |
| 6 | 4 |
| 8 | 60 |
| 10 | 8 |

## Basic and Production Dimensioning and Tool and Die Drafting

Table XIII indicates basic and production dimensioning methods and tool and die drafting areas. Following are the percentages of respondents which either reviewed or covered in depth each topic listed.

TABLE XIII

| TOPICS | PER CENT REVIEWED | PER CENT IN DEPTH |
|---|---|---|
| BASIC DIMENSIONING | | |
| Aligned system | 16 | 80 |
| Unilateral system | 8 | 88 |
| Metric system | 52 | 32 |
| Auxiliary view | 20 | 72 |
| Tubing | 40 | 36 |
| Irregular curves | 44 | 44 |
| PRODUCTION DIMENSIONING | | |
| Base or datum line | 8 | 88 |
| Chain | 36 | 52 |
| Polar coordinate | 40 | 32 |
| Tabular | 40 | 40 |
| True position | 20 | 72 |
| Standard parts | 20 | 68 |
| Interchangeable assemblies | 20 | 72 |
| Classes of fit | 16 | 80 |
| Unilateral tolerances | 28 | 68 |
| Bilateral tolerances | 24 | 72 |
| Limit system | 12 | 80 |
| Basic hole method | 8 | 84 |
| Basic shaft method | 20 | 72 |
| Angular tolerances | 20 | 68 |
| Splines | 52 | 28 |
| Tapers | 48 | 36 |
| Keys and keyslots | 36 | 48 |
| Slots and grooves | 44 | 40 |
| TOOL AND DIE DRAFTING | | |
| Fundamentals | 20 | 32 |
| Basic design fundamentals | 20 | 32 |
| Jig and fixture details | 12 | 40 |
| Drill jigs | 16 | 36 |
| Milling fixtures | 16 | 32 |
| Turret lathe set-ups | 16 | 24 |
| Cutting tools | 12 | 28 |
| Dies | 8 | 40 |

## Graphics

Topics in graphics are listed in Table XIV along with the percentage of respondents which, 1) handle the topic as an informational unit, 2) require the student to graphically represent the item, and 3) require both graphical representation and an informational background dealing with the topic.

TABLE XIV

| TOPICS | INFORMATIONAL UNIT | GRAPHICALLY REPRESENT | BOTH |
|---|---|---|---|
| GEOMETRIC CONSTRUCTION | | | |
| Bisect a line | 64 | 76 | 48 |
| Divide a line into equal parts | 64 | 80 | 52 |
| Draw a curved line parallel to another | 56 | 72 | 44 |
| Draw a line through a point perpendicular to a line | 64 | 80 | 52 |
| Bisect an angle | 60 | 84 | 52 |
| Construct an angle equal to a given angle | 56 | 76 | 48 |
| Construct a triangle with two sides and included angle | 56 | 80 | 48 |
| Construct a pentagon | 44 | 64 | 36 |
| Construct a hexagon with distance across flats | 60 | 64 | 52 |
| Construct an octagon with distance across flats | 48 | 60 | 36 |
| Construct a circle tangent to two intersecting lines | 56 | 88 | 52 |
| Construct an arc tangent to two circles | 60 | 84 | 52 |
| Rectify an arc | 52 | 32 | 12 |
| Construct an ellipse (two circle method) | 64 | 64 | 48 |
| Construct an ellipse (major and minor axes) | 48 | 56 | 40 |
| Construct a parabola | 56 | 44 | 24 |
| Construct a hyperbola | 56 | 36 | 24 |
| Construct an involute | 52 | 28 | 24 |
| Construct an evolute | 44 | 28 | 24 |
| Construct a helix | 52 | 44 | 24 |
| Construct a spiral | 48 | 32 | 16 |
| BASIC ENGINEERING GEOMETRY | | | |
| True length of a line | 52 | 92 | 52 |
| Point projection of a line | 52 | 92 | 52 |
| Edgewise view of a plane | 52 | 92 | 52 |
| True size of a plane | 52 | 92 | 52 |
| Relationships between lines | 56 | 88 | 52 |
| Relationships of planes | 56 | 80 | 48 |
| Relationships of lines and planes | 52 | 84 | 48 |
| Relationships of lines and points | 56 | 88 | 52 |

| TOPICS | INFORMATIONAL UNIT | GRAPHICALLY REPRESENT | BOTH |
|---|---|---|---|
| INTERSECTIONS | | | |
| Plane surfaces intersecting; | | | |
| Plane surfaces | 52 | 80 | 44 |
| Single curved surfaces | 52 | 64 | 36 |
| Warped surfaces | 52 | 44 | 28 |
| Double curved surfaces | 44 | 44 | 24 |
| Single curved surfaces intersecting; | | | |
| Single curved surfaces | 48 | 72 | 40 |
| Warped surfaces | 48 | 36 | 24 |
| Double curved surfaces | 40 | 40 | 24 |
| Warped surfaces intersecting; | | | |
| Warped surfaces | 56 | 28 | 20 |
| Double curved surfaces | 48 | 32 | 20 |
| Double curved surfaces intersecting; | | | |
| Double curved surfaces | 40 | 44 | 20 |
| DEVELOPMENTS | | | |
| Oblique prism | 56 | 76 | 48 |
| Oblique cylinder | 52 | 72 | 44 |
| Oblique pyramid | 52 | 64 | 40 |
| Oblique cone | 48 | 68 | 40 |
| Truncated prism | 56 | 68 | 48 |
| Truncated cylinder | 52 | 68 | 44 |
| Truncated pyramid | 56 | 64 | 44 |
| Truncated cone | 48 | 64 | 40 |
| Sphere | 52 | 44 | 32 |
| Paraboloid of revolution | 40 | 32 | 20 |
| Rectangular transitions | 52 | 60 | 40 |
| Circular transitions | 44 | 52 | 32 |
| Circular and rectangular transitions | 48 | 64 | 36 |
| Triangulation | 44 | 76 | 40 |
| CAM DRAWING | | | |
| Radial type cams | 52 | 80 | 44 |
| Cylindrical type cams | 56 | 60 | 32 |
| Uniform motion | 48 | 80 | 40 |
| Modified uniform motion | 56 | 60 | 28 |
| Harmonic motion | 48 | 60 | 40 |
| Acceleration and deceleration motion | 52 | 64 | 28 |
| Variable motion | 64 | 52 | 32 |
| Oscillation motion | 64 | 52 | 32 |
| GEAR DRAWING | | | |
| Spur gear and pinion | 52 | 80 | 44 |
| Bevel gears | 52 | 56 | 24 |
| Worm gears | 52 | 56 | 24 |
| Spur gear and rack | 44 | 56 | 20 |
| Gear teeth forms | 48 | 64 | 28 |
| Grant's odontograph method | 52 | 28 | 16 |

| TOPICS | INFORMATIONAL UNIT | GRAPHICALLY REPRESENT | BOTH |
|---|---|---|---|
| ASSEMBLY DRAWING | | | |
| Subassemblies | 48 | 76 | 40 |
| Layout | 48 | 84 | 48 |
| Outline | 44 | 64 | 36 |
| Installation | 56 | 44 | 24 |
| Exploded pictorial | 64 | 44 | 28 |
| Perspective | 64 | 44 | 32 |
| PIPING DRAWING | | | |
| Piping symbols | 40 | 36 | 16 |
| Single line representation | 40 | 40 | 16 |
| Double line representation | 44 | 28 | 12 |
| Isometric representation | 44 | 40 | 20 |
| Pipe sizes and types | 48 | 40 | 24 |
| Pipe fittings | 48 | 36 | 20 |
| Valves | 52 | 32 | 20 |
| CHARTS, GRAPHS AND DIAGRAMS | | | |
| Rectilinear chart | 32 | 48 | 20 |
| Logarithmetic chart | 36 | 40 | 16 |
| Semilogarithmetic chart | 40 | 32 | 12 |
| Trilinear chart | 44 | 8 | 4 |
| Polar chart | 40 | 16 | 4 |
| Bar graph | 36 | 40 | 20 |
| Pie chart | 40 | 28 | 12 |
| Flow chart | 40 | 28 | 12 |
| Distribution chart | 36 | 16 | 4 |
| Three-dimensional chart | 40 | 8 | 4 |
| Concurrent coplanar vectors | 40 | 52 | 24 |
| Concurrent noncoplanar vectors | 48 | 44 | 24 |
| Noncurrent coplanar vectors | 44 | 40 | 20 |
| String polygon | 40 | 40 | 20 |
| Two variables with two parallel scales nomographs | 28 | 28 | 8 |
| Three variables with three parallel scales nomographs | 28 | 20 | 8 |
| Three variables with N or Z chart nomographs | 20 | 12 | 4 |
| Four variables with four parallel scales nomographs | 24 | 8 | 4 |
| TECHNICAL ILLUSTRATION | | | |
| Freehand sketching | 52 | 80 | 48 |
| Oblique illustration | 52 | 80 | 48 |
| Axonometric illustration | 40 | 76 | 40 |
| Dimetric illustration | 40 | 44 | 20 |
| Trimetric illustration | 44 | 36 | 20 |
| One-point perspective | 40 | 60 | 32 |
| Two-point perspective | 36 | 56 | 28 |
| Line shading | 40 | 28 | 20 |
| Smudge shading | 32 | 16 | 12 |
| Air brush shading | 32 | 20 | 12 |
| Photo retouching | 28 | 12 | 12 |
| Inking | 44 | 28 | 20 |
| Special equipment | 32 | 24 | 12 |

## Manufacturing Processes, Industrial Fabrication and Inspection and Testing Instruments

Table XV lists topics in manufacturing processes, industrial fabrication and inspection and testing instruments, along with the cooresponding percentage of schools which, 1) handles the topic as an informational unit, 2) requires the student to graphically represent the topic, and 3) requires the student to either perform or experience the topic as given.

TABLE XV

| TOPICS | INFORMATIONAL UNIT | GRAPHICALLY REPRESENT | PERFORM OR EXPERIENCE |
|---|---|---|---|
| MANUFACTURING PROCESSES | | | |
| Internal machine operations | 52 | 32 | 44 |
| External machine operations | 52 | 28 | 36 |
| Surface treatments | 44 | 16 | 32 |
| Casting processes and techniques | 40 | -- | 8 |
| Casting design considerations | 40 | 12 | -- |
| Forging processes and techniques | 36 | -- | 4 |
| Forging design considerations | 36 | 4 | -- |
| Sheet metal processes and techniques | 32 | -- | 4 |
| Sheet metal design considerations | 32 | 8 | -- |
| Sheet metal developmental layouts | 28 | 20 | 8 |
| Sheet metal seams and joints | 32 | 8 | 4 |
| INDUSTRIAL FABRICATION | | | |
| Welding processes | 28 | -- | 12 |
| Welding joints | 28 | 20 | 16 |
| Welding design considerations | 32 | 20 | -- |
| Weldment symbols | 32 | 20 | -- |
| Riveting processes | 32 | -- | 4 |
| Riveting design considerations | 32 | 8 | -- |
| Riveting symbols | 28 | 12 | -- |
| Brazing and soldering processes | 28 | -- | 8 |
| Brazing and soldering design considerations | 28 | 4 | -- |
| Brazing and soldering symbols | 24 | 8 | -- |
| Thread forms, series and classes | 24 | 28 | -- |
| Bolts, studs and screws | 24 | 28 | -- |
| Pins, retaining rings and keys | 28 | 24 | -- |

| TOPICS | INFORMATIONAL UNIT | GRAPHICALLY REPRESENT | PERFORM OR EXPERIENCE |
|---|---|---|---|
| INSPECTION AND TESTING INSTRUMENTS | | | |
| Rules | 36 | 12 | 40 |
| Calipers | 36 | 16 | 40 |
| Vernier micrometer | 28 | 8 | 40 |
| Vernier caliper | 28 | 12 | 32 |
| Vernier height gauge | 16 | 4 | 20 |
| Gauge blocks | 28 | 12 | 32 |
| Optical comparator | 20 | 0 | 24 |
| Dial indicator | 24 | 4 | 24 |
| Go no-go gauges | 28 | 12 | 20 |
| Strainometer | 16 | 0 | 12 |
| Interferometer | 8 | 4 | 4 |
| Hardness testing | 24 | 0 | 28 |
| Impact testing | 16 | 4 | 16 |
| Endurance testing | 20 | 4 | 8 |
| Magnetic testing | 20 | 4 | 8 |
| Radiographic testing | 16 | 4 | 0 |
| Electrical testing | 16 | 4 | 8 |
| Ultrasonic testing | 20 | 4 | 4 |

## Materials and Properties

Table XVI contains topics in engineering materials and properties and the percentage of respondents which felt the topic as being necessary in their program.

TABLE XVI

| TOPICS | PER CENT | TOPICS | PER CENT | TOPICS | PER CENT |
|---|---|---|---|---|---|
| MATERIALS | | | | | |
| Metals production | 80 | Cast iron | 84 | Aluminum | 80 |
| Carbon steel | 84 | Wrought iron | 80 | Magnesium | 68 |
| Alloy steel | 84 | Copper | 76 | Nickel | 68 |
| Stainless steel | 84 | Brass | 72 | Tin | 68 |
| Tool steel | 80 | Bronze | 72 | Zinc | 68 |
| Thermoplastics | 64 | Rubber | 56 | | |
| Thermosetting plastics | 68 | Resin- fiber | 48 | | |
| PROPERTIES | | | | | |
| Shock resistance | 76 | Metallic luster | 36 | Strength | 84 |
| Corrision resistance | 72 | Toughness | 72 | Plasticity | 80 |
| Electrical resistance | 56 | Energy capacity | 36 | Elasticity | 80 |
| Elec. conductivity | 56 | Elongation | 68 | Ductility | 84 |
| Compressive strength | 76 | Fatique limit | 72 | Malleability | 76 |
| Modulus of elasticity | 84 | Rupture strength | 72 | Brittleness | 76 |
| Modulus of toughness | 52 | Creep limit | 52 | Hardness | 84 |
| Modulus of resilience | 52 | Fussibility | 40 | Stiffness | 76 |

## Design Projects

Sixty-four per cent of the respondents included design projects in their program. Table XVII indicates the range of semester hours credit awarded for these design projects.

TABLE XVII

| SEMESTER HOURS | PER CENT |
|---|---|
| 0 | 36 |
| 2 | 4 |
| 3 | 8 |
| 4 | 4 |
| 6 | 12 |
| 8 | 16 |
| 9 | 4 |
| 10 | 8 |
| 12 | 8 |

Table XVIII lists topics in the design area and the percentage of respondents which include these topics in their program.

TABLE XVIII

| TOPICS | PER CENT |
|---|---|
| Design considerations | 64 |
| Design process | 64 |
| Model construction | 20 |
| Designer's characteristics | 64 |
| Individual projects | 60 |
| Group projects | 48 |

## Drawing Reproduction

Sixty-eight per cent of the respondents indicated the inclusion of drawing reproduction methods.

## Computer Graphics

Sixteen per cent of the respondents indicated computer graphics as being contained in their program.

## Technically Related Areas

Table XIX includes ten technically related areas and the percentage of respondents which, 1) review the area lightly, 2) cover the area in depth, or 3) devote one class solely to the area listed.

TABLE XIX

| TOPICS | REVIEW | IN DEPTH | ONE CLASS |
|---|---|---|---|
| Mechanics | 4 | 24 | 60 |
| Strength of materials | 4 | 20 | 68 |
| Mechanism | 0 | 28 | 64 |
| Hydraulics and pneumatics | 16 | 16 | 44 |
| Heat treatments | 20 | 32 | 20 |
| Metallurgy | 8 | 28 | 48 |
| Quality control | 24 | 36 | 4 |
| Instrumentation and control | 28 | 16 | 16 |
| Technical report writing | 4 | 4 | 76 |
| Data processing and computer programming | 20 | 16 | 28 |

## Technical Electives

Table XX lists suggested technical electives and the percentage of respondents which request their students to enroll in the area listed.

TABLE XX

| ELECTIVES | PER CENT |
|---|---|
| Basic drafting | 4 |
| Manufacturing processes | 4 |
| Machine tools | 4 |
| Welding | 4 |
| Architectural and mechanical systems | 4 |

| ELECTIVES | PER CENT |
|---|---|
| Computer programming | 16 |
| Electronics | 8 |
| College physics | 4 |
| Labor economics | 4 |
| Chemistry | 8 |
| Psychology | 4 |
| Art appreciation | 4 |
| Photography | 4 |
| Logic | 4 |

Twenty-eight per cent of the respondents stated that no provisions had been made for the students selection of electives since their program did not allow for electives of any type.

# CHAPTER V

## SUMMARY, CONCLUSIONS, RECOMMENDATIONS AND PROBLEMS FOR FURTHUR STUDY

### Summary

The purpose of this study was to ascertain: 1) what similarities and differences exist among schools regarding required drafting courses such as technical illustration and required technically related courses such as manufacturing processes; and 2) what duties the mechanical engineering technician is expected to perform, as illustrated by the schools' emphasis of particular technical areas.

Educational respondents were restricted to community colleges in the state of Illinois offering a two-year degree program in mechanical engineering technology. Data were received from twenty-five schools through the use of information forms.

Curricular titles were diversified enough so that no one title took precedence over another. Sixteen per cent of the respondents indicated "mechanical technology" as their title. The word "technology" was included in the majority of responses.

The average frequency of curricular consultation by industry was twice per year within a range of consultation of every two months to never.

The majority of respondents did not maintain an industrial internship program. Programs that were available averaged six semester hours of credit.

Two-thirds of the respondents required either two, three or four courses in drafting. Credit awarded for these courses averaged twelve semester hours within a credit range of zero to thirty-two semester hours.

Of the ninety-six per cent of schools which required mathematics, the majority indicated eight to ten semester hours of credit as being minimal. Three-fourths of the schools required technical mathematics courses as compared against math department courses. Algebra and trigonometry were found to be the most prevalent with a ninety-two per cent affirmative response.

Of the ninety-two per cent of schools which required physics, three-fourths indicated eight semester hours of credit as being minimal. Three-fourths of the schools required technical physics courses as compared against physics department courses. Mechanics and heat were found to be most prevalent with a ninety-five per cent affirmative response.

Basic and production dimensioning were found to be highly significant topics. On all items listed the range of affirmative responses was seventy-two to ninety-six per cent, with the majority of items closest to the ninety-six percentile. Four per cent of the respondents indicated having no instruction in these areas.

Forty-four per cent of the respondents indicated having no tool and die drafting experiences available to their students. Thirty-six per cent indicated having extensive instruction in the area of tool and die drafting.

Basic geometrical construction was found to be a significant factor. The majority of respondents indicated their use of such instruction. Advanced geometrical construction (i. e., spiral, hyperbola, involute, etc.) was approved of by one-third of the respondents. Eight per cent indicated no geometrical construction in their program.

Graphical representation of basic engineering geometry had an approval range of eighty to ninety-two per cent. The majority of respondents reported the utilization of basic engineering geometry in their program. Eight per cent indicated no basic engineering geometry in their program.

One-half of the respondents indicated the inclusion of intersectional drafting and developmental drafting in their program.

One-half to three-fourths of the respondents reported the inclusion of cam drawing and gear drawing in their program. One-eighth, or twelve per cent, stated no such instruction in these areas.

Assembly drawing was contained in the majority of the respondents' programs. Only eight per cent indicated having no such instruction in assembly drawing.

One-third of the respondents provided no instruction in the area of piping drawing. Most instruction in this area was of the informational type.

Of the various charts, graphs and diagrams listed, vectors received the highest affirmative response, yet, no majority of affirmative responses were recorded under this area. One-fourth of the respondents reported no instruction in any chart, graph or diagram.

Nine-tenths of the respondents stated that some form of technical illustration appeared in their program. The only areas to receive a majority of affirmative responses were freehand sketching, oblique and axonometric illustrations and one and two-point perspectives.

Of the manufacturing processes listed, only machine operations as an informational unit received a majority. Surface treatments, casting, forging and sheet metal, respectively, declined in the percentage of schools which handle each as an informational unit, a graphical representation unit or in provided manipulative experiences.

Industrial fabrication received a one-fourth acceptance response as informational units. One-fifth of the schools required their students to graphically represent various fabrication methods and techniques. Almost one-half of the schools reported no instruction in this area.

Sixty per cent of the schools indicated the acceptance of various inspection and testing instruments. The more basic instruments (rules, calipers, etc.) took precedence over the more advanced equipment, both as informational units and available manipulative experiences. Of the various testing methods, hardness testing received a higher degree of acceptance than that of any other type.

Three-fourths of the respondents indicated they presented to their students seventy-five per cent or more of the materials listed. Only twelve per cent stated instruction dealing with these materials was not available at their school.

A majority of the responses stated they included a minimum of seventy per cent of the properties of materials listed. One-fifth stated having no instruction in this area.

A wide range of design projects was reported by two-thirds of the respondents. Six to eight semester hours of credit was determined as being the average. Individual projects were preferred over group projects, and the area of model construction received only a one-fifth acceptance response.

Two-thirds of the respondents indicated the inclusion of drawing reproduction methods in their program.

Computer graphics received less than a one-fifth response.

With an acceptance response of eighty-eight per cent, the area of mechanics had two-thirds of the respondents devoting a class solely to the topic.

Nine-tenths of the respondents approved having a strength of materials area in their program. Two-thirds reported devoting one class solely to this area.

Mechanism was approved of with a nine-tenths affirmative response. Two-thirds devoted one class to this topic only.

Three-fourths of the respondents reported hydraulics and pneumatics as being in their program. One-half of the total respondents provided one class for this area only.

Heat treatments which received an approval response of three-fourths, was covered in depth by one-third of the respondents.

With an approval rate of eighty-four per cent, metallurgy had one class provided by one-half of the respondents.

Two-thirds of the respondents reported quality control as being in their program. One-third of the total respondents covered this area in depth.

Instrumentation and control, which received a two-thirds approval response, had one-fourth of the respondents covering this material lightly.

Technical report writing, while receiving an eighty-four per cent approval response, had three-fourths of the total respondents treating it as one whole class.

Two-thirds of the respondents approved of data processing and computer programming. A total of one-fourth of the respondents devoted one class solely to this area.

Technical electives which received more than a four per cent response were computer programming, electronics and chemistry. One-fourth of the respondents had no provisions for electives.

## Conclusions

This study was controlled by the extent to which the actual practices of the responses could be measured through the use of information forms. The following conclusions are drawn from the data obtained from the respondents:

1. No geographical preference within the state of Illinois can be determined relative to the location of the respondents.

2. Mathematics and physics are as important to the program as those subjects which are directly, technically related.

3. Basic areas of drafting were widely accepted and taught.

4. Course availability relative to unique areas of drafting followed no consistent pattern.

5. The emerging area of computer graphics is not incorporated into the vast majority of programs.

6. Mechanics, strength of materials, mechanism, metallurgy, engineering materials and its' properties have become widely accepted as integral units of most programs.

7. Areas of quality control, instrumentation and control, technical report writing and data processing/computer programming have each received increased emphasis.

8. A lessened degree of general acceptance can be ascribed to the areas of manufacturing processes, industrial fabrication and manufacturing production measurement instruments.

## Recommendations

Relative to community colleges in Illinois offering a two-year degree program in mechanical engineering technology, recommendations based on findings of the study include:

1. The establishment of a formal relationship between schools for the purpose of formulating, reviewing and establishing instructional guidelines and policies.

2. Greater interschool uniformity of technically related laboratory instruction to more closely reflect state, rather than local, requirements.

3. Increased emphasis in teaching speciality areas of drafting.

4. Greater accentuation of manufacturing processes and industrial fabrication methods.

5. Encourage academic participation of industry through wider utilization of industrial internship programs and curricular consultation by industry.

## Problems for Further Study

The following problems were noted during the progress of this study. Relative to community colleges in Illinois offering a two-year degree program in mechanical engineering technology, suggestions for further study include:

1. What characteristics, relative to personality, background and interests, can be established of the students entering the mechanical engineering technology program?

2. What positions do mechanical engineering technology graduates now hold, how successful have they been and what are their opinions of the academic instruction they received?

3. What affect does the past enrollment in a high school vocational program have upon the success of a mechanical engineering technology student?

4. What is the status of mechanical engineering technology instructors regarding their academic and trade preparation, class rank, salary, tenure and other similiar factors?

# B I B L I O G R A P H Y

# SELECTED BIBLIOGRAPHY

## A. BOOKS

American Society for Engineering Education, The Engineering Technician. Washington, D. C.: American Society for Engineering Education, 1970.

Angel, Juvenal L. Matching Technicians to Jobs. New York, New York: World Trade Academy Press Inc., 1971.

Bateman, John H. Materials of Construction. New York, New York: Pitman Publishing Corporation, 1950.

Beakley, George C. Careers in Engineering and Technology. London: Macmillan Company, 1969.

Brooking, Walter J., ed. Career Opportunities - Engineering Technicians. Chicago: J. G. Ferguson Publishing Company, n. d.

Davis, Harmer E. Testing and Inspection of Engineering Materials. 3rd ed. New York: McGraw-Hill Book Company, 1964.

Fetter, William A. Computer Graphics in Communication. New York: McGraw-Hill Book Company, 1965.

French, Thomas E. Graphic Science and Design. New York: McGraw-Hill Book Company, 1970.

Giesecke, Frederick E. Technical Drawing. 5th ed. New York: Macmillan Company, 1963.

Harris, Charles O. Strength of Materials. 2nd ed. Chicago: American Technical Society, 1965.

Hoelscher, Randolph P. Graphics for Engineers, Visualization, Communication and Design. New York: John Wiley and Sons, Inc., 1968.

Kepler, Frank Roy. An Analysis of Drafting for Teachers. Boston: D. C. Heath and Company, 1948.

Mills, Adelbert P. Materials of Construction. 6th ed. New York: John Wiley and Sons, Inc., 1965.

Parr, Robert E. Principles of Mechanical Design. New York: McGraw-Hill Book Company, 1970.

Pippinger, John J. Industrial Hydraulics. New York: McGraw-Hill Book Company, 1962.

Rising, J. S. Engineering Graphics. 4th ed. Dubuque: William C. Brown Company, 1970.

Rosenthal, Daniel. Introduction to Properties of Materials. Princeton: D. VanNostrand Company, Inc., 1964.

Thomas T. A. Technical Illustration. New York: McGraw-Hill Book Company, 1960.

Wellman, B. Leighton. Introduction to Graphical Analysis and Design. New York: McGraw-Hill Book Company, 1966.

Wright, Lawrence S. Drafting-Technical Communication. Bloomington, Illinois: McKnight and McKnight Publishing Company, 1968.

Yankee, Herbert W. Machine Drafting and Related Technology. New York: McGraw-Hill Book Company, 1966.

## B. PUBLICATIONS OF THE GOVERNMENT, LEARNED SOCIETIES, AND OTHER ORGANIZATIONS

Career Education in Illinois Public Community Colleges and Technical Institutes. Illinois Board of Vocational Education and Rehabilitation, Springfield: 1972.

Doolittle, Clifford H. Trends in Engineering Technician Enrollments and Graduates. New York: Engineering Manpower Commission of Engineers' Joint Council, 1967.

Guide For Use in Developing Training Programs in Mechanical Technology. State College, Mississippi: Curriculum Laboratory Trade and Technical Education State Department of Vocational Education, 1966.

Larson, Milton E. Review and Synthesis of Research in Technical Education. Columbus, Chio: Center for Research and Leadership Development in Vocational and Technical Education, 1966.

United States Office of Education. 25 technical careers you can learn in 2 years or less. Washington: United States Government Printing Office, n. d.

## C. PERIODICALS

Dobrovolny, Jerry S. "Drafting Technology Versus Machine Design Technology." Technical Education, November, 1969.

Engineering and Technology Advisory Committee of the College of Engineering, at the University of Illinois. "Machine Design Technology - A Suggested Two-Year Post-High School Program." Engineering Technology, Series No. 4, 1968.

## D. UNPUBLISHED MATERIAL

Dreyer, S. F. "Engineering Graphics Courses from the Viewpoint of Mechanical Engineering Educators." Unpublished Ed.D. dissertation. University of Oklahoma, 1959.

# APPENDIX A

Introductory Letter to the Educational Institution

Follow-up Letter to the Educational Institution

Information Form for the Educational Institution

Dear Sir:

With the approval of my Graduate Committee, I am conducting a research study entitled "A Comparative Analysis of the Mechanical Engineering Technology Curriculum as Offered Through the Community Colleges of Illinois". The purpose of the study is to ascertain whether there is a significant difference among schools pertaining to mechanical drafting and technically related courses.

Only those community colleges in Illinois offering a two year program in mechanical engineering technology will be contacted. This means a total of forty schools only are eligible to assist in this study. It is therefore respectfully requested that either yourself or a drafting instructor complete the enclosed form. The form will take approximately fifteen minutes to complete. A few of the areas included in this study are basic and production dimensioning, geometrical construction, intersections, developments, cams, gears, technical illustration, manufacturing processes, materials and properties, strength of materials and quality control.

Information received will be handled confidentially and will not be used in an embarrassing or derogatory manner. Names, schools and locations will not be divulged. If you choose to participate in this study, a follow-up form will be mailed to you listing the results of this study.

Will you please complete the enclosed form and return it to me as soon as possible? I am quite anxious to receive your assistance with this study. Your anticipated cooperation will be greatly appreciated and respected. Thank you for your time and consideration.

Sincerely,

Richard Koppitz

Dear Sir:

A few weeks ago your office was sent a brief letter explaining a research study being conducted. As a vocational administrator your assistance would prove of value to the study. By participating in this study you may aid schools starting new mechanical engineering technology programs or those engaged in upgrading their present program.

To date I have not received an information form from your school. Assuming that the original form did not reach your desk, I am enclosing a second form for your consideration. It is very important that I receive information forms from all schools. If you have returned the previous form, please disregard this letter. Thank you for your cooperation.

Sincerely,

Richard Koppitz

# INFORMATION FORM

NAME ______________________________

POSITION ______________________________

SCHOOL ______________________________

ADDRESS ______________________________

Dear Sir:

Thank you for your participation in this study.

Will you please mark the enclosed form accordingly? A return envelope is enclosed for your convenience. You will, at a later date, received an abbreviated outline of the results. I am quite anxious to receive this form as soon as possible. You may omit your name and address if you desire. Thank you for your cooperation.

INSTRUCTIONS: This form includes the areas of mechanical drafting and technically related areas. Each area is by no means complete as this would result in a rather massive form. Basics and highly technical material is purposely omitted. Check only those items found in your school. Omit any items not found in your school.

**ITEMS 1 – 6: WRITE IN THE APPROPRIATE ANSWER AS IT APPLIES TO YOUR SCHOOL.**

1. CURRICULUM TITLE
   Please state the title of your educational program as it appears in your 1971-1972 school catalog.

2. CURRICULAR PARTICIPATION BY INDUSTRY
   Is a local advisory type committee ever consulted as a means of curricular updating? Yes ( ) No ( )
   If yes, how often, on the average, is the committee consulted?

3. INDUSTRIAL INTERNSHIP
   Can a student earn academic credit, for participation in an internship program? Yes ( ) No ( )
   If yes, how many hours?
   quarter hours or semester hours

4. DRAFTING CREDIT
   How many courses in drafting is a student required to take?

   How much credit is awarded to the student?

   quarter hours or semester hours

5. MATHEMATICS
   How many hours of mathematics are required in your program?
   quarter hours or semester hours
   Are the courses ( ) Technical Math or ( ) Regular Math?
   (check those math areas required in your program)
   ( ) Basic math ( ) Trigonometry ( ) Calculus
   ( ) Algebra ( ) Analytic geometry ( ) Slide rule

6. PHYSICS
   How many hours of physics are required in your program?
   quarter hours or semester hours
   Are the courses ( ) Technical Physics or ( ) Regular Physics?
   (check those physics areas required in your program)
   ( ) Mechanics [forces, work, energy, momentum, etc.]
   ( ) Heat [temperature, heat transfer, thermodynamics, etc.]
   ( ) Sound [waves, propagation, acoustics, transmission, etc.]
   ( ) Electricity [fields, capacitance, AC and DC circuits, etc.]
   ( ) Magnetism [fields, inductance, magnetic materials, etc.]
   ( ) Light [nature, reflection, refraction, etc.]

**ITEMS 7 – 9: CHECK THE FIRST BRACKET IF THE ITEM IS ONLY REVIEWED OR THE SECOND BRACKET IF IT IS COVERED IN DEPTH.**

7. BASIC DIMENSIONING
   ( ) ( ) aligned system of dimensioning
   ( ) ( ) unilateral system of dimensioning
   ( ) ( ) dimensioning with the metric system
   ( ) ( ) auxiliary view dimensioning
   ( ) ( ) dimensioning of tubing
   ( ) ( ) dimensioning of irregular curves

TYPES OF DIMENSIONING
( ) ( ) base or datum line
( ) ( ) chain
( ) ( ) polar coordinate
( ) ( ) tabular
( ) ( ) true position
( ) ( ) standard parts
( ) ( ) interchangeable assemblies

TOLERANCES
( ) ( ) classes of fit
( ) ( ) unilateral system
( ) ( ) bilateral system
( ) ( ) limit system
( ) ( ) basic hole method
( ) ( ) basic shaft method
( ) ( ) angular tolerances

UNIQUE MACHINING OPERATIONS
( ) ( ) splines ( ) ( ) keys and keyslots
( ) ( ) tapers ( ) ( ) slots and grooves

9. TOOL AND DIE DRAFTING
   ( ) ( ) fundamentals [dimensioning, stock columns]
   ( ) ( ) basic design fundamentals [speed, cost, quality]
   ( ) ( ) jig and fixture details [link, V block, slide guide]
   ( ) ( ) drill jigs [jig types, bushings, ejectors]
   ( ) ( ) milling fixtures [types of cuts, attachments]
   ( ) ( ) turret lathe set-ups [lathe types, chucking]
   ( ) ( ) cutting tools [turning tools, milling cutters]
   ( ) ( ) dies [types, punch and die clearance, lubricants]

**ITEMS 10 – 22: PLACE A CHECK MARK IF THE ITEM IS AN INFORMATIONAL UNIT AND A SECOND MARK IF IT IS GRAPHICALLY REPRESENTED BY THE STUDENT.**

10. GEOMETRIC CONSTRUCTION

| | INFORMATIONAL UNIT | GRAPHICALLY REPRESENTED |
|---|---|---|
| Bisect a line | | |
| Divide a line into any number of equal parts | | |
| Draw a curved parallel to another | | |
| Draw a line through a point perpendicular to a line | | |
| Biset an angle | | |
| Construct an angle equal to a given angle | | |
| Construct a triangle with two sides and included angle given | | |
| Construct a pentagon | | |
| Construct a hexagon with distance across flats given | | |
| Construct an octagon with distance across flats given | | |
| Construct a circle tangent to two intersecting lines | | |
| Construct an arc tangent to two circles | | |
| Rectify (find the true length of) an arc | | |
| Construct an ellipse using the two circle method | | |
| Construct an ellipse with major and minor axes given | | |
| Construct a parabola | | |
| Construct a hyperbola | | |
| Construct an involute | | |
| Construct an evolute | | |
| Construct a helix | | |
| Construct a spiral | | |

11. BASIC ENGINEERING GEOMETRY

| | | |
|---|---|---|
| True length of a line | | |
| Point projection of a line | | |
| Edgewise view of a plane | | |
| True size of a plane | | |
| Relationships between lines | | |
| Relationships of planes | | |
| Relationships of lines and planes | | |
| Relationships of lines and points | | |

12. INTERSECTIONS

| | | |
|---|---|---|
| PLANE SURFACES (prisms, pyramids) intersecting: | | |
| Plane surfaces | | |
| Single curved surfaces | | |
| Warped surfaces | | |
| Double curved surfaces | | |
| SINGLE CURVED SURFACES (cones, cylinders) intersecting: | | |
| Single curved surfaces | | |
| Warped surfaces | | |
| Double curved surfaces | | |
| WARPED SURFACES (hyperbolic paraboloid) intersecting: | | |
| Warped surfaces | | |
| Double curved surfaces | | |
| DOUBLE CURVED SURFACES (sphere) intersecting: | | |
| Double curved surfaces | | |

13. DEVELOPMENTS

| | | |
|---|---|---|
| Oblique prism | | |
| Oblique cylinder | | |
| Oblique pyramid | | |
| Oblique cone | | |
| Truncated prism | | |
| Truncated cylinder | | |
| Truncated pyramid | | |
| Truncated cone | | |
| Sphere | | |
| Paraboloid of revolution | | |
| Rectangular transitions | | |
| Circular transitions | | |
| Circular and rectangular transitions | | |
| Triangulation | | |

14. CAM DRAWING

| | | |
|---|---|---|
| Radial type cams (plate, toe and wiper) | | |
| Cylindrical type cams (grooved and end) | | |
| Uniform motion | | |
| Modified uniform motion | | |
| Harmonic motion | | |
| Accelaration and deceleration motion | | |
| Variable motion | | |
| Oscillation motion | | |

15. GEAR DRAWING

| | | |
|---|---|---|
| Spur gear and pinion | | |
| Bevel gears | | |
| Worm gears | | |
| Spur gear and rack | | |
| Gear teeth forms (involute, cycloid) | | |
| Grant's odontograph method | | |

16. ASSEMBLY DRAWING

| | | |
|---|---|---|
| Subassemblies | | |
| Layout | | |
| Outline | | |
| Installation | | |
| Exploded pictorial | | |
| Perspective | | |

17. PIPING DRAWING

| | | |
|---|---|---|
| Piping symbols | | |
| Single line representation | | |
| Double line representation | | |
| Isometric representation | | |
| Pipe sizes and types | | |
| Pipe fittings | | |
| Valves | | |

| | INFORMATIONAL UNIT | GRAPHICALLY REPRESENTED | PERFORMED OR EXPERIENCED |
|---|---|---|---|
| **18. CHARTS, GRAPHS AND DIAGRAMS** | | | |
| Rectilinear chart | | | |
| Logarithmetic chart | | | |
| Semilogarithmetic chart | | | |
| Trilinear chart | | | |
| Polar chart | | | |
| Bar graph | | | |
| Pie chart | | | |
| Flow chart | | | |
| Distribution chart | | | |
| Three-dimensional chart | | | |
| Concurrent coplanar vectors | | | |
| Concurrent noncoplanar vectors | | | |
| Noncurrent coplanar vectors | | | |
| String polygon | | | |
| Two variables with two parallel scales nomographs | | | |
| Three variables with three parallel scales nomographs | | | |
| Three variables with N or Z charts nomographs | | | |
| Four variables with four parallel scales nomographs | | | |
| **19. TECHNICAL ILLUSTRATION** | | | |
| Freehand sketching | | | |
| Oblique illustration | | | |
| Axonometric illustration | | | |
| Dimetric illustration | | | |
| Trimetric illustration | | | |
| One-point perspective | | | |
| Two-point perspective | | | |
| Line shading | | | |
| Smudge shading | | | |
| Air brush shading | | | |
| Photo retouching | | | |
| Inking | | | |
| Special equipment | | | |
| **20. MANUFACTURING PROCESSES** | | | |
| Internal machine operations (drilling, turning, countersinking, counterboring, spotfacing, boring, reaming, honing, etc.) | | | |
| External machine operations (planning, milling, and turning of slots, grooves, dovetail tongues, chamfers, tapers, reliefs, necks, recesses, splines, flats, etc.) | | | |
| Surface treatments (grinding, knurling, scraping, buffing, polishing, lapping, superfinishing, etc.) | | | |
| Casting processes and techniques | | X | |
| Casting design considerations | | | X |
| Forging processes and techniques | | X | |
| Forging design considerations | | | X |
| Sheet metal processes and techniques | | X | |
| Sheet metal design considerations | | | X |
| Sheet metal developmental layouts | | | |
| Sheet metal seams and joints | | | |
| **21. INDUSTRIAL FABRICATION** | | | |
| Welding processes | | X | |
| Welding joints | | | |
| Welding design considerations | | | X |
| Weldment symbols | | | X |
| Riveting processes | | X | |
| Riveting design considerations | | | X |
| Riveting symbols | | | X |
| Brazing and soldering processes | | X | |
| Brazing and soldering design considerations | | | X |
| Brazing and soldering symbols | | | X |
| Thread forms, series and classes | | | X |
| Bolts, studs, screws, nuts and washers | | | X |
| Pins, retaining rings and keys | | | X |
| **22. INSPECTION AND TESTING INSTRUMENTS** | | | |
| Rules | | | |
| Calipers | | | |
| Vernier micrometer | | | |
| Vernier caliper | | | |
| Vernier height gauge | | | |
| Gauge blocks | | | |
| Optical comparator | | | |
| Dial indicator | | | |
| Go no-go gauges | | | |
| Strainometer | | | |
| Interferometer | | | |
| Hardness testing | | | |
| Impact testing | | | |
| Endurance testing | | | |
| Magnetic testing | | | |
| Radiographic testing | | | |
| Electrical testing | | | |
| Ultrasonic testing | | | |

**ITEMS 23 – 26: CHECK EACH ITEM IF REVIEWED.**

23. ENGINEERING MATERIALS AND PROPERTIES

METALLIC MATERIALS

( ) metals production ( ) cast iron ( ) aluminum
( ) carbon steel ( ) wrought iron ( ) magnesium
( ) alloy steel ( ) copper ( ) nickel
( ) stainless steel ( ) Brass ( ) tin
( ) tool steel ( ) bronze ( ) zinc

NONMETALLIC MATERIALS

( ) thermoplastics ( ) rubber
( ) thermosetting plastics ( ) resin-impregnated fiber

PROPERTIES

( ) strength ( ) shock resistance ( ) metallic luster
( ) plasticity ( ) corrosion resistance ( ) toughness
( ) elasticity ( ) electrical resistance ( ) energy capacity
( ) ductility ( ) elec. conductivity ( ) elongation
( ) malleability ( ) compressive strength ( ) fatiqu.. limit
( ) brittleness ( ) modulus of elasticity ( ) rupture strength
( ) hardness ( ) modulus of toughness ( ) creep limit
( ) stiffness ( ) modulus of resilience ( ) fussibility

24. DESIGN PROJECTS

Robert E. Pall in "Principles of Mechanical Design" defines mechanical design as, "the application of many of the principles of science and technology in the creation of a product and the consideration of the various factors that affect its production and use". To what extent does each student in your curriculum engage in the design process? Note that while certain drafting courses may be termed design drafting, no actual design may take place. How many hours can a student earn working on either individual or group projects? (Fill in one)

quarter hours or semester hours

(check those design aspects that are in your program)

( ) Design considerations (function, safety, maintenance, cost, standardization)
( ) Explanation of design process (concept formulation, analysis, refinement, testing, conferences)
( ) Model construction (mock-ups, prototypes)
( ) Designer's characteristics (visualization, thoroughness, problem solving ability)
( ) Individual projects
( ) Group projects

25. DRAWING REPRODUCTION

( ) diazo copy, microfilm, dye-transfer, etc.

26. COMPUTER GRAPHICS

( ) input-output devices, integrated systems, plotting machines,etc.

**ITEMS 27 – 36: CHECK FIRST BRACKET IF AREA IS REVIEWED LIGHTLY, CHECK SECOND BRACKET IF COVERED IN DEPTH OR CHECK THIRD BRACKET IF ONE CLASS IS DEVOTED SOLELY TO THE TOPIC.**

27. ( ) ( ) ( ) MECHANICS (Statics & Dynamics) vectors, work equilibrium, friction, centroids, impulse, energy, momentum, kinematics, kinetics, acceleration
28. ( ) ( ) ( ) STRENGTH OF MATERIALS force systems, stress and strain, deflection, shear and bending moments, torsional shear, eccentric loading
29. ( ) ( ) ( ) MECHANISM mechanics of machinery, gears, chains, pulleys, belts, cams, couplings, bearings, and other power transmitting systems
30. ( ) ( ) ( ) HYDRAULICS AND PNEUMATICS air and fluid power transmission circuits and controls (accumulators, boosters, actuators, pumps)
31. ( ) ( ) ( ) HEAT TREATMENTS temperature measurement and control, cooling media, hardening, annealing, carburizing, cyaniding
32. ( ) ( ) ( ) METALLURGY standard classification systems, crystalline structure changes, constitutional diagrams, powder metallurgy
33. ( ) ( ) ( ) QUALITY CONTROL sampling techniques, control charts, specification and tolerance rationalization
34. ( ) ( ) ( ) INSTRUMENTATION AND CONTROL theory and use of electrical instruments, power control devices, control systems
35. ( ) ( ) ( ) TECHNICAL REPORT WRITING organization and preparation of technical reports, techniques of collecting, interpreting and presenting data
36. ( ) ( ) ( ) DATA PROCESSING AND COMPUTER PROGRAMMING input/output media, stored program concepts, documentation techniques, basic and full autocoder

**ITEM 37: LIST THOSE TECHNICAL ELECTIVES WHICH YOU REQUEST A STUDENT ENROLL IN. GIVE COURSE TITLE AND A BRIEF DESCRIPTION OF EACH.**

37. TECHNICAL ELECTIVES

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________
6. ______________________________